Texas Water Development Board

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TO: Board Members

THROUGH: Jeff Walker, Executive Administrator
Sam Hermitte, Interim Deputy Executive Administrator, Water Science & Conservation
Todd Chenoweth, General Counsel

FROM: Kevin Kluge, Director, Conservation and Innovative Water Technologies
Cameron Turner, Manager, Agricultural Water Conservation
John Sutton, Manager, Municipal Water Conservation

DATE: January 31, 2018

SUBJECT: An Assessment of Water Conservation in Texas Report

ACTION REQUESTED

Consider approving the Assessment of Water Conservation Report, conducted jointly with the Texas State Soil and Water Conservation Board, as a supplement to the 2017 State Water Plan.

BACKGROUND

In 2001, the 77th Texas Legislature passed Senate Bill 312 which requires the Texas State Soil and Water Conservation Board and the Texas Water Development Board to jointly conduct a study of ways to improve or expand water conservation efforts and to report to the legislature, as part of or as a supplement to, the state water plan (Texas Water Code §16.022). The report is required to include:

1) an assessment of both agricultural and municipal water conservation issues;
2) information on existing conservation efforts by the TWDB and the Texas State Soil and Water Conservation Board;
3) information on existing conservation efforts by municipalities receiving funding from the TWDB as specified in water conservation plans submitted by the municipalities as part of their applications for assistance;
4) a discussion of future conservation needs;
5) an analysis of programmatic approaches and funding for additional conservation efforts;
6) an assessment of existing statutory authority and whether changes are needed to more effectively promote and fund conservation projects; and
7) an assessment of the TWDB's agricultural water conservation program.

Our Mission

To provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas

Board Members

Kathleen Jackson, Board Member | Peter Lake, Board Member

Jeff Walker, Executive Administrator

KEY ISSUES

The Texas State Soil and Water Conservation Board met on November 16, 2017, and approved final revisions to the report.

The TWDB portion of the report includes information on challenges and opportunities in water conservation. It does not contain any specific legislative recommendations pertaining to TWDB programs.

This is the fourth time this report has been issued. The TWDB and the Texas State Soil and Water Conservation Board previously produced supplemental reports to the 2002, 2007, and 2012 state water plans.

RECOMMENDATION

The Executive Administrator recommends approval of the January 2018 Assessment of Water Conservation in Texas Report for publication and delivery to the legislature, in accordance with the requirements set forth in Texas Water Code §16.022.

Attachment A: An Assessment of Water Conservation in Texas, January 2018

Attachment A

Attached is a draft copy of the legislative report,
An Assessment of Water Conservation in Texas, January 2018

An Assessment of Water Conservation in Texas

Prepared for the 85th Texas Legislature as a supplement to the 2017 State Water Plan

January 2018

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Peter Lake, Member
Jeff Walker, Executive Administrator

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Texas Water Development Board

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Executive summary

In 2001, the 77th Texas Legislature passed Senate Bill 312 (codified in Texas Water Code §16.022) requiring the Texas State Soil and Water Conservation Board (TSSWCB) and the Texas Water Development Board (TWDB) to jointly conduct a study of ways to improve or expand water conservation efforts and present their findings to the legislature as a part of or a supplement to the state water plan. As required by statute, this report provides an assessment of agricultural and municipal water conservation issues; conservation efforts by the TWDB, TSSWCB, and municipalities receiving financial assistance; a discussion of future conservation needs; an analysis of programmatic approaches and funding for additional conservation efforts; an assessment of existing statutory authority changes and whether changes are needed to more effectively promote and fund conservation projects; and an assessment of the TWDB's Agricultural Water Conservation Program.

In the 2017 State Water Plan, all 16 regional water planning groups recommended water conservation as a water management strategy[1]. By 2070, these conservation strategies (if implemented) would provide 2,344,000 acre-feet of water per year, representing over 30 percent of the approximately 8.5 million acre-feet per year in additional water supplies needed to meet ever growing demands in Texas. Implementation of these strategies requires financial investments to repair aging infrastructure, conduct education programs, and provide cost-share assistance for conservation planning and installation of water efficient equipment. The TWDB and TSSWCB programs provide entities and individuals with technical assistance in conservation planning and financial assistance, which will help to support implementation of the recommended conservation water management strategies in the 2017 State Water Plan.

[1] Texas Administrative Code §357.10 defines a water management strategy as "a plan or specific project to meet a need for additional water by a discrete user group, which can mean increasing the total water supply or maximizing an existing supply, including through reducing demands."

Section 1. Assessment of agricultural and municipal water conservation issues

Texas Water Code §11.002 defines conservation as "(1) the development of water resources; and (2) those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses." Conservation is often considered an essential demand management strategy in response to drought, yet the importance of conservation and water use efficiency extends well beyond drought. Advances in new technologies offer opportunities to improve irrigation efficiency, leak detection, and automation of water deliveries and data collection in the agricultural and municipal water use sectors.

The 2017 State Water Plan identifies significant water needs for both municipalities and irrigated agriculture. Whereas municipal water needs are primarily associated with population growth, especially in the Dallas-Ft. Worth metroplex and the greater Houston area (regions C and H, respectively), the majority of the irrigation water needs are associated with water level declines in the Ogallala Aquifer, primarily in the Texas High Plains (Region O; Figure 1).

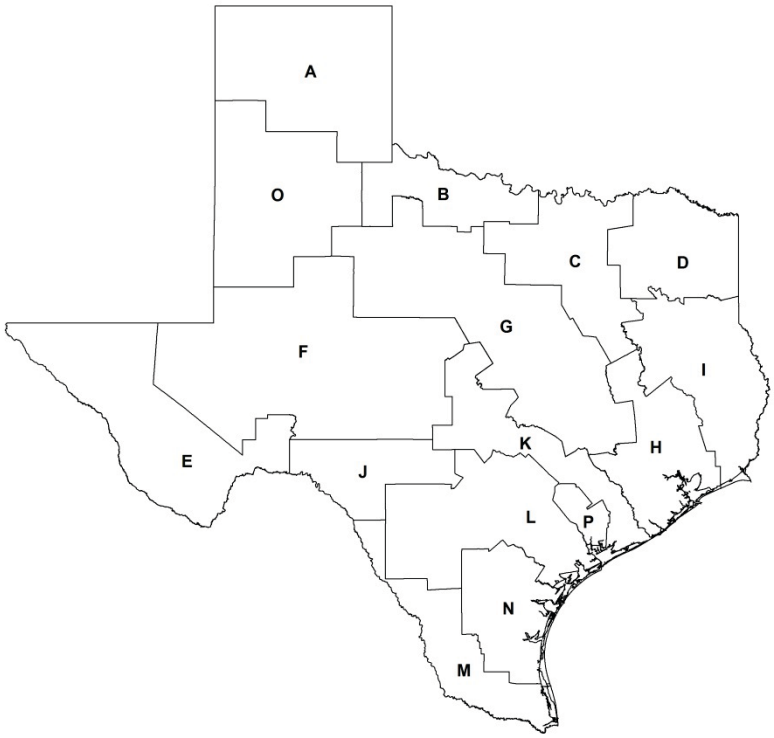

Figure 1. Regional Water Planning Areas.

Conservation strategies are projected to provide about 30 percent of future new water supplies from all recommended strategies, consisting of irrigation conservation (15.7 percent), municipal conservation (9.6 percent), drought management (2.7 percent), and other conservation (2.4 percent).

Agricultural water conservation issues

The 2017 State Water Plan recommends about 639,000 acre-feet per year in irrigation conservation strategies in 2020 and 1.33 million acre-feet per year in 2070. Agricultural water conservation includes irrigation best management practices for both on-farm and in-district water use applications. Regional variations in water sources, major crops, water management, and irrigation practices further complicate discussions of agricultural water conservation in Texas.

The in-district irrigation conservation strategies identified in the plan include replacement of, or fixes to, aging conveyance systems through canal lining and pipeline replacement, and infrastructure upgrades that save water but often cost significantly more than other conservation strategies. Furthermore, implementation of certain on-farm conservation strategies is not practical without first making necessary investments in the distribution systems. This is especially true in the Lower Rio Grande Valley where the vast majority of irrigated agriculture relies on surface water delivered by irrigation districts. An individual landowner may be hesitant to invest in costly upgrades to a pressurized irrigation system (an on-farm water conservation strategy) without access to a reliable and adequate supply of water.

Additional on-farm irrigation conservation strategies identified in the state water plan include changes to irrigation methods and equipment, such as conversion to Low Energy Precision Application (LEPA) or subsurface drip irrigation. These practices are more efficient, but an improvement in efficiency does not necessarily equate to water savings. This irrigation efficiency improvement simply allows producers to achieve higher yields per unit of water applied.

With competing demands and declining access to adequate irrigation supplies, agricultural producers continue to adopt efficient, cost-effective irrigation practices. Technologies such as real-time soil-moisture monitoring and remote management of irrigation systems offer agricultural producers opportunities to realize water savings and improve their water management via irrigation scheduling. Most agricultural producers are familiar with existing cost-share programs that facilitate adoption of conservation practices. Similarly, irrigation districts participate in programs that provide matching funds to upgrade their infrastructure. Demand for cost-share programs through TSSWCB and the TWDB, from individual landowners as well as irrigation and groundwater conservation districts, remains high, but the number of entities participating in loan programs for agricultural water conservation projects is limited.

Municipal water conservation issues

The 2017 State Water Plan recommends about 204,000 acre-feet per year in municipal conservation strategies in 2020 and 811,000 acre-feet per year in 2070. This is in addition to the estimated share of future passive conservation savings from plumbing codes and water efficiency standards (295,000 acre-feet per year in 2020 and 887,000 acre-feet per year in 2070), which are embedded in municipal water demand projections. Municipal conservation includes a variety of activities such as installation of low-flow plumbing fixtures, implementing water conservation pricing structures, and water loss programs, or landscape irrigation restrictions.

The 2017 State Water Plan also compares the near-term (2020) conditions of no water management strategies to future (2070) conditions assuming full implementation of the plan using a calculation method that includes

- using the baseline projected municipal gallons per capita per day projections,
- the addition of supply volumes provided by municipalities to manufacturing, and
- exclusion of existing municipal reuse supply volumes.

If all the recommended municipal conservation and reuse strategies were implemented in 2070, the projected statewide municipal average gallons per capita per day would decline from the currently projected 163 gallons per capita per day in 2020 (without recommended conservation or reuse strategies) to approximately 124 gallons per capita per day in 2070 (with recommended conservation and reuse strategies). This calculated 2070 water use is well below the comparable statewide municipal total water use goal of 140 gallons per capita per day recommended by the Water Conservation Implementation Task Force created by the 78th Texas Legislature through Senate Bill 1094 (TWDB, 2004). The 2017 State Water Plan is the first plan to report meeting the Task Force's recommended statewide water conservation goal within the planning horizon.

Even with the projected reduction in gallons per capita per day water use, there remain a few challenges. One challenge is the uncertainty of water conservation strategies being implemented and how successful they may be in reaching their goals. Related to addressing this challenge, the 84th Texas Legislature, through passage of House Bill 1, Rider 26, provided $2,250,000 in general revenue funds to the TWDB to manage a contract to study the most effective and accurate process to measure water conservation statewide, and by regional water planning area, quantify sufficient municipal water conservation strategies to meet the goals of the 2017 State Water Plan. This study is scheduled to be completed by September 2017, and will be helpful to the regional water planning groups, as well as local water utilities.

Perhaps another challenge is the economic viability of water utilities. Seasonal weather patterns can have a direct impact on water use and water sales. A dry summer might increase sales, or with water use restrictions in place because of drought, might limit water use and sales. At the

same time, a wet summer might also limit use and sales. Utilities may not have a rate structure that provides financial stability during such impacts because of social-economic concerns or because of political reasons. Rate studies and rate structures can help a utility maintain a sound economic base while often having minimal impact on customers.

Section 2a. Information on existing conservation efforts by the TWDB

The TWDB's mission is to provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas. TWDB conservation efforts include providing technical assistance and funding to encourage water conservation and the implementation of water conservation strategies across the state.

Technical assistance

We provide outreach, education, training, data, literature, and other technical assistance to promote increased water use efficiency throughout Texas. TWDB performance measures for the conservation program include targets for technical assistance activities including but not limited to teacher training, literature orders, data requests, and participation in public outreach events. Information on the number of entities, individuals, and unique communities served is recorded to track program performance. Technical assistance requests have remained high and, though it can vary from year to year, assistance provided has consistently been 20 to 40 percent above performance targets.

