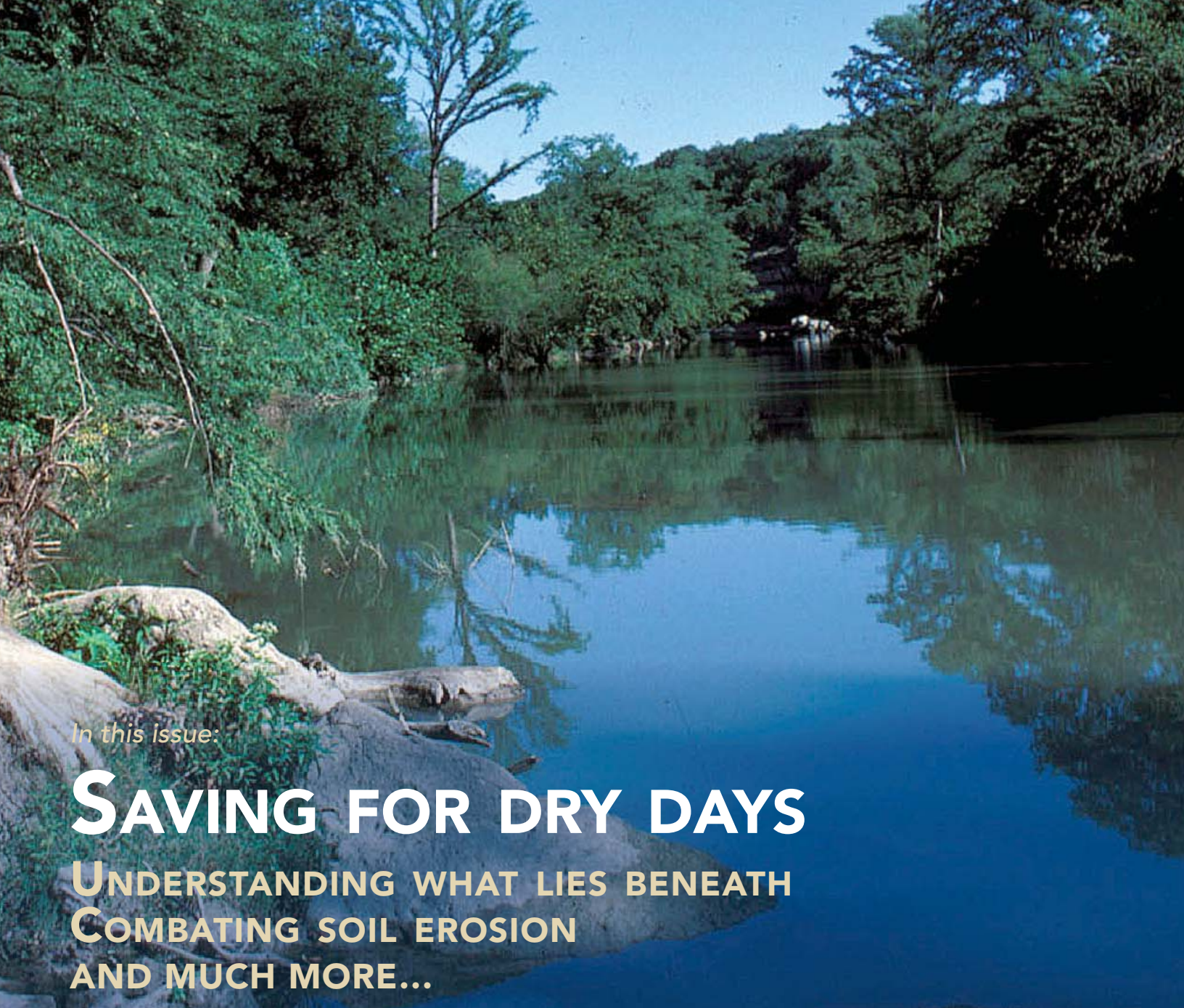


tx : H₂O

A Publication of the Texas Water Resources Institute

Fall 2008



In this issue:

SAVING FOR DRY DAYS

**UNDERSTANDING WHAT LIES BENEATH
COMBATING SOIL EROSION
AND MUCH MORE...**



Working to Make Every Drop Count

As you may already know, I am leaving my position as director of Texas Water Resources Institute (TWRI) to take a faculty position at the Texas AgriLife Research and Extension Urban Solutions Center at Dallas, beginning in January 2009.

In this position, I will focus on improving urban and suburban water management.

I have enjoyed my 20 years in administration positions with Texas AgriLife Research (Texas Agricultural Experiment Station). I am proud of the accomplishments of the institute since Dr. Bill Harris and I came on board eight years ago. I want to thank the TWRI staff and Texas A&M AgriLife faculty and administration for helping TWRI achieve a number of important milestones:

- Attracting over \$56 million in grants and contracts involving about 200 faculty since 2001,
- Providing approximately \$350,000 in small research grants to more than 70 graduate students from universities across Texas,
- Strengthening TWRI's relationship with Texas AgriLife Extension Service,
- Welcoming Dr. Ralph Wurbs as TWRI's associate director for engineering programs,
- Establishing a new TWRI program to assist faculty in offering water resources training courses for professional development,
- Strengthening the communications efforts of the institute through a major web presence and this magazine, and
- Increasing TWRI personnel from four to 19 full-time faculty and staff and establishing project management and communications teams to strengthen relationships with local, state, and federal water agencies.

I look forward to working with TWRI's many cooperators in my new role.

A handwritten signature in black ink that reads "Charles Allan Jones".

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On the cover:

The City of Kerrville stores excess water from the Guadalupe River in its Aquifer Storage and Recovery facility. Photo by Earl Nottingham, © Texas Parks and Wildlife Department.

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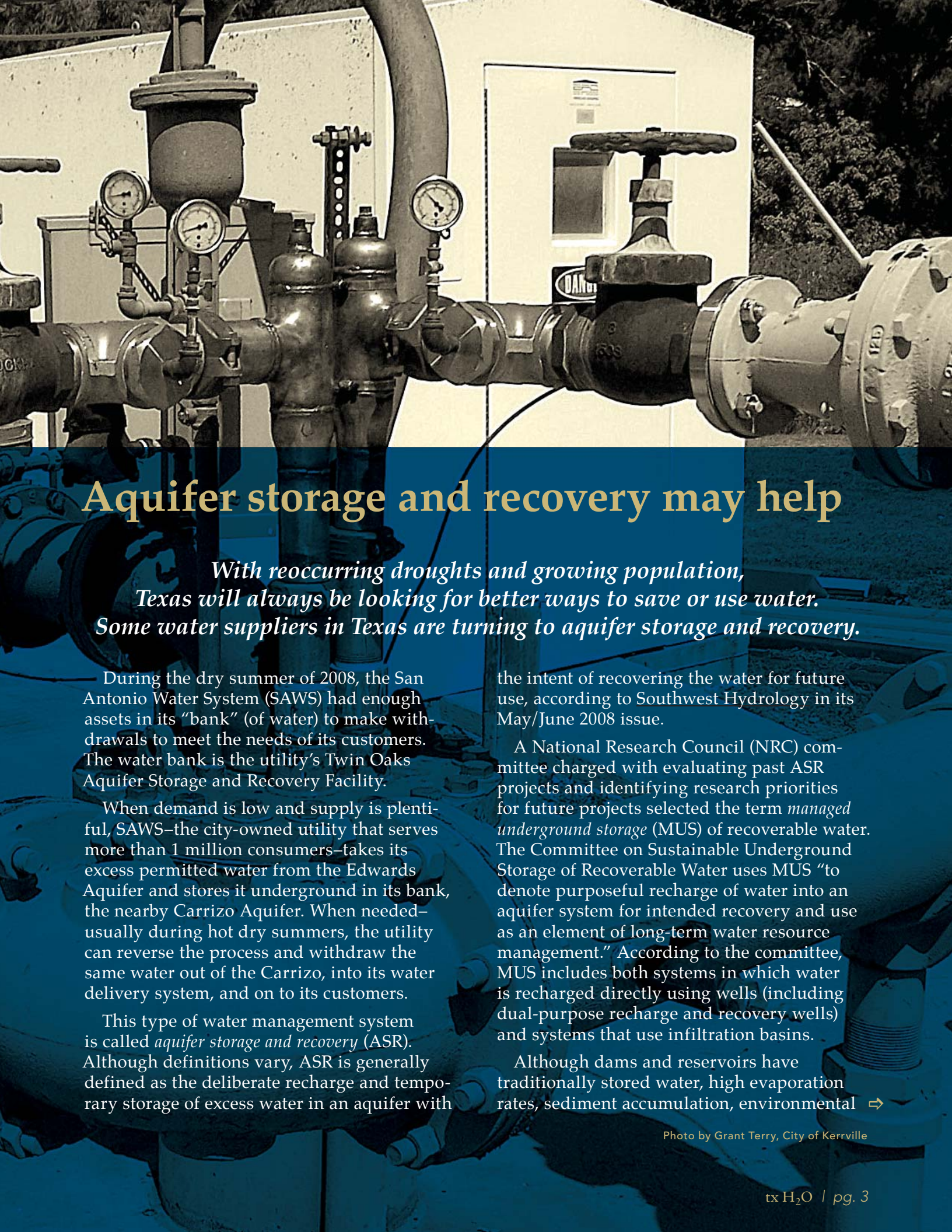


