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WATER FOR TEXAS 2012 STATE WATER PLAN

2012

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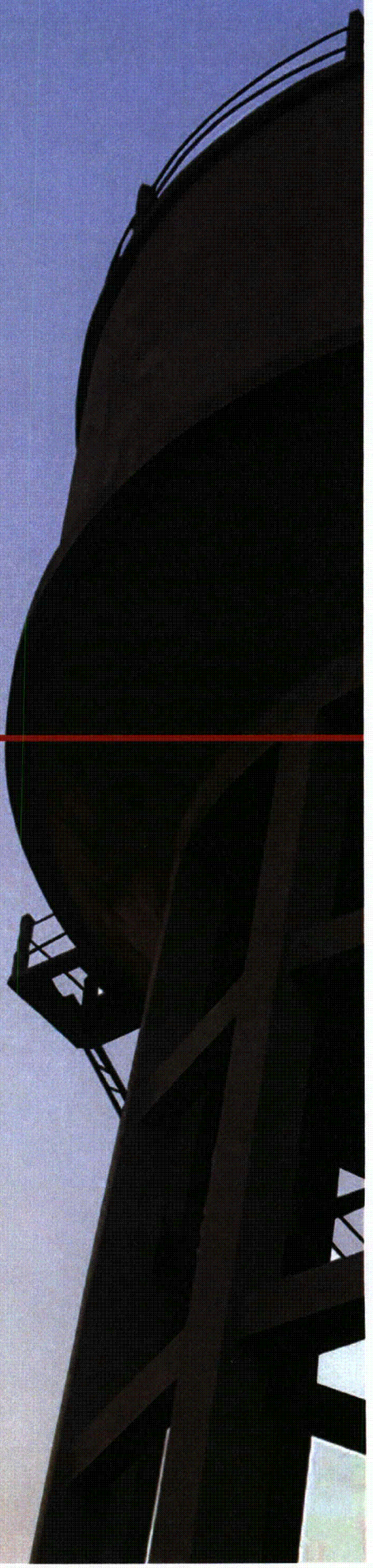

WATER FOR TEXAS 2012 STATE WATER PLAN

2012

Water for Texas

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January 5, 2012

To the People of Texas:

Texas is currently experiencing what has been described as the worst one-year drought in the state's history, again emphasizing the importance of long-range planning to meet the state's water needs. The 2012 State Water Plan is the third plan that incorporates 16 regional water plans developed under Texas Water Code, Section 16.053. Reflecting the dedicated work of over 400 voting and nonvoting members of the regional water planning groups, this plan was developed between January 2006 and December 2011. This document provides recommended actions to provide long-term water supply solutions to meet water supply needs during drought of record conditions. The State Drought Preparedness Plan is developed by the Drought Preparedness Council for managing and coordinating the state's response. The State Drought Preparedness Plan outlines measures to prepare for, respond to, and mitigate the effects of drought and can be found at http://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/droughtPrepPlan.pdf .

The primary message of the 2012 State Water Plan is a simple one: In serious drought conditions, Texas does not and will not have enough water to meet the needs of its people, its businesses, and its agricultural enterprises. This plan presents the information regarding the recommended conservation and other types of water management strategies that would be necessary to meet the state's needs in drought conditions, the cost of such strategies, and estimates of the state's financial assistance that would be required to implement these strategies. The plan also presents the sobering news of the economic losses likely to occur if these water supply needs cannot be met. As the state continues to experience rapid growth and declining water supplies, implementation of the plan is crucial to ensure public health, safety, and welfare and economic development in the state.

Respectfully submitted,

Edward G. Vaughan, Chairman

Acknowledgments

The 2012 State Water Plan would not have been possible without the time and expertise of numerous people and organizations throughout the state of Texas. The Texas Water Development Board (TWDB) would like to express its sincere appreciation to all of those that participated in the development of the 16 regional plans and this state water plan: the more than 400 regional water planning group members, consultants, and administrative agencies; staff of the TWDB; Texas Parks and Wildlife Department, Texas Department of Agriculture, Texas Commission on Environmental Quality, and other state and federal agencies; and the individuals and organizations that provided public input during the planning process.

Finally, we would like to thank the leadership of the state of Texas for their consistent support and recognition of the importance of water planning.

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Quick Facts

The population in Texas is expected to increase 82 percent between the years 2010 and 2060, growing from 25.4 million to 46.3 million people.

Water demand in Texas is projected to increase by only 22 percent, from about 18 million acre-feet per year in 2010 to about 22 million acre-feet per year in 2060.