The statewide water conservation public awareness program, "Water IQ: Know Your Water", educates Texans about their water resources. The program provides support to participating local entities through online access to information about their local water resources and conservation programs. The Water IQ website[2] also provides water saving tips, a search tool for locating water suppliers by zip code, information on upcoming water-related events, and numerous other resources.

"TWDB Kids" is the umbrella term for all water conservation education efforts at the TWDB. The website[3] serves as the gateway to the agency's K-12 conservation education resources and features interactive games, water science visualizations, and many other activities to teach students about key water concepts. Staff also provide classroom resources and hands-on activities based on TWDB's "Major Rivers" (grades 4 and 5), "Raising Your Water IQ" (grades 6 to 8), and "Water Exploration" (high school) learning-standards-based educational programs.

We conduct training through workshops and webinars and provide outreach at conferences, trade shows, and other public events. The TWDB staff in the municipal water conservation section provides technical assistance to entities completing their water loss audits, water conservation plans, and water conservation annual reports (discussed in detail in section 3). Agricultural water conservation staff activities are described in section 7.

[2] www.wateriq.org
[3] www.twdb.texas.gov/kids

In 2013, the 83rd Texas Legislature provided funds through Senate Bill 1 to TWDB with a directive to develop an online database to consolidate reporting requirements for the water use survey, water loss audit, and annual conservation report that would allow for the reports to be completed, submitted, and viewed online. Starting with the submissions of the 2014 water loss audits, utility-entered water use survey data are auto-populated into the water loss audit, ensuring consistency in data reporting. In January 2017, an entity's utility profile, water conservation plan, and water conservation annual report will all be accessible online as well. Data from the water use survey and the water loss audit will auto-populate the conservation annual report along with required ancillary information such as targets and goals from water conservation plans. Water-use trend reports and similar analyses will also be available.

Rainwater harvesting

We provide education and outreach on rainwater harvesting and supports the promotion of rainwater harvesting as a water conservation practice. *The Texas Manual on Rainwater Harvesting*, published in 2005 and available online for free, remains the standard guide for rainwater harvesting in Texas. The TWDB developed the Texas Rain Catcher Awards in 2007 to educate the public and recognize excellence in the application of rainwater harvesting technology and has presented 37 awards to date. The TWDB also provides online training to municipal and county permitting staff pursuant to Local Government Code §580.004[4].

Conservation literature

In addition to providing a wide array of water conservation literature free to the public when exhibiting at outreach events, we distribute literature throughout Texas on a partial cost-recovery basis[5]. Brochures address topics that include a landscape watering guide, tips for conserving water in and around the home, and agricultural water conservation practices. The *Water for Texas* coloring and activity book remains popular. Water providers and informal educators often order large quantities of conservation literature to provide to their customers and students (Table 1).

[4] Local Government Code §580.004. Rainwater Harvesting

[5] Examples online at www.twdb.texas.gov/conservation/literature.

Table 1. Conservation literature distribution report, fiscal years 2001–2015

Fiscal year	Orders	Free pieces shipped	Paid pieces shipped	Collected
2011	234	85,673	125,787	$20,974.60
2012	143	45,188	77,395	$11,998.89
2013	157	51,822	129,206	$20,056.01
2014	136	50,425	52,413	$7,976.97
2015	89	30,461	42,765	$8,248.92
Total	759	263,569	427,566	$69,255.39

Conservation education grants

In 2013, the 83rd Texas Legislature appropriated $1 million to TWDB to fund water conservation education. Through a competitive process, five projects received grant funding to provide local, regional, and state-wide education activities during fiscal years 2014 and 2015 (Table 2)[6].

Table 2. Conservation education grants, fiscal years 2014 and 2015

Entity	Description	Amount
Colorado River Alliance	Conservation activities and hands-on learning projects	$140,000
North Texas Municipal Water District	Children's water conservation campaign for schools	$150,000
Texas American Water Works Association	Conservation training programs for medium and small water systems	$62,925
Texas Nursery & Landscape Association	Enhancement and promotion of the Texas WaterSmart landscape and irrigation program	$375,785
Texas Water Foundation, Inc.	Statewide conservation campaign and survey	$211,290
Total		$940,000

Other financial assistance programs and funding for conservation

Recognizing the need for a dedicated source of funding to implement the strategies identified through the state water planning process, the 83rd Texas Legislature passed House Bill 4 and Senate Joint Resolution 1, which—following voter approval—allowed for the creation of the State Water Implementation Fund for Texas (SWIFT)[7]. The legislation includes goals for 20

[6] The original amount of $1,000,000 was allocated and approved for five grant recipients. During contract negotiations, two recipients identified cost savings that reduced their funding requests. There was inadequate time to issue another request for proposals during the biennium to obligate the remaining $60,000.

[7] www.twdb.texas.gov/financial/programs/swift.

percent of the funding for conservation and reuse projects, as well as 10 percent for agricultural and rural projects. During the first two years of the SWIFT program, TWDB provided over $4.5 billion in funding commitments for projects included in the state water plan. Seven of those projects qualified as conservation projects (Table 3).

Table 3. SWIFT projects with conservation activities funded during fiscal years 2015 and 2016

Entity	Description	Amount
City of Austin	Advanced metering infrastructure	$80,195,000
City of Bedford	Water distribution and automatic meter readers	$90,000,000
City of Fort Worth	Advanced metering infrastructure	$76,000,000
City of Keller	Enhanced water loss control and conservation program	$12,180,000
City of Waco	Advanced metering infrastructure	$12,000,000
Hidalgo County Irrigation District #1	Agricultural irrigation conveyance System improvements	$7,100,000
Sabine River Authority	Sabine River Authority pump station	$75,000,000
Total		$352,475,000

In addition to SWIFT, several other financial assistance programs at TWDB include funding opportunities for conservation activities, including, for example, the Agricultural Water Conservation Fund, the Clean Water State Revolving Fund, the Drinking Water State Revolving Fund, and the Rural Water Assistance Fund[8]. Entities apply for funding to address water loss, meter replacement, infrastructure rehabilitation, and other efficiency improvements. Examples of projects funded through the Agricultural Water Conservation Fund are provided in Appendix A and B.

Staff support for the Water Conservation Advisory Council

Texas Water Code §10.010[9] states that TWDB shall provide administrative support to the Water Conservation Advisory Council, whose mission is

> *to establish a professional forum for the continuing development of water conservation resources, expertise, and progress evaluation of the highest quality for the benefit of Texas—its state leadership, regional and local governments, and general public.*

The Water Conservation Advisory Council[10] meets in Austin at least once every quarter to work on the seven charges assigned to it by the legislature. Progress made on these charges is

[8] www.twdb.texas.gov/financial
[9] Texas Water Code §10.010

documented in a biennial report delivered to the legislature on December 1 of each even-numbered year. Six workgroups composed of council members, their alternates, and other interested parties meet more frequently, often through conference calls, to update the online best management practices guide consisting of voluntary efficiency measures intended to save a quantifiable amount of water within a specified timeframe. Council workgroups also solicit nominations for the Blue Legacy Awards, presented at the Capitol as part of Texas Water Day in the spring of odd-numbered years, to showcase the water conservation efforts of private organizations, public entities, and individuals.

[10] www.savetexaswater.org

Section 2b. Information on existing conservation efforts by the TSSWCB

Texas farmers, ranchers, and forest landowners have a long history of voluntarily conserving the natural resources entrusted to them. The Texas State Soil and Water Conservation Board (TSSWCB) was established in 1939 in response to the ecological and agricultural devastation of the Dust Bowl. The TSSWCB works in partnership with Texas' 216 local soil and water conservation districts (SWCDs) to encourage the wise and productive use of the State's soil and water resources in a manner that promotes a clean, healthy environment and strong economic growth. The TSSWCB administers Texas' soil and water conservation law and delivers coordinated natural resource conservation programs to agricultural producers throughout the state. The TSSWCB is responsible for planning, implementing, and managing programs for preventing and abating agricultural and silvicultural (forestry-related) nonpoint sources of water pollution; administers a water supply enhancement program to increase available surface and groundwater supplies through the targeted control of water-depleting brush in areas in need of water conservation; works to ensure the State's network of 2,041 flood control dams is protecting lives and property from flood damage; works to improve border security along the Rio Grande through control of carrizo cane; and facilitates the Texas Invasive Species Coordinating Committee.

The TSSWCB has six major programs that address agricultural water conservation issues: Conservation Implementation Assistance Grant Program, Conservation Outreach and Education, Water Quality Management Plan Program, Flood Control Program, Rio Grande Carrizo Cane Eradication Program, and Water Supply Enhancement Program. In addition the TSSWCB is a statutorily-authorized member of the Water Conservation Advisory Council.

While neither the Conservation Implementation Assistance Grant Program nor the Water Quality Management Program is designed specifically or solely for water conservation, each includes water conservation in its implementation. Focused messages regarding water conservation are integrated into the agency's statewide delivery of conservation outreach and education programs to audiences including agricultural producers, rural landowners, school-age children, urban residents, and the general public. The Flood Control Program contributes to water conservation by preventing sediment from reaching the State's major water supply reservoirs that would otherwise reduce conservation storage capacity. While border security objectives guide the Rio Grande Carrizo Cane Eradication Program, water conservation is an ancillary benefit of controlling the species along the Rio Grande. Water conservation is the primary objective of the Water Supply Enhancement Program by reducing water lost to evapotranspiration and interception through the targeted control of brush. More information on the programs of the TSSWCB is available at http://www.tsswcb.texas.gov/.

Today, proper land stewardship and conservation enable production of more food, fuel, and fiber than ever on reduced acreage using no more water than was used in the 1950s. Most of the conservation practices implemented under land stewardship provide a greater benefit to public water resources, but can be very costly to farmers and ranchers. The technical assistance and financial incentives provided by the TSSWCB through various state funded programs is a key incentive to ensure continued land stewardship and enhancement of water supply in Texas. The efforts of private landowners are vitally important because voluntary land stewardship helps maximize the effectiveness of all other water management strategies. Many Texans today, especially those in urban areas, enjoy the public benefits, such as clean plentiful drinking water, they derive from the voluntary land stewardship provided by private landowners and agricultural producers throughout the state.

Soil and Water Conservation Districts – conservation program delivery system

SWCDs serve as the State's primary delivery system through which technical assistance and financial incentives for natural resource conservation programs are channeled to agricultural producers and rural landowners. The State's 216 local SWCDs give farmers and ranchers the opportunity to solve conservation challenges locally, instilling in landowners a stewardship ethic and individual responsibility for soil and water conservation.

Since 1984, the Texas legislature has appropriated funds annually to the TSSWCB for assisting the 216 SWCDs in Texas in their efforts to provide technical assistance to agricultural producers. These funds are typically used to pay for local conservation technicians who work with owners and operators of agricultural or other lands to implement various conservation practices, including those that address water conservation. In 2015 the TSSWCB provided $2.14 million to soil and water conservation districts for technical assistance. For fiscal years 2016 and 2017 this amount is $2.2 million per year.

Education and outreach

The TSSWCB has a statewide conservation outreach and education program that promotes, supports, and recognizes proper stewardship of the State's natural resources. Focused messages regarding water conservation are integrated into the program and delivered to a variety of audiences including agricultural producers, rural landowners, school-age children, urban residents, and the general public.

The TSSWCB distributes a wide range of water conservation publications, free to the public, including the Water Conservation BMP Guide for Agriculture in Texas.

The agency has continued outreach efforts through social media platforms including Facebook and Twitter and has expanded efforts via other platforms including LinkedIn, Instagram, and YouTube. Through these services, the TSSWCB has expanded its outreach to newer generations while improving its ability to communicate with traditional clientele.

Texas conservation awards program

Each year, the TSSWCB and the Association of Texas Soil and Water Conservation Districts co-sponsor the Texas Conservation Awards Program to recognize and honor those who dedicate themselves and their talents to the conservation and wise use of the State's renewable natural resources. The 2015 Awards Program marked the 37th year of this joint program. Local SWCDs select their outstanding individuals and submit them to the regional competition. Those selected as regional winners are honored each May at regional awards banquets. From these regional winners, a state winner is selected for Conservation Farmer, Conservation Rancher, Conservation Teacher, Friend of Conservation, Conservation District, Conservation Poster, and Junior and Senior Essay. These individuals are invited to the Annual State Meeting of Texas SWCD Directors for recognition.

The conservation awards program provides competition and incentives to expand and improve conservation efforts, resource development, and increase the wise utilization of renewable natural resources. Through these conservation awards, SWCDs and citizens are benefited.

