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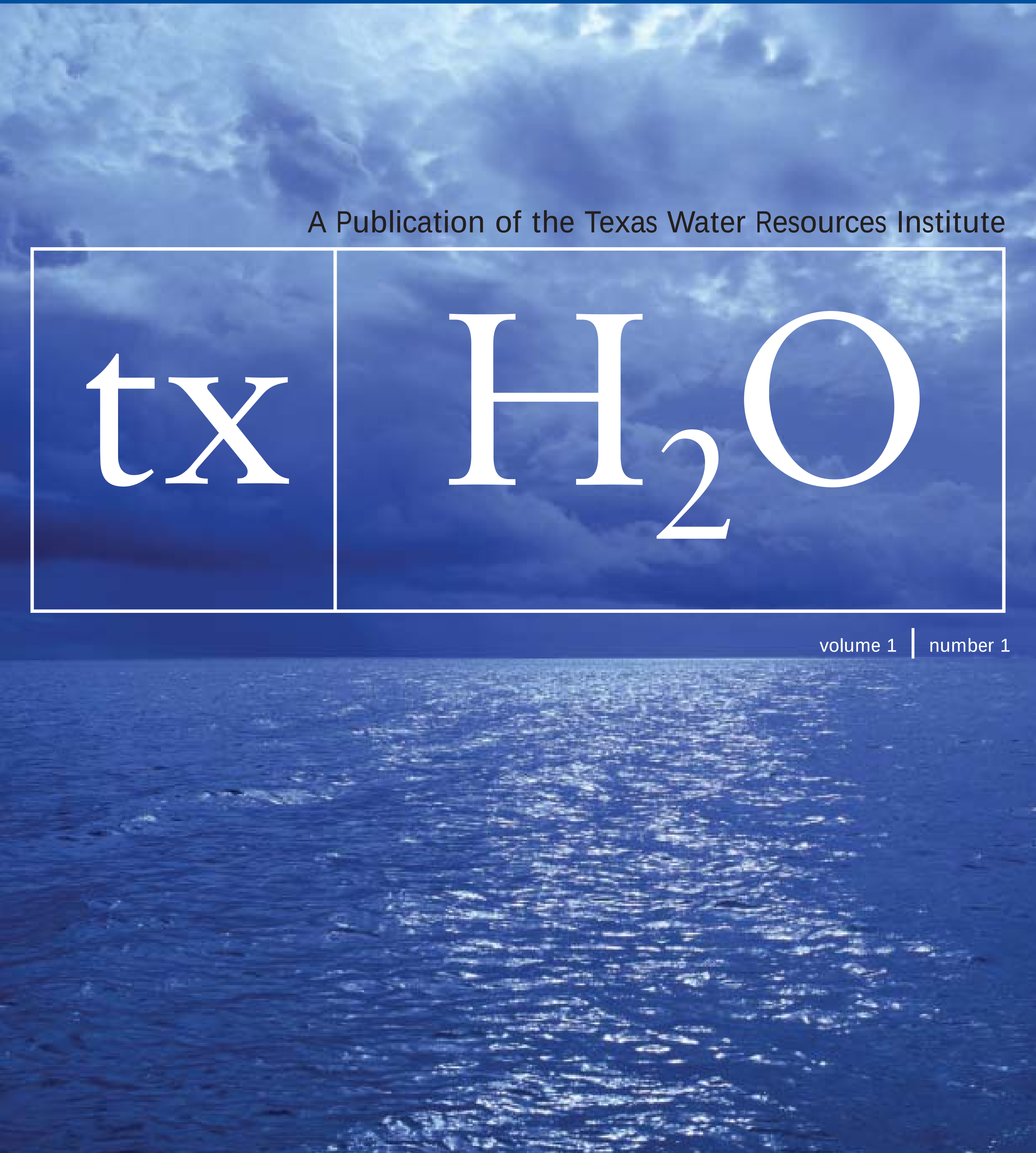

A Publication of the Texas Water Resources Institute

# tx $H_2O$

volume 1 | number 1

## In This Issue:

- MEXICO'S WATER DEBT
- THE FUTURE OF DESALINATION
- SEDIMENT SETBACK
- PHOSPHORUS LOSS
- CLOUD SEEDING
- RAINWATER HARVESTING
- AND MUCH MORE!

## Building on the Past, Looking to the Future

Drs. Elsa Murano and Ed Smith have made it clear—water resources issues continue to be a high priority for TAES, TCE and the College of Agriculture and Life Sciences. They also strongly support our cooperation with other TAMU colleges, state and federal agencies, and other universities. TWRI looks forward to providing continued leadership for water resources programs through grant administration, project management, and communication and outreach programs.

Notable accomplishments:

- Increased total funding obtained, administered and/or facilitated by the Institute from roughly $500,000 in FY00 to more than $8 million in FY05
- Developed close-working relationships with water scientists throughout Texas and with other states, other water centers and institutes, and diverse agencies and organizations
- Strengthened Extension education and communication abilities related to water resources and developed capabilities for project management
- Initiated a competitive grants program for graduate students with USGS funds to promote graduate student involvement in water resources-related fields of study. Since FY01 the Institute has supported 53 students with over $269,000 in funding
- Helped more than 100 faculty members obtain funding for research and/or Extension education projects
- Developed strong working relationships with The Texas A&M University System's Washington D.C office and with key Texas Congressional offices, as well as with more than 25 local, regional, state and federal agencies, and universities
- Recognized by USGS and National Institutes of Water Resources as a "Top Five" water institute in the review of all U.S. water institutes over the past five years

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Texas Water Resources Institute
*make every drop count*

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Story by Raul L. Garcia



# Mexico Transfers Water to U.S.

*New issues arise after partial water debt is paid*

Mexico released 210,785 acre-feet of water to Texas into Amistad International Reservoir on Saturday, March 19, 2005, to alleviate its sizable water debt to the U.S. arising from international treaty requirements. This delivery is an addition to the 56,750 acre-feet of water Mexico transferred to Texas on March 12 in Falcon Reservoir. Mexico's recent water debt is now cut by more than 50 percent.

Mexico released the water soon after signing a settlement with the U.S. calling for the whole debt to be paid by September 2005. Now farmers and other water users in the Rio Grande Valley are effectively utilizing this extra water.