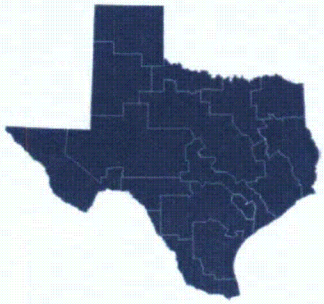
Existing water supplies — the amount of water that can be produced with current permits, current contracts, and existing infrastructure during drought — are projected to decrease about 10 percent, from about 17.0 million acre-feet in 2010 to about 15.3 million acre-feet in 2060, due primarily to Ogallala Aquifer depletion and reduced reliance on the Gulf Coast Aquifer.

If Texas does not implement new water supply projects or management strategies, then homes, businesses, and agricultural enterprises throughout the state are projected to need 8.3 million acre-feet of additional water supply by 2060.

Annual economic losses from not meeting water supply needs could result in a reduction in income of approximately $11.9 billion annually if current drought conditions approach the drought of record, and as much as $115.7 billion annually by 2060, with over a million lost jobs.

The regional planning groups recommended 562 unique water supply projects designed to meet needs for additional water supplies for Texas during drought, resulting in a total, if implemented, of 9.0 million acre-feet per year in additional water supplies by 2060.

The capital cost to design, construct, or implement the recommended water management strategies and projects is $53 billion. Municipal water providers are expected to need nearly $27 billion in state financial assistance to implement these strategies.



Executive Summary

"If Texans cannot change the weather, they can at least, through sound, farsighted planning, conserve and develop water resources to supply their needs."

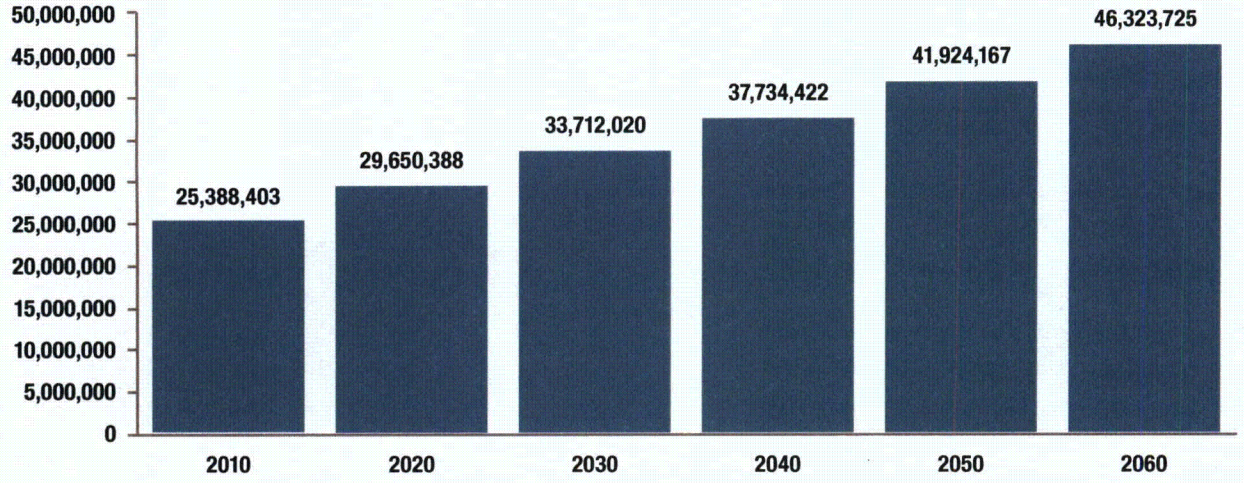
— A Plan for Meeting the 1980 Water Requirements of Texas, 1961

WHY DO WE PLAN?

This plan is designed to meet the state's needs for water during times of drought. Although droughts have always plagued Texas, the one that occurred in the 1950s was particularly devastating. It was, in fact, the worst in our state's recorded history and is still considered Texas' "drought of record." The purpose of this plan is to ensure that our state's cities, rural communities, farms, ranches, businesses, and industries will have enough water to meet their needs during a repeat of this great drought.

As recognized by the Texas Legislature upon passage of omnibus water planning legislation in 1997, water—more than any other natural resource—challenges the state's future. Scarcity and competition for water, environmental concerns, and the cost of new water supplies have made sound water planning and management increasingly important. With the state's population expected to grow by 82 percent in the next 50 years, the availability of water supplies during times of drought is essential for not only the Texans of today but for those of tomorrow as well.

FIGURE ES.1. PROJECTED POPULATION GROWTH.



HOW DO WE PLAN?