Soil and water stewardship public speaking contest

The Soil and Water Stewardship Public Speaking Contest is open to high school students interested in soil, water, and related renewable natural resource conservation. The contest is aimed at broadening student's interest and knowledge of conservation and how individuals must depend on and take care of the world around them for survival. The contest is coordinated through the Association of Texas Soil and Water Conservation Districts, with contests at the local, regional, and state level. Local winners compete in the ten state areas and the first and second place winners advance to compete for the state title.

Wildlife Alliance for Youth

The Wildlife Alliance for Youth is a consortium of state, federal, and private organizations working together to provide support and technical assistance to agricultural teachers and 4-H leaders who train youth in various aspects of wildlife conservation and management. After foundation skills are acquired, teams compete in a series of graduated local and regional contests which culminates in a state competition event. Participating youth demonstrate knowledge of theory through practical application of problem solving scenarios related to wildlife management in the field.

Water Quality Management Plan program

In 1993 the Texas Legislature passed Senate Bill 503 directing the TSSWCB to implement water quality management plans in Texas. A water quality management plan is site-specific and developed through SWCDs for agricultural or silvicultural lands. The plan includes appropriate and essential land treatment practices, production practices, management measures, or technologies applicable to the planned land use. The purpose of a water quality management plan is to achieve a level of pollution prevention or abatement determined by the TSSWCB, in consultation with local SWCDs, to be consistent with state water quality standards. Currently, TSSWCB has 10,660 certified water quality management plans in Texas. While this program is designed for water quality, many of the practices included in a water quality management plan are effective at conserving water as well. Water conservation practices include: conversion to more efficient irrigation systems, irrigation land leveling, irrigation tail water recovery, and pond sealing. The Texas Legislature appropriated approximately $1.9 million per year for this program in the 2014–2015 biennium and also in the current 2016–2017 biennium.

Flood Control program

There are 2,041 flood control structures across the state built on private property through the USDA-Natural Resources Conservation Service Watershed Program. Each of these watershed projects is sponsored by a SWCD, along with co-sponsors such as counties, cities, and water control and improvement districts. Seventeen of these structures are multi-purpose structures, which means that besides flood control they also provide water for municipal, industrial, and agricultural uses. In addition, all of the structures are designed to capture sediment for the life of the dam, which benefits downstream water supply reservoirs by reducing sedimentation and preserving water supply capacity. As an example, there are approximately 900 flood control structures in the Upper Trinity River watershed which reduce sedimentation into several water supply reservoirs in the Dallas-Fort Worth area. Statewide, the total design sediment storage of these flood control structures is about 390,000 acre-feet.

Local watershed project sponsors, such as the SWCDs, are responsible for the operation and maintenance of these structures to ensure that the structures will continue to provide sediment reduction and flood control benefits. However, many sponsors have difficulty in raising adequate funds locally to meet maintenance and repair needs. Therefore, in 2010 the legislature began providing funds to the TSSWCB for grants to local SWCDs to assist with maintenance and repair of these dams. For the 2016–2017 biennium, the legislature appropriated $14.8 million for this program. This program is helping to ensure that flood control structures in Texas are maintained in good condition to enhance both public safety and water supply statewide.

Rio Grande Carrizo Cane Eradication program

Large dense stands of non-native carrizo cane (Arundo donax) now occupy the banks and floodplains of the Rio Grande. These stands of invasive riparian weeds present considerable obstacles for the protection of the international border by law enforcement and agricultural inspectors, by both significantly reducing visibility within law enforcement areas, and providing favorable habitat for agriculturally-damaging cattle ticks.

Carrizo cane is considered one of the greatest threats to the health of riparian ecosystems in the southwestern United States, impairing the ecological function and biodiversity of the Rio Grande. Carrizo cane is a noxious brush species that consumes precious water resources to a degree that is detrimental to water conservation. As a result of this weed's high evapotranspiration capacity, infestations threaten water supplies for agricultural and municipal drinking water uses in south Texas.

In order to help meet the Governor's border security priorities, the 84th Texas Legislature, in 2015, directed the TSSWCB, through Senate Bill 1734, to develop and implement a program to eradicate carrizo cane along the Rio Grande.

The TSSWCB must develop a program that establishes long-term management of invasive carrizo cane at a landscape scale along the entire Rio Grande. Comprehensively addressing the impacts of carrizo cane on border security are paramount to the program, while also accruing benefits to the ecosystem health of the Rio Grande and water user groups in South Texas. While achieving border security objectives, the Rio Grande Carrizo Cane Eradication Program should also enhance water savings by conserving water lost to evapotranspiration by the cane, even accounting for water use by regrowth of native riparian plants.

The process to develop a program will involve affected landowners, municipalities, other state and federal governmental entities, and concerned citizens. The TSSWCB is in the "public scoping" stage of soliciting input from the public and affected stakeholders on how this program should be implemented.

More information on the Rio Grande Carrizo Cane Eradication Program is available at http://www.tsswcb.texas.gov/arundo.

Water Savings from the Rio Grande Carrizo Cane Eradication program

Carrizo cane consumes water resources to a degree that is detrimental to water conservation, threatening water supplies for agricultural and municipal drinking water user groups in South Texas. There is an estimated 30,000-60,000 acres of carrizo cane along the entire Rio Grande (U.S. Department of Agriculture-Agricultural Research Service; Texas Parks and Wildlife Department). Several studies (Zembal and Hoffman 2000; Oakins 2001; Jackson et al. 2002) have

indicated that Arundo's water use is three times that of native vegetation. Other studies (Jackson et al. 2002; Iverson 1994) indicate that carrizo cane can consume 3.8-5.6 acre-feet of water per acre of cane per year. Control of carrizo cane infestations along the Rio Grande could yield as much as 76,000 to 224,000 acre-feet of water savings.

Since 2009, the U.S. Department of Agriculture-Agricultural Research Service has been releasing biological control agents along the Rio Grande to combat carrizo cane infestations. Scientists have estimated that a 22 percent reduction in carrizo cane above-ground biomass attributed to biological control along the Rio Grande over the period 2009–2014 had water savings of 6,593 acre-feet per year, even accounting for water use by regrowth of native riparian plants (Goolsby et al. 2015). It is anticipated that carrizo cane control along the Rio Grande through the TSSWCB Rio Grande Carrizo Cane Eradication Program will achieve comparable water conservation savings.

Water Supply Enhancement Program

Over at least the past 16 decades, rangeland vegetation in the United States, largely in the West, has undergone a large-scale conversion from grasslands and savannas to woodlands and shrubland. Noxious brush, detrimental to water conservation, has invaded millions of acres of rangeland and riparian areas in Texas, negatively impacting the water budget and reducing or eliminating stream flow and aquifer recharge through interception of rainfall and increased evapotranspiration. Brush control has the potential to enhance water yield by conserving water lost to evapotranspiration, recharge groundwater and aquifers, enhance spring and stream flows, improve soil health, restore native wildlife habitat by improving rangeland, improve livestock grazing distribution, protect water quality and reduce soil erosion, aid in wildfire suppression by reducing hazardous fuels, and manage invasive species. (TSSWCB 2014)

In order to help meet the State's critical water conservation needs and ensure availability of public water supplies, in 1985, the 69th Texas Legislature established the Brush Control Program (Senate Bill 1083) administered by the TSSWCB. Subsequently as a result of the Texas Sunset Advisory Commission's recommendations for improving agency programs, in 2011, the 82nd Texas Legislature passed House Bill 1808 which delineated major changes to TSSWCB's programs, including the elimination of the Brush Control Program, effective September 2011. House Bill 1808 established a new program administered by the TSSWCB, the Water Supply Enhancement Program, with the purpose of increasing available surface and ground water supplies through the targeted control of brush species that are detrimental to water conservation (e.g. juniper, mesquite, saltcedar).

In accordance with statute, the TSSWCB must prepare and adopt the *State Water Supply Enhancement Plan* (formerly the *State Brush Control Plan*). The *State Water Supply Enhancement Plan* serves as the State's comprehensive strategy for managing brush in all areas of the state

where brush is contributing to a substantial water conservation problem. The *State Water Supply Enhancement Plan* also serves as the programmatic guidance for the Water Supply Enhancement Program. The TSSWCB adopted the current *State Water Supply Enhancement Plan* on July 28, 2014. The plan is a "living" document and must be reviewed at least every two years.

The TSSWCB collaborates with SWCDs, and other local, regional, state, and federal agencies to identify watersheds across the state where it is feasible to implement brush control in order to enhance public water supplies. Water Supply Enhancement Program funds may only be allocated to projects that have a completed feasibility study that includes a site-specific computer model. The TSSWCB uses a competitive grant process to rank feasible projects and allocate grant funds through the program, giving priority to projects that balance the most critical water conservation need of municipal water user groups with the highest projected water yield from brush control.

In watersheds where Water Supply Enhancement Program funds have been allocated, TSSWCB works through local SWCDs to deliver technical assistance to landowners in order to implement brush control activities for water supply enhancement. A 10-year resource management plan is developed for each property enrolled in the program which describes the brush control activities to be implemented, follow-up treatment requirements, brush density to be maintained after treatment, and supporting practices to be implemented including livestock grazing management, wildlife habitat management, and erosion control measures. Cost-share incentive funding is then provided through the Water Supply Enhancement Program to landowners implementing brush control activities on eligible acres consistent with their resources management plan.

The TSSWCB publishes a statutorily-required Water Supply Enhancement Program *Annual Report* which serves as a comprehensive analysis of the program's effectiveness during the preceding calendar year. The *Annual Report* documents program results, assesses the program, reports on program participant compliance with resource management plans, and reports overall projected water yield enhanced.

More information on the Water Supply Enhancement Program is available at http://www.tsswcb.texas.gov/brushcontrol.

Feasibility studies and priority watersheds

In accordance with Texas Agriculture Code §203.053(b), for a watershed to be considered eligible for allocation of Water Supply Enhancement Program cost-share incentive funds, a brush control feasibility study that includes a watershed-specific computer model must be completed and must demonstrate increases in projected post-treatment water yield as compared to the pre-treatment conditions.

Since 1998, TSSWCB has collaborated with many partnering entities to conduct these assessments of the feasibility of conducting brush control for water supply enhancement in watersheds across Texas. These feasibility studies identify watersheds where it is feasible to enhance public water supplies through brush control. The computer models provide estimates of the projected water yield enhanced through brush control.

In accordance with 31 Texas Administrative Code §517.25 and the *State Water Supply Enhancement Plan*, the TSSWCB may consider accepting brush control feasibility studies and designating the studied areas as priority project watersheds. Feasibility studies have been conducted and published, and the reports accepted by the TSSWCB as established Water Supply Enhancement Program project watersheds, for 23 watersheds (Figure 2) (16 Feasibility Studies published by multiple entities between 1999 and 2016 for the TSSWCB; accessible from http://www.tsswcb.texas.gov/reports#feasibilitystudy).