"Impacts on this year's crop mix would be hard to determine exactly because planting intentions were made before the water became U.S. property," said Allen Sturdivant, Extension Associate for Texas Cooperative Extension. "Annual crop mixes fluctuate for a number reasons including weather, comparative and market-window advantages, pricing expectations, and the expected profitability of alternative crop enterprises."

Mexico's water transfer allows for this year's planting patterns and crop estimates to go as planned and for future patterns or extra crop production to be possible.

"The current situation favors an increase in overall irrigated acreage since there is more available water, or a loosening of resource constraints," Sturdivant said. "Whether the water will be used to increase [the production of] vegetables, sugarcane, or other field crops is still unknown."

New regulations pertaining to the extra water, such as adopting water-saving technologies, have not yet been imposed.

Sturdivant said the water transfer does not pose much of a storage problem since some of the debt delivery was a paper transfer of water already in the reservoirs. Also, Falcon and Amistad Reservoirs still aren't completely full.

"The added water that will actually hit the farm gates will be less than the accumulated debt," Sturdivant said. Under the 1944 Water

Treaty, 41 percent of the water is for conveyance loss credits.

Since the Rio Grande is over-appropriated and its water shared between the U.S. and Mexico, water issues in this region have been and continue to be complex. Water availability issues in this region have been controversial, especially since Mexico acquired a total debt of 1.5 million acre-feet of water from 1992-2002. As of October 2004, Mexico owed 717,000 acre-feet of water.

In 1992, the effects of Mexico's water debt were not immediately felt in the Rio Grande Valley because reservoir water remained and was still being consumed. Water supply and irrigation deficiencies started in 1995 when water demands surpassed the amount of accessible water.

Over the past 12 years, South Texas communities have endured many economic losses during times of drought because of Mexico's delay in repaying their water debt. Without Mexico's water inflows, the Falcon and Amistad Reservoir's essential roles to provide resources for crops and growers, tourism, and jobs for South Texas' economy are diminished.

With Mexico's currently scheduled repayment plans, water resources and crops in the Rio Grande Valley can withstand the effects of drought conditions, and water levels maintained. The two lakes located at Falcon and Amistad Reservoirs are extremely vital to crop growth and the irrigation systems since these reservoirs are the primary sources of water for the valley.

The additional water will guarantee Valley farmers the water they need for the planting season. South Texas growers, ranchers, and stakeholders have a sense of assurance that they can depend on Mexico for future water transfers in the coming months.

Photo by Jim Lyle

Story by Amanda Crawford

# The Future of Desalination in Texas

*Brine can transform water supplies in Texas communities*

As Texas' population grows, the ever-present threat of water shortages looms. However, technology is also advancing, providing possible solutions for water deficiencies. One such solution is desalination–a cost-effective method of producing potable and useable water from existing saltwater resources.

While desalination use has advanced along the Texas Gulf Coast after Governor Rick Perry's 2002 desalination initiative announcement, water treatment opportunities in other areas still exist. The Texas Water Development Board (TWDB) published a report identifying the location and amount of brackish and saline groundwater in Texas available for desalination.

Oil production brings contaminated or produced water (also called brackish water) to the surface. There are more than 200,000 producing wells in Texas, and most of them produce about seven times more water than oil. Handling this water is expensive because it must be transported for storage and injection into another well.

However, if produced water is desalinated on site, the pollutants can be reinjected into the formation without an Environmental Protection Agency (EPA) Class I hazardous injection permit; salts from the brackish water came from the original formation. Presently, several research efforts are underway to find beneficial uses for waters produced from oil and gas exploration in Texas.

Even with its obstacles, desalination of produced water is a more cost-efficient method of dealing with brine. For example, produced water management and disposal costs can amount to $2,000 a day for every 1,000 barrels of oil (bbl) produced. Using on-site desalination could save half of this cost, producing an annual net profit of more than a quarter million dollars. If only 10 percent of operators take advantage of desalination, they can save $3.5 million annually, dramatically demonstrating the profitability of brine desalination.

To better understand desalination, here are terms used to describe water and groundwater.

- Freshwater contains less than 1,000 milligrams per liter (mg/L) of total dissolved solids (TDS).
- Brackish groundwater includes slightly-saline (between 1,000 to 3,000 mg/L TDS) and moderately-saline (3,000 to 10,000 mg/L TDS) levels.
- Saline water has more than 10,000 mg/L TDS and seawater has about 35,000 mg/L TDS.

Both water produced from oil wells and some groundwater contain brackish and saline water. In terms of desalination, brackish water is the best treatment candidate, and approximately one-third of the produced water in Texas falls into this category.

Desalinating produced brackish water comes with its drawbacks. Produced water can be up to four times saltier than seawater, making it difficult to work with. In addition, it contains crude petroleum which can be somewhat soluble in water and metal salts leached from rock formations. Furthermore, because of the oil in this produced water, it requires more pre-treatment than seawater does.

Even with the additional cost of pre-treatment, the total operating costs during 7-hour days average less than $10 for 23,000 gallons of brackish water processed. For an average $1 bottle of water (16.9 fl. oz.), the cost of producing this water would be approximately $.000057 per bottle, for a profit of nearly 100 percent. To be fair, standards for drinking water are high, and such treatment would receive intense examination by the state before approval.

If drinking water is not the ideal use for this water, there are several other alternatives. Because minimal regulations exist for livestock drinking water, ranchers can use desalinated water for their purposes. More than 133 million gallons of treatable water are produced each day, which is a sufficient irrigation amount for farmers as well, even if no other sources for irrigation existed.

Besides the economic benefits, on-site treatment is less hazardous than transporting large qualities of brine on public roads. As researchers assess the environmental efficiency of desalination, it is clear that desalination will play an integral part in the future of water production and conservation.

Many universities, state agencies and other organizations have been key players in desalination studies. By 2020, the U.S. Bureau of Reclamation, EPA, Department of Energy, Bureau of Land Management and Sandia National Laboratories are anticipating that desalination and water purification technologies will contribute significantly to ensuring a safe, sustainable, affordable, and adequate water supply for the United States. These organizations address both the potential for groundwater purification and the challenges that lie ahead.

Researchers from Texas A&M University, University of Texas at Austin, Rice University, University of Houston, Lamar University, Texas Tech University, University of Texas at El Paso and Texas A&M University-Kingsville are also making key advances in desalination research.

