



Economic Potential of Certain University Programs Lauded

The photo at right is a clue to answering the question: What core area at Arizona's state universities was recently identified as having the greatest potential for providing future economic benefits to the state? The answer is ecological sciences according to a study by the Battelle Memorial Institute.

The report singled out the areas of hydrology and water resources for special attention stating, "The University of Arizona is #1 nationally in hydrology; add to that distinction the four water centers, each dealing with a different problem area, and Arizona State University's and Northern Arizona University's contributions, and Arizona has arguably the world's biggest and best water resource portfolio." Arid/semi-arid lands ecology and urban ecology also were noted for their excellence. (See page 5 for news brief about a new Arizona State University program, "Consortium for the Study of Rapidly Urbanizing Areas.")

Prepared for the Arizona Commerce and Economic Develop Commission and the Arizona Department of Commerce, the \$186,000 study evaluated which university research areas could best support state efforts to build its economic future through private-public partnerships between industry, higher education and government.

(The photo shows UA students measuring stream flow on Sonoita Creek.)



Photo: Dennis Scheall

Desalination, an Emerging Water Resource Issue

In coverage of the current water events of the day desalination has lately been gathering greater national attention. Recent newsworthy events include the construction and operation of the Western Hemisphere's largest desalination plant in Tampa. Meanwhile California is experiencing a surge of interest in desalination, with plants proposed or planned at 13 sites along the coast.

Nor is California limiting its desalination operations to coastal areas. The Calleguas Municipal Water District plans to remove salt from groundwater under the Simi and Conejo valleys, with plants converting up to 30,000 acre-feet a year of brackish groundwater into potable supplies.

From these and other developments from around the country it is obvious that desalination is shaping up to be an important 21st century water resource issue, with an expanding role in the perennial quest for additional water supplies. Although its water supply potential is getting most of the recent attention, desalination also can be used to improve water quality of current supplies.

What significance does this emerging issue have for Arizona? What salinity issues confront the state? What commitments or activities demonstrate the state's concern about salinity? What resolution does the state seek to resolve its salinity problems?

The situation in Arizona shows desalination to be a multifaceted issue, with more at stake than just reducing the cost of the treatment process to increase water supplies. Arizona confronts certain political and water quality and supply issues that ensure some variations to the desalination issue as it plays out in other states.

One of the more obvious differences, one shared by many other states, is that

Continued on page 2



C O N T E N T S

Water Vapors	3
News Briefs	4
Guest View	6
Legislation and Law.....	7
Publications	8
Special Projects	9
Announcements.....	10
Public Policy Review	11

Desalination...continued from page 1

landlocked Arizona will not be desalinating seawater. The value of inland brackish water as a water supply is being increasingly recognized. It is a resource that previously had been overlooked since other higher-quality, more potable water supplies were available. With supplies of such waters now more limited brackish water is attracting attention as a potential drinking water source.

It is Arizona's involvement in the politics of salinity at the international level that distinguishes the state's situation. In this arena, Arizona's involvement with salinity and salinity control predates the current interest. Through its participation in the Colorado River Basin Salinity Control Forum Arizona has been active in desalination strategies since 1975.

The seven basin states created the forum in response to the political crisis arising when Mexico objected to the salinity levels of the Colorado River as its waters entered the country. The forum's intent was to reduce salinity and recommend water quality standards for various points along the Colorado River. The issue was water quality, and the goal was to reduce the amount of salt entering the river from the upper basin states. Strategies included encouraging on-farm irrigation efficiencies to control salinity and taking measure to prevent saline groundwater from entering the river.

Recently Arizona's interest in the Colorado River salinity issue has acquired a new focus due to its concern about ensuring the state's supply of Colorado River water. Unlike other areas of the country where new desalination plants are being proposed, at issue in Arizona is the operation of a plant that was constructed over ten years ago. The state is urging the U.S. Bureau of Reclamation to put the Yuma desalination plant on line. To Arizona, desalination in this situation is a water supply issue.

The plant was constructed to reclaim drainage water from the Wellton-Mohawk Irrigation District, to ensure that water delivered to Mexico is suitable for beneficial use. Per treaty obligation, the United States is to ensure delivery of 1,500,000 acre-feet of water each year. Drainage from the irrigation district averages more than 100,000 acre-feet per year which, because of its high salinity, was unsuitable for delivery

Desalination Road-map Charts Road Ahead

A recent desalination event of special national significance was the Feb. 12 release of the "Desalination and Water Purification Technology Road-map." The U.S. Bureau of Reclamation has taken the lead among federal agencies in desalination and collaborates with Sandia National Laboratories on desalination projects. The road map is a product of this collaboration.

The road map took on an ambitious task, to plot out a research and development path for advancing desalination technologies, from the present to 2020. If followed, the path promises a more general application of desalination technologies to help meet the nation's water supply needs. Congress, federal agencies, utilities, research institutions and individuals will have the road-map to refer to when determining desalination research priorities.

In a sense, its designation as a "road-map" is somewhat misleading. Its proffered sense of direction was not worked out with the narrowly focused, direct-from-here-to-there outlook of an AAA road-map. Instead the desalination road-map provides background information and analysis of water supply issues pertinent to desalination, building a case that desalination holds promise as a source of future water supplies. The road-map is a call to action, an effort to place desalination on the national water resource agenda.

The document was compiled by a panel of experts, with representatives of the private sector, municipal water agencies, academic and other research institutions and the federal government participating. Two of the committee members are from Arizona: Peter Fox, Arizona State University and Michael Gritzak, Phoenix Water Services Department. (The report is available at: <http://www.sandia.gov/water/siteMap.htm>).

to Mexico. In what was to be a temporary solution to the problem, drainage water was bypassed around the Mexican diversion at Morelos Dam, with the 100,000 acre-feet not figuring into the Mexican Colorado River allocation.

That the wastewater was being bypassed was not a critical issue at one time since there were abundant flows on the Colorado River during most of the 1990s, and the Lower Basin States were not using their full 7.5 million acre-feet allocation. Operation of the plant therefore, which was completed in 1992, was not critical. Times have changed, however, with water supplies back to normal and lower basin states' water demands in excess of compact apportionments. Meanwhile the upper basin demands continue to grow.

Arizona argues that the bypassed water is in a sense a lost opportunity, its flows not credited as part of Mexico's entitlement. It says that delivery of water in excess of treaty requirements will result in an increased frequency of water supply shortages in the United States. Arizona water users stand to be hurt the most since the Central Arizona Project is junior to all other water users in

the Lower Basin.

The federal government is balking at starting up the plant, offering instead to retire Arizona and California farmland to free up additional water supplies. Arizona doubts this a workable strategy and is urging the operation of the plant. This is a very controversial issue since the bypassed water has environmental value in maintaining the Cienga de Santa Clara in Mexico. If the plant were operating, the reduced wastewater then flowing to the cienga would greatly increase in salinity, posing a threat to the wetlands.

While desalination of Colorado River water is debated officials in central Arizona are pondering their salinity concerns and the possible role of desalination. The area is plagued by a salt loading problem, with the diversion and use of surface water resulting in an accumulation of salts. Phoenix area water officials have organized the Central Arizona Salinity Study to investigate the worsening problem.

Steve Rossi, the principal water resources planner for the City of Phoenix, says phase one of the study has been an

Continued on page 12



Water Vapors

WRRC Conducts Water Conference/Forum

A particularly daunting critique of a conference is to describe it as experts talking to experts. Some kind of closed-door encounter comes to mind, self-referential in its focus, its sessions marked by an inbreeding of talent and ideas. It is the legendary smoked fill room without the smoke.

Not so the Water Resources Research



Tom Whitmer of the Arizona Department of Water Resources discusses water resource activities in rural areas. (Photo: Joe Gelt)

Center's May 1-2 conference in Prescott. Titled "Local Approaches to Resolving Water Resource Issues," the conference was conducted as a forum, to bring together people actively engaged in resolving water resource issues in various, mostly rural areas of the state. Also varied was participants' focus of interest, to include the local, regional and agency view. Participants' expertise had to do with solving problems, as is indicated by the conference subtitle, "What's Working, What Hasn't Worked and Building on Existing Efforts." Conference attendees included about 200 people from more than 40 Arizona communities.

In opening the conference, Sharon Megdal, WRRC associate director, stated, "All politics are local politics. If it doesn't work at home, it's not going to work in the state, and it surely won't make a difference nationally." In other words, the local is

where the action is, where people feel most directly the consequences of a situation and, as a result, have a better sense of what needs to be done or not done.