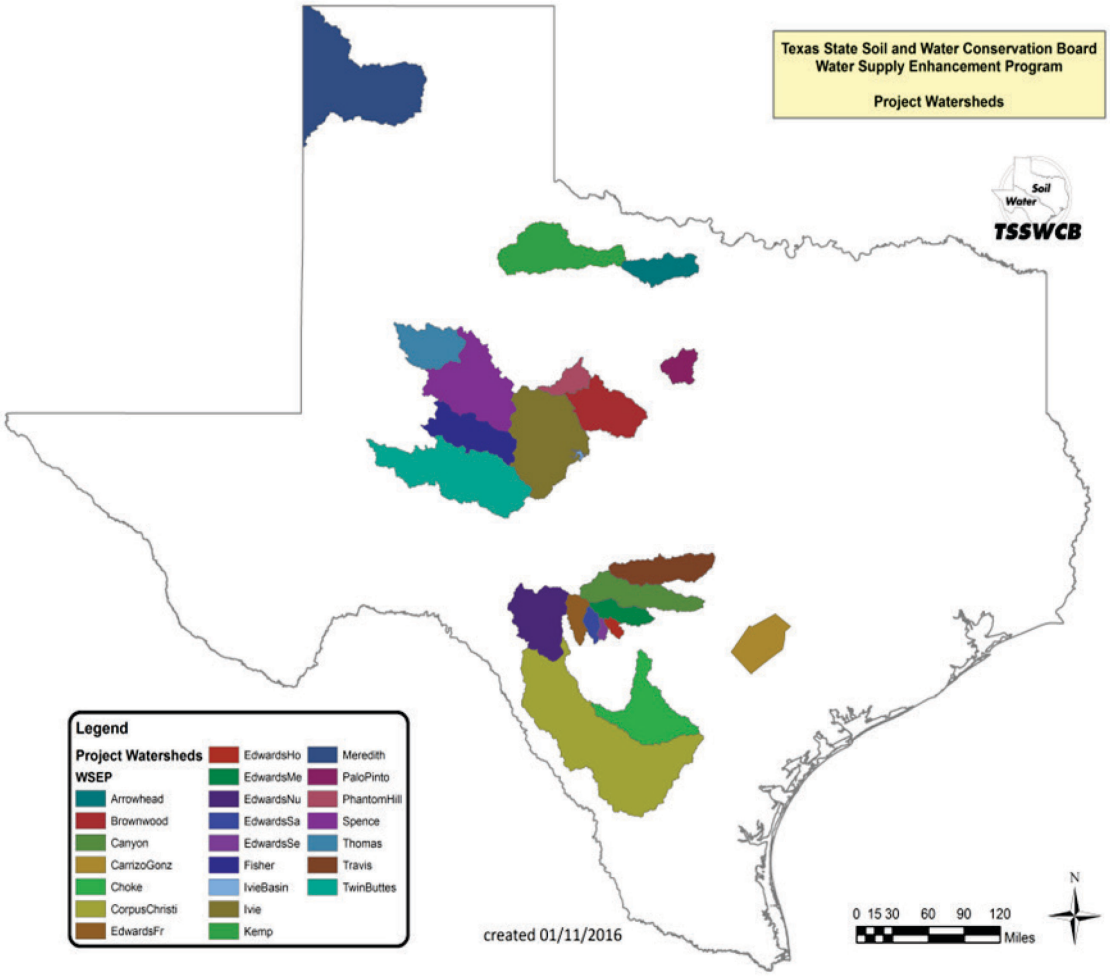

Figure 2. Completed feasibility studies and project watersheds

Several feasibility studies are in progress; that is, computer models are being developed for these watersheds. Once these studies are completed, if they demonstrate increases in projected post-treatment water yield as compared to the pre-treatment conditions, the TSSWCB may consider accepting the feasibility studies and establishing these areas as Water Supply Enhancement Program project watersheds. Some of these studies are being conducted solely with funds from TSSWCB and some are collaboratively funded by third-parties (Figure 3).

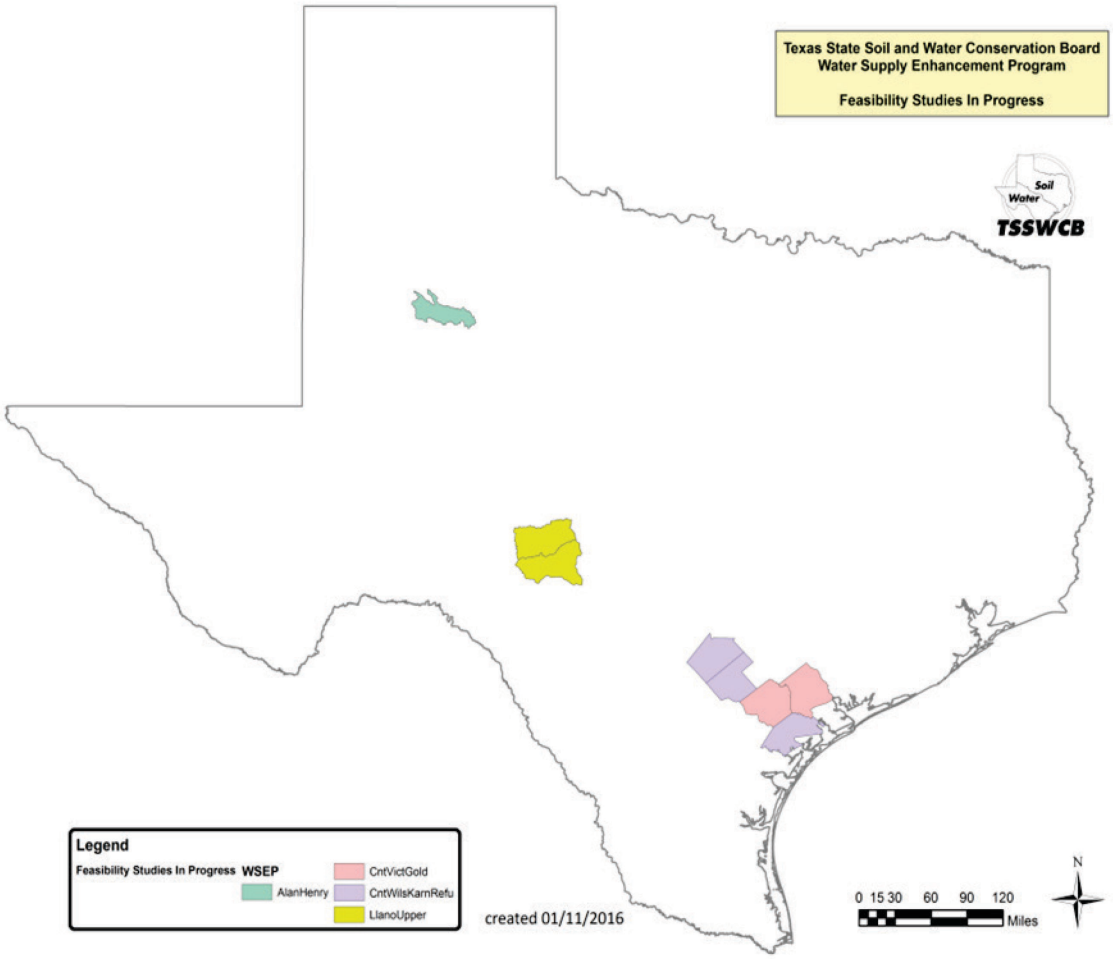

Figure 3. Brush control feasibility studies currently being conducted

Water Supply Enhancement Program interaction with the state water plan

In prioritizing water supply enhancement projects for funding, the TSSWCB must consider the need for conservation of water resources within the territory of a proposed project, based on the state water plan as adopted by the TWDB (Texas Agriculture Code §203.053(d)(1)). The TSSWCB also considers whether or not a regional water planning group has identified brush control as a water management strategy in the state water plan.

Brush control for water supply enhancement is addressed in different ways by the 16 regional water planning groups. Brush control and voluntary land stewardship, as recommended water management strategies, are included in the 2017 State Water Plan.

Of the 16 regional water plans, brush control (also known as, range management or land stewardship) is discussed in 13 plans. Brush control is recommended in some form (either as a water management strategy or as a policy recommendation) in nine of those plans, and the 2017 State Water Plan identifies three regions where brush control is a fully evaluated recommended water management strategy with a quantified yield under drought of record conditions.

Water savings from brush control through the Water Supply Enhancement Program

Full implementation of brush control, as modeled in all published feasibility studies for the 24 approved Water Supply Enhancement Program project watersheds, has a total projected annual water yield of 2.41 million acre-feet of water that could be conserved if the State was able to provide cost-share incentive funding to landowners to treat 15.86 million acres of brush in those watersheds. These projections depend greatly upon the extent of voluntary landowner participation and on the climatic conditions across the state that influence the sequence of drought and rainfall events.

Since the beginning of a statewide comprehensive strategy for managing brush where it is contributing to a water conservation program, through the Water Supply Enhancement Program and its predecessor the Brush Control Program, over 852,068 acres of brush have been treated (fiscal years 2000–2015) in various priority watersheds across the state.

Water conserved through the TSSWCB Water Supply Enhancement Program in 2012–2016 and projected in 2017–2021 is shown in Figure 4. Water conserved each water year is based on acres of brush treated during the previous ten fiscal years and is calculated according to water yield projections in published feasibility studies. Realization of projected water conserved depends greatly upon the extent of voluntary landowner compliance with follow-up treatment requirements and on the climatic conditions across the state that influences the sequence of drought and rainfall events. Water yield for 2012–2021 should be higher based on acres of brush treated through the Brush Control Program in fiscal years 2002–2011; however, water yield data for the Brush Control Program for fiscal years 2002–2011 are not readily available. Water yield for 2018–2021 will be higher based on acres of brush to be treated utilizing fiscal year 2017 cost-share incentive funds and if funds are appropriated by the Texas Legislature for the 2018–2019 and fiscal years bienniums.

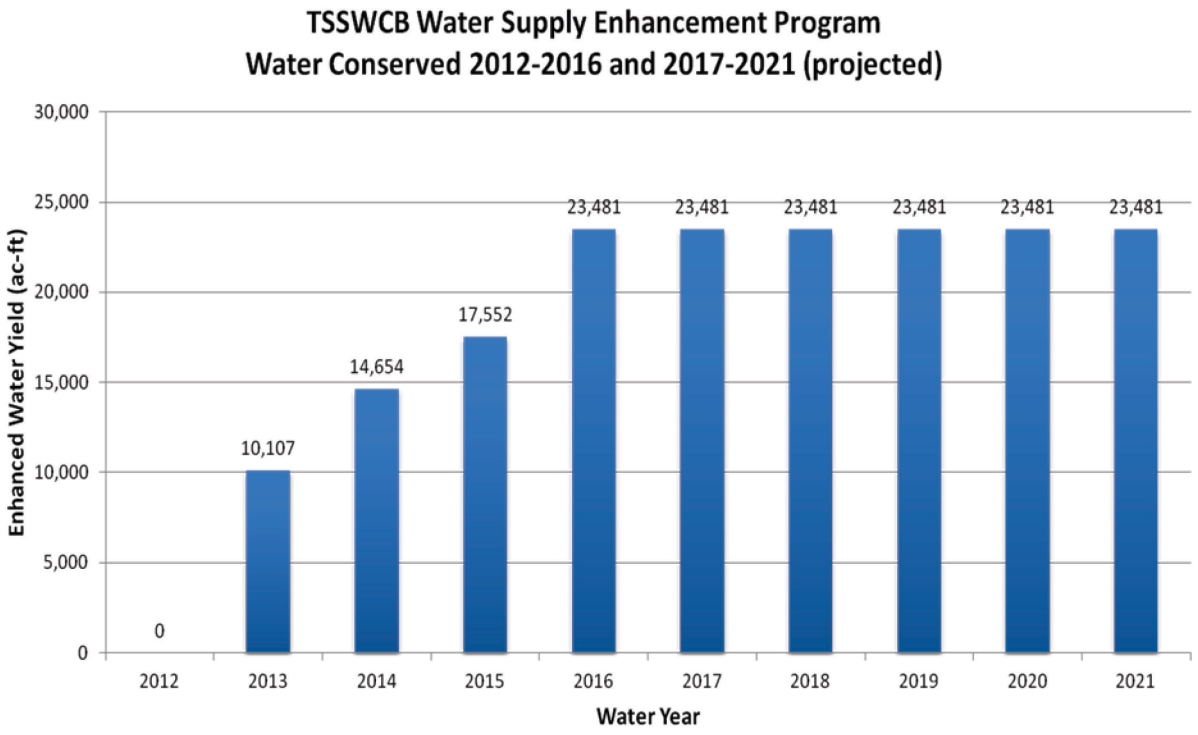

Figure 4. Water Conserved through the Water Supply Enhancement Program 2012-2021

Coordination with federal agencies

The Conservation Partnership, consisting of the 216 local soil and water conservation districts, the TSSWCB, and the federal U.S. Department of Agriculture-Natural Resources Conservation Service (Figure 5), is one of the most efficient and effective mechanisms for conducting natural resource conservation programs targeted to agricultural producers and rural landowners. Most of TSSWCB's programs are coordinated through the conservation program delivery system of the state's 216 local soil and water conservation districts. The districts provide technical and planning assistance to help agricultural producers implement water conservation best management practices on their farms and ranches.

The TSSWCB Flood Control Program is directed to dams built through the U.S. Department of Agriculture-Natural Resources Conservation Service programs. Administering the Flood Control Program therefore requires close coordination with the Natural Resources Conservation Service on dam safety, design, and construction. In addition, top priority for dam repair is given to projects that have been allocated federal funds through the Natural Resources Conservation Service's programs such as the Watershed Rehabilitation Program and the Emergency Watershed Protection Program. The availability of federal funds helps TSSWCB accomplish significantly more dam repairs by using State funds as leverage for the federal money. Currently, TSSWCB is leveraging state funds with federal funds on ten Watershed Rehabilitation Program

projects and twenty-three Emergency Watershed Protection Program projects. Planning and design are underway on ten other dams that expect to receive federal funds in the future, including one multipurpose dam for flood control and water supply.