### Texas A&M University

- Modeling and designing pretreatment processes and strategies that influence performance of desalination processes
- Evaluating patented capacitive deionization technology
- Finding methods to desalinate brackish and saline groundwater, and treat oilfield-produced water
- Evaluating operational issues related to proposed desalination plants
- Modeling how salinity constraints affect usable water yield in river and reservoir systems

### University of Texas at Austin

- Differentiating traits of ideal membranes to develop a total recycle membrane system
- Modifying polymers to improve membrane performance through a unique stretching process
- Assessing desalination byproducts
- Evaluating effects of brine reject waters discharged with bays and estuaries and on dissolved oxygen levels
- Assessing how plant operations might affect temperature and salinity regimens in Lavaca Bay
- Examining public attitudes toward desalination projects

### Rice University

- Evaluating parameters that optimize pretreatment processes
- Assessing use of certain membranes to treat waters with high levels of dissolved organic matter and suspended solids
- Developing data about water quality parameters associated with oilfield-produced water
- Assessing whether additional water via desalination may improve long-term peace between Israel and the Gaza Strip

### Lamar University

- Comparing performance of conventional pretreatment methods used in desalination with the use of membranes and deoxygenation methods
- Developing membranes resistant to inorganic scaling and characterizing how desalination processes affect the stability of the membranes

### Texas Tech University

- Developing closed loop pretreatment systems for space travel
- Creating methods to reuse desalination byproducts

### University of Houston

- Evaluating and testing effects of pretreatment and operating conditions on membrane performance
- Monitoring and predicting membrane performance with other technologies
- Developing integrated portable membrane systems for use in remote locations

### University of Texas at El Paso

- Evaluating use of desalination technologies to treat impaired and saline waters
- Incorporating thermal energy to power membrane distillation


Photo by: Jerrold Summerlin

# Pond Scum

*Researchers prepare a plan to use Riverside Campus ponds*

Eight years ago, 10 ponds were built on the Texas A&M University Riverside Campus. But the agricultural program for which these ponds were intended moved away from that campus and the ponds were neither used nor maintained. Thomas DeWitt, assistant professor of ecological genetics with the Department of Wildlife and Fisheries Sciences, and his colleagues recently discovered these ponds and set out to make educational and experimental use of them through the creation of mesocosms, or culture systems for fish larvae.

According to Dewitt's report, the existing aquatic projects were conducted in Dewitt's 180-gallon aquaria at the Riverside Campus indoor facility. Using the ponds reduces many problems these indoor aquaria produce, such as conflict among faculty research and teaching programs. For this reason, the Texas Water Resources Institute (TWRI) chose to award a Water Resources Research Grant for the restoration and operation of these ponds.

Because of their neglected state, the ponds required a few improvements. Two ponds needed work removing cattails, one had to be deepened to match the others, and two more ponds were added.

Despite the necessary improvements, the ponds have major potential. Because they were dug in a natural clay area, they can hold water without requiring liners. The pond site was also equipped with water and electricity, making on-site research potentially more productive. In addition, there are security fences and regular police patrols of the area to protect research.

DeWitt recommended that the ponds be used for at least eight undergraduate courses in the Department of Wildlife and Fisheries Sciences to evaluate and measure natural selection factors, predator behavior and morphology, experimental foodweb manipulations, habitat structure and use, ecology, and several additional proposed research studies.

These ponds also offer the ability to perform nutrient and chemical studies, behavioral and functional ecology experiments, and community ecological and evolutional studies of algae, aquatic vascular plants, invertebrate grazers and predators (snails, insects, crustacean), larval amphibians, fish, and turtles.

"The ponds not only provide a new research area, but also encourage cooperation among faculty," DeWitt said. "These ponds have the potential to provide priceless training and learning expansion into the future."

Story by Amanda Crawford



Photo by: Dennis Hoffman

# Sediment Setback

*Fort Hood's sediment and erosion cause problems for the base*

Since 1942, Fort Hood has been home to the U.S. Army's III Mobile Armored Corps. It is the only U.S. military post able to station and train two armored divisions at once. At this base, troops execute weapons qualification tasks and tank gunnery training to equip them to become some of the best soldiers in the country.

The heavy artillery traffic that operates on the 335-square-mile terrain greatly disturbs and deteriorates the soil and vegetation, causing serious topsoil loss and sediment problems. Direct raindrop impact on the pulverized bare soil leads to erosion and sediment-filled runoff, which deteriorates the land and contaminates local water sources. For this reason, the Texas Water Resources Institute (TWRI) and Blackland Research and Extension Center (BREC) are working with the military and USDA Natural Resource Conservation Service in attempting to conserve and protect the soils on the base, reduce sedimentation problems, and enhance training opportunities for future soldiers.

## Sediment's Dangers

Sediment-filled runoff ends up in Lake Belton, the water source for Fort Hood and local communities. Ultraviolet light, or sunlight, naturally kills bacteria; therefore, suspended sediment in the area's water is particularly problematic because of its ability to diminish the water's light absorption. Sediment can also spread absorbed hazardous chemicals or compounds such as pesticides through the water.

In addition, the trampling of plants deteriorates the vegetation, changing from taller plants to shorter grasses. In extreme cases, the soil is exposed. Erosion at Fort Hood strips the land of essential nutrients that plants need to grow, and destroys any chance that the vegetation will redevelop on its own. Further trampling and erosion exposes the rocks beneath the soil and produces large gullies, or ditches. This has negative effects on military maneuvering and watershed ecology, permanently destroying surrounding habitats, and diminishing the quality of the training grounds.

### Hope in Sight

Restoration at an early stage provides hope for success because some of the nutrients are still available in the soil. It also saves money because restoration can be expensive if starting over from scratch.

Proper use of vegetation, the most important element in land rehabilitation, can improve the sediment problem. Vegetation protects the soil from damage, and vegetation and soil work together to maintain a nutrient balance. It also acts as a filter to remove sediment from run-off, preventing the sediment from entering lakes and rivers. Plants also reduce the speed of water flow over the soil, slowing erosion.

