

Earliest North American Canals Found in Tucson

Work continues as researchers seek additional information about a series of prehistoric irrigation canals recently discovered along the Santa Cruz River in Tucson that include the oldest canals ever found north of Mexico. Radiocarbon dating on charcoal fragments found in the canals and on plant remains in the different layers of the site indicate the series of canals were constructed between about 3,000 and 2,000 years ago.

"The discovery is significant because we have not found canals this old before in the Southwest," says Jonathan Mabry of Desert Archaeology, Inc. "The oldest canals previously found dated to about 2,000 years ago. This discovery pushes them back another 1,000 years."

It is not just their antiquity that sets these canals apart from others studied in the area. They also shed light on aspects of Hohokam culture that has long puzzled archeologists.

"The Hohokam are famous for building hundreds of miles of canals in the Phoenix Basin," Mabry says. "The Hohokam canal sys-

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The above aerial view of a recent archaeological excavation near the I-10/Ina Road interchange in Tucson shows a 3,000-years old canal in the deepest level of site. See side feature. (Photo: Adriel Heisey)

Do Waterborne Pathogens Pose Risks to Wastewater Workers?

A wastewater treatment plant is in the business of processing sewage, sludge and untreated wastewater, and this can be a risky business for workers at the plant. Wastewater treatment workers confront a variety of potentially hazardous on-the-job conditions including exposure to toxic gases, chemicals and physical hazards.

One other obvious possible job hazard is contact with waterborne infectious pathogens. A sample of raw sewage from a municipal sewage treatment plant could potentially include representatives of all the pathogenic microorganisms that have a host in that locale.

Airborne, waterborne, foodborne, bloodborne, and sexually transmitted pathogens can be present, along with human viral, bacterial, fungal and parasitic pathogens. Further, microbial toxins and allergens are found with microbial pathogens in sewage.

A recent announcement promoting sale of a work safety video for water/wastewater treatment plant personnel states: "The bottom line is quite simple: Water/wastewater workers are exposed to just about every type of occupational hazard except nuclear radiation." Allowing for marketing-motivated hyperbole the statement still reflects a generally acknowledged concern about the safety and health of wastewater treatment workers

The existence of pathogens in wastewater is unquestioned. The critical issue is whether and to what degree these pathogens pose health risks to wastewater treatment

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personnel. In evaluating the potential hazard University of Washington microbiologist Mansour Samadpour says, "To put the situation in perspective most of the risk in any kind of wastewater treatment environment results from slipping or falling causing bodily injury. Safety factors and physical exposure are much higher risks than microbiological concerns."

Yet pathogens pose sufficient risk to wastewater treatment workers to raise concern among microbiologists like Samadpour. Research undertaken thus far of the effects of various pathogens have at times been inconclusive, although in some cases, such as hepatitis A and leptospirosis, the potential risk is well established.

Other pathogens have received considerably less attention. Karen Mulloy of the Program of Occupational & Environmental Medicine of the University of New Mexico writes, "The many pathogenic organisms present in sewage, sludge and untreated wastewater can produce a variety of illnesses among workers who are exposed. However, there have been few epidemiologic studies conducted among sewage workers in the U.S. to determine the actual prevalence and types of infections." Mulloy is especially concerned that, "Few studies have looked at the long-term health effects of exposure among sewage workers."

Samadpour describes one of the problems encountered when researching the health of on-the-job wastewater treatment workers: "Workers with a weak immunity system continually get sick and tend to leave the job. Those who stay have a good immune system and continue working. Normal precautions may be sufficient for these workers who can adjust to the work environment."

According to Samadpour, however, some workers may have certain physical conditions that justify the recent increased concern. He says that with an aging population more workers may be under treatment for cancer, and as a result of chemotherapy may

be immunosuppressed. Also an increased number of woman are working in the field, and a mild form of immunosuppression may accompany pregnancy.

Samadpour says "Once you become immunosuppressed an environment that was perfectly OK may now not be OK and could cause sickness." He adds, "There has to be recognition in the field that special circumstances like immunodeficiency and immunosuppression call for consultation with an occupational physician."

Vaccination has been considered as a preventive measure for two pathogens known to pose risk to wastewater workers, leptospirosis and hepatitis A. In developing countries, leptospirosis has posed a decreasing threat over time. For this reason and because of the adverse effects associated with revaccination, leptospiral vaccination is not recommended. Engineering controls and personal protection equipment are considered sufficient to provide workers protection against leptospirosis.

Whether sewage workers should be vaccinated for hepatitis A has sparked debate, even controversy. Although the Center for Disease Control does not include wastewater workers as an occupationally exposed group, many in the occupational medical field believe such workers should receive the hepatitis A vaccine. It is considered a very safe vaccine, its administration posing no excessive risk

Endotoxins are receiving much recent attention as a potential health threat to wastewater workers. Present in gram-negative bacteria and released at the time of death and autolysis by the organism, endotoxins have been historically linked to various diseases with occupationally descriptive names: brown lung, mill fever, weaver's cough, mattress makers' fever, grain fever and bible printers' fever.

A recent article in the Water Online Newsletter carries the headline, "Endotoxins: a new concern for workers in the wastewater industry." The article goes on to discuss how many respiratory health effects experienced by wastewater workers may have been incorrectly diagnosed. The actual cause according to the author may be directly related to exposure to large doses of endotoxins. The situation has prompted some occupational health researchers to suggest that recommended exposure limits be set for endotoxins.

Not all researchers however are convinced that endotoxins pose a potential health threat to wastewater workers. Most studies of airborne endotoxin levels have been conducted at agricultural sites and cotton mills, with few such studies actually conducted at wastewater treatment plants. Samadpour even questions the accuracy of the methods used to measure airborne endotoxins.

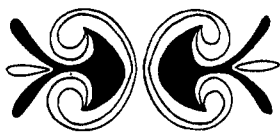
Does the situation call for new federal regulatory action to protect the health of wastewater workers? Mulloy thinks not: "I don't think any new federal regulations are needed, specifically for sewage workers. They fit very well under OSHA regulations."