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Story by Kathy Wythe

Saving for dry days



Aquifer storage and recovery may help

With reoccurring droughts and growing population, Texas will always be looking for better ways to save or use water. Some water suppliers in Texas are turning to aquifer storage and recovery.

During the dry summer of 2008, the San Antonio Water System (SAWS) had enough assets in its “bank” (of water) to make withdrawals to meet the needs of its customers. The water bank is the utility’s Twin Oaks Aquifer Storage and Recovery Facility.

When demand is low and supply is plentiful, SAWS—the city-owned utility that serves more than 1 million consumers—takes its excess permitted water from the Edwards Aquifer and stores it underground in its bank, the nearby Carrizo Aquifer. When needed—usually during hot dry summers, the utility can reverse the process and withdraw the same water out of the Carrizo, into its water delivery system, and on to its customers.

This type of water management system is called *aquifer storage and recovery* (ASR). Although definitions vary, ASR is generally defined as the deliberate recharge and temporary storage of excess water in an aquifer with

the intent of recovering the water for future use, according to Southwest Hydrology in its May/June 2008 issue.

A National Research Council (NRC) committee charged with evaluating past ASR projects and identifying research priorities for future projects selected the term *managed underground storage* (MUS) of recoverable water. The Committee on Sustainable Underground Storage of Recoverable Water uses MUS “to denote purposeful recharge of water into an aquifer system for intended recovery and use as an element of long-term water resource management.” According to the committee, MUS includes both systems in which water is recharged directly using wells (including dual-purpose recharge and recovery wells) and systems that use infiltration basins.

Although dams and reservoirs have traditionally stored water, high evaporation rates, sediment accumulation, environmental ⇒

Photo by Grant Terry, City of Kerrville

costs, and the decreasing availability of land for dam and reservoir construction are major reasons for increasing interest in ASR. Water stored in ASR systems offers many benefits, including less evaporation, increased water supplies, emergency supplies for droughts, and reduced need for water infrastructure development.

Dr. Robert Mace, director of Texas Water Development Board's groundwater resources division, said ASR allows communities and water suppliers to maximize their water resources by managing their water conjunctively.

"Texas needs every tool in the toolbox for its water resources, and ASR is one of those tools," Mace said.

Dr. Zhuping Sheng, associate professor at the Texas AgriLife Research and Extension Center at El Paso, who served on the NRC's committee, agreed: "It (ASR) is a viable management tool in addressing water shortage because seasonal and multi-year storage of water is often a necessary component of integrated water resources management strategies."

The NRC committee also concluded that underground storage of recoverable water holds potential as a national strategy. In its report, "Prospects for Managed Underground Storage of Recoverable Water," the committee said, "Given the growing magnitude and complexity of the nation's water management challenges, managed underground storage should be seriously considered as one means to satisfy the demand for water and cope with water scarcity."

How ASR Works

ASR projects vary widely in the type of source water, method of recharge, aquifer

type (storage space), and method of recovery. The source water for ASR systems can be surface water diverted from lakes or rivers, excess water from an aquifer, stormwater runoff, or reclaimed wastewater. The water is then recharged into the aquifer through injection wells, infiltration basins, and/or natural drainages. The stored water forms a lens or a "bubble" atop the water already in the aquifer, depending on recharge methods and aquifer characterization. The water is then recovered through wells (which may be the same as the injection wells) or natural discharge of groundwater to a stream.

Some recharge systems also include infiltration galleries that use slotted pipelines buried underground to recharge the aquifer through the vadose or unsaturated zone above the water level, Sheng said.

Examples of ASR in Texas

The SAWS Twin Oaks Aquifer Storage and Recovery facility, which started operations in 2004, was the first project to come on line after San Antonio began shifting its needs from a total reliance on the Edwards Aquifer, said Steve Clouse, SAWS chief operating officer.

A key component of its 50-year water supply plan, the facility in south Bexar County includes a treatment plant, 16 wells that draw excess water from the Edwards Aquifer, and a 30-mile pipeline that moves the water into a large-scale underground storage facility in the Carrizo Aquifer.

Current storage at Twin Oaks — the second largest facility of its kind in the country — is about 48,000 acre-feet of water, or 16 billion gallons.

Clouse said that when San Antonio has rainy periods and water levels in the Edwards

'Texas needs every tool in the toolbox for its water resources, and ASR is one of those tools.'

— Dr. Robert Mace

Director of
Texas Water Development Board's
groundwater resources division



The City of Kerrville has stored excess Guadalupe River water in its ASR system since 1990. The city currently has two ASR wells. Photo by Grant Terry, city of Kerrville.

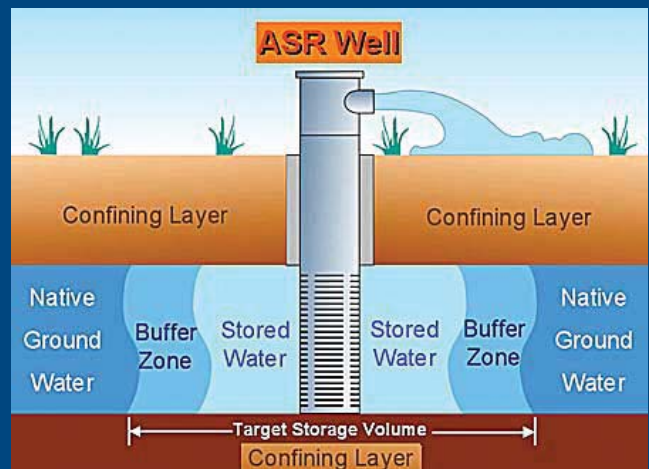
Aquifer are high, the utility diverts the water into ASR storage.

“When we have those really wet summers like we saw in 2007, it’s really ideal to continue to store while we are in that time of surplus because we know that drought is coming around the corner,” he said.

Besides 2008, the facility proved its value in the summers of 2005 and 2006 when the region experienced droughts. The retrieval of ASR water during those summers helped the region avoid strict drought restrictions.

“Conservation is a really high profile issue in San Antonio,” Clouse said. “We have the lowest per capita water use in Texas and probably one of the lowest in the country. Our Twin Oaks ASR facility is another tool to help us to conserve during times of plenty so we have water when need it, during periods of drought.”

The City of Kerrville has been storing its excess permitted water in an ASR system since 1990. The city draws water from the Guadalupe River during the wet season—usually September through the middle of May—treats the water, and injects it into the underlying Lower Trinity Aquifer



After a buffer zone is formed, recovery efficiency from ASR wells is usually close to 100 percent, according to David Pyne, an expert in ASR systems. Drawing courtesy of David Pyne, ASR Systems, LLC

(Hosston and Sligo formations) for storage. During the dry season, the city recovers, re-treats, and uses the stored water, said Grant Terry, Kerrville’s water production division superintendent.

The city has two ASR wells and will add another within the next couple of years, Terry said.