A number of conference participants told of their experiences at the local level; e.g. in local government or working to organize watershed groups. Basic to their plans of action was broad and varied public participation, to involve all interests. Along these lines, Barbara Litrell of the League of Women Voters Sedona/Verde Valley Water Committee told of work in organizing citizen groups throughout Yavapai County to create the North Central Arizona Regional Watershed Coalition. The organization is to ensure a broader public voice.

The regional perspective also was considered, with regional variously defined to include an Active Management Area and Indian reservations. Attorney Lee Storey described the Santa Cruz Active Management Area as confronting different hydrologic conditions, and therefore different management challenges, than other AMAs within the state. Mary Thomas, lieutenant governor of Gila River Indian Community, discussed water issues of concern to her people.

Herb Dishlip spoke from another regional perspective when he discussed Ar-

izona's negotiations with California to limit its use of Colorado River water. The Colorado River basin is regional on a large scale. Dishlip, however, brought the focus back to the local by saying this multi-state affair can

Water Research, Education and Outreach Funded.

The University of Arizona recently used its Technology and Research Initiative Funds to support various water projects and provide stipends to outstanding water resource students. See centerfold supplement for information about funded projects and students.

be understood in reference to issues confronting local watersheds. It is a watershed issue writ very large.

The agency perspective was not neglected, with representative of state and federal agencies discussing their activities to resolve state water resource issues. The conference theme that cooperation pays dividends was evident when Karen Smith of the Arizona Department of Environmental Quality described arrangements worked out between ADEQ and the Arizona Department of Water Resources.

ADWR Director Herb Guenther, Sen. Tom O'Halleran and Arizona Corporation Commission Chairman Marc Spitzer made up the state officials panel. In what was an appropriate closing note for the conference,

Continued on page 4



Arizona Water Resource is published 6 times per year by the University of Arizona's Water Resources Research Center. AWR accepts news, announcements and other information from all organizations

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News Briefs

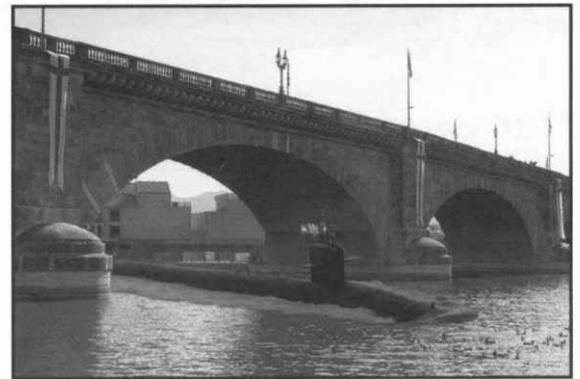
Recharging Treated Water May Alter Groundwater Quality

A recent U.S. Geological Survey study found that recharging an aquifer with treated surface water may affect groundwater quality. The study sounds a warning to officials who are considering injecting and storing treated water underground to improve water supply and availability. The process may affect the future usability of the water.

The study found that when treated surface water recharges an aquifer, the by-products of the water disinfection process accumulate in the aquifer. Included among the by-products are trihalomethanes (THMs), formed when chlorine reacts with organic matter in an aquifer. Further, extracted water still contained measurable concentrations of THMs long after a greater volume of water had been pumped than injected.

THMs are carcinogenic compounds, and their concentrations in drinking water are regulated by the U.S. Environmental Protection Agency. The mean total concentration of THMs in the aquifer was estimated to be 58 micrograms per liter. The EPA's stated maximum level for THMs is an annual average of 0.08mg/l.

According to the study THMs continued to form in the aquifer until the residual disinfectant (chlorine) in the injected surface water is used up, and that bacteria in the aquifer does not consume significant amounts of THMs. THM concentrations in the water extracted from the aquifer decreased over time as the injected water mixed with the native groundwater in the aquifer.



History repeats itself. In 1934, Arizona Governor B.B. Moeur sent a contingent of National Guardsmen to prevent the building of a dam on the Colorado River. In pursuit of its battle objectives it requisitioned a ferryboat, and newspapers gleefully dubbed the contingent the "Arizona Navy." Above is a leaner, meaner Arizona navy, with the "Gov. B.B. Moeur" submarine gliding under London Bridge in Lake Havasu. The digitally composed photo was used by Herb Guenther in a power point presentation at the Water Resources Research Center Prescott conference. California take note. (Photo: Arizona Department of Water Resources)

Conference...continued from page 3

O'Halleran called for more public involvement in state water resource issues to counter the influence of special interests.

Two ideas sufficiently interwoven throughout the presentations to stand as major conference themes would be: (1) diverse problems call for diverse solutions, with no single remedy fitting all situations and (2) involve all interested individuals and parties when addressing an issue. (Or as expressed by Carol Erwin, Phoenix area director of the U.S. Bureau of Reclamation: "Don't get caught by the revenge of the uninvited.")

Finally, comments made by two speakers offer part of the rationale for the conference. John Munderloh, coordinator for the Yavapai County Water Advisory Committee, said water has become a popular topic of conversation in his area, rivaling sports talk. Steve Rossi, principal water resources planner for the City of Phoenix, made somewhat the same point when he said that when he now attends social events people who had previously expressed little interest in his professional background approach him to garner water information, his water expertise increasing his social standing. He believes the drought has raised peoples' water consciousness.

What these comments demonstrate is that citizens are becoming increasingly aware of water as an issue of personal and public concern. The conference reflected that growing interest.

The researchers say THMs formed in the aquifer are very difficult to remove completely. In the course of the study, only 67 percent of the chloride and THMs injected into the aquifer system were recovered after 132 percent of the volume of the injected water had been extracted. With 250 percent of the volume of injected water removed from the aquifer 80 percent of the injected THMs

had been recovered.

Miranda Fram, lead author of the study, says the accumulation of THMs could be minimized by removing the residual chlorine in the water before injection or by modifying the extraction program.

The USGS report, "Processes Affecting the Trihalomethane Concentrations Associated with the Third Injection, Storage, and Recovery Test at Lancaster, Antelope Valley, California, March 1998 through April 1999" by Miranda S. Fram, Brian A. Bergamaschi, Kelly D. Goodwin, Roger Fujii, and Jordan F. Clark can be found at: <http://water.usgs.gov/pubs/wri/wri034062/>.

New ASU Center Studies Urban Environment

Arizona State University's newly established Consortium for the Study of Rapidly Urbanizing Areas will have a 486-square mile laboratory as it focuses on the City of Phoenix. One of the fastest growing urban regions in the country, the Phoenix area is suited for the role, its rapid urbanization raising demographic, environmental and other issues. Water resources will be one of the areas to be studied.

Proposed San Juan Pipeline Raises Complex Legal Issue

Two tribes and a city located within two states are working on a water supply project made additionally complicated since its completion would entail delivering upper basin Colorado River water for use in the lower basin.

The project involves constructing a 250-mile pipeline to deliver about 36,000 acre-feet of San Juan River water to Gallup, New Mexico as well as to the Navajo Nation capitol of Window Rock and Navajo communities in New Mexico and Arizona. The Jicarilla Apache of New Mexico also would benefit from the proposed project.

First discussed about 1970, the plan made little headway until 2000 when New Mexico legislators voted some funding for the proposed project, and the U.S. Bureau of Reclamation got involved in the steering committee and suggested several project alternatives. The steering committee selected a preferred plan, and an environmental impact statement was initiated.

The communities that stand to benefit from the project rely on groundwater, with the San Juan River, the identified source of water for the project, the closest surface water supply. The 1,200 acre-feet delivered to the Jicarilla Apaches would come from the tribe's water rights to the river. Navajo's water rights are being looked to for supplying the rest of the water for the project. Complicating the situation, however, is that Navajo water rights to the San Juan River have not yet been settled.

Navajo negotiations for San Juan River water include 27,000 acre-feet of depletion rights for use in this project, to be delivered to the reservation. Gallup has several options to secure a source of water for its needs. The city can request through the Secretary of the Interior uncontracted water from the Navajo Reservoir or the city can negotiate with the Navajo Tribe, once

its water rights are settled, or with the Jicarilla Apaches for tribal waters to supply its needs.

Much obviously depends upon the settlement of Navajo water rights to the San Juan, not only to supply water for the project, but also to provide the means to construct it. Rege Leach, reclamation team leader of the U.S. Bureau of Reclamation western Colorado Office, says "At this point, we are looking at this project as wrapped around the Navajo settlement on the San Juan in New Mexico. There is the likelihood that the Navajo piece would be repaid through the settlement. We are assuming at this time that Gallup's piece and the Jicarilla Apache piece would be fully repaid by those entities."