Samadpour also does not believe in a need for new federal regulations. He says the solution instead is to screen treatment plants to identify exposure areas and to quantify exposure "We look at the treatment plant, at the entire process, and we take air samples at different stages, to identify areas of concern."

"This screening process can be done quite easily and at very little cost. A combination of engineering and administrative controls and personal protection can then be applied to solve most microbiological problems."

Coming Soon: Brochure for Wastewater Treatment Workers

The research project "Waterborne infectious pathogens in wastewater — determination of presence, survivability and risks to wastewater treatment plant and collection system workers" includes the task of preparing a brochure. Scheduled to be available in about four or five months, the brochure, "Control of Microbiological Hazards in the Wastewater Treatment Environment," will be a resource to wastewater treatment plant personnel on issues relating to risk of waterborne pathogens in the workplace. Principal investigator of the project is Mansour Samadpour of the University of Washington's Department of Environment Health, School of Public Health. (mansour@u.washington.edu) His research can be reviewed at his web site (<http://faculty.washington.edu/mansour/>) by clicking WWTP. The brochure will be available from the Water Environment Research Foundation, the agency funding the research. Check its web site for brochure availability. (<http://www.werf.org/>)



Water Vapors

Exotic Species, a Threat to Natural Law and Order

Exotic species are often outlaws in their effect on water. Ruthless, ecological misfits, resisting methods to control or arrest their growth, exotic species can usurp water for their own use, making life difficult for the flora or fauna of an area. They also are said to be invasive which again emphasizes their marauding, reckless ways.

No doubt, exotic species can be a treacherous lot, outrageously well equipped to take charge of an area. For example, the Asian swamp eel has been sited within a mile of Florida's Everglades National Park, to the consternation of federal wildlife officials. The eel sounds like a creature out of a work of science fiction. The three-foot-long eel apparently eats anything in its path, has no known enemies, survives in salt and fresh water and on land, can change genders in order to facilitate year-round breeding, lays 1,000 eggs at a time, and is so durable that one lived in a wet towel for seven months with no food or water.

The exotic species plaguing Arizona waterways and water bodies may not be as awesomely formidable, although they can be aggressive in their own ways. Tamarisk or salt cedar line riparian areas, replacing native trees and releasing valuable water into the atmosphere. *Salvinia molesta* has been sited in Arizona and, if it takes hold, could spoil recreational activities, threaten fish and wildlife and interfere with irrigation and electrical generation. Crayfish have wrought havoc in the state's high country lakes and streams by devouring stream vegetation and tiny aquatic animals. There is concern that the zebra mussel will make an appearance in the state.

Exotic species also can affect water affairs in less direct and dramatic ways. For example, there is the Africanized Bee or Killer Bee, a celebrity among exotic species, and a nuisance at times to water utility workers as is shown in the following story.

Bees in Box Pose Threat to Meter Readers

Consider the plight of the water meter reader, on the front line between water provider and consumer, collecting essential data for the final reckoning, the settling of scores between utility and water users; in short, they read meters to tabulate water bills. If that is not burden enough along come killer bees.

The number of African "killer" bees have been increasing in the state, showing up in various locations including meter pits or boxes, those subsurface casements containing water meters. The damp, dark, cool conditions within the boxes are to the bees liking. As might be expected the bees complicate the work of the water meter reader.

Encountering bees at meter boxes has gotten to be a fairly regular occurrence. Sharon Norden, water operations superintendent/business services division at Tucson Water, says that last year 148 work orders were issued to investigate bee problems at meters. She adds that this numbers does not include problems handled by radio call or direct summons to an exterminator.

Jane Smith, the assistance customer services administrator for the Phoenix water customer services department, is not sure of the exact number of bee incidents at city water meters but says, "I would say we respond several times a week."

Standard operating procedures have

been established to handle bee problems. Norden says, "If meter readers notice any bees they don't read the meter. We send someone out later to follow up on it. Of course, if it is in a highly trafficked area where it may pose a health or safety threat to the public we call an exterminator immediately. We like to try to take care of it ourselves."

The Phoenix water department at first tried the humane approach by working with professional bee keepers. Smith says, "We had limited success with the bee keepers. We would call, and they would usually go at night when the bees are quieter and try to remove them because they wanted them for honey. But since they were working gratis they did not always respond as quickly as we needed. We now have a contract with a pest control outfit."

Bees are not the only unwelcome critter that may be found lurking in the dark of a meter box. Norden says, "Anything you have in the desert Southwest that likes dark, cool, moist conditions might occupy a meter box — scorpions, spiders and even snakes."

The bees could pose problems for other water workers besides meter readers since they travel near water, with colonies likely to be established close to canals, drainage ditches, retention basins and other water ways. Workers involved in such areas need to be on the look out for unwelcome colonies.



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News Briefs

25 AZ Small Systems Fail to Meet EPA Reporting Laws.

Operators of 25 small community water systems in Arizona recently received warning letters from the U.S. Environmental Protection Agency for failing to distribute water quality reports to their customers. The systems were notified that they have 30 days to distribute the reports to their customers or face possible penalties up to \$5,000. Mandated by the Safe Drinking Water Act, the report informs the public about the source of their drinking water, detected contaminants and what, if any, actions were necessary.

Before the due date for the first report, October 19, 1999, the Arizona Department of Environmental Quality mailed notices in April and again in September 1999 reminding community water systems about the requirement and the pending deadline. The first report was to cover 1998. In April 2000, ADEQ sent warning notices to water systems that had not complied.

All those receiving EPA letters are small utilities. Tim Edwards, executive director of the Arizona Small Utilities Association, suggests why. "Any new regulation puts a burden on all systems but especially the smaller systems. Some operators may not understand the requirement, but mostly it comes down to affordability."

Edwards says ASUA makes an effort to ensure that members are aware of the reporting requirement, even offering a template to guide operators in providing the necessary information for the report, along with other services.

