tx H$_2$O

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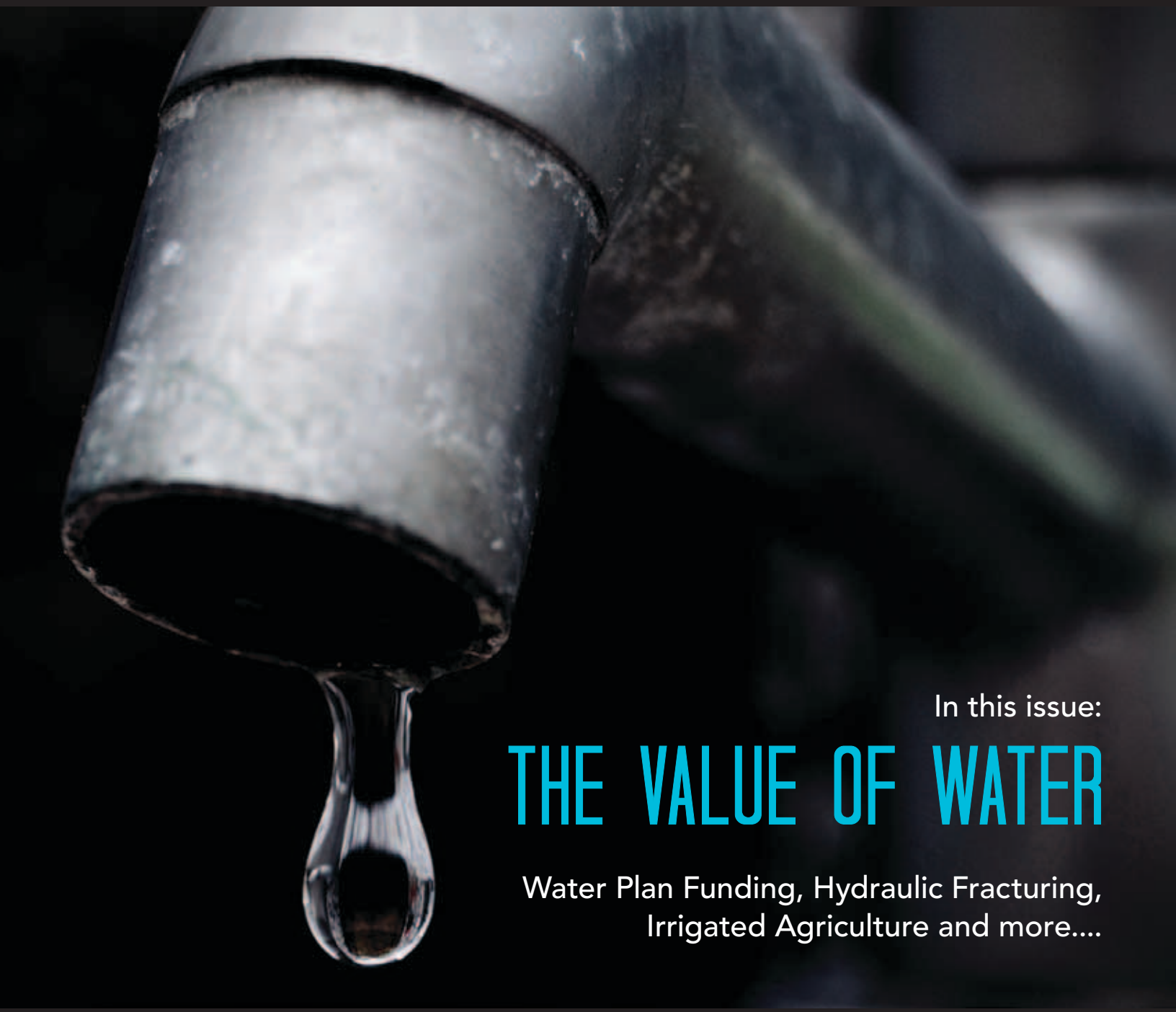

In this issue:

THE VALUE OF WATER

Water Plan Funding, Hydraulic Fracturing, Irrigated Agriculture and more....

Texas A&M AgriLife Research
Texas A&M AgriLife Extension Service
Texas A&M University College of Agriculture and Life Sciences

Working to make every drop count

The development of this issue of *txH2O* began with a question: What is water worth?

Texas faces significant challenges and opportunities regarding water, and the future of that water is intrinsically tied to financial decisions at every level—personal, local, regional, state and federal.

Research, infrastructure, education, technology, conservation—they all require investment of resources. Investment necessitates a vested interest in the product, so the question is, how much do Texans value water? Do we value water as much as we value other products? Will a culture that stands in long lines for the latest smartphone view investments in replacing outdated 1950s water infrastructure with the same sense of demand? Will such water-saving technologies be worth it? How will we prioritize water used for municipalities, industries and agriculture? Will a sustainable water supply be seen as essential to the public's well-being and not be taken for granted?

We look at some of these questions and more in this issue of *txH2O*, through the science-based lens called for by our ongoing mission to facilitate water resources research and education in Texas. This issue opens with an examination of the state water plan and all of the variables surrounding its possible funding and implementation. We also provide a short overview of the current legislative session and water issues that lawmakers may address.

Dr. Calvin Finch, director of the Water Conservation and Technology Center, compares water saving strategies in his recurring column, and another article covers the power generation industry's use and consumption of water. Experts also discuss hydraulic fracturing and its water use, as well as potential new technologies to perfect the process. We also describe the major economic impacts that drought has had on lakes and tourism in Texas, spotlighting Lake Travis and Lake Conroe.

Our goal is to tell the stories of important water resources research and education. If you have a story to tell, please let us know.

As always, let's continue to make every drop count.

Roel Lopez
Interim Director

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Texas Water Resources Institute
make every drop count

Volume 8, number 1, Winter 2013

The 83rd Texas Legislature will be debating funding the state water plan and other water-related issues during its session. Photo by Leslie Lee.

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Lake O' The Pines in East Texas saw very low water levels in October 2012. Recent drought impacts to the entire state, including usually rainy East Texas, have motivated some lawmakers to call for the Legislature to act. Photo by Robert Burns, Texas A&M AgriLife Communications.

WORTH IT?

Weighing the costs of implementing the state water plan and the consequences of doing nothing

In Texas, ensuring water security for a burgeoning population dependent on diminishing water supplies is nothing if not complicated.

The closest thing to a clear solution to Texas' water woes is the state water plan, experts say. Every five years, the Texas Water Development Board (TWDB) publishes the plan, which is composed of science-based contributions from the state's 16 regional water planning groups.

Created after the 1950s drought, TWDB is equipped by the state to provide loans to local governments for needed water supply projects identified during their regional water planning process. The state water plan takes into account all water users and lays out strategies over a 50-year planning horizon.

However, legislators haven't funded the plan in previous years due to other looming budget priorities and the plan's total capital cost. Some insiders have predicted that it will receive some sort of dedicated funding source during the 83rd Legislative Session, while others have wondered if the current political climate can tolerate the large financial undertaking. On January 10, state Rep. Allan Ritter filed two bills: HB 4, proposing "the creation and funding of the state water implementation fund for Texas to assist the Texas Water Development Board in the funding of certain water-related projects," and HB 11, providing "for an appropriation of money from the Economic Stabilization Fund to finance certain water-related projects."*

Facing Texas' water realities

These three numbers give a snapshot of the economic side of Texas' water situation: 1.1 million, 26.9 billion and 140.

1.1 million people—that's just slightly less than the city of Dallas' current population.

It's also the number of Texans who would lose their jobs by 2060 if drought of record conditions recurred and water management strategies identified in the state water plan were not implemented, according to TWDB data projections.

$26.9 billion—that's the estimated total state financial assistance requested by regional water planners, out of the $53.1 billion total capital cost needed to implement the water plan.

However, this assistance would not be direct appropriation funds, officials said, but instead would be low-interest loans to the local and regional entities that will actually implement and construct the plan's water supply projects. According to TWDB, of the $26.9 billion, all of the principal and the majority of the interest would be paid back to the state.

140 days—that's how long Texas' 83rd Legislature will convene.

During those five months, legislators such as Ritter are aiming to make progress towards ensuring the state's water supplies.

The state has the facts, and it has a plan to prevent the 2060 projected water supply shortfall of 8.3 million acre-feet. The question is—what's going to be done with that plan?

An unimplemented plan

The state water plan is the envy of other states, experts say—it's comprehensive, far-reaching, bottom-up. It involves the people, the planners, the number-crunchers. It looks back and also plans ahead.

"It's great that we have regional water planning groups, with this bottom-up planning process because people can look at what their needs are at the local and regional level," said Tom Mason, a former general manager of the Lower Colorado River Authority. Mason currently practices water and environmental law in Austin.

But, experts such as Mason ask, what's the use of a great plan if it is not implemented?

"It's an excellent document, and compared to other states I think Texas does a great job of preparing a water plan, but a plan implies a prelude to action, and implementation is really important," Mason said. ⇨

**Editor's note: At press time, these bills had received support from several interests groups, but the water plan's future was still uncertain, dependent on the coming weeks' discussion in the Legislature.*

"Planning is important, but implementing the plan is critical," said Carolyn Brittin, TWDB deputy executive administrator.

Brittin said the longer Texas procrastinates on beginning the projects, the more vulnerable the state will be during drought and the more costly it will be to implement the needed projects in the future.

Breaking down the price tag

Total capital cost of $53.1 billion is enough to stop taxpayers in their tracks, but officials said not only is the price tag spread out over the 50-year planning period, only $26.9 billion of the total would come from the state, in the form of low-interest loans.

"No matter what state funding mechanism is chosen or used to fund the plan, local and regional water providers and their customers will repay 100 percent of the capital costs to construct the projects, as well as the majority of the interest," Brittin said. "$27 billion in projects does not mean $27 billion in appropriations."

Heather Harward serves as executive director of the H2O4TEXAS Coalition, a nonprofit organization working to mobilize public support for implementation of the plan.

Harward said $26.9 billion is "still a substantial number, but what that boils down to is something along the lines of approximately $150 million a year, according to most of the models coming out of the water development board and the Legislature.

"That money is loaned—it's not given away, and these are not grants," Harward said. "This is the state partnering with local entities to provide the most fiscally conservative financing options for implementing the plan."

She said the low-interest loans would involve benefits that are very important when implementing major infrastructure projects.

"The ability to use low-interest deferred loans, through state participation, gives projects more time before they start paying back, which is very critical when you're talking about some of these projects that take years of engineering and design," Ritter said.