Further complicating the situation is that water pumped from the San Juan to supply the designated locations would entail moving water from the Upper Colorado River Basin for use in the lower basin. The San Juan is located in New Mexico in the upper basin. The project proposes using the water in three river basins, with a portion used in the upper Colorado River basin in New Mexico, another portion used in the Rio Grande basin and a portion for the lower basin in areas of New Mexico and Window Rock, Arizona. This plan bristles with legal complexities.

Leach says, "It is a contentious issue. Some read the Colorado River Compact to prohibit moving water between basins." What is being proposed is unprecedented and resolving the issue will require negotiations and evaluating the law of the river.

Leach also explains they are in the process of completing a draft environmental impact statement, and they hope that pending water issues will be resolved in the meantime, with the resolution reflected in the completed EIS.

The consortium will coordinate ASU research in urban development currently underway in various academic fields. A prime intent is to combine the university's environmental science and engineering research in metropolitan Phoenix with other related university fields. The goal is to bring an interdisciplinary approach to problem solving and to broaden the research focus to include analysis of global urban affairs.

The consortium builds upon ASU's established commitment to urban studies. Its Center for Environmental Studies receives National Science Foundation support to participate in its Long Term Ecological Research program, to study ecological processes occurring over long periods of time in the Phoenix area. The new consortium will be housed at the center, with center director, Charles Redman, heading it.

Environmental Industry Provides Profits, Jobs

Recently released U.S. Department of Commerce statistics profile the economic health of the water/environmental industry. Statistics show current annual revenues for the entire industry at \$200+ billion for more than 115,000 revenue-generating enterprises that employ 1.4 million workers.

Municipalities are the largest segment of the marketplace, with more than 80,000 local government divisions acquiring approximately \$65 billion in environmental technologies every year. But domestic sales are virtually flat with only 3-5 percent growth a year.

In terms of gross revenue and employment, environmental technology is larger than such industries as aerospace, computer

hardware, paper, steel, textiles and chemicals. Environmental technology also employs more than six times the workers than motor vehicle and car body manufacturing and nearly equals that sector's revenues.

In 2003, exports of environmental technology goods and services will top \$21 billion, representing a positive trade balance of \$10 billion and creating 170,000 new jobs. Currently the global environmental technology market is slightly over \$500 billion per year and is projected to grow to \$564 billion by 2005 and to \$1 trillion by 2010.

Experts predict a 10 percent annual growth rate in parts of Asia, E. Europe and Latin America. Considering the current situation — US companies have less than a 5 percent share of the non-US market. — US companies may not be in position to take advantage of the opportunities.



Guest View

ACC Considers Environmental Effects of Utilities' Proposed Actions

Arizona law seen to support course of action

Marc Spitzer, Chairman of the Arizona Corporation Commission, contributed this Guest View.

As Arizona continues to deal with the implications of drought and massive population growth, an entity many people have 'never heard of' and few people understand will be at the forefront of water issues. To understand how those decisions will be made, it is important to understand a brief history of utilities regulation in Arizona (don't worry – it's not that boring).

The Arizona Corporation Commission (the "Commission") is unlike public utility or public service commissions in most other states. The Commission's authority is derived from Arizona's 1912 Constitution, so its jurisdiction over utilities doing business in Arizona is not circumscribed by the Legislature or the Governor — as in other states (see California's electricity crisis).

Arizona's populist founding fathers held a healthy distrust of utilities, so the Commission was made subject only to the will of Arizona's voters, and the direct election of Arizona's Commissioners again makes the Commission a distinct, and populist minority among public utilities commissions. For an interesting discussion of the Commission's historical roots and expansive authority, see, e.g., *Arizona Corporation Commission v. Woods*, 171 Ariz. 286, 830 P.2d 807 (1992).

Aside from structural considerations, utilities regulation is subject to a debate over the scope of such regulation. One school of thought holds that the regulator's role is that of pure rate regulation — essentially an accounting exercise. Under this model, the sole objective is to achieve reliable service (water, gas, electric, and telecommunications) for the lowest possible price. The universe of issues subject to debate is narrow, but complex. For example, determinations of systemic redundancy and reserve margins are necessary, which require a balancing of cost versus reliability. Accounting questions predominate, such as the utilities' cost of capital and rate of return, and the timing of plant and equipment being placed in service. The foregoing decisions, upon arithmetic computation, lead to the rates paid by customers.

A more enlightened analysis of utilities' regulation, at least in my view, includes the consideration of the effects of public utility service on the environment. Arizona law would appear to support this view. See Arizona Revised Statutes Section 41-360, et. seq. (authorizing the Arizona Power Plant and Line Siting Committee).

Just as the Legislature acknowledged the impact upon the environment from Commission decisions on power plant and transmission line siting, we also must recognize the effects of the Commission's decisions in gas, electric and water rate cases on the environment. For this reason, the Commission has become increasingly active in evaluating the sources of water and the appropriateness of those sources and in mandating that all water companies

adopt curtailment plans for water shortages before the shortage occurs.

In one example of the Commission's focus on the environmental impacts of water use, the Commission found that the Sun Cities' water company should cease using groundwater to irrigate golf courses and replace it with available, untreated CAP water — and ensure that the groundwater not be pumped from the aquifer for any other reason. The resulting order will save over 6,500 acre-feet per year of groundwater and have a dramatic effect on the region's aquifer.

The Commission is now faced with a great challenge: keeping rates affordable at the 287 small water companies in Arizona while dealing with the financial costs of the new U.S. Environmental Protection Agency arsenic standard. Some early cases have already begun, and in some small water systems the cost of meeting the arsenic standard is greater than the total value of the water system.

Whether the arsenic standard is justifiable under scientific risk analysis or not is now irrelevant — federal law is clear and the EPA standard must be met. The Commission has worked closely with the Arizona Department of Environmental Quality and the Arizona Department of Water Resources to coordinate and develop an Arsenic Master Plan. ADEQ will collaborate with water companies to identify methods to remove arsenic; ADWR through the Water Infrastructure Financing Agency will strive to provide financing to the companies that need it; and the Commission will work with the companies and the ratepayers to ensure that those costs are recovered without exceeding the ability of ratepayers to pay.

The Commission will increase its use of tiered rate structures, which will mean that as a customer uses more water he bears proportionally more of the total costs — the equivalent of progressive taxation. Water companies will have to adopt Commission-approved curtailment tariffs that make clear to all customers (in advance) what steps they will have to take should the company's sources of water become constrained. Our hope in adopting tiered rates and curtailment plans is that we begin to raise the public awareness of the value of water in Arizona — and in so doing, see a reduction in water use in high-use areas.

My first vote as a member of the Commission in January 2001 was to create the "Environmental Portfolio Standard," by which the Commission ordered all Arizona load-serving electric companies to use renewable energy sources. No one has complained about the modest cost, because Arizona voters collectively value the environmental ethic. Public policy is all about balancing competing interests. The Arizona Corporation Commission now believes that environmental impacts of utility regulation must be considered. That was not always the case — but I believe the principle is now firmly part of Arizona law, as it should be. 🏠

Special Supplement

UA Expands Role in Water Research, Education and Outreach

The University of Arizona recently announced awards to faculty and staff to support work in water research, education and outreach. UA students also benefitted, with fellowships awarded to undergraduate and graduate students enrolled in water related studies. This boost in water resource support came from the legislatively authorized Technology and Research Initiative Fund.

(TRIF's origin was a November 2000 voter approved increase in the state sales tax to support education. A portion of the amount went to the state's university system, to invest in technology and research-based initiatives. UA uses some of its TRIF funding for the competitive grants program. The four UA water centers involved in TRIF are the Engineering Research Center for Environmentally Benign Semiconductor Manufacturing; Center for Sustainability of Arid and semi-Arid Hydrology and Riparian Areas; Water Quality Center; and Water Resources Research Center).

A request for proposals was issued in November, with 66 proposals submitted to compete for \$1 million of TRIF funding. The 21 proposals that were funded represent a broad range of work to be accomplished by highly qualified UA faculty and staff, all of whom have partnered with agencies outside the university for direct dollar and/or in-kind support.

The projects involve 54 UA primary investigators from four colleges, and 19 departments/schools/units across campus. Seventy-two entities are listed as partners, including schools and school districts, municipal, county, state and federal government agencies, private sector companies and other associations. Over \$300,000 has been secured from off campus as direct dollar matches.