The following water systems face EPA fines for failing to distribute their water quality reports (number of customers in parenthesis): Arizona Windsong Water Co., Sanders, (400); Leslie Canyon Water Users, Douglas, (60); Lacosta Water Users Assoc., Douglas, (56); Sunrise Mobile Home Park, Sierra Vista, (22); Kachina Village MHP, Kachina Village, (240); Ash Creek Water Co., Central, (1050); Eagle View Village/Matori Farms, Aguila, (200); P.A.I. Domes-

tic/Matori Farms, Aguila, (120); Oatman Water Co., Oatman, (536); White Hills Water Co., Bullhead City, (130); Joshua Hills Water Co., Dolan Springs, (200); White Mt. Lakes Estates, White Mountain Lake, (950); Running Bear Mobile Resort, Lakeside, (150); Rillito Water Users Assoc., Rillito, (213); Decker Community Water, Tucson, (29); Bidegain Water Co., Kearny, (49); Kelvin-Simmons Co-op, Kearny, (33); Hong Kong Water Co., Superior, (30); Maricopa Mt. Water Co., East Maricopa, (660); Maricopa Mt. Water Co., NW Maricopa, (225); Davis Ranch Landowners, Marana, (46); Hidden Valley Farnettes, Maricopa, (74); Hacienda Acres Water System, Wittman, (80); Buffalo Run Mobile Home Park, Camp Verde, (180); Beverly Gardens, Prescott, (150).

Poll Assesses River Awareness

Aesthetics may outrank science in a recent survey as Americans overwhelming support the protection and conserving of rivers but lack a good understanding of the workings of a watershed.

In a recent poll 98 percent of respondents said it was important to protect and conserve American rivers. Only about half the respondents, or 56 percent, however, were able to describe a watershed as a geographic area defined by the flow and movement of surface water toward a common river or other body of water.

Other results further gauged Americans understanding of rivers:

Only 36 percent were aware that nonpoint-source pollution — contamination from varied sources that is carried by runoff — is the prime source of water-quality problems for rivers.

Just 15 percent knew that the actions of individuals is the greatest source of river pollution. 44 percent incorrectly identified industrial sources as the biggest polluter of the nation's waterways.

Only one-third correctly recognized land use and urban sprawl as the most serious threat to watersheds.

59 percent were unaware that agricultural runoff causes more river pollution than what derives from industrial sources.

42 percent incorrectly believed that water entering storm drains is treated at water treatment plants.

About half the respondents thought that dumping a quart of oil down a storm rain would result in an oil slick 100 feet or less, whereas the actual figure is two acres or 6,000 square feet.

Commissioned by National Geographic the "River IQ" study is part of a program that will include students, teachers, families, and communities in projects to preserve rivers and conserve water. The goal is for Americans to become responsible river stewards.

Other sponsors of the program include Coca-Cola, the Conservation Fund and the River Council. The latter is made up of various organizations including American Rivers, Izaak Walton League of America, River Network, Trout Unlimited, and Waterkeeper Alliance

The national telephone poll targeted 750 adults and 250 children, and the margin of error was plus or minus 4 percentage points.

Special Events Mark SRP's 2003 Centennial

SRP's centennial in 2003 will be an occasion to inform Arizona citizens about the project, its history, growth, and achievements during its 100 years of operation. Planned events include the publication of a history of the SRP, from its inception to the present day. SRP historians Fred Andersen, Katherine May, Marc Campbell and Shelley Dudley are working on the project, to be published in fall 2002.

Various museums will host traveling and semi-permanent exhibits devoted to the SRP. The SRP Heritage Program will be working with Phoenix Museum of History in developing a SRP historical perspective, to be exhibited from October 2002 to December 2003. Exhibits also will be displayed at Pueblo Grand and the Arizona Historical

Museum in Papago Park. Other exhibit sites also will be identified.

A highlight of the SRP centennial year will occur in April 2003 when the Arizona History Convention takes place in Tempe. The main focus of the conference will be the history of the SRP. A call for papers will be issued in about a year. Other topics can be addressed, but conference organizers hope to attract many papers discussing the development of Central Arizona and SRP. Prominent western historians Patricia Limmerick and Donald Pisani will participate in panel discussions.

For more information about events planned for the SRP Centennial contact Shelly Dudley, SRP archivist, 602-236-6627, or Bruce Dings, Arizona Historical Society, Tucson, 520-628-5774.

Value of Water Tanks for Migrants Questioned

The effectiveness of water stations established to save the lives of border crossers is being questioned after the recent death of a Mexican citizen. Despite obtaining water from two stations within Organ Pipe Cactus National Park Jorge Alonso Mireles died from heat exhaustion. Alonso was within a group of eight illegal immigrants.

The incident reinforces some U.S. Border Patrol officials belief that the stations established to provide relief from extreme

thirst may in fact be creating a false sense of security. The agency is concerned that some undertake the trek with undue confidence knowing water is available. The Tucson-based humanitarian group, Humane Borders, set up two 60-gallon water tanks in the park in March in an effort to reduce fatalities among border crossers. Thirty-foot flagpoles mark the location of the tanks.

The Rev. Robin Hoover, co-founder of Humane Borders, defends the project saying that Allonso's death is not reason to question the value of the water tanks. He says many others have obtained water from the tanks and continued their journey with no ill effects.

The availability of water would not necessarily save those too dehydrated to benefit from drinking. At a certain stage of dehydration a person is unable to drink and keep it down.

The U.S. Border Patrol videotaped an interview with Fidel Alonso, brother of Jorge, and an agency spokesperson says the interview bolsters the contention that the water tanks represent a hazard. In the video Fidel describes how the water enabled them to continue their journey. At one point he says, "There was more than enough water but he (Jorge) couldn't make it."

At the time the water tanks were installed the Border Patrol's Tucson Sector went along with the project, instructing agents not to lie in wait at the stations. Al-

though this policy is to continue the recent incident has intensified the agency's concern that border crossers are taking increased risks because of the availability of water.