According to TWDB, every $1 billion in financial assistance provided for water plan projects, over the course of project implementation, will generate $1.75 billion in sales revenues in the construction, engineering and materials sectors and supporting businesses; create $888.8 million in state gross domestic product; add $43.9 million in state and local tax receipts; and create or support nearly 13,077 jobs in the state. Supporters say the benefits of the plan will outweigh the costs.

"And, again, the annual revenue number is so important—$150 million," Harward said. "Of course that's still a significant amount, but relative to the state's overall annual budget it's microscopically small. And what gets so lost in this conversation is that not only are these loans, and the money ultimately flows back to the state, but also that with a lack of implementation, costs will only continue to increase."

Evaluating the plan

The loans would fund a diverse list of projects and strategies that each region has identified as needed to meet future water demands. The strategies vary widely in terms of cost.

"Aquifer storage and recovery and desalination are more so long-term strategies because of cost," Brittin said.

Municipal conservation is the most cost-effective way to ensure the state's water supply, she said.

"The state water plan calls for almost a fourth of the 'new water' to come from conservation, and that's terrific," Mason said. "I'd love to see us focus on that first and foremost because it's the cheapest, the fastest, the most efficient way to make 'more' water available."

According to the plan, municipal conservation strategies are expected to result in about 650,000 acre-feet of supply by 2060, with irrigation conservation and other conservation strategies totaling another 1.5 million acre-feet per year. Regional water plans contain detailed proposals on the specific water conservation projects needed, Brittin said.

Prioritization of projects is an area in which the plan could improve, Mason said.

"It's over 500 individual water supply projects and strategies, but it is not prioritized," Mason said. "That's really important. If there's going to be any sort of state funding involved, I think we need to have some serious conversations at the state level, at the Legislature and water agencies, about how to grapple with which projects are best for the state as a whole and how do we prioritize them."

Brittin said funding realities serve to help regions prioritize strategies.

"I think you see that when regions recommend projects to be implemented in the plan, there's an inherent prioritization there, in that those that are more costly are recommended for later decades of the planning cycle, as opposed to those that are more cost effective and easier to implement today, those are recommended in the earlier decades," she said.

"Due to the cost of seawater desalination and some of the permitting issues that exist around it, we're seeing that recommended in later decades in the plan, like 2050 or 2060."

The "do-nothing plan"

Even with the plan's potential shortcomings, the consensus among water-minded legislative leadership seems to be that kick-starting implementation of the water plan is preferable to doing nothing.

"Last year's devastating drought made it clear that something needed to be done," said House Speaker Joe Straus at an October 2012 *Texas Tribune* event on water. "The 'do-nothing plan' is not one we should consider."

Currently, with the plan not implemented, a repeat of drought of record conditions would present Texas with an immediate water shortage of 3.6 million acre-feet annually, according to TWDB. If the state follows the "do-nothing plan," TWDB estimates that by 2060 Texas businesses' and workers' lost income would total roughly $116 billion. Foregone state and local business taxes associated with lost commerce would total $9.8 billion.

"Climatologists' predictions seem to suggest that the drought is not going to subside anytime in the immediate future," Harward said. "So I think we'll continue to feel the pain throughout the state, which will result in economic losses, if we don't take bold action now." ⇨

A center-pivot irrigation system near Pilot Grove, Texas. Photo by Robert Burns, Texas A&M AgriLife Communications.

Plan gains momentum

"I've had senators and representatives from all over the state talking to me about water—and that's been a first for me," Ritter said. "The reason for that is for the first time in my lifetime, every part of the state of Texas felt the (2011) drought to the extreme. Even where I live, where we get 45 to 60 inches of rain, we felt it—to the extent that if we would have had another year of no rain, we wouldn't have had the water to provide our area. That's scary.

"So, the dynamics are different than they were before 2011."

Whether other pressing budget issues will overshadow legislators' recollections of the historic 2011 drought is yet to be seen. If current drought conditions worsen, will pressure on lawmakers to take action on water increase? Or if conditions ease, will the previous drought fade from their memories like it was just a bad dream?

"I have watched this issue from different vantage points since the passage of Senate Bill 1 in 1997," Harward said. "And I see more momentum than I ever have before. The drought was an unfortunate catalyst, and I believe the drought culminated with our outreach efforts as well as those by the leaders in the Legislature on this issue."

Ritter chairs the House Natural Resources Committee, which is tasked with keeping an eye on drought and water supply issues.

"You can't have a functional society without water resources—it can't happen," Ritter said. "And, what we know, just from the years of developing a state water plan, is that the cost of developing new water resources is skyrocketing.

"The smart thing for us to do would be to start on this critical path of developing water resources and not have what years ago was about $20 billion in costs, and is now $53 billion, end up being $100 billion."

Funding options

Ritter said he anticipates that members will propose various scenarios for funding mechanisms and hopes to see creative solutions for meeting these funding needs.

One funding mechanism that is more viable than it was last session, Harward said, is an investment from the Economic Stabilization Fund—commonly referred to as the Rainy Day Fund. According to the Texas Comptroller's Office, the fund currently holds more than $8 billion, generated largely by oil and gas production taxes. Following the state's 1986 economic slump, as noted in comptroller documents, voters approved a constitutional amendment creating the fund in the November 1988 general election.

"That's a revenue source that I've long advocated for and thought was a great fit, because the Economic Stabilization Fund by name just fits hand-in-glove with the water plan because we can prove immediate job growth and both short- and long-term economic development (would result from implementation). So to me it seems like the perfect marriage, considering the issue and the intention of those dollars," Harward said.

Some experts say lawmakers may be warming up to the idea of using a portion of the fund for water purposes, and Ritter's HB 11 proposes such a plan.

Support from other interest groups regarding increased state spending on water is also developing. At the Texas Farm Bureau's annual meeting in December 2012, members voted in favor of the state developing a source of revenue, either through a dedicated fund or from the Rainy Day Fund, to make implementation of the state water plan possible.

"We understand the state water plan will be expensive, and we need a dedicated revenue source to fund it," said Bureau President Kenneth Dierschke in a press release. "Recognizing that agriculture is one of the major water users in the state, we want to be part of the solution."

The Texas Association of Businesses has also chimed in, voicing support in fall 2012 for increased fees on water use and vehicle registrations to fund state investment in water and transportation infrastructure.

Staying ahead of the curve

"We are close to being so far behind the curve (on water) that catching up will be difficult," Ritter said. "I'm very concerned about that. You could say the same thing for highways, but I think we're a little further behind the curve on water than we are on transportation. And I'm sorry that it costs money, but it does cost money."

"Yes, the plan is asking for money, but we're trying to get across that this is a good investment, and it is one that is going to improve job growth and economic prosperity," Harward said.

And so, all eyes turn to the Legislature and the long list of issues facing Texas lawmakers in 2013. Will water make the cut? Or will the plan continue to be just a plan?

"It's a priority—it's a priority of leadership and of members of the Legislature, but also of 'we the people,'" Ritter said. "The Legislature cannot solve this problem all by itself. Each one of us, working with our local entities, is responsible, too.

"But it is solvable. We know that. With the state water plan, with the road map, we know that we can develop water resources as new innovations come along, as we learn better management technologies and continue doing a better job."

For more information, visit *txH2O* online at *twri.tamu.edu/publications/txH2O*.

TEXAS A&M AGENCIES REQUEST FUNDING TO ADDRESS WATER RESOURCE MANAGEMENT

With the drought of 2011 exposing the frailty of Texas water supplies and management, highlighting the state's future challenges, three of the nation's preeminent research and education agencies—the Texas A&M AgriLife Extension Service, Texas A&M AgriLife Research and Texas A&M Engineering Experiment Station—are aligning their expertise and outreach capabilities in water resource management to benefit Texans.

The agencies are requesting $20 million for an exceptional appropriations item from the 83rd Texas Legislature for fiscal years 2014–2015 that focuses on aggressive research and extension education about water. The objectives of the requested exceptional item are to 1) leverage Texas' agricultural and life sciences expertise to address urban and rural surface water, groundwater and reusable water issues through research, technology development and best practices and 2) improve municipal, manufacturing, irrigation, recreational and agricultural water utilization and conservation.

Benefit to Texans

According to the exceptional item, which is part of the budget requests by the agencies to the Legislative Budget Board, county-by-county needs assessments conducted in 2011 involving stakeholders, producers and residents, identified water as the top statewide priority. There is an urgency to develop and implement new technologies and best practices in both rural and urban environments, the exceptional item states.

How and when water is used or reused in homes, businesses or industries—including landscapes and production agriculture—require both research and education to reach a high-quality water future. Supplies must be assessed and managed with emphasis on such factors as bacteria, nutrients, stormwater runoff, routine conservation and treatment/reutilization strategies.

Image from *CGTextures.com*

According to the item, this requested investment in water research and education will make a critical difference in the state's ability to increase the efficiency and utility of its water resources. It will also facilitate research to develop advanced technologies and next-generation best management practices for water in Texas.

Initiatives

Initiatives funded by the request would include the following:

- Develop models that predict the potential impact on water supplies due to drought, land use and municipal water use under different climate scenarios.
- Accelerate development and adoption of innovative conservation technologies that solve water supply problems and secure future supplies.
- Develop, educate and assist in implementing more comprehensive practices for managing irrigation water use and water-capture methods to improve efficiency across cropping systems, residential and business areas, urban landscapes and forage production. These practices will include alternative sources such as saline water, reclaimed water, graywater, and wastewater and expanding AgriLife's existing Evapotranspiration Network to use weather data and soil and crop conditions for real-time decision making to maximize crop production with minimal irrigation.
- Deliver water use and conservation education to Texas residents, water districts and municipalities via four regional training teams and through online courses.
- Target modern plant breeding and biotechnology to develop geographically appropriate drought-tolerant and water-use-efficient plants.
- Develop efficient, cost-effective advanced irrigation, water capture and treatment technologies.
- Analyze the economic impacts and policy implications of water investments in the agricultural sector across both rural and urban Texas.
- Analyze the adoptability, return on investment and environmental benefit of new water technologies.

To read the complete exceptional item, visit *agrilife.org/agrilife-offices/externalrelations/.*

To understand more about the Texas funding process, visit *senate.state.tx.us/SRC/pdf/Budget_101-2011.pdf.*

Story by Leslie Lee

10 THINGS TO KNOW ABOUT WATER AND THE 83RD TEXAS LEGISLATURE

A brief primer on water issues in the current legislative session

1. Texas' 83rd Legislative Session began Jan. 8 and ends May 27.
   - March 8, the 60th day, is the deadline for filing bills and joint resolutions other than local bills, emergency appropriations and bills that have been declared an emergency by the governor.