Water planning in Texas starts at the regional level with 16 regional water planning groups, 1 for each of the 16 designated planning areas in the state. Each planning group consists of about 20 members that represent at least 11 interests, as required by Texas statute, including **Agriculture, Industry, Public, Environment, Municipalities, Business, Water Districts, River Authorities, Water Utilities, Counties, and Power Generation.**

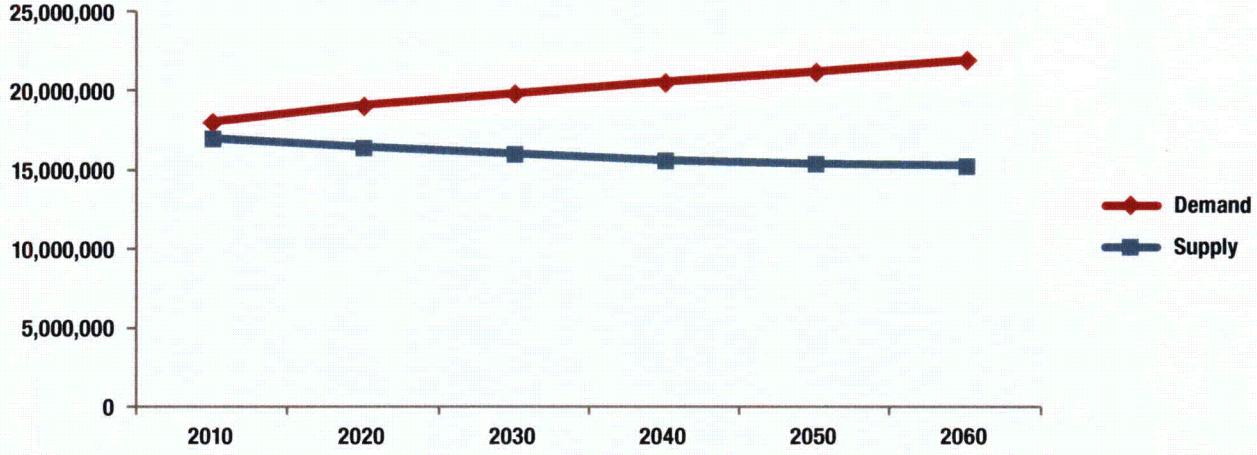
During each five-year planning cycle, planning groups evaluate population projections, water demand projections, and existing water supplies that would be available during times of drought. Planning groups identify water user groups that will not have enough water during times of drought, recommend strategies that could be implemented to address shortages, and estimate the costs of these strategies. While carrying out these tasks, planning groups assess risks and uncertainties in the planning process and evaluate potential impacts of water management strategies on the state's water, agricultural, and natural resources.

Once the planning groups adopt their regional water plans, they are sent to the Texas Water Development Board (TWDB)—the state's water supply planning and financing agency—for approval. TWDB then compiles the state water plan, which serves as a guide to state water policy, with information from the regional water plans and policy recommendations to the Texas Legislature. Each step of the process is open to the public and provides numerous opportunities for public input.

HOW MANY TEXANS WILL THERE BE?

The population in Texas is expected to increase significantly between the years 2010 and 2060, growing from 25.4 million to 46.3 million people. Growth rates vary considerably across the state, with some planning areas more than doubling over the planning horizon and others growing only slightly or not at all (Figure ES.1). Thirty counties and 225 cities are projected to at least double their population by 2060, but another 52 counties and 158 cities are expected to lose population or remain the same. The rest are expected to grow slightly.

FIGURE ES.2. PROJECTED WATER DEMAND AND EXISTING SUPPLIES (ACRE-FEET PER YEAR).



HOW MUCH WATER WILL WE REQUIRE?

Although the population is projected to increase 82 percent over 50 years, water demand in Texas is projected to increase by only 22 percent, from about 18 million acre-feet per year in 2010 to a demand of about 22 million acre-feet per year in 2060 (Figure ES.2). Demand for municipal water (including rural county-other) is expected to increase from 4.9 million acre-feet in 2010 to 8.4 million acre-feet in 2060. However, demand for agricultural irrigation water is expected to decrease, from 10 million acre-feet per year in 2010 to about 8.4 million acre-feet per year in 2060, due to more efficient irrigation systems, reduced groundwater supplies, and the transfer of water rights from agricultural to municipal uses. Water demands for manufacturing, steam-electric power generation, and livestock are expected to increase, while mining demand is expected to remain relatively constant.