Because the aquifer is a confined aquifer, the water displaces the native groundwater and stays in place. “It’s just like a bubble of ⇒

stored water,” he said. “We have the right type of aquifer and the right type of water beneath us.”

With the city currently relying on ASR stored water for 5 percent of its water needs, with another 5 percent coming from native groundwater and the rest from the Guadalupe River, Terry said Kerrville officials see the ASR water as an “insurance policy” during water shortages.

More than an insurance plan

Besides using ASR as a savings plan when water is scarce, some water utilities also use ASR as a groundwater management tool.

The El Paso Water Utilities (EPWU) has injected highly treated wastewater from the Fred Hery Reclamation Plant in northeast El Paso into the Hueco Bolson Aquifer since 1985.

Dr. Bill Hutchison, EPWU’s water resources manager, said EPWU began using ASR as part of a strategy to solve the groundwater overdraft problem and as a way to dispose of effluent from its wastewater treatment plant. The utility has the capacity to inject 10 million gallons a day into the aquifer and at one point was putting approximately 16,000 to 17,000 acre-feet a year into the aquifer. However, the utility currently only injects about 1,500 acre-feet a year through its spreading basin.

Hutchison said EPWU no longer needs to inject large amounts of water because the groundwater level has stabilized, and golf courses and power plants have increased their uses of the reclaimed water.

“We have cut (groundwater) pumping by more than one-half in the last 25 years,” he said.



Although EPWU currently does not need to inject large amounts of water into its ASR wells, Hutchison said the system will continue to be an important part of the utility's management plan.

"In the future it may be advantageous (to inject), so it's a matter of maintaining flexibility at this point," he said.

The Future of ASR

The City of Corpus Christi is setting the stage for ASR to "stretch out its water supply," said Max Castaneda, water resources management advisor for the City of Corpus Christi.

The first step was to create the Corpus Christi Aquifer Storage and Recovery Conservation District in 2005 by the Texas Legislature. The district was formed to protect the rights of the stored water once the city begins the project, Castaneda said.

Although still developing an action plan, the city plans to use excess water from its O.N. Stevens Treatment Plant as the source water for injecting into ASR wells. The district is still studying the locations of the injection/recovery wells, Castaneda said. Total target storage volume for the ASR wellfields is approximately 6.1 billion gallons, or about 19,000 acre-feet.

Castaneda said not only will ASR water not evaporate like surface water, but it also will provide extra, needed water when the city has to close part of its water treatment system for repairs. "We will have the ability to tap into the stored water while we are doing operation and maintenance to the treatment system," he said.

Along with developing the ASR facility within Corpus Christi, the city's current long-range planning includes development of up to two ASR wellfields on North Padre and Mustang Islands. Total target storage volume for the two ASR wellfields on the islands is approximately 1.2 billion gallons, or about 3,700 acre-feet.

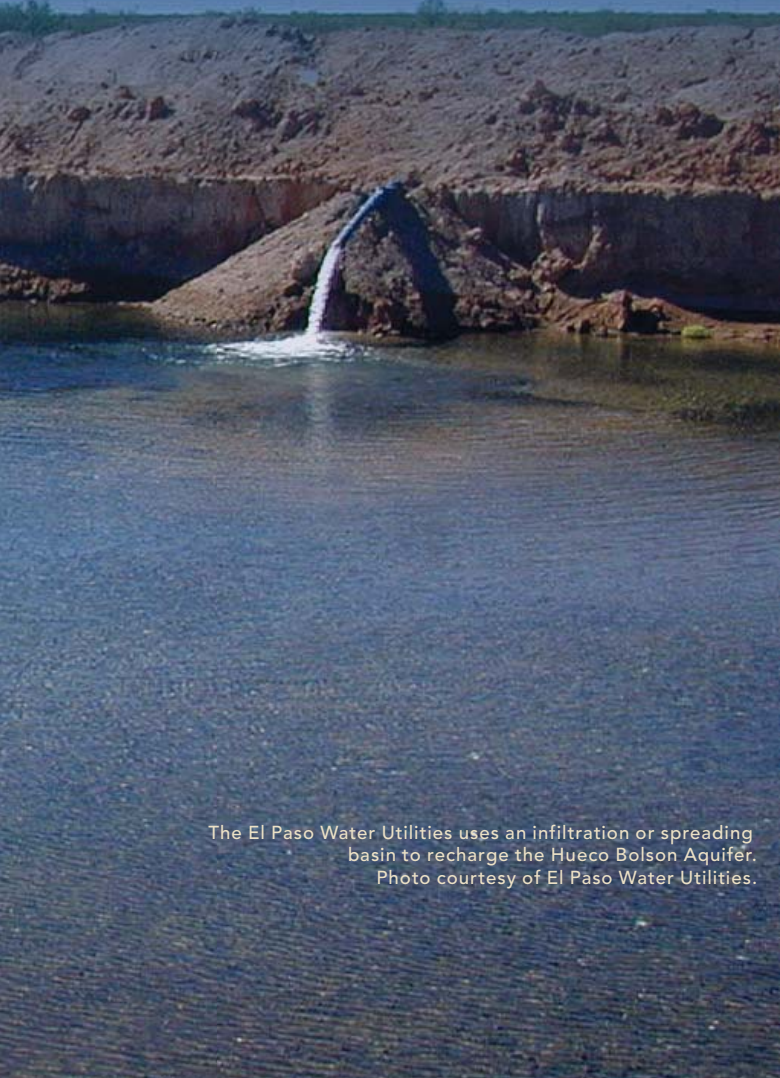
With only three ASR facilities in Texas, Mace believes Texas will eventually see more ASR projects.

"I think ASR would be a good option for some communities to look to more efficiently manage their water resources," Mace said, "because it has worked for Kerrville and for San Antonio. It's not too much of a stretch to think that it would work elsewhere in the state."

Mace said that the Texas Legislature has encouraged ASR as an option for water management by including it in the 1997 Senate Bill 1. This legislation established a statewide comprehensive regional water planning program.

In the 2007 Water for Texas state water plan, several regional water planning groups mentioned ASR as considerations in their water management strategies.

"As the population in Texas grows, we are going to have to use our water more efficiently, and ASR is definitely one of the tools to allow people to do that," Mace said. 💧



The El Paso Water Utilities uses an infiltration or spreading basin to recharge the Hueco Bolson Aquifer. Photo courtesy of El Paso Water Utilities.

Research needs to address ASR challenges

For all its benefits, aquifer storage and recovery (ASR) does have some potential challenges that warrant further research and planning, according to scientists and others involved in ASR.

In 2005, the National Research Council (NRC) convened a Committee on Sustainable Underground Storage of Recoverable Water to evaluate past experiences with ASR, or what the committee called *managed underground storage* (MUS) of recoverable water. Another committee goal was to identify the research priorities for development of future underground storage projects.

The NRC committee said MUS “poses its own unique challenges that need to be addressed through research and regulatory measures.”

The committee’s report, “Prospects for Managed Underground Storage of Recoverable Water,” assesses the factors affecting the performance of managed underground storage system projects. The committee made numerous recommendations for needed research and regulatory needs. These recom-

mendations along with the full report may be read at http://www.nap.edu/catalog.php?record_id=12057.

One overall recommendation of the NRC committee is the creation by water agencies of “an independent advisory panel ... to provide objective, third-party guidance regarding design, operation, maintenance, and monitoring strategies for these projects.”

The committee also said that water managers considering underground storage should “incorporate 3-D capable geographic information systems to map and analyze major aquifers as part of comprehensive, regional planning efforts.”

Dr. Robert Mace, Texas Water Development Board’s (TWDB) director of the groundwater resources division, said Texas has the information to do the 3-D imaging through the TWDB’s groundwater availability modeling (GAM) program, and TWDB is asking the legislature for support in developing this system.

To better predict the success and effects of a managed underground storage system, the NRC report recommends further research on



various aspects of the hydrologic feasibility of these projects, their impacts on surface water, and the hydrogeologic properties of underground aquifers.

Dr. Zhuping Sheng, associate professor at the Texas AgriLife Research and Extension Center at El Paso, who served on the committee, agreed that understanding the hydrogeologic properties of aquifers is critical.

“More research is needed to analyze different aquifer properties to identify what kind of aquifer is more appropriate for storage,” he said.

