ARIZONA
WATER RESOURCE

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Arizona Has Untapped Geothermal Potential

The U.S. Department of Energy recently announced a new initiative "GeoPowering the West," an effort to promote the development and use of geothermal power in the western states. According to DOE, all of Arizona's neighboring states have good geothermal resources, with California, Nevada and Utah listed as the top three states with electrical generation potential and New Mexico considered a high potential state. Arizona does not make the rankings.

Arizona's no-show raises question about the state's geothermal potential. What potential does the state have, and what purposes could its geothermal reserves serve?

In Arizona, water as a source of energy mostly means hydroelectric power. Glen Canyon and Hoover dams come to mind, where surging water turns turbines to generate electricity. Geothermal power puts groundwater to work. Extreme heat deep within the earth rises near the surface and heats groundwater that then becomes naturally occurring hot water and steam, and a source of geothermal energy.

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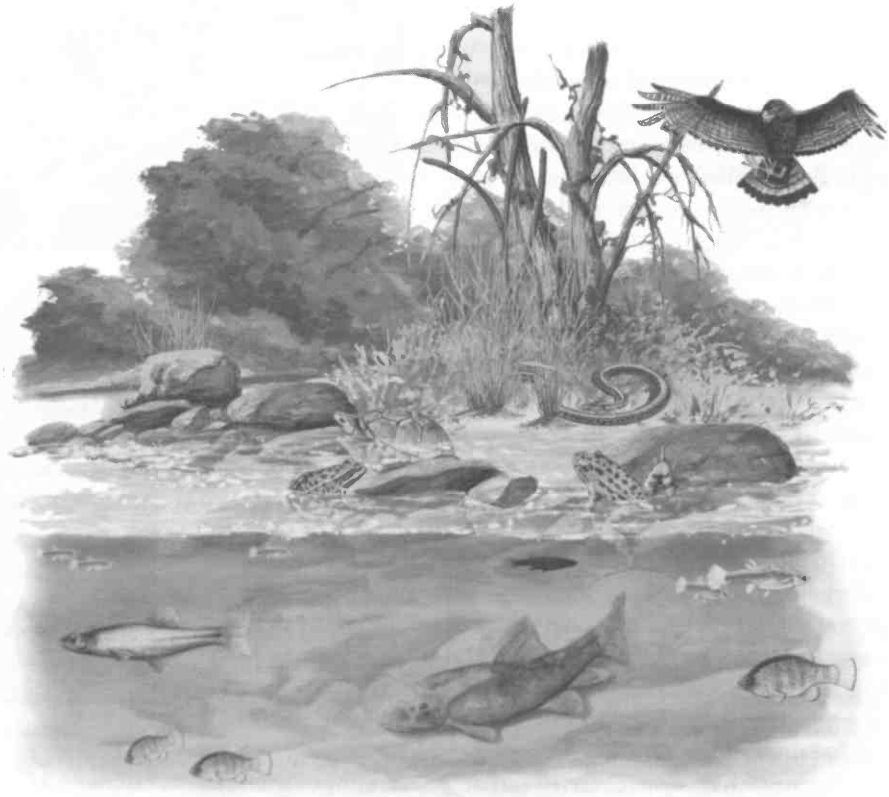

Pima County is about to begin public meetings on its new Sonoran Desert Conservation Plan. Two years in the making, the plan proposes to save more than 250,000 acres for mountain parks, preserving streams and washes and protecting ranch land along the county's urban edges. The plan calls for changes in ordinances and procedures, including expanded impact fees, an environmental resource ordinance, water conservation and a one-stop permitting process for required permits at all levels of government. Water management obviously is an integral part of the plan. (See "Special Projects," page 9 for a description of water projects undertaken as part of the plan.) Art work by Pima County Graphic Design Section.

CONTENTS

Endocrine Disrupters in Water

What Are EDs? What Risks Do They Pose?

Endocrine disrupters (EDs), a relatively new term in the water quality glossary, is the focus of much recent discussion and debate. What are EDs, and what are their water quality implications?

ED is a self-defining term; i.e. EDs are compounds that disrupt the endocrine system. The endocrine system consists of various glands that regulate the functioning of all organ systems. Since the endocrine system is involved in such critical functions as basic metabolism and reproduction, even slight interferences with endocrine functions, especially during certain phases of the life cycle, can cause profoundly damaging effects.

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EDs represent a broad array of compounds of varied origins and could include natural hormones; various pharmaceuticals including birth control pills; and estrogen replacement products and other steroids. Many of these compounds are taken by humans, excreted and released with wastewater or effluent. Pesticides and various industrial chemicals like dioxin and PCBs also are sources of EDs that often end up in water bodies. While not hormones themselves, they are hormonal active agents.

Concentrations of EDs are likely to be extremely small, occurring at times in nanograms per liter. On a temporal scale this is equivalent to about one second in 31 years. Yet, one nanogram per liter of a typical pharmaceutical is equivalent to about two trillion molecules per liter. This represents a rather large quantity to bind with receptors in the human or animal body.

Resistant to chemical and biological degradation, endocrine disrupting chemicals appear to persist in the environment and to bioaccumulate. EDs are distributed worldwide, and virtually all living organisms are directly or indirectly exposed to them, through ingesting contaminated foods or waters, breathing contaminated air, or merely through contact with contaminated soils, sediments or water.

Much of the concern about the potential hazards of EDs can be traced to the development in 1938 of a man-made estrogen, called diethylstilbestrol or DES. Hailed at the time as a miracle drug, DES essentially mimics the action of sex hormones in the body. Its many uses at the time included treating women to prevent miscarriages. Later it was found that some daughters of women having taken DES during pregnancy developed a rare tumor of the vagina.

Scientists have since observed certain populations of wildlife with symptoms of exposure to environmental contaminants that affect the endocrine system; e.g. feminized fish that were exposed to municipal and industrial effluent and alligators with delayed or abnormal sexual differentiation from central Florida lakes contaminated with organochlorine pesticides. Questions also have been raised about whether EDs are the cause of the documented general decrease in human semen quality and increased breast cancer in woman.