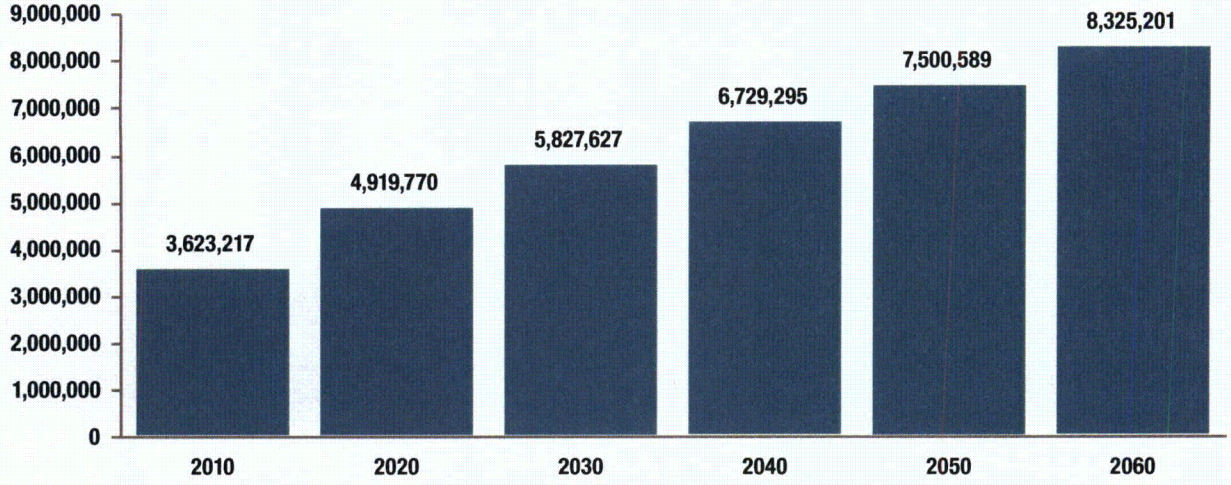
HOW MUCH WATER DO WE HAVE NOW?

Existing water supplies—categorized as surface water, groundwater, and reuse water—are projected to decrease about 10 percent, from about 17.0 million acre-feet in 2010 to about 15.3 million acre-feet in 2060. For planning purposes, existing supplies are those water supplies that are physically and legally available, defined as the amount of water that can be produced with current permits, current contracts, and existing infrastructure during drought.

Groundwater supplies are projected to decrease 30 percent, from about 8 million acre-feet in 2010 to about 5.7 million acre-feet in 2060. This decrease is primarily due to reduced supply from the Ogallala Aquifer as a result of its depletion over time and reduced supply from the Gulf Coast Aquifer due to mandatory reductions in pumping to prevent land subsidence.

Surface water supplies are projected to increase by about 6 percent, from about 8.4 million acre-feet in 2010 to about 9.0 million acre-feet in 2060. In a departure from the convention employed in previous regional water plans, some surface water supplies were added to the accounting of existing supplies only in the decade when an existing contract was expanded to call on the increased amount of supply, as the increase

FIGURE ES.3. PROJECTED NEED FOR ADDITIONAL WATER IN TIMES OF DROUGHT (ACRE-FEET PER YEAR).



would only then become "legally" available. With the adoption of this convention by some planning groups, existing surface water supplies are projected to increase over the planning horizon. In previous plans the full amount of supply was shown from the first decade, and supplies were shown to decrease over time as a result of sedimentation of reservoirs.

Existing supply from water reuse is expected to increase from 482,000 acre-feet per year in 2010 to about 614,000 thousand acre-feet per year by 2060. This represents an increase of about 65 percent in 2060 reuse supplies, as compared to the 2007 State Water Plan.

DO WE HAVE ENOUGH WATER FOR THE FUTURE?

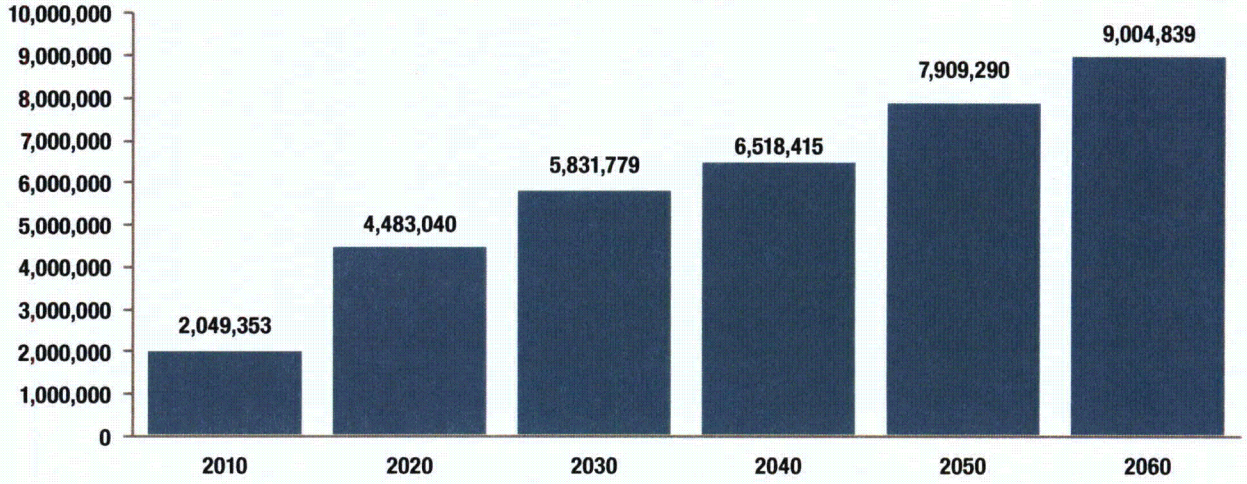
We do not have enough existing water supplies today to meet the demand for water during times of drought. In the event of severe drought conditions, the state would face an immediate need for additional water supplies of 3.6 million acre-feet per year with 86 percent of that need in irrigation and about 9 percent associated directly with municipal water users. Total needs are projected to increase by 130 percent between 2010 and 2060 to 8.3 million acre-feet per year (Figure ES.3). In 2060, irrigation represents 45 percent of the total needs and municipal users account for 41 percent of needs.