TRIF funding also is used to support the Water Fellowship Awards. Five outstanding undergraduates studying water resources at UA will each receive a \$4,000 award, and four outstanding graduate students will each receive \$20,000. These are exceptional students with the ability to make significant contributions to the study of water resources at UA and beyond.

Following are brief summaries of TRIF-funded projects. Also listed are the names of students receiving TRIF fellowships.

Research, Education and Outreach Projects

Microbial Mechanisms for Observed Rapid and Large-Scale Denitrification in Irrigated Desert Soils: Potential Low Cost Methods to Remediate Nitrate in Soil and Groundwater. \$49,000. Dr. Edward Glenn, Environmental Research Laboratory, Dept. of Soil, Water and Environmental Science.

Work will focus on study and development of management practices using conventional irrigation technology for the inexpen-

sive remediation of aquifers and soils contaminated with nitrates and perchlorate. Nitrates from fertilizer application, mine tailings, and sewage effluent, and perchlorate from explosive manufacturing sites are sources of widespread contamination of groundwater in Arizona, which pose a potential health hazard. Trials have shown that microbial denitrification occurs in soils under deficit irrigation of landscape or crop plants and has the potential to both cleanup aquifers and improve surface conditions of numerous sites in the state on a large scale.



Rex Adams, research specialist at the Laboratory of Tree-Ring Research, cores a Douglas-fir tree in the Catalina Mountains. Data from the LTRR is included in the study, "Evaluation of Paleo Data to Determine Past, Present and Future Hydrologic Variability in Arizona." (See page S-4 for project summary) Photo: Ron Towner

Evaluation of M&I Water Conservation Measures Through Actual Water Savings & Cost/Benefit Analysis. \$29,400. Val Little, Water Resources Research Center.

Project will evaluate municipal and industrial water conservation programs/strategies implemented in Arizona and throughout the West. Analyses will be done to determine actual water savings, costs and benefits for targeted conservation measures, with a comparison between measures worked out as well. The information generated will be used to produce a needed primary resource and reference document. There will also be an interactive web site for conservation program evaluation for use by decision makers, enabling them to save water and use existing resources more efficiently. The goal is to achieve the greatest water saving per dollar spent on water conservation efforts.

Water on Wheels — Development of a Mobile Water Laboratory/ Education Center. \$88,400. Dr. Randall Norton, Graham County Cooperative Extension; Dr. Lee Clark, Safford Agricultural Center; Sue Martin,

Graham County Cooperative Extension; Jonie Burge, Safford Agricultural Center.

This project involves the modification and use of a mobile trailer, to bring water education to K-12 students in Graham, Greenlee and northern Cochise counties. Students will rotate through hands-on experiments at four stations focusing on the water cycle, watershed education, groundwater dynamics, and water chemistry/biology housed in a specially designed mobile laboratory. As the first of its kind in the state, the vehicle will deliver water education to rural areas and serve as a prototype for use in other counties across Arizona.

"Unless we manage water as a precious resource, using the most advanced scientific research to assure water quality and water supply, all other efforts to develop a globally competitive economy in Arizona will come to naught." UA President Peter Likins

Mountain Block Recharge and the Hydrology of Caves: An Interactive Display. \$18,620. Susan Pater, Cochise County Cooperative Extension; Kim McReynolds, Area Agent, Natural Resources.

Interactive displays, a touch-screen kiosk and an animated web site will be developed, produced and maintained to increase hydrologic literacy of the general public at Kartchner Caverns. The Caverns is the state's newest and most popular state park that draws 200,000+ visitors a year. Understanding mountain block recharge, the hydrology of caves, the hydrology of the nearby San Pedro River, and the importance of groundwater will lead to greater public awareness of water resource concerns and the need for conservation.

Know Your Water: Manual of Water Quality and Treatment for the Home Owner. \$37,075. Dr. Janick Artiola, Dept. of Soil, Water and Environmental Science; Dr. Kathryn Farrell-Poe, Dept. of Agricultural and Biosystems Engineering.

A handbook of water quality parameters, water quality standards and home treatment options will be produced for the general public to assist them in making informed decisions about the need and use of potentially costly home water treatment. An electronic version will also be available for direct web access.

Destructive Treatment of Halogenated, Semivolatile Solvents in Soil-Vapour Extraction Gases. \$24,500. Dr. Eduardo Sáez, Dr. James Baygents, Dept. of Chemical and Environmental Engineering; Dr. Brian Barbaris, Superfund Basic Research Program; Dr. J. Brent Hiskey, Dept. of Materials Science and Engineering; Dr. Eric Betterton, Dept. of Atmospheric Science.

This project will examine and implement a cost-effective alternative technique for field scale treatment of sites contaminated with hazardous semivolatile chlorinated solvents. Trichloroethylene (TCE) and perchloroethene (PCE) are primary contaminants of dozens of hazardous waste sites in Arizona. The removal of these solvents from soil vapor extraction gases from the vadose zone will be explored using a gas diffusion membrane-electrode assembly

obtained from a modified fuel cell. The contaminants will be converted to non-halogenated, nontoxic products.

Antibiotic-Resistant Bacteria and Endotoxins in Association with Land Application of Biosolids: Possible Impact on Quality of Groundwater Supplies and Comparison to Other Routes of Work-Related and Household Exposure. \$55,660. Dr. Patricia Rusin, Dr. Chris Rensing, Dept. of Soil, Water and Environmental Science.

Research will determine whether antibiotic-resistant bacteria and endotoxins in biosolids used as an agricultural land amendment act as a significant source of contamination to Arizona water resources or pose a risk to public health. Evaluation of the relative health risk of antibiotic-resistant bacteria and endotoxins from biosolid application compared to other common routes of exposure, the impact on groundwater, and transfer of antibiotic resistance genes to soil and groundwater bacteria will be explored. This will be pertinent information for the biosolids industry, regulatory agencies and the community as use of this soil amendment continues to increase.

Quantifying Mountain Front Recharge in Southeastern Arizona. \$52,620. Dr. James Hogan, Dr. Brenda Ekwurzel, Dept. of Hydrology and Water Resources.

Quantification of natural recharge and improved conceptual understanding of natural recharge rates are crucial for developing water resources management strategies and establishing and maintaining riparian conservation goals. Isotopic tracers will be used to investigate mountain front recharge, which is an important if not dominant recharge pathway for alluvial basin aquifers in Arizona. Water resources managers will be able to use the information generated to better quantify natural replenishment rates and have an improved understanding of how climate, vegetation change and development might impact recharge rates.

Integrated Water Education Implementation in the Classroom. \$58,140. Dr. Lisa Elfving, Dept. of Biochemistry & Molecular Biophysics; Dr. Elizabeth Hancock, Dr. Jean Morrill, Dept. of Hydrology and Water Resources.

Water resource kits for classroom use based on critical themes (i.e. water quality, watershed processes) will be developed and supplied to teachers, with specific training, to enable effective delivery of quality water education. Course material will be integrated into the existing curriculum. Classroom support will be provided by graduate students trained to function as water education specialists. Increased understanding of water science and improved instruction in science and math are anticipated. Over a three year period it is projected that there will be thousands of face contacts with these new resource materials.

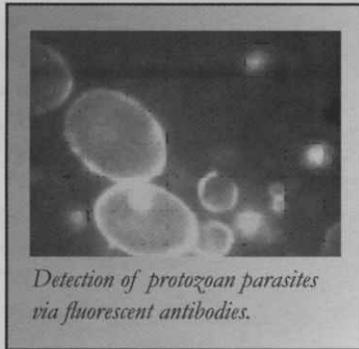
Development of Riparian Evapotranspiration and Ecohydrologic Models to Predict Changes in and Consequences of Riparian Water Availability. \$69,510. Dr. Thomas Maddock III, Dr. James Shuttleworth, Dept. of Hydrology and Water Resources; Dr. Travis Huxman, Dept. of Ecology and Evolutionary Biology.

This project will lead to the completion of a new groundwater model for evapotranspiration (ET), and refinement of an ecohydrologic model to predict the hydrological and ecological changes in, and consequences of, riparian zone water availability. Products of

this work will have immediate and direct benefits to the San Pedro River ecosystems and its stakeholders as well as region-wide benefits. Conservation planners and regional water planners are seeking tools to make informed decisions regarding effects of water allocation decisions on environmental amenities.

Occurrence and Control of Emerging Waterborne Pathogens in the State of Arizona. \$46,340. Dr. Charles Gerba, Dept. of Soil, Water and Environmental Science.