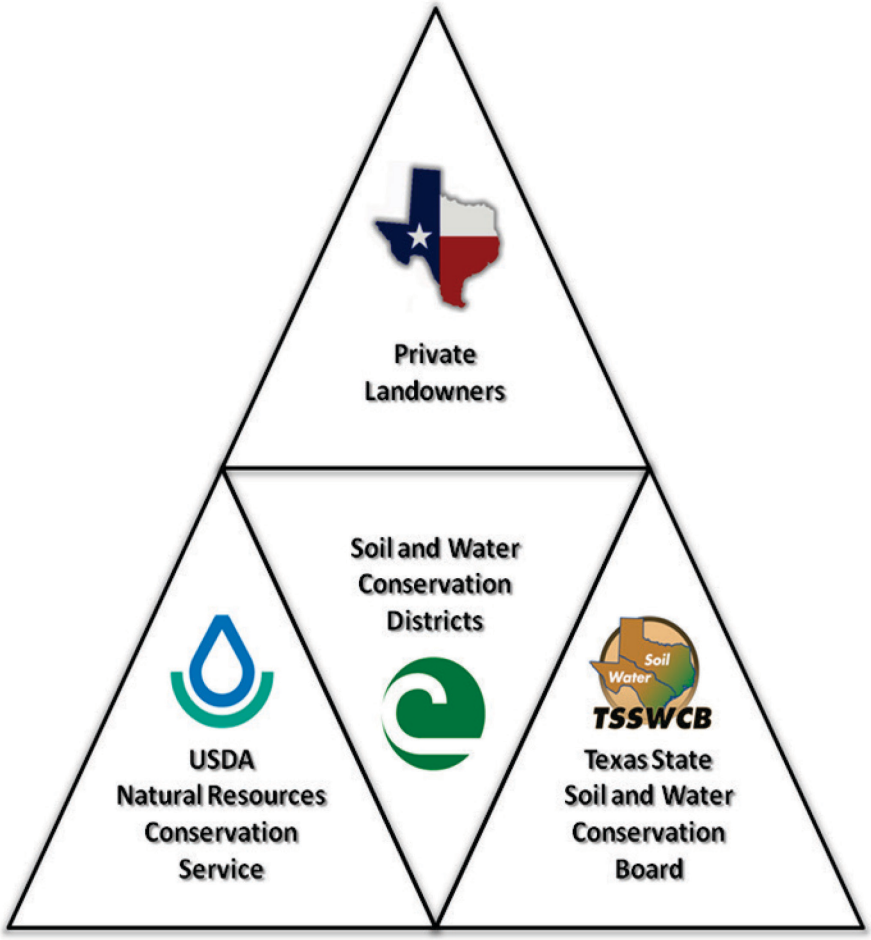

Figure 5. Texas Conservation Partnership—over 76 years of conservation assistance

Section 3. Conservation efforts by municipalities receiving funding from the TWDB

Municipalities receiving funding from the TWDB are required to submit conservation plans, annual reports, and water loss audits as a condition of their financial assistance. Those reports include water use data, water conservation targets and goals, water loss information, and descriptions of an entity's conservation efforts.

Water conservation plans and annual reports

Since 1989, entities receiving financial assistance of more than $500,000 from TWDB must submit water conservation plans and an annual report of their implementation to TWDB. Additionally, entities with either a non-irrigation surface water right of more than 1,000 acre-feet per year or an irrigation surface water right greater than 10,000 acre-feet per year are required to submit a water conservation plan to the Texas Commission on Environmental Quality and provide a copy of that plan to TWDB. In addition, after 2009, entities with 3,300 connections or more must also submit a water conservation plan to TWDB[11].

Conservation plans must include 5- and 10-year goals for total water use (all water produced by the utility divided by its population), residential water use (all water sold by the utility for residential use divided by its single-family and multifamily population), and water loss expressed in gallons per capita per day (Table 4). The plans are required to be revised every five years. Entities required to submit a water conservation plan are also required to report annually on the implementation of their conservation plan (Table 5) and submit a copy of their water conservation plan to the appropriate regional water planning group for consideration in identifying water management strategies (31 Texas Administrative Code Chapter 363, Subchapter A, Rule 363.15/Texas Water Code §15.106(b)).

Table 4. Water conservation annual report data

	5-Year Goal†	2011	2012	2013	2014	2015
Total GPCD*	146	157	148	148	148	143
Residential GPCD*	92	103	94	82	79	78
Water loss GPCD*	17	16	21	20	20	18
Percent water loss	12	10	12	13	14	13
Percent water reuse	NA‡	7	7	6	8	9
Percent water conserved	NA‡	6	10	6	8	13

* gallons per capita per day, † 5-year goals from 2014 conservation plan data; ‡not applicable

[11] Find more details at www.twdb.texas.gov/conservation/municipal.

Table 5. Activities reported in water conservation annual reports

Activity	2011	2012	2013	2014	2015
Meters replaced	360,353	459,026	326,305	364,875	359,957
Leaks repaired	194,587	154,674	96,991	140,976	110,387
Education programs	354	301	308	266	297
Drought plans activated	230	168	164	179	118

Water loss audits

All retail public water suppliers are required to submit a water loss audit once every five years. In addition, retail public water suppliers with either an active financial obligation with the TWDB or with more than 3,300 connections must submit an annual water loss water audit[12] (Texas Water Code §16.0121 and Texas Administrative Code §358.6).

In 2013, the Texas Legislature passed house bills 857, 3604, and 3605 relating to water loss audits, water conservation plans, and TWDB financial assistance. One outcome of these bills is that TWDB is now required to establish water loss thresholds to be used in consideration of financial assistance applications for water supply projects. Retail public utilities requesting assistance with water loss that is at or above the established threshold must use a portion of the funding to mitigate water loss within their system. In 2015, the Texas Legislature passed House Bill 949, allowing the TWDB to waive that requirement at the request of the retail public utility, if TWDB finds that the utility is satisfactorily addressing their water loss (Texas Water Code §§16.0121(g) and (h)).

[12] http://www.twdb.texas.gov/conservation/municipal/waterloss/index.asp

Section 4. Discussion of future conservation needs

The American Society of Civil Engineers[13] gave infrastructure in the United States a near-failing grade of "D+". Texas was no exception: flood control, dams, and drinking water sectors in the state all had a ranking of "D" or "D-" in the *2012 Report Card for Texas' Infrastructure* (ASCE, 2012). Addressing these infrastructure needs will require significant investment and implementation of recommended water management strategies to ensure adequate water supplies during times of drought. With the population projected to reach 51 million by 2070, the Texas-sized thirst for water will require thoughtful planning and swift action to ensure the availability of adequate water supplies (Figure 6).

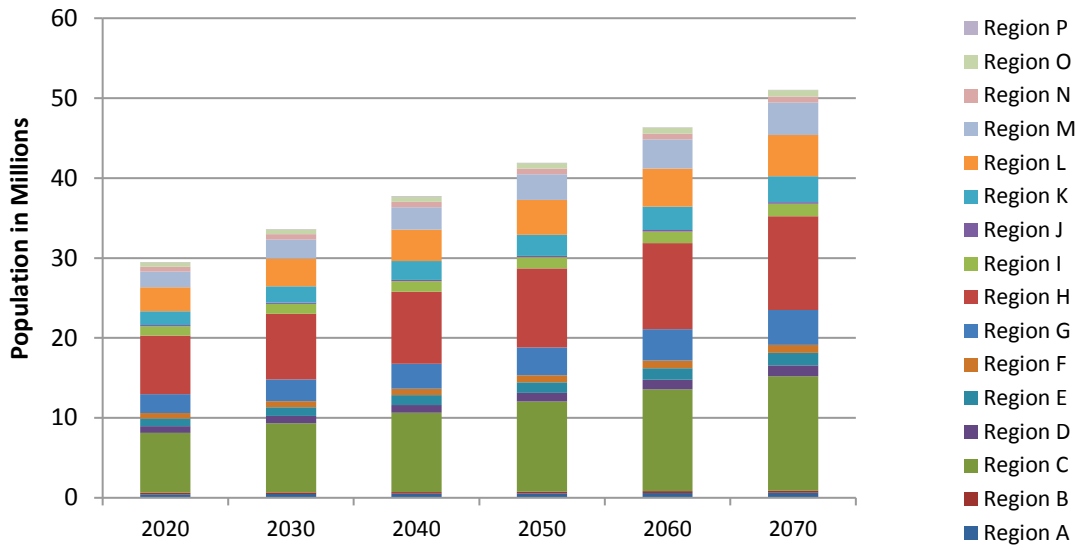

Figure 6. Projected population growth in Texas by regional water planning area

Texas must plan for this growth to not only address the need for a safe, secure, and sufficient drinking water supply for all Texans, but also for the industries that fuel our economy, power a reliable energy grid, provide an abundance of locally-grown agricultural products, and sustain the environmental needs of the state. To that end, the 16 regional water planning groups recommended water management strategies to meet the growing water demands (Figure 7) of the state, including an increasing commitment to conservation.

[13] http://www.infrastructurereportcard.org/

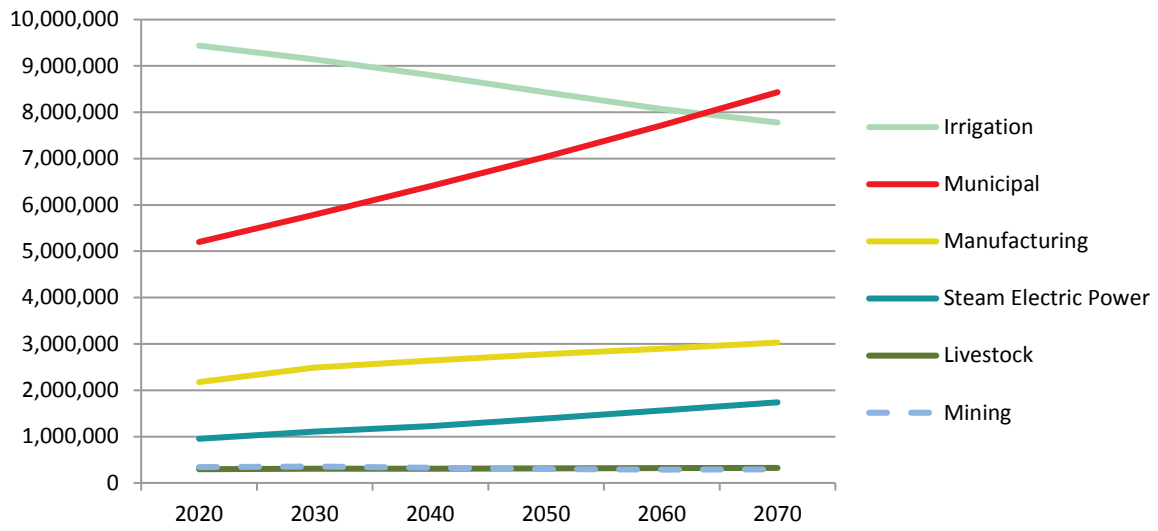

Figure 7. Projected annual water demand by water use category (acre-feet)

Through the regional water planning process, local stakeholders identify water management strategies that will meet their future water needs. The regional water planning groups must consider conservation in their evaluation of water management strategies in planning for the future growth and water supply needs in their region. Conservation focuses on efficiency of use and the reduction of demands on existing water supplies and is often one of the most cost-effective sources of new water supplies. Financial assistance in the form of grants, loans, and other incentives encourages adoption of these proven conservation strategies.

All 16 regional water planning groups identified conservation as a recommended strategy. Conservation and drought management accounts for 30 percent of the 2070 projected new water supply volumes from all recommended strategies (Figure 8), yet the capital costs associated with implementing the conservation strategies amounts to only about six percent of the overall $62.6 billion cost associated with implementing all recommended water management strategies in the 2017 State Water Plan. To realize these cost-effective conservation goals will require strong leadership at the state, regional, and local level to overcome the challenges associated with the perceptions, economics, and measurement of conservation efforts.