The committee also recommends more research on understanding potential contaminants in the source water and the interaction of the source water with the native water in the storage aquifer.

“The ASR system poses significant challenges around issues related to water quality requirements for injected water and recovered water,” Sheng said. Issues dealing with mixing the source water with the native groundwater or freshwater with saline water, potential removal processes for various contaminants and microbes, and having the correct water quality indicators for source water and recovered water, need to be better understood through additional research, he said.

Mace said understanding the water quality issue is necessary when considering implementing an ASR project. “When you mix two different types of water, you can get strange chemical things to happen, such as materi-

als coming out of solution or precipitating, which can then block pores of the aquifer and decrease the ability for the water to get into the aquifer or come out.”

The economic and regulatory aspects of underground storage are other areas that need additional examination and solutions from the federal, state, and local water regulatory authorities. Science-based criteria for residence time, travel time, or travel distance regulations for recharge water recovery should be developed, Sheng said.

The NRC report recommends that a model state code be drafted to assist states in developing regulatory programs for these systems. Sheng suggested that an economic analysis of a MUS project should address how the multiple benefits and costs of the project should be captured.

Dr. Allan Jones, Texas Water Resources Institute’s (TWRI) director, agreed that more research is needed in the ASR field.

“Based on the information in the committee’s report, there is clearly a need for more research on ASR or MUS systems,” he said. “Scientists from The Texas A&M University System and other Texas universities have the expertise to make valuable contributions to this growing area of water management. We at TWRI look forward to helping facilitate research projects coming out of the committee’s recommendations.” 💧



Understanding what lies beneath

Groundwater critical to Texas water

Groundwater is a critical element in the mix for supplying the state and nation with enough water. A major source of water in Texas, used for domestic, municipal, industrial and agricultural purposes, groundwater makes up almost 60 percent of the approximately 17 million acre-feet of water used annually. About 80 percent is used for irrigating crops.

Many individuals and organizations are involved in understanding and protecting groundwater. Scientists are researching the quality and quantity of groundwater while the Texas Legislature is enacting laws to protect groundwater and state agencies are accumulating data about groundwater. The Texas Water Development Board (TWDB) and Texas Commission on Environmental Quality (TCEQ) work together on many of the groundwater issues.

Glossary

The following glossary defines terms associated with groundwater and gives an overview of organizations and programs associated with groundwater in Texas:

Aquifers: Geological formations that can store, transmit, and yield groundwater to a well or spring. Groundwater comes from nine major and 21 minor aquifers in Texas.

Confined aquifer: Layer of water that is held between two layers of clay. The recharge area is limited to land surface where the aquifer's geologic material is exposed to the land surface.



Unconfined aquifer: Layer of water that has a confining layer on bottom and a layer of permeable soil and geologic strata above it. The recharge area is all of the land area above the unconfined aquifer.

Groundwater Rights: Access to groundwater is a property right of the landowner. This allows a landowner the right to capture the water beneath his or her property, and sell, lease, and move the water pumped from his or her property to a neighbor, corporation, or city. Texas courts have limited the rule of capture in order to prohibit a landowner from:



San Marcos River Waterfall. Photo by Earl Nottingham, © Texas Parks and Wildlife Department

- pumping water for the purpose of maliciously harming an adjoining neighbor,
- pumping water for a wasteful purpose,
- causing land subsidence (sinking) on adjoining land from negligent pumping, and
- drilling a slant well that crosses the adjoining property line.

Texas legislators have passed several laws that curtail groundwater pumping. Three

major restrictions to prevent unlimited pumping of groundwater govern:

- pumping water that comes from the underflow of a river,
- pumping groundwater without a permit from an aquifer within the jurisdiction of a groundwater conservation district (GCD), and
- pumping groundwater from the Edwards Aquifer within the jurisdiction of the Edwards Aquifer Authority without authority. ⇒

Groundwater Conservation District

(GCD): A local unit of government authorized by the Texas Legislature and ratified at the local level to manage and protect groundwater. There currently are 95 groundwater conservation districts in Texas. Texas law authorizes GCDs to modify the rule of capture by regulating groundwater production through permitting of non-exempt water wells, well spacing requirements, and through other rules as deemed necessary to conserve, preserve, protect, recharge, prevent waste of groundwater, and control subsidence.

Groundwater Management Area (GMA):

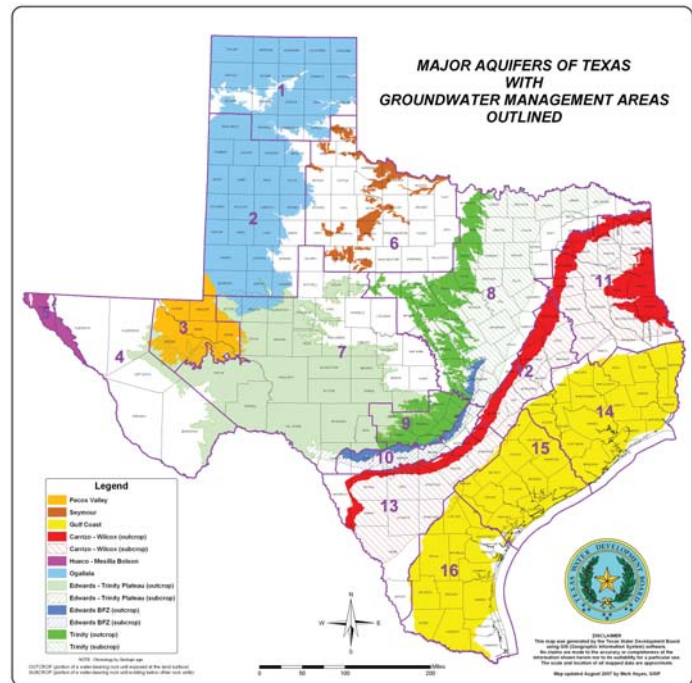
An area delineated and designated by TWDB for joint planning and managing groundwater resources. Each area is comprised of individual groundwater conservation districts. The decisions for current GMAs include groundwater availability using data collected from regional member districts and defining the quantity of allowed groundwater production.

Priority Groundwater Management Area

(PGMA): An area designated and delineated by TCEQ that is experiencing, or is expected to experience, critical groundwater problems within 25 years. They include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies. The Legislature authorized TCEQ, TWDB, and the Texas Parks and Wildlife Department (TPWD) to study, identify, and delineate PGMA's and to initiate the creation of GCDs within those areas.

Groundwater Availability Modeling

(GAM): (<http://www.twdb.state.tx.us/gam/>) The process of developing and using computer programs to estimate future trends in the amount of groundwater available in an aquifer and which is based on hydrogeologic principles, actual aquifer measurements, and stakeholder guidance. TWDB has responsibility for the GAM program. It and its consultants have modeled the major aquifers and currently are modeling the minor aquifers. These models will be important tools for GCDs and Regional Water Plan-



ning Groups to evaluate water-management strategies and to assess present and future groundwater availability trends under normal and drought conditions.

Well Information/Groundwater Quality Data: (http://www.twdb.state.tx.us/GwRD/waterwell/well_info.asp) A database that contains well information, including location, depth, well type, owner, driller, construction and completion data, aquifer, water level, and water quality data. Of the 1,000,000 plus water wells drilled in Texas over the past 100 years, more than 130,000 have been inventoried and the data entered into the TWDB groundwater database. Access to TWDB's Groundwater Database (and other databases) through an ArcIMS mapping and data display service is available at <http://wiid.twdb.state.tx.us/>.

Texas Groundwater Protection Committee (TGPC): (<http://www.tgpc.state.tx.us/Default.htm>) An interagency committee that develops a comprehensive groundwater protection strategy which coordinates the activities of all the participating agencies and documents what needs to be done to protect groundwater in Texas. The strategy includes guidelines for prevention of

contamination, conservation of groundwater, and coordination of groundwater protection activities of the agencies and entities represented on the TGPC. Recent reports of the TGPC include the following:

- Joint Groundwater Monitoring and Contamination Report – 2007
- 2008 State of Texas Water Quality Inventory Groundwater Assessment

Texas Alliance of Groundwater Districts: (<http://www.texasgroundwater.org/>) *Educates the public, furthers groundwater conservation and protection activities, and provides for the exchange of information between individual districts as well as with the public.*

TWDB's Groundwater Resources Division: (<http://www.twdb.state.tx.us/GwRD/pages/gwrindex.html>) *Responsible for all aspects of groundwater studies in the state.* This group monitors water levels and quality in the state's aquifers, conducts regional-scale aquifer modeling, and houses and maintains water well records. It approves groundwater districts' management plans, and provides groundwater information to citizens and lawmakers of the state.