"Our Stolen Future," a book published in 1996, attracted public attention to the issue. In the tradition of "The Silent Spring," "Our Stolen Future," written by Theo Colborn, Dianne Dumanoski and John Peterson Myers, warned of an impending crisis, reporting that synthetic chemicals are now pervasive in the environment. By mimicking natural hormones these chemical disrupt the normal reproductive and development process and pose a serious threat to future generations of people and wildlife.

A general consensus among most scientists, however, is that the data is insufficient to determine the ecological or human health risks posed by EDs. Yet sufficient evidence exists to raise concerns and warrant further study, and government action is underway. Within the EPA Office of Research and Development Strategic Plan, ED research is identified as one of the six high-priority topics. The agency has developed a comprehensive ED research plan.

Further, in response to mandates of the 1996 Food Quality and Protection Act and the Safe Drinking Water Act, EPA is developing an ED screening program, with notice of the final program expected in Dec. 2001. This final policy statement will describe the screens and tests to be required as part of the program, as well as the chemicals to be included and the priority-setting procedure for determining the order of testing.

In response to requests from various federal entities, the National Research Council studied the ED issue and published a report last year. In its report the NRC committee avoided the term endocrine disrupters because it "is fraught with emotional overtones and [is] tantamount to a prejudgement of potential outcomes." They substituted the term "hormonally active agent" or HAA as a more neutral term, "defined as an agent that has demonstrated hormone-like activity in a test system."

Book Finds Reasons for Concern

Because the endocrine disruption question has surfaced so recently, the scientific case on the extent of the threat is still far from complete. Nevertheless, if one looks broadly at a wide array of existing studies from various branches of science and medicine, the weight of the evidence indicates that humans are in jeopardy and are perhaps already affected in major ways. Taken together, the pieces of this scientific patchwork quilt have, despite admitted gaps, a cumulative power that is compelling and urgent. (from Our Stolen Future, *by Colborn, Dumanoski and Myers)*

After reviewing existing scientific knowledge, the NRC Committee on HAAs in the Environment decided that more information is needed before HAAs potential to harm developing organisms can be understood. The report views as inconclusive current evidence showing that harmful ecological and health effects can result from exposure to certain chemicals, stating that such evidence does not clearly demonstrate whether hormonal properties caused the observed effects or whether some other toxicological agent was the cause.

The NRC report recommended various research areas to study exposure to HAAs. These include long-term monitoring of known HAAs; study of human and other biota intake of phytoestrogens and synthetic HAAs; and identification of primary exposure sources. The report also recommended study of primary routes of exposure, e.g., diet and drinking water, to determine typical baseline intake levels.

Others argue that sufficient ecological evidence exists to demonstrate the hazards of EDs and to justify action. They say that protecting public health in the real world involves more than a commitment to the scientific ideals of strict cause-and effect proof that may be more appropriate to controlled laboratory experiments. They call for examining information from a variety of sources including wildlife data, laboratory studies and research on the mechanism of hormone action or toxicity. They say weighing such evidence would demonstrate the need for more immediate action.

Water Vapors

Tucson Drinks CAP Water, Part 2

In praising Tucson Water's new approach to introducing CAP water to its customers, recent news stories described, sometimes in lively and colorful prose not usually associated with journalism, the previous ill-starred effort to deliver CAP water to the community. Whatever that unfortunate occurrence represented hydrologically, it is now providing journalists the opportunity to practice some creative writing.

A recent Associated Press article was rather restrained. When first delivered, CAP was said to be "brown, yucky water." In a September 22 *Tucson Citizen* editorial titled, "CAP Delivery: Tucson Water Now Has It Right," today's CAP water is said to be better because "there will not be a trace of the brown smelly gunk that spewed from some city taps in 1994." Later in the editorial the "foul water" is said to have loosened rust and "sent it spewing from residents' taps."

Next day the *Tucson Citizen* carried another CAP story saying the "yechy taste of CAP water" is a thing of the past, and the "brown, bad-tasting water" will be a distant memory. The same article said citizens use to high-quality groundwater were understandably upset when they began receiving, "smelly, strange-tasting, tinted river water."

Lest the above leave a foul taste in the mouth, a description of the new and improved CAP water might be mentioned. At the end of a recent demonstration project that delivered blended CAP to a number of households, participants were queried about the taste of the water. One resident described the blend as having "a softer taste and no aftertaste."

Water and Sex

As topics of interest water and sex have been around for a long time. Water and sex are like birth and death, all primal concerns that challenge the human capacity for understanding and wonder, and many and varied have been the thoughts devoted to each. What then can be said about water or sex that has not been said before? Combine sex and water, however, and some interesting results can be achieved. All that is needed is creativity as two recent examples demonstrate.

Here was a cake worthy of the occasion. No candle-bedecked delicacy, this manhole-topped cake was in honor of Pima County Wastewater Management Department's 100-year anniversary on September 20. One hundred years ago plans for the first Tucson sanitary sewer system were finalized. The majority of the gravity line sewers from that first sewer project, which served downtown Tucson, are still in service today.

In his talk at the Water Resources Research Center's spring conference, *The 20th Anniversary of the Groundwater Management Act*," University of Arizona law professor Robert Glennon noted, "The conference organizers are delighted by the large turnout, but I am not really surprised. It's a popular subject, because, if you think about it, water in the American West and sex share two things in common. First, both are topics many people like to talk about. And, second, people are very concerned that someone else is getting more than their fair share."

Another example of the twining of water and sex appeared in the July issue of *Harper's Magazine*. In that issue Jacques Leslie wrote an article, "Running Dry," about the pending world water crisis. In critiquing water use, he observes Las Vegas where he notices that water and sex have something in common, at least in the Neon City. He writes, "Las Vegas is America's city of fantasy, and water, not wealth, is its greatest fantasy of all, displayed more lasciviously than sex."