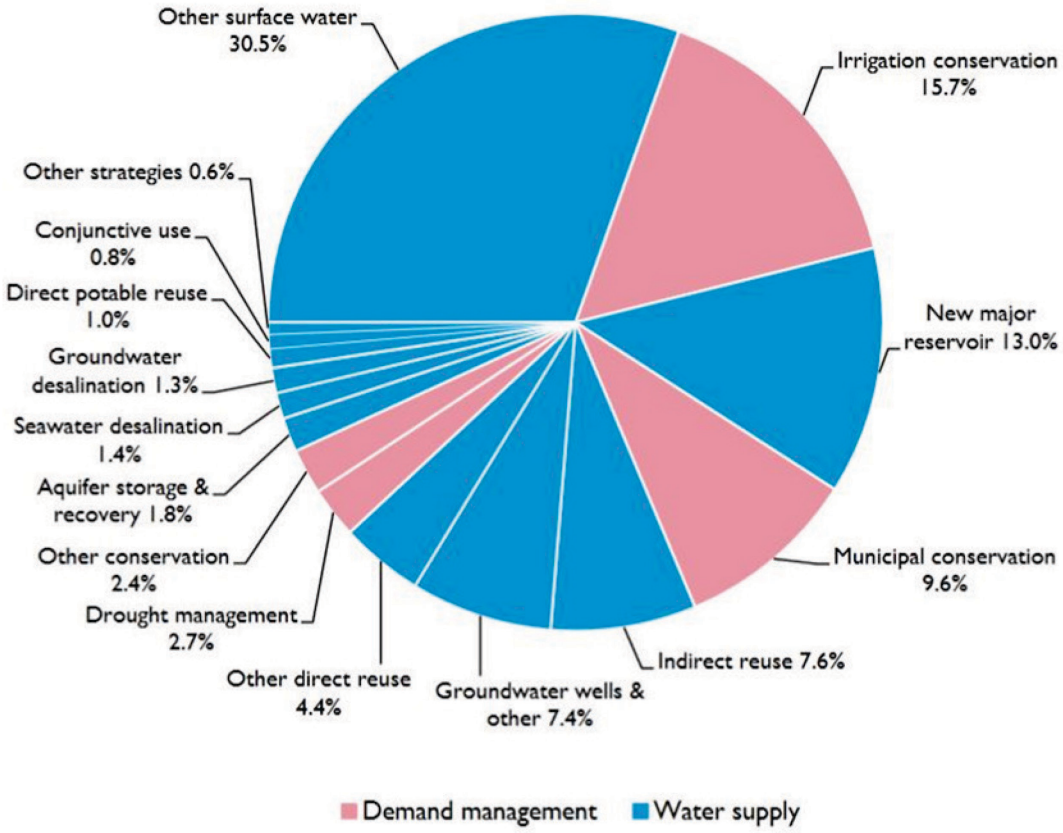

Figure 8. Share of recommended water management strategy by type in 2070

Section 5. Analysis of programmatic approaches and funding for conservation

According to the Texas A&M AgriLife Extension Service, only 20 percent of Texans believe there will be an adequate water supply to meet demands in the next 10 years, while nearly 45 percent believe water supply issues are not a problem where they live (Boellstorff and others, 2010). Water conservation begins with awareness. The TWDB and TSSWCB programs provide a framework for successful technical assistance to increase awareness of the importance of water conservation in meeting the state's water needs. However, these efforts often operate without a dedicated source of funding. Many conservation programs at the TWDB and the TSSWCB receive general revenue appropriations. Other financial assistance programs may be supported by issuance of bonds, federal funding, or dedicated funds established through previous legislative action. For example, as the Agricultural Water Conservation Program at TWDB draws down the balance of dedicated Agricultural Water Conservation Fund, the program could be at risk of running out of money and being discontinued. Programs supported by federal funding may also be at risk of decreasing funding allocations depending upon congressional action and federal budget appropriations.

Conservation strategies can essentially be broken down into two approaches: demand-side efforts at the water-user level and supply-side efforts at the water-supplier level. Supply-side infrastructure improvements such as addressing water loss may offer a return on investment in terms of increased revenue streams. These types of projects are well-adapted to a variety of financial assistance programs at TWDB. Demand-side conservation strategies such as toilet replacements, low-flow showerheads, homeowner irrigation system audits, and conservation education programs are a few examples of municipal water conservation strategies that are better suited to a rebate program, grant funding, or cost-share assistance.

Water IQ: Know Your Water (TWDB)

The TWDB administers the statewide water conservation awareness campaign called Water IQ: Know Your Water. The program operates through support from existing TWDB staff: no funding is allocated to the program. A 2004 research study conducted by Tuerff-Davis EnviroMedia, Inc. (TWDB, 2004) showed that the more Texans knew about their water resources, the more likely they were to participate in conservation activities. The more knowledgeable Texans are about the state's water resources, the more likely they are to be engaged in water issues, the planning process and the future of water in Texas.

Major Rivers (TWDB)

The TWDB administers the Major Rivers educational campaign on a cost-recovery basis and distributes materials via printed booklets and teacher guides. This limits the reach and adoption

of the program to those who can afford to purchase additional educational materials. Conservation staff would like to develop an accessible online, interactive viewer similar to that of the interactive state water plan[14]. This effort would likely require additional funding and staff resources.

The TexMesonet (TWDB)

The TWDB established the TexMesonet[15] to create a unified virtual network of high quality data to support flood monitoring and flood forecasting efforts by the National Weather Service, regional river authorities, and local emergency responders. The network will also be useful in monitoring and responding to drought and wildfires and in providing information to use water more efficiently for landscape and agricultural irrigation. The TWDB also funded a study of the feasibility of establishing a statewide evapotranspiration network to assist agricultural producers with irrigation scheduling and to help both agricultural producers and individual homeowners implement conservation strategies identified in the regional and state water plans.

Water Supply Enhancement Program (TSSWCB)

The Brush Control Program was unfunded for seven bienniums (fiscal years 1986–1999) from its inception until 1999, when the 76th Texas Legislature appropriated funds to begin implementing the program. The TSSWCB was appropriated funds for six bienniums (fiscal years 2000–2011) to carry-out the Brush Control Program ($54.24 million in total) (Figure 9). Notably, the 77th Texas Legislature directed that proceeds of Agricultural Water Conservation Bonds be transferred from the TWDB as a grant of $15 million to the TSSWCB to be used for brush control projects. Since passage of House Bill 1808, the TSSWCB has been appropriated funds for three bienniums (fiscal years 2012–2017) to implement the Water Supply Enhancement Program ($13.82 million in total). Most recently, the 84th Texas Legislature continued funding for the Water Supply Enhancement Program by providing $2,638,413 per year to the TSSWCB for fiscal years 2016–2017.

The need for brush control cost-share incentive funds is much greater than the appropriated funding. For example, based on appropriated funds, the TSSWCB was only able to meet 33 percent of the demand for cost-share incentive funding as requested for the eligible projects received during the Water Supply Enhancement Program Fiscal Year 2016 request for proposals, leaving an unmet demand for over $3.5 million in cost-share incentive funding for that year.

Brush control for water supply enhancement is one of the more cost-effective water management strategies. During fiscal years 2014 and 2015, through the Water Supply Enhancement Program, 29,406 acres of brush management was incentivized by the state. For

[14] Experience the interactive state water plan at 2017.texasstatewaterplan.org/statewide.
[15] www.texmesonet.org

these acres, landowners received cost-share incentive funding through the program totaling $2,123,992 in state funding ($72.23 per treated acre of brush). Based upon the computer models used in developing the feasibility studies, this work is projected to enhance public water supplies by 8,826.45 acre-feet per year ($240.64 per acre-foot of water) over the next 10 years. It is worth noting that this cost cannot easily be compared to those established in the state water plan. The water yields and costs of the recommended water management strategies in the state water plan are based upon a repeat of drought of record conditions. Whereas, the water yields and cost estimates provided in the TSSWCB feasibility studies assume average rainfall conditions. However, a straight-forward analysis of the cost per acre-foot of water conservation savings still provides a degree of comparability. For comparison, some aquifer storage and recovery projects approved as water management strategies by regional water planning groups cost in the range of $675 to $2,500 per acre-foot of water conserved (2.8 to 10.4 times as much as brush control). For comparison, some brackish groundwater desalination projects approved as water management strategies by regional water planning groups cost in the range of $2,100 to $5,300 per acre-foot of water conserved (8.7 to 22 times as much as brush control).

Economic analysis included in 20 of the published feasibility studies estimates that the total capital cost (i.e. the State's cost-share) for full implementation of brush control as modeled is over $1.17 billion (for comparability, costs from feasibility studies were adjusted for inflation to 2015 dollars). For fiscal years 2000–2017, TSSWCB has been appropriated $68.06 million to implement the Water Supply Enhancement Program and its predecessor the Brush Control Program; this is only 5.8 percent of needed funds as estimated in the brush control feasibility studies.

The Water Supply Enhancement Program is not substantially funded to achieve significant water conservation benefiting implementation of the state water plan; this need is identified in the TSSWCB's Strategic Plan for Fiscal Years 2017 to 2021 as an impediment to effective agency operations. Increased appropriations by the Texas Legislature for landowner cost-share incentives will allow TSSWCB to more substantially implement the Water Supply Enhancement Program, potentially conserving up to 2.41 million acre-feet of water per year from brush control, thereby benefiting implementation of the state water plan.

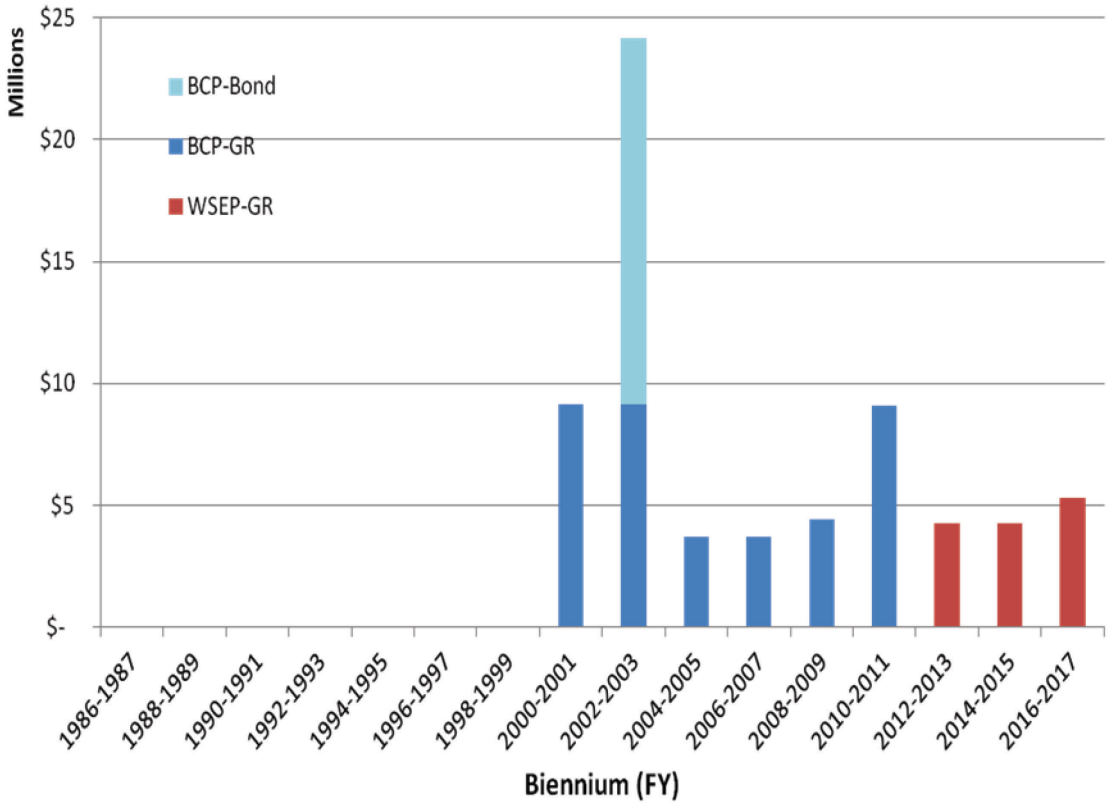

Figure 9. Legislative appropriations for brush control and water supply enhancement

Rio Grande Carrizo Cane Eradication Program (TSSWCB)

In order for the TSSWCB to successfully implement the Rio Grande Carrizo Cane Eradication Program, the 84th Texas Legislature indicated a need of $4.9 million per fiscal year for at least five fiscal years (Fiscal Note attached to Senate Bill 1734). Funds are needed for:

- local SWCDs to provide on-the-ground technical assistance and conservation planning for landowners;
- direct control and treatment of carrizo cane, potentially including mechanical, chemical, and biological control methods conducted by contracted private service providers; and
- conducting scientific investigations to ensure the program is successful, including documenting the water conserved from managing carrizo cane.

While the 84th Texas Legislature established the Rio Grande Carrizo Cane Eradication Program in 2015, no appropriation of funds was made to implement the program for the 2016-2017 biennium. The TSSWCB is not able to successfully implement the program without funding; this need is identified in the agency's Strategic Plan for Fiscal Years 2017 to 2021 as an impediment

to effective agency operations. Implementation of this program is a Homeland Security function, as documented in the Texas Homeland Security Strategic Plan 2015-2020.