The future looks more optimistic for Fort Hood thanks to TWRI, BREC, and NRCS's introduction of new ways to protect the area's land and water. One of the new practices being introduced is the use of compost to more rapidly establish protective regetative cover. Another effective solution is installing small check-dams, also called "gully-plugs," across eroding channels, which prevents further erosion by blocking the flow of water and reducing sediment loads in runoff. Another solution is soil ripping, which rejuvenates the soil and provides opportunities for growth and plant stability improvement. Water flows into the soil, rather than turning off and eroding trenches.

Because of the nature of Fort Hood's training, erosion and sediment will always be a problem. The efforts of TWRI and BREC on this project minimize the problems and provide hope for safety and excellence at this base.

## Supporting Student Research

The Texas Water Resources Institute (TWRI) will fund 10 graduate student research projects for 2005-06 conducted by graduate students and researchers at Texas A&M University, Rice University, Texas A&M University Kingsville, Baylor, and the University of Texas at Austin.

Funded by TWRI through the U.S. Geological Survey as part of the National Institutes for Water Research annual research program, TWRI will publish articles and reports about the progress of these studies.

Grants began March 1, 2005, and will run through February 28, 2006. Awarded up to $5,000 to begin, expand, or extend research projects, each applicant had to also provide evidence of $10,000 in matching funds. TWRI received over 70 submissions in response to this year's request for proposals.

The following projects were funded:

- "Evaluation of Standards for Compost Blankets in Stormwater Control," Lindsay Birt, Department of Biological and Agricultural Engineering at Texas A&M University; Russell Persyn, research advisor.
- "Evolution of Irrigation Scheduling Using the Biotic Model," Josh Bynum, Department of Soil and Crop Sciences at Texas A&M University; J. Tom Cothren, research advisor.
- "Enhancing a Distributed Hydrologic Model for Storm Water Analysis within GIS Framework in an Urban Area," Zheng Fang, Department of Civil and Environmental Engineering at Rice University; Philip Bedient, research advisor.
- "Assessing the Potential of Zerovalent Iron to Reduce Nitrate Mobility," Omar Harvey, Department of Soil and Crop Sciences at Texas A&M University; Cristine Morgan, research advisor.
- "Determining the Efficacy of Biological Control of Saltcedar on the Colorado River of Texas," Jeremy Hudgeons, Department of Entomology at Texas A&M University; Allen Knutson, research advisor.
- "A Decision Support System to Develop Sustainable Groundwater Management Policies for a Multi-County Single Aquifer System," Muthukumar Kuchanur, Department of Environmental and Civil Engineering at Texas A&M University - Kingsville; Venkatesh Uddameri, research advisor.
- "Watershed Development and Climate Change Effects on Environmental Flows and Estuarine Function," Marc Russell, Department of Natural Sciences at the University of Texas at Austin; Paul Montagna, research advisor.
- "Spatial Patterns in Wetland Nutrient Biogeochemistry: Implications for Ecosystem Functions," Thad Scott, Department of Biology at Baylor University; Robert Doyle, research advisor.
- "Carbon Aerogel Electrodes: Absorption-Desorption and Regeneration Study for Purification of Water," Sanjay Tewari, Department of Civil Engineering at Texas A&M University; Timothy Kramer, research advisor.
- "Evaluation of Spatial Hetergeneity of Watershed through HRU Concept Using SWAT," Xueson Zhang, Department of Forest Science; Raghavan Srinivasan, research advisor.

For more information on these research projects visit our Web site at http://twri.tamu.edu/usgs.php.

# Assessing Phosphorus Loss to Protect Surface Water

The Texas State Soil and Water Conservation Board (TSSWCB) in collaboration with the Department of Soil and Crop Sciences at Texas A&M University, Texas Cooperative Extension (TCE), Texas Water Resources Institute (TWRI), and the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS), have developed a field validation of the Texas Phosphorus Index.

This project, located near Bosque and Leon Rivers, began June 1, 2002, and ended June 30, 2004. The main objectives were to determine how soil properties in the Bosque and Leon River watersheds affect phosphorus levels, and to modify the Texas Phosphorus Index to improve its ability to predict the concentration of phosphorus in precipitation runoff. The Texas Phosphorus Index, a tool designed to assess the potential for phosphorus to move from agricultural fields to surface water, is a promising resource management method that better formulates and implements such regulation programs. It is an integrated approach that considers soil and landscape features in order to find appropriate phosphorus management practices by estimating phosphorus delivery to surface water.

Other goals were to compare soil tests and extractable soil solution phosphorus levels in runoff, and to evaluate the Texas Phosphorus Index in better classifying field sites relative to phosphorus loss potential, which can be used to prioritize fields for phosphorus management. Agriculturalists are developing and operating programs that minimize phosphorus losses, thereby reducing the amount that enters regional waters.

Phosphorous is a necessary element in the growth and nutrition of plants and animals. Since there is a need for it in crop production, many fertilizers are used to enhance the supply of existing phosphorus in soils.

Environmental concerns arise when too much phosphorus, along with other nutrients, becomes runoff and reaches surface waters. When phosphorus is lost from fields or other sources and comes in contact with surface waters, eutrophication occurs. Eutrophication is an increase in the fertility status of natural waters that causes faster growth of algae and other aquatic plants. Phosphorus levels are directly related to excessive algae growth in most fresh waters. It is one of the principal causes of impaired surface water quality in Texas, as well as the United States.

Minimizing phosphorus pollution of surface water from agricultural fields involves management practices that control both the source and transportation factors of soil. Influences that affect the source and the amount of phosphorus transported include the type of phosphorus applied and the content in the soil itself. Transportation factors include rainfall, irrigation, erosion, and runoff.

The overall aim of environmentally sound practices is to keep soil fertility levels of phosphorus to a range that is best for crop growth, while decreasing the loss of soluble phosphorus by runoff, drainage, or erosion.

Researchers studied 40 sites (20 the first year and 20 in the second year) in the Bosque and Leon River watersheds. Site selection was based on fixed features designed to evaluate data and related variables including soil testing rates, timing and methods of fertilizer application, and whether phosphorus was used near streams or other bodies of water. These factors better assessed the sources of phosphorus and the potential for runoff or erosion.

Runoff factors for a field are used in a mathematical equation, outlined in an 8 x 5 matrix, to determine whether the phosphorus movement risk is very low, low, medium, high, or very high. Weighted values, based on condition classes and relative importance, enable researchers to calculate a numeric point value. Total index points for a certain field are then compared to a standard index to find the overall phosphorus runoff risk for that site.