Water CASA Gets Water Conservation Grant

The Water Conservation Alliance of Southern Arizona (Water CASA), a Water Resources Research Center program, has been awarded one of 16 Urban and Community Forestry Grants from the Arizona State Lands Department. The $4,530 grant will enable Water CASA to develop and conduct the Graywater-Water Harvesting Workshop series, demonstrating the use of water harvesting and graywater reuse techniques to irrigate residential landscapes. The series will be held in the Tucson area, in the service areas of Water CASA member water companies. Participating in the series will be: Avra Water Co-op, Community Water Co. of Green Valley, Flowing Wells Irrigation District, Town of Marana Water Department, Metro Water District, and the Town of Oro Valley Water Department.

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News Briefs

Crayfish Threat to AZ Waterways

They are variously called crawdads, spiny lobsters or crayfish, but Arizona Game and Fish officials consider them a voracious menace that is wreaking havoc on aquatic ecosystems throughout the state.

Researchers have observed clear, biologically diverse streams transformed into muddy streams with thousands of crayfish. Crayfish first devour the vegetation that stabilizes stream banks and bottoms, before eating the pond snails, the mayfly larvae, caddisfly larvae and other insects. Their menu then expands to include tadpoles, fish, turtles and even garter snakes. Trout can eat small crayfish. Larger crayfish, however, go unchecked and eat the fishes' food supplies.

Arizona Game and Fish is in the process of adopting a law to make it illegal to transport crayfish live. Nevada and Utah already have a similar law, and California and Montana may soon follow suit.

Arizona is the only mainland state with no native species of crayfish. Their introduction to the state was partly due to government agencies releasing the critters into state waters to control weeds and feed bass and other game fish. Fishermen using crayfish for bait also did their part to introduce the exotic specie.

Meanwhile the Arizona agency hopes to reduce the state crayfish population by touting their culinary potential. Plentiful, easy to harvest and with no limits, and simple to prepare – just like crabs and other shellfish – crayfish, which can grow up to six inches in Arizona, may be an up-and-coming culinary delight, at least Game and Fish hopes so. The agency included some crayfish recipes in a recent newsletter.

Grant Celebrates Heritage of Colorado River

Thanks to a $295,483 grant from the National Endowment for the Humanities, the Arizona Humanities Council will be administering a project to examine the history and meaning of the Colorado River. Titled "Colorado River: Moving Waters in the Arid West," the project is a collaborative effort involving all the Colorado River Basin states – Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. The project will focus on three main themes: the geographical, historical, environmental and technological forces that shape the realities of western water; the legal history that determines the rights to the river water; and the literary and creative arts the rivers has inspired.

Project funds will support a three-part radio documentary, a traveling exhibit, lectures and book discussions, community-initiated exhibits and a website. Arizona program sites will include Page, Parker, Yuma and Phoenix.

Task Force Confronts Waterborne Disease Threat

Seven valley cities and four county and state health agencies have formed a task force to help cope with situations that may arise if an outbreak of a waterborne disease occurs in the Phoenix metropolitan area. Their collaborative efforts are intended to ensure a quick response time and open channels of communications about best strategies to follow in dealing with the outbreak. A prime goal is to provide quick, accurate information to the public.

Participating cities include Chandler, Gilbert, Glendale, Mesa, Phoenix, Scottsdale and Tempe. Also involved are the Maricopa County Public Health Department, the Maricopa County Environmental Services Department, the Arizona Department of Health Services and the Arizona Department of Environmental Quality.

"We developed this communications plan because if one water system is affected it is more than likely other systems within the valley are also going to be affected because we have similar source waters. We also supply water to each other," says Michelle DeHaan, task force co-chair. Bob Hollander is the other task force co-chair.

The plan covers varied situations, designating escalated responses depending upon the severity of the situation. Possibly only increased investigation will be needed, although in a more serious situation a "boil water advisory" might be issued. The plan also provides steps for de-escalation, as conditions return to normal.

DeHaan believes the Phoenix area is relatively safe. "Our source waters are extremely pristine compared to other parts of the country. We do not have wastewater treatment plants discharging into our riv-

ers." For additional information about the task force contact DeHaan at 480-321-5685.

GAO Criticizes States' Water Quality Spending

The General Accounting Office (GAO) recently released a report suggesting that state water programs do not spend enough to ensure safe drinking water – and it's not due to a lack of federal funding. In fact, the report said sufficient federal funding has been available, but states have often not always accessed these funds nor used them to best effect.

Rather than a lack of federal funding, the GAO reports that state-imposed spending constraints were to blame. The report said states often set staffing and funding levels too low, with structural and equipment improvements getting priority funding. The report also faulted state hiring practices. It claimed states often offered inadequate salaries to attract and retain qualified staff. In other cases, hiring freezes prevented the states from filling positions. GAO interviews with state officials suggest that current staffing and funding levels will be inadequate to meet new regulatory requirements in the future.

The report was the result of a congressional request that GAO examine funding for drinking water programs in light of the 1996 amendments to the Safe Drinking Water Act. These amendments require states to implement new standards for certain contaminants. The full report is available at: http://www.gao.gov/new.items/rc00298t.pdf

FDA Issues Final Report on Bottled Water Labeling

The U.S. Food and Drug Administration recently issued a final report on bottled water labeling. The report was in response to the federal Safe Drinking Water Act amendments of 1996. The amendments required public water suppliers to issue Consumer Confidence Reports (CCR) to their customers and also directed the FDA to publish a final study of the appropriate methods of informing customers of the contents of bottled water.

The FDA concluded that information provided in the CCRs, with certain exceptions for items solely applicable to public water supplies, is the type of information that also should be provided to bottled water consumers. The FDA also noted, however, that some information not included in CCRs would be appropriate for bottled water; e.g., the type of treatment the bottled water received.

The FDA considers the best way to inform bottled water users is with label information that includes a company contact address or telephone number. The report finds it is not feasible to include all CCR-type information on a label, in a pamphlet at retail, or on the Internet.

