

ARIZONA WATER RESOURCE

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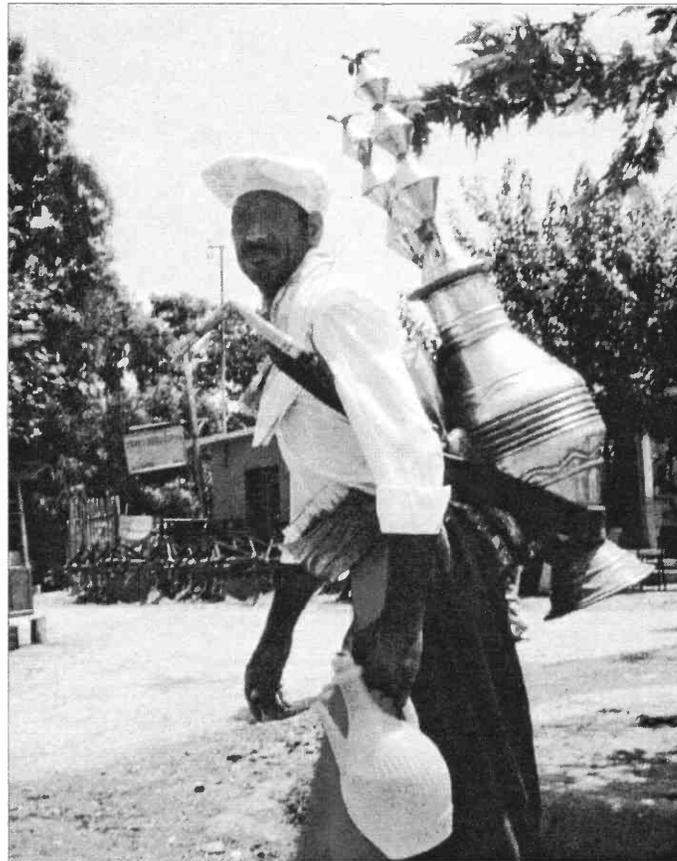
UA Hydrology Dept. to Lead \$16 Million Water Sustainability Center

The University of Arizona is the lead institution in a new \$16 million, multi-university center that will develop ways to efficiently manage water resources in semi-arid regions. Professor Soroosh Sorooshian of UA Hydrology and Water Resources will direct the new National Science Foundation (NSF) Science and Technology Center (STC). Researchers and students from several colleges at UA will be involved, as well as other universities, government agencies and private institutions.

Water resources are under extreme stress in many semi-arid regions because of rapid development, variations in climate and disruptions caused by long-term climate change. Sustaining these resources through the 21st century will depend on effectively managing water resources systems, Sorooshian says.

Developing water management

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The University of Arizona's Center of Middle Eastern Studies hosted a photography exhibit titled, "Fluid Meanings: Water as Resource in the Middle East." The photo to the left is of a water seller from Adana, Turkey. Now mostly seen in rural areas, the water seller peddled cold water or other beverages during hot summer months. (Photo: Mary B. Switzer)

Drought Increases CAP Demand

The Central Arizona Project is helping to relieve water shortages caused by this season's drought. And because of increased CAP deliveries Arizona will likely come close this year to using its full allocation of Colorado River water.

Despite recent July rains dry conditions continue in Arizona, fulfilling earlier expectations that this would be a very dry summer. La Niña effects were evident early in the year, and the period of January through March was the driest on record. Rain in early April provided some relief but not enough to mitigate developing drought conditions. CAP has been preparing for possible increased water demands since January by pumping extra water into Lake Pleasant. In May, storage at the lake was about 741,000 acre-feet or 13 percent above the normal storage limit of 654,000 acre-feet.

Although Arizona is experiencing drought conditions a water surplus has been declared on the Colorado River, the source of CAP water. This situation reflects the shift of storm patterns in the region. A season of heavy snow in the Rockies generally means the Arizona mountains are left high and dry, and vice versa. Interpreted hydrologically, low flow on the Salt, Agua Fria, Verde and the Gila generally means abundant flow on the Colorado River. The workings of weather favor CAP's role as a provider of drought relief.

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Drought Increases.... continued from page 1

Because of the dry conditions the runoff that Salt River Project normally receives between January through May was minimal this year. In fact, the period was the eighth driest on record. As a result, SRP's reservoir system, the source of much of the water for the Phoenix area, is 30 percent below normal for this time of year. As part of a strategy to cope with the water shortage SRP purchased 75,000 acre-feet of CAP water. The 75,000 acre-feet is about equal to another Saguaro Lake.

The utility also requested an additional 66,500 acre-feet of in-lieu Water Bank water, to replace groundwater that would otherwise have been pumped. Despite dipping into these water sources the utility will still need to pump 300,000 acre-feet of groundwater. This represents about a third of SRP's total annual supply. During years of more normal precipitation the utility generally pumps 50,000 to 100,000 acre-feet.

CAP water also is being used to keep San Carlos Lake from drying up. The water level of the lake is sufficiently low that reservoir releases to serve the San Carlos Irrigation and Drainage District (SCIDD) and the Gila River Indian Community (GRIC) threaten the fish population in the lake. Even with the recent rains the lake is a meager 4.4 percent of capacity. CAP will deliver 31,590 acre-feet to SCIDD and GRIC, to be used instead of lake water. This marks the second time CAP water was used to preserve the lake. In 1997, CAP delivered 17,000 acre-feet to the irrigation districts. In addition, both SCIDD and GRIC are purchasing

CAP water to supplement the sparse supply from the Gila River

Increased use of CAP water means Arizona will come closer to using its full Colorado River allocation of 2.8 million acre-feet. Current records for deliveries were set in 1997 when about 2.854 million acre-feet were used. An unmeasured return flow estimated at 246,000 acre-feet reduced this amount to an actual net use of 2.6 million acre-feet. The boost in CAP water use that year was mainly attributable to the Arizona Water Bank having come on line. CAP water use was down in 1998 because of the excess El Niño precipitation.

The May water use forecast this year anticipated 2.785 acre-feet for calendar year 1999. Actual use will probably be somewhat higher, but return flow credits again are expected to reduce this figure. Drought conditions account for the increased demand this year.