TCEQ's Groundwater Planning and Assessment: ([\[mitting/water_supply/groundwater/gw_index.html\]\(http://www.tceq.state.tx.us/permitting/water_supply/groundwater/gw_index.html\)\)](http://www.tceq.state.tx.us/per-</p></div><div data-bbox=)

U.S. Geological Survey (USGS) National Water-Quality Assessment Program: (<http://water.usgs.gov/nawqa>) *Supports national, regional, and local information needs and decisions related to water-quality management and policy.* Part of the program is focused on regional assessments of groundwater status and trends in principal aquifers, including the Ogallala Aquifer, the Edwards-Trinity Aquifer, and the Texas coastal uplands and lowlands aquifer systems. The USGS implemented the National Water-Quality Assessment (NAWQA) Program in 1991. More information can be obtained at <http://water.usgs.gov/nawqa/studies/praq/>.

Other USGS groundwater Web sites include:

Ground-Water Data for Texas: (<http://waterdata.usgs.gov/tx/nwis/gw>)

Ground-Water Availability in the United States: (http://pubs.usgs.gov/circ/1323/pdf/Circular1323_book_508.pdf) *Examines what is known about the nation's groundwater availability.* This report outlines a program of study by the USGS Ground-Water Resources Program to improve our understanding of groundwater availability in major aquifers. 💧

Photo by Danielle Supercinski, TWRI

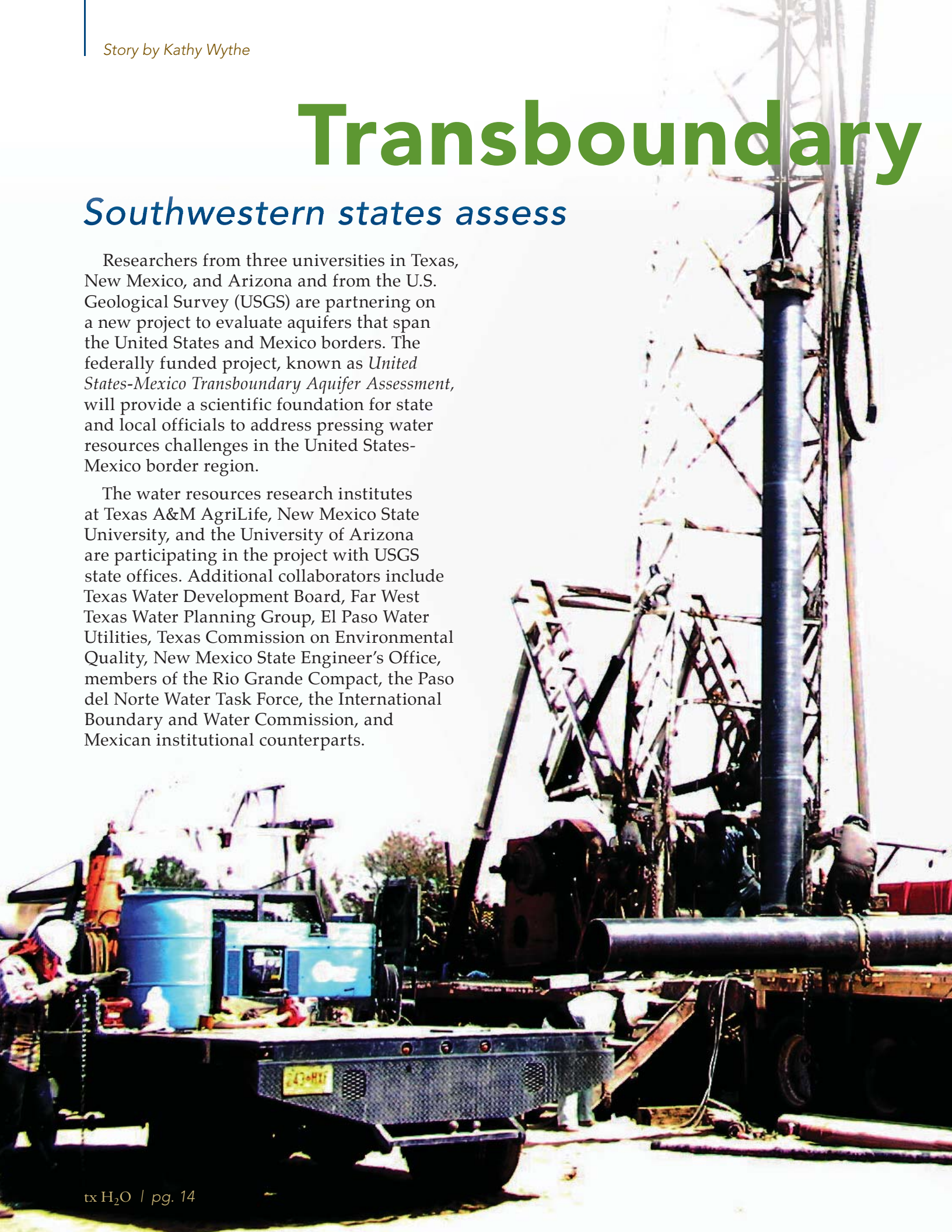


Transboundary

Southwestern states assess

Researchers from three universities in Texas, New Mexico, and Arizona and from the U.S. Geological Survey (USGS) are partnering on a new project to evaluate aquifers that span the United States and Mexico borders. The federally funded project, known as *United States-Mexico Transboundary Aquifer Assessment*, will provide a scientific foundation for state and local officials to address pressing water resources challenges in the United States-Mexico border region.

The water resources research institutes at Texas A&M AgriLife, New Mexico State University, and the University of Arizona are participating in the project with USGS state offices. Additional collaborators include Texas Water Development Board, Far West Texas Water Planning Group, El Paso Water Utilities, Texas Commission on Environmental Quality, New Mexico State Engineer's Office, members of the Rio Grande Compact, the Paso del Norte Water Task Force, the International Boundary and Water Commission, and Mexican institutional counterparts.



aquifers

“Water is a major factor in the economic development of these areas.”

—Karl Wood, director of the New Mexico Water Resources Research Institute at New Mexico State University

Dr. Ari Michelsen, director of the Texas AgriLife Research and Extension Center at El Paso, serves as principal investigator for Texas. He said the U.S.-Mexico border region is experiencing rapid economic and population growth. With these increases comes additional demand on water resources across the border region.

“Water is a major factor in the economic development of these areas,” said Karl Wood, director of the New Mexico Water Resources Research Institute at New Mexico State University. New Mexico State is the lead institution for this project.

Because surface water is scarce and unreliable, the area relies heavily on groundwater in aquifers. Municipal and other water users are increasing their use of groundwater, raising concerns about the long-term quality and availability of this supply, Michelsen said.

“Groundwater is the major and, in many areas, the only water source for much of the U.S.-Mexico border region,” he said. “It is used for all the drinking water in southern New Mexico, all of Juarez, Mexico, and for half of the El Paso area.” ➔





Groundwater is an important source of water for farmers in irrigating their fields in the border region of southwestern United States and Mexico. The United States-Mexico Transboundary Aquifer Assessment project will evaluate the aquifers that hold the groundwater.

Using groundwater for irrigation is also a factor because of the continuing drought that has affected these areas, Wood said.

Wood and Michelsen said that one of the greatest problems is that not much is known about the aquifers. The project will address these questions: How extensive and how deep are the aquifers? Which directions are the aquifers flowing? What is the quality of the aquifers at various depths? How fast are they recharging or declining in supply and quality?

Answers to these questions will help with understanding and managing the groundwater, Michelsen said.

