tx H₂O

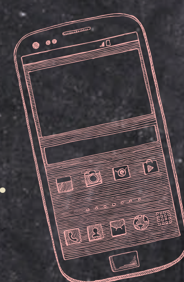
A Publication of the Texas Water Resources Institute

Spring 2016

TURNING RESEARCH INTO REALITY

TAMUS scientists use inaugural Water Seed Grants to develop resource-saving inventions, technologies

eBeam technology



water reuse

Runoff water reduced by 40%

WATER MANAGEMENT APPS AND SENSORS

Savings of more than $70,000 on water bills

GETTING WATER-SAVING TECHNOLOGIES FROM RESEARCH TO CONSUMERS IN 4 YEARS FLAT

Hydraulic fracturing

WaterMyYard + 61 Texas cities = 160 million gallons of H_2O

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

Developing sustainable water management policies and practices to support Texas' municipalities, agriculture and industries is one of the state's biggest challenges. In 2013 the Texas Legislature charged three agencies of The Texas A&M University System with developing new technologies and tools to improve the efficiency of agricultural and municipal water use.

In response, Texas A&M initiated a competitive water research seed grant program. This program provides funding for Texas A&M AgriLife Research, Texas A&M AgriLife Extension Service and Texas A&M Engineering Experiment Station personnel to work in interdisciplinary teams to develop new technologies and approaches in water-use efficiency. The first round of this seed grant program resulted in more than 150 faculty working to bring forward 64 research ideas. Of those, seven proposals were funded and completed during fiscal years 2014 and 2015.

The program's second round has just begun with more than 50 research ideas considered and seven selected for funding over fiscal years 2016 and 2017. These projects seek to understand water-use efficiency and conservation from a wide range of disciplinary perspectives, addressing issues such as creating decision-support tools to aid water management during droughts; potential uses of poor quality and unconventional water as nonpotable water supplies; deployment of innovative monitoring systems to improve water management; and development of advanced technologies for water treatment and reuse.

This issue of *txH2O* provides an overview of the first round of projects, highlighting their impacts on helping Texas manage its water resources. The project's final reports are available on our online version of *txH2O* at *twri.tamu.edu/txh2o*.

I believe this water seed grant program has the potential to bring about significant and impactful changes to Texas' water management, and I look forward to seeing it evolve even further to better help meet our state's water needs. And, I applaud the Texas Legislature in being forward-thinking and committed to addressing this issue.

Please join us as we continue to make every drop count.

John C. Tracy
Director

tx H_2O

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Texas Water Resources Institute
make every drop count

Volume 11, number 1, Spring 2016

Inside

Water graphic by Freepik.com

txH2O *is published two times a year by the Texas Water Resources Institute (TWRI), which is part of Texas A&M AgriLife Research, the Texas A&M AgriLife Extension Service and the Texas A&M University College of Agriculture and Life Sciences. TWRI is funded in part by the U.S. Geological Survey and authorized by the Water Resources Research Act. To subscribe to txH2O or Conservation Matters, TWRI's monthly e-mail newsletter, visit twri.tamu.edu.*

Q & A

with Dr. John C. Tracy

In December 2015, Dr. John C. Tracy was officially named director of the Texas Water Resources Institute (TWRI). Tracy had served as director of the Idaho Water Resources Research Institute at the University of Idaho for the last 11 years, also serving as the associate vice president for research and previously as interim vice president for research at the university.

With an extensive background in civil engineering — a doctorate and master's from the University of California-Davis and his bachelor's from Colorado State University, all in civil engineering — and an impressive research record in agriculture and water resources, Tracy is helping bring interdisciplinary research to the forefront of TWRI's efforts.

txH2O sat down with Tracy to discuss his transition to the institute and get his take on everything from groundwater management to Texas barbecue.

How has your background prepared you to be TWRI's director at this particular time in Texas water?

I've been in research administration, in particular environmental water resources administration, for more than 15 years, and that has taught me about the business of research and the business of outreach and engagement. That preparation was invaluable and enables me to work in a leadership capacity.

In regards to the specific issues here in Texas, I've worked in a variety of climatological zones — everywhere from Kansas and South Dakota to Nevada, California and Idaho. That doesn't cover all of the climatological zones found in Texas, but it has allowed me to see many different perspectives on water management and the different approaches for moving research forward. I've seen approaches on how to get information to urban settings versus rural settings, the different perspectives that come with areas relying on dryland agriculture versus those on irrigated agriculture, communities living on groundwater versus surface water. And I think that breadth of experience has given me a good foundation to take on this position.

But, I also completely understand that the range of water issues in Texas is about as broad as you can get. And they are very representative of the range of water issues you see across the United States and the world. So, even with the good foundation that I have, it is still a learning process.

This particular time in Texas water is very interesting because Texas has gone through a series of droughts, intermixed with some flooding, and a large expansion of the urban population. Texas is very cognizant of the need to adequately manage its water resources to continue the population and economic activity and not face situations like what California has faced, where you see significant parts of the economy slow down because of a lack of water. The level of awareness in Texas that water is an important issue that needs to be addressed, and how The Texas A&M University System can use its research, extension and education activities to help, makes it a really opportune time to be here.

What is your vision for the institute over the next five years?

My vision for the institute is several-fold. First, continue its core activities that have been well-recognized and well-respected across much of the water resources community in the state. What I would like to do is build on that and have the institute present more of a face of water resources for the Texas A&M System. We want TWRI to be a focal point that communicates all of the faculty's and researchers' water capabilities to constituents around the state and nation. We want to show what's here and make sure everybody is aware of it.

Second, with our programmatic activities, I would like to push our engagement with the growing metropolitan areas in Texas and have a role in moving forward research and outreach activities that would be more helpful to urban areas. I'd also like us to engage more with industries that need high-quality water. We already do this with agriculture, obviously, but there are many more industries that have those types of water management needs. And lastly, for Texas A&M to continue its role in the global economy, we need to be able to address water issues around the world and especially in developing nations.

As you are meeting water resources people around the state, what concerns about Texas water are you hearing most often?

There are two categories of major concerns out there: physical and policy/regulatory. With physical concerns, drought is still ever-present in everyone's minds. It's clear that because of the drought and flooding in Texas, building resilience to droughts is on people's minds across many fields — from agriculture to ecology to urban studies. It's very clear that working toward building better drought resiliency into Texas water planning and management is a big concern. The second physical concern is an awareness of the need to effectively manage the state's groundwater supplies. Aquifers are not going to be managed under one catch-all system, but rather we should be really focusing on developing mechanisms to effectively manage groundwater for both the economies and communities it supports, but also for the physical circumstances in which groundwater exists.

Then on the policy and regulatory front, there's a tremendous amount of concern related to how changes in water quality regulations and potential endangered species listings could impact Texas waterways and Texas' ability to manage its water. There is a fair amount of work going on in relation to riparian ecology and improving and protecting wildlife habitat because having a species listed potentially takes a lot of the maneuverability out of water management capabilities.

From your perspective, what do you think are the most pressing water resources issues facing Texas right now?

We tend to focus on the short-term: potential regulatory constraints or ESA (Endangered Species Act) listings, or drought when it's happening, or declining aquifers when they're rapidly dropping. But I think all of those issues wrap-up into one big subject, which is having a statewide water plan that allows for regional flexibility in implementing resilient water management strategies.

There's a tendency to say, 'Well we have the state water plan and it has all of the answers for how we manage water.' But what I've seen here so far is that the plan provides more guidelines and roadmaps for all of the regional water entities — river authorities, groundwater management areas, etc. — so I think it's good in the sense that it lays out the parameters of what needs to be addressed at a regional to local level in developing good water plans. And then the implementation, the actual management, occurs at the more local level, and I think that's an effective way to go.

When we're looking at the big issues, such as drought and listings of species, all of those individual issues that need to be addressed must be viewed in an integrated fashion. That is an overriding theme from my perspective. Because if you're looking at a drought plan and your whole drought plan can be blown apart by a species being ⇨

listed, then you don't have a very effective drought plan. And if you have a water management plan that only works when you're not in a drought, then, again, not a good plan.

So, if you have a plan that looks at all of the components in an integrated fashion, then maybe there's a potential to find synergies for what you're doing to try to mitigate against floods and develop drought-resilient water plans. There are always opportunities to look at these things through integrated management and not just as individual problems. When we approach water issues, we need to think of them in relation to the whole of water management.

Can you tell us about your dual-appointment, as both director of TWRI and a professor in the Zachry Department of Civil Engineering, and your role in the engineering community at Texas A&M?

My educational background has always been in civil engineering, but my research has always had a large agricultural focus to it, so this was a natural fit to help bridge these two worlds here. In practice, it's been great because having the appointment in engineering has allowed me to more effectively build trust with faculty and administrators in engineering as we move forward on opportunities together. We have the ability to bring together these two huge colleges within Texas A&M and attack some of these interdisciplinary issues really effectively.

What future ventures are you most looking forward to as TWRI director?

Right now I'm still looking forward to learning a whole lot more about Texas water issues and meeting the broader Texas water resources community. I've already met a lot of people, but I'd say it's been just a fraction of the people I will have met a year or two from now. That venture of just becoming more embedded in and understanding of the water landscape in Texas is a lot of work, but I'm looking forward to it.

I'm also excited about the water-energy-food nexus program in development at Texas A&M and where that can go. TWRI will play a supportive role, and the program will bring together a broad number of faculty groups across campus to address this interdisciplinary issue. I see that really growing and Texas A&M being well-known for it five years from now.