AZ WaterCommunity NEWS

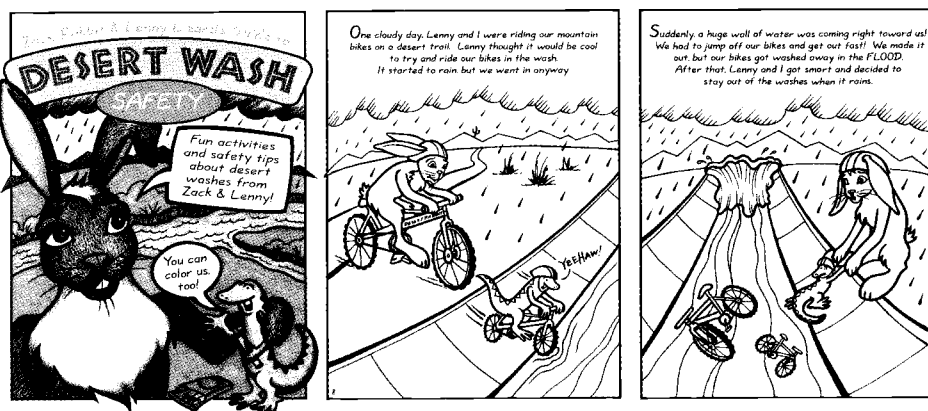
Gov. Jane Hull has appointed **Brad Hill**, Peoria's water resources manager, to the Arizona Water Resources Advisory Board. Hill becomes one of 15 board members knowledgeable about state and local water resource issues who make recommendations on water resource planning, policy and legislation to the director of the Arizona's Department of Water Resources.

The **Nature Conservancy of Arizona** has appointed a new state director, **Patrick Graham**, and moved the position from Tucson to Phoenix. Graham explains, "The feeling was to have the state director in a more central location." The Tucson office, however, will remain the largest in terms of staff.

David M. Esposito has been named manager of the Arizona Department of Environmental Quality's southern regional office in Tucson. He was formerly director of the ADEQ's Waste Programs Division

Arizona State University Professor **Wendell Lee Minckley** died June 22. Minckley is considered to have contributed more than anyone else to fish preservation in the Southwest, while mentoring generations of graduate students sharing his interest.

Larry Linser died June 17. He had served as deputy director of the Arizona Department of Water Resources before leaving the agency in 1995 for a private consulting practice. Linser initiated the process of deciding surface rights for streams and negotiating Indian water rights. His interests also included flood control, dam safety and the development of state water banks.



Above is the cover and two pages from "Desert Wash Safety," a coloring book featuring Zach Rabbit and Lenny Lizard. Its intent is to warn children that desert washes can be danger zones. In a little over year, two Tucson youth have lost their lives in washes. The most recent case was on August 1 when a 14-year-old boy was sucked through a storm drain and washed a half-mile downstream. The coloring book, available in English and Spanish, can be ordered free from the Tucson Transportation Department's Stormwater Section (phone: 520-791-4372) and is online at www.ci.tucson.as.us/pdf/washsafety.pdf



Guest View

Arizona's Rural Water Future: Meeting the Challenges

Doug C. Nelson, Ph.D. contributed this Guest View. Dr. Nelson is a natural resource economist and attorney specializing in utility and water law. He serves as executive vice president of the Arizona Rural Water Association. These remarks are those of Dr. Nelson and not the Arizona Rural Water Association.

Rural Arizona is experiencing challenges in meeting water demands. "Rural water," for purposes of this article, is the water systems outside the service area of the Central Arizona Project. Competing water demands, between rural areas and among water users, are more controversial than selecting a stadium site.

Water is difficult to manage, in part, because water suffers from misconceptions. Many perceive water as being "free," even if they pay more for "designer water" than the gasoline in their SUVs. Some think people will stop coming if there is insufficient water. And some believe that "their" water will be available for "their" future use. Water, as a "fugitive" resource, has a tendency to wander away, unlike say copper or a stand of trees. Water also has a domino effect: pumping groundwater or drawing water from a stream affects others who may be some distance away.

An intricate body of law and tradition once protected water rights. With growing metropolitan demands, expanding Native American uses, and increasing environmental requirements, the rights to *future* water use are eroding away. Economic and political pressures now more than ever dictate entitlements to water.

Groundwater in rural Arizona is largely unregulated and highly variable. Geological and hydrological conditions differ extensively among and within watersheds. Annual runoff can vary tremendously from year to year.

The courts, with an expansive view of subflows, are adjudicating surface water rights. Reduced pumping from wells that affect stream flows, such as along the Verde and Gila rivers, will likely diminish consumptive rural water supplies. Some Indian settlements provide leased water for metropolitan cities without addressing the water demands of rural communities.

Not surprising, water options rest with federally supported organizations, such as the Salt River Project and the CAP. Water users in those areas have the luxury of deciding whether to use Colorado River water, regional surface water from rural watersheds, reuse treated effluent, or leased tribal water. They have the flexibility of "banking" water for the future and the ability to tap a local or distant groundwater source during extended droughts.

The Arizona Legislature has appropriated funds for local water activities called "water initiatives" in rural areas, through the Arizona Department of Water Resources. Continued support is needed for these efforts. However, financing of these studies is not enough. What happens to the results if there is no plan or framework to implement solutions? Will the "shelf-life" of the study expire before an implementing organization is created? Rural Arizona

needs the continuity of transforming studies into planned solutions.

Creating Active Management Areas in rural Arizona will not solve water supply problems. The AMAs address the use of lower-cost groundwater during the abundance of Colorado River and other water sources. Rural Arizona generally lacks alternative water supplies. Regulations do not create water. Conserving water results more from common sense, education and budgets than mandated by rules. Without the administrative weight of an AMA, forming local or regional water organizations will best address the unique challenges of each area.

Rural communities have begun to see the importance of planning their water futures. Local water providers and other stakeholders should be able to organize a water organization without seeking special legislation. Each rural area could select from a menu of activities and powers, under a state authorized Rural Water Authority (RWA).

Estimating water supplies and projecting future demands is costly and controversial. Harboring fact-gathering responsibilities with regulatory obligations creates suspicion. The position of State Water Engineer was dissolved with the formation of ADWR and the receipt of CAP water. The time has come for creating a State Water Engineer office to provide technical information and assistance to rural water organizations.

Local water providers and governments would be able to form a RWA by filing a petition with the State Water Engineer. Depending upon the desires of the petitioners, the Authority may merely engage in planning while other watersheds might invest in regional water systems and levy taxes to support those projects.