AZ WaterCommunity NEWS

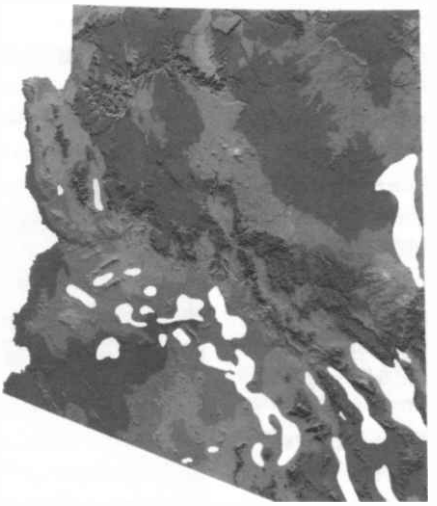
A Center on the Impacts of Urban Development on Southern Arizona's Desert Environment has been created at the University of Arizona. Located within the UA College of Agriculture's School of Renewable Natural Resources, the new center is a collaborative venture with the non-profit Rincon Institute. Focusing its research on the ecosystem of the Rincon Valley, the center will provide information on the controversial issue of growth and conservation. The center formalizes a relationship between the UA and the Rincon Institute that has been ongoing for about a decade. For more information contact C.P. Patrick Reid, director of the School of Renewable Natural Resources, 520-621-7257.

The **Water Infrastructure Finance Authority of Arizona** has awarded technical assistance grants to 39 Arizona communities with limited resources and significant water quality needs. Derived from federal and state sources, the $568,415 in grant monies will be used to develop infrastructure construction projects for eligible wastewater and drinking water systems.

Geothermal...continued from page 1

The uses of geothermal energy are determined by temperature, with the hottest reserves (greater than 150°C or 302°F) generally used for electric power generation. The process involves boring deep into the earth's crust, to tap into the hot, briny reservoirs of water. The water is pumped to the surface and converted to steam that spins turbine engines to generate electricity. Geothermal energy for electrical production is the main goal of the DOE initiative. Arizona, however, lacks the thermal capacity to generate electricity, although the state has other geothermal potential.

Water temperatures lower than what is needed to generate electricity also have geothermal uses. Low temperature (less than 90°C or 194°F) and moderate temperature (90°C - 150°C or 194°F - 302°F) geothermal water can be used for direct use and ground-source heat pumps. Direct use means using the water directly, without heat pump or power plant, for such applications as heating of buildings and use in industrial processes, greenhouses, aquaculture and resorts. Direct use projects generally involve resource temperatures between 38°C (100°F) to 149°C (300°F).



White areas shown on the map have potential for geothermal resources.

Arizona geothermal potential has been evaluated to some extent. During 1977-82, the Geothermal Assessment team within the Arizona Bureau of Geology

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Guest View

Recharge - Where's the Wet Water?

Steve Weatherspoon, a partner in the Tucson law firm of Chandler, Tullar, Udall & Redhair, LLP., contributed this Guest View. He is a member of the Board of Directors of the Central Arizona Water Conservation District and the Governor's Water Management Commission.

Arizona has embarked on the pursuit of recharge in a way never before seen. We are simply enamored with the concept. We have created legal mechanisms that promote continued groundwater mining at the expense of direct use of CAP water. Indeed, we have made recharge a cornerstone of our long-term water management policy.

Beginning in the mid-1980s, Arizona enacted a series of underground water storage statutes. This culminated in 1996 with the creation of the Arizona Water Bank.

We enacted laws that permit water to be recharged in one area and withdrawn, rather mined, in a totally distinct hydrologic area in the same active management area. The point of recharge can be fifty miles down gradient from the point of withdrawal but the law pays no heed. Moreover, existing users near recharge sites may drain or otherwise benefit from the stored supply.

The above scenario is direct recharge. The idea is that groundwater mining at the point of withdrawal will be replenished by the recharged water. Sounds reasonable - but what happens to the folks fifty miles up gradient when the well goes dry.

Direct recharge is not our only type of recharge. Notably, it accounts for a relatively small amount of the recharge to date. No, the real king of recharge is indirect or in lieu recharge, now called groundwater savings. Names aside, it works the same.

The idea is that groundwater mining at the point of withdrawal will be replenished by the recharged water. Sounds reasonable - but what happens to the folks fifty miles up gradient when the well goes dry.

Groundwater savings facilities are farms. The idea is that if an irrigator takes CAP water instead of pumping groundwater, then the unpumped groundwater is saved, presumably for future municipal use. Groundwater savings is most cost effective. It is a win-win situation.

For example, the Water Bank or a municipal provider can buy CAP water for $45/acre foot and sell it to an irrigator for $22. Not only has the irrigator gotten water at a favorable rate, the bank or municipal provider, for $23 an acre foot, gets long term storage credits that enable them to pump almost the same amount of groundwater as was saved. Again, this pumping (mining) of groundwater can be from anywhere within the same AMA as the farm, distance notwithstanding.

Meanwhile, back on the farm, as time passes there will be significantly less CAP water available and the prices will not be competitive with groundwater pumping costs. Start up the pumps.

Logic and economics dictate that when CAP water is no longer available, the irrigators, unless their lands are earlier consumed by development, will pump the aquifers to the depth past which farming is uneconomic. This is the same depth the irrigation uses would have depleted those basins in any event. Hey - where's our saved groundwater?

Not only is it going to be tough to find, let alone use, any of that saved groundwater; on top of that (or bottom), we have created legal rights to pump groundwater in amounts near those that were supposed to be saved. The thought of double-dipping perhaps comes to mind.

So how much of this recharge have we done? Through 1998, DWR records reflect that a total of 1,857,170 acre-feet in long term storage credits have been issued. Of that amount, eighty percent represent credits accrued through groundwater savings. The remaining represents direct recharge. Most of the recharged water has been CAP but almost 70,000 acre-feet has been effluent.

Our courtship with recharge has been fueled, in large part, by the legitimate and important goal of taking all of Arizona's remaining entitlement off of the Colorado River through the CAP. Let it not be said we have the facility but no use for the water. We can use and conserve the water - but that does not mean we have to call things recharge that are not recharge.