WHAT CAN WE DO TO GET MORE WATER?

When projected demands for water exceed the projected supplies available during drought conditions, the planning groups recommended water management strategies—specific plans to increase water supply or maximize existing supply. These strategies included 562 unique water supply projects designed to meet needs for additional water supplies for Texas during drought (this figure is lower than presented in previous plans because it does not separately count each entity participating in a given project).

The strategies recommended by regional water planning groups would provide, if implemented, 9.0 million acre-feet per year in additional water supplies by 2060 (Figure ES.4). Water management strategies can include conservation, drought management,

FIGURE ES.4. WATER SUPPLIES FROM WATER MANAGEMENT STRATEGIES IN THE STATE WATER PLAN (ACRE-FEET PER YEAR).



reservoirs, wells, water reuse, desalination plants, and others. About 34 percent of the volume of these strategies would come from conservation and reuse, about 17 percent from new major reservoirs, and about 34 percent from other surface water supplies.

Some planning groups recommend water management strategies that would provide more water than would be needed during a repeat of the drought of record. This "cushion" of additional supplies helps address risks and uncertainties that are inherent in the planning process, such as:

- greater population growth or higher water demands than projected;
- climate variability, including a drought worse than the one experienced during the 1950s; and
- difficulties in financing and implementing projects.

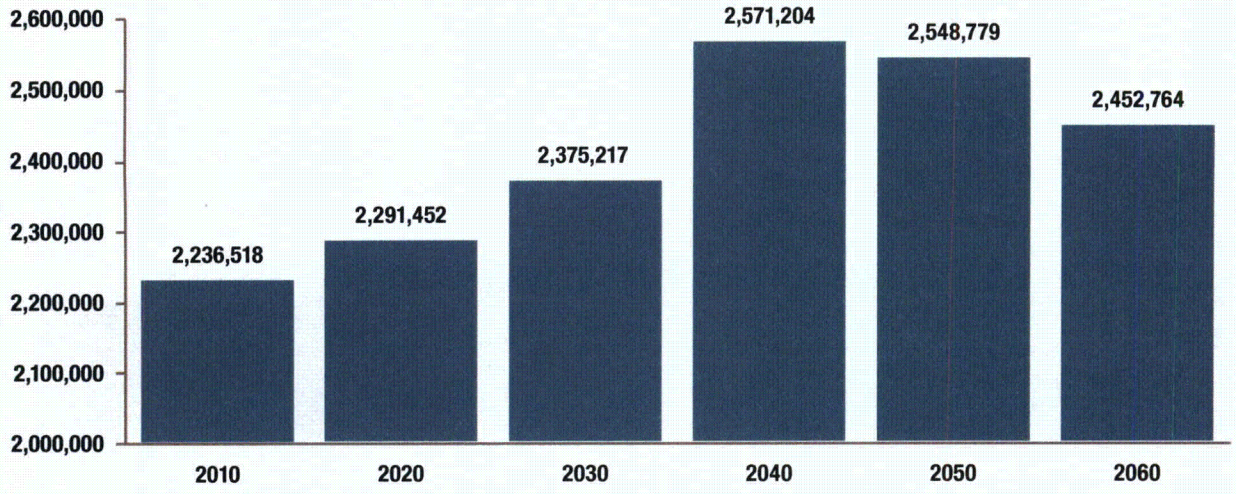
ARE ALL THE WATER SUPPLY NEEDS MET?

Four planning groups were able to identify strategies to meet all of the needs for water identified in their regions, including municipal, manufacturing, mining, irrigation, steam-electric power generation, and livestock. Twelve planning groups were unable to meet all water supply needs for each water user group in their planning areas. Approximately 2.2 million acre-feet of water supply needs are unmet in 2010, increasing to approximately 2.5 million acre-feet in 2060 (Figure ES.5). Unmet water supply needs occur for all categories of water user groups, with the exception of manufacturing. Irrigation represents the vast majority (98-99 percent) of unmet needs in all decades. The major reason for not meeting a water user group's water supply need is that the planning group did not identify an economically feasible water management strategy to meet the water supply need.

HOW MUCH WILL IT COST?