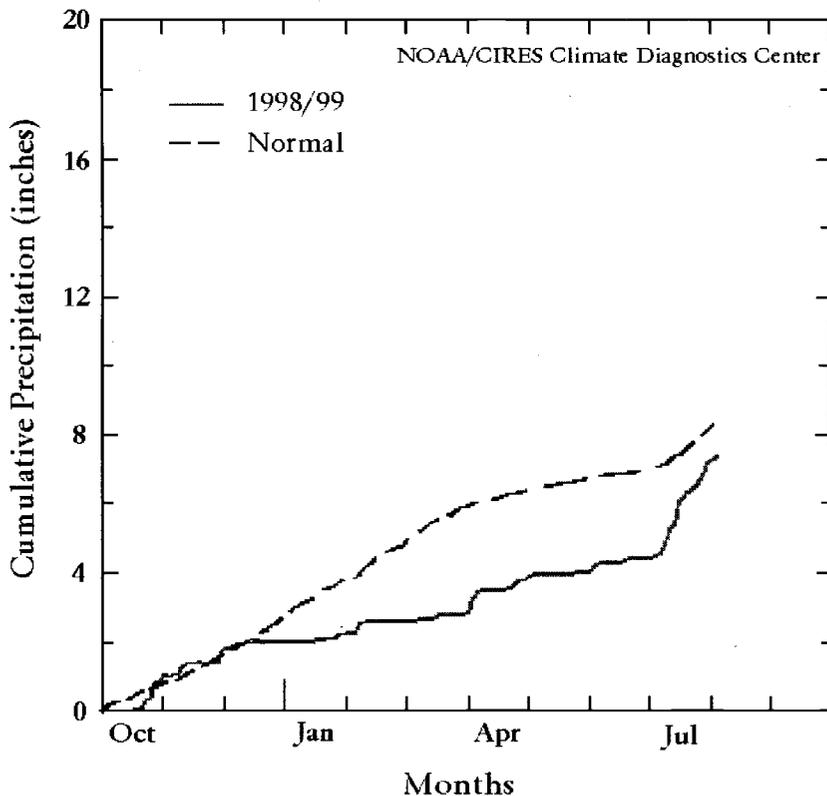
The increased CAP demand also is providing an opportunity to demonstrate the system's delivery capacity. This summer, CAP has set new daily flow records, measured in cubic feet per second (cfs). In fact, peak deliveries on June 30 and July 1 were about 3,900 cfs which at maximum flow locations along the canal exceeded the 3,000 cfs design capacity of the canal. At times last month a steady 3,600 cfs flow has been maintained, with canals on the west end of the system running about 400 cfs and about 3,200 cfs of deliveries down stream from Lake Pleasant. This is fullest capacity the canal has operated, and CAP officials say it demonstrates that the canal can run safely and efficiently at that level.

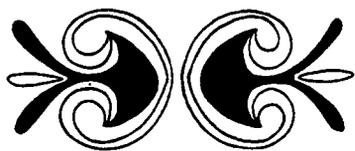
July Rains Bring Relief, but State Still Dry

Areas of Arizona received varied monsoon rainfall in July: 0.94 inches in Yuma, 2.05 in Safford, 2.9 in Phoenix and 6.8 in Tucson. The rainfall helped reduce the precipitation deficit, although precipitation over the last 12 months remains below normal. Because of last month's precipitation, drought conditions in areas of the state have eased, although a dry August could reverse the promising situation.

Although the short-term situation has improved, prospects for the fall remain in doubt. In the tropical Pacific, water temperatures are below normal, with signs of dropping further. This means the ongoing La Niña will likely linger into a second year. As a result, above normal temperatures and below normal rainfall would likely begin in September and continue into the winter. Signs point, however, to La Niña not being as strong as last winter. The warmth and dryness of the coming months then might not be as great as occurred last winter at the beginning of the drought.

Arizona Cumulative Precipitation (10/01/98 to 08/04/99)





Water Vapors

Tooting Our Horn

The Water Resources Research Center chalked up several successes lately. WRRC staff wrote a recently-published report, *Water in the Tucson Area: Seeking Sustainability*. (See "Publications" for details.) *The Arizona Daily Star* described the 155-page publication as offering "an encyclopedic range of information about local water issues, from 19th century well digging to current conservation strategies." *The Tucson Citizen* described it as "a comprehensive, politically untainted exam of water issues in the Tucson area" and "a valuable tool." We're just really glad it's done.

WRRC staff also prepared a newspaper supplement that was distributed with *The Arizona Daily Star* on Sunday, July 11. The 4-page full color supplement, printed by Tucson Newspapers, Inc. as a public service, contains information from the sustainability publication.

WRRC also has established a website with information about water research being conducted at the UA. This searchable data base is found at: <http://ag.arizona.edu/AZWATER/uaresearch/>

A final success story should be noted. Barbara Tellman, WRRC senior research specialist, received the first annual Arizona Audubon Council's "Educator of the Year" award. Barbara was recognized for her many publications, presentations and other good works in areas including riparian habitat, artificial wetlands, history of rivers, and impacts of exotic species.

Water Cliches to Fight About

"Whiskey's for drinking and water's for fighting about." So often quoted as to qualify as the premier water cliché of all times, at least in the West, this hackneyed and shop-worn remark labors at a truth. (The water cliché of next greatest currency is "Water flows uphill to money.") Often noted for its relaxing and aesthetic qualities, water also has sown a lot of ill will and provoked many conflicts, both within and among nations.

Resolving Water Conflicts

Knowing that battle lines are often drawn over water President Truman once offered a suggestion to soothe troubled waters. In a speech in Kansas City in April 1945, Truman said, "When Kansas and Colorado have a quarrel over water in the Arkansas River, they don't call out the National Guard in each state and go to war over it. They bring suit in the Supreme Court of the United States and abide by the decision. There isn't a reason in the world why we cannot do that internationally."

One might at first be taken with how the remark admirable reflects the American post-war feeling of buoyancy. Our way triumphed, and other nations would do well to look to us as a fitting model. Those of us familiar with Arizona water history, however, might fault Truman for his oversight. At least one water conflict provoked a state to call up its National Guard against another state. In 1933, Arizona mustered troops to prevent California from building diversion works on the Colorado River.

The Colorado River Compact, which Arizona eventually signed, divvied the waters among the Colorado River states. Many consider the compact to be a masterful piece of public policy, for, among other reasons, the rather large number of parties involved in the settlement: seven states and the federal government. That so many interests can abide by a negotiated compact is rightly considered an accomplishment.

To give credit where credit is due, however, the Danube River might be consid-

ered as providing a better example of cooperative river management. Located in Central Europe, the Danube is 1,700 miles long, running through or affecting water flow in 17 nations. These nations have reached accord on both water allocation and, more recently, pollution reduction needs. Although strained at times, the agreement seems to be holding up reasonably well.

Conflict Resolution

Recently the Japanese percussionist group Ondekoza, (in Japanese, "Demon Drummers") performed in Tucson. Program notes described a legend associated with one of the drums: "Odaiko or big drum is an instrument made of one tree trunk with a weight of 700 pounds and a diameter of four to five feet. The story has it that two villages were struggling for the control of their river which was the sole source of water in a year of severe drought. The battle was fought by drummers of both groups who attempted to outdo each other's performance. Since the existence of their village was at stake, their determination to survive was reflected in the sound produced by their drums. It was said that the losing team took responsibility for their defeat and committed suicide."

This settling of a water dispute through drumming might be viewed as an early example of conflict resolution, but for the unfortunate suicide of the losing side. In contrast, no casualties were reported when Arizona's National Guard took on California over Colorado River rights.