The parasite *Naegleria fowleri* and the Norwalk virus are two pathogens that have recently emerged as water quality problems in Arizona. *N. fowleri* in the water supply caused the death of two young children in separate episodes in Peoria, and the Norwalk virus has caused illness among visitors to Grand Canyon National Park on river rafting expeditions. The potential human exposure to *N. fowleri* from drinking water and effectiveness of current control measures will be examined. Sources and potential control methods for *N. fowleri* will be investigated. The work will provide much needed information to public health departments, water departments, and government agencies.



Detection of protozoan parasites via fluorescent antibodies.

Quantifying Potential Endocrine Disruption in Effluent Dominated and Effluent Dependent Waters within Arizona: Fish as Habitat Assessment Biomarkers. \$49,000. Dr. David Walker, Environmental Research Laboratory, Dept. of Soil, Water and Environmental Science/Dept. of Wildlife and Fisheries Science; Dr. Dennis McIntosh, Dept. of Soil, Water and Environmental Science.

As population centers grow in Arizona so does the prevalence of effluent dominated waters (EDW's) which are becoming increasingly important as habitat for wildlife. These waters may contain chemicals which can cause endocrine disruption in vertebrates, often resulting in decreased fecundity at the population level. While emerging technologies exist to rapidly analyze endocrine disruption in EDW's, they often fail to address the long-term, chronic effects of low-level exposure to these chemicals. In order to better understand these effects, native species of fish will be grown in captivity using water collected from EDW's throughout the state and their blood and plasma levels analyzed for sex hormones and morphological abnormalities. This quantification will enhance the ecological characterization of EDW's so that appropriate treatment technologies can be implemented to reduce any detrimental effect caused by endocrine disrupting compounds.

Hydrologic and Water Quality Modeling for Watershed Assessment and Planning. \$23,060. Dr. Phillip Guertin, School of Renewable and Natural Resources.

The project is to improve and expand the functionality of a user-friendly decision support system (DSS) called the Automated Geospatial Watershed Assessment (AGWA) tool. This is already an effective tool for use by stakeholders to develop, understand and

evaluate alternative watershed management strategies. Modifications of the system would enable application for developing watershed-based water quality plans that address non-point source pollution.

Arizona Water and Pesticide CD. \$19,110. Louis Carlo, Dr. Paul Baker, Dept. of Entomology and Cooperative Extension.

The use and misuse of pesticides due to drift, over application, and unsafe storage are leading to accumulating pesticide residues in our waterways. The Arizona Water and Pesticide Safety CD is a multimedia distance learning course that will explain the problem of pesticides in our waterways and it will teach safety guidelines to protect community health and environmental quality. Plans include the distribution of this multimedia distance learning course throughout Arizona. This CD will strengthen outreach and education aimed at providing a high-quality water supply and watershed environment in Arizona.

Tailored Drought Planning for Arizona. \$47,570. Dr. Greg Garfin, Institute for the Study of Planet Earth; Dr. Barbara Morehouse, Institute for the Study of Planet Earth/Dept. of Geography and Regional Development; Dr. Andrew Comrie, Dept. of Geography and Regional Development.

The recent drought and its differential impacts across the state highlighted the lack of a statewide process for identifying and addressing water management stresses, particularly in rural areas. This project, conducted in coordination with the Arizona Drought Task Force, will include (1) analysis and synthesis of hydroclimatological information on drought at temporal and spatial scales useful for drought monitoring and decision making; (2) identification of local-scale sensitivities and vulnerabilities to drought within Arizona; (3) characterization of interactions among risk factors across different levels from local to state to federal; and (4) education and outreach emphasizing interpretation and use of scientific information, forecasts and related decision tools.

Proposals Expertly Evaluated

In early May, three review panels met on campus to evaluate and rank TRIF proposals. The proposals were placed within one of three general groupings: education; water quality; and a combination of water supply and social science. Each proposal received two primary and two secondary reviews from a panel of ten to thirteen experts. Relevance to state and community water issues, scientific/technical merit, leveraging of TRIF funds, and the competence and background of the PIs were the four criteria used for evaluation. Following the individual panel meetings, the chairs and co-chairs of the three panels met with UA water center directors to present their panel rankings and develop a final ranking for all proposals.

Estrogenic Activity in Reclaimed Water and Stormwater. \$50,630. Dr. Robert Arnold, Dept. of Chemical and Environmental Engineering; Dr. David Quanrud, Arid Lands Studies; Dr. Kevin Lansey, Dept. of Civil Engineering and Engineering Mechanics.

Arizona surface waters that are effluent dominated frequently contain levels of estrogenic compounds that are known to produce developmental problems in continuously exposed fish. Work

is designed to monitor Arizona effluent-dominated streams for whole-water estrogenic activity using a variety of in vitro bioassays, examine treatment and polishing methods that can remove estrogens from wastewater and establish levels of estrogenic activity in stormwater runoff. Water resource managers need this information to regulate water reuse practices safely and efficiently in Arizona.

Detection of Noncytotoxic and Treatment Resistant Human Virus Populations in Drinking Water Using Integrated Cell Culture/PCR. \$53,630. Dr. Kelly Reynolds, Environmental Research Laboratory, Dept. of Soil, Water and Environmental Science.

Contamination of surface water resources by human viruses is causing considerable concern due to their small size and long-term survival that make them less likely to be removed by treatment processes. A rapid and reliable method for the evaluation of drinking and reuse water supplies and disinfectant efficacy for the elimination of a variety of human pathogenic viruses in drinking water will be developed by this work.

Improved Turf and Landscape Irrigation Management for Northern Arizona. \$48,020. Dr. Paul Brown, Dept. of Soil, Water and Environmental Science; Dr. Peter Waller, Dept. of Agricultural and Biosystems Engineering.

The objective of this project is to improve the efficiency of landscape irrigation in Northern Arizona by developing a multifaceted educational program. Specific aspects of the program will include the development of: 1) publications that describe and encourage proper landscape irrigation management in high elevation areas; 2) a website to disseminate project information; 3) irrigation demonstration projects; 4) annual landscape irrigation workshops in Payson, Flagstaff, and Prescott; and 5) a small network of automated weather stations that will improve irrigation management by providing accurate estimates of evaporative demand in Payson, Flagstaff, and Prescott.

Educational Workshops and Feasibility Study for Sustainable Forage Production on the Havasupai Reservation. \$17,215. Dr. Edward Martin, Dr. Donald Slack, Dept. of Agricultural and Biosystems Engineering; Elizabeth Didier, Assistant Agent, Agriculture Natural Resources, Mojave County.

Adjacent to a remote corner of Grand Canyon National Park, the Havasupai Reservation is accessible only by helicopter, pack animal or foot, with food and supplies imported into the community. A feasibility study to investigate the possibility of restarting agriculture coordinated with educational workshops on water conservation, water quality, irrigation practices and crop production would help the tribe become more sustainable. Effluent and creek water are available water resources. Utilizing the waste water will have the dual benefit of using a resource that already exists in the village and reducing the loading of waste ponds which are a potential source of health problems when rains flood the village and lead to contamination of Havasu Creek.

Simulated Basin Model for Water Resource Planning and Education. \$108,680. Dr. Kevin Lansey, Dept. of Civil Engineering and Engineering Mechanics; Dr. Paul Blowers, Dr. Wendell Ela, Dept. of Chemical and Environmental Engineering; Dr. Paul Brooks, Dr. Steven Stewart, Dept. of Hydrology and Water Resources; Dr. Paul Wilson, Dept. of Agricultural and Resource Economics.

A valuable interactive tool to improve water resources management decisions will be provided by developing an integrated decision support simulation model. Understanding the impact of alternative management options, including identification of new water sources, conservation measures, water reclamation and water treatment on a cost effective basis will be possible for both technical and non-technical constituents. Selection and evaluation of alternative management plans for specific locations will be possible by tailoring the general model with local information. In addition to identifying solutions for water managers and policy makers, the model will be critical in educating the public and generating acceptance of water plans.

The Evaluation of Paleo Data to Determine Past, Present and Future Hydrologic Variability in Arizona. \$53,820. Dr. Victor Baker, Dept. of Hydrology and Water Resources; Dr. Jeffrey Dean, Dr. David Meko, Dr. Ronald Towner, Laboratory of Tree-Ring Research; Dr. Juan Valdes, Dept. of Civil Engineering and Engineering Mechanics.