2. The House Committee on Natural Resources was specifically charged with researching drought and water issues and developing a report on its findings during the period between sessions.

   The committee's interim charges included examining the following issues:
   - the statewide drought and the performance of state, regional and local entities in addressing it; drought's impact on the state water plan and strategies for the state to deal with drought
   - the water-energy nexus in the state
   - desalination projects in Texas, including brackish groundwater desalination
   - agricultural irrigation conservation incentives
   - agencies and programs under the committee's jurisdiction and their implementation of relevant legislation from the previous session

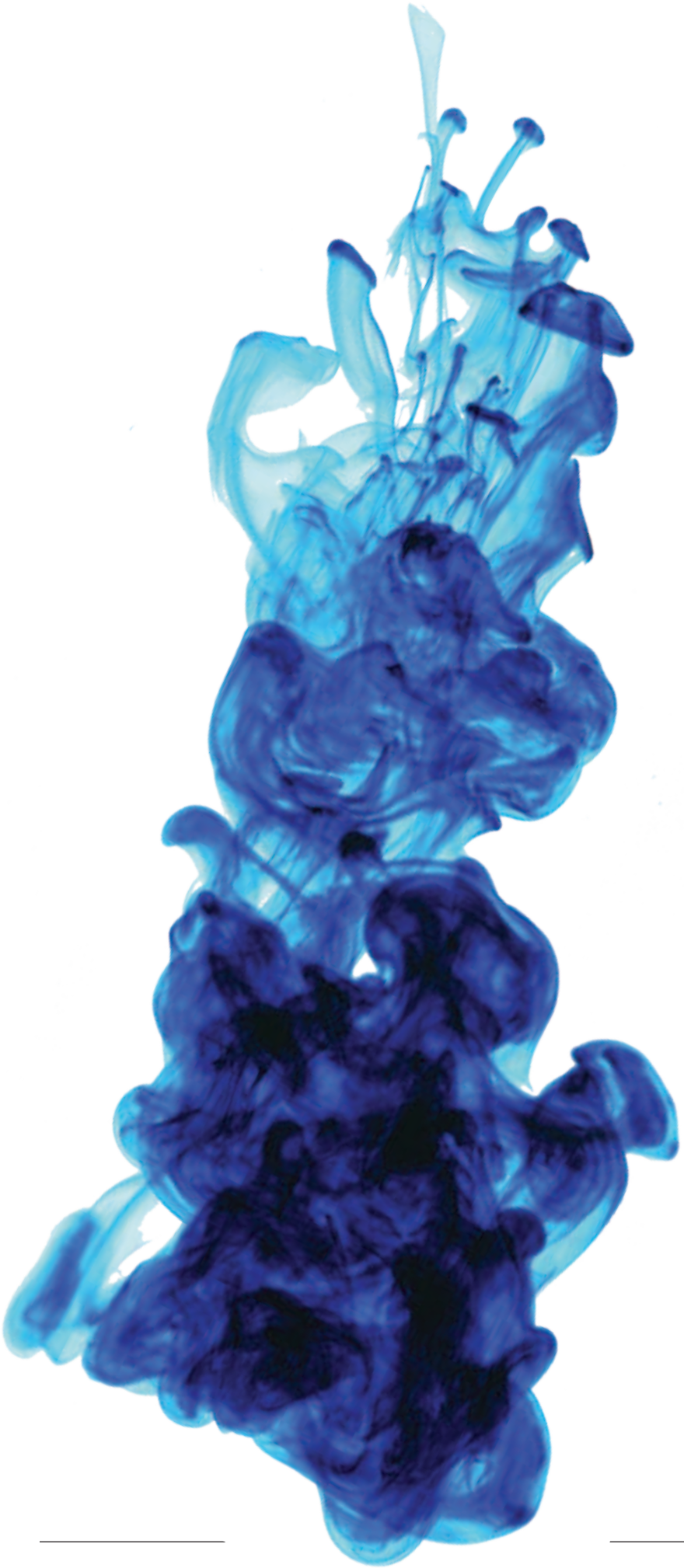
3. The House Natural Resources Committee's jurisdiction includes overseeing the Texas Commission on Environmental Quality, as it relates to the regulation of water resources, as well as the Multi-State Water Resources Planning Commission, the Texas Water Development Board and several river compacts.

4. The interim charges given to the Senate Committee on Natural Resources also involved studying the following water issues:
   - impediments to implementation of the state water plan and recommendations on ensuring that Texas has access to sufficient water for future generations
   - alternatives to using surface water or groundwater in the generation of electricity and extraction of fuels, and the potential for desalinization and other technologies for the reuse of brackish water
   - recommendations on the management of groundwater resources
   - the bundling of small water and sewer systems by a single investor-owned utility and the causes and regulatory issues associated with rapidly escalating water and sewer rates for Texans who live in unincorporated and rural areas

5. The House's interim charges are available in full at *www.house.state.tx.us/_media/pdf/interim-charges-82nd-march-release.pdf.*

   The Senate's interim charges are available in full at *www.senate.state.tx.us/assets/pdf/SenateInterimCharges82_Final.pdf.*

6. Distributed to the Legislature and the Governor's Office at the beginning of the session, the House Committee's interim report recommended establishing a "dedicated fund and funding source for the implementation of the state water plan." The full report is available at *www.house.state.tx.us/_media/pdf/committees/reports/82interim/House-Committee-on-Natural-Resources-Interim-Report.pdf.*



7. To keep up with the House Natural Resources Committee's meetings, go to *www.house.state.tx.us/committees*, and visit *www.senate.state.tx.us/75r/senate/Commit.htm* for the Senate's.

8. To keep up with the status of bills filed by the Legislature, visit *www.legis.state.tx.us/BillLookup/BillNumber.aspx*.

For an idea of the input lawmakers may be receiving from constituents regarding water, the annual Texas Lyceum Poll showed this year that voters were open to the possibility of tap fees increasing to fund water supply projects.

A snapshot of registered voters' opinions on public policy, the poll found that 64 percent of voters claimed they would be willing to pay more in water tap fees to ensure that the state's water needs are met. The poll was taken in September 2012 and sampled 1,175 registered voters in Texas, with 44 percent self-identifying as Democrat and 44 percent as Republican. The Texas Lyceum is a nonprofit, nonpartisan group. The poll can be accessed at *www.texaslyceum.org*.

9. In regards to groundwater regulation, the Texas Supreme Court case *The Edwards Aquifer Authority v. Burrell Day and Joel McDaniel*, which was decided in February 2012 in favor of rule of capture for groundwater, could have an impact on water discussions in the Legislature. The full decision is available at *www.supreme.courts.state.tx.us*.

Image from *CGTextures.com*

COMPARING STRATEGIES

State funding of capital projects versus water conservation

The Texas Legislature seems intent on helping local water purveyors finance a portion of the water supply projects described in the 2012 state water plan (*Water for Texas 2012*). The plan says that $26.9 billion is needed from the state to meet our water needs in the future. The plan also says that failure to provide the funds will cost $116 billion in lost income and will result in more than 1 million lost jobs by 2060 if we are subjected to a drought of record before adequate water supplies are in place.

Twenty-seven billion dollars is a lot of money, but it is only half of the funds needed for an adequate water supply. The timing of the money's availability is important. The most important issues involve the actual commitment of the funds, what form they are in and when they will be available. Nearly as important, however, is how projects will be prioritized.

One of the most significant factors in prioritization is the issue of selecting between high-cost capital projects, such as reservoirs and recycling systems, versus conservation projects, such as high-efficiency toilet distribution, industrial water-saving technology, elimination of water loss due to poor infrastructure and incentives for conversion to low water-use landscapes.

WATER CONSERVATION & TECHNOLOGY CENTER
Securing Our Water Future

It is not a simple choice.

Capital project advocates say conservation projects do not really create new water as a reservoir does. However, that argument does not seem to "hold water" to me. In the simplest definition, "creating new water" means having water available for new jobs and new residential populations. The water saved by replacing an old, inefficient toilet with a new, efficient toilet is just as available as water from a new reservoir. The "new water" is also just as permanent as a reservoir because the old, inefficient plumbing is no longer available.

Unless familiar with the billions of gallons of water produced by San Antonio's or El Paso's water conservation efforts, one might believe the volumes of water available from conservation are not large enough to make a difference. That is just not true. Conservation has largely met new water needs for economic and population growth for many decades in San Antonio and El Paso.

Some say the new water supplies created by toilet replacement, industrial technology change and landscape conversion is too dependent on individual behaviors and proper maintenance of technologies. It is true that this philosophy is relying on thousands of mini-projects versus a few large projects, but even reservoirs fill in with silt and require regular maintenance. The analysis of which water supply option is more reliable would be an interesting study. How does the accumulation of silt and sedimentation in drought-sensitive reservoirs compare to the performance of the conversion of household or industrial water-use technology in terms of long-term reliability of the new water supplies?

An analysis of the cost per unit of water produced and the time required to have the first water available would need to be included in any analysis.

The purpose of this discussion is not to dismiss the capital projects; it is to suggest that both types of projects must be included in the mix. Purveyors funding new water resources for Texas need to recognize the importance of including water conservation projects to contribute inexpensive, new water supplies that can be online quickly.

Story by Danielle Kalisek

WATER VALUE IN POWER GENERATION

Experts distinguish water use and consumption

Having enough water available for municipal and agricultural needs is often discussed; however, having the water needed to generate electric power and the electricity needed to treat and transport water is a struggle all its own.

According to *Water for Texas 2012*, the state water plan, steam-electric power generation demand in 2010 was 733,179 acre-feet of water per year and is projected to increase to 1,620,411 by 2060; however, that amount only accounts for 7.4 percent of 2060 total water demand. Steam-electric falls fourth in the list of six categories, with municipal (38.3 percent), irrigation (38.1 percent) and manufacturing (13.1 percent) demands leading, followed by livestock (1.7 percent) and mining (1.3 percent) demands.

Water use versus water consumption

When talking about water for power generation, two important terms must be explained and understood: water use and water consumption, said Dr. Susan Stuver, research scientist with the Texas A&M Institute of Renewable Natural Resources and Texas Water Resources Institute.

"If you're using water and putting it back where it came from, it's water use," Stuver said. "A power plant is not consuming millions of gallons; it just needs (the water) once and then puts it back, and keeps using the same water over and over again.

"Water is drawn from the reservoir, used to cool the power plant and is then returned to the reservoir where it can therefore be used for other activities such as habitat for wildlife or recreation."

On the other hand, she continued, water consumption means that water is removed from the water system and becomes unavailable for other uses; it either becomes waste or must undergo treatment if it is to be reused, or in the case of irrigation, it is consumed by plants.