We should view the prospect to divert large amounts of Colorado River water over the next fifteen to twenty years as a real challenge and a golden opportunity. It is perhaps a chance to determine if large groundwater basins adjacent or near the CAP can be used as reservoirs. The idea is that this stored water could be put back in the CAP to meet delivery needs in times of shortage. We don't need a reservoir that can handle annual fluctuations of inflow. Rather, we need ones that can accommodate long-term fluctuations in the available supply from the Colorado that will surely occur.

Maybe such spots don't exist. The point is, we need to find out now, if not yesterday. We should embark on an aggressive course of surveys to soon determine whether such a concept is hydrologically sound. If so, we should set aggressive goals to store five to ten million acre-feet at such sites in the next twenty years. It's not a cheap way to recharge water. But at least that water can be recovered and put back in the ditch and taken to people who need wet water. Water is never cheap when there is not enough to go around.

The figures five to ten million acre-feet are not mine. That's the general range of estimates I have heard as to what we will need to make up shortages in firm CAP municipal and industrial deliveries over the fifty year term of the Project. I believe we must soon adopt policies to assure that this projected shortfall is made up of with newly-imported wet water. Consistent with our current and sound groundwater management policies, this water should not come from mining groundwater in the overdrafted basins of central and southern Arizona in the name of illusive recharge credits.

Legislation and Law

Complex GMA Review Underway Amidst Hopes and Concerns

The big news in Arizona water affairs is the current review of the Groundwater Management Act. Passed in 1980, the law has been in effect for 20 years, with another 25 years to go to achieve its safe yield goal. Almost at midpoint, the law, duly tried, tested and, in some instances, found wanting, was due for a review.

Many in the state were ready for the challenge, and a multi-tiered committee structure was put in place to review the GMA and identify areas of concern and recommend changes to the law. Involved in the evaluation and review are Active Management Area Task Forces, a Technical Advisory Committee and a Governor's Water Advisory Commission, each with a designated role and representing a variety of interests.

In describing the GMA process as "ground up," Governor Jane Hull acknowledged the key role played by the Active Management Area Task Forces. It is at the AMA level that the day-to-day workings of the act are most closely observed and where the formal evaluation began. About a year ago, each AMA established a task force to review the workings of the GMA and identify problems and adopt recommendations.

With task forces operating at ground level, other working groups were established at other points in the chain of command, to ensure varied input and broad recognition of concerns; thus the multi-AMA Governor's Water Management Commission (GWMC) and the Technical Advisory Committee (TAC). Governor Jane Hull appointed members to the GWMC, charging the committee with evaluating water management regulations and activities within the AMAs. Further, it is to make recommendations regarding changes to laws, rules or policies to facilitate achievement of a long-term, reliable water supply. The schedule calls for recommendations to be submitted to the Legislature in 2002.

Arizona Department of Water Resources Director Rita Pearson Maguire appointed members to TAC. TAC serves as a resource to the GWMC, evaluating the task forces' recommendations and providing recommendations and technical support to the GWMC.

Shortly after the GWMC was appointed a complaint arose that Native Americans were left out of the process. In response to the concern, Hull created the Native American Groundwater Advisory Committee to ensure that Arizona tribes are involved in the review process. The council will meet regularly with the three GWMC co-chairmen. Hull said she had not previously included tribal members since Indian lands are not subject to the GMA or state statute.

As work got underway another committee formed, also involving the three GWMC co-chairmen, with the chairperson and/or co-chairpersons of each of the AMA Task forces. Called the Executive Committee of TAC, this committee was formed to function as a small working group.

With work just beginning it is premature to evaluate the review process and its likelihood of achieving significant changes to the GMA. A few early concerns, however, have surfaced. For example, some observers have complained of the makeup of the GWMC, claiming it is not representative of the full range of state water interests. (See sidebar)

The Technical Advisory Committee met Sept. 15 in Casa Grande. (Photo: Val Little)

Others, although initially skeptical about the rather elaborate organizational structure set up to review the GMA, have adopted a wait-and-see attitude before commenting on the workings of the arrangement. Are responsibilities and duties clearly understood, to enable the commission, committee and task forces to work smoothly together? Will the organizational structure function to ensure that local, task force concerns get due consideration at the commission level? These and other such questions will be answered as work progresses on the GMA review.

Meanwhile the review process is touted as a concerted effort, with varied input from different levels and interests, all getting due attention as participants work toward the common goal of improving the GMA. ADWR has established a website (http://www.water.az.gov/gwmc/) with extensive information about the review process, including the names of GWMC and TAC members, schedule and agendas of meetings, task force recommendations, and general background information about water management in the state. The website also provides a link to post queries and comments regarding the GWMC and the TAC.

Different Views of Same Commission

Following are two comments from newspapers reporting on Governor Hull's Water Management Commission.

The commission, we believe, has a flaw. It's not whole. It is top heavy in the state's major water users – agriculture, municipalities, mines and developers. Arizona Republic editorial, July 6.

Hull's commission ... includes farmers, environmentalists, business and government representatives and average folks who simply want to make sure they can turn on their faucet and get a glass of water. Tucson Citizen editorial, July 5

Publications

Water in the West
edited by Char Miller
This volume includes a collection of articles from *High Country News* on the struggle over the West's most precious and scarce resource, with chapters on the Northwest salmon crisis, Glen Canyon Dam, federal and urban water projects, Native American water rights, watershed restoration, and water management. The book is $29.95 shipping and handling included, available from High Country News, P.O. Box 1090, Paonia, CO, 81428; phone:1-800-905-1155.

Websites Offer Drought Info, Past and Present
With drought occurring in various parts of the country, people might be interested in the following two drought websites. Available from the National Geophysical Data Center in Boulder, a website on drought history entitled "North American Drought: A Paleo Perspective," (www.ngdc.noaa.gov/paleo/drought/) explains how data from sources such as tree rings, lake sediments and archeological remains can provide insight about past droughts. Data from the natural archive are used to interpret 20th century North American droughts in the context of hundreds to thousands of years in the field of paleoclimatology. Paleoclimatology includes the collection of evidence of past climate conditions, and the investigation of the climate process underlying these conditions.