And, just for fun, what have been your favorite parts of moving to Texas and transitioning to life in Aggieland?

My wife and I are foodies, and everywhere we've lived we've gone out of our way to sample the local version of barbecue. So, when we were in Washington D.C., we went to the North Carolina coast and had east Carolina barbecue, which is a different style than Carolina hill barbecue, which is different than Memphis barbecue, and we really enjoyed that. But, none of those focus on brisket barbecue. So, we've really enjoyed sampling the wide range of brisket barbecue here. There are rankings out there of the best barbecue joints in Texas, and we've already been to several of those in Bryan and Austin.

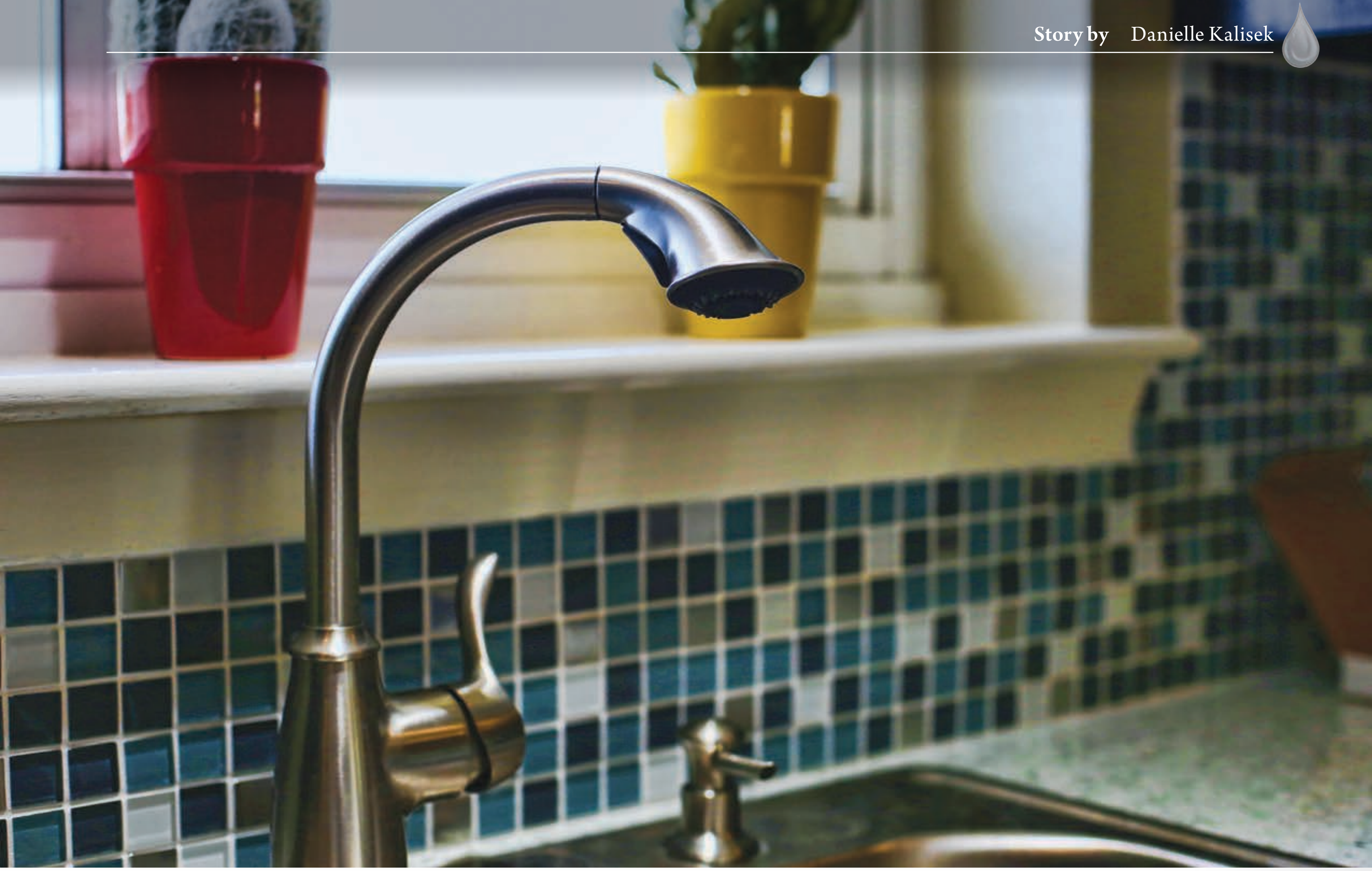
We've enjoyed the unique and distinct cuisine in the various regions around Texas; that has been quite fun. We came from a pretty good food scene, but it's much bigger and better down here.

Another part of living in College Station that's struck me is Kyle Field; the magnitude of Kyle Field is always stunning when I drive by. It is just impressive beyond belief. It serves as a landmark for me.

One big change from moving here has been adjusting our gardening to the climate and the soils. I've always gardened, and the biggest shock here has been realizing that we have to be on top of our gardening in January. We realized that we had to get our tomato starts going in January so that they'd be ready for planting in the middle of March! It's a very different gardening schedule for us. And when we started looking at things that we can grow here, it's a whole new world! We like pomegranates and realized we can grow pomegranates here, so we ordered some and should have some fruit by the fall, and there's no other place we've lived where we could do that.

People have also been incredibly friendly and helpful here in College Station, but also as we've driven around to Houston and Dallas and other cities, it seems to be part of Texas culture that people here are overtly friendly, and that's been great.

Story by Danielle Kalisek



Bringing water-use data to life

Web portal assists utilities and consumers with water-use efficiency

Consumers and utilities can see in more detail how much their household water use adds up through the project. Photo by Leslie Lee, Texas Water Resources Institute.

Urban water conservation is high on the list of managing Texas' future water supplies. The approaches used in current urban water conservation programs span everything from rebates, education and landscape watering restrictions. A team of researchers and specialists of The Texas A&M University System recently focused on a different aspect of urban water conservation, asking the question: Can providing consumers with information about their water use help them conserve more water?

To answer this question, the team used advanced metering infrastructure (AMI) data as its starting point.

Over the past 10 years, some water utilities have installed AMI meters at consumers' homes. AMI is an integrated system of smart meters, communications networks and data management systems that enables two-way communication between utilities and their customers. AMI technology allows utilities to read meters data at hourly or smaller intervals as opposed to the traditional once-per-month of manual meters.

The most common way for consumers to see the recorded information is to include their total water use data in either their printed or electronic monthly bill. However, the project team has brought this data to life by building an online, user-friendly web portal that allows users to see their individual household's daily water use and projected water bill. ⇨

Working with Arlington Water Utilities, the AMI project team automated a process in which the city uploads data on a daily basis, and in turn, this information is uploaded to the web-based portal.

"Now water users can see exactly how many gallons they use to water their lawns, wash their cars or feed a malfunctioning toilet, and how much each of these costs in dollars and cents," said Dr. Kelly Brumbelow, associate professor in Texas A&M's Zachry Department of Civil Engineering and principal investigator for the project. "This is a big improvement over lumped monthly bills where the consumption and cost associated with any particular usage is hidden in the total."

Viewing and using AMI data

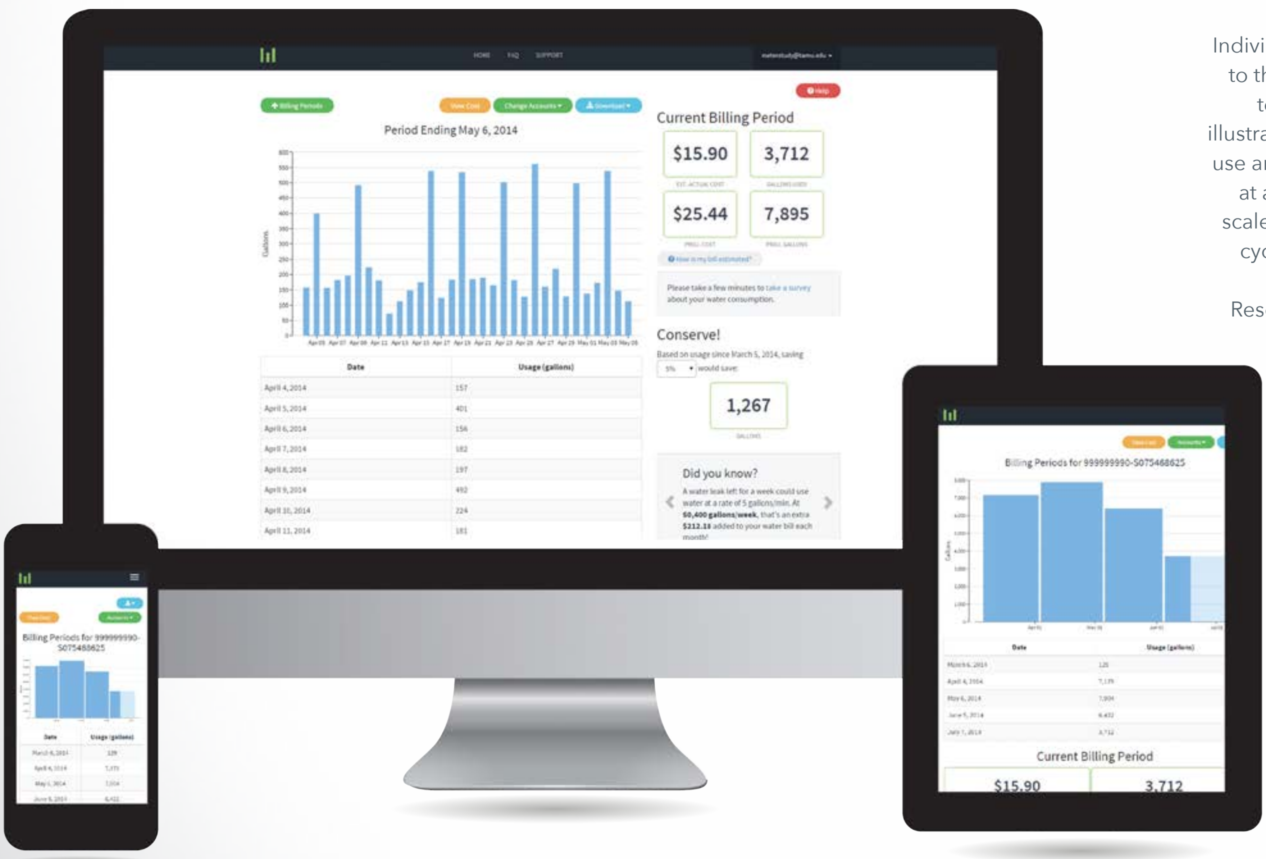
Residents can log in to the secure portal to see bar charts illustrating their water use in gallons and costs at both a daily scale within a billing cycle and an hourly scale within a selected day. Consumers can also project what they will use if they continue their current water use, said Dr. Allen Berthold, Texas Water Resources Institute (TWRI) research scientist and one of the project's researchers. The ability to change the bar chart to dollars, manage multiple meters, download data and set high-usage alerts have also been built into the web portal.