"It is a common mistake to lump water use and water consumption together," Stuver said. "We should always make the careful distinction because reducing water consumption and reducing water use will have very different results."

Cooling technology options

The amount of water a power plant uses depends on the type of plant and its cooling system. The cooling technologies currently used in Texas thermal power plants include once-through cooling and wet cooling tower systems, which both use water to condense steam, and dry cooling systems that use air to condense steam. Some cooling systems use more water, but consume less, while others use less water, but consume more.

For example, dry cooling systems use less water and consume less water than either of the wet cooling systems. However, according to experts, they may not be as effective in certain environments or may not be the technology of choice for a variety of reasons.

With wet cooling towers, the amount of water used will vary by plant based largely on the amount of power produced and the quality of the steam used, said Kent Zammit, senior program manager at Electric Power Research Institute (EPRI). EPRI is an independent, nonprofit organization that ⇨

In Grimes County, the sun sets over Gibbons Creek Reservoir, the cooling water supply for an adjacent power plant. Photo by Leslie Lee.

performs research, development and demonstrations in the electricity sector for the benefit of the public.

"For example, using once-through cooling would withdraw more water but generally consumes less than half of the water compared to using wet cooling towers," Zammit said. "Using dry cooling would virtually eliminate any water use for cooling."

"Having a variety of technologies to rely on is a smart choice," Stuver said. "Dry cooling is a great technology for places where the ambient temperature stays relatively cool since dry cooling technologies can only 'cool' to the ambient temperature around them.

"Places in deep South Texas can get to temperatures of 115 degrees Fahrenheit in the summer months and therefore are not optimal for dry cooling."

While retrofitting existing power plants to wet cooling towers or dry cooling systems has been suggested, that would be extremely expensive and result in unoptimized operating conditions, Zammit said. Such a retrofit would be comparable to changing a 20-year-old car to a hybrid drive system to get better gas mileage—it is technically feasible, he said, but would not make economic sense given the remaining life of the car.

A recent report prepared for EPRI by the Water Conservation and Technology Center, which is part of The Texas A&M University System, stated that Texas power producers who use once-through cooling typically consume less than 1 acre-foot of water per 1,000 megawatt-hours of electricity produced. This is lower than the national average for once-through systems. Wet cooling towers only use approximately 5 percent of the water that once-through systems use, but they consume at least 100 percent more water than a once-through system, since the majority of the heat rejection for wet cooling towers is through evaporation of water.

Conservation at Texas power plants

Because the electric power generation community understands the importance of water, a lot is being done to conserve water at Texas power plants, Zammit said.

For one, renewable energy sources (wind and solar photovoltaic) are being constructed in the state, and these energy sources require no cooling water.

"Renewable energy sources tend to be lower water consumers," he said.

Power plants can also be designed to use nonpotable water like sewage effluent and high-salinity groundwater, he said. In addition, EPRI is researching projects that could become the next generation of water conservation technologies.

Benefits of cooling reservoirs

Some existing plants use once-through cooling with water withdrawn from manmade reservoirs, Stuver said. There are 209 reservoirs in the state of Texas, and a lot of those lakes serve the public as recreational areas for boating, skiing, fishing, camping and more. The reservoirs also provide wetland and riparian habitats for wildlife.

"The power plants are the ones who keep the water in those lakes," she said. "They need a big lake, but let other people use it. Power plants don't contaminate the water, but they cycle it through and then put it back."

"With normal rainfall, reservoir levels can be maintained without much makeup water," Zammit said. "But in drought conditions, additional water may be needed to maintain the reservoir level at a minimum level necessary for operation of the power plant."

The Calaveras Lake near San Antonio is a good example—the 3,624-acre lake offers fishing, boating and watersport opportunities and a park including a nature trail, campsites, shaded picnic tables, a fishing pier and a boat ramp, Stuver said. It is also a great bird-watching location.

"This lake is actually a power plant cooling reservoir that was formed in 1969 by the construction of a dam to provide a cooling pond for a complex of power plants that supply additional electricity to the city of San Antonio," she said. "The Calaveras reservoir has a tremendous economic impact on the area primarily from the large populations of threadfin shad and large-mouth bass fish that grow well in the warm, nutrient-rich waters."

Texans also benefit from the water used for power generation in multiple ways. Reliable generation of electricity is necessary for pumping water to cities and farms and for treating water and sewage. Electricity powers nearly everything residents do. It is particularly important in providing heating or cooling and providing power to business and medical equipment. In short, electricity drives the state's economy and resulting quality of life.

Renowned research

Researchers at Texas A&M University are studying water consumption in various industries.

"Texas A&M has world-renowned leaders that come together both from the water conservation and petroleum and electrical engineering fields," Stuver said. "We take new discoveries to the next level by converting those discoveries into technologies that we commercialize to stimulate the economy.

This has led to strong partnerships with the power generation industry, power production industry, oil and gas industry, government and policymakers as well as other universities."

The Water Conservation and Technology Center has just finished the water consumption study for power generation mentioned throughout this article and is preparing to begin a new study in 2013 on water consumption in lignite mining, she said. The Texas Water Resources Institute and Texas A&M Institute of Renewable Natural Resources are working with the Global Petroleum Research Institute to reduce the environmental footprint of hydraulic fracturing through water conservation strategies, wastewater treatment technologies and innovations in desalination.

Benefits of water consumption

While used cooling water can easily be reused, power plants do consume water. However, this consumption serves an important function in the electric generation process, experts say.

Stuver said water consumption for power generation and power production, such as drilling and fracturing, is important, just as is the water needed to grow our food. It is, of course, important to save water where we can, she said, but not at a cost that will either make electricity unaffordable or lead to rolling blackouts due to not enough power being generated to meet our demands.

"In other words, we should always bear in mind the bigger picture," Stuver said.

For more information, visit *txH2O* online at *twri.tamu.edu/publications/txH2O*.

Gibbons Creek Reservoir serves as the cooling water supply for an adjacent power plant and as a recreational lake. Photo by Leslie Lee.

Story by Kathy Wythe

FRACTURED

Experts examine the contentious issue of hydraulic fracturing water use

In a state where oil and gas are king, and water is—in words commonly attributed to Mark Twain—"for fighting over," an unconventional method that uses water to extract oil and gas from Texas' underground fields is causing passionate debate.

This method—hydraulic fracturing—uses water and other fluids under pressure to fracture or crack shale rock, releasing oil and gas from the rock. Combined with the use of horizontal drilling, fracturing has unlocked large deposits of oil and gas and opened up new oil and gas fields in areas around the country. The majority of hydraulic fracturing in Texas occurs in the Barnett Shale near the Dallas–Fort Worth Metroplex, Eagle Ford Shale in South Texas and Wolfe Camp Shale in West Texas' oil-rich Permian Basin.

One slice of the debate centers on the amount of water fracturing uses and the impact on and value of the water used to nearby communities.

Although the current conversations about hydraulic fracturing can be intense, the method has been around for years.

"We've been doing hydraulic fracturing for 50 years, and we've been horizontal drilling for 20 or 30 years," said Dr. Stephen Holditch, professor in Texas A&M University's Harold Vance Department of Petroleum Engineering. Holditch is also director of Texas A&M Energy Institute for Petroleum Research, and the Global Petroleum Research Institute.

He said that in the 1990s and 2000s, hundreds of rigs were running in South and Central Texas, developing the Austin Chalk formation. These wells were drilled horizontally and were stimulated using hydraulic fracturing. "So the technology being used today in the shale reservoirs was actually developed over the last 20 years in the Austin Chalk and other areas," Holditch said.

"We can always improve some of our operating principles and practices, but it's not brand new technology that we're trying to understand."

The current attention, according to Texas A&M experts, is caused by the dramatic increase over the past few years in unconventional natural gas and oil production using hydraulic fracturing and horizontal drilling and the fact that this drilling is in areas unaccustomed to oil and gas activity.

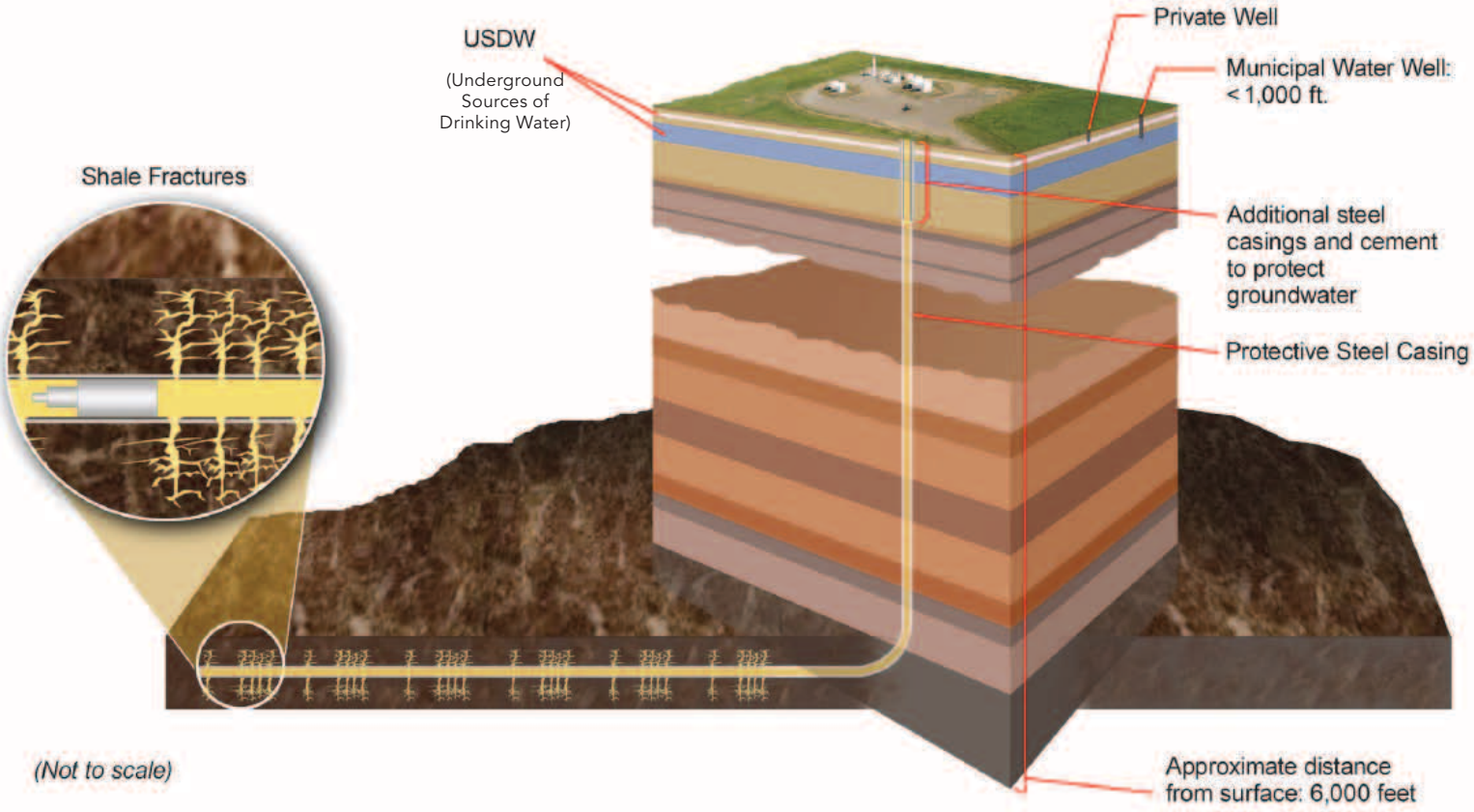
Holditch said the industry has been producing oil and gas from conventional reservoirs for a hundred years. "Now what we have found in the last five or 10 years is that source rocks are still loaded with oil and gas," he said. Source rocks are usually organic-rich shales in which petroleum forms.