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News Briefs

Tucsonans Likely to Vote Again on CAP

Tucson's water struggles continue, with yet another voter initiative giving voters one more opportunity to decide the fate of Central Arizona Project water in their community. The Citizens Alliance for Water Security filed nearly 22,000 signatures attached to an initiative proposal, more than twice the number needed to place the initiative on the ballot.

Its presence on the November ballot would mark the fourth time in a dozen years that Tucson voters have been asked to decide CAP water use. The persistence

of the issue has prompted some to speak of it in intergenerational terms, with the latest initiative dubbed, "Son of Proposition 200." Passed in 1995, Proposition 200 restricted delivery of treated CAP water. A related initiative promoting recharge was defeated at the ballot in 1987 and a 1997 initiative would have severely weakened Proposition 200's provisions.

The present proposition would in effect revise Proposition 200's Water Consumer Protection Act. The new proposition's provisions include the following:

- The ban on direct delivery of treated river water would be extended for five years, unless salt content is significantly reduced. The 5-year period would commence when Tucson Water is in full compliance with terms of the ballot measure.
- Salaries of mayor and City Council members would be withheld if they failed to meet specified deadlines.
- A super-majority of five votes from

the seven-member mayor and council would be required to raise water rates, instead of the four "yes" votes the city charter now specifies.

- Groundwater supplies in the city's central basin would be fully replenished within five years with recharged treated CAP water.

Opponents to city water policy have cast the CAP controversy as between the common citizen and a power structure made up of city politicians, utility officials and developers. Since the last CAP voter initiative in 1995, Tucson Water hired a new director, David Modeer. Under his leadership Tucson Water has been more actively promoting at the grass-root level CAP direct delivery.

Both sides of the controversy agree that CAP water should be used to preserve dwindling groundwater reserves. Opinions differs whether it should be delivered to citizens, or used solely for agricultural, mining, and industrial purposes.

Fish Kills a Problem at Some Southern Arizona Lakes

Treated Sewage Cause of Lakeside Fish Kill

Repeated fish kills at Lakeside Lake on Tucson's east side posed a puzzle. City officials have long blamed Arizona Game and Fish which stocks the lake, claiming fish died from the stress of being transported from hatcheries. More recently, city officials theorized that the lake's 30-foot depth and cement bottom might have contributed to several mass fish kills and high fish mortality. Runoff from heavy rains has also been mentioned as a potential cause.

An 18-month study commissioned by the city concluded, however, that effluent, which has been pumped into the lake since June 1990, is the ultimate cause of the fish kill. The effluent in the lake introduces heavy nutrient loading which spurs the growth of algae and other plants. This excessive growth of algae then chokes off oxygen needed by the fish.

The report notes that because of its nutrient levels and algal biomass Lakeside can be considered as eutrophic. This means the lake is so rich in nutrients that the excessive growth of aquatic plants and the resulting bacteria consume most of the oxygen, choking fish and other organism. This is more likely to occur during warm weather.

Officials are considering solutions to the problem. If the effluent were further treated the problem might be solved, but it would be costly. For example, Tucson's Silverbell Lake is filled with effluent and has not had mass fish kills. That effluent, however, is first recharged in the Santa Cruz River, then captured by downstream wells and pumped it into the lake.

Proposed solutions include making Lakeside a boating marsh only. The city also is considering stocking the lake with white Amur fish that eat algae and aquatic weeds.

Fish Kill Occurs at Arivaca Lake

Climatic conditions played havoc in June with the trophy bass population at Arivaca Lake. A combination of cloud cover and strong winds created conditions that killed from about 4,000 to 5,000 fish at the southern Arizona lake. The fish died from oxygen starvation caused by a die-off of floating algae (phytoplankton).

Oxygen levels at the lake measured less than 1 part per million. To survive most warm-water species require at least 3 to 4 parts per million. Six or 7 parts per million is needed for them to continue to grow.

A chain of events led to the June fish kill. After three years of drought the lake was practically empty. The winter rains of last February then filled the lake and submerged the vegetation. This resulted in a great increase of nutrients that boosted algae growth as the weather warmed.

The recent cloud cover disrupted the photosynthesis of the algae. The algae began to die off, and their decay removed oxygen from the water. The strong winds played a part by stirring up the water. Nutrients at the bottom of the lake turned over, further increasing high nutrient levels and low oxygen. Such summer kills occur occasionally in shallow man-made lakes.

Smaller, younger fish are more likely to survive than mature fish. They remain closer to the surface where they can get sufficient oxygen. Fishing is not expected to be good at Arivaca lake for about two years. Anglers will have to wait for about five years before the trophy bass are back.



New Navajo Pumping Plant Promises Potatoes

Irrigated acreage on the Navajo reservation will be expanding when a new pumping plant begins operation this summer. A component of the Navajo Indian Irrigation Project (NIIP), the Gallegos Pumping Plant will increase reservation irrigated acreage by about a third, from the current 64,000 acres to 84,000 acres.

The Gallegos Plant will draw a maximum of 880 cubic feet per second from the San Juan River, lifting the water 330 feet to a sandy plateau to irrigate potato crops destined to become potato chips. Operating at full capacity, the eight pumps will run at 39,600 horsepower and consume about \$1.1 million worth of electricity per year.

Increased irrigated acreage promises employment opportunities to the Navajo Tribe which has an unemployment rate of about 44 percent. The additional irrigated acreage may create as many as 3,000 new jobs.

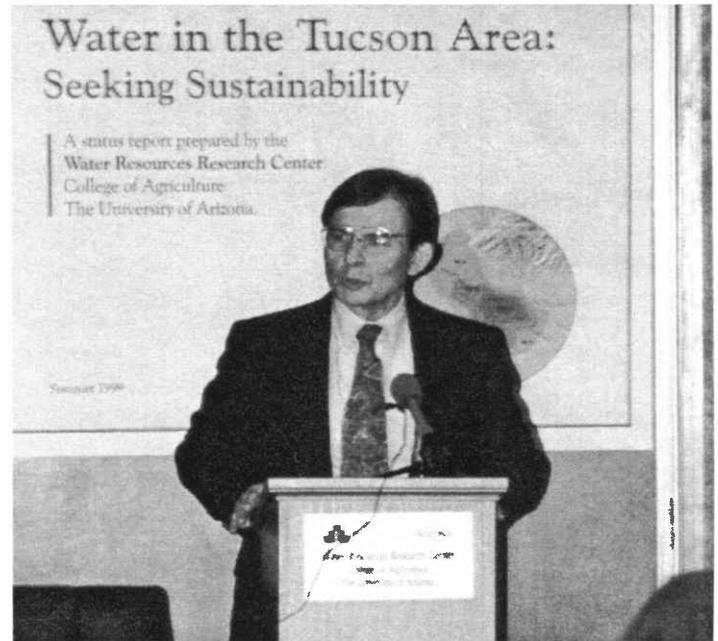
The Gallegos Plant is the latest step taken toward fully implementing the NIIP. The project was constructed to fulfill a 1868 treaty obligation and also is a partial payment to the tribe for 110,000 acre-feet of water delivered annually to Albuquerque. The Navajo have water rights of 508,000 acre-feet per year from Navajo Dam.