Dedicating groundwater for future rural uses by the Arizona Legislature is an ideal worth exploring. After adopting a water plan, the local RWA would file its report with the State Water Engineer. As rural watersheds develop more slowly than the AMAs, rural counties and communities would have the assurance of an adequate water supply.

In addition to securing the water future of our California and Nevada neighbors, Arizona policies should encourage "water banking" for the benefit of rural Arizona. Considerable resources are devoted to protecting Arizona's Colorado River allocation during interstate negotiations. Similarly, Arizona should invest in exploring water banking, exchange and recharge opportunities in rural Arizona.

Financing of solutions presents the greatest challenge. Partnering with the federal government, which owns about 43 percent of the land in Arizona, created the water foundation for our metropolitan cities. Similar collaborative efforts should assist our rural communities in augmenting their water supplies and preserving their lifestyles and economic futures. Investing in a safe and dependable water supply is more desirable than funding more regulations or responding to future water crises.



Legislation and Law

Governor's Commission Takes on Tough Job, Makes Progress.

The task at hand was to review the workings of Arizona's Groundwater Management Act, noting its deficiencies and shortcomings, and to develop recommendations to better achieve its goal of preserving the state's groundwater resources. To take on the formidable task, Governor Jane Hull appointed a Governor's Water Management Commission.

It was undoubtedly an ambitious plan, to bring together within a commission various representatives and interests to work on water issues, a perennially contentious topic, with the goal of achieving some kind of consensus about the future course of the GMA. The GWMC has now labored over a year and is in the process of finalizing preliminary recommendations for public review and comment in the fall. A final report is due Dec. 1, to include recommendations to the Arizona Legislature to consider during the 2002 session.

Although the GWMC is still on the job, enough work has been done to ask: Has the process worked to ensure a thoughtful revision of the GMA? With 47 members on the GWMC, various viewpoints prevail, but some common concerns emerged from interviews with a number of commission members.

One major concern was that the commission had too much to do in too short a period of time, a problem with varied consequences. As the work of the commission got started members were to peruse background materials. Considering the tight time line it soon became evident that efforts to absorb background information was consuming valuable time needed for the commission's main task of reviewing the GMA.

Much of the work was done by various committees, subcommittees, workgroups and sub-workgroups. These were formed at various times to work at different tasks, often in response to a shift in program direction. Some members complained it was difficult to keep track of the various committees and their tasks. The large size of the commission also was noted as causing problems.

Some members are frustrated by an awareness that what needs to be done will not likely get done within the established time frame. The complexity of the issues further complicates efforts at maintaining a predictable work schedule, with the result that some deadlines are not being met. For example the commission's original plan of adopting recommendations in July and August proved unworkable.

The issue of time constraints gathers additional concern when it is seen as a possible factor influencing the commission's actions and decisions. For example, some members felt the commission did not always provide due deliberations on various issues before making decisions. In response, others claimed that commission members did make an effort to properly debate each issue, but time constraints restricted lengthy discussion and deliberation.

Others who believe the commission slighted some issues have a less benign view of its intent and actions. They claim that commission members representing particular interests often protected their own turf by emphasizing certain issues over others. As a result some concerns attracted less attention than others. Still others say that a balanced view was taken and that perceptions of what got due attention are often in the eye of the beholder.

The impartiality of the commission was a concern as the process began. At the outset members were encouraged to practice statesmanship, to rise above their particular interests to work for the general good, with common gain over individual advantage. Some members questioned whether this ideal of statesmanship was in fact achieved.

They say leverage was lacking to guide the commission to take on troublesome, more complex issues, often with broad public policy implications. They complained that non-controversial issues, those of the lowest common denominator, tended to get broad commission support, to the neglect of more weighty matters.

Some members agreeing that the commission's recommendations may not be deep, probing or earth shattering say it is because the process has not been driven by a perceived sense of crisis or even urgency. Commission members therefore lacked the motivation for major GMA overhauling. This situation greatly contrasts with circumstances that motivated passage of the GMA in 1980.

Commission members generally feel, however, that some important issues have been identified and addressed and that the legislative recommendations can be the impetus for significant and positive changes to the GMA. Regret was shared that other issues will not make it on the agenda due to time constraints.

Commission work is still in progress, with a true test of its effectiveness up ahead when recommendations are finalized for legislative consideration. Recommendations OK'd for public review will then receive greater scrutiny. At that time, difficult decisions will have to be made, with give and take negotiated, before a final vote. The commission's performance of this task will be its final test and legacy.

Conference to Discuss GWMC Results

The University of Arizona's Water Resources Research Center has scheduled a conference focused on the work of the Governor's Water Management Commission. The conference will serve as a forum to inform legislators, the media and the public about major outcomes of GWMC proceedings. It will provide an opportunity for commission members to discuss commission recommendations; topics that were discussed without reaching consensus; and issues in need of future attention. The conference will be conducted at the Heard Museum in Phoenix, Nov. 13. For additional information contact Terry Sprouse, WRRRC, 520-792-9591 X 13 or check the WRRRC web site: <http://www.ag.arizona.edu/azwater/>



Publications

Water Quality: Better Data and Evaluation of Urban Runoff Programs Needed to Assess Effectiveness

Government Accounting Office

This GAO document was prepared to report on 1) the amount of runoff from urban areas, particularly from roads, highways and other impervious surfaces, and its effects on water quality and (2) the programs that federal regulations require local governments to develop to address urban runoff and the costs and effectiveness of those programs. The review was performed from August 2000 through May 2001 and can be accessed at GAO Report web site: http://www.access.gpo.gov/su_docs/aces/aces160.shtml

Envisioning the Agenda for Water Resources Research in the Twenty-First Century

National Research Council

With the intent of outlining a roadmap to guide policymakers the Water, Science and Technology Board held a series of discussions at several of its meetings in 1998-2000 about the future of the nation's water resources and the appropriate research needed to achieve their long-term sustainability. An outgrowth of those discussions, this report discusses major research questions related to the critical water issues that face the nation. It lays out an interdis-

ciplinary research portfolio for the next 20 years and recommends agenda-setting processes that can maximize the nation's ability to prioritize and conduct water resources research. The publication identifies 43 research issues within three main topical areas: water availability, water use and water institutions. Additional funding for water research is called for since problems cannot be solved with the current level of investment in water resources research. Copies of the report can be obtained from Western Science and Technology Board, National Research Council, 2101 Constitution Ave., N.W. Washington, DC 20418