"The energy industry has never had this much advancement in technology since the invention of the rotary drilling rig," said Dave Burnett, director of technology for the Global Petroleum Research Institute and research coordinator for Texas A&M's Harold Vance Department of Petroleum Engineering. "Hydraulic fracturing practices designed for shale plays are causing that growth. As we learn more, it becomes more economical and each well becomes more productive. Wells are two to three times more productive than they were 10 years ago."

Much of the increased activity is occurring near communities, such as west of Dallas–Fort Worth, that have had little oil and gas exploration activity until recently. These communities are witnessing a huge buildup of oil and gas wells as well as the associated effects on infrastructure and increase in traffic, experts said.

Extracting new sources of oil and gas

Hydraulic fracturing is not a drilling process but a method of extracting oil and gas after wells are drilled. Oil and gas companies use a fracturing liquid that is a mixture of approximately 90 percent water, 9 percent sand or other granular propping agents, and less than 1 percent chemicals used primarily to viscosify the fluid so it can transport the sand, Holditch said. The fracture fluid is then pumped into the drilled well with enough pressure to fracture the low-porosity shale rock, which is usually one to three miles below the surface.



These cracks or fractures increase the permeability of the reservoir allowing the natural gas or oil to more easily flow to the wellbore.

Holditch said hydraulic fracturing pushes the earth apart with hydraulic force. "After the fluid opens the cracks, the propping agent is pumped in to prop open the fracture," he said. "It creates pathways for the oil and gas to flow from the reservoir back to the surface."

Water use in hydraulic fracturing

The amount of water used in hydraulic fracturing is a major concern, especially in drought-prone Texas. Water-use volumes vary widely, from 1 million to 6 million gallons per well, depending, in part, on where the wells are drilled and what fracturing techniques are used.

Estimates of current and future water use in each basin also vary. Some of the variation is because of unknowns such as development of new fracturing technologies that consume less water and the discovery of new formations for drilling.

According to a study conducted by Drs. Jean-Philippe Nicot and Bridget Scanlon of The University of Texas at Austin's Bureau of Economic Geology and published in *Environmental Science & Technology*, the cumulative water use for shale gas production fracturing in the Barnett Shale totaled 117,000 acre-feet, or just over 38 billion gallons to stimulate about 15,000 wells from 2000 to June 2011.

A June 2011 Bureau of Economic Geology report, *Current and Projected Water Use in the Texas Mining and Oil and Gas Industry*, estimated that in 2008, the latest year with complete information, 35,800 acre-feet of water were used in Texas for fracturing wells, mostly in the Barnett Shale area. The report was funded by the Texas Water Development Board to help with its water planning.

The report authors also projected that the overall water use for fracturing will increase to a peak of approximately 120,000 acre-feet by 2020–2030.

Comparing water uses

The amount of water used in hydraulic fracturing may seem substantial, but is small when compared to water use by agriculture, manufacturing and municipalities, according to the Texas Water Development Board's 2012 state water plan. Mining, ⇨

Steel casing lines the well and is cemented in place to prevent any communication up the wellbore as the fracturing job is pumped or the well is produced. Shallow formations holding freshwater that may be useful for farming or public consumption are separated from the fracture shale by thousands of feet of rock. Image from Shale Gas: Applying Technology to Solve America's Energy Challenges, National Energy Technology Laboratory, 2011.

which includes oil and gas drilling, comprised an estimated 168,273 acre-feet out of a total of 16,321,364 acre-feet per year in 2009. By 2060, the demand for mining is projected to increase to 292,294 acre-feet per year or 1.3 percent of the total water demand.

Referring to 2010 data about the Barnett Shale's water use for fracturing, Holditch said: "By far, the amount of water being used for other sources has been more than what is used in drilling. That's not to say that it's not an issue, but the oil and gas industry is not using, in the grand scheme of things, a lot of water when compared to other uses."

Local impacts cause concern

Though water use for shale gas is only about 1 percent of statewide water withdrawals, local impacts of using the water vary, the experts said.

"It is a lot of water, and if it's in your backyard you're going to be concerned with it," Holditch said. "I don't downplay this as a non-issue; it is a real issue."

Dr. Susan Stuver, research scientist with the Texas Water Resources Institute and Texas A&M Institute of Renewable Natural Resources, said though a great deal of water is needed for hydraulic fracturing, it is not needed for a sustained amount of time.

"A lot of water is needed during the completion phase of energy production, which is when the fracturing occurs, but then not much is needed after that," she said. "Therefore, a problem may arise with timing. If the oil and gas industry needs water in a peak water-use season and during a drought, will we be prepared to balance the municipal, agricultural and other industrial demands to account for this?

"Just like there are institutions that manage electrical demand during peak months, we are going to need an institution that can properly predict and manage water needs and demands to ensure there is enough supply to meet everyone's needs."

According to the Nicot and Scanlon paper, at the county level, the projected net water use for fracturing is sometimes larger than projected pumping for all other uses. The authors gave the example of Karnes County in the Eagle Ford Shale, where most of the water used for fracturing is groundwater.

The authors wrote that in 2010-2060 Karnes County is projected to use a maximum of 2,000 acre-feet of water a year for fracturing and average 1,100 acre-feet per year. The projected average annual water use for all uses except fracturing for local water government entities is projected to be 1,900 acre-feet.

Citing Cotulla—a town in South Texas between San Antonio, Corpus Christi and Laredo with a population of 3,603—as an example, Burnett said: "Each one of the wells in South Texas uses more water in the 3 months that it is drilling than Cotulla uses in the same 3 months."

The difference, he said, is the use of water for fracturing is a temporary, one-time use.

"Once the well is drilled, it is not such an impact on the environment," Burnett said.

Competing interests

When comparing water use for fracturing to other uses, Dr. Darrell Brownlow, a cattle rancher and landowner in South Texas, who has a doctorate in geology and geochemistry, said a broad perspective needs to be taken, looking at not only the amount of water used but also the economic value for the communities where fracturing is taking place.

He said research suggests there is enough water to support agriculture and hydraulic fracturing in the Eagle Ford Shale and that the economic opportunities for local landowners defend the use of the area's groundwater for hydraulic fracturing.

Brownlow is a board member for the San Antonio River Authority and for more than a decade was a member of the South Central Texas Regional Planning Group (Region L). He said in Region L, where 80 percent of the Eagle Ford Shale activity occurs, the regional planning group predicts about 42 percent of available water will be used for municipal purposes in 2020, 30 percent for irrigation and 5 percent for mining, of which about 2.5 percent would be for fracturing.

"In South Central Texas, we use more water for washing clay out of rock (to make roads, bridges, concrete and cement) than we do for hydraulic fracture," he said.

Everything associated with oil activity is taxable, Brownlow said. Mineral taxes; severance taxes paid to the state; federal income taxes paid on royalties and profits; property taxes; school district taxes—everything in that economic arena is taxed. Those taxes, he said, bring money to the communities.

"Every acre-foot of water from the Carrizo (Aquifer) used in hydraulic fracturing has a gross revenue potential of about $2,080,000," he said.

Some interest groups have examined whether fracturing can negatively affect the value of homes near the oil and gas operations.

In the Barnett Shale area, some property values may be negatively affected, according to a study conducted by Integra Realty Resources–DFW for the city of Flower Mound. The study said residential property in the Flower Mound market valued at more than $250,000 and within 1,000 feet of a well site can experience a 3 to 14 percent decrease in value.

However, the report also stated that "data from most well sites studied in this report outside Flower Mound suggests that there is little or no impact on residential property from proximity to well sites. Sales comparison research indicated that a diminution in value due to proximity to natural gas sites occurs only for properties immediately adjacent to the site."

The report pointed out that several sales where view of the well site was obstructed by buffers such as trees indicated value is not measurably impacted, even when the property is in close proximity.

Ways to save water

Almost everyone involved agrees that the amount of water used in hydraulic fracturing needs to be reduced. The answer is better technology—both in the fracturing process and in recycling more of the flowback, or water left over from the fracturing process—and identifying other substances besides freshwater that could be used for fracturing, the experts said.

According to Holditch, in most cases, the well will return between 10 and 30 percent of the water injected over the first few days and weeks back to the surface. The rest of the water stays in the formation and cannot be reused.

"The water that flows back will have minerals, oil, salt and other impurities that must be filtered or removed before the flowback water can be reused," he said.

Burnett and his partners from the Houston Advanced Research Center, Matagorda Redfish Society and CMGC Foundation are focusing on research and demonstrations to remove contaminants in flowback water through advanced water treatment technologies.

Burnett said they are beginning a three-year project in South Texas to bring new membrane filtration technologies to the field and demonstrate to the industry, the public and regulators the technologies that work.

By using different filtration processes and reverse osmosis, the group is able to remove the different contaminants such as bacteria, corrosion products, suspended solids, heavy metals, hydrocarbons and other chemicals from the flowback water, making it more suitable for reuse.

With these advanced treatments removing contaminants from the flowback and with fracturing technology becoming more efficient, Burnett believes the percent of flowback water will increase and the amount of that water that can then be recycled will increase. ⇨

DOES HYDRAULIC FRACTURING CAUSE CONTAMINATION?