Constructed in the early 1960s, the NIIP did not begin operations until 1973. The project at first watered 10,000 acres and was slowly expanded. With expenditures to date totaling \$406 million, the project now irrigates 63,900 acres by means of sprinkler irrigation. Future plans call for another pumping plant to irrigate an additional 26,000 acres.

When completed NIIP is expected to be one of the largest Indian irrigation projects in the country. Considering, however, that estimates for completing the proposed pumping plant range from seven to 12 years this distinction resides in the future. Nor is the delay in constructing the proposed pumping plant an isolated occurrence. Funding of the entire NIIP has been an ongoing struggle due to Congressional opposition to BIA's funding requests. Because of this situation implementation of NIIP is now about 30 years behind schedule.

Research Links Bacteria in Water and Stomach Ulcers

Researchers have reportedly found a direct link between contaminated drinking water and stomach ulcers. Scientists at Pennsylvania State University interviewed residents who drank from wells and other private, untreated water sources in Pennsylvania where the bacteria *Helicobacter pylori* was found. They found a statistically significant correlation between the presence of the bacteria and stomach ulcers in residents who drank the contaminated water. Water is usually tested for coliform bacteria in water systems around the country, however the ulcer-causing *H. pylori* bacteria was found in coliform-free water samples — indicating that current testing standards may not be adequate. The new research may not be inconsistent with the theory linking stomach ulcers and stress, because stress produces acid in the stomach that aids in the growth of bacteria.



University of Arizona President Peter Likins held a press conference June 21 to announce publication of Water in the Tucson Area: Seeking Sustainability and to pledge the UA's commitment to providing water expertise and information to the Tucson community. The publication is part of a broader study of water sustainability currently underway at the UA. At the news conference Likins explained his special interest and support of this effort, "We're trying, with this example, to find a way for the university's extraordinary expertise...to be available to the community." Emphasizing the university's objective role in such issues, Likins said, "We won't make decisions that are properly yours, not ours to make." Water in the Tucson Area was written and published by the UA Water Resources Research Center. (See Publications)

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Arizona Department of Environmental Quality
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 Arizona Municipal Water Users Association
 Central Arizona Water Conservation District
 Geraghty & Miller
 Metro Water District
 Salt River Project
 Tucson Water
 USGS Water Resources Division
 Water Conservation Alliance of Southern Arizona
 Water Utilities Association of Arizona

Their contributions help make continued publication of this newsletter possible.

Stream of History

Journalism Narrates Water Tales.

Newspaper stories provide a running account of water concerns in Tucson around the turn of the century. Some stories could have been written yesterday; for example, the need to conserve water. Other stories now strike us as coming from a more innocent era when water use and regulation were a far less complex business than they are today. Dates and brief summaries of stories are provided below.

11/15/81 City Council grants former mayor Robert W. Leatherwood the privilege of introducing water into the city.

9/1/82 Tucson Water Company delivers first water to the City of Tucson via gravity pipe system.

10/26/82 We have water in abundance and there should be no excuse for dusty streets. Now we have plenty of water, and it is time to beautify the city.

6/5/84 No one thing has done more to advance the permanent stability of Tucson than the introduction of water. It moved the people to beautify home surroundings by planting trees, shrubbery, lawns and flower spots.

3/3/87 At the next meeting of the City Council the price of water will be up for discussion. In compliance with the instructions the city clerk had previously received he had sent letters to other

western cities to ascertain the annual amount paid for water for public purposes. Replies have been received and will be presented to the mayor and Council. 11/13/92 Tucson is recognized as the headquarters for Arizona, and the completion of the irrigating system in this valley will make it ahead of the most favored portions of California. 1/9/93 Mr. Shortridge says that 5,000 gallons of water per day is put on the streets to keep the dust down. He states that some individuals request more to be put down in front of their homes and businesses but this causes mud and creates more dust later. In the summer months he reports using 10,000 gallons per day. 6/9/06 Charles Haffield, the rainmaker, is to come to Arizona next month to conduct some more of his experiments with a view to drawing the reluctant moisture from the heavens. He will make his headquarters in Tucson. Although Haffield has been branded as a faker, the government has become interested in this experiments and he is to be assisted in his work here by the Department of Agriculture. 6/24/06 Owing to the consumption of water at present being far in excess of all attention to ordinance No. 143, which says that all irrigating shall be done between the hours of 5 and 8 o'clock PM and that under supervision of some person on the premises. Persons allowing faucets to run during other hours, than those specified in this section, upon conviction shall be subject to a fine not exceeding \$50. All leaky plumbing fixtures must at once be repaired, and if found still leaking by inspectors, after proper notice, ordinance will be enforced.

H2O Conservation Notes

Flawed Flappers Fuel Low-Flush Flap

Water conservation professionals are in the awkward position of publicly defending ultra-low-flush (ULF) toilets as effective water conservation devices even as they quietly debate growing evidence that some ULF models become water wasters as they age. Congressman Knollenberg (R-MI) once again is trying to repeal the water use efficiency standards for plumbing fixtures contained in the Federal Energy Policy Act. Low consumption plumbing fixtures, including ULF toilets using 1.6 gallons or less, were required in new construction on a national basis as of 1994.

Some early ULF toilets needed frequent double flushes or had other serious design flaws, but most models now work well when new. The issue is durability over time. Many models of ULF toilets contain proprietary parts, such as early-close flapper valves, that wear out and cannot be readily found in hardware or plumbing supply stores. Even home improvement stores that sell ULF toilets often do not stock spare parts, leaving the homeowner to decide whether to live with a leaky toilet or replace the proprietary part with a generic flapper, which may greatly increase water use. In many cases, the homeowner is not even aware that the replacement part differs from the original, or that installing it will increase water use.

The problem is significant for the many water and wastewater utilities that spent hundreds of millions of dollars on rebates and

other programs to replace existing toilets with ULFs, which were expected to reduce water demand and wastewater flows for decades. Hillsborough County, Florida, which spent \$7 million over six years on 58,000 toilet rebates, reports its customers installed over 190 different ULF models. Now this wide variety of ULF models and lack of standardized parts are causing the initial water savings to erode. New federal drinking water regulations leading to higher disinfection levels in many communities, may further shorten the useful lives of flappers and other rubber parts.

What to do about the problem is not clear. Some conservation professionals advocate limiting rebates to ULF models with standard parts, such as some pressure-assist toilets. A short-term strategy calls for compiling a catalog of all ULF toilet makes and models, listing sources for those parts that wear out over time. The catalog would be available at major home improvement and plumbing outlets, as well as on the internet.

Longer-term strategies include more research on which ULF models rely on proprietary parts, and how quickly the parts deteriorate. This information could then be used to urge major toilet suppliers and municipalities offering rebates to avoid the more problematic models. One study by the Water Resources Research Center and the City of Phoenix Water Department is looking at the water use of some 200 toilets installed through City of Tucson rebates eight years ago.