A rainfall simulator, called a Tlaloc 3000, measured phosphorus levels, and estimated other nutrient levels in runoff. A series of three simulations were conducted at each location on 1.5 m x 2 m plots. The application rate was 7.5 cm per hour, which is the standard rate used across the nation. Runoff samples (1,000 mL) gathered at two intervals were then analyzed for pH, element content, soluble phosphorus, and suspended phosphorus by the Texas A&M Soil, Water and Forage Testing Laboratory.

Public education and outreach was another purpose of this study. Through the efforts of county Extension agents and multi-county meetings, resource managers and landowners learned about the hazard of phosphorus runoff and how to use the Texas Phosphorus Index as a management tool. Efforts to provide news and training about the Phosphorus Index for the Texas Commission on Environmental Quality (TCEQ), TSSWCB, NRCS and other groups was also important.

Results of this field study will help confirm the Texas Phosphorus Index by proposing modifications to improve accuracy. Quantitative evaluations involving the measurement and estimation of phosphorus in runoff, and runoff analysis dealing with the type of phosphorus, can determine necessary best management practices (BMPs) to decrease the magnitude of phosphorus losses from agricultural fields.

Ultimately, the Texas Phosphorus Index helps determine the main factors that lead to phosphorus risks. Management of phosphorus can be very site specific and requires a well-coordinated effort between landowners, agriculturalists and soil conservationists.

The major challenge is to create a plan that effectively uses all nutrient sources and reduces phosphorus losses in bodies of water while maintaining or improving crop profitability and environmental quality.

# The Sky is Falling

*Using cloud-seeding technology to produce rain*

Because drought and water shortages are ever-present threats, many Texas Water Districts have constructed alternate methods of preserving, and now producing water. Cloud-seeding is one such solution.

Cloud-seeding introduces foreign particles into an unproductive cloud, enhancing the formation of water droplets. In simpler terms, it is a way to produce rain by increasing the size of water droplets in a cloud that otherwise aren't heavy enough to fall on their own.

Silver iodide is a favored seeding agent because its crystalline composition is almost equal to the structure of ice crystals contained in convective clouds. Seeding with silver iodide can supply up to ten trillion artificial ice crystals.

Seeding takes place either below or above a cloud. In the first method, an aircraft's wings are mounted with flares burning silver iodide, which is then released beneath the cloud. The cloud's updraft carries the particles into the core of the cloud where tiny water droplets, which can create rain, are abundant. Wing-tipped generators containing acetone and seeding material can also outfit the aircraft.

From above the cloud, an aircraft drops the silver iodide flares into the upper region of seedable convective clouds. The crystals develop rapidly by tapping the vast field of moisture as the cloud grows, attracting water droplets in the cloud. The ice crystals quickly transform into a raindrop heavy enough to fall to the ground.

Texas has a rather extensive weather modification program.

- The first statewide program, the Colorado River Municipal Water District, is one of the oldest weather modification programs in the world. Established in 1971 to generate runoff into Lake Thomas and E.V. Spence Reservoir on the Colorado River, this program covers 2.6 million acres between Lubbock and Midland.

- The West Texas Weather Modification Association, based in San Angelo, covers 6.4 million acres in west central Texas.

- The South Texas Weather Modification Association is based just south of San Antonio and runs on a year-round basis, covering 6.6 million acres.

- The Southern Ogallala Aquifer Rain Program embraces territory in Texas and New Mexico. It covers 5.8 million acres.

- The West Central Texas Weather Modification Association, established in 2001, covers 4.9 million acres and bases its radar and aircraft in Abilene.

- The Trans Pecos Weather Modification Association is the newest rain enhancement program. Begun in May 2003, it covers 5.1 million acres between El Paso and Midland and operates its own equipment.

Cloud-seeding is a long-term commitment that requires much planning and constant work. It must be done consistently to provide definite results. Weather modification programs must survive for years in order to be useful because of the great variations in weather.

Additionally, cloud-seeding can be counterproductive if performed too late in the cloud formation-dissipation cycle. Since not all clouds have the potential to create rain, there are certain guidelines. Convective clouds are best for cloud-seeding because they are unstable in the atmosphere, making them better alteration candidates. The cloud must also have a temperature below 23 degrees Fahrenheit and have sufficient moisture, or seeding will not be effective. Seeding at the wrong time or place can actually decrease rainfall.

Another concern regarding cloud-seeding is the downwind effect–the theory that increased rainfall produced by weather modification in one area is offset by decreased rainfall in another area. However, the Texas Department of Licensing and Regulation (TDLR), claims that cloud-seeding can actually increase rainfall up to 100 miles downwind from the intended area.

The TDLR works to promote the growth and use of cloud-seeding technology through research, contributing $0.045 per acre of the total cost (about $0.08 per acre) of cloud-seeding. The TDLR was also responsible for administrating the Texas Weather Modification Act of 1967. This act requires agencies to regulate cloud-seeding through a licensing process in order to control it in the state of Texas, forcing responsible use of this weather modification technique.

The most obvious advantage of cloud-seeding is increased rainfall compared with unseeded clouds of the same height.

"Cloud-seeding can increase rain levels by 200 percent, cloud area by 43 percent and precipitation time by 39 percent," said George Bomar, state meteorologist. "Weather modification can also reduce the size of hail, another beneficial result."

Seeded clouds also have more longevity and ground area coverage. The resulting rains are more gentle, widespread, and longer-lasting.

# Communicating Outcomes

*Collaboration leads to water conservation*

Sunny skies and cool weather greeted project participants as they arrived at the fourth annual Rio Grande Basin Initiatives (RGBI) Conference, April 12-14, 2005, in Alpine. It was a productive week that provided numerous discussions on local water issues, agency reports, and Task Group breakout sessions and concurrent Task Group reports.

The RGBI is a federally funded effort involving Experiment Station researchers and Extension educators from both Texas and New Mexico. The project partners with a number of other state and federal agencies to enhance water conservation programs. The purpose for the initiative is to develop and adapt water conservation practices through research, and then through Extension education, to implement water-saving practices. Primarily, the project focuses on irrigation efficiency in both agricultural and urban areas.

RGBI project participants from New Mexico State University (NMSU) and Texas Agricultural Experiment Station and Texas Cooperative Extension attended the meeting as well as participants of new projects from the Texas State University System (TSUS) and the University of Texas (UT). This three-day event brought together project administrators, state and federal agency partners, irrigation district managers, Extension agents and specialists, and Experiment Station researchers.