Another, more contentious, issue for hydraulic fracturing than the amount of water used is the possible contamination of groundwater and surface water with byproducts of the fracturing process or the other activities associated with unconventional oil and gas exploration.

Reports exist supporting the fact that hydraulic fracturing does not cause contamination; others conclude it does.

Dr. Stephen Holditch, professor in Texas A&M's Harold Vance Department of Petroleum Engineering, said he does not believe water contamination specifically from the fracturing process is occurring. What may happen, he said at the Growing Texas conference in October 2012, is that shallow wells are not plugged properly or are cracked, causing the fracturing water to seep into the water supply.

Because of all the controversy, at the request of Congress, the U.S. Environmental Protection Agency is conducting a study to better understand any potential impacts of hydraulic fracturing on drinking water resources: *epa.gov/hfstudy/index.html*.

To address the concerns about hydraulic fracturing, the Texas Senate passed a bill in May 2011 requiring oil and gas operators to disclose the chemicals they use in fracturing on the website FracFocus (*fracfocus.org*) as well as with the Railroad Commission of Texas. FracFocus is maintained by the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission.

Burnett also believes that the industry will turn from using fresh groundwater sources to make up the fluid and begin tapping brackish groundwater resources not used for either agriculture or public consumption.

"By the end of four years we should be able to see brackish water being used; we should see freshwater use by oil and gas drop by 90 percent," he said.

Holditch said the key to saving water with hydraulic fracturing is not using freshwater at the start, noting that the oil and gas industry does not pump freshwater during hydraulic fracturing operations.

"They start with freshwater, but then add 2 percent to 6 percent potassium chloride solution to the fluid to minimize clay swelling in the formation," he said. "As such, the industry could easily convert to using low salinity brine for mixing fracturing fluids, thus eliminating the need to use any freshwater. Some companies are already using low salinity brines.

"There is no reason that we couldn't start with saltwater," he said. "There's no reason we can't drill down into some brackish aquifers and produce water … and use that for fracturing. That's what I predict is going to be the future."

According to Stuver, the main reason why the industry doesn't currently start with brackish water is that the amount of salt in brackish water varies depending on water well location. "The industry would need to either desalinate down to proper salt levels or measure and add more to get the proper saline concentration," she said.

Holditch said research is ongoing to develop the "recipe" for using saltwater as fracture fluid, a recipe that will vary with each well site. Petroleum engineering researchers at Texas A&M, as well as oil and gas service companies, are investigating using saltwater for fracturing, he said. (See sidebar on Texas A&M research projects.)

"Since the source of the saltwater will be totally different depending on where the water comes from, then the recipes will be site-specific," he said. "As such, you will need a chemist in the field to make sure the recipe is tweaked for each well because the base fluid will be different."

According to the Railroad Commission of Texas, the state agency that oversees the oil and

TEXAS A&M RESEARCH ONGOING IN HYDRAULIC FRACTURING

Texas A&M University Harold Vance Department of Petroleum Engineering and its partners have numerous projects dealing with hydraulic fracturing. A few include:

Reducing the Environmental Impact of Gas Shale Development: Advanced Analytical Methods for Air and Stray Gas Emissions and Produced Brine Characterization (GSI Environmental, Texas A&M Global Petroleum Research Institute [GPRI] and Research Partnership to Secure Energy for America [RPSEA])

Laboratory Measurement of Propped Fracture Conductivity in the Barnett Shale (Crisman Institute: Hill)

Field Testing of Environmentally Friendly Drilling Systems (GPRI, U.S. Department of Energy National Energy Technology Laboratory, and M-I SWACO)

Environmentally Friendly Drilling: Technology Integration Program (Houston Advanced Research Center, GPRI)

Diagnosis of Multiple Fracture Stimulation in Horizontal Wells by Downhole Temperature Measurement for Unconventional Oil and Gas Wells (Crisman Institute: Zhul)

gas industry, it has approved several companies' requests for recycling projects in the Barnett Shale that will reduce the amount of freshwater used.

Other possible sources of water for fracturing include reuse of municipal wastewater.

"What we need to do is to get away from using freshwater … and that'll solve a lot of problems," Holditch said.

Waterless fracturing?

According to David Blackmon, managing director for public policy and strategic communications for FTI Consulting, oil and gas companies are working to develop technologies to reduce the amount of water used in fracturing jobs. Blackmon spoke in October 2012 at the Growing Texas conference, organized by the Texas A&M Energy Institute.

One new development, Blackmon said, is a gel that keeps brine water from contacting the drill pipe, preventing corrosion of the pipe. "We have been able to use 33 percent brine content rather than freshwater in frac jobs using this gelling agent," he said, adding that it has helped reduce the overall volume of water used.

In a joint House Committee on Natural Resources and House Committee on Energy Resources meeting in June 2012, Lance Robertson, vice president for Marathon Oil Company, testified that the company is trying waterless fracturing by using a gel.

Robertson said Marathon's move to waterless fracturing has reduced water consumption by 40 percent in the first 90 days of operations. In the company's Eagle Ford fracturing operations, 97 percent of the water is nonpotable brine.

Some companies are using propane as the fracturing fluid instead of water, Blackmon said. "The great thing about that is it doesn't use any water," he said, "and the companies are able to resell the propane when it comes up back from the hole."

Blackmon said one company executive has told him that in two to three years, the industry won't have to use any freshwater in hydraulic fracturing.

"That is a huge game changer."

For more information, visit *txH2O* online at *twri.tamu.edu/publications/txH2O*.

Image from *CGTextures.com*

Integrated Fracture Placement and Design Optimization in Unconventional Gas Reservoirs (Crisman Institute: Gildin and Jafarpour)

Modeling Hydraulic Fracturing of Shales (Crisman Institute: Ghassemi)

Shale Permeability Estimation from Fracture Calibration Test (Crisman Institute: Economides)

Extent of Propped Fractures in the Stimulated Reservoir Volume (Crisman Institute: Economides)

Evidence of Stress Dependent Permeability in Long Term Production Data (Crisman Institute: Economides)

Simulation of Multistage Fracturing of Horizontal Wells for Shale Oil Production (Crisman Institute: Economides and Moridis)

Investigation of Fracture Fluid Performance in Oil Shale with Surfactant Additives by X-Ray Tomography Methods (Crisman Institute: Schechter)

Re-Use of Produced Waters as Hydraulic Fracturing Fluids (Crisman Institute: Nasr-El-Din)

Story by Kathryn Boutwell

A TALE OF TWO LAKES

Texas tourism industry continues to deal with drought impacts

Travis County and Montgomery County are separated by more than 150 miles, and yet they both share one all-too-familiar issue—lakes hit hard by drought.

Lake Travis is considered full at 681 feet mean sea level, while Lake Conroe, in Montgomery County, is full at 201 feet. In 2011, Lake Travis dropped to 626 feet; a much smaller water body, Lake Conroe dropped to 192 feet.

Although their communities are geographically separate, two groups of residents championing the lakes set out to do quite similar things. Noticing the possible effects of drought and falling lake levels on lake-related businesses and real estate values, concerned citizens sought to evaluate the precise economic impact, if any, that drought had on their communities.

Lake Travis Community Coalition

Beginning in 2009, the Lake Travis Community Coalition raised funds for a study investigating the economic value of Lake Travis. The coalition, made up of local governments, utility districts, chambers of commerce and companies from around the lake, called upon real estate research firm Robert Charles Lesser & Co. (RCLCO) to evaluate two things.

"We were first tasked with determining the significance of the economic and fiscal impact of Lake Travis on Travis County and surrounding communities in normal lake level years," said Todd LaRue, of the Austin RCLCO office. "We were then tasked with quantifying the impacts that low water levels have on the economic and fiscal impact."

On Sept. 29, 2011, the Lake Travis Coalition received the completed Lake Travis Economic Impact Report.

To reach its conclusions, the report found a baseline for the economic impacts associated with Lake Travis during nondrought times in 2010. Then, the same factors were measured during drought, and drought-related impacts were assessed.

The report concluded that the total assessed value of all land surrounding Lake Travis was $8.4 billion. According to the Lake Travis report, "lake-front and lake-cove parcels are assessed at a premium to other residential parcels." These lakefront homes have higher assessed property taxes than their nonlake-front counterparts.

"Long-term low water levels could have a substantial impact on the value of over $8 billion in property on and around the lake," LaRue said.

The report concluded that as a result of various taxes—including sales taxes from businesses surrounding Lake Travis, hotel occupancy taxes and mixed beverage taxes—the fiscal impact of land and businesses around Lake Travis was $207.2 million in 2010, the baseline, nondrought year. The tax revenues went, primarily, to local economies.

The economic impact of spending that would not occur without the lake can be thought of as tourism-based impact, according to the report. Tourists spend money on transportation, food, lodging, shopping and entertainment. This amounts to about $115 per visitor per day, the report stated. For the baseline, nondrought year of 2010, it was estimated that total visitor spending was about $168.8 million as a result of park visits, vacation rentals and boating.

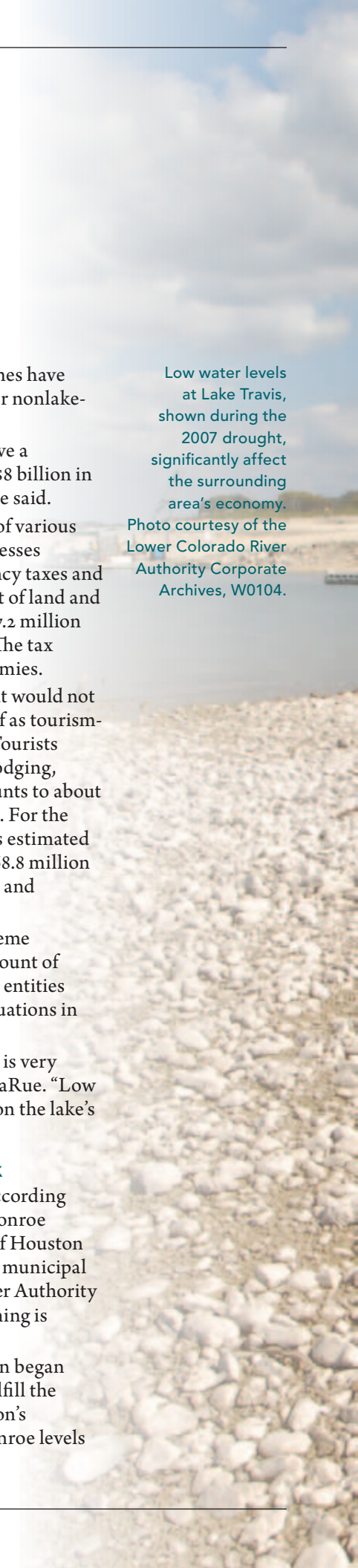
"When Lake Travis experiences extreme fluctuations in water levels, the total amount of tax revenues collected by state and local entities declines," the report reads. "Major fluctuations in lake levels decrease visitor spending."