The consensus among conservation professionals is that concerted action on the part of large municipal water and wastewater utilities is needed to get the toilet industry to act. Otherwise they fear Congress may reject the entire ULF fixture because of faulty parts. This would be like throwing out the baby with the bath water because the tub leaks.



Special Projects

The University of Arizona Water Resources Research Center (WRRC) administers the Section 104b program of the Water Resources Research Act. Funded by the U.S. Geological Survey, 104b provides support for small research projects investigating water issues of importance to the states and the regions. WRRC was provided \$55,000 to \$60,000 to fund 104b research. Only faculty members at Arizona's state universities are eligible to receive program funding. Four projects received 104b funding:

Project Title: Isotope bihydrology of an ephemeral drainage.

Principal Investigators: David Williams, Kevin Hultine, University of Arizona and David Goodrich, USDA-ARS Southwest Watershed Research Center

Project Description: Although ephemeral channels are integral components of groundwater/surface water systems in arid basins of the Southwest, inadequate knowledge exists of pattern and process relating to water movement through these systems. What is specifically lacking is knowledge on transpiration losses from groundwater and soil by dominant woody riparian species and details of recharge in specific ephemeral drainages. The project will establish a suite of hydrological and ecophysiological isotope studies at Walnut Gulch in southeastern Arizona to characterize the fate of water moving through a representative ephemeral drainage in a semiarid region.

The project takes a multi-disciplinary approach and attempts to relate biological controls on evapo-transpiration to processes of groundwater recharge. Specifically, results will shed light on the magnitude and timing of deep recharge from ephemeral channels to the upper San Pedro watershed aquifer.

Project Title: Approaches to reduce taste and odor problems in drinking water. *Principal Investigators:* Milton R. Sommerfeld, Tomas A. Dempster, Arizona State University

Project Description: Municipalities in the Phoenix Metropolitan area have experienced taste and odor problems in their drinking water. The problem seems to be increasing, especially during the late summer and extending into winter. Two compounds, 2-methylisoborneol (MIB) and geosim, are generally recognized as causing the unpleasant earthy/moldy taste and odor. Blue-green algae (cyanobacteria) and fungi (actinomycetes) are thought to produce these compounds. This project involves collaboration between operators of Chandler Water Treatment Plant and Arizona State University researchers, with cooperation of Salt River Project

The researchers' approach is to: 1) isolate and culture algae, bacteria and fungi from the treatment plant and at sites in the distribution system in an attempt to identify the specific "culprit" organisms; 2) determine the efficiency of several laboratory control treatment methods (e.g., copper sulfate, chlorine, etc.) on the individual "culprit" organisms; and 3) assess the efficiency of pilot field treatments (physical, chemical, biological) on the control of the specific organisms.

Project Title: Partitioning the causative factors of evapo-sublimation. *Principal Investigators:* Charles C. Avery, Leland R. Dexter, Northern Arizona University

Project Description: Studies show that sixty to seventy-five percent of the usable water resources for western states originates as snowfall. The accumulated water commonly sits for long periods as snow prior to melting. This exposes it to vapor loss through a number of relatively poorly described and poorly quantified pathways. The researchers refer to the combination of these vapor losses as evapo-sublimation abstraction.

Previous field studies suggest that 1.5 mm of snow water equivalent is lost in northern Arizona during an average, clear winter day. With the large amount of snow accumulated during the winter season, the loss can substantially reduce the available water resources. Current water resource forecasting fails to consider the variables involved in evapo-sublimation. The ratio of snowfall to runoff is therefore immaterial.

The researchers have designed and constructed a cold-chamber based "sublimimeter," a closed box in which snowpack is weighed while subjected to a controlled environment. They are able to control airflow and lamp intensity but have not yet implemented a way to control humidity. Program funding will allow them to build such a device as well as to develop a multiple-regression model.

Experiments will allow the researchers to explicitly separate (partition) critical evap-sublimation variables, identify specific sub-problems for future analysis and construct better physically based models of evapo-sublimation.

Project Title: Physical effects of flood flows on seedling growth and survivorship: comparative responses of native riparian trees and shrubs to saltcedar. *Principal Investigators:* Julie Stromberg, Crystal Levine, Arizona State University

Project Description: Altered water regimes have caused substantial decline in productivity, species diversity, and extent in many of Arizona's native riparian forests. Some dam managers are attempting to restore native vegetation by prescribing controlled flood flows; timing spring flood flow to coincide with the germination phenology of targeted species. Some of their efforts have achieved notable success.

Unregulated streams of the Southwest typically carry high sediment loads. If deposited on young seedlings by mid-season flooding, the sediment can kill or scour the seedlings. Native seedlings have a high stem growth rate that may reduce the likelihood of complete sediment burial by monsoon-driven flood flows. Similarly, rapid root elongation would provide some insurance against being dislodged by scouring flow. Since flow in southwestern rivers is driven by bi-modal precipitation patterns, native riparian tree species may be better adapted to withstand mid-summer floods than exotics accustomed only to spring floods from melted snow.

The study objectives are: 1) to quantify seedling growth and survival thresholds of four dominant woody riparian species: Fremont cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), seep willow (*Baccharis salicifolia*), and tamarisk (*Tamarix chinensis*) in response to a) simulated flood scour, b) sediment burial, c) water availability, and d) soil texture; 2) to contribute information for development of an effective long-term plan to curtail further colonization by *Tamarix* and to help re-establish native riparian forest on managed Arizona rivers.



Publications

Water in the Tucson Area: Seeking Sustainability

Joe Gelt, Jim Henderson, Kenneth Seasholes, Barbara Tellman and Gary Woodard

This status report discusses water conditions and issues in the Tucson area, from overdraft and demand trends to CAP water use and varied methods of water treatment. Underlining the report is the belief that Tucson's critical water issues are complex, cutting across hydrological, social, cultural, engineering, economic and political fields. The publication pulls together a vast range of information to encourage a broad involvement of varied interests, from citizens to government officials, in the discussion and resolution of Tucson's water problems. The publication was prepared by The University of Arizona's Water Resources Research Center at the direction, and with the financial support of UA President Likins as a public service. The report is one part of a broader study of water sustainability currently underway at the UA. Copies of the report are available from the Water Resources Research Center, The University of Arizona, 350 N. Campbell Ave., Tucson, AZ 85719; phone: 520-792-9591; fax: 520-792-8518; email: wrrc@ag.arizona.edu. The report along with an interactive water budget also is available on the WRRC website: <http://ag.arizona.edu/AZWATER/>

Two reports on Arizona water conditions have been issued by the U.S. Geological Survey. The reports may be purchased from the National Technical Information Service, Springfield, Virginia 22161. Copies are available for examination at U.S.G.S. offices in Tucson, Tempe, Flagstaff, and Yuma.