The Texas and New Mexico research groups are starting with the Mesilla Basin Aquifer, which underlies portions of New Mexico, Texas (near El Paso), and Mexico. Other priority aquifers set to be studied are the Hueco Bolson Aquifer in Texas and the Upper Santa Cruz and Upper San Pedro aquifers in Arizona and Mexico. Researchers may add others during the study.




“This information is critical to protecting water quality to safeguard human health and ensure sustainable economic development along the U.S.-Mexico international boundary.”

—Dr. Ari Michelsen,

director of the Texas AgriLife Research and Extension Center at El Paso

Sen. Jeff Bingaman of New Mexico sponsored the 2007 bill authorizing \$50 million over ten years for the project. Co-sponsors included Sen. Pete Domenici of New Mexico, Sen. Jon Kyl of Arizona, and Congressman Silvestre Reyes of Texas. The program was partially funded in 2008 with \$500,000 to begin the project.

“The overall goal is to develop a sound, scientific understanding and assessment of the aquifer extent, amount of water available, movement, use, and quality of our shared border aquifers,” Michelsen said. “This

information is critical to protecting water quality to safeguard human health and ensure sustainable economic development along the U.S.-Mexico international boundary.” 

At the Cameron County Irrigation District No. 2 in San Benito, sluice gates inside the concrete structure control water flowing through the main canal into the district. Photo by Danielle Supercinski, TWRI.



Rio Grande project partnerships

Water quality and quantity issues in the Rio Grande are nothing new for the Rio Grande Basin. However, the continued activities and projects by several universities and local, state, and federal agencies to help solve these problems are not widely known or understood.

Irrigated agriculture in the basin consumes more than 85 percent of the region's water, and water must be diverted from agricultural irrigation to meet growing municipal demands. With the population expected to double in the next 50 years, the urban water demands will increase proportionately.

Texas Water Resources Institute (TWRI), part of Texas A&M AgriLife, facilitates, manages and/or is involved in several projects throughout the Rio Grande region to help better manage available water, improve water quality, and meet present and future water demands. Researchers, Extension personnel, and others are partnering to help irrigators and urban residents better manage the region's water resources.

Rio Grande Basin Initiative

Conserving water and maintaining water quality in the Lower Rio Grande Valley are essential issues as population growth and urban water demands increase. Since 2001, the *Efficient Irrigation for Water Conservation in the Rio Grande Basin* project, also known as the Rio Grande Basin Initiative (RGBI), has focused on meeting present and future water demands through irrigation water conservation measures. RGBI efforts focus on efficiently using available water resources, creating new water supplies, and expanding educational programs. This project has successfully documented more than 4 million acre-feet of water savings.

RGBI is a joint effort between The Texas A&M System and New Mexico State University, working through Texas AgriLife Research, Texas AgriLife Extension Service and New Mexico Cooperative Extension Service and Agricultural Experiment Station. The project is funded by the U.S. Department of Agriculture's Cooperative State Research, Education and Extension Service, and administered through TWRI.

In one area of the project, RGBI researchers assist irrigation districts with managing aquatic and riparian vegetation, primarily non-native species like hydrilla, water lettuce, water hyacinth, saltcedar, and giant cane. Non-native vegetation causes many problems with irrigation water, including clogging canals, limiting flow, and excessive usage. Demonstrations using an integrated pest management approach have been instituted in the Rio Grande Valley where triploid grass carp

were introduced to control hydrilla. In addition, beetles and wasps are used to control giant cane and saltcedar. Standard mechanical and chemical practices are also used.

Rio Grande farmers rely on irrigation canals to water their crops, but they are losing water from cracks that allow water to seep out to areas that do not need irrigation. Seepage from on-farm water conveyance losses range from 10-30 percent. Unimproved delivery canals and conveyance systems cause significant losses of water, which reach as much as 60 percent of the total flow in the system. Water salvaged by lining major canals saves an estimated 10-30 percent, or 30,000 to 90,000 acre-feet of water per year. Measurements of seepage losses by canal segments help prioritize those canals where limited federal and state funds should be used for improvements.

RGBI economists have developed economic models to help guide capital irrigation system rehabilitation projects and water treatment and pricing alternatives. These include the following:

- RGIDECON© is used to perform economic analysis of capital rehabilitation projects, in collaboration with the U.S. Bureau of Reclamation.
- CITY H2O ECONOMICS© analyzes and reports on the economic life-cycle costs of a new municipal surface-water treatment facility, in collaboration with McAllen Public Utility Water Systems.
- DESAL ECONOMICS© considers all financial and economic aspects to provide a life-cycle cost value that allows an accurate comparison with other desalination plants analyzed with the same technique and other water sources as well.

With the success of RGBI, various partnerships have been established. There are now numerous additional water conservation and water quality projects developed in the Lower Rio Grande Valley of Texas with the same primary focus of meeting present and future ⇨

water demands while sustaining water quality through efficient use and protection of water resources.

El Morillo Drain Diversion Canal

The *El Morillo Drain Project*, established in 1966, has improved water quality in the Lower Rio Grande by diverting salt water from the Rio Grande through the El Morillo Drain to the Gulf of Mexico. Each year, the El Morillo Drain keeps 200,000 tons of salt out of the Rio Grande. Without the El Morillo project, the salinity levels in the Rio Grande would be far above federal regulation levels and would detrimentally affect the agricultural industry, fish and wildlife habitat, and the drinking water source for many Rio Grande Valley residents. However, the El Morillo Drain is in dire need of repair and improvement. Ideally, the system needs a complete renovation in addition to annual maintenance, but the economics of this task are beyond available funds. Therefore, through the RGBI, a team of economists led by Dr. Ed Rister and Dr. Ron Lacewell with Texas AgriLife Research and AgriLife Extension Service, have worked to assess the value of the El Morillo Drain to show local cities and residents the benefit received from the drain's existence. Annual benefits are estimated to be from \$40 million to over \$100 million. Through this economic analysis, the project helps decision makers evaluate value and alternatives for a source of funds to repair and maintain the El Morillo Drain over the years.

Arroyo Colorado Watershed Protection

The Arroyo Colorado has a history of poor water quality, and the Texas Commission on Environmental Quality (TCEQ) has listed it as an impaired water body since the state began its surface water quality testing program. The Arroyo Colorado is not a normal stream; it is modified for flood control and dredged for commerce. These physical changes contribute significantly to its water quality impairments. Because of the extreme reductions in pollutant loading needed for water quality improvement, the following five Arroyo Colorado

watershed protection projects are currently under way:

Implementation of the Arroyo Colorado Watershed Protection Plan, with funding by TCEQ, is administered by TWRI and directed by the Arroyo Colorado Watershed Partnership in collaboration with multiple local entities. The project focuses on implementation activities and deliverables outlined in the watershed protection plan. Project personnel seek additional funds to sustain water quality improvement efforts. To date, the collaborative partnership involves more than 700 individuals, federal and state agencies, cities, and numerous non-governmental organizations.

Education of Best Management Practices in the Arroyo Colorado Watershed, funded by the Texas State Soil and Water Conservation Board (TSSWCB) and administered by TWRI and AgriLife Extension, educates agricultural producers on better land management to reduce nonpoint source pollution. The project promotes associated programs, implementing best management practices (BMPs) to protect water quality. This three-year project, scheduled to end March 2009, has reached more than 5,000 valley residents. See related story on pages 22 & 23.

The Integrated Farm Management Program, funded by the U.S. Environmental Protection Agency and administered by TWRI and AgriLife Extension, is a new three-year program. It will build on the already successful education program in the Arroyo Colorado Watershed to train agricultural producers on BMPs in production, nutrient, irrigation, and pesticide management.

Assessment of Agricultural Nonpoint Source Pollution in the Arroyo Colorado, with funding from the TSSWCB, is administered by TWRI, AgriLife Research and Texas A&M University—Kingsville. They are analyzing water quality of agricultural field runoff and drainage waters to determine efficacy of BMPs, to assess using the drainage ditches as a natural wetland system and to provide data for calibration of the SWAT (Soil Water Assessment

Tool) model for estimating future loading into the river. In cooperation with TSSWCB and USDA-Natural Resources Conservation Service (NRCS), AgriLife Research scientists are also building a map indicating installed BMPs to target education and implementation needs. Given the rapid land use changes in this watershed, this project developed a revised land use/land cover map for the Arroyo Colorado to help support the SWAT model. The final map will be available on the Arroyo Colorado Web site.