The National Drought Mitigation Center at the University of Nebraska-Lincoln maintains a home page for the Drought Monitor, which is a color map with accompanying text showing which parts of the United States are experiencing various degrees of droughts. (enso.unl.edu/monitor/monitor.html) The text describes the drought's current impacts, future threats and prospects for improvement. The Drought Monitor is a synthesis of several different scientific drought indices, outlooks, and news accounts that represent a consensus of federal and academic scientists.

Protecting Drinking Water: A Workbook for Tribes
Water Education Foundation
Developed with EPA funding this publication includes background information on the importance of protecting source water from pollution and includes a step-by-step work plan for tribes interested in developing a protection plan for their drinking water. The workbook is designed to serve as a template for such programs, with forms and tables for photocopying. It also offers a simplified approach for assessment and protection that focuses on identifying and managing immediate contamination threats. The book is available in WordPerfect format on the Foundation's website (www.water-ed.org) on the "What's New " page, through the fall. Hard copies are available for $25 from Water Education Foundation, 717 K St., Suite, 317, Sacramento, CA 95814; phone: 916-444-6240; fax: 916-448-7699.

Publications Show Student Interest in Water Issues Starts Early

Water learning begins early, as two projects undertaken last year by Arizona public school students demonstrate. With the beginning of a new school year, a description of these two project is timely, not only to show what students can accomplish, but to give credit where credit is due.

StudentsWrite History of "River Path"
The Davis Bilingual Magnet School, the Roskurge Bilingual Middle School and the Barrio Anita neighborhood teamed up to write a children's book, *A Path to the River*, about an historic irrigation ditch that once carried Santa Cruz River water into the Barrio Anita neighborhood. The City of Tucson's Multiple Benefit Water Project provided the incentive for the project.

The "Introduction" describes the project: "We are kids from Davis Bilingual Magnet School and Roskurge Bilingual Middle School. Our ages range from 6 to 13. We started the project by researching the 20th-century connection between Barrio Anita and the Santa Cruz River. We invited people who lived in the neighborhood. We asked questions and they told us stories. Some of them remembered an irrigation ditch that used to run through the neighborhood. We chose the irrigation ditch as the theme for the first art project because it represented a physical link between the neighborhood and the river."

Production of the book was made possible by a youth grant from PRO Neighborhoods. Cost of the book is $10. Contact Freda Johnson for copies. Phone: 520-622-1933.

Eighth-grade Students Research Water Marketing
Eighth-grade students at Sierra Vista Middle School were awarded $10,000 for a research paper they wrote examining the question, "Should water rights be bought and sold like other products are both and sold?" In their work they presented both sides of the issues, offering both pros and cons. They submitted their research results to a contest sponsored by the Arizona Advisory Council for Environmental Education.

The water marketing research was organized into the following categories: surface water information; groundwater information; Indian water rights and adjudication; water rights should be bought and sold, reasons; water rights should not be bought and sold, reasons; and team's evaluation.

The first-place award money supported a student field trip in the spring that included visits to various points of water interest, including Hoover Dam, tours of the CAP headquarters and the Salt River Project and a boat ride on Tempe Town Lake. For more information about the project contact Marty Sheppard, the instructor who worked with the students on the project, at 520-515-2930.

Special Projects

Water, a Critical Element in Sonoran Desert Conservation Plan

Pima County has embarked on an ambitious and far-reaching plan to deal with local endangered species issues that have polarized the community. Because of the presence of the rare cactus ferruginous pygmy owl, developers and even a local school district have had their building projects challenged by federal regulations. Adding to their frustrations they found the federal rules they were to follow unclear. Further, they questioned the value of scientific surveys they were required to conduct. Several lawsuits ensued.

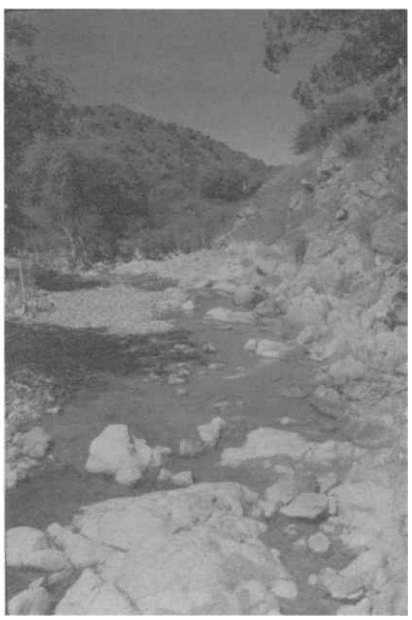
The Pima County Board of Supervisors decided that a Multi-Species Habitat Conservation Plan (MHCP) was preferable to an ongoing site-by-site analysis and permitting process. The MHCP is the core of a larger project, the Sonoran Desert Conservation Plan (SDCP). Other U.S. regions have implemented the MHCP approach, but the Pima County plan is the most comprehensive, both in its geographical scope and the varied topics studied. Water issues are integral to the plan and will be emphasized here, although many other aspects too numerous to mention in this short article also play an important role in the plan; e.g. archaeological resources and fiscal considerations.

Two years ago the Board directed staff to undertake a complex task which was to become the SDCP. They were to start work on a blueprint for Pima County that would satisfy requirements of the Endangered Species Act; protect cultural resources; preserve open space within such areas as ranches; provide recreational opportunities; and find cost-effective ways to achieve the goals of the plan while allowing for provision of adequate housing and infrastructure for residents.

The Board believed that good science was essential to developing the plan and assembled a team of prominent biological scientists who met regularly as volunteers. The team included scientists from the University of Arizona and state and federal agencies. They met to determine the species to be studied, identify information to be gathered and recommend studies to be undertaken.

The scientists reviewed materials developed by consultants and others. Surveys of the vulnerable species provided a comprehensive picture instead of the spotty surveys previously conducted for rezonings. The baseline information includes data on the locations of vulnerable species, their habitat needs (including water), historical and present ranges, and the significant threats they confront.