"A wealth of information is being developed, not only by ourselves, but collaboratively with a number of others involved," said B. L. Harris, Project Manager of the Rio Grande Basin

Initiative and associate director of the Texas Water Resources Institute.

The purpose of this conference was to put all three of the separately funded projects together to discuss methods and ways to collaborate and cooperate, and to prevent unnecessary duplication, Harris said. The conference brought together several RGBI Task Groups for annual reporting of significant accomplishments and joint planning for future efforts. Peer and merit reviews evaluated on-going activities, and participants discussed partnership opportunities with federal and state agencies for both Texas and New Mexico.

“Obviously one of the principal themes over the past few days and life of the project has been collaboration, collaboration, collaboration,” said Craig Runyan, Water Quality and RGBI Program Coordinator for NMSU, during closing remarks. “It's meaningful and it's helped a lot. It's certainly helped our water program at NMSU. Collaboration isn't something new to us. Institutionally, professionally, career-wise, that's what we do—we collaborate.”

The cooperation between the universities and the interaction with those universities, stakeholders, and other agencies has given us an institutional capacity to keep this project relevant, Runyan said.

The RGBI is in its fourth year and continues to work toward the common goal, conserving the water in the Rio Grande Basin.

For conference presentations and reports, go to: http://riogrande.tamu.edu.

## Live, Learn and Thrive

*RGBI team award presented at NMSU ceremony*

by Danielle Supercinski

Rio Grande Basin Initiative (RGBI) participants received the Team Award from New Mexico State University (NMSU) on April 21, 2005, during the NMSU Live, Learn and Thrive awards convocation.

New Mexico efforts are led by Craig Runyan, coordinator for NMSU project efforts, and assisted by Leeann DeMouche. Runyan, DeMouche and 40 other members of the RGBI received this award for demonstrating the power of team action in achieving significant water savings in agricultural irrigation and in addressing community water needs. Other partners who also received this award were B. L. Harris, Sterling Grogan, Gary Esslinger, and Subas Shah.

The RGBI is a joint project involving NMSU and The Texas A&M University System agencies, Texas Cooperative Extension and Texas Agricultural Experiment Station. It is a federally funded effort through the Cooperative Research, Education and Extension Services. The project partners with a number of other state and federal agencies, including Elephant Butte Irrigation District and the Middle Rio Grande Conservancy District in New Mexico.

*(From left to right) Leeann DeMouche, Bill Harris, Craig Runyan, and Gary Esslinger were all present to receive the RGBI Team Award for their collaborative efforts in water conservation and efficiency.*

# Rainwater Harvesting

*An Underutilized Conservation Project*

Rainwater harvesting, a water collection practice used throughout the world for over 4,000 years, gives consumers access to an additional water source on their property. The collected rainwater is often used for landscape irrigation, but, with proper treatment, it can be used for drinking water.

Most people do not take advantage of this sensible opportunity. While rainwater-harvesting systems do involve costs, in the long run, they have the potential to conserve both money and water.

There are two general approaches to harvesting rainwater: a simple system and a complex system.

## Simple System:

In a simple rainwater harvesting system, runoff from rainfall is collected and used on-site. Distribution systems channel the captured rainwater to holding areas.

The roof of a building or home is one commonly used catchment. The bigger the roof, the larger the volume of water collected. Gravity then naturally directs the water to collection vessels at the edge of the roof which store it for direct landscape use.

Roofing made from iron, aluminum, or cement is preferable because it absorbs little or no water.

## Complex System:

A complex rainwater harvesting system also includes catchments, but the water is directed by a conveyance system to closed storage containers. Roof catchment systems use canals or gutters and downspouts as conveyance systems.

Filtration removes debris from the water before it is stored. The amount of filtration needed depends on the size of the distribution tubing and emission devices. Larger tubing requires more filtration due to increased debris amounts. In-line filters and leaf screens are effective filtration methods.

Storage containers can be under or above ground. Underground containers, while having the advantage of gravity's natural pull, are more expensive.

When it is time to use the water, the distribution system uses garden hoses, constructed channels, pipes, or drip systems (with or without pumps) to direct water from the storage containers to landscape plants or other outdoor or in-home uses.

## Why install a rainwater harvesting system?

Texas is particularly suitable for rainwater harvesting because of its unique rainfall pattern. Peak rainfall occurs in April and May, followed by a dry period from June to August, with more rain from September to October. Using an adequate rainwater harvesting system, Texans can easily get through the dry periods of the year without the need for additional water.

Each year, irrigation accounts for 30 percent to 50 percent of Texas urban water use, averaging 20 gallons of water per square foot per year (871,200 gallons per acre). Using a rainwater harvesting system, a 1,000 square foot roof area can collect 600 gallons of water from only an inch of rain. Clearly, harvested rainwater can help reduce the demands on surface and groundwater for urban landscape irrigation, save municipal water supplies, and lower homeowner water bills.

Rainwater quality is another benefit when compared to treated water sources. For example, naturally occurring rainwater is sodium-free, which can force salts away from the root zone, an important consideration in areas with waters with moderate to high salinity.

"Sodium-free rainwater can also prevent the buildup of sodium in the soil profile," said Dr. Monty Dozier, Texas A&M University water resources Extension specialist. "Use of irrigation water with moderate to high sodium content can impact soil quality and interfere with plants' water uptake."

Plants respond much better to natural rainwater because it lacks the chemicals that are added to processed water, and its natural softness makes it better for household uses. Because of its low salinity, purified rainwater is also much healthier for those on a low-sodium diet.

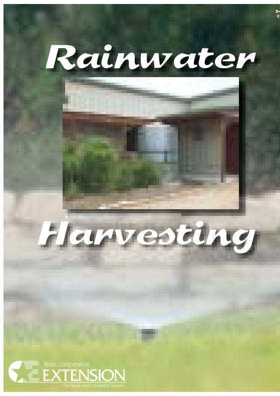
Rainwater harvesting can also reduce flooding, erosion, and contamination of surface water by better controlling hydrologic processes on an individual piece of property.

The cost of implementing a home rainwater harvesting system ranges from $5,000 to $8,000. Many Texas cities have offered rebates and tax exemptions for those willing to install them.