It is critically important that agency planners, land managers, politicians, public interest groups and the general public understand past hydrologic variability, the frequency and severity of extreme events, and the probabilities of their incidence in order to make more informed decisions concerning the management of Arizona's water resources. The proposed paleohydrological research, along with historical records and paleoclimatic data, will be assembled into a database to enable assessment of hydrologic trends. The resulting increased accuracy for prediction of return periods for floods and droughts, plus the more accurate characterization and forecasting of drought periods, will have a tremendous impact on water policy and management.

Water Fellowship Recipients

The following graduate students have been awarded \$20,000 TRIF fellowships: David Brown, Dept. of Geography and Regional Development, Advisor: Dr. Andrew Comrie; Otakuye Conroy, Dept. of Chemical and Environmental Engineering, Advisor: Dr. Robert Arnold; Andrew Hinnel, Dept. of Hydrology and Water Resources, Advisor: Dr. Ty Ferre; and Paula Renda da Costa, Dept. of Agricultural and Biosystems Engineering, Advisor: Dr. Gene Giacomelli.



Graduate student Andrew Hinnel was one of the UA students to receive a TRIF fellowship. He is shown making electrical resistance tomography measurements to track the movement of subsurface water.

The following undergraduate students have been awarded \$4,000 TRIF fellowships: Stephanie Freeman, Dept. of Chemical and Environmental Engineering, Advisors: Dr. James Field, Dr. Reyes Sierra; Erin Gleeson, Dept. of Hydrology and Water Resources, Advisor: Dr. Paul Brooks; Arin Haverland, Dept. of Soil, Water, and Environmental Science, Advisor: Dr. James Riley; Michael Liga, Dept. of Agricultural and Biosystems Engineering, Advisor: Dr. Donald Slack; and David Roncayolo, Dept. of Civil Engineering and Engineering Mechanics, Advisor: Dr. Juan Valdes.



Legislation and Law

Law Would Create National Water Commission

A bill introduced in the U.S. House calls for a major water planning effort at the national level. The bill is in response to concerns about inconsistencies and discrepancies in U.S. water management, with federal, state, interstate and local agencies all sharing jurisdiction. Its intent is to provide the framework to encourage coordination and planning among water resource management agencies.

The bill states that there has not been a comprehensive assessment of water resources in the United States since 1978, and there has not been a comprehensive review of water policies since 1973. The bill intends to remedy the situation.

Titled the Twenty-First Century Water Commission Act or HR135, the bill would create a seven-member panel of water policy experts to study U.S. water availability issues and project future water supply and demand. The commission also would review current water management programs at each level of government and develop recommendations for a comprehensive water strategy. The bill would authorize \$9 million to support designated activities.

The commission's task would be to craft a report identifying ways to ensure a dependable water supply for the next 50 years. More specifically, the duties of the commission are to use existing water assessments and conduct such additional assessments as may be necessary to project future water supply and demand; study current water management programs of federal, state and local agencies and private sector entities directed at increasing water supplies; and consult with representatives of such agencies and entities to develop recommendations for a comprehensive water strategy.

In adopting its recommendations, the commission is to respect the rights of states in regulating water rights and uses; identify incentives to ensure a dependable water supply for the nation over the next 50 years; develop strategies to avoid unfunded mandates; eliminate duplication among federal agencies; consider all available technologies, make recommendations for capturing excess water and flood water for conservation and subsequent use in times of drought; develop financing options for public works projects; and develop strategies to conserve existing water supplies and repairs to infrastructure.

The commission would issue interim reports every six months and a final report within three years. The commission would disband a month after the issuance of the final report.

Some officials not in favor of the bill defend the status quo. They argue that the current regional and incremental approach to water policy allows for appropriate consideration of geographic differences and states' rights. Other critics include some conservationists who say they are concerned that the bill favors structural

solutions and construction of new supplies over improved water management. U.S. Rep. John Linder of Georgia introduced the bill.

Proposed Law Would Protect Utilities From Lawsuits

A bill has been introduced in the U.S. House that would shield water utilities from lawsuits if they are in compliance with federal and state regulations. Called the Drinking Water Standards Preservation Act or HR 306, the act would amend the Safe Drinking Water Act to provide procedures for claims relating to drinking water.

The act designates conditions that would need to be met before a public utility could be found liable for personal or property damages due to its delivery of water with a regulated contaminant. In effect, a plaintiff would have to demonstrate that the public water system had violated regulations in a negligent manner and that the violation did in fact cause the injury. In other words, a utility would have to be clearly in violation of the SDWA to be subject to liability.

In the case of an unregulated contaminant, the plaintiff must establish that substantial scientific evidence exists that the substance in the water which the plaintiff claims caused the injury was of such a nature, and in such amounts, that it was reasonably likely to have caused the injury; that the injury actually was caused by delivery of water that contained such a substance; that the water system knew or should have known that the substance was in the drinking water at such a level and was likely to cause the injury; and that it was feasible for the supplier to have removed such contaminant to a safe level.

The bill is in response to a growing number of lawsuits against water utilities, many of them prompted by improved methods of establishing cause-and-effect relationships between various contaminants and debilitating health conditions. Proponents of the bill argue that if a utility is meeting established drinking water standards it should not be penalized for not providing protection above and beyond what is required by law. What is at stake they argue is the established procedure for setting national drinking water standards.

Per the Safe Drinking Water Act, EPA now sets such standards. It is then up to the states to set drinking water standards at least as strict as EPA's to maintain primacy over drinking water programs in their state.

Tommy Holmes, AWWA legislation program manager, says, "We don't always agree with EPA's outcome but it is a pretty thoughtful process that could be undermined by 12 jurors in state court."

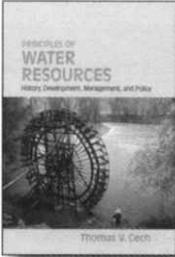
In cases filed in California, the State Supreme Court has ruled that compliance with the SDWA is an absolute defense for utilities regulated by the California Public Utilities Commission. The majority of water systems, however, are not regulated by the PUC. ■





Publications & On-Line Resources

Water Resources Self Help for the Non-Professional



Principles of Water Resources: History, Development, Management, and Policy, by Thomas V. Cech, John Wiley & Sons, Inc., 480 pages, \$91.95 hardcover. (For purchasing information check: www.wiley.com/college/cech).

One of the generally unrecognized needs in the water resource field is for a book to explain water resource principles and practices to people without a professional background in water. This would be someone without formal training or work experience in a water discipline, whether hydrology, law, public policy, etc. With folks at the local level increasingly valued for their input into water resource planning and management, such non-professionals are taking more active roles in water affairs, as members of advisory committees, watershed groups or as stakeholders with a direct interest in the resolution of a water issue.

There is a specialized need, not well served by any current publication effort. They are often committed, motivated, interested people who are aware that their on-the-ground experiences are part of a much larger water resource picture. They likely realize the need for a broader view of the water resource field, to understand with greater depth the issues that directly involve them and also to learn about other related water topics of importance at the state, regional and national levels. What they need is a good source of background information, to broaden their water resource frame of reference to include historical, hydrological, legal, regulatory and other water resource related matters. Where do such people turn for water information?

In some ways they are provided for, with government officials and researchers offering their expertise and services. Also various reports are at hand. The government reports that are generally available, however, often are narrowly focused, their designated purpose served by a functional prose. Valuable for meeting certain objectives, these texts provide a limited contri-

bution to a general water resource education. Web sites offer a mother lode of water resource information, of varied usefulness.

Those seeking a general background in water resources might consult "Principles of Water Resources — History, Development, Management, and Policy" by Thomas V. Cech. That it is a textbook might be off putting to some already laboring in the water resource field. They may go along with the generally held premise that textbooks are for students in a classroom. Yet the virtues of this particular textbook broaden its usefulness beyond the classroom, qualifying it as an excellent general water resource reference work — although it is unfortunately priced at a high textbook cost.

By broadly defining the study of water resource as including "disciplines such as mathematics, science, geography, geology, biology, political science, meteorology, and even psychology," the author provides the reader with an appreciation of the rich complexity of water resource studies. Discussions provide sufficient depth and detail to interest those already knowledgeable in some aspects of the water resource field. The non-specialists active in projects and assignments can consult the book to broaden and deepen their understanding of the tasks at hand, as well as to view their work in the broader water resource context. The book will fill in informational gaps and broaden water resource awareness and understanding.

Information is variously presented, to include case studies, tables, figures, maps, side bars and guest essays. This adds variety and appeal to the text formatting and enhances readability. Information is more accessible. Informative web sites are identified.