A Primer on Climatic Variability and Change in the Southwest

Robert Merideth

Focusing on Arizona and New Mexico, this primer provides an overview of the role and relevance of climate to the Southwest's society, economy and environment. Intended for decision makers, stakeholders and interested citizens this publication attempts to show how climatic variability and change affect the lives and livelihood those living in the region. For a copy of this primer or related reports contact Udall Center for Studies in Public Policy, University of Arizona; phone: 520-884-4393; web site: udallcenter.arizona.edu

Irrigating India: My Five Years as USAID Advisor

Sol Resnick, as told to Elaine Minor Resnick

Complications developed when Resnick requested wheelbarrows and shovels for an irrigation project. "Wheelbarrows? Is Resnick crazy," exclaimed a Washington official. "We'll send you earthmovers. Just tell us what you want"

A brief incident within the book, the event might represent the style and substance of Resnick's work in India. He requested the wheelbarrows and shovels for a small-scale village irrigation project, to be built by the villagers themselves. At a time when India was undergoing profound historical changes Resnick realized that the best tools to serve the needs of villages were those the village could use themselves. Real change does not come from above and beyond but from within the village itself.

In his book Resnick describes his work in Indian Villages, with a keen eye on local life, but also commenting on the ways of the more privileged classes. His work also brings him into contact with various government officials, both American and Indian. He meets and gains the support of Chester Bowles, U.S. ambassador to Indian, and Indian Prime Minister Nehru.

Narrated and transcribed as a series of "Sol stories," the memoir holds together as a unified work, the view of a sensitive and compassionate man coping with the complexities of Indian culture and committed to improving the lives of villages. (See



Village woman working on a diversion project.

page 11 of this newsletter for excerpts from the book.)

Sol Resnick is Professor Emeritus Hydrology and Director Emeritus of the Water Resources Research Center at the University of Arizona. In 1998, the Arizona Hydrological Society awarded him its Life Time Achievement Award. A water expert of international repute, Resnick has worked for USAID and the World Bank and has taught at universities in the United States, Israel, Brazil and Thailand.

The book is available online at amazon.com, in select bookstores or call 520-529-2122; fax 520-529-6345; email: eburton@worldnet.att.net



Special Projects

USGS Program Expands Streamflow Data Collection

The U.S. Geological Survey operates about 7,000 streamflow-gaging stations throughout the nation to serve as river sentinels, gathering and recording information about the flow in the nation's rivers and streams. Transferring streamflow into a flow of information, the gaging stations provide accurate and valuable data to serve the needs of many organizations. For example, the Salt River Project uses this data to manage its reservoirs on the Salt and Verde rivers.

The great majority of these stations operate as joint ventures, with more than 800 state, local, tribal or other federal agencies sharing costs. USGS is the senior partner, operating the system for the benefit of all and widely and freely distributing data. Arizona has 220 such sites within the USGS system, with about 35 entities signed on as co-sponsoring partners.

The system that functioned well over time is now reaching a critical point, its current capabilities inadequate to meet growing demands for varied and expanded information. Cooperators have dropped out of the program, often with the result that streamgages are discontinued at a time when emerging issues and technologies have increased the need for reliable streamflow information. Also technological upgrades are needed to improve system reliability and decrease costs.

In response to such concerns the National Streamflow Information Program was established, to upgrade the streamflow-gaging network and ensure a stable and modern river monitoring system. NSIP will enhance operations by supporting the following activities: intensive data collecting during major floods and droughts; periodic assessment and evaluation of streamflow characteristics to determine impacts of climate and land-use change; development of an effective system for delivering data to users; and implementation of a research and development program. NSIP's first year of funding was FY 2000.

NSIP establishes a two-tiered approach to streamgaging, with the ongoing cooperative network now joined by a newly established federal network. NSIP will boost the cooperative network by enabling USGS to pay the fixed cost of the system, thereby decreasing cooperators' per-streamgage cost by about 40 percent.

NSIP's federal network is a system of streamgages strategically positioned throughout the country, in various states, to provide a national perspective. Mostly identified from among those within the present network, these streamgages represent a subset of the total number. Totally funded by USGS, this selected core will deliver real-time information, uncompromised by varying support from funding partners. Its continuous operation ensured, the federal network will pursue specific objectives relating to interstate and international waters, flood forecasts, river basin outflows, sentinel watersheds and water quality.

The NSIP network will eventually consist of 4,421 streamgages, with most identified from the roster of active USGS streamgages but also including inactive USGS streamgages or streamgages oper-

ated by other agencies. At times new stream gages may be constructed or added to the NSIP network. In Arizona, 85 sites have been identified to be included in the NSIP federal network, 57 of them currently active.

Arizona's streamgaging sites have special importance since the state has a higher number of unregulated streams than most states. Uncontrolled by reservoirs, the unregulated streams can be gaged to better determine long-term river conditions, thereby promoting a fuller understanding of such issues as climate change, flood frequency and water quality. Information from unregulated streams also can be used to devise equations for use with ungaged streams, for such purposes as estimating 100 year floods, etc.

Another NSIP benefit is the funding of remote sites that do not attract the interest of local sponsors. In Arizona, such sites may be located for example within the Grand Canyon. NSIP funding could be used to support such sites if they contribute to a national perspective.

Arizona received funding this year for two sites. The funding will be used to rebuild the infrastructure of a streamgage on the Santa Cruz River. A cableway on the river at Nogales was used to measure high flows until it was condemned because of deterioration. NSIP funds are being used to repair the cableway at this key site which should be back in operation by the end of the year. This site enables verification of high flows to ensure adequate flood warning. Funding also was used to install a temporary streamgaging station on Centennial Wash upstream of the town of Wenden to ensure adequate response time in the face of a possible flood threat.