"When residents have access to their own water-use information at such intervals, they can determine which activities use the most water," Berthold said. "This type of data allows them to also set numeric conservation goals for their home instead of qualitative goals.

"If residents see water being used in the middle of the night when no one was awake, this could be indicative of a leak. Push notifications can be sent to alert the resident of this type of water use," he said. "Additionally, if larger than normal amounts of water are used at once, residents can identify where the water is being used and make changes accordingly."

Analyzing water-use data

The team is continuing to analyze the water-use data to determine if portal users use less water. Preliminary results indicate portal users reduced their water use by an average of 8.7 percent in the wintertime and 17 percent in the summertime compared to nonportal users, Brumbelow said.



Individuals can log in to the secure portal to see bar charts illustrating their water use and related costs at a daily or hourly scale within a billing cycle. Screenshots by Texas Water Resources Institute.

"When compared to the state water plan's expectation of municipal water conservation providing 19 percent of the 2060 municipal water supply needs in Texas, these results are promising," he said.

Additional years of data are needed to further validate current results and show greater potential savings, he said.

"Some challenges during this project were that summer 2014 was an unusually wet summer, well-timed rains depressed outdoor water use for all consumers, and drought restrictions were not constant," Brumbelow said. "While this is usually a good thing, for what we were looking at in this project, it was a bit of a challenge."

In addition to evaluating the web portal data, the team analyzed existing data from the utility, such as lot size, appraised value, zoning, living area and zip code, and conducted surveys.

The first consumer survey was sent to both users and nonusers of the web portal soon after the web portal was launched June 2013.

"Both survey responses and existing data were paired with consumers' respective water use and analyzed to identify the predictors of water consumption among both users and nonusers of the web portal," Berthold said. "Results indicated that neither existing data nor psychological data were good predictors of water consumption, but the two combined gave the best results. Specifically, zoning, income bracket, number of people in the house and living area were the strongest predictors of water usage."

Water-saving results

So far, the project team has seen successful results from consumers using the web portal, its data and survey responses received.

"It is a well-known fact that the more people know about their water resources, the more likely they are to participate in water conservation," said Dr. Kevin Wagner, TWRI's deputy director and a co-principal investigator on the project. "With AMI, we are observing just this. We are providing customers knowledge regarding their consumption and related costs, and as a result of this knowledge, they are conserving more."

Results from the web portal stats and surveys show consumers use it.

"The web portal has produced good results as far as people using it, and we have 1,190 users to date," Berthold said. According to the survey responses, 22 percent of users access the web portal once a week and 38 percent access it at least once a month.

"The major impact of this project was the ability to reduce water consumption by an average of 17 percent amongst web portal users during the summer months," Brumbelow said. In addition, 81 percent of respondents said they have a better understanding of how much water is used in the home, and 54 percent have changed their behavior as a result of seeing their water usage.

To provide educational assistance to utilities, the team developed two guidebooks that are available on TWRI's website. The first guidebook, "Considerations for Adopting AMI and AMR," was designed to help utilities when they are considering adopting the technology. The second guidebook, "Utility Customer Profile Guide for Water Conservation Planning," was designed to assist utilities in analyzing data when planning water conservation programs.

Three publications have also been submitted for review to various journals with more anticipated, Berthold said.

During the project, the team partnered with Johnson Controls Inc. to deliver eight education programs across the state to more than 140 people, including many utilities' staff. Presentations were given at each of these programs about the web portal, analysis, results and goals for project expansion, but the focus of the trainings was to provide utilities with information about AMI systems so they could be more informed when purchasing one.

"These trainings were very successful," Berthold said. "Utilities from across the state attended and all of the feedback I received was extremely positive. This was a topic many people had requested, and attendance at these events showed the importance of these trainings about emerging technology."

Brumelow said although a pilot project, it achieved "bottom-line" accomplishments. "The water conserved by our AMI portal users has resulted in a savings of over $70,000 on their water bills — that's money kept in their wallets. And, the utility has newly available water that's enough for 150 ⇨

The web portal allows users to see how much water is used by their activities, such as irrigation, and they can adjust their water use accordingly. Photo credit: Crestock.

new families with no new outside supplies brought in. These are both spurs to continued economic growth."

Continuing AMI work

The success of the project and input from water conservation professionals and others has confirmed that continued research is needed.

"Water conservation is a large part of meeting future water demands and should continue to be an area of focus for Texas A&M AgriLife Research, the Texas A&M AgriLife Extension Service and the Texas A&M Engineering Experiment Station," Brumbelow said. "Further, the need for water conservation program evaluation has been echoed by various utilities, and this project plays a role in that area of research as well."

Leak detection is another area of potential growth, and utilities are interested in the development of technology to detect leaks, he said.

The AMI project received continued funding beginning in November 2015 for another two years, which will include working to copyright the developed features for licensing to utilities and/or private industry. The project team has also been working with The Texas A&M University System Office of Technology Commercialization to copyright the web portal development code, database structure and design.

Additional features the team plans for the new project include more email alerts, a mobile app, consumer reports, neighborhood comparisons, conservation education materials and indoor and outdoor use estimates.

The team also plans to expand to new utilities, continue data collection and analysis, deliver education programs and present at state and national conferences. It will also develop standardized best management practices for the Water Conservation Advisory Council and participate in and pursue a National Science Foundation Innovation-Corps grant to conduct market research.

This project was funded by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas

Title: Achieving Household Water-use Efficiency Using Advanced Metering Infrastructure

Principal Investigator: Kelly Brumbelow

Co-Principal Investigators: Kevin Wagner, Scott Cummings

Story by Leslie Lee

Landscape irrigation runoff causes water quality issues and wastes potable water. Photo by Dr. Benjamin Wherley, Texas A&M Department of Soil and Crop Sciences

OFF AND RUNNING

Aggie scientists invent high-tech system to reduce landscape runoff

What's so wrong with runoff?

Dr. Benjamin Wherley presented this question to a room full of water experts at Texas A&M University in February, most of them familiar with the details of why urban landscape irrigation runoff is a big problem. In addition to being a total waste of potable water, runoff can carry bacteria, excess fertilizer nutrients, sediment and other harmful things out of yards and into local water bodies, causing water quality issues.

The researchers at the symposium knew about the results of excess landscape watering, but how could the average homeowner stop runoff? Irrigation system controllers can be complicated, and runoff depends on many interconnected variables, including soil type and moisture, weather conditions and water quality.

For the last two years an interdisciplinary team of engineers, irrigation researchers and turfgrass experts have been developing, testing and perfecting a solution: the landscape irrigation runoff mitigation system, or LIRMS. The team was co-led by Wherley, assistant professor in Texas A&M's Department of Soil and Crop Sciences, and Dr. Jorge Alvarado, associate professor in Texas A&M's Department of Engineering Technology and Industrial Distribution.

A curbside solution

Runoff occurs when irrigation water does not infiltrate into the landscape's soil, and it is influenced by many factors. Soils may be very tightly compacted, as is the case with many new homes; most builders like home sites' soils to be compact and easier to manage, Wherley said. Too dry or too moist soil can also result in runoff, and soil type matters as well. Clay soils, found in many Texas regions, filter water very slowly. Weather conditions also affect infiltration rates, and drought-triggered residential watering restrictions sometimes cause homeowners to irrigate less often but much more heavily.

"Much of our research focuses on irrigation management, and we recognize that people are wasting quite a bit of water through runoff," Wherley said. "In our tests, we have found that in many cases, landscapes lose about one-third of the irrigation water to runoff."

The team embarked upon creating LIRMS because in residential landscapes, runoff water will become an even greater issue in the future, he said. Water quality and sodium content may change in water supplies as cities turn to alternative sources such as reclaimed water. Sodium reduces soil permeability and will increase runoff as it builds up in the soil over time.