A book that needs writing is a water resource guide to Arizona, with specific issues discussed in reference to the state's unique political, cultural, geological and hydrological conditions. Such a volume could be directed to a wide readership, from water professionals to interested citizens. Until that book is written, "Principles of Water Resources" will serve as a useful reference work to readers seeking a general water resource education.

USGS Web Site Builds Customized Watershed Maps

Users can log on to a new U.S. Geological Survey web site (<http://az.water.usgs.gov/rwi-ii/>) and build customized maps of some Arizona rural watersheds. USGS, in cooperation with the Arizona Department of Water Resources and Yavapai County, is studying three contiguous rural areas in Arizona: the upper and middle Verde River watershed; the Fossil Creek, East Verde River and Tonto Creek watersheds in the Mogollon Highlands; and the Coconino Plateau.

When web site visitors select a watershed, a shaded relief map of the area is displayed. They can then select from individual data layers that include wells, springs, and active streamflow-gaging sta-

tions and display them on the map. Zoom and navigation tools enable users to scale maps up or down. By clicking on data points, users can view data available in USGS databases. Different images (precipitation and geophysical data, or a satellite view of the area) also can be draped on the maps.

The web site is part of USGS studies under the aegis of the Arizona Rural Watershed Initiative program, administered by the ADWR, to help rural areas of the state address water-related issues and concerns. USGS studies are designed to yield a better understanding of the hydrologic systems in the study areas.



Special Projects

Project WET's Water Education Outreach is a Cooperative Venture

Water education is a growing movement in Arizona, with more presentations now offered, more materials available, and more personnel and organizations coordinating their efforts to better promote water awareness in the state. Taking a pivotal role in this movement is the Water Resources Research Center's Project WET (Water Education for Teachers) at the University of Arizona.

Arizona Project WET Coordinator Kerry Schwartz says, "The growth of water education in the state has been a step-by-step process, with things now coming together to strengthen and expand the program."

In step with the movement, WET has been covering more ground, both in its service area and the range of its educational offerings, thanks to the support of various government agencies and operations.

The City of Phoenix Conservation Office has been a WET partner and has worked with the project for the past ten years. A city survey found that water users wanted more water conservation education. In response, the city sponsored Project WET workshops, offering 16-hour sessions to enable teachers to earn continuing education credits.

Schwartz says, "In 2001-02 we got a great response, with 30 to 40 people per workshop. We also did two water festivals in the Phoenix Valley, and we brought in the U.S. Bureau of Reclamation, Arizona Department of Water Resources, Central Arizona Project, Salt River Project and Arizona Department of Environmental Quality as cosponsors."

The Phoenix Active Management Area took note of WET activities in the area and became a prime project sponsor. Schwartz says, "Phoenix AMA's involvement in the water festivals and its attendance at subsequent water education workshops encouraged its efforts to create a cohesive water resource education program. We now have a grant from the Phoenix AMA, not only for doing teacher workshops, but for training facilitators who can then conduct the workshops."

The agency sponsored two WET facilitator workshops in the Phoenix metropolitan area. (The purpose of facilitator workshops is to train interested persons who in turn will train classroom teachers and educators.) The goal is to have a cadre of facilitators to work with central Arizona teachers to promote water education in the classroom. Having facilitators from the area ensures that water education presentations will reflect local conditions and issues. The ADWR grant funded training for 40 facilitators in central Arizona.

Along with sponsoring workshops ADWR also is providing funds for a water resource supply center in central Phoenix. The center will be a place where teachers, after they have received training from Project WET facilitators, can obtain books, groundwater flow models, enviroscape models and supplies for water education activities.

BuRec is taking the lead in supporting WET activities in areas

outside the Phoenix AMA by sponsoring WET facilitator workshops in northern and southern Arizona. The northern Arizona facilitator training was held in Flagstaff, March 14-15, with participants coming from a broad geographic area including Williams, Sedona and the Navajo Nation.

The bureau also is sponsoring a fall facilitator workshops in southern Arizona, to include participants from an area ranging from Yuma to Sierra Vista. The Tucson AMA also will be a partner in this event, purchasing supplies and providing stipends to the facilitators.

WET water festivals are an annual fall event. This year a festival will be conducted in Safford on Sept. 26, with another festival scheduled for the West Phoenix Valley. The Safford festival will involve 600 fourth grade students; the Phoenix event is expecting to host 1,000 fourth grade participants.

In a further example of partnering, BuRec is working with ADWR to develop water history trunks along with other kinds of water teaching tools. An effective water conservation teaching device, history trunks contain various artifacts relating to an "old fashioned" water use, such as ice tongs, a washboard and a canvas canteen. This new supply of history trunks will be available to classrooms throughout the state.

This may be the start of something new. Schwartz says, "Hopefully there is going to be repository for supplies for workshops and teaching tools in the north, central and southern areas of the state."

BuRec also is taking a role in reaching out to non-AMA areas by sponsoring HydroSmarts, a monthly water feature of the "Bear Essential News," a newspaper distributed free to school children. Through ADWR's initiative, HydroSmarts features Project WET's "Kids in Discovery Series" activities each month along with contact information for WET workshops and resources.

Water education horizons are further broadening as other state agencies get involved. In meeting National Pollutant Discharge Elimination Standards — a U.S. Environmental Protection Agency program now administered by the Arizona Department of Envi-



Project WET Coordinator Kerry Schwartz demonstrates the groundwater flow model to African visitors to the Water Resources Research Center. Photo: Joe Gelt



Announcements

ADEQ Seeks Applicants for Water Quality Improvement Grants

The Arizona Department of Water Quality is requesting applications for projects to be funded during the 2003 grant cycle of the Water Quality Improvement Grant Program. Approximately \$1.2 million is available for multiple awards during this grant cycle, with money provided by the U.S. Environmental Protection Agency under the provisions of the 319(h) section of the Clean Water Act. Accomplishments of successful grant applications must include: improve, protect or maintain water quality in an Arizona water body by addressing a non-point source of pollution; demonstrate acceptable water quality management principles, sound design and appropriate procedures; yield benefits at a level commensurate with project costs for the benefit of the state; have an on-the-ground implementation component within Arizona; and provide for at least 40 percent of the project costs as non-federal match. Deadline to submit applications is Sept. 24. For a grant manual with program information and application forms call Danese Cameron at 602-771-4569 or at 800-234-5677, X 771-4569. The manual can be downloaded at the ADEQ web site: <http://www.adeq.state.az.us/envIRON/water/mgmt/planning.html#improve>. Grant workshops will be conducted throughout the state in July.

Check Online Catalog for Federal Watershed Funding

EPA's recently updated "Catalog of Federal Funding Sources for Watershed Protection" is available on-line on a searchable website. The website offers information on 84 federal funding sources that may be available to help fund watershed-related projects. The website was developed by the EPA's Office of Water Finance Work Group with representatives from the Office of Wetlands, Oceans and Watersheds, Office of Wastewater Management, and Office of Ground Water and Drinking Water. For more information call 1-800-490-9198 or visit <http://www.epa.gov/watershedfunding>.

Call for Papers, Also Upcoming Conference

The American Membrane Technology Association has issued a call for papers for its Aug 4-7, 2004 biennial conference, "Water Resource Development Using Membranes." The theme of the conference will focus on the role of membranes in the development of water resources for municipal and industrial growth. Increasingly membranes are playing a major role in providing water professionals with new and cost effective solutions to satisfy the demand for additional water supplies. The conference will explore the current technological solutions in seawater desalination, wastewater reclamation and water quality enhancement using membranes to remove water borne pathogens, in addition to other topics. Abstracts must be submitted by Sept. 1, 2003. For additional in-

formation check the AMTA web site: <http://www.membranes-amta.org>. Also check the web site for information on the AMTA Aug. 3-5 symposium, "Membrane Technology Comes of Age," with pre-conference workshop "National Road Map for Desalination Research."

Arizona Drought Task Force Seeks Input

The Governor's Drought Task Force is in the process of establishing an effective and efficient approach to accomplishing its task. It is committed to using the best scientific information available and having significant stakeholder involvement in the design of the drought plan. A drought task force web site has been established, linked to the Arizona Department of Water Resources website, at www.water.az.gov/gdtf/. Suggestions are welcomed for additional links, materials that should be included, graphics, etc. Also encouraged are suggestions regarding the planning process and any concerns. Email suggestions and comments to wrtdtf@adwr.state.az.us

National Groundwater Conference Scheduled

The National Ground Water Association will host its 2003 Ground Water Expo Dec. 9-12 in Orlando, FL. The NGWA mission is to enhance the skills and credibility of all groundwater professionals, develop and exchange industry knowledge and promote the groundwater industry and understanding of groundwater resources. For additional information about the conference check the NGWA website, <http://www.ngwa.org>.