Water Resource Data Arizona Water Year 1998

S. Tadayon, N.R. Duet, G.G. Fisk, H.F. McCormack, G.L. Pope and P.D. Rigas

Prepared in cooperation with the state of Arizona and other agencies, this U.S. Geological Survey report includes a compilation of surface-water, chemical-quality and groundwater data. The report contains discharge records for 167 gaging stations, annual peaks for 27 crest-stage partial-record stations and three miscellaneous sites; stage and/or contents records for 10 lakes and reservoirs; water-quality records for 14 continuous record stations; two miscellaneous sites, and 186 wells.

Statistical Summaries of Streamflow Data and Characteristics of Drainage Basins for Selected Streamflow-Gaging Stations in Arizona Through Water Year 1996.

G.L. Pope, P. D. Rigas and C.F. Smith

The report contains discharge records for 142 continuous-record stream-flow gaging stations (active and discontinued) and 178 peak-flow stations (active and discontinued) in Arizona through water year 1996. Stream-flow records were generated only for stations with a minimum of 10 years of data.

Activities of the Water Resources Division in Arizona, 1996-97
Steve A. Longworth, Ellen K. Van De Vanter and Sidney A. Alwin
The report, published by the U.S. Geological Survey, summarizes the 34 water-resource projects worked on during fiscal years 1996 and 1997. Also included is a brief history of the organization, the mission of its water resource division, organization of the Arizona District, funding sources, and a summary of water conditions in Arizona. The report may be purchased from the U.S. Geological Survey, Information Services, Box 25286, Denver Federal Center, Denver, CO 80225-0286; phone: 303-202-4210.

The Politics of Ecosystem Management

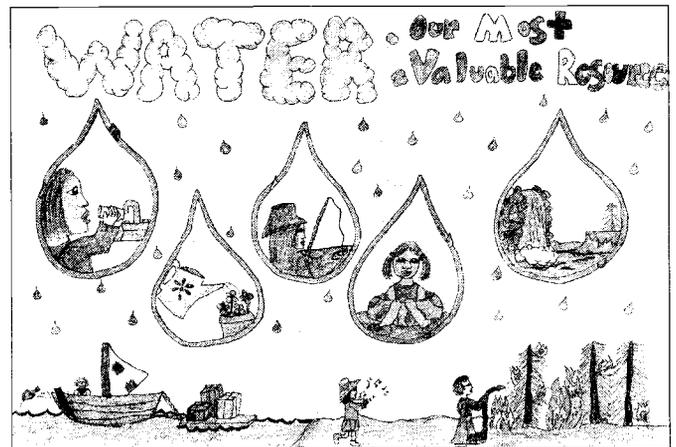
Hanna J. Cortner and Margaret A. Moote

While political factors are an important aspect of ecosystem management, they are greatly disregarded by most authors and scholars of the subject. This book looks at the political difficulties that must be faced as ecosystem management evolves from theory into practice. The book can be purchased for \$25 paper and \$50 cloth from Island Press. Contact: Robbie Kaplan, 1718 Connecticut Avenue N.W., Suite 300, Washington, D.C. 20009-1148; phone: 202-232-7933; fax: 202-234-1328; email: rkaplan@islandpress.org

Water Resources Impact

The American Water Resources Association

The AWRA announce their newest publication, a bi-monthly magazine focusing on logical resolutions to today's water resource problems. It will provide articles pertaining to contemporary solutions for everyday problems faced by water resource management. Yearly subscriptions are available by mail and cost \$40 domestic and \$50 foreign (add \$15 for airmail). For additional information contact: American Water Resources Association, 950 Herndon Parkway, Suite 300, Herndon, VA 20170-5531; phone: 703-904-1225; fax: 703-904-1228; email: awrahq@aol.com



Above is an Arizona winning entry in an art contest for work to be placed in the International Office of Water Education's 1999-2000 calendar. The artist is Lynn Sharpy, a fifth grader at MacArthur School, Mesa. The other Arizona winner is Mandy Krumm, a third grader from McDowell Elementary School, Fountain Hills. Two winners are chosen each year from each of ten western states. Lin Stevens-Moore, Project WET director at WRRC, organized the contest in Arizona.



Legislation & Law

Water Resources Legislation: 1999 Legislative Summary

Water management-related legislation passed by the 44th Arizona Legislature is summarized below. The general effective date of the following legislation is August 6, 1999. (The summary was prepared by the Arizona Department of Water Resources.)

HB 2463 Water Banking Amendments

As part of the legislation that created the Arizona Water Banking Authority (AWBA), the Arizona Water Banking Study Commission was created to evaluate the effectiveness of AWBA's powers and duties and make appropriate recommendations to the Legislature. HB 2463 was the result of the Study Commission's recommendation and includes the following provisions: 1) Authorizes AWBA to enter into agreements with Arizona water users to provide water storage services and to administer the storage accounting thereby assisting water users to earn water storage credits; 2) Provides the AWBA the authority to loan long-term storage credits to Arizona water users for short-term use with appropriate compensation to the AWBA; 3) Allows the AWBA to earn long-term storage credits by obtaining and storing effluent if the AWBA has stored the available excess CAP water and if CAP water is not otherwise available; and 4) Expands the ability of the AWBA to provide drought protection for water providers that do not generally provide CAP to their customers.

HB 2262 CAGRDR; Assured Water Supply allows a city, town or private water company that qualifies as a member service area of the Central Arizona Groundwater Replenishment District (CAGRDR) to meet the physically available water supply standard of the assured water supply rules by entering into a contract with the CAGRDR to store water in the area where the water will be recovered from or to re-

ceive water through direct delivery from the CAGRDR. First however CAGRDR must submit a water availability status plan for approval by the Arizona Department of Water Resources. Following the initial submittal of a plan, CAGRDR must submit subsequent plans every five years as part of its submittal of long-range plans describing the activities the CAGRDR proposes to undertake to fulfill their replenishment obligations. The amount of water that may be served pursuant to these agreements is limited to no more than 20,000 acre-feet per year.

HB 2144 Drainage Water Withdrawal

Permits allows water withdrawn pursuant to a drainage water withdrawal permit in designated waterlogged areas to be used or conveyed for a nonirrigation use within the designated waterlogged area. Use of the water withdrawn pursuant to a drainage water withdrawal permit is to be accounted for as surface water when determining compliance with water conservation requirements during the second and third management periods. The water must be used in a riparian habitat or at a turf-related facility such as a golf course, park or school served by a nonirrigation grandfathered right or a general industrial use permit. Rather than be levied a groundwater withdrawal fee, a user who withdraws groundwater pursuant to a drainage water withdrawal permit must pay a \$500 annual fee to be deposited into the Water Quality Assurance Revolving Fund.