AgriLife Research is conducting the *SWAT Model Simulation of the Arroyo Colorado Watershed project*. This project, also funded by TSSWCB and administered by TWRI, is simulating the current pollution loadings using the SWAT computer model, which will help with reassessment of needed load reductions. Additionally, the updated model (projected to be completed by March 2009) can simulate load reduction scenarios for a suite of BMPs specified by the TSSWCB.

Agricultural Water Conservation Demonstration Initiative

In September 2004, the Harlingen Irrigation District partnered with Delta Lake Irrigation District, AgriLife Extension, Texas A&M-Kingsville, Rio Farms, Texas Citrus Mutual, TSSWCB, NRCS, and Lower Rio Grande Valley agricultural producers to begin a large-scale, 10-year *Agricultural Water Conservation Demonstration Initiative (ADI)*. Funded by the Texas Water Development Board, ADI gathers comprehensive data to evaluate the impact of on-farm water conservation techniques on crop productivity, irrigation water-use, and available water supplies, providing education to agricultural producers. ADI includes constructing a meter calibration facility, maximizing the efficiency of flood irrigation, demonstrating the effectiveness of major irrigation technologies, and showcasing how to implement beneficial findings from field demonstrations to irrigation districts and producers. ➡

The Texas Water Resources Institute has five Arroyo Colorado projects under way to help improve the water quality of the arroyo. Photo by Brad Cowan, Texas AgriLife Extension Service



Impacts of biological control of giant reed in the Lower Rio Grande Valley

Giant reed, *Arundo donax*, was introduced to the Rio Grande area in the 1800s. It has since absorbed large quantities of water, greatly increases potential for flood damage, and may impact homeland security. As a non-native plant, *Arundo* growth is difficult to control and suppresses native vegetation in wetland habitats, forming dense thickets lining Lower Rio Grande Basin waterways.

Dr. John Goolsby, USDA–Agricultural Research Service, has ongoing experiments with three biological control agents that feed on the giant reed. In a project funded by RGBI, Dr. Georgianne Moore, Texas A&M University, is working with Goolsby to study effects of these agents on the growth and water consumption of the giant reed. Impacts of biological control on transpirational water loss from giant reed in the Lower Rio Grande Valley will contrast growth rates and transpiration of plants infected with the three agents and will study development and use of new scaling methodology to estimate transpiration in a natural stand.

Economists evaluate the potential annual gross benefits of giant reed control using assumed levels of values of various factors contributing to the comprehensive assessment. Future research efforts are intended to improve identifying and assessing contributions to this program’s economic-benefit calculations and the accuracy of such calculations. Current efforts better specify and increase the accuracy of the estimated range of annual water savings.

The RGBI project has leveraged funds from contributing agencies and organizations. It has brought more than \$3 million to the Valley from 2001 to present. More than \$2.7 million is anticipated to be spent on additional programs between now and 2010, when the project ends. ADI is contributing \$3.8 million more to the project.

Additional Rio Grande Basin Federal Initiatives

One project is led by Sul Ross State University and involves all five universities of the Texas State University System (TSUS). This initiative complements RGBI efforts and, due to careful collaboration and joint activities, duplication is minimized. TSUS’s Sustainable Agricultural Water Conservation in the Rio Grande Basin addresses conservation issues in the basin and possible solutions to the area’s ongoing water struggles with groundwater and surface water. Project objectives focus on general biological assessment, GIS, database compilation, and Web-accessible ARCIMS. This project is creating a basinwide perspective for integrated management and sustainable use of water resources.

Another federal initiative led by the University of Texas at Austin was the Rio Grande – Rio Bravo Studies, which has recently ended. It focused on developing GIS-based water resource tools for the basin area shared between Mexico and the United States. UT cooperated with the National Water Commission of Mexico to develop a geodatabase to build hydrologic information systems for supporting hydrologic analysis and modeling. The information will help develop bi-national cooperation between Mexico and the United States concerning water in the Rio Grande Basin. It will also provide accurate and reliable data necessary for analysis and resolution of water resources issues.

Participants of all these projects communicate regularly. They meet during the year to review ongoing efforts and plan for collaborative activities. 💧

Rio Grande Basin Initiative

<http://riogrande.tamu.edu>

Arroyo Colorado

<http://arroyocolorado.org/>

Agricultural Demonstration Initiative

<http://www.hidcc1.org/node/6>

Texas State University Projects

<http://www.rivers.txstate.edu/rg/>

University of Texas Projects

<http://www.crwr.utexas.edu/riogrande.shtml>



As shown looking into Mexico from the U.S. side of the Rio Grande in Rio Grande City, agriculture is prevalent on both sides of the border. Water from the Rio Grande is essential for agricultural irrigation systems in the valley. Photo by Danielle Supercinski, TWRI

Combating soil erosion

AgriLife scientists discovering what works for Fort Hood



When most people think of Fort Hood, they think of the military readying troops for combat. When a group of Texas AgriLife Research scientists think of Fort Hood, it's combating soil erosion.

Fort Hood is one of the largest military installations in the United States. It has more than 214,000 acres and the largest concentration of armor in the country. Soldiers in heavy tanks and armored vehicles are continually conducting training exercises on the land. This training has caused compacted ground, loss of plant cover, and accelerated soil erosion that deposits excess sediment in area streams and lakes.

AgriLife Research scientists in Temple and College Station are working with the USDA's Natural Resources Conservation Service

(NRCS) and the military's Integrated Training Area Management (ITAM) to combat this soil erosion while maintaining sustainability of the training mission and ensuring high quality natural resources in the watersheds.

In the initial stages of this partnership, Dr. Dennis Hoffman, senior research scientist, and other researchers at Texas AgriLife Research Blackland Research and Extension Center began monitoring water quality. They measured nutrient and sediment losses across many of Fort Hood's watersheds. As a result of the monitoring NRCS and ITAM put in more than 30 sediment retention ponds to trap sediment contained in stormwater runoff.

"We then began to monitor watersheds to estimate sediment trapping as a result of the ponds," Hoffman said.

NRCS and ITAM began to implement additional conservation to reduce erosion. These practices included gully plugs (small rock dams built to stop gully erosion) and contour ripping (deep plowing of the ground), which reduces soil compaction. Less soil compaction allows water to soak into the soil and reduces runoff and erosion. Hoffman's group then determined the effectiveness of these practices.

"Our monitoring showed a remarkable reduction in runoff and erosion as a result of those conservation practices," Hoffman said. One area of the training lands monitored was Shoal Creek. Monitoring showed a 90 percent reduction in sediment running into the creek.

"Our research has shown that these conservation practices work really well," Hoffman said.

With their long-term monitoring, the researchers are able to keep a pulse on the effectiveness of these practices and know when a practice might need to be restored. "It's pretty cheap insurance because it gives you an idea when you need to go in and fix it," Hoffman said.

In 2003, a new project, *Range Revegetation Pilot Project for Fort Hood, Texas*, was initiated with federal funding through NRCS to the Texas Water Resources Institute. The revegetation project brought composted dairy manure from the Bosque River watershed to Fort Hood to use as a soil amendment to test its impact on increasing vegetation to help control erosion. Taking the compost out of the Bosque River watershed also helped relieve that watershed of excess phosphorus found in compost, said Dr. William Fox, assistant professor at Blackland.

"Two major environmental problems were addressed at the same time," Fox said. "Excessive nutrients in one watershed are being used to fertilize nutrient-starved soil in another."

To date the project has purchased, transported, and applied more than 20,000 tons

of composted dairy manure from the North Bosque River watershed and established research and demonstration plots on approximately 1,700 acres of training lands on Fort Hood.

Fox said that their research has shown that compost does increase the vegetation on some landscapes at Fort Hood, and they have developed science-based standard operating procedures for applying compost.

Using compost alone for large-scale land application, however, is not sufficient, he said.