To tackle these challenges, the research team built LIRMS out of two main components: a sensor that can detect when runoff is occurring, and a connection to either the main sprinkler system controller or individual sprinklers so that irrigation can be paused or stopped during runoff.

The team's research began with developing and testing several prototype sensors that sensed runoff, using various technologies, including water-sensitive electrical switches, floats similar to those in toilets, water wheels and others.

Small enough to fit inside a curb, the LIRMS product is both compact and smart. The 'brains' of the unit can take multiple inputs, from multiple runoff sensors and from multiple irrigation heads, Alvarado said, making very efficient irrigation runs possible.

LIRMS prototype sensors were validated both in the lab and in the field to show the capability of detecting runoff, Wherley said.

When the tests were complete, LIRMS had not only reduced runoff water volumes by an average of 40 to 50 percent during a typical 30-minute, 1-inch irrigation run, but also allowed for 10 to 30 percent more water to soak into the soil during such runs.

Ideal tool for water-wise communities

Wherley envisions LIRMS as a convenient technology to help municipalities and communities reduce both pollution and water waste.

"When I talk to water managers in the Dallas-Fort Worth area, they say that in many of those communities, heavy soils and a lot of sloped areas result in runoff being a major issue," he said.

Rain sensors are currently required by law on all irrigation systems on new homes, Wherley said. Similarly, incentivizing or requiring runoff sensors such as LIRMS could result in significant water savings, he said, and the costs would be minimal. Even the team's custom-built LIRMS prototypes were cheap enough to construct that their resulting water-cost savings would mean LIRMS could potentially "pay for itself" within one to two years, he said.

LIRMS prototypes being tested at the Texas A&M Department of Soil and Crop Sciences Urban Landscape Runoff Facility. Photo by Dr. Benjamin Wherley, Texas A&M Department of Soil and Crop Sciences.

LIRMS also makes it possible to automate the cycle-soak style of lawn irrigation that Wherley and his colleagues often recommend, which is a big deal for the landscape irrigation industry, he said.

"With most irrigated landscapes, soil infiltration rates are low and precipitation rates are high, so you do need to break the run up with pauses," Wherley said.

Cycle-soaking solves the slow soil infiltration issue through irrigation runs programmed to water for multiple cycles for a shorter amount of time, such as 10 minutes, with pauses of 30 minutes or more between each cycle, allowing time for the water to soak into the soil. Many average homeowners set their sprinkler irrigation systems for straight 30-minute runs, resulting in not only wasted water running off but also unmet landscape water needs, Wherley said.

When LIRMS detects runoff, it pauses the system for a given amount of time and then picks up the irrigation run where it left off, resulting in pulses of irrigation with intermittent pauses. Although this often results in a 30-minute run taking a few hours to complete, Wherley said, a more efficient and complete soaking of the soil takes place.

But to the average homeowner, understanding how to set a controller to cycle-soak can be confusing, he said.

"We have automated that process via LIRMS, instead of relying on people to cycle-soak, and I think that could have a big impact on water-use efficiency in landscapes," Wherley said.

LIRMS also compliments and improves upon other already existing landscape irrigation technologies, such as rain sensors and soil moisture sensors, because "it goes right to the point," Alvarado said.

"If the soil is saturated and the water isn't soaking in, then the runoff sensor will detect that," he said. "If the soil is dry and the water is running off, the runoff sensor will detect that as well." ⇨

Building on the invention

A provisional patent has been filed for the system, and a second phase of the project has been funded. The team plans to test LIRMS units in real-world conditions in urban cities and get feedback from water managers in the second phase. Researchers will also be developing an app to enable remote use of LIRMS and viewing of irrigation data.

"We're actually going to get a couple of units out onto residential landscapes, and we're going to work closely with water managers on that," Wherley said. "We will be building up a nice dataset to show, here's the amount of water we can save under these types of soils and these conditions to demonstrate what this system is capable of."

LIRMS could benefit not only residential neighborhoods but also resorts, golf courses and commercial landscapes, Alvarado said.

"Within two years, we hope that LIRMS technology will be on the market and available to consumers," Wherley said.

"If we can keep this water on the landscape, then we're not only eliminating runoff of compounds that might impair the environment, but we're also getting more water into the soil, which will result in a greener lawn that might be perceived as not needing as much water, continuing the water savings. It will help people achieve a better landscape, using less water than they've been using."

Title: Development of a Landscape Irrigation Runoff Mitigation System

Principal Investigator: Benjamin Wherley

Co-Principal Investigators: Jorge Alvarado, Fouad Jabar, Richard White, Casey Reynolds

This project was funded by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas.

(L) Texas A&M researchers evaluate operation of the curb-installed LIRMS in response to irrigation runoff generated during a test run.

(R) During initial testing at the Texas A&M Department of Soil and Crop Sciences Urban Landscape Runoff Facility, Texas A&M researchers discuss LIRMS controller design and operation. Photos by Dr. Benjamin Wherley, Texas A&M Department of Soil and Crop Sciences.

Less is more

Expanded WaterMyYard Program helps Texans reduce water use for healthier lawns

All over Texas, homeowners are unknowingly drenching their yards — thanks to inefficient practices or leaky irrigation systems. Often more than 50 percent of landscape water is wasted due to overwatering, according to Texas A&M University experts.

Encouraging residents to use science-based ways to water their lawns could help alleviate this problem, but this approach has two challenges: most homeowners do not know how to calculate water requirements, and determining irrigation runtimes to meet those water requirements can be complicated.

With the WaterMyYard Program, homeowners can easily find out exactly how much water their landscape actually needs, without having to know the science behind it. First launched in 2013 as a joint effort of the North Texas Municipal Water District (NTMWD) and the Texas A&M AgriLife Extension Service's Irrigation Technology Program, WaterMyYard has since evolved and expanded statewide.

Meeting homeowners' needs

The WaterMyYard web app uses automated weather stations and local evapotranspiration, or ET, data to generate water recommendations specific to each user's landscape. ET is a measure of how much water plants need to grow and remain healthy.

The program delivers weekly emails and text messages to users who live within the program's service areas. Service areas are sponsored by a water district such as the NTMWD, water utilities and cities that have purchased their own ET-based weather station.

With intuitive and easy-to-use data entry options, the web app tells homeowners how long, in minutes, they should run their systems for maximum efficiency and water conservation.

Users are first prompted to enter the address or zip code where their yard is located. Then they enter their sprinkler precipitation rate. If homeowners do not know their rate, they can select their type of system, such as multistream sprinklers or drip irrigation, by clicking one of the images. WaterMyYard then generates the recommendation on how many times and how many minutes to run their irrigation system that week. Users can subscribe to future weekly water recommendations by text message or email. ⇨

Photo by Danielle Kalisek, Texas Water Resources Institute.

Without WaterMyYard, homeowners tend to overwater their lawns and irrigate during dormant seasons. Photo by Charles Swanson, Texas A&M Department of Biological and Agricultural Engineering.

A cure for chronic overwatering

Prior to NTMWD residents using WaterMyYard, district surveys revealed that most homeowners watered three or more times per week, said Denise Hickey, NTMWD's public relations and water conservation manager.

Because most homeowners don't do the research on how to properly care for their lawns, Hickey said, they tend to have a "set it and forget it" mindset for their irrigation controllers and often end up overwatering. The surveys also showed that homeowners were irrigating during the dormant season for lawns, a time when it is unnecessary and wasteful to add supplemental water.

"We're trying to raise awareness of how to properly irrigate your lawn while conserving water," she said. "And actually, they'll have a better lawn even during drought periods if they water with best management practices."

The need to initiate better water management practices for homeowners, coupled with recent drought periods, prompted NTMWD to reach out to AgriLife Extension.

"We received a request from NTMWD to come up with a way to inform homeowners how to run their sprinklers," said Dr. Guy Fipps, professor and Extension specialist in Texas A&M's Department of Biological and Agricultural Engineering (BAEN). "It had to be easy to use and require no knowledge of ET or irrigation systems."

The growing demand for WaterMyYard

Over a two-year period, 13 cities from NTMWD were added to the program. As requests to simplify and expand the program began to come in from other municipalities around the state, it became clear the program needed some changes.

"The first question asked by cities wishing to join the program was: 'How many ET weather stations do I need?'" Fipps said. "It turns out that there was no established methodology to determine how many ET stations are needed in an urban area for irrigation purposes."

With that in mind, Fipps put together a team consisting of Dr. Gretchen Miller, professor in Texas A&M's Zachry Department of Civil Engineering; Dr. Richard White, professor in Texas A&M's Department of Soil and Crop Sciences; and Seydou Traore, BAEN Extension associate, to develop such a methodology.

The team examined the spatial variability of ET in urban areas by mounting special sensors on a vehicle that was driven along pre-selected routes, along with thermal image analysis of satellite images of the same areas.

"The goal was to develop a methodology that is simple enough that it can easily be applied to all urban areas in Texas while providing accurate guidance on station placement," Fipps said. "The methodology developed will not only be useful for WaterMyYard but has widespread application in water management, water planning and climate change analysis, among others."

To expand WaterMyYard to new service areas, specialists installed weather stations and remote rain gages for better coverage. Photo by Charles Swanson, Texas A&M Department of Biological and Agricultural Engineering.