In 2001, Senate Bill 2 was passed to exempt tax on items purchased for rainwater harvesting. The City of Austin offers a rebate of half the cost of a system installation to industrial, commercial, and institutional customers at existing facilities—a value of up to $40,000. Hays County provides a property tax and application fee rebate for those with rainwater harvesting systems.

These incentives are definitely encouraging people to build rainwater harvesting systems. The number of people with harvesting systems increases every year, but there is still more room for growth. Rural landowners and homeowners may find use of a complete rainwater harvesting system an attractive alternative to the expense of drilling and maintaining a private water well. In fact, in some areas of Texas, groundwater may not be available, making rainwater harvesting the only viable way to secure a water supply.

Rainwater harvesting systems are a practical alternative for Texans, especially related to water costs and conservation. If you are interested in learning more about rainwater harvesting, download or purchase a copy of the latest Texas Cooperative Extension publication B-6153 available at http://tcebookstore.org/.



# Improving Stormwater Quality

The City of Houston, Harris County, the Harris County Flood Control District and the Texas Department of Transportation have teamed up through a Joint Task Force (JTF) to address Houston's stormwater pollution prevention efforts and requirements of the National Pollutant Discharge Elimination System (NPDES) stormwater permit program.

**Background:**

In 1998, the Environmental Protection Agency (EPA) Region 6 in Dallas issued an NPDES permit to the JTF. The JTF has been recognized as being consistent, economical, and efficient by the EPA and they have commended the JTF for their unity and cooperation involved in the environmental efforts of each of the four entities. The Houston/Harris County community will be moving toward the Texas Pollutant Discharge Elimination System (TPDES) that has now completed its fifth year with the NPDES permit.

**Problem:**

Stormwater is an increasingly serious concern because it impairs the quality of water resources. Stormwater, when produced by rain or snowmelt flowing over the land, captures debris, chemicals, hazardous wastes, and/or sediment. These contaminants then make their way to drainage systems that flow directly into rivers, lakes, wetlands, or bays. The polluted stormwater runoff can affect the health of plants, fish, animals, and people, as well as reduce the recreational value of water resources.

Urbanization also has a major impact on the quality of local streams because it alters what and how stormwater flows in each watershed. Construction activities inherent to urbanization replace natural groundcover with impervious surfaces such as buildings, roads, and parking lots that do not allow rainfall to penetrate the soil.

Without the presence of vegetation, stormwater is rapidly converted into runoff, meaning that a greater volume of water reaches drainage systems faster, resulting in increased flooding. Moreover, most stormwater is contaminated with pesticides, fertilizers, pet waste, automotive by-products, floatable debris, and other toxic materials that pour directly into downstream waters.

Dr. John Jacob, director of the Texas Coastal Watershed Program, said urban planning is very important because as cities expand, so do impervious surfaces.

“By making communities denser, cities will better control their growth, drastically improving water quality,” Jacob said. “The pattern of development is the single most important part of preserving our natural environment.”

Jacob also said that as polluted stormwater becomes a key contributor to the declining quality of water bodies, strong enforcement of stormwater regulations and compliance with these regulations has become essential.

The Clean Water Act (CWA) was enacted to decrease or eliminate pollution sources from industrial sites that are exposed to stormwater runoff. The CWA, along with the EPA, has authorized the NPDES permit program and requires industrial locations to implement a Stormwater Pollution Prevention Plan.

In order to implement a Stormwater Pollution Prevention Plan, nine sections must be fulfilled. These sections include a project description, best management practices (BMPs), structural control practices, permanent stormwater controls, other water controls, approved state and local proposals, maintenance and inspections of controls, and pollution deterrence measures for non-stormwater discharges.

Best management practices are the primary method to regulate stormwater. These practices aim at decreasing the quantity of contaminants polluting water resources. BMPs consist of sediment, erosion, and stormwater management controls. Most BMPs focus on managing pollution from agricultural regions, automotive facilities, construction and industrial sites, forestry locations, and residential areas. These BMPs provide standard procedures to better manage stormwater runoff and maintain or improve water quality.

"The Texas Coastal Watershed Program is involved in city landscaping projects in which fertilizers and pesticides are restricted," Jacob said. "This program also works with Houston area cities and the Harris County Flood Control District to develop wetlands in order to route and cleanse stormwater."

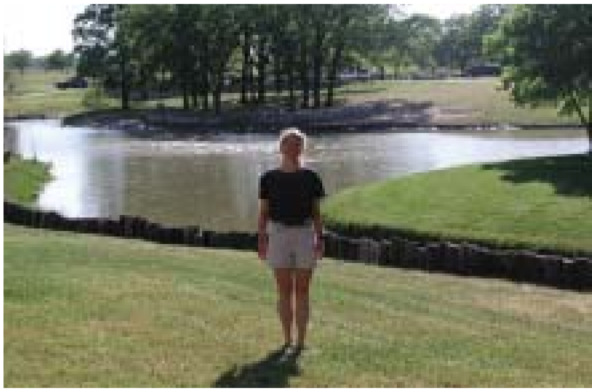
Public education is needed to support the implementation of stormwater programs and to communicate the significance of pollution prevention. Educational and outreach programs are initiated by the Texas Coastal Watershed Program, such as Marissa Sipocz's Wetland Restoration Team and Chris LaChance's Water Smart Landscaping Program. The Wetland Restoration Team actively works with urban children to teach them the importance of water quality.

Other programs and organizations in the Houston area were also created to enhance stormwater quality. The Galveston Bay Estuary Program is a program of the Texas Commission on Environmental Quality (TCEQ) that intends to restore, preserve, and safeguard estuaries that are in danger of being polluted by eliminating the number of floatables that pass through streams into the bay.

Managing stormwater is key in maintaining the security and quality of our water resources. Controlling stormwater by both its quality and quantity entails minimizing interferences with its natural flow. By proper design and regulation, the impact of urbanization and pollution on local watersheds can be considerably reduced.

# Radon Concern in the Hickory Aquifer

*Graduate student assesses radionuclide problem*



As the primary water source for Mason, Concho, McCulloch, San Saba, Menard, Kimble, and Gillespie counties in Central Texas, the threat of elevated radionuclide concentrations in the Hickory Aquifer's groundwater poses health risks for residents in the area.