"Although compost can help us grow more desirable vegetation without nutrients becoming a problem in the watersheds, the costs associated with large-scale applications are great," Fox said. "So now we are working to understand how we can integrate compost with other erosion control practices to optimize its benefits with much lower costs.

"There is a place for using compost in the toolbox. It's just not with large-scale application."

The project is continuing through 2009 with research on using compost to establish vegetation buffers near the bank of the streams as well as using compost in coordination with contour ripping practices.

Preliminary results show that putting compost and grass seeds over the contour rips helps establish vegetation buffers and reduces run-off, Fox said.

In research conducted by graduate student Lisa Prcin of Blackland and her advisor Dr. Fred Smeins of Texas A&M University's Ecosystem Science and Management Department, the combination of contour ripping and compost reduced run-off by 55 percent compared to a 35 percent reduction with contour ripping alone.

Using compost with the contour ripping also reduces the cost of compost by reducing the amount of compost applied while increasing the efficacy of the contour ripping practice, Fox said. ➡

“What we have found out,” he said, “is that we need mechanical practices in the form of contour ripping, structural in the form of gully plugs, and natural processes, like compost amendments and reseeding, to address erosion from a systems approach and ultimately stem the flow of sediment into Lake Belton.

“Developing an understanding on how these practices interrelate and the efficacy of erosion control provides military land managers with information for their conservation planning programs,” Fox said.

With the start of the federally funded *Fort Hood Training Lands Restoration and Maintenance* project in Fiscal Year 2007, AgriLife Research, ITAM, and NRCS are applying suites of conservation to the more than 67,000 acres of training lands on west Fort Hood.

Along with implementing these practices, the next step will be to enhance and apply decision support tools such as simulation modeling to the training lands. Fox explained that these tools will provide military land managers with more information for implementing their conservation programs. The first tool the researchers are using is the Agricultural Policy/Environmental eXtender (APEX) model, a watershed-scale hydrologic model currently used to assess croplands to determine erosion impacts. This tool has already been applied on Fort Hood scenarios and continues to be enhanced to meet the

needs for application to military land systems, Fox said.

“This enhancement would allow land managers to run simulations of different suites of erosion control practices on specific landscapes and estimate the impact of these on training lands and natural resources prior to implementing conservation practices on the ground,” Fox said. “These decision support tools will help the military spend money more cost effectively for erosion control and provide opportunities for military land managers to address both training and natural resources management issues with a systematic approach.”

Once these tools are fully adapted, they can be applied nationally and internationally, on military posts and non-military lands, he said. “We plan on ultimately ending up with a product that can provide proactive planning for many entities nationwide.”

Building upon the successes of the Fort Hood restoration projects, a team of Texas A&M scientists was recently awarded \$647,000 by USDA Cooperative State Research, Education and Extension Service to conduct further research on the impacts of conservation practices on restoration of grazing land systems. This team will be using state-of-the-art computer simulation models to quantify impacts of multiple practices including re-seeding, contour ripping, and brush control. 💧

“We plan on ultimately ending up with a product that can provide proactive planning for many entities nationwide.”

—Dr. William Fox, assistant professor at Blackland

Fort Hood soldiers in heavy tanks and armored vehicles are continually conducting training exercise on the training lands, creating significant soil erosion and water quality issues.



Blackland's flood warning system protects soldiers

A flood warning system resulting from a Texas AgriLife Research water quality monitoring project at Fort Hood is potentially saving lives and property.

The Flood Alert System via Telemetry or FAST uses stream level sensors attached to cell phones to notify Fort Hood Range Control of flooding at six low water crossings. The sensors are part of Blackland Research and Extension Center's Fort Hood Water Quality Monitoring project, designed to help Fort Hood manage its land resources.

June Wolfe, assistant research scientist, developed the system after researching and adapting the best technologies available for this use.

Wolfe, who works for project leader Dr. Dennis Hoffman, said the No. 1 reason for installing the FAST system was "to protect soldiers by alerting them of dangerous flood conditions."

Equipment and personnel had been lost at low water crossings during storms, he said.

Wolfe said the sensors, which constantly monitor stream depth, are programmed to issue alerts when the streams reach certain depths. These alerts are transmitted by cell phones to a Blackberry located in Fort Hood's Range Control office. The Blackberry delivers a text message, describing the location of the flooding so the military can warn soldiers training in the area and block off access to the crossings.

Each remote station also has an internet address that allows computers at Blackland to monitor real-time stream levels at the crossings. The data are uploaded to a Web site (<http://www.brc.tamus.edu/decision-aids/flood-alert-system.aspx>) at 10-minute intervals. Each station's current depth and latest polling time are displayed on individual panels. Charts display stream level over the past 24-hour period.

Wolfe gave a recent example of the FAST in action.

Rains from Hurricane Dolly missed Fort Hood, but a large amount of rain fell north of the fort. "A surge of water came down Cowhouse Creek, the main creek crossing Fort Hood," Wolfe said. "Many low water crossings went from 0 to over 10 feet deep."

Because it wasn't raining on the fort, Wolfe pointed out, troops in the field were not aware of the flood conditions.

FAST alerted Range Control officers to the rapidly changing stream levels, and they notified the field trainers.

"I watched the whole thing remotely via our web site," Wolfe said.

The project staff is considering installing flashing lights activated by the sensors during flooding. Wolfe said they also hope to use real-time stream level and weather data to develop a flood prediction model to forecast the likelihood of flooding across Fort Hood.

TWRI Briefs

RGBI Conference Success

More than 100 participants attended the 2008 Annual Rio Grande Basin Initiative (RGBI) Conference held July 14-17 in Las Cruces, NM, at the Farm and Ranch Heritage Museum. Project participants highlighted their accomplishments and discussed plans to continue ongoing efforts or initiate new activities through the Efficient Irrigation for Water Conservation in the Rio Grande Basin project.

The annual progress and accomplishments report and conference presentations, notes and photos can be found on the conference wrap-up Web site at <http://riogrande-conference.tamu.edu/wrapup/2008/>.

TWRI welcomes new staff

Gary Bryant recently joined the Texas AgriLife Extension Service as a program specialist for water programs. He works for the Texas Water Resources Institute in Fort Stockton, replacing Mike Mecke, who recently retired. Bryant is working with AgriLife Extension agents and specialists, federal and state agency personnel, and various water clientele to develop and deliver Extension educational programs focusing on priority water needs of West Texas.



Bryant has been involved in soil sciences for more than 20 years, including soil hydraulic conductivity, salinity issues, revegetation, on-site waste disposal, point and non-point source pollution control, and property management. Prior to joining AgriLife Extension, Bryant was founder and president of Soil and

Water Services, Inc. in Blue Ridge, Georgia. He has also held positions in Alaska, New Mexico, and Texas. He was a consultant with the supercollider project and lignite mining operations in Texas.

Bryant earned his bachelor's degree from the University of Arkansas and his master's degree from Texas Tech University.

Jaime Flores recently joined the Texas Water Resources Institute as the watershed coordinator for the institute's Arroyo Colorado Watershed Protection Plan Implementation project, replacing Laura DeLeGarza.



As watershed coordinator, Flores coordinates the Arroyo Colorado Watershed Steering Committee. He also facilitates and tracks implementation measures described in the completed watershed protection plan for the Arroyo Colorado. Flores works with the steering committee members to publicize and build awareness for these watershed improvement efforts, provide extensive outreach and education, and seek additional funding for implementation activities.

Flores received his bachelor's degree in geology from Baylor University and has 15 years of experience in the environmental industry. Flores has worked primarily in the Rio Grande Valley. Prior to joining the institute, he was with Geologic Drilling Inc.

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RGBI Conference Field Tour



Gary Esslinger, general manager of Elephant Butte Irrigation District in New Mexico, lead the field tour for the Annual Rio Grande Basin Initiative Conference in Las Cruces. The field tour consisted of a tour of the Elephant Butte irrigation system, Mesilla Valley agricultural production, the Zul (geologic) collection and the New Mexico State University Windmill Center.

RGBI Field Tour participants viewed some of the Mesilla Valley's precision irrigation monitoring methods. Pictured to the left is a solar-powered flow monitor used to better control and calculate the amount of irrigation water flowing through canals and/or pipelines. Photo by Danielle Supercinski, TWRI