In addition to validating ET station location requirements, the recent efforts also included a revamp of WaterMyYard web programming. Since the original WaterMyYard app was programmed for a single service area, Fipps said that to expand the program statewide, significant new programing was required, including the capability to incorporate multiple locations and sponsors who may be on different drought stages and watering restrictions.

"We simplified the user interface, increased the number of options for customizing local site parameters and modified email formatting," Fipps said. "'Back-end' programing that simplified the incorporation of new sponsors, service areas, weather stations and remote rain gages was successfully completed."

Through the efforts of Fipps and the WaterMyYard team of David Flahive, BAEN programmer, and Charles Swanson, BAEN Extension program specialist, a new version of WaterMyYard was launched in July 2015 to provide further coverage and customization for more areas.

At a city level, delivering additional data and coverage allows for better recommendations for the consumers, Hickey said.

"We realized that, for example in Allen, the weather station was located in east Allen but west Allen may have gotten some rain when east Allen did not, so you wouldn't get a good representation of the weather patterns or the city," she said. "NTMWD installed additional rain gages so WaterMyYard would have better coverage of that region."

Water utilities across the state are embracing the expanded and improved program as well.

There are now 61 Texas cities in the program, including Bryan, College Station and Irving, and member cities of the Lower Colorado River Authority in the Austin area and the Upper Trinity Regional Water District.

"It's continuing to expand very fast through the state," Fipps said. "Besides the 61 cities currently in the program, we have several more water districts and cities that are joining the program in 2016."

The estimated water savings from the WaterMyYard Program for the 2015 irrigation season was approximately 160 million gallons of water, he said. Recognizing the program's success, the Water Conservation Advisory Council awarded NTMWD and AgriLife Extension the 2015 Municipal Blue Legacy Award for WaterMyYard.

In a June 2015 survey taken by NTMWD, consumers reported they thought the most beneficial part of the program was the weekly emails or texts recommending users not to water.

"Over the next 50 years, about one-quarter of our water supply is going to come from individual conservation and reuse efforts," Hickey said. "We know we can save a lot through managing the way we water our lawns. WaterMyYard is an excellent tool to help educate and guide the homeowner when they need to water or when they don't need to water, thus saving water for the future."

The expansion of the project was funded, in part, by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas.

Title: Spatial Variability of ET, Rainfall and Other Parameters in Urban Environments as Related to Further Deployment of the WaterMyYard Program

Principal Investigator: Guy Fipps

Co-Principal Investigators: Gretchen Miller, Richard White, Charles Swanson

Story by Kathy Wythe

Cesar Garcia, Texas A&M Engineering Experiment Station research engineering associate with the Texas Center for Applied Technology, shows the different elements of the Dashboard for Irrigation Efficiency Management. Photo by Leslie Lee, Texas Water Resources Institute.

INNOVATIVE INFORMATION

Online dashboard designed to help farmers irrigate just enough, at just the right time

In one of the most water-stressed regions in the United States, irrigation professionals and software developers are joining forces to develop a web-based technology that will help Texas High Plains farmers evaluate how much and when to irrigate their crops.

Still in development, the Dashboard for Irrigation Efficiency Management, or DIEM, is a product of Texas A&M AgriLife Research, the Texas A&M AgriLife Extension Service and the Texas A&M Engineering Experiment Station's Texas Center for Applied Technology (TCAT).

DIEM integrates local farm and environmental information with results from prior water-use efficiency field experiments. The dashboard allows irrigators to see the relationships between soil water, planting dates, weather and irrigation and their effects on crop yield and water-use efficiency.

The dashboard prescribes a season-long, field-specific irrigation schedule that optimizes yield and water-use efficiency based on rainfall and irrigation availability. Farmers can then use the schedule to enhance or confirm their irrigation decision-making. As the growing season progresses, they can update the irrigation schedule recommendation based on real-time observations.

The declining aquifer

Beneath the Texas High Plains lies the Ogallala Aquifer, the largest aquifer in the United States and the main source of water for irrigating the region's 2 million acres of cotton.

But the aquifer is being depleted faster than it is being recharged, forcing the agricultural community to become more and more efficient with increasingly less available water. ⇨

Texas A&M AgriLife Research scientists found that farmers were probably applying too much water too early in the growing season with pivot irrigation systems. Photo courtesy of Texas A&M AgriLife Research.

As one of the most experienced irrigation experts in the Texas High Plains, Jim Bordovsky, senior research scientist and agricultural engineer with AgriLife Research at Halfway, has seen farmers improve their irrigation efficiency over the years, but sees more opportunities for water savings.

"We have seen from our research that in our environment we have situations in which water is not being used as efficiently as it might be at different times of the year or through different types of irrigation systems or on different soils," he said.

Putting into perspective the importance of water savings in this area, Bordovsky said that 1 inch of water conserved on half of the region's irrigated cotton acreage is greater than Lubbock's current municipal water demand for a 20-month period, which is 83,000 acre-feet.

The idea for DIEM grew out of a four-year field research project that Bordovsky and others recently completed. That project looked at defining water-use efficiency within segments of the cotton-growing season. The researchers wanted to determine the best time during the growing season to apply limited water to get an optimal return in terms of crop production per unit of water invested, Bordovsky said.

"During the four-year period, we had extreme differences in rainfall, fairly wet and extremely dry and in-between," he said. "Looking across those different years with different rainfall and different temperature patterns, we saw the same general trend, which was that we were probably applying too much water too early in the growing season with pivot irrigation systems."

Bordovsky said the Texas High Plains region experiences high evaporation losses in the early part of the summer growing season. "When irrigating, we are simply not getting as much water in the ground as we think," he said. "We have shown in this research that although we can increase cotton yield by irrigating early versus not irrigating at all during this early period, this increase in yield is relatively

With additional funding, researchers hope to address crops other than cotton and continue irrigation timing experiments on different soil types and with different irrigation systems. Photo courtesy of Texas A&M AgriLife Research.

small compared to the increased in yield achieved by applying water toward the end of the growing season."

The study showed that limiting early season cotton irrigation could potentially reduce annual water use by more than 27 trillion gallons of water per year on the High Plains with relatively small declines in lint yield compared to current practices.

From those results and from other research through the years, the idea for DIEM came about. "We wanted to capture irrigation research results in a software tool that could easily be conveyed to the end users," Bordovsky said.

DIEM's goal, he said, is to make it easier for users to visualize when they might be able to reduce their water use without causing a great deal of yield loss.

Visualizing irrigation

Working with Dr. Jim Wall, executive director of TCAT, and TCAT's software developers, the team developed an information dashboard that configures basic historical, near real-time and future agronomic data.

The dashboard was built by leveraging a technology called the Information Dashboard Framework (IDF), developed by TCAT in coordination with AgriLife Research's Institute for Infectious Animal Diseases. IDF collects, filters, processes and then presents information from multiple data sources, including weather and soil databases, crop and economic models, and in the future, crop canopy and soil sensors.

The DIEM dashboard integrates field-specific soil profile characteristics; current local water availability, including the pumping capacities of the irrigation wells and water volume or pumping limits; and environmental factors such as potential evapotranspiration, rainfall and other past and current weather information. It also incorporates irrigation system characteristics; crop growth characteristics, such as planting date; and relevant field research on when best to distribute available irrigation water.

When inputting information into DIEM, the farmer selects the specific field and weather station as well as planting date, number of irrigated acres and other inputs. The dashboard then produces a custom, optimized irrigation schedule; a DIEM yield score, which is the estimated pounds of cotton lint per acre; and a DIEM irrigation water-use efficiency score, which is pounds of cotton lint per acre-inch of irrigation water. ⇨

Jim Bordovsky, senior research scientist and agricultural engineer with AgriLife Research at Halfway, says irrigation efficiency for cotton has increased but there are more opportunities for water savings. Photo courtesy of AgriLife Research.

Then, the farmer can either accept the schedule or evaluate different "what if" scenarios by adjusting inputs, such as changing the available irrigation flow rate or the irrigation amount per application. The farmer can observe the resulting changes on the soil water profile, the DIEM yield and water-use efficiency scores and then print the revised irrigation schedule.

Bordovsky said as the crop season progresses, new data, such as actual crop evapotranspiration and rainfall, automatically replaces historical and projected estimates to "re-optimize" the remaining seasonal irrigation schedule. This adjustment can be monthly, weekly or daily, depending on the user's needs.

"The producer can look at that information and say, 'I think my crop needs more water, and he can apply more water,'" Bordovsky said. "There is nothing sacred about the irrigation schedule. It is simply a guide, based on current field-specific information and the available regional research, as to what can be done with the water that's available. The producer may know something about his system, his crop, his ground, that would dictate that he do something else."

Unique tool

Bordovsky said although there are other available irrigation scheduling tools, DIEM approaches irrigation scheduling differently.

"We are looking at water resource availability as the first step in irrigation scheduling as opposed to looking at the crop water needs first," he said.

"In the Southern High Plains, we are water-limited and the question becomes: 'I have this much water and the ability to deliver it to a specific area, what can I do with that water?' instead of 'I have a crop and at this time it needs a specific amount of water that I may, or may not, be able to deliver.'

"Another difference is that we are looking forward in terms of water availability over the entire growing season versus looking backward and attempting to replenish soil water used since the last irrigation with limited resources," he said.

Future of DIEM

With additional funding, Bordovsky said he hopes to address crops other than cotton and continue irrigation timing experiments on different soil types and with different irrigation systems. The team will also conduct beta testing with farmers in the field during the summer of 2016, make more improvements to the DIEM system and hopes to make it more widely available for the 2017 crop year.