"The economic impact of Lake Travis is very significant to the local economy," said LaRue. "Low water levels have a severe consequence on the lake's economic impact."

Lake Conroe Communities Network

Lake Conroe is an interesting case, according to Terry Bowie, president of the Lake Conroe Communities Network. Since the city of Houston owns rights to two-thirds of the lake for municipal water purposes and the San Jacinto River Authority owns the other third, future water planning is complicated.

As drought took hold in 2010, Houston began pumping water from Lake Conroe to fulfill the city's water needs. Coupled with Houston's withdrawal, the drought led to Lake Conroe levels falling dramatically. ⇨



Low water levels at Lake Travis, shown during the 2007 drought, significantly affect the surrounding area's economy. Photo courtesy of the Lower Colorado River Authority Corporate Archives, W0104.

"Few industries are more vulnerable to the ravages of severe drought and water shortages than the travel industry."

Texas Travel Industry Association, 2012 public forum

To assess the impact of low lake levels on the economy of the Lake Conroe area, in 2010 the Lake Conroe Communities Network, led by Bowie, carried out a research plan.

"The study was commissioned for lake level effect regardless of the cause," Bowie said. "Due to the fact that while all involved had an intuitive feeling that low lake level has an adverse effect on the economy, there was no hard data substantiating that feeling. The Lake Travis study was a consideration, but not the sole basis" for the network study.

According to the report, researchers at Texas A&M University reviewed and evaluated existing lake-level studies, one of which was by the engineering firm Freese and Nichols, and examined how fluctuating lake water levels affect the surrounding property values and sales tax revenues.

Texas A&M researchers included Drs. George Rogers, Jesse Saginor and Samuel Brody from the Department of Landscape Architecture and Urban Planning and Dr. Georgianne Moore from the Department of Ecosystem Science and Management.

After their initial evaluation, the researchers analyzed sales taxes and surveyed businesses to estimate the impact of lake levels on sales tax revenues. Next, they surveyed residents and assessed property values to estimate the impacts on property values. This information was compiled into the Lake Conroe Report and was submitted to the network in Montgomery County in July 2012.

What was found at Lake Conroe was not dramatically different than what was found at Lake Travis. As lake levels decline, the potential for significant economic impact to the lake community increases.

Along the south end of the lake, through the city of Montgomery, State Highway 105 provides increased tourism traffic independent of lake-related activities, the report found. Therefore, the impact to lakeside businesses not along the 105 corridor is greater than those in the corridor.

Still, recreational business owners report being "greatly hampered" during periods of drought, said the report.

"As a marina owner, along with owning a house on the lake, the continual loss of water is extremely disconcerting," said one local business owner during the survey portion of the study. "Our marina business is down two-thirds compared to previous years."

"If the lake level is reduced below normal for extended periods of time, it will adversely affect the Montgomery County economy—period," Bowie said.

The report showed that there is "more than $1.6 million per year in lost sales tax revenue in the city of Montgomery for each foot of water lost in the lake beyond 2 feet." That is, for each foot the lake falls, sales tax revenues drop by over 10 percent.

As distance from the lake increases, the effect of low lake levels decreases. Unlike with Lake Travis, on Lake Conroe there are many diverse, independent economies that are not lake-based. Cities such as Conroe and Willis are not directly affected by changes in tourism based on lake levels, the report stated, noting that proximity to Interstate 45 was a possible cause for this economic insulation.

"Residential properties located in lake subdivisions are valued … around 15 percent higher than similar properties … elsewhere in the county," the report stated.

According to the report, lakefront homes sell for a premium on Lake Conroe, and "residents expect the impact of lake-level changes … in lake communities to be 28 percent (reduction of the selling price)." However, just 5 miles from the lake, property values are not affected by the lake level at all.

One positive effect of low lake levels was reported by the Lake Conroe Fire Department: "low lake-levels have resulted in fewer drunken, impaired boating citations." Also, the department reports an "improved bottom line for boat towing companies," as more boats run aground due to low lake levels.

However, community members said the negative impacts of lakes dropping still far outweigh any positive effects.

"Water is critical to the county's present and future well-being," Bowie said. "Important decisions regarding its prudent use are now being made almost on a daily basis.

"The network would like for the various government agencies as well as our legislative representatives to have sufficient data to make good decisions," Bowie said. "It is hoped the (report) information will assist in this decision-making process."

For more information, visit *txH2O* online at *twri.tamu.edu/publications/txH2O*.

Story by Danielle Kalisek

WATER USE, ECONOMIC VALUE OF IRRIGATED AGRICULTURE EXAMINED IN NEW REPORT

In 2007, statewide irrigated agriculture had a $4.7 billion economic value, according to the Texas Water Development Board and Texas State Soil and Water Conservation Board.

Texas A&M AgriLife Research and Texas A&M AgriLife Extension Service experts recently released a report, *Status and Trends of Irrigated Agriculture in Texas*, highlighting the current status of irrigation impacts in Texas.

"Irrigation is very important to agriculture in Texas," said Dr. Kevin Wagner, associate director of the Texas Water Resources Institute and lead author of the special report, published by the institute. "Not only does it contribute billions to our economy, it helps farmers mitigate production risk in the state's semi-arid climate while also improving crop quality and value."

According to the report, regional impacts of irrigated agriculture vary greatly, and in regions such as the High Plains, the economic impact is significant. In that region alone, the total economic impact of converting all irrigated acres to non-irrigated dryland farming would be an annual net loss of more than $1.6 billion of gross output, more than $616 million of value added and nearly 7,300 jobs. In addition, loss of irrigation in the Winter Garden (Frio, Medina, Uvalde and Zavala counties) would result in a loss of $55 million in vegetable and melon production, $22 million in additional economic activity and 872 jobs. Finally,

Agricultural irrigation systems continue to gain efficiency, experts say. Photo by Kay Ledbetter, Texas A&M AgriLife Communications.

in the rice-producing middle Gulf Coast region (Colorado, Matagorda and Wharton counties), the irrigation-dependent rice industry contributed $441 million in annual output to the region and supported 3,900 jobs across all sectors based on 2008–2010 data.

Projected economic impacts from lost irrigation are due not only to reduced production and associated processing, but also to reduced demand for inputs such as fertilizer, chemicals, energy and machinery. All of these factors are linked throughout the state's economy, according to experts.

"Irrigation is critical to our food production and food security and is a vital component of Texas' productive agricultural economy," Wagner said.

Because of drought conditions and water supply concerns, he said Texans are looking to improve water conservation and management strategies across the board.

"Decision makers need the facts on just how much water agriculture is using as well as how much food and fiber it's producing with that water."

The content in the report was drawn primarily from data published by Texas A&M University, AgriLife Research, AgriLife Extension, Texas Water Development Board and U.S. Department of Agriculture's National Agricultural Statistics Service.

"The report aims to be a concise survey of the most current body of knowledge on irrigated agriculture in Texas," Wagner said.

"Over the past several decades, significant advances have been made in irrigation efficiency, as many irrigators now use high-efficiency advanced irrigation technologies, such as low-pressure center pivot sprinkler systems or subsurface drip irrigation," said Dr. Dana Porter, associate professor and Extension agricultural engineering specialist, who also contributed to the report.

"However, challenges remain and there are opportunities for continued improvements in water-use efficiency through application of situation-appropriate efficient irrigation technologies and best management practices, including irrigation scheduling, and through use of drought-tolerant crop varieties and integrated crop and pest management practices," she said.

Highlights from the report include:

- While statewide agricultural irrigation application rates have stayed relatively constant since the mid-1970s, agricultural yields have increased significantly as improvements in irrigation technology and management, crop management and crop genetics have been developed and implemented.
- Texas agricultural irrigation averages less than 18 inches per acre annually. In comparison, a College Station study found that average households supplemented rainfall by applying 22 inches of water annually to lawns.
- The statewide economic value directly derived from irrigated agriculture was $4.7 billion in 2007.
- Agriculture is a part of the broader food and fiber sector—which accounts for 9 percent of the state's economy.
- Although both surface water and groundwater are used for agricultural irrigation, the source of most agricultural irrigation water is groundwater. In 2000, 86 percent of the irrigated acres in the state used groundwater.
- Irrigation efficiency has gone from 60 percent to 88–95 percent in much of the state today, allowing Texas to get much more value and agricultural output from its water.

The report can be viewed online at *twri.tamu.edu/publications/educational-materials/2012/em-115/*.

As of 2008, center pivot sprinklers are used on nearly 80 percent of Texas' irrigated acres.

Story by Kathryn S. Boutwell

LONE STAR HEALTHY STREAMS

Keeping Texas streams clean

The Lone Star Healthy Streams program recommends moving livestock from one area to another over time to prevent fecal material from accumulating in creek pastures. Photo from Crestock Corporation.

Think contaminated water only occurs in developing countries? Even in the United States, high levels of bacteria in some water bodies make them potentially unsuitable for recreation.

About 300 water bodies in Texas contain excess bacteria. These bacteria come from many sources such as wastewater plants, septic systems, livestock operations and wildlife.

To combat excess bacterial levels in recreational water sources in Texas, the Texas Water Resources Institute (TWRI), Texas A&M AgriLife Research and the Texas A&M AgriLife Extension Service combined forces in creating the Lone Star Healthy Streams (LSHS) program.

"I believe the LSHS project produced some very good information to help stakeholders protect their water resources," said Curtis Scrivner, a landowner involved in preliminary LSHS activities.

According to Larry Redmon, leader of the LSHS program, livestock producers can more easily make wise choices for reducing pollution originating on their operations if they know the benefits of clean water to agricultural operations, the current laws and policies on water quality, the ways that bacteria can enter water, and the range of solutions that are available for them to reduce water quality problems. The LSHS program is designed to educate landowners on these topics. ⇨

Through their partnership, TWRI, AgriLife Research and AgriLife Extension have successfully completed the first stage of the LSHS program and have begun the second.

Stage I

Stage I focused on evaluating best management practices (BMPs) designed to reduce bacterial contamination of water bodies, said Kevin Wagner, TWRI's associate director. This research, led by Wagner, was carried out at both private ranches and established research centers such as the U.S. Department of Agriculture's field site in Riesel, the Texas A&M University Department of Animal Science's Beef Cattle Systems Center near College Station, and the Welder Wildlife Refuge in Sinton.