The estimated total capital cost of the 2012 State Water Plan, representing the capital costs of all water management strategies recommended in the 2011 regional water plans, is $53 billion. This amount represents about a quarter of the total needs for water supplies, water treatment and distribution, wastewater treatment and collection, and flood control required for the state of Texas in the next 50 years (Figure ES.6). These costs consist primarily of the funds needed to permit, design, and construct projects that implement

FIGURE ES.5. UNMET WATER SUPPLY NEEDS (ACRE-FEET PER YEAR).



recommended strategies, with the majority of the costs (about $46 billion) going toward meeting municipal needs; that is, the needs of residential, commercial, and institutional water users in cities and rural communities. Based on surveys conducted as part of the planning process, water providers will need nearly $27 billion in state financial assistance to implement strategies for municipal water user groups.

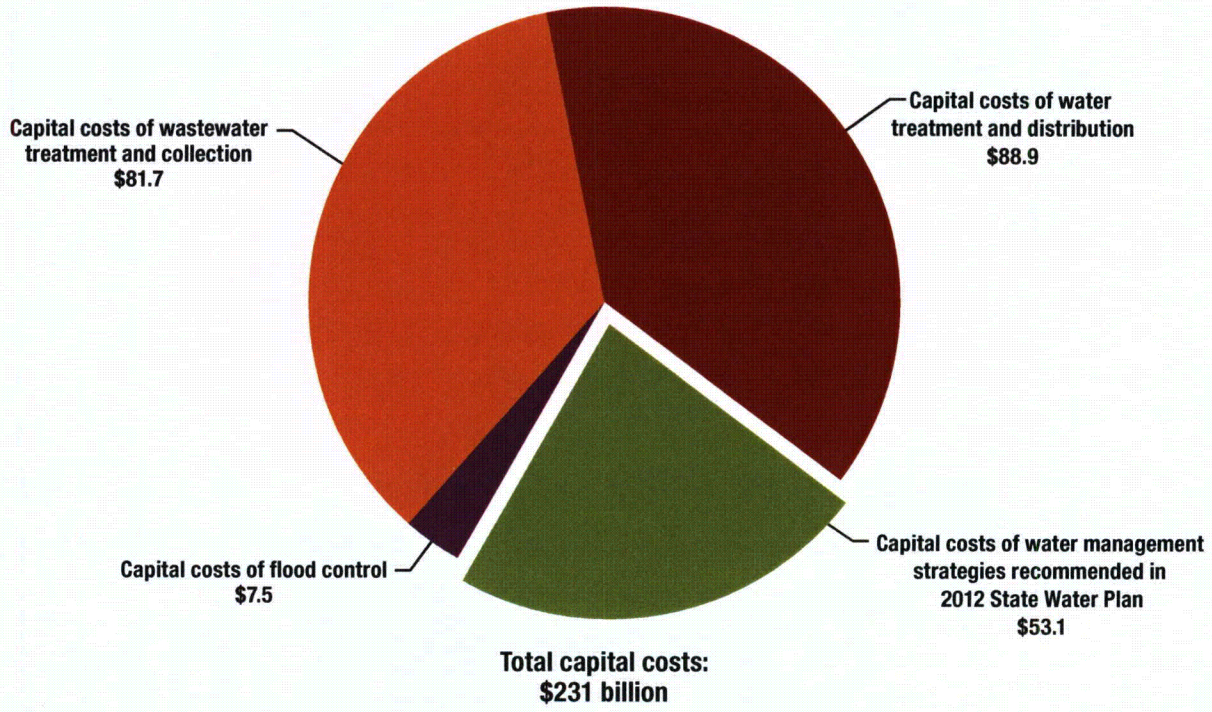
WHAT IF WE DO NOTHING?

If drought of record conditions recur and water management strategies identified in regional water plans are not implemented, the state could suffer significant economic losses. If a drought affected the entire state like it did in the 1950s, economic models show that Texas businesses and workers could have lost almost $12 billion in income in 2010. By 2060 lost income increases to roughly $116 billion. Foregone state and local business taxes associated with lost commerce could amount to $1.1 billion in 2010 and $9.8 billion in 2060. Lost jobs total approximately 115,000 in 2010 and 1.1 million in 2060. By 2060, the state's projected population growth could be reduced by about 1.4 million people, with 403,000 fewer students in Texas schools. If we do nothing, over 50 percent of the state's population in 2060 would face a water need of at least 45 percent of their demand during a repeat of drought of record conditions.

WHAT MORE CAN WE DO NOW TO PREPARE FOR TIMES OF DROUGHT?

The state and regional water plans must be implemented to meet the state's need for water during a severe drought. Water providers surveyed during the planning process reported an anticipated need of $26.9 billion in state financial assistance to implement municipal water management strategies in their planning areas. This amount represents about 58 percent of the total capital costs for water supply management strategies recommended for municipal water user groups in the 2011 regional water plans. Of the total reported needs for state financial assistance, nearly $15.7 billion is expected to occur between the years 2010 and 2020, $4.2 billion will occur between 2020 and 2030, and $4.1 billion between 2030 and 2040.