NM Symposium on Hydrologic Modeling

New Mexico Symposium on Hydrologic Modeling will be conducted at Macey Center, New Mexico Tech, Socorro, NM, Aug. 12. Registration deadline for the one-day technical symposium is August 8. For additional information and to register check the New Mexico Water Resources Research Institute's web site at <http://wrii.nmsu.edu/index.html>.

NRWA Plans Fall Conference

The National Rural Water Association's 2003 annual conference will be Oct. 19-22 in Oklahoma City. Attendees registering by Sept. 5 will receive a discount. According to NRWA, "This exciting fall event gives water professionals throughout the nation a chance to network with peers, communicate with high-ranking government officials, examine new products, technologies and services, as well as have some fun." NRWA represents more than 22,000 water and wastewater utilities in the U.S. Check the NRWA web site for more information and to register online: <http://www.nrwa.org>.



Public Policy Review

by Sharon Megdal

Steps to Take to Resolve Water Resource Challenges at Regional Level



The Water Resources Research Center's May conference was deemed a success by those in attendance. The focus was on developing and implementing solutions to water resource challenges at the regional level, rather than at a centralized (state) or local level.

As reported elsewhere in this newsletter (See Vapors, page 3), several speakers offered their insight and guidance. Many important

but simple messages were conveyed at the conference. Attendees were warned not to suffer from "paralysis of analysis"; some actions can be taken while awaiting the data necessary for other decisions. We were told to get that elephant of litigation, which requires significant monetary resources and casts a cloud over decision making, out of the refrigerator. We were reminded to make sure all the issues are on the table. Several speakers acknowledged the problems associated with excluding individuals or groups because you don't want to hear what they might have to say. That there is no single "silver bullet" answer to most complex challenges was highlighted.

While there is no simple or common solution to the multitude of problems and challenges, John Sullivan of Salt River Project provided a useful model for approaching resolution of local and regional water issues. He pointed to four state water success stories: the Groundwater Management Act; resolution of water claims with Indian Tribes; the Central Arizona Project; and the Arizona Water Banking Authority. He noted that each of them required the following three steps: resolving claims to water; legislation at the state and/or federal level; and a method of financing.

Sullivan noted that those addressing water challenges in rural Arizona should look to a similar model. He emphasized that there is a role for the state legislature to play. His message was for the local stakeholders to get behind the legislative establishment of the framework necessary to enable implementation of regionally generated solutions.

Conference speakers provided information about many regions of the state. Certain areas of the state are ripe for action. The

activities of Fort Huachuca and concerns about San Pedro River flows have been central to the endeavors of the Upper San Pedro Partnership. Strong federal interest has assisted in identifying financial resources necessary for studies, and there is active participation of diverse interests in identifying water resource problems and potential solutions.

The Verde watershed is also a hotbed of activity. The beauty of the region coupled with rapid growth rightly has people concerned about balancing the needs of nature with the needs of people. Here, too, there is active participation of diverse interests, and progress is being made in acquiring and disseminating information. Yet, there is significant concern about the activity of new and existing exempt wells in the Active Management Area portion of the watershed and the unregulated drilling in the non-AMA portions of the watershed. There the situation is even more complicated due to the importance of surface water and rights to that surface water.

In the Flagstaff area, conservation is working to reduce water demand in absolute terms. The Gila watershed has learned that collaboration is the key to address water quality as well as quality of life concerns. Limited economic resources are a problem, however.

While many are averse to extending the regulatory reach of the Arizona Department of Water Resources, few argue about the benefits associated with predictable and sensible groundwater regulation. That growth in the AMAs must depend largely on renewable water resources and 100 years of demonstrated physical water supply, for example, is generally acknowledged as being good for the regional economies. Elsewhere, on the other hand, absence of assured water supply requirements may mean less confidence about the sustainability associated with growth.

The local and regional efforts discussed at the conference largely focused on the long-term. People are working in good faith. ADWR is actively facilitating the process of developing solutions, without determining the outcomes. Participants should keep in mind John Sullivan's simple model as they endeavor to develop and implement workable and timely solutions to their water resource challenges. ■

Project Wet...continued from page 9

ronmental Quality — cities and towns have to write storm-water plans, and these plans must include an education program. This could provide WET another outreach opportunity. WET has an Arizona non-point source pollution curriculum, developed with an ADEQ grant. WET's use of the curriculum, however, has been handicapped by a lack of water quality funding.

In another development, water education is an important theme in ADWR's Drought Task Force. Its charge includes developing a statewide water conservation education strategy and provides for creation of a conservation education workgroup to

address water conservation.

Schwartz says, "What we are doing is trying to look at what is needed in rural Arizona. Its water education needs are obviously different than the cities. We think that Project WET can meet a lot of the needs in the rural areas."

For more information about Arizona Project WET contact Kerry Schwartz (520-792-9591, X22 or kschwartz@ag.arizona.edu) or check the web site: <http://ag.arizona.edu/AZWATER/wet/>. The National Project WET web site (<http://www.projectwet.org/>) displays WET activity guides and resources. (The July-Aug AWR will feature Arizona Project WET guides and resources.)

Desalination...continued from page 2

evaluation of the problem. He says, "We studied the salt balance in the valley and asked how much salt is coming into the area vs. how much is leaving. We found that about a million tons per year of salt are coming into the valley and staying."

Central Arizona Project water and water from the Salt and Verde rivers are responsible for much of the salt. Also contributing to the salt loading is reclaimed water. Water reclaimed for use from a treatment plant increases salinity. Estimates are that one cycle of municipal use increases the salt content of water by 200 to 400 milligrams per liter. Sanitary discharges and water softeners contribute to the salinity of reclaimed water.

Rossi asks, "How does the elevated levels of salinity in our source waters affect our ability to use the water down the road? The study is looking at that but also looking at the economics; for example, what does this high salt content mean for consumers and utilities?"

He says the shorter life span of fixtures and appliances and the cost to industry was estimated to be about \$30 million per year. "That is a rough number, mostly direct costs, but it is a starting point."

Groundwater in the southwest portion of the valley has especially high salinity, with water in the Buckeye area at 2,500 milligrams per liter and even more at times. (Brackish water is generally considered to be over 1,000 mg/l.) Rossi says some of this water could be treated to serve future water demands in the area. He says, "We are in some very preliminary discussions — very preliminary — about a possible regional brackish water desalination plant somewhere in the west valley. It could take this brackish water, irrigation tail water and water from the end of the Salt River Project system and convert it to potable supplies."

Unlike areas in Southern California the Phoenix area is not overly strapped for water supplies to require immediate adoption of desalination. Rossi says, "From a water resource planning perspec-

tive we are not in a critical situation in the city, but we also realize that our growth path is phenomenal. Desalination of brackish groundwater is not something we need to do soon, but it is part of our long-range plan."

Tucson also is participating in the Central Arizona Salinity Study. The city faces future water quality decisions that may involve desalination. In introducing CAP water to its customers, Tucson Water has been delivering a blend of groundwater and CAP water. Eventually, as increased amounts of CAP water are included in the blend, the salinity of water delivered to customers will increase, although it is unlikely to be more than 600 to 650 mg/l.

Water quality has been at ticklish issue in Tucson, with the troubled introduction of CAP water contributing to citizens' wariness in matters of water quality. As a result, the utility is concerned about the public's reaction to increased salinity. It intends to hold public hearings to solicit citizen input about what options to pursue. One option would be to build a desalination plant to ensure a high quality drinking water. This would be an expensive proposition that would increase the cost of water. This is not an immediate issue, but more of a down-the-road concern, to be considered as part of long-range planning.

In a sense, Tucson's consideration of desalination is to improve the aesthetics of water. Drinking water at 600 to 650 mg/l is not unpalatable, although water users whose supply was once total groundwater and then a blend might object. In Phoenix, where water supplies tend to be of higher salinity than those in Tucson, citizens drink water of about 600 mg/l.

With desalination on the national water resource agenda, many areas now look to the treatment process to help maintain sustainable water supplies. Arizona at this point is not among them. Improvements in desalination technology, however, will benefit the state. Central Arizona will be better able to confront its salt loading problem, and communities like Tucson can improve the quality of current drinking water supplies. 🏠



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