"At these ranches and research centers, both traditional and novel, or innovative, BMPs were implemented and their effectiveness evaluated so that the most successful techniques could be identified," Wagner said. "This study provided us with a good idea of which management techniques worked to reduce bacteria levels and which didn't.

"We highly recommend rotational grazing," Wagner said. The method requires moving livestock from one area to another over time. This prevents fecal material from accumulating in creek pastures during rainy seasons and ending up in streams.

"Results showed that when alternative off-stream water was provided, the amount of time cattle spent in the creek was reduced 43 percent," Wagner said.

Alternate water sources allow animals to drink at facilities away from a stream, reducing the amount of feces that enter the stream.

He said that while Stage I is technically over, research will continue to explore new BMP techniques that will benefit both streams and landowners.

Stage II

Based on information gathered in Stage I, groups of research scientists, resource conservation agencies and producers collaborated to compile the LSHS manuals, which include BMPs identified in Stage I.

"Stage II focuses on education," said Jennifer Peterson, LSHS statewide coordinator. "For each bacterial contributor, we created a manual and a presentation outlining BMPs that are operation-specific."

The program published manuals for poultry, beef cattle, feral hogs, horses and dairy cattle. Each manual has been endorsed by natural resource agencies and industry associations. For example, the dairy cattle program has been endorsed by the Natural Resource Conservation Service (NRCS) and the Texas Association of Dairymen. The manuals are available both online and in hard copy.

"The management practices identified in the Lone Star Healthy Streams manuals are generally practices that can both reduce nonpoint source contributions to lakes and streams and improve an operation's bottom line," said Jay Bragg, associate director of commodity and regulatory activities at the Texas Farm Bureau.

The manuals include information about Texas water quality and sources of financial assistance for BMP implementation. Although not the focus of the

The practices listed in the Lone Star Health Streams manuals will allow livestock owners and landowners to further protect Texas waterways. Photo from Crestock Corporation.

There are many BMPs that can help keep Texas waters safe and clean!

Beef Cattle: Rotate cattle to upland pastures during wet periods; graze creek pastures during dry periods. Promote loafing, drinking and grazing away from creeks using additional shade, alternative water supplies and proper grazing management.

Dairy Cattle: Construct a waste treatment lagoon by building an embankment and/or excavating a pit or dugout to biologically treat waste.

Feral Hogs: Although they require more effort to install and maintain, using corral traps is extremely effective in reducing feral hog numbers, especially in conjunction with other control methods.

Horses: Maintain filter strips—areas of herbaceous vegetation established between a water body and cropland, grazing land or disturbed land—to remove sediment, bacteria, organic material, nutrients and chemicals resulting from overland flow.

Poultry: An on-farm composting system using windrows, static piles and in-vessel composting can effectively reduce pathogens to levels that are acceptable in organic soil amendments.

LSHS program, the BMPs listed in the manuals will allow livestock owners and landowners to further protect Texas waterways from runoff that contains sediments, nutrients and pesticides. Examples of BMPs found in the manuals include rotational grazing and provisions for alternate water supplies for livestock.

"Our next step is a statewide educational program that educates livestock producers and landowners about these best management practices," Peterson said.

"We recently finished writing and publishing our curriculum and have also developed an online course for the program," she said. "We are in the process of scheduling programs around the state."

In the coming months, programs will be made available to landowners in areas that have identified the source of bacterial impairment in their watershed. AgriLife Extension will conduct programs for landowners on BMP implementation.

"The agricultural community can choose to regulate itself through stewardship and conservation practices rather than have the solutions determined by those who may not understand the industry," Redmon said. "It is important for landowners to become involved and make a difference in protecting our state's most vital resource."

The LSHS program has received support on the importance of education and BMP implementation not only from scientists, but also from farmers and landowners.

"Local demonstration projects may be the most effective way to demonstrate the benefits of these management practices," Bragg said.

"I think some good information came from the Lone Star Healthy Streams project—given they wrote a prescription for the entire state and the state is so diverse," Scrivner said.

Additional program partners include the Independent Cattleman's Association of Texas, Texas and Southwest Cattle Raisers Association, Texas Wildlife Association, Texas Association of Dairymen, Texas Horse, Texas Poultry Federation, Texas Pork Producers Association and Texas Parks and Wildlife Department.

Funding for the LSHS program was provided by NRCS, the State of Texas and the Texas State Soil and Water Conservation Board through the U.S. Environmental Protection Agency.

Texas A&M AgriLife programs receive water conservation awards

Two groups involving Texas A&M AgriLife Research and Texas A&M AgriLife Extension Service personnel were recognized in fall 2012 with Save Texas Water Blue Legacy Awards in Agriculture from the Water Conservation Advisory Council.

The Blue Legacy Awards, which annually recognize outstanding water conservation efforts and successes of the agriculture community, were given to the Ogallala Aquifer Program, a university and federal agency research-education consortium, and the AgriLife Extension–Panhandle District 1 2011 North Plains Corn Irrigation Demonstration Project: Efficient Profitable Irrigation in Corn, or EPIC.

The Ogallala Aquifer Program was created by Congress in 2003 to find solutions to problems arising from declining water levels in the High Plains aquifer, according to Dr. David Brauer, research agronomist with the U.S. Department of Agriculture's Agricultural Research Service and manager of the program.

Brauer said the program includes approximately 80 state and federal scientists from the Agricultural Research Service, Kansas State University, Texas A&M University through AgriLife Research and AgriLife Extension, Texas Tech University and West Texas A&M University.

Dr. Kevin Wagner, Texas Water Resources Institute's associate director and Texas A&M's representative on the program's leadership team, said: "For the Ogallala Aquifer Program to win this award illustrates the progress and achievements that have been made in promoting water conservation while helping to maintain or improve the profitability of farming and the prosperity of farming communities in the Texas High Plains," Wagner said. "The institute is proud to support the Texas A&M AgriLife researchers and Extension specialists involved in this important program."

Dr. John Sweeten, resident director of the Texas A&M AgriLife Research and Extension Center at Amarillo, said that in addition to developing water conservation technologies for agricultural producers, the program provides scientifically based data and knowledge.

"Using this information, both farmers and policymakers can make effective decisions regarding water use and conservation," Sweeten said.

AgriLife Research and Extension personnel at Amarillo and Lubbock extensively involved in the Ogallala Aquifer Program include Steve Amosson, Jim Bordovsky, Ken Casey, Paul DeLaune, Nich Kenny, Shuyu Liu, Thomas Marek, Jaroy Moore, Seong Park, David Pointer, Dana Porter, Pat Porter, Nithya Rajan, Charlie Rush and Qingwu Xue.

EPIC is a demonstration effort conducted by AgriLife Extension and funded primarily by the North Plains Groundwater Conservation District, said Kenny, AgriLife Extension irrigation specialist in Amarillo. It is designed to address the adoption of improved irrigation management strategies to increase water-use efficiency, crop productivity and production profitability.

EPIC includes project members Kenny and AgriLife Extension county agents Scott Strawn, J.R. Sprague, Marcel Fischbacher, Michael Bragg, Kristy Synatschk and Brad Easterling.

Includes information from a Texas A&M AgriLife Today news release.

The Ogallala Aquifer Program was created to find solutions to problems arising from declining water levels in the major aquifer. Texas A&M AgriLife Extension Service photo.

Experts investigating graywater for landscapes

A Texas A&M AgriLife Research ornamental horticulturist is working with others in The Texas A&M University System to determine the feasibility of using graywater to irrigate home landscapes.

"There has been interest in and discussion about the possible use of graywater for irrigating home landscapes, but so far little formal research has been done to validate its practicality," said Dr. Raul Cabrera, associate professor of ornamental horticulture at the Texas A&M AgriLife Research and Extension Center at Uvalde.

Cabrera said graywater is essentially "soapy" water left after tap water has been run through a washing machine or used in a bathtub, bathroom sink or shower and does not contain serious contaminants.

He said while it is difficult to precisely estimate the statewide potential for water savings by using graywater, it may reduce household landscape water use by up to 50 percent, depending on the size and type of landscape plants used and the household's geographical location.

"The average household uses as much as 50-60 percent of its water consumption for the landscape—grass, ornamental plants, trees, etc.," he said. "Considering that the average family of four produces about 90 gallons of graywater per day, if this was used to irrigate a landscape, it could represent a significant water savings."

Using graywater is one of the easiest ways to reduce the need for potable water typically used in a home landscape, said Dr. Calvin Finch, director of the Water Conservation and Technology Center (WCTC) in San Antonio, which is administered by the Texas Water Resources Institute (TWRI) and Texas Center for Applied Technology (TCAT), both part of the Texas A&M University System. TWRI is participating in the graywater research by providing funding through its Rio Grande Basin Initiative. The initiative is administered through the U.S. Department of Agriculture's National Institute of Food and Agriculture.

Finch said the 2012 state water plan identifies more than 500 specific activities that, if implemented, would help meet the state's future water needs.

"One of the low-hanging-fruit projects that is often overlooked is use of graywater from households," he said. "Research results indicate that with minimum precautions water from our showers, bathroom sinks and clothes washers could be used to meet up to 10-15 percent of our overall landscape water needs."

Graywater differs from reclaimed water in that it is not water captured from sewer drainage or stormwater systems and then run through a wastewater treatment facility, Cabrera said.

"Reclaimed or 'purple-line' water is used for irrigation by some large-acreage operations such as golf courses, sports fields and large businesses," Cabrera said. "But graywater is just potable water that has been used for fairly benign household activities and could be reused immediately or stored and used soon after its initial use.

"It is also not what is referred to as 'black' water, which is used water from a toilet or the kitchen sink, both of which have a higher potential for containing bacteria and other organisms considered hazardous for human health. In this regard, graywater poses a minimal risk, particularly if we look primarily at water generated from clothes-washing machines."

Cabrera said one concern about using graywater on home landscapes is possible salt content.

"Some detergents may have a high salt content in the form of sodium, chloride or boron, which could potentially 'burn' a plant," he said. "Part of our research here will involve determining the salinity and specific constituents found in graywater and their effect on plants, plus determining the efficacy and function of irrigation systems."

He said there is also the concern that some of the constituents in soapy water might plug drip irrigation systems, thus requiring additional and periodic care and maintenance.

"Additional research will address how variations in water quality, such as soft versus hard water, may affect the salt content and chemical constitution of the produced graywater and how it affects plant growth and quality," Cabrera said.

He said TCAT will "evaluate the plumbing and delivery technology needed to retrofit a household" so graywater could be used to irrigate a home landscape.

The original Texas A&M AgriLife Today story can be found at today.agrilife.org.

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