NSIP will not only enable more and increasingly varied information to be collected but will provide the means to transmit, store and distribute the information via the Internet. NSIP funds supported development of NATWEB, a national system of redundant web servers designed to ensure data delivery in times of high customer demand, heavy Internet traffic or local failures in power or communications systems. Another advance in data delivery is the system called NWIS-Web (<http://water.usgs.gov/nwis>), designed to provide the entire storehouse of USGS data to the public.

Data delivery will be further refined by expediting the process of providing streamflow data collected at frequent — usually 15-minute — intervals. This is expected to be accomplished in FY 2002. Finally NSIP plans include new web-based applications to allow users to select any location on any stream and use GIS interfaces and existing statistical models to compute streamflow characteristics.

NSIP also will support research and development. In its quest for new approaches to streamgaging, NSIP will invest \$5 million per year to improve the understanding of streamflow and the way it is measured and analyzed.

The web site <http://water.usgs.gov/nsip> provides additional information on the NSIP program including a map showing streamgaging sites in Arizona, including new/proposed sites.



Announcements

New Mexico Water Institute Host 46 Annual Conference

The New Mexico Water Resources Research Institute will be conducting its 46th annual water conference in Santa Fe, Nov. 5-7. The event is co-sponsored by the New Mexico Watershed Coalition and the New Mexico Riparian Council. The theme of this year's conference is "New Mexico Watershed Management: Restoration, Utilization and Protection." For additional information about the conference including preliminary program and costs check the WRRI web site: <http://wrri.nmsu.edu>

Grants Available for Wetlands Conservation

The Fish and Wildlife Service seeks proposals for matching funds for wetland and wetland-associated upland conservation projects. The awards provide up to \$50,000, to be matched by at least a 1:1 contribution of non-federal funds. The grants may be used only for wetlands acquisition, creation, enhancement, or restoration. For additional information contact: Keith Morehouse, Div. of Bird Habitat Conservation, U.S. Fish and Wildlife Service, 4401 N. Fairfax Dr., Suite 110, Arlington, VA 22203. phone: 703-358-1784; fax: 703-358-2282; email: keith_morehouse@fws.gov; web site: <http://northamerican.fws.gov/NAWCA/grants.htm> The deadline for applications is Nov. 30.

Native American Forum on Environment and Natural Resources

"Building Native Nations: Environment, Natural Resources and Governance" is an international conference and forum organized by the Morris K. Udall foundation and the Udall Center for Studies in Public Policy at the University of Arizona. Topics include institution building, economic development, traditional knowledge and science and technology. The conference/forum is scheduled for Dec. 11-13 in Tucson. For additional information contact 520-884-4393.

Nominations Sought for Endangered Rivers

The American Rivers organization is in the process of compiling its list of America's Most Endangered Rivers of 2002. The selection process includes accepting nominations from grassroots organizations, and nominations are then judged by criteria including the magnitude and imminence of the threat to the river, and the likelihood that major action during the coming 12 months could either intensify or lessen the threat. Nomination must be submitted by Oct. 1. Nomination papers are available online at www.americanrivers.org Questions can be addressed to Rebecca Sherman, phone: 202-347-7550; email: outreach@amrivers.org

EPA Asks Comments on Arsenic Standards

The U.S. Environmental Protection Agency is requesting public comment through Oct. 31 on a new arsenic-in-tap-water standard before deciding the issue early next year. Comments are sought on whether the arsenic standard should be set at 3 ppb, 5 ppb, 10 ppb or 20 ppb. In addition, the agency asks commentators to submit new information for review. For background information on the issue see the web site: <http://www.epa.gov/safewater/arsenic.html> Comments are to be submitted to the W-99-16-VI Arsenic Comments Clerk, Water Docket, (MC-4101) U.S. EPA, 1200 Pennsylvania Ave., NW, Washington DC 20460 or submitted via email to: ow-docket@epa.gov This fall, the agency will publish another notice to request public comment on the reviews that are underway.

Proposals Invited for AZ/New Mexico History Conference

Historians involved in western water may be interested in an invitation for proposals for papers on any aspect of New Mexico or Arizona history for presentation at the New Mexico-Arizona Joint History Convention, to be held April 11-13, 2002 in Las Cruces, New Mexico. Of special interest are two cash awards to be presented for papers. A \$200 prize will be awarded for the best paper dealing with the territorial period of Arizona history. Papers dealing with Arizona geography, broadly defined, or cartography are particularly encouraged. Also the Arizona Humanities Council, as part of its "Moving Waters: The Colorado River and the West" project, is offering \$200 for the best historical paper addressing any aspect of the Colorado River. All proposals must be submitted by Oct. 1 to Bruce J. Dinges, c/o Arizona Historical Society, 949 E. Second St., Tucson, AZ 85719. Upon proposal acceptance, presenters competing for a prize must submit a completed paper of no more than twelve double-spaced, typed pages (exclusive of notes) to Bruce Dinges by February 1, 2002. Papers not being submitted for a prize must be in hand no later than March 1, 2002.

Border Conference Calls for Abstracts

Although the conference, "Integrated Transboundary Water Management," is to be conducted in Michigan not far from Canada, its focus also includes the southern U.S. border with Mexico. Sessions are expected on contrasting transboundary water issues on both northern and southern U.S. borders. A call for abstracts has been issued for the conference, with abstracts due Oct. 1. The conference will be held in Traverse City, Michigan July 23-26, 2002. Conference sponsors include the Universities Council on Water Resources, National Ground Water Association and the U.S. Army Corps of Engineers Institute for Water Resources. For additional information check the web site: <http://www.uwin.siu.edu/ucowr/>



Outside Readings

More to “Irrigating India” Than Irrigation

“Outside Readings” includes reprints or abstracts of editorials, features, articles or other published materials that appeared in various publications.

Following are excerpts from “Irrigating India,” by Sol Resnick. (See page 8 for information about the book.) Trained as a civil and agricultural engineer, Resnick realized that more than technical skills were needed when working with villagers unfamiliar with modern advances in health and hydrology. Resnick worked in India for the Agency of International Development from 1952-57.

Villagers often relied on the old ways when needing water, and Resnick found that the effectiveness of the old ways sometimes depended upon scientific understanding, albeit dubiously applied.