The TSSWCB has included an Exceptional Item for the Rio Grande Carrizo Cane Eradication Program in the agency's Legislative Appropriations Request for the 2018–2019 biennium. The agency has requested $3 million across the biennium ($1.5 million per fiscal year) for the program. Funding will allow the TSSWCB to implement the program and help achieve the State's border security priorities, while also accruing benefits to agricultural and municipal water user groups in South Texas. The Rio Grande Carrizo Cane Eradication Program will conserve water lost to evapotranspiration by carrizo cane, even accounting for water use by regrowth of native riparian plants, thereby benefiting implementation of the state water plan (specifically in Regions J and M).

Section 6. Assessment of existing statutory authority

In 2012, the Alliance for Water Efficiency released a report titled *The Water Efficiency and Conservation State Scorecard: An Assessment of Laws and Policies* that identified strong examples of water efficiency and conservation law. One chapter showcases examples from across the country of outstanding state statutory and regulatory provisions that promote water use efficiency and conservation: Texas received one of the two highest scores. Those statutes and provisions are implemented in part through conservation programs at the TWDB and the TSSWCB. With a few minor changes to statutory authority, the effectiveness of these programs could be expanded significantly.

TSSWCB's Water Conservation Programs

Recommendation 1: The State Water Supply Enhancement Plan (implemented through TSSWCB's Water Supply Enhancement Program) is Texas' comprehensive strategy for managing brush in all areas of the state where brush is contributing to a substantial water conservation problem. Voluntary land stewardship in general [Texas Water Code §§1.003(7), 1.004(a) and (b), 11.0235(b)], and TSSWCB programs specifically (e.g., the Water Supply Enhancement Program), are poorly positioned and integrated into the state water plan and the 16 regional water plans. While the TSSWCB is the State's primary soil and water conservation agency delivering natural resource conservation programs to agricultural producers and private landowners, the agency is not one of the named ex-officio members of each regional water planning group. Further, while the 216 local SWCDs serve as the State's primary conservation delivery system through which technical assistance and financial incentives for natural resource conservation programs are channeled to agricultural producers and rural landowners, SWCDs are not one of the named interests that have to be represented on each regional water planning group. Note that SWCDs are a named member group for the Basin and Bay Stakeholder Committees associated with the environmental flows process [Texas Water Code §11.02362 (f)(2)(D)].

Voluntary land stewardship, and TSSWCB programs specifically, would be better positioned as a cornerstone for water conservation and integrated into the state water plan and the 16 regional water plans, if statutory changes were made to Texas Water Code §16.053(c) to 1) add the TSSWCB as one of the named ex-officio members of each regional water planning group, and 2) add SWCDs as one of the named interests that have to be represented on each regional water planning group. This would strengthen the relationship between land stewardship programs in the Texas Agriculture Code with State policy regarding voluntary land stewardship in the Texas Water Code. This would better integrate the TSSWCB Water Supply Enhancement Program into the state water plan, increasing implementation of voluntary land stewardship activities (including brush management), thereby increasing water conservation by agricultural landowners, benefiting implementation of the state water plan.

This recommendation is also included in 1) the TSSWCB Strategic Plan for Fiscal Years 2017 to 2021 as an impediment to effective agency operations, and 2) the Water Conservation Advisory Council's Progress Made in Water Conservation in Texas – Report and Recommendations to the 85th Legislature.

Recommendation 2: Most appropriations from the Texas Legislature have a two-year life to be expended after the end of the fiscal year for which the appropriation was made. However, "construction" appropriations have a four-year life to be expended per Texas Government Code §403.071(b). The Texas Parks and Wildlife Department has an appropriation rider (General Appropriations Act for the 2016-2017 biennium) that specifically labels certain appropriations, including "landowner incentive grants," as "construction" thereby extending their life to four years. The TSSWCB regularly experiences weather-related delays in flood control construction projects. Such delays have resulted in loss of unexpended balances in these construction appropriations after the two-year life of the appropriation.

The likelihood of lapsed funds due to weather-related delays in construction projects would be decreased if an appropriation rider was added for the TSSWCB which labels funds that are to be utilized for construction of flood control structural repair and rehabilitation projects as "construction" appropriations for the purpose of determining the life of the appropriation under the provisions of Texas Government Code §403.071(b). This will decrease the likelihood of lapsed funds due to weather-related delays in construction projects and the TSSWCB will be better able to complete flood control repair or rehabilitation projects.

This recommendation is also included in the TSSWCB Strategic Plan for Fiscal Years 2017 to 2021 as an impediment to effective agency operations.

TWDB's Agricultural Water Conservation Program

The TWDB has statutory authority through the Agricultural Water Conservation Program (Texas Water Code §17.871–17.912) to issue bonds, enter into bond enhancement agreements, and create a linked deposit program with private lending institutions such as the Farm Credit System. Since 1985, TWDB has issued $36 million in Agricultural Water Conservation Bonds out of the $200 million in bonding authority for the program.

The TWDB received approval in 1994 to use funds from the State Energy Conservation Office's Oil Overcharge Fund to reduce the interest rates offered through the Agricultural Water Conservation Loan Program. The subsidized interest rates attracted political subdivisions (primarily groundwater conservation districts) to participate in the program. From 1986 through 2003, TWDB provided 80 agricultural water conservation loans to political subdivisions that then passed the savings on to their producers. Sixty of these loans occurred between 1994 and 2003. Since 2004, TWDB has provided 16 loan commitments for conservation projects to only three

groundwater conservation districts. A few of the districts previously involved in the loan program stated that they no longer participate because they do not wish to act as the banker for those individual loans to agricultural producers.

One other aspect of the Agricultural Water Conservation Program is the ability to develop a linked deposit program. In 2003, the 78th Texas Legislature passed Senate Bill 1053 that allowed for the creation of a linked deposit program at the TWDB. Through analysis of the potential demand for the linked deposit program in 2004, the TWDB determined that the cost of bond issuance and third-party administrative costs would likely result in limited demand from agricultural producers due to relatively high interest rates. A linked deposit program through a commercial lending institution such as the Farm Credit System would offer agricultural producers across the state an opportunity to install conservation measures with funding provided from a familiar banker. If the interest rates were competitive, this sort of program might be more popular with agricultural producers than the existing Agricultural Water Conservation Loan Program offered through participating local subdivisions.

The TWDB will continue to investigate the feasibility of establishing the linked-deposit program and other aspects of the Agricultural Water Conservation Program, especially as it relates to potential opportunities to meet the 10 percent agricultural and rural targets established through SWIFT.

Section 7. Assessment of the TWDB's Agricultural Water Conservation Program

The Agricultural Water Conservation Program provides education, outreach, technical and financial assistance to promote agricultural water conservation across the state. The TWDB provides grants and loans to fund conservation projects and programs. Examples of the types of projects funded include cost-share of irrigation metering equipment, on-farm demonstration of new technologies and conservation practices, research and education, and irrigation improvements to district-owned infrastructure and equipment (Figure 10). The source of funding for the program is the Agricultural Water Conservation Fund.

Figure 10. Canal lining funded through the El Paso County Water Improvement District No. 1.

During fiscal years 2011 through 2015, TWDB approved seven loans worth just over $10.6 million and 35 grant projects totaling almost $9.3 million[16]. This total includes 13 agricultural water conservation monitoring projects funded through the $3 million in General Revenue appropriations provided by Senate Bill 1, Rider 25, passed during the 83rd Legislative Session in 2013. These grants provided cost-share funding for metering equipment in groundwater conservation districts with rules requiring metering. The total also includes a $3.6 million grant to the Texas Alliance for Water Conservation—an agricultural water conservation demonstration

[16] See appendices for detailed project descriptions and funding amounts.

project in the Texas High Plains administered through Texas Tech University—as directed in Senate Bill 1, Rider 22, passed during the 83rd Legislative Session, 2013 (Figure 11). The Agricultural Water Conservation Program provides a cost-effective, proven means to promote agricultural water conservation in the state. Based on current activities, without additional appropriations, the Agricultural Water Conservation Fund could be depleted within the next 10 to 15 years.

Figure 11. Texas Alliance for Water Conservation, 2014 Summer Field Day demonstration.

Within the TWDB-funded agricultural water conservation demonstration projects, agricultural producers schedule irrigation by using soil moisture monitoring equipment in tandem with remote management systems leading to improved irrigation efficiency and water savings. Producers receive the equipment and monitoring services at a reduced cost. These demonstration projects have proven effective in the implementation of irrigation conservation strategies. Similar projects would be eligible for loan funding, but administrative costs, fees, and interest would increase the overall cost to producers thereby reducing the likelihood of participation. Agricultural producers are much more likely to adopt the technology if they receive the equipment at a reduced cost, similar to a homeowner taking advantage of a toilet rebate program.

To measure the effectiveness of conservation projects funded through the program, TWDB requires grant and loan recipients to report annual water savings or improvements in water use efficiency as a percentage of their estimated water use before the TWDB-funded improvements (Tables 6 and 7).

Table 6. Water savings (in acre-feet) from agricultural water conservation grants

Fiscal year	Baseline water use	Water savings	Percent improvement
2011	745,650	49,022	7
2012	522,611	44,131	8
2013	318,189	17,805	6
2014	257,275	18,777	7
2015	319,814	25,809	8
Total	2,163,539	155,544	7

Table 7. Water savings (in acre-feet) from agricultural water conservation loans

Fiscal year	Baseline water use	Water savings	Percent improvement
2011	24,714	6,498	26
2012	37,696	10,781	29
2013	44,669	12,585	28
2014	39,851	10,722	27
2015	40,868	6,551	16
Total	187,798	47,137	25

Grant and loan recipients report annual water savings following approval of funding. An analysis of the cost per acre-foot of conservation savings during fiscal years 2011–2015 provides an indication of the program success. The grant projects provided an estimated $60 per acre-foot per year of conservation savings, and the loan projects provided conservation savings of $225 per acre-foot per year. The average of these two cost estimates is $142 per acre-foot, but the water savings summed for both grants and loans for those five fiscal years divided by the total funding is only $98 per acre-foot. These calculations suggest a water savings return provided through the program that is comparable to the expected cost range of the recommended irrigation conservation water management strategies in the 2017 State Water Plan, estimated at a statewide average cost of $147 per acre-foot.

The TWDB provides grants for cost-share reimbursements for equipment through the voluntary irrigation metering program. This cost-share program provides an incentive for the agricultural producer to install the equipment and helps groundwater conservation districts and other participating entities implement metering programs of their own. The producer receives a tool to assist with their irrigation management, and the district gains data useful to groundwater modeling efforts, management decisions, and rulemaking. The voluntary irrigation metering program and the demonstration projects provide examples of successful conservation cost-share programs by encouraging adoption of advanced technologies. Continued programmatic

funding allocations for the TWDB agricultural grants program will allow TWDB to build upon the success of the demonstration projects and equipment cost-share grants.

In addition to the financial assistance provided through the program, Agricultural Water Conservation staff is responsible for developing the annual irrigation water use estimates, providing education and technical assistance to the public, and staffing exhibit booths to provide outreach at farm shows, conferences, field days, and other public venues. The Manager of the Agricultural Water Conservation Program also serves as the TWDB liaison to the Texas State Soil and Water Conservation Board and as the TWDB designated member on the State Technical Advisory Committee to the State Conservation at the U.S. Department of Agriculture – Natural Resources Conservation Service.

Conclusion

Conservation efforts at the TWDB and TSSWCB include programs targeting a wide range of potential benefits. Education, data, technical assistance and financial incentives are common threads throughout each of these programs. With the added focus on conservation in the 2017 State Water Plan, these programs will continue to provide value to the state in promoting best management practices in the area of water conservation.

As the state experiences unprecedented droughts like in 2011 and floods like in 2015, the fluctuations in soil moisture puts an added pressure on our aging infrastructure. The growing public awareness of water loss issues ensures that it will receive increasing levels of attention with each additional occurrence.

With a growing population competing for water resources, the importance of and commitment to conservation must remain at the forefront when planning and implementing the state water plan. The Texas economy is diverse and resilient, but all sectors depend upon access to clean water supplies that are reliable, affordable, and adequate to maintain that economic vitality. The shared commitment to conservation at the TWDB and the TSSWCB ensures the state, the public, and the local political subdivisions receive the education, outreach, technical support, and financial assistance necessary to realize the conservation goals set forth in the 2017 State Water Plan.

References

Texas Administrative Code (358.6; 363.15; 517.25)

Texas Agriculture Code (203.053)

Texas Government Code (403.071)

Texas Local Government Code (580.004)

Texas Tax Code (11.31; 11.32)

Texas Water Code (1.003; 1.004, 10.001-10.011; 11.002; 11.0235; 11.02362; 15.106; 16.0121; 16.022; 16.053; 17.871-17.912)

Alliance for Water Efficiency, and Environmental Law Institute, 2012, The Water Efficiency and Conservation State Scorecard: An Assessment of Laws and Policies, 68 p.