HB 2189 Environment; Corrections

As part of a comprehensive legislative effort to address Department of Environmental Quality issues two provisions addressed matters important to water quantity management. The first applied to language in Water Quality Assurance Revolving Fund statutes that extends to the second management plan a provision that ADWR must account for groundwater withdrawn pursuant to a groundwater quality remediation in the same way as it accounts for surface water in determining compliance with third, fourth and fifth management plan conservation requirements. The second amendment clarifies that groundwater withdrawn from wells drilled to replace wells closed as a result of contamination addressed in a remedial action does not qualify for the conservation accounting break, nor does the

groundwater qualify for an exemption from assured water supply accounting provisions.

SB 1150 Generating Plants; Air, Water Study was passed to address issues regarding the use of groundwater in a gas-fired power plant proposed to be located near Kingman, Arizona. This bill creates a joint legislative study committee on gas fired electrical generating plants that is directed to evaluate the effects on the aquifers and other water sources that result from the use of groundwater and surface water by such plants. The bill also directs the committee to look at air quality, revenue, taxation and economic development issues.

SB 1173 CAWCD Board; Population Basis (Laws 1999, Chapter 58)

addresses the potential concern that in the 2000 census Pima County population will exceed 700,000, thereby entitling Pima County to increase its representation on the Central Arizona Water Conservation District Board from 4 to 10 directors. Representation on the board would then be equal to that of Maricopa County, when the population of Pima County is approximately one-third that of Maricopa County. This legislation maintains a 15 member board, with one seat to Pinal County, four to Pima County and ten to Maricopa County. To address proportional representation requirements, a system of proportional weighting of board votes is established based on the distribution of the population of each county.

General Appropriations bill for fiscal years 2000 and 2001 addressed two issues pertaining to ADWR. The first created a \$1.2 million rural water studies appropriation for FY2000 to be used to provide state contributions to water management studies conducted in eight areas of the state. In addition, the Arizona Water Protection Fund received no appropriation, and was directed instead to use currently unencumbered funds to finance its activities for the 2000 and 2001 fiscal years.





Announcements

Position Available: Project WET Program Coordinator

University of Arizona's Water Resources Research Center announces a vacancy for an Instructional Specialist Sr. Position. Incumbent develops, presents and coordinates Project WET (Water Education for Teachers), educational activities, projects and programs as part of an overall K-12 water education program. Check UA Human Resources web site for details: www.hr.arizona.edu

"Conserve This!" Water Conservation Workshop

The Water Conservation Alliance of Southern Arizona (Water CASA) is sponsoring a one-day working conference, "Horizontal Solutions to Water Conservation Struggles in a Sometimes Vertical World" September 28 at the University Marriott Hotel in Tucson. The conference objective is for members of the greater water conservation community to identify and address current concerns in the field and to chart future directions. For additional information contact Val Little, Water CASA, 350 N. Campbell Ave, Tucson, AZ 85719; phone: 520-792-9591 ex.55; fax: 520-792-8518; email: vlittle@ag.arizona.edu

AWWA Schedules Speciality Conference

The American Water Works Association's second biennial specialty conference on water resources issues will be conducted September 26-29 in Norfolk, Virginia. Topics include source water protection, conservation and demand management, aquifer storage and recovery, and membrane treatment. The conference is geared towards water resource professionals including engineers, planners, utility operations and management personnel and regulators. For additional information contact: Rick Harmon, AWWA; phone: 303-347-6195; email: rharmon@awwa.org

Conference on Rural AZ Water Issues

The Phoenix and Flagstaff chapters of the Arizona Hydrological Society are co-hosting the 1999 Arizona Hydrological Society Symposium. The theme is "Water Issues and Partnership for Rural Arizona," and sessions include the following topics: general stream adjudications; recharge processes and problems; riparian restoration; GIS and data management systems; and U.S./Mexico Border Environmental issues. The symposium is being held at the Hon Dah Resort in Hon Dah, Arizona on September 8-11. For information contact: Arizona Hydrological Society, c/o Planners Ink, Irene Ogata, 240 N. Court Ave., Tucson AZ 85701; phone: 520-882-8177; fax: 520-882-8465; email: planink@azstarnet.com

AWWARF Issues RFP for Water Research

The AWWA Research Foundation requests proposals for projects on the following water research topics: 1) avoiding negative outcomes from emergency events (RFP 2636); 2) contribution of source water type to the endemic level of microbial disease (RFP 2637); 3) customer attitudes and perceptions of point-of-use applications and bottled water use (RFP 2638); and 4) public perception of tap water chlorinous flavor (RFP 2639). Proposals submitted in response to these RFPs must be postmarked by November 1. For additional information contact: AWWARF, 6666 W. Quincy Ave., Denver, CO 80235. phone: 303-347-6211; web site: <http://www.awwarf.com/>

ASCE Call for Papers

The American Society of Civil Engineers is hosting a 2000 Joint Conference on Water Resources Engineering and Water Resources Planning & Management, to be held July 30 - August, 2000 in Minneapolis. This first-time ever joint conference marks a new era of partnership between ASCE's Water Resources Engineering and Water Resources Planning & Management divisions. Not just for engineers, this conference is being developed to include presentations from allied disciplines, with a focus on issues that cross both the water resources engineering and resource planning and management. For more information on the call for papers or conference program visit the conference website at <http://www.mpls2000.asce.org> Abstracts for presentations and poster sessions are due October 15.

Science/Law Interrelate at Upcoming Conference

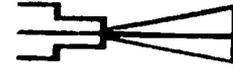
On November 11- 13 the James El Rogers College of Law, University of Arizona, will host an interdisciplinary conference: Environmental Restoration: Challenge for the New Millennium. The conference will draw together nationally recognized speakers from the fields of history, hydrology, ethics, biology, ecology, philosophy, environmental policy, public administration, economics and law to discuss environmental restoration. A key focus of the conference will be the interrelationship between science and law. For further information contact Vicki or Donna at the Development Office, James E. Rogers College of Law, The University of Arizona; phone: 520-621-8430.

Dam Safety Conference

The Association of State Dam Safety Officials will hold its Dam Safety '99 conference on October 10-13 at the Hyatt Regency in St. Louis, Missouri. Engineers, geologists, hydrologists, dam owners and others working in the field of dam safety are invited to attend. The final date to make hotel reservations is September 10. For additional information contact: Association of State Dam Safety Officials, 450 Old Vine Street, Lexington, KY 40507; phone: 606-257-5140; fax: 606-323-1958; email: damsafety@aol.com



Calendar of Events



RECURRING

Arizona Hydrological Society

(Flagstaff). 2nd Tuesday of the month (during the school year), 7:00 pm NAU, Southwest Forest and Science Complex, 2500 S. Pine Knoll Dr., Room 136, Flagstaff. Contact: Abe Springer 520-523-7198.

Arizona Hydrological Society (Phoenix). Usually 2nd Tuesday of the month. Contact: Christie O'Day 602-379-3087 ext. 224.

Arizona Hydrological Society (Tucson). Usually 2nd Tuesday of the month. Contact: Laura Davis 520-326-1898.

Arizona Water Protection Fund Commission. Contact: Irmalisa Horton 602-417-2400 ext. 7016.

Arizona Water Resources Advisory Board. Contact: Kathy Donoghue 602-417-2410.

Central Arizona Water Conservation District. Usually 1st and 3rd Thursdays of the month, time to be determined one week before. CAP Board Room, 23636 N. 7th St., Phoenix. Contact: Ardis McBee 602-869-2210.

City of Tucson Citizens Water Advisory Committee. Usually 1st Tuesday of the month, 7:00 am - 9:00 am 310 W. Alameda, Tucson. Contact: John O'Hare 520-791-5080 ext. 1446.

Maricopa Association of Governments / Water Quality Advisory Committee. Contact: Lindy Bauer 602-254-6308.

Maricopa County Flood Control Advisory Board. Usually 4th Wednesday of the month, 2:00 pm, 2801 W. Durango, Phoenix. Contact: Kathy Smith 602-506-1501.

Phoenix AMA, GUAC. Scheduled monthly, please call. Conference Room A, 500 N. 3rd St., Phoenix. Contact: Mark Frank 602-417-2465.

Pima Assoc. Governments / Water Quality Subcommittee. Usually 3rd Thursday of the month, 9:00 am 177 N. Church St., Suite 405, Tucson. Contact: Greg Hess 520-792-1093.

Pinal AMA, GUAC. Usually 3rd Thursday of the month, 2:00 pm. Pinal AMA Conference Room, 1000 E. Racine, Casa Grande. Contact: Randy Edmond 520-836-4857.

Prescott AMA, GUAC. 2200 E. Hillside Rd., Prescott. Contact: Phil Foster 520-778-7202.

Santa Cruz AMA, GUAC. Usually 3rd Wednesday of the month, 9:00 am, Santa Cruz AMA Conference Room, 857 W. Bell Rd., Suite 3, Nogales. Contact: Kay Garrett 520-761-1814.

Tucson AMA, GUAC. Usually 3rd or 4th Friday of the month, 9:00 am, Tucson AMA Conference Room, 400 W. Congress, Suite 518, Tucson. Contact: Kathy Jacobs 520-770-3800.

Tucson AMA, Safe Yield Task Force. Every Wednesday. Contact: Kathy Jacobs 520-770-3800.

Verde Watershed Association. Contact: John Parsons and Tom Bonomo, VWA Newsletter Editors, Verde Watershed Association, P.O. Box 4595, Camp Verde, AZ, 86322. 520-567-2496. Message phone: 520-649-9978, email: obarc@sedona.net <http://www.vwa.org>

Water Users Association of Arizona. 2nd Friday of the month at noon (except in September). Call for reservations and exact location. Contact: Paul Gardner, 480-987-3240.

Yavapai County Flood Control District Board of Directors. Contact: Ken Spedding, 520-771-3197.

UPCOMING



November 16-17, **Wetlands and Remediation: An International Conference.** Salt Lake City, Utah. Early registration fee is \$545 government/university and \$595 industry if payment is received before August 31. Thereafter the rates will be \$595 government/university and \$645 industry. For information contact: The Conference Group at 800-783-6338.

November 8 -10, **Divided Waters – Common Ground / Aguas divididas – Areas comunes** is a bi-national conference to foster cooperation in the environmentally sensitive Upper San Pedro Basin of Sonora, Mexico and Arizona. Further information will be forthcoming and can be obtained from the SALSA website: <http://www.tucson.ars.ag.gov/salsa/salsahome.html> Information requests and queries can be directed to either Dr. Bruce F. Goff, USDA-ARS, phone: 520-670-6380, ext 1498; email: bgoff@tucson.ars.ag.gov or Dr. Christopher J. Watts, IMADES, phone: 52-62-10-15-95, email: watts@cideson.mx

December 2 -3, **The Rio Grande Compact: It's the Law.** For more information on the New Mexico's Water Resources Research Institute's annual conference contact Cathy Ortega Klett, NM Water Resources Research Institute, NMSU Box 30001 Dept 3167, Las Cruces, NM 88003; phone: 505-646-4337; fax: 505-646-6418; email: coklett@WRRI.nmsu.edu

Submit calendar, announcement, or publication information to Chris Hudson, WRRIC; phone: 520-792-9591 x16; fax 520-792-8518; email crhudson@ag.arizona.edu

New Center.... continued from page 1

strategies demands integrating and accommodating a wide variety of needs, both environmental and human. To do this, the STC will set research priorities by involving researchers and water resources managers and users. Among the large water providers now active in the center are Arizona's Salt River Project, the Elephant Butte Irrigation District in New Mexico and the Metropolitan Water District of Southern California

By providing decision-makers with reliable information the program also will help resolve pressing water issues at the local level. Sorooshian identified Tucson's ongoing struggle with Central Arizona Project issues as the type of problem the new program can help resolve.

More accurate measurements of groundwater recharge rates will enable hydrologists to determine to what extent Tucsonans can rely on the aquifer for water supplies, he said. Also increased accuracy in predicting frequency of droughts and floods and rainfall trends will greatly affect how groundwater is used in the area, he said.

Research will differ from most water resources research in the degree to which it is coordinated, inter-disciplinary and user-directed. The goal is to generate research findings and models with real-world applications and get the new technology rapidly implemented.

Along with research, the STC will support educational and outreach activities. Educational efforts will span kindergarten through graduate school levels and will include development of programs and curricula for use in science education programs. The center aims to educate a new generation of water resources managers, providing them an interdisciplinary perspective and new technological skills and tools. Increasing the number and diversity of young people considering careers in various water resources fields is another major goal. The STC also will

undertake to increase the hydrologic literacy of the general public.

Outreach activities will be geared not only at making decision-makers aware of the technology being generated by researchers, but also at informing researchers what improved information is needed by decision-makers. This two-way flow of information is geared at increasing the usefulness of new water resources management tools.

The center will draw upon researchers with varied expertise and from diverse locations, enabling it to investigate larger, more complex problems than can be addressed by individuals or small groups working in a local area. For example, center researchers plan to study riparian systems and the various aspects of water and salinity balance on a basin-wide scale. These results then will be used to develop basin-scale hydrologic and chemical models. Social science research will focus on demographic and economic shifts, changing legal structures and economic markets for water, and at changing public attitudes toward sustainable water management.

The \$16 million will fund center operations for five years, after which it will be reviewed by NSF for an additional five years of funding. Participating academic institutions include New Mexico Tech, Pennsylvania State University, University of California (UCLA, Scripps and Riverside), Columbia University Biosphere 2, University of New Mexico, Arizona State University, Northern Arizona University, Desert Research Institute, Instituto Mexicano de Tecnologia del Agua and Instituto el Medro Ambiente y Desanollo Sostenable del Estado de Sonora.

Participating government institutions include Los Alamos National Laboratory, U.S. Geological Survey, Agricultural Research Service, Army Corps of Engineers and the International Boundary and Water Commission. Participating private, non-profit organizations include World Laboratory of Lausanne, Switzerland.

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