The villagers needed a water supply, usually a well or a tank. When they needed to dig a new well, they sought help from a famous local water diviner. The diviner was a rather clever but lazy man who figured out a way to do his divining from home. The villagers walked twenty or thirty miles to his village bringing with them carefully drawn maps of their own village. The diviner spread the maps on the ground. He made sure they included the location of every banyan tree in the village. Then he took out his old pocket watch. The watch no longer told time, but did tell where the water was located. He’d hold the watch by its chain and dangle it over the map, slowly moving it in circles until the watch began to shimmy. “There,” he’d say. “Dig there and you will find water.” And he was right. He knew that wherever the big banyan trees grew, there had to be a good water supply. He’d make sure the watch shimmied over the biggest tree and sent the villagers home to dig.

Other water diviners went from village to village. They knew the trick was to find a big tree. They would invariably tell the villagers to dig on the west side of the tree so that the women would have shade as they did their laundry at the well in the morning.

*Resnick’s efforts to expose villagers to the outside world could leave them feeling incredulous. Returning from New Delhi he would bring back magazines acquired from embassy staff. Village woman would then find out about the world beyond their villages by looking at pictures in *Good Housekeeping*, *Better Homes and Garden*, and *House Beautiful*.*

After dinner I brought my magazines out to the campfire and the village women gathered. They took a magazine and sat on the ground, paging through, looking at the pictures. I guess they could figure out what a chair or bed was, but if they came to a picture of a dishwasher, they would come to me and say, “Sab, Sab, what is this?”

How do you explain a dishwasher to a person who doesn’t even know what a dish is? The women lived in one-room huts and cooked in a corner or outside on an open fire. They owned a few cooking pots and utensils and some small wooden bowls, but ate off leaves with their fingers. How do you explain an electric stove, a toaster, a Mixmaster? They carried their water from wells or the

river. How do you explain faucets on a sink? They washed their clothes in the river or at the well and left them to dry on rocks. How do explain a washing machine and dryer? I did my best and the women oohed and aahed.

Word spread that the American had magazines with wonderful pictures. Women from the villages walked in to see the now-famous magazines. They sat in small groups around the campfire with the local village women who with their new knowledge about the outside world, explained the intricacies of the modern American kitchen to their friends who also oohed and aahed. But the new women couldn’t believe what they were hearing. The local women would call out, “Sab, Sab come here and tell about the dishwasher to my friend. She does not believe me.” And I moved from group to group in response to “Sab, Sab,” and explained how a dishwasher worked

To combat a severe cholera outbreak Resnick had wells drilled to provide an alternative drinking water supply to the polluted river. Villagers initially refused to use the pure well water.

I got in touch with the state engineer who brought down a drilling rig. We dug more wells and, as always, tested the well water. It was pure. When the villagers refused to use the well water, the AID public health doctor had an idea. He assembled all of the villagers for a meeting on the cricket field.

He stood in front of the people and asked, “You know how when your wives menstruate, they are impure? How they cannot cook your food? How you separate them from the rest the village? How they live alone in their separate little huts when they are impure?” The villagers solemnly nodded yes. He continued, “The same thing happens to the River Goddess. She is menstruating and her water is impure. You cannot use her water to bathe or drink until she is clean again.” You could see the light grow in their eyes as they comprehended what he said. They got the message. As they began to use the well water, they found that they actually liked it better than the river water and continued to drink it after the cholera epidemic subsided.

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Canals...continued from page 1

tems are the largest pre-Columbian earth works in North America if you calculate the volume of earth moved to make them, and archeologists could not find any precedent for them. It looked like full-blown canal technology right from the beginning.”

In uncovering canals 1,000 years older than the Hohokam canals, archaeologists now realize irrigation technology developed in the Sonoran Desert over a longer time period than was previously thought. “For the first time we have a precedent in the Sonoran Desert for the complex irrigation systems the Hohokam built later,” Mabry says.

The canals also are helping settle questions about the influence of Mexican cultures on the development of irrigation technology in the U.S. Southwest. Southwestern cultures farmed crops that derived from Mexico, including maize, squash and beans, and it was a logical inference that knowledge of canals and irrigation also migrated northward from more advanced Mexican civilizations.

Yet the canals in the Tucson area were more complex than the canals in Mexico, even those of the same age. Whereas the Mexican canals were designed to capture slope runoff, the canals in this area diverted a perennial river flow. The Tucson canals were traced over a quarter mile, and their alignments and gradients indicated they conveyed water from the Santa Cruz River, which flowed mostly year-round during that time period. “The Tucson canals were bigger and involved more complicated tasks than canals of a similar age in Mexico,” Mabry says.

As a result researchers now speculate that the early farmers of the Sonoran Desert may have developed irrigation technology on their own, in response to their needs. Mabry says, “There is now the possibility that canal irrigation was a home-grown technology in the Sonoran Desert.”

Conditions along the Santa Cruz and other southeastern Arizona rivers better supported the early development of irrigation technology than sites within the Phoenix Basin, although the latter location is where the Hohokam later constructed their most their impressive canal systems. In the north, the Salt and Gila rivers are larger and more powerful rivers than the Santa Cruz River, and their regular flooding would have washed out any efforts to construct canals within the flood plain.

Mabry says the Hohokam learned to cope with this situation. “They learned the trick of diverting the Gila and Salt rivers and built their canals up on terraces above the floodplain, out of harm’s way from the floods.” This enabled them to effectively irrigate with these unruly rivers.

The Phoenix area has not many sites older than Hohokam. Mabry explains that few wild foods grew in the area, and a culture therefore needed a highly productive irrigated agriculture before it could settle the area. The Hohokam developed this irrigation.

Mabry says perhaps the early farming culture in the Tucson area first figured out canal irrigation. “This knowledge was passed on and developed from generation to generation. The Hohokam then took it a step further and were able to later successfully colonize the Phoenix Basin.”

The discovery of the canals was made in 1998 as a result of an archaeological excavation carried out in advance of an Arizona Department of Transportation highway construction project. Archaeologists from Desert Archaeology, Inc. identified the canals at the site of Las Capas (“The Layers”), at depths between two and six feet below the surface of the former floodplain of the Santa Cruz River. The researchers plan to submit a report on the significance of the canals to the journal *Science*.



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