FIGURE ES.6. TOTAL CAPITAL COSTS FOR WATER SUPPLIES, WATER TREATMENT AND DISTRIBUTION, WASTEWATER TREATMENT AND COLLECTION, AND FLOOD CONTROL (BILLIONS OF DOLLARS).



About $400 million would be for projects in rural and economically distressed areas of the state.

The planning groups also made a number of regulatory, administrative, and legislative recommendations that they believe are needed to better manage our water resources and to prepare for and respond to droughts. Based on these recommendations and other policy considerations, the TWDB makes the following recommendations to facilitate the implementation of the 2012 State Water Plan:

ISSUE 1: RESERVOIR SITE AND STREAM SEGMENT DESIGNATION

The legislature should designate the three additional sites of unique value for the construction of reservoirs recommended in the 2011 regional water plans (Turkey Peak Reservoir, Millers Creek Reservoir Augmentation, and Coryell County Reservoir) for protection under Texas Water Code, Section 16.051 (g). These sites are shown in Figure ES.7.

The legislature should designate the nine river or stream segments of unique ecological value recommended in the 2011 regional water plans (Pecan Bayou, Black Cypress Creek, Black Cypress Bayou, Alamito Creek, Nueces River, Frio River, Sabinal River, Comal River, and San Marcos River) for protection under Texas Water Code, Section 16.051. The sites are shown in Figure ES.8.

ISSUE 2: RESERVOIR SITE ACQUISITION

The legislature should provide a mechanism to acquire feasible reservoir sites so they are available for

development of additional surface water supplies to meet future water supply needs of Texas identified in the 2011 regional water plans and also water supply needs that will occur beyond the 50-year regional and state water planning horizon.

ISSUE 3: INTERBASIN TRANSFERS OF SURFACE WATER

The legislature should enact statutory provisions that eliminate unreasonable restrictions on the voluntary transfer of surface water from one basin to another.

ISSUE 4: PETITION PROCESS ON THE REASONABLENESS OF DESIRED FUTURE CONDITIONS

The legislature should remove TWDB from the petition process concerning the reasonableness of a desired future condition except for technical review and comment.

ISSUE 5: WATER LOSS

The legislature should require all retail public utilities to conduct water loss audits on an annual basis, rather than every five years.

ISSUE 6: FINANCING THE STATE WATER PLAN

The legislature should develop a long-term, affordable, and sustainable method to provide financing assistance for the implementation of state water plan projects.

WHAT HAVE WE DONE ALREADY TO IMPLEMENT WATER MANAGEMENT STRATEGIES FROM PREVIOUS PLANS?

In response to the 2007 State Water Plan, the 80th and 81st Texas Legislatures provided funding to implement $1.47 billion in state water plan projects through three of TWDB's financial assistance programs. To date, TWDB has provided over $1 billion in low-interest loans and grants to implement 46 projects across the state, all of which represent water management strategies in the 2006 regional water plans and the 2007 State Water Plan. Once fully implemented, these projects will supply over 1.5 million acre-feet of water needed during times of drought to millions of Texans. In 2011, the 82nd Texas Legislature authorized additional funding to finance approximately $100 million in state water plan projects. These funds will be available during state fiscal years 2012 and 2013. TWDB has also provided over $500 million in funding to implement water management strategies recommended in the 2007 State Water Plan through other loan programs.

To provide a measure of the progress made in implementing the strategies included in the 2007 State Water Plan, TWDB surveyed project sponsors of recommended municipal water management strategies. Of the 497 projects for which responses were received on behalf of the sponsoring entities, 139 of them (28 percent) reported some form of progress on strategy implementation. Of these, 65 (13 percent) reported that strategies had been fully implemented. Of the 74 projects (15 percent) that reported incomplete progress, 13 (3 percent) reported that project construction had begun. The number of fully implemented projects—65—represents a significant increase from the 21 projects that the 2007 State Water Plan reported had been implemented from the 2002 State Water Plan. The implementation of many of these projects would not have been possible without the funding provided by the Texas Legislature through TWDB's financial assistance programs.

Like all planning efforts, state water plans have made recommendations based on the needs of the times during which they were developed. When times change, so do plans. Some projects that were once recommended may be no longer feasible or necessary due to advances in technology or changes

in water availability, population and demographics, or state or federal policies. The five-year state and regional water planning cycle is designed to address risks, uncertainties, and emerging needs in our ever-changing state. So if we cannot change the weather, Texas will have a plan to meet the needs of our communities for water when the next drought inevitably arrives.