"I am excited about the opportunity to capture irrigation research outcomes and put them into a simple and intuitive form for end users to access," he said.

This project was funded by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas.

Title: Timely Management of Limited Irrigation Crops in Texas Using an Empirically Based Model and Innovative Information Dashboard Technology

Principal Investigator: James P. Bordovsky

Co-Principal Investigators: James Wall, Dana Porter, Keith Biggers, Mark Kelley, Srinivasulu Ale

Story by Kathy Wythe

THE KEY TO PERFECTING WATER REUSE?

Researchers prove eBeam technology successfully removes water contaminants

At the National Center for Electron Beam Research on the Texas A&M campus, researchers use high-energy, high-speed electrons generated in a linear accelerator to modify or transform items. Photo by Leslie Lee, Texas Water Resources Institute.

A technology that uses electrons moving at almost the speed of light may soon be used to turn wastewater into drinking water.

In a joint research project, scientists from The Texas A&M University System successfully demonstrated the feasibility of using electron beam, or eBeam, technology to treat wastewater for direct potable reuse. Dr. Suresh Pillai, director of Texas A&M's National Center for Electron Beam Research, and Dr. Bill Batchelor, R.P. Gregory '32 Chair professor in Texas A&M's Zachry Department of Civil Engineering, collaborated on the project.

With Texas' decreasing water availability and increasing water demand, Pillai said a growing number of water providers are using or considering water reuse, either direct or indirect, for drinking water.

Potable reuse is using treated wastewater to supplement drinking water supplies. Indirect potable reuse usually has the treated wastewater enter an environmental buffer such as a river, lake or aquifer before it goes to the drinking water treatment plant. Direct potable reuse uses engineered treatment processes instead of an environmental buffer to purify the wastewater before introducing it either into the drinking water treatment plant or directly into the drinking water distribution system.

"Developing improved water treatment processes is a key aspect of solving water challenges, particularly those in direct potable reuse," Batchelor said.

The researchers based their project on the hypothesis that eBeam technology is a water treatment process that can make wastewater clean enough for direct potable reuse.

"No one has done research on using eBeam technology with the focus being on water reuse and contemporary and emerging contaminants," said Pillai, who is also a professor in Texas A&M's Department of Nutrition and Food Sciences and Department of Poultry Science. "It has always been done with wastewater treatment as a focus, rather than water reclamation."

A Superman-like energy

Put simply, eBeam technology uses high-energy, high-speed electrons generated in a linear accelerator to modify or transform items. The electrons are moving so fast, Pillai said, "if you sat on one of those electrons, you could go between Los Angeles to New York about 37 times in one second."

Pillai said this technology can be used for many applications. For example, the medical industry uses it to sterilize medical products and devices, and the food industry uses it to eliminate microbial pathogens in ground beef and spices.

Destroying pollutants

The project looked at using eBeam radiation to remove pathogens such as salmonella, shigella and Hepatitis A virus and other pathogens, as well as estrogenic compounds and two emerging pollutants.

In a series of experiments, effluent from two wastewater treatment plants in College Station were spiked with defined numbers of bacterial, viral and protozoan pathogens and estrogenic compounds and were then exposed to varying eBeam doses. The researchers were able to establish the eBeam dose ranges needed to kill the pathogens; however, the exact dose for eliminating estrogenic compounds needs further research, Pillai said.

Batchelor conducted a series of experiments to evaluate the potential of eBeam treatment to remove trace levels of bromate and perfluorooctanoic acid (PFOA). Bromate is classified as a possible human carcinogen, and PFOA is a waterproofing material that persists indefinitely in the environment. The experiments showed that the eBeam irradiation was able to break down these compounds.

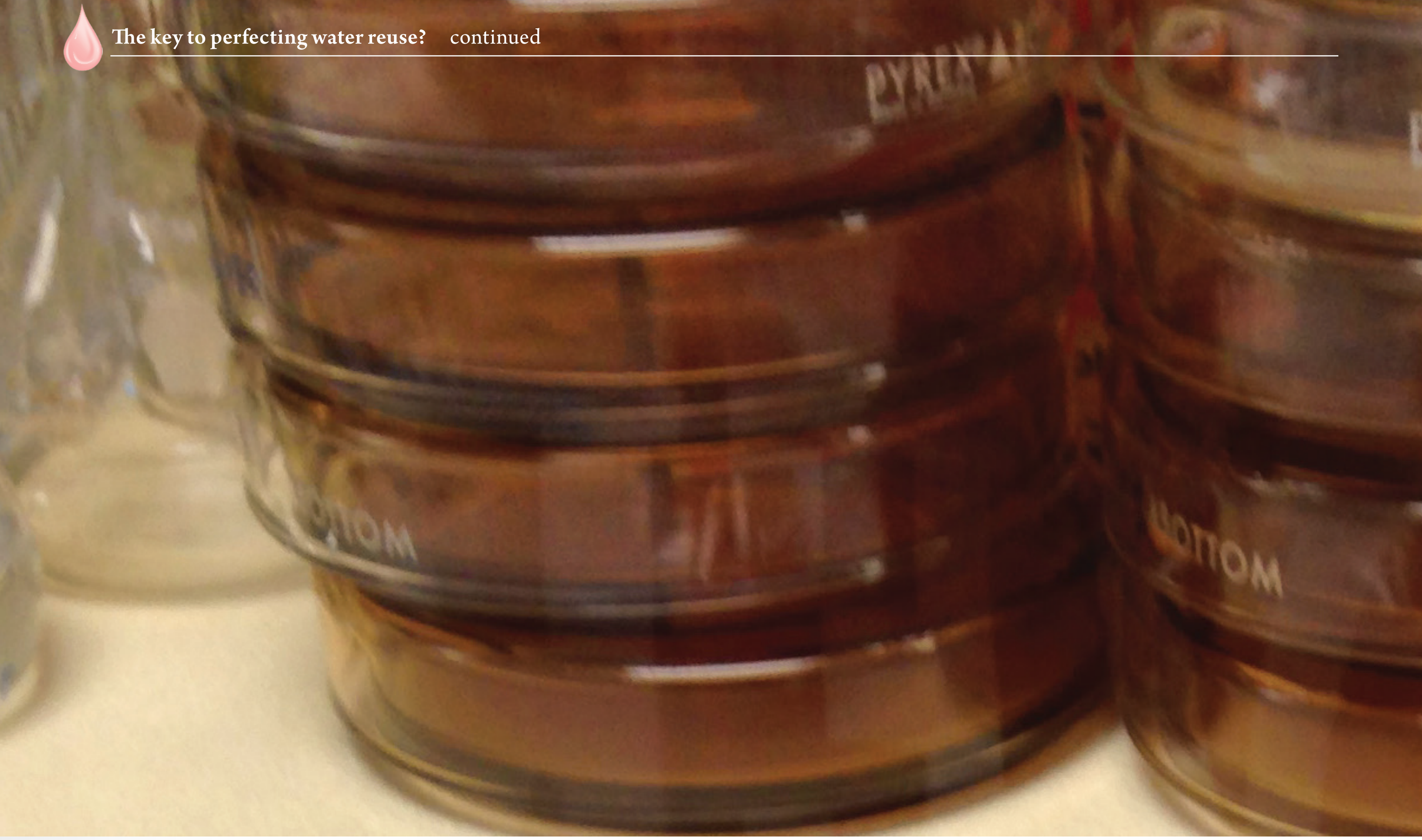
Feasible and cost-effective

"Applying electron beams to water is an innovative treatment process that can not only destroy pathogenic microorganisms that can cause disease but also destroy chemical contaminants that also have adverse effects on human health," Batchelor said. Relatively high doses are required to accomplish this.

Using eBeam technology could eliminate some of the traditional steps in wastewater treatment, such as chlorination, ozone and UV, Pillai said, adding that eBeam treatment does not involve heat or chemicals or produce secondary undesirable wastes. "Therefore the carbon footprint of this technology is also significantly smaller compared to current technologies," he said.

While using eBeam technology on wastewater is feasible, both researchers said there are some issues that still need addressing before it is commercially used.

Batchelor said one of the important findings of their research was that the composition of the wastewater can have major effects on contaminant removal, both positive and negative. "This means that the effectiveness of eBeam treatment needs to be considered on a case-by-case basis," he said. "Although the project made progress in developing a tool to predict eBeam effectiveness for different waters, more information is needed on the process to allow the tool to make accurate predictions." ⇨



The project did establish that the technology would be extremely cost effective for very large wastewater treatment plants that treat volumes in excess of 100 million gallons a day, Pillai said.

"If one of those large plants decided to use this technology, the economic model says it is far cheaper than anything else around," he said. "But the problem we have is that there are not machines that are being designed to treat that volume of water. That is why this technology has not moved forward.

"There needs to be more research and development to build a type of machine that can be put into wastewater plants," Pillai said. "There is currently no machine that is powerful enough."

He said the project has had an impact both regionally and nationally. Engineers from the city of Dallas have performed test runs with their water samples using the eBeam technology, and the city is currently exploring the possibility of adopting the technology in its operations.

The U.S. Department of Energy "Accelerators for America" program is exploring the use of linear accelerator technologies for environmental applications.

If eBeam technology is to be used for water treatment, Pillai said it will create a paradigm shift. "One of the big goals in using electron beam is to make transformational changes in how to treat water," he said.