The science team identified riparian areas and their water supplies as critical to species survival and health. Pima County staff, the Pima Association of Governments and consultants prepared a series of reports with crucial mapping of locations of perennial and intermittent streams, springs, riparian areas, and shallow groundwater areas. Pumping occurring near those areas also was noted. A watercourse report by Barbara Tellman of the Water Resources Research Center and engineering consultants addressed the physical properties of watercourses and identified flooding characteristics such as overbank storage areas and distributary/sheet flow areas. The resultant mapping will aid in identifying areas to be preserved as natural floodplains for flood control purposes and for riparian protection. Several reports focused on aquatic species of plants and animals.



Pima County's Sonoran Desert Conservation Plan mapping identified 55 perennial and 82 intermittent reaches for 74 different streams and more than 250 springs in Pima County. Nearly 100 potential shallow groundwater sites are identified, and some of the larger ones have been delineated. (Photo: B. Tellman)

The entire county was divided into sub-areas by watershed, with the special characteristics and needs of these areas examined. Groups interested in specific areas did some of the reports. For example, in Arivaca, which is an area of isolated shallow groundwater, a group determined how much additional pumping would cause the cienega in the Wildlife Refuge to dry up. They found that even without rezonings water use will quickly exceed supply. Reintroduction of native fish and frogs has been proposed. This is more complex undertaking than releasing creatures into ponds. The processes of relatively natural watercourses are needed for success. Studies of native plants and animals show that a natural flood-drought cycle regime is highly beneficial to native species such as cottonwood trees and fish.

A comprehensive preliminary plan went to the Board of Supervisors Sept. 26., starting a public participation process, with final decision-making occurring over a period of months. The proposals include new preserves; expansion of existing preserves; agreements with ranchers to preserve ranch lands with good wildlife habitat; establishment of wildlife corridors; historical and archaeological programs; riparian protection and rehabilitation; reduction of invasive exotic species; changes in laws, regulations and procedures (such as one-stop federal and local permitting application); educational programs; and proposals for better management of county-owned lands. The proposals also call for continued research and monitoring as well as additional studies on such topics as cost-effective methods of providing infrastructure; affordable housing; cost of various growth patterns; environmental justice; and a series of reports on vulnerable species and their habitats.

For more information on this complex plan, along with text of major documents, a complete list of studies and ordering information, see Pima County web site www.co.pima.az.us/cmo/sdcp/

Announcements

AZ Game & Fish Heritage Grants

Arizona Game and Fish seeks applications for its Heritage Grants within the following program areas: urban wildlife and urban wildlife habitat; public access; environmental education; schoolyard grants; IIPAM (identification, inventory, acquisition, protection, and management of sensitive habitat); shooting ranges; and boating access. Applications are available from the RSO, phone: 602-622-1469; email: rso@u.arizona.edu or from address below. Contact: Robyn Beck, AZ Game and Fish Dept., Director's Office, Funds/Planning Section, 2221 W. Greenway Rd., Phoenix, AZ 85023-4312. Phone: 602-789-3530; email: rbeck@gf.state.az.us; website: http://www.gf.state.az.us/frames/other/index.htm Deadline is Nov. 30.

EPA Funds for Environmental Education

The Environmental Protection Agency (EPA) is soliciting grant proposals from educational institutions, environmental and educational public agencies and not-for-profit organizations to support environmental education projects. A notice appeared in the Federal Register (65 FR 53146, Aug. 31, 2000). The Environmental Education Grants Program provides financial support to projects that design, demonstrate, or disseminate environmental education practices, methods, or techniques. Non-federal matching funds of at least 25 percent of total cost of the project is required. For more information visit http://www.epa.gov/enviroed Nov. 15 is deadline for submitting applications.

Arizona Game and Fish and EPA are sources of environmental education funding. (See notices on this page.) Above, students work on a water harvesting experiment in a WRRC Project WET presentation. Photo: Val Little.

Call for Papers/Posters: Riparian Habitat and Floodplains Conference

A conference integrating California riparian and floodplain restoration, research, conservation, partnerships, education, policy, and biota seeks papers in the following major theme areas: 1) conservation and restoration of riparian and floodplain habitat 2) research and technology in restoration and monitoring of riparian and floodplain habitat; and 3) policy and programs in riparian and floodplain management. Abstracts for papers or posters are due by November 17. For program information, visit http://www.tws-west.org/riparian/ or contact: Diana Craig USDA Forest Service, phone: 707-562-8930; email: dcraig01@fs.fed.us or Lyann Comrack California Department Fish and Game: 858- 467-4208; email: lcomrack@dfg.ca.gov

Funding for Arid Lands Research

The International Arid Lands Consortium, which supports research and training on the development, management, restoration and reclamation of arid and semiarid lands, is offering awards up to $75,000 for 12- to 30-month projects. Projects must be: 1) demonstration projects applying innovative knowledge and technology derived from research for the management of sustainable arid lands ecosystems and 2) research and development projects that lead to management for sustainable forest, shrubland, grassland, and agroforestry in arid and semiarid ecological systems. Also supported is research to improve management of soil and water resources in agronomic systems. For more information contact: Jim Chamie, IALC, 1955 E. 6th St.; phone: 520-621-3024; fax: 520-621-7834; email: jchamie@ag.arizona.edu. Also check web site. http://ialcworld.org/Projects/rfp2001.html The deadline for proposals is November 15.