Radon is a natural, radioactive gas that may be found indoors in air or drinking water. Radon is the decay product of radium, so radon indirectly reflects the presence of radium. Radon in groundwater occurs from the decay of radium both within the aquifer host rock and in the groundwater itself. It does not react chemically with either, however, because it is a noble or inert gas. About 1 percent to 2 percent of potentially harmful radon originates in drinking water.

Studies have shown that people exposed to large quantities of radon in the air may have increased lung cancer risk. Although the health effects related to drinking water with high radon are unclear, household use of water containing high radon concentrations can release potentially dangerous levels of radon into the air.

Leslie Randolph, a graduate student at Texas A&M University's Department of Geology, is using her U.S. Geological Survey (USGS) Research Grant administered through the Texas Water Resources Institute (TWRI) to assess the spatial and temporal distribution of radon in Hickory groundwater.

Randolph conducts her research at a small field site in the Katemcy Creek watershed in northern Mason and southern McCulloch counties. She hopes to gather enough data to achieve the first step in a long-term assessment of radionuclides in the Hickory aquifer system's groundwater.

Previously, no systematic study has been done to assess the degree of the radionuclide problem, but Randolph will explore the relationships between observed radon distributions, aquifer stratigraphy and mineralogy, and groundwater dynamics.

A primary goal of the research is to evaluate the function of major stratigraphic variations on radon concentrations. Randolph hopes to "provide new insights regarding the occurrence and distribution of radon and radium in the world's aquifers that are geologically and hydrologically similar to the Hickory aquifer," she said, anticipating her research leading to further investigations of relationships between radon gas and its parent nuclides, aquifer mineralogy, and aquifer geochemistry.

Another goal, which she admits may be idealistic, is to determine if one or more stratigraphic zones in the aquifer contain radionuclide concentrations within adequately safe levels in terms of human risk.

"Water wells could be designed to draw from only those zones, rather than from across the entire aquifer as typically is done," Randolph said.

Groundwater samples are collected during both the summer irrigation season and periods of static flow in the aquifer. This allows Randolph to better assess effects of differing groundwater flow rates on radon activity. At the field site, Randolph prepares the samples for radon and radium analysis, and she analyzes them for anion concentrations. Additional samples are sent to the TAMU Trace Element Research Lab for cation and trace element analysis.

Randolph designed a groundwater sampling scheme based on the stratigraphic variations in the Hickory sandstone aquifer at the field site. Her preliminary measurements show that radon activities vary between approximately 100 picoCuries per liter (pCi/L) and 1000 pCi/L, with the lowest activities in water collected from within a fault zone, and the higher activities found generally in the lower parts of the aquifer. Activities overall are generally higher when nearby irrigation wells are pumping.

These numbers may sound high, but they actually are of questionable concern in terms of human health risk. The EPA has not yet set a maximum contaminant level (MCL) for radon in drinking water, but recommends a limit of 4000 pCi/L for untreated water and 300 pCi/L for treated water.

However, radon's radioactive parent radium has been detected in groundwater from many Hickory Aquifer water wells at levels that exceed the MCL of 5 pCi/L. Randolph uses stratigraphy to assess the variations in radium concentrations at her field site.

Through this preliminary effort, Randolph has discovered that not only has the expenditure been surprisingly high, but she has run into some other difficulties as well.

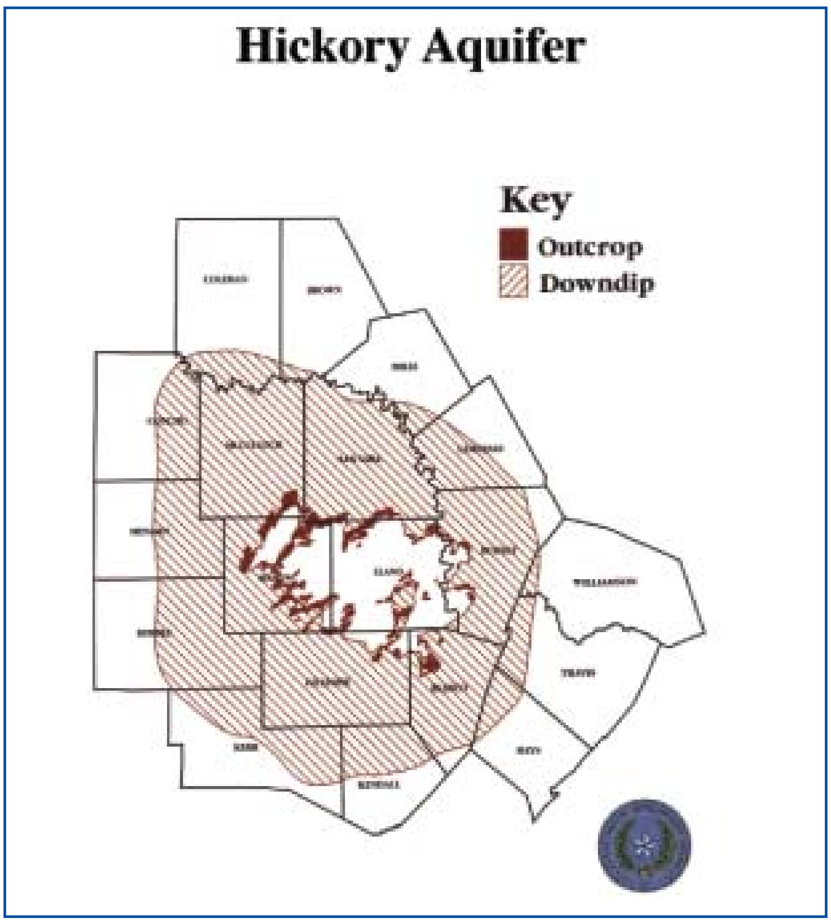
"The financial cost of doing the research is higher than I anticipated," Randolph said.

"Coordinating groundwater collection opportunities with the researcher who installed the wells, the local farmers, and Mother Nature has proven more difficult than I anticipated."

She said that she appreciates the TWRI grant because it has helped her pay for necessary analytical instruments and field and laboratory supplies.

"This research could not have been done without TWRI's help," Randolph said.

Because most people are not aware of the risks associated with radionuclides in drinking water, Randolph hopes her research will inform the average person about their existence and give them the knowledge to be on the lookout for these natural contaminants.



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