"Having this technology in the 'tool-box' of water reclamation technologies would open up innovative, high-value, commercially viable and environmentally sustainable solutions and strategies for water reuse."

This project was funded by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas.

Title: Significant Expansion of Water Reuse Using Electron Beam (eBeam) Technology

Principal Investigator:
Suresh D. Pillai

Co-Principal Investigator:
Bill Batchelor

Effluent from two wastewater treatment plants in College Station were spiked with bacterial, viral and protozoan pathogens and estrogenic compounds and were then exposed to varying eBeam doses. Photo courtesy of Texas A&M Zachry Department of Civil Engineering.

New Water Seed Grants funded

Following a successful first round of funding for fiscal years 2014 and 2015, the Texas Legislature again charged three agencies of The Texas A&M University System to address the critical need for efficiency in agricultural and municipal water use.

For fiscal years 2016 and 2017, Texas A&M AgriLife Research, the Texas A&M AgriLife Extension Service and the Texas A&M Engineering Experiment Station (TEES) funded seven projects, chosen out of 54 submitted proposals for a total of $1,581,137 as part of the Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms Program.

The seven projects and their principal investigators are:

- Improving Technologies for Multi-Well Managed Aquifer Recharge Systems, Dr. Gretchen Miller, TEES, Zachry Department of Civil Engineering
- Continued Development, Research, and Commercialization of a Web-Based Portal Using Advanced Metering Infrastructure Water Data, Dr. Kelly Brumbelow, TEES, Zachry Department of Civil Engineering
- Development, Deployment, and Demonstration of the Dashboard for Irrigation Efficiency Management (DIEM), Jim Bordovsky, AgriLife Research
- Unified Data Integration and Adaptive Control for Water-Efficient Irrigation, Dr. Dana Porter, AgriLife Extension, Department of Biological and Agricultural Engineering
- Creation of an UAV Multi-spectral Imaging Platform for Detecting Leaks in Irrigation Canals and Municipal Underground Pipelines, Dr. Guy Fipps, AgriLife Extension, Department of Biological and Agricultural Engineering
- Field Deployment and Integration of Wireless Communication and Operation Support System for the Landscape Irrigation Runoff Mitigation System, Dr. Benjamin Wherley, AgriLife Research, Department of Soil and Crop Sciences
- Policy Enhancing a “Dry Year” Option during Major Water Shortage to Compensate Agriculture and Provide Urban Water, Dr. Luis Ribera, AgriLife Extension, Department of Agricultural Economics

As the oil and gas activity grew in South Texas, concern also grew about using freshwater for hydraulic fracturing. Texas A&M scientists have determined that there is enough brackish, saline and produced water to replace freshwater. Photo credit: iStock.com.

Unconventional resources

Researchers examine replacing freshwater with alternative waters in oil and gas well fracturing

Fueled by the use of hydraulic fracturing combined with horizontal drilling to extract oil and gas, the Eagle Ford Shale in South Texas in recent years became one of the most prolific oil and gas plays in the country. As more and more wells were drilled, however, concerns grew that freshwater use for hydraulic fracturing would drain South Texas communities of water needed for municipal and agricultural use.

In a recent study, a group of Texas A&M University petroleum engineering researchers and Texas A&M AgriLife Extension Service and Texas A&M AgriLife Research personnel set out to determine if brackish and saline waters from the Carrizo-Wilcox Aquifer and produced waters recovered from oil and gas wells could replace freshwater in hydraulic fracture fluids, saving the valuable freshwater for other uses.

Hydraulic fracturing uses water and other fluids under pressure to fracture, or crack, the tight shale rock, providing pathways for oil and gas to flow to the well. Produced water is the used fracturing fluid that flows back to the surface after hydraulic fracturing is complete.

Like most aquifers, the Carrizo-Wilcox not only contains freshwater but brackish and saline waters as well. Brackish water is salty water that typically contains total dissolved solids in concentrations ranging from 1,000 to 10,000 milligrams per liter; saline water has more than 10,000 milligrams per liter of total dissolved solids.

The researchers' goals were to quantify the volumes of brackish and saline waters in the portion of the Carrizo-Wilcox Aquifer that overlies the Eagle Ford Shale, determine the compatibility of those waters and produced waters as source waters for hydraulic fracture fluids, and verify the economics of using those waters instead of freshwater, said Dr. Walter Ayers, visiting professor in the Texas A&M Harold Vance Department of Petroleum Engineering.

No one had adequately described the quantity and quality of brackish and saline waters in the Carrizo-Wilcox, Ayers said; previous studies had focused mainly on freshwater.

Why the concern?

Even before the recent oil and gas boom, water was limited in South Texas, with most water supplies pumped from the Carrizo-Wilcox.

"In the Eagle Ford Shale, the oil and gas industry uses about 5 million gallons of freshwater-based fracture fluid per well," said Dr. Duane McVay, Albert B. Stevens Chair professor in petroleum engineering. With ultimately 34,500 or more wells anticipated for the Eagle Ford Shale, that adds up to about 500,000 acre-feet of water.

If the researchers could quantify how much compatible brackish and saline water in the Carrizo-Wilcox could be used for fracturing instead of freshwater, then they could quantify how much freshwater could be conserved for other uses, such as irrigation and drinking.

"We wanted to demonstrate to the oil and gas industry that they have an abundant supply of brackish and saline waters in the Carrizo-Wilcox Aquifer to use in fracture stimulation of wells, and they do not have to use potable water," Ayers said.

Unique mapping methodology

The researchers began by mapping the Carrizo-Wilcox, dividing the aquifer into four layers: the Carrizo, and the upper, middle and lower Wilcox units. They also divided the land area into eight different regions, based on geological properties and oil and gas fluid properties.

They used oil and gas well logs and Texas Water Development Board data to calculate the volumes of brackish and saline waters as well as to map their salinity and chemical composition.

"What we did had not been done before," Ayers said. "We applied different techniques that allowed us to extend mapping further to the southeast, beyond the shallower freshwater, to characterize the Carrizo-Wilcox Aquifer where it contains brackish and saline water."

The team used electrical resistivity logs integrated with published water composition data to identify different water compositions within the aquifer for each of the eight regions. In each aquifer region, there is a different electrical resistivity response because of differences in the water's composition and concentration of ions. The resistivity indicates the water's salinity.

The results were encouraging.

"The volumes of recoverable brackish and saline waters exceed the anticipated need for all future fracture stimulation operations in the Eagle Ford," Ayers said. "Even if we use only 1 percent of the water in place, it greatly exceeds what is needed."

For instance, in one region, the researchers found that the water demand for hydraulic fracturing would be about 5,000 acre-feet over the remaining life of the play, while the amount of recoverable brackish water in the Carrizo was 70,000 acre-feet and in the upper Wilcox 21,000 acre-feet, more than enough to meet the industry's needs.

They also determined that water wells' flow rates would support the amount of water delivery needed for fracture stimulation.

Testing compatibility

In another part of the project, the researchers determined the chemical specifications needed for waters to meet fracture fluid requirements and then assessed the compatibility of the brackish and saline aquifer waters as well as the produced waters.

Because chemical compositions of the waters vary throughout the eight areas, it is important to know their compositions, since different ions, such as sulfate, calcium and others, in high enough concentrations can cause problems with the different chemicals used in fracture fluids.

Their research showed that the compositions of most of the Carrizo-Wilcox waters did not significantly affect performance of fracture fluids and are compatible with fracturing.

Economics of using brackish, saline waters

The researchers also built an economic model of a centralized water management system to determine the economics of using brackish, saline and produced waters in hydraulic fracturing. All water management costs associated with hydraulic fracturing over the span of field development were included in the analysis, such as acquisition, transportation, storage, disposal and treatment.

Using brackish and saline aquifer waters as source water in hydraulic fracturing operations was found to be economically feasible, in part, because of the close proximity of those waters to current and future Eagle Ford development.

"Increasing the fractions of brackish, saline and produced waters used in fracture fluids reduces fracturing water costs," he said. "We demonstrated that the cost is less than using freshwater, so that gives operators some incentives."

Study's usefulness

McVay said the researchers hope their study will encourage oil and gas operators to consider using more brackish and saline waters instead of freshwater in fracturing operations.

Although it is easier for operators to use freshwater, this study shows that costly treatment is rarely needed to make Carrizo-Wilcox brackish and saline waters and Eagle Ford produced waters compatible unless higher fractions of saline and produced waters are used instead of the lower saline brackish waters.

To communicate the study's outcomes to South Texas landowners, Monty Dozier, AgriLife Extension regional program leader, has spoken to landowners and AgriLife Extension agents at different venues. The investigators will present their findings at a national meeting. Eventually they will publish an extensive report and make it available to interested companies.

"It's a paradigm shift on the part of operators when they can read these research results and see that it is in their best economic interests to use brackish or saline waters," Ayers said. "Although some are already doing that, I think it will bring others around to this thinking."

This project was funded by a joint Texas A&M AgriLife Research, Texas A&M Engineering Experiment Station and Texas A&M AgriLife Extension Service Water Seed Grant: Creation and Deployment of Water-Use Efficient Technology Platforms. In 2013, the Texas Legislature charged the agencies to address the critical nexus for water-use efficiency as part of addressing the future water needs of Texas.