(ASCE) American Society of Civil Engineers, 2012, 2012 Report Card for Texas' Infrastructure, 6 p.

Boellstorff, D.E., M.L. McFarland, and C.T. Boleman, 2010, Water Issues in Texas: A Survey of Public Perceptions and Attitudes about Water, Texas A&M AgriLife Extension Service, B-6219, 40 p.

Goolsby, J.A., P.J. Moran, A.E. Racelis, K.R. Summy, M. Martinez-Jimenez, R.D. Lacewell, A. Perez de Leon, and A.A. Kirk, 2015, Impact of the biological control agent Tetramesa romana (Hymenoptera: Eurytomidae) on Arundo donax (Poaceae: Arundinoideae) along the Rio Grande River in Texas, Biocontrol Science and Technology, v. 26:1, pp. 47-60.

Iverson, M.E., 1994, The Impact of Arundo donax on Water Resources. pp. 19-25. In: N.E. Jackson, P. Frandsen, and S. Douthit (eds.). November 1993. Arundo donax Workshop Proceedings. Ontario, California.

Jackson, N.E., W. Katagi, and C. Loper, 2002, Southern California Integrated Watershed Program – Arundo Removal Protocol, Santa Ana Watershed Project Authority, Riverside, California.

Oakins, A., 2001, An Assessment and Management Protocol for Arundo donax in the Salinas Valley Watershed, Capstone Project, California State University Monterey Bay, Seaside, California.

Office of Governor Greg Abbott, September 30, 2015, Texas Homeland Security Strategic Plan, 2015–2020, 67 p.

Texas State Soil and Water Conservation Board, 2016, Strategic Plan for Fiscal Years 2017 to 2021.

Texas State Soil and Water Conservation Board, 2014, State Water Supply Enhancement Plan.

Texas State Soil and Water Conservation Board, 2005, Water Conservation Best Management Practices Guide for Agriculture in Texas.

Texas Water Development Board, 2016, Water for Texas: 2017 State Water Plan, TWDB, 133 p.

Texas Water Development Board, 2012, An Assessment of Water Conservation: Report to the 82nd Texas Legislature, submitted by the Texas Water Development Board and Texas State Soil and Water Conservation, 58 p.

Texas Water Development Board, 2006, An Assessment of Water Conservation in Texas Prepared for the 80th Texas Legislature, submitted by the Texas Water Development Board and Texas State Soil and Water Conservation Board, 28 p.

Texas Water Development Board, 2004, TWDB contracted report #2004483531: Statewide Conservation Public Awareness Research Study, Tuerff-Davis EnviroMedia, Inc., 265 p.

Texas Water Development Board, 2001, Report 347: Surveys of Irrigation in Texas – 1958, 1964, 1969, 1974, 1979, 1984, 1989, 1994, and 2000, 102 p.

Texas Water Development Board in cooperation with Chris Brown Consulting, Jan Gertson Consulting, and Stephen Colley Architecture, 2005, The Texas Manual on Rainwater Harvesting, Third Edition, 56 p.

Water Conservation Advisory Council, 2016, Progress Made in Water Conservation in Texas – Report and Recommendations to the 85th Legislature, Texas Water Development Board, 21 p.

Water Conservation Implementation Task Force, 2004, Report to the 79th Legislature, Texas Water Development Board, 78 p.

Zembal, R., and S. Hoffman, 2000, Environmental Assessment of the Santa Ana Watershed Program, Orange County Water District.

Appendix A. TWDB agricultural water conservation grants, fiscal years 2011–2015

Fiscal year	Grant recipient	Amount	Project description
2011	Hemphill County Underground Water Conservation District	$10,373	• Irrigation measurement—purchase and installation of 5 flow meters and a portable flow meter to verify accuracy of installed meters. • Producers receive meters at a reduced cost and gain a useful water management tool. • The district receives actual water use data which is useful in planning and management decisions. • The district will also be able to verify meter accuracy upon installation and over the years through use of the portable flow meter.
2011	Colorado County Groundwater Conservation District	$50,000	• Irrigation measurement—purchase and installation of 56 flow meters. • Producers receive meters at a reduced cost and gain a useful water management tool. • The district receives actual water use data which is useful in planning and management decisions.
2011	North Plains Groundwater Conservation District	$250,000	• Agricultural water conservation demonstrations of irrigation tools, technologies, and practices for growers in the Northern High Plains. • Award winning "200-12" Corn Irrigation Project began with a goal of producing 200 bushels of corn with 12 inches of supplemental irrigation water.
2011	Texas A&M AgriLife Research	$77,208	• Educational field days including demonstrations of irrigation efficiency technologies • Targeting agricultural producers in Groundwater Management Areas 1 and 6.
2011	Texas Tech University	$101,049	• Irrigation system audits for irrigation efficiency improvement recommendations. • Involves fields and participating agricultural producers involved in the Texas Alliance for Water Conservation project.
2012	Coastal Bend Groundwater Conservation District	$25,000	• Irrigation measurement—purchase and installation of 19 flow meters. • Producers receive meters at a reduced cost and gain a useful water management tool. • The district receives actual water use data which is useful in planning and management decisions.
2012	Mesquite Groundwater Conservation District	$50,000	• Irrigation measurement—purchase and installation 60 flow meters. • Producers receive meters at a reduced cost and gain a useful water management tool. • The district receives actual water use data which is useful in planning and management decisions.

Fiscal year	Grant recipient	Amount	Project description
2012	Panhandle Regional Planning Commission	$200,000	• Educational outreach and training for targeted users of the Texas High Plains Evapotranspiration Network for use in irrigation scheduling. • Producers in the Texas High Plains benefit from the availability of irrigation scheduling tools, online crop water use and weather data, and regional training workshops. • The region benefits through potential producer adoption of an irrigation conservation strategy identified in their regional water plan. • Potential water savings estimated to be in the range of 0.5–2.0 acre-inches of water savings per irrigated acre at an implementation cost estimated at $8.99 per acre-foot of groundwater saved according to the 2011 Panhandle Regional Water Plan.
2012	Texas A&M University - Kingsville	$136,982	• Demonstration of improved water conserving irrigation techniques to educate citrus growers in the Lower Rio Grande Valley. • This project is a result of research demonstrated through the Texas Project for Ag Water Efficiency. • Previous research and demonstrations of narrow border flood have shown approximately 36 percent less water applied on citrus trees than traditional flood irrigation without any associated losses in fruit yields or quality. • Research will demonstrate and prove the cost-effectiveness of this strategy along with further research on a partial root zone drying strategy to area producers through open field-days. • The costs of implementing these strategies are estimated to be approximately $30 to $40 per acre. • Demonstrations to area producers have the potential to generate up to 49,000 acre-feet of irrigation savings per year, if all area citrus producers were to adopt these practices.
2013	Bureau of Economic Geology at the University of Texas	$194,029	• Feasibility and assessment of remote sensing technologies to assist with estimating irrigation water use in Texas. • TWDB will benefit through research and proof of concept of remote sensing as a technique to estimate irrigation water use in the state. • A non-biased means of estimating irrigation water use is needed to compare with existing estimates and possibly to improve upon existing methodologies.
2013	Harlingen Irrigation District	$200,000	• Efficiency improvements to the irrigation conveyance system involving replacement of concrete laterals with pipelines. • Expected to generate 377 acre-feet of water savings per year through addressing water loss in the irrigation water conveyance system.

2013	Lower Colorado River Authority	$101,700	• Installation and automation of canal check gate structures in the LCRA Gulf Coast Irrigation Division. • This project is expected to generate 400 acre-feet of water savings per year.
2013	Lower Neches Valley Authority	$100,000	• Irrigation measurement — purchase and install metering equipment in the Devers Canal System. • Through a similar previous project, installation of metering equipment along with volumetric pricing resulted in average annual savings of 1.14 acre-feet per acre with an average annual benefit to the authority of $1,327,889 and an annual average of 19,505 acre-feet of water savings. • This project will have similar benefits as it installs meters and implements volumetric pricing in an area that is currently not metered by the authority.
2014	Coastal Bend Groundwater Conservation District	$25,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2014	El Paso Water Improvement District No.1	$200,000	• The project involves using fiber-reinforced concrete for canal-lining activities in an area of the district with water loss of 3,000 acre-feet per year due to "seepage that is intercepted by shallow irrigation wells in the vicinity of the canal and south of the international border." • The project will line approximately one-third of this high water loss area; estimated to save 1,000 acre-feet per year. • Surface water users in this part of the state are experiencing new drought-of-record conditions; usable Rio Grande Project water available for release in 2013 was the lowest level ever in the 97-year history of the project.
2014	High Plains Underground Water Conservation District No. 1	$617,500	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2014	Mesquite Groundwater Conservation District	$150,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.

2014	North Plains Groundwater Conservation District	$197,313	• The "3-4-5 Grain Production Maximization" project builds upon the success of the district's award-winning "200-12 Project" established in 2010 as a commercial-scale, field demonstration project that involves district personnel, local producers, and private industry. • This project continues the demonstrations of innovative irrigation management practices and strategies on actual producer farms with private industry coordination and outreach via field days to facilitate benefits to other producers in the region.
2014	North Plains Groundwater Conservation District	$600,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2014	Panhandle Groundwater Conservation District	$107,500	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2014	Santa Cruz Irrigation District No. 15	$200,000	• This project involves using fiber-reinforced concrete for canal-lining activities in an area of the district currently experiencing 938 acre-feet of annual water loss and is estimated to conserve 670 acre-feet of this annual loss and to provide annual cost savings of $17,866. • Water conserved benefits all farmers in the district when on an allocation program.
2014–2015	Texas Tech University	$3,600,000	• Senate Bill 1, Rider 22, passed during the 83rd Legislative Session, extends and expands upon the existing the Texas Alliance for Water Conservation project funded through Texas Tech University. • Appropriated $1.8 million from each fiscal year out of the Agricultural Water Conservation Fund. • Research and demonstrations of agricultural water conservation technologies and practices benefit area producers in the Texas High Plains. • The project identifies cost-effective strategies to maintain or enhance profitability and helps producers deal with declining water availability in the Ogallala Aquifer.
2015	Brewster County Groundwater Conservation District	$10,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.

2015	Brush Country Groundwater Conservation District	$10,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	Cameron County Irrigation District No. 6	$150,000	• Replacement of 3,800 linear feet of the Saldaña Canal with enclosed (24-inch PVC) pipeline. • Producers involved in the project will also attend an agricultural water conservation education seminar at the Rio Grande Center for Ag Water Efficiency.
2015	Coastal Bend Groundwater Conservation District	$200,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	Edwards Aquifer Authority	$22,050	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The authority will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	Gulf Coast Water Authority	$200,000	• Through this project the authority will purchase and install open-channel flow meters to provide real-time water use data and implement conservation pricing. • These activities will encourage irrigation water use efficiency in rice production
2015	Lower Neches Valley Authority	$30,000	• This project involves 23 percent reimbursement of meter equipment. • The authority will report water use data on an annual basis following installation of all equipment.
2015	Mesa Underground Water Conservation District	$12,500	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.

2015	Mesquite Groundwater Conservation District	$150,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	North Plains Groundwater Conservation District	$800,400	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	North Plains Groundwater Conservation District	$295,050	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment. • Funding for this project was provided through Senate Bill 1, Rider 25, passed during the 83rd Legislative Session, for districts with promulgated rules requiring metering.
2015	South Plains Underground Water Conservation District	$20,000	• This project involves 50 percent reimbursement of eligible meter equipment purchases. • The district will report water use data on an annual basis following installation of all equipment.
2015	Texas A&M University - Kingsville	$200,000	• The project continues and builds upon TWDB funded research at the Citrus Center in Weslaco. • Activities involve evaluation and demonstration of water saving techniques to improve irrigation efficiency in citrus production through low-cost irrigation system improvements. • Private landowners contributed by offering their own citrus fields for a portion of the demonstrations.

Appendix B. TWDB agricultural water conservation loans, fiscal years 2011–2015

Fiscal year	Loan recipient	Amount	Project description
2011	Panhandle Groundwater Conservation District	$1,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2012	Panhandle Groundwater Conservation District	$1,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2012	Sandy Land Underground Water Conservation District	$2,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2013	Panhandle Groundwater Conservation District	$2,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2014	Sandy Land Underground Water Conservation District	$2,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2014	Panhandle Groundwater Conservation District	$2,000,000	Low-interest loan for lending to individual landowners for private irrigation system improvements.
2014	North Plains Groundwater Conservation District	$620,000	Low-interest loan for irrigation system improvements at the district-owned Water Conservation Center in Etter, TX.