POTENTIAL FUTURE PLANNING ISSUES

During every planning cycle, new issues emerge that influence the development of regional water plans and the state water plan. The following issues, discussed in further detail in the 2012 State Water Plan, are potentially among some of the issues that will impact future rounds of planning:

- Changes in population projections based on the results of the 2010 U.S. Census (Chapter 3, Population and Water Demand Projections).
- Changes in water demand projections from population growth or varying water use activities, such as the increased use of water for hydraulic fracturing mining operations (Chapter 3, Population and Water Demand Projections) or expanded production of biofuels (Chapter 10, Challenges and Uncertainty).
- Impacts to water availability from new environmental flow standards or modeled available groundwater numbers based on the desired future conditions of aquifers (Chapter 5, Water Supplies).
- Limitations of groundwater permitting processes that provide for term-permits or that allow for reductions in a permit holder's allocations, which could impact the feasibility of water management strategies (Chapter 5, Water Supplies).
- Lack of sufficient financial assistance to aid in implementation of recommended water management strategies (Chapter 9, Financing Needs).
- Other uncertain potential future challenges such as natural disasters or climate variability (Chapter 10, Challenges and Uncertainty).

FIGURE ES.7. DESIGNATED AND RECOMMENDED UNIQUE RESERVOIR SITES.

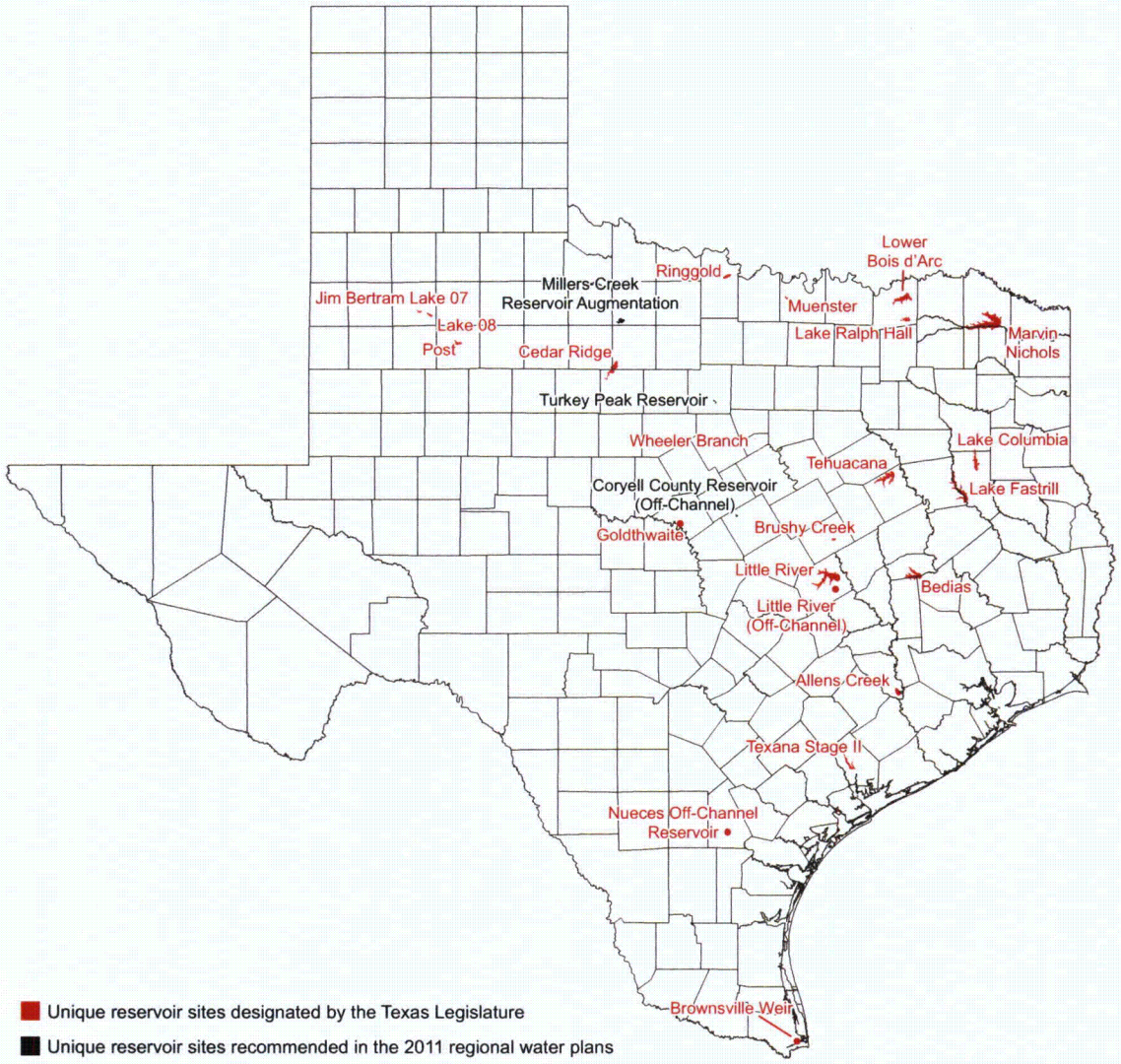