Title: Assessment of Brackish and Saline Aquifers and Flowback Waters As Source Waters for Hydraulic Fracture Fluids in Texas Unconventional Resource Development

Principal Investigators: Duane McVay, Susan Stuver, Walter Ayers, Robert Lane, Jesse Alonzo, David Burnett, Monty Dozier

Story by Leslie Lee

TWRI IN 2015

Another year of helping Texans make every drop count

The Texas Water Resources Institute (TWRI) has been helping solve Texas' water issues through research, education and outreach for more than 60 years. In 2015, TWRI's projects produced numerous accomplishments, and new leadership and opportunities arrived with the announcement of Dr. John C. Tracy as institute director in December.

New urban water resiliency project begins

Funded by the National Science Foundation in 2015, the Urban Water Resiliency in a Climatic and Demographic Hot Spot project is co-led by the University of Texas' Environmental Science Institute (UT–ESI), TWRI, Texas Tech University and the University of Texas at San Antonio. As Central Texas experiences population booms and widespread land-use changes, researchers are studying the interconnected changes projected for the region's climate, water availability, population and land use, all of which will impact its future water resiliency.

A research network will coordinate efforts to address the region's rapidly changing human and natural systems, focusing on four research nodes — climate projections, water science, water and population scenarios, and resiliency and stakeholders.

With UT–ESI, TWRI is co-leading the network's resiliency and stakeholders research node, which will help assess potential decisions and actions of municipal, regional and state government and area stakeholders.

A continuing legacy of watershed protection

As a statewide leader in watershed planning and implementation, TWRI is continually engaging with local stakeholders in watersheds around the state to help improve water quality.

In the Lower Rio Grande Valley, after a decade of successful implementation by stakeholders and TWRI, the Arroyo Colorado Partnership is updating its watershed protection plan to enhance its impact.

IMPACTS AND ENGAGEMENTS

Image credits: thesquid.ink, freepik.com.

3,503 *txH2O* magazine subscribers

15 students supported

37 news releases and **63** media mentions

$3,331,850 in external grants

17 publications

105 presentations to **3,795** people in attendance

29 trainings and workshops, with **1,211** people in attendance

10 watersheds improved

3,088 social media followers

435,032 tweets viewed by Twitter users

Photo credit: iStock.com.

In East Texas, the Attoyac Bayou Watershed Protection Plan was accepted by the U.S. Environmental Protection Agency and is now being implemented with TWRI's help.

Supporting Extension programs

Partnering with the Texas A&M AgriLife Extension Service is essential to TWRI's effectiveness. The institute helps support many AgriLife Extension programs educating Texans in natural resources stewardship.

TWRI supports Texas A&M's Department of Soil and Crop Sciences' continuation of the award-winning Texas Well Owner Network Program, which helps private water well owners around the state ensure their drinking water quality. The department and TWRI will also launch the Healthy Lawns and Healthy Waters Program in 2016. The institute's Texas Riparian and Stream Ecosystem Education Program continues providing trainings in priority watersheds around the state as well as valuable online resources.

As work keeps TWRI's researchers and professionals busy and the institute continues to grow and evolve, Texans can keep counting on TWRI as a source for reliable water research and educational resources and programs.

More of TWRI's 2015 impacts are in the institute's 2015 Annual Report, available in full at *twri.tamu.edu/about*.

2015 Highlights

- The Texas Well Owner Network won a 2016 AgriLife Extension Superior Service Award and a 2015 Extension Education Community Education Materials Award from the American Society of Agronomy.
- TWRI secured $3 million of U.S. Department of Agriculture's Natural Resources Conservation Service Regional Conservation Partnership Program funding to improve water quantity and quality in the Lower Rio Grande Valley.
- The Advanced Metering Infrastructure (AMI) web portal assists consumers in reducing water use and helps utilities provide better customer service. In 2015, two guidebooks were developed and eight trainings were held. Preliminary results demonstrated 8.7 to 17 percent seasonal reductions in water use by portal users.
- TWRI supports and helps lead the newly formed Texas A&M Water-Energy-Food Nexus Initiative, which is committed to solving the challenges of sustaining these three interconnected resources.
- In the Arroyo Colorado Watershed, more than 100,000 residents were educated on physical watershed processes through a model displayed at 221 events. Forty-two colonias with 17,054 residents decommissioned their septic systems and connected to centralized wastewater treatment plants through TWRI's efforts.
- The Leon River Watershed Protection Program educated landowners on best management practices through more than 30 field days and workshops and facilitated the repair or replacement of more than 65 failing septic systems.
- TWRI partnered with 30 local, state and federal water management agencies; 21 Texas A&M centers, departments and institutes; 17 universities; nine NGOs and consulting firms; and numerous stakeholder groups.

Wagner named TWRI deputy director of engagement

Dr. Kevin Wagner was named the deputy director of engagement of the Texas Water Resources Institute (TWRI) in January 2016. Formerly TWRI associate director, Wagner's new role includes engaging with the water resources community in Texas and the nation and coordinating TWRI's outreach activities with the Texas A&M AgriLife Extension Service and The Texas A&M University System.

"One of the foundational elements of the water institute is being able to develop effective engagement with the water community," said Dr. John C. Tracy, TWRI director. "Kevin has such a tremendous reputation in Texas and such experience across the state, he is ideal to serve in this role as a strong link between the A&M System and the water resources community."

Wagner has more than 20 years of experience in watershed assessment and planning, stakeholder engagement and conservation practice research and education, including 12 years in management positions. He joined TWRI in 2005 as a project manager and was responsible for developing and implementing water-related research and education projects.

Through his years at TWRI, Wagner said he has seen water resources concerns evolve. For much of the last decade, his work mainly centered on mitigating bacterial impairments in water bodies. However, since the 2011 drought, his focus has shifted to include drought-related issues and water conservation.

"I'm excited about this opportunity to help better align the excellent water research and outreach programs throughout the A&M System with the needs of the state, nation and beyond," he said. "Water resources research and education are more critical now than ever before with water shortages and declining water quality being observed globally."

Wagner also serves as an adjunct professor in Texas A&M's Department of Soil and Crop Sciences and mentors graduate students in their water resources research. He helps teach the annual Texas Watershed Planning Short Course for water resource professionals from throughout the state and nation.

Prior to joining TWRI, Wagner served as nonpoint source team leader and assistant director of programs for the Texas State Soil and Water Conservation Board. He received his bachelor's degree in biology from Howard Payne University, master's in environmental sciences from Oklahoma State University and doctorate in agronomy from Texas A&M.

Brian Jonescu, Clare Entwistle and (not pictured) Victor Gutierrez are new staff members on TWRI's water team. Photo by Leslie Lee, Texas Water Resources Institute.

New faces join TWRI's water team

The Texas Water Resources Institute's (TWRI) water team continues to increase its expertise and capabilities, adding three members within the last year: Clare Entwistle, Brian Jonescu and Victor Gutierrez.

Entwistle, who joined TWRI as a graduate research assistant in 2014, became a research associate in April 2016. In this position, she provides leadership for various research and extension projects. Currently, she is working on the Matagorda Basins project, where she will be working with stakeholders as well as state and local governments to develop a watershed protection plan for the Tres Palacios Watershed.

Entwistle received her bachelor's degree in mathematics with a minor in biology from Kalamazoo College in Kalamazoo, Michigan. She is currently pursuing a master's degree in Texas A&M University's Water Management and Hydrological Science Program.

As a research assistant, Jonescu provides leadership for the various water quality monitoring projects performed by the institute. Currently, he is leading a group of TWRI graduate students in monitoring water quality in the Navasota River, Little River, Lake O' the Pines and Tres Palacios Creek watersheds. He also works on various research and extension projects including watershed protection plans, watershed characterizations and quality assurance plans.

Jonescu initially joined TWRI as a graduate student researcher in 2014. He received his bachelor's degree in environmental science from Baylor University in 2013 and is currently working on his master's degree in Texas A&M's Water Management and Hydrological Science Program.

Gutierrez is a Texas A&M AgriLife Extension Service assistant for the institute and works on implementing the Arroyo Colorado Watershed Protection Plan in Weslaco. Through the Cost Share Education project, he helps coordinate and facilitate the project's local activities, including working with commodity groups and AgriLife Extension agents to plan and implement field days and educational meetings.

Prior to joining the institute in July 2015, Gutierrez was a research assistant with Texas A&M University-Kingsville where he earned a bachelor of science in general agriculture.

Other water team members include Dr. Allen Berthold, research scientist; Nikki Dictson, Extension program specialist; Jaime Flores, program coordinator; and Dr. Lucas Gregory; project specialist and quality assurance officer. The team is led by Dr. John C. Tracy, director; and Dr. Kevin Wagner, deputy director.

The Texas Well Owner Network Program received a 2016 Superior Service Award in the team category presented at the Growing a Healthy Texas 2016 Texas A&M AgriLife Extension Service Awards ceremony Jan. 12 in Bryan. Superior Service Awards recognize AgriLife Extension faculty and staff members who provide outstanding performance in Extension education or other outstanding service to the organization and to Texas. Team members pictured with Dr. Doug Steele, AgriLife Extension director, are (left to right): Steele; John W. Smith, soil and crop sciences; Paul Pope, agricultural leadership, education and communications; Danielle Kalisek, Texas Water Resources Institute; Drew Gholson, soil and crop sciences; Dr. Diane Boellstorff, soil and crop sciences; and Ryan Gerlich, biological and agricultural engineering. Photo courtesy of Texas A&M AgriLife Extension Service.

Texas A&M AgriLife Extension Service

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