Water Purification Research Funding

A cooperative venture involving the National Water Research Institute and the U.S. Bureau of Reclamation, the National Centers for Water Treatment Technologies are open to investigators interested in pursuing water purification research. Funding of $10,000 also is available to support research. Centers are located in various areas of the country including Aqua 2000 in San Diego and the Water Quality and Improvement Center at Yuma Desalting Plant. Contact the National Centers for Water Treatment Technologies, 10500 Ellis Ave., PO Box 20865, Fountain Valley, CA 92728-0865; phone: 714-378-3278; fax: 714-378-3375 or download application from http://www.ocwd.com/nwri/

NM Water Institute Hosts 45th Annual Meeting

Titled "Water, Growth and Sustainability: Planning for the 21st Century," this conference will be held Dec. 4-6 in Albuquerque and will examine various state and western growth and water issues, including international border water concerns, rural issues and the impact of domestic wells. A Water Banking Workshop also will be conducted to discuss whether water banking will result in better management of NM water resources. For more information contact: NMWRRI-Water Conference, MSC 3167, Box 30001, Las Cruces, NM 88003 or visit http://wrri.nmsu.edu/

Calendar of Events

RECURRING

Arizona Hydrological Society (Flagstaff). 2nd Tuesday of the month (during the school year). Meeting times and locations may vary, NAU, Southwest Forest and Science Complex, 2500 S. Pine Knoll Dr., Room 136, Flagstaff. Contact: Abe Springer 520-523-7198, email: abe.springer@nau.edu

Arizona Hydrological Society (Phoenix). Usually 2nd Tuesday of the month, locations vary. Contact: Christie O'Day 602-379-3087, ext 224. cmoday@usgs.gov or beth proffitt e.proffitt@worldnet.att.net

Arizona Hydrological Society (Tucson). Usually 2nd Tuesday of the month. Contact: Mike Block 520-575-8100 or mblock@metrowater.com

Arizona Water Banking Authority (Phoenix). Next quarterly meeting will be held on Sept. 13 at the ADWR in Phoenix. Contact: Nan Flores 602-417-2418.

Arizona Water for People Committee. Phoenix, meets on the 2nd Thursday of even-numbered months at City of Phoenix Squaw Peak Facilities, 6202 N. 24th St., Phoenix at 6 p.m. Contact Dave Christiana 602-417-2400, ext 7339; Tucson, meets the 3rd Thursday of even-numbered months. Time and place varies. Contact Sheila Bowen, 520-625-8409 or sbowen@communitywater.com

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

Arizona Water Resources Advisory Board. Phoenix, meets at the ADWR 10am to 12 noon. quatterly meetings aug 4 and nov 3. Contact: Bobbie Wood 602-417-2410. bjwood@adwr.state.az.us

Central Arizona Water Conservation District. Usually 1st and 3rd Thursdays of the month, time to be determined one week in advance. CAP Board Room, 23636 N. 7th St., Phoenix. Contact: Ardis McBee 623-869-2210. amcbee@cap-az.com

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

Maricopa Association of Governments/Water Quality Advisory Committee. Contact: Lindy Bauer 602-254-6300.

Maricopa County Flood Control Advisory Board. Usually 4th Wednesday of the month, 2:00 p.m., 2801 W. Durango, Phoenix. Contact: Kathy Smith 602-506-1501 or kks@mail.maricopa.gov

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

Pima Assoc. of Governments Environmental Planning Advisory Committee meets first Friday of every month at 9:30am 1:30pm., 177 N. Church St., Suite 405, Tucson. Contact: Claire Zucker 792-1903 czucker@pagnet.org.

Pima Assoc. of Governments Water Quality Subcommittee. Usually 3rd Thursday of the month, 1:30pm., 177 N. Church St., Suite 405, Tucson. Contact: Claire Zucker 792-1903 czucker@pagnet.org.

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. Hillsdale 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 a.m., 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: verdewatershed@yahoo.com; website http://vwa.southwest-water.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

Atmospheric, Surface and Subsurface Hydrology and Interactions

The above conference will be held Nov. 5-8 in Research Triangle Park, North Carolina. Concurrent technical sessions include hydrological analysis and modeling; surface/groundwater interactions; groundwater flow and transport modeling; and Latin American and Iberian water resources applications. For the preliminary program, registration information and forms check the website: www.aihydro.org. or write to AIH, 2499 Rice St., Suite 135, St. Paul MN 55113. phone: 651-44-8169; fax: 651-484-8357.

Geothermal...continued from page 5

and Mineral Technology (now known as the Arizona Geological Survey) conducted a reconnaissance of the state's geothermal resources, with attention focused mainly on the southern part of the state. The agency issued reports evaluating Arizona's geothermal potential. Drilling would have been the next step, but neither federal nor state funds were available to support the project. This work was part of a national effort at that time, with federal funds provided to states to research their geothermal potential to reduce the nation's reliance on foreign oil.

Various reports resulted that showed Arizona has many areas with low-to-moderate-temperature fluids at depths sufficiently shallow to tap and use for energy. Areas of geothermal activity in Arizona are mostly located in the basin and range providence, mainly in the southern part of the state. Nine counties were identified as having such geothermal reserves including the metropolitan Phoenix and Tucson areas. Reports also were done to determine the geothermal potential for various cities, including Clifton, Scottsdale-Paradise Valley, Tucson, Willcox and Yuma.

In the 1970s, the Geothermal Commercialization Team within the University of Arizona's Department of Chemical Engineering studied possible uses of geothermal resources. The team completed geothermal development plans for Cochise, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz and Yuma counties. These reports are available from the Arizona Geological Survey. (See the summer issue of the Arizona Geological Survey's publication, "Arizona Geology," for a list of available AZGS geothermal publications.)

A recent geothermal database for Arizona indicates 1,251 discrete thermal wells or springs in the state. The thermal fluids, however, are put to traditional water resource uses; i.e., irrigation of field crops, municipal water supply and industrial uses, with little advantage taken of the heat carried by the waters. At present, geothermal aquaculture is the only major direct-use application in the state. In fact, Arizona leads the nation in the aquacultural use of geothermal fluids.

The summer issue of "Arizona Geology" identifies a wide range of possible uses of geothermal energy within various sectors, including domestic, industrial and especially agriculture. According to the publication the low-to-moderate-temperature geothermal fluids found in the state can be used to heat homes and businesses. Agriculture uses include controlled-environment agriculture, such as greenhouses and nurseries, aquaculture, grain and vegetable drying, and soil warming for mushroom growing and earthworm farms.

The evidence points to an obvious discrepancy between current and potential geothermal applications in the state. Geothermal energy would seem to represent an untapped potential in Arizona, presenting opportunities yet to be developed.

Arizona Water Resource

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College of Agriculture and Life Sciences
The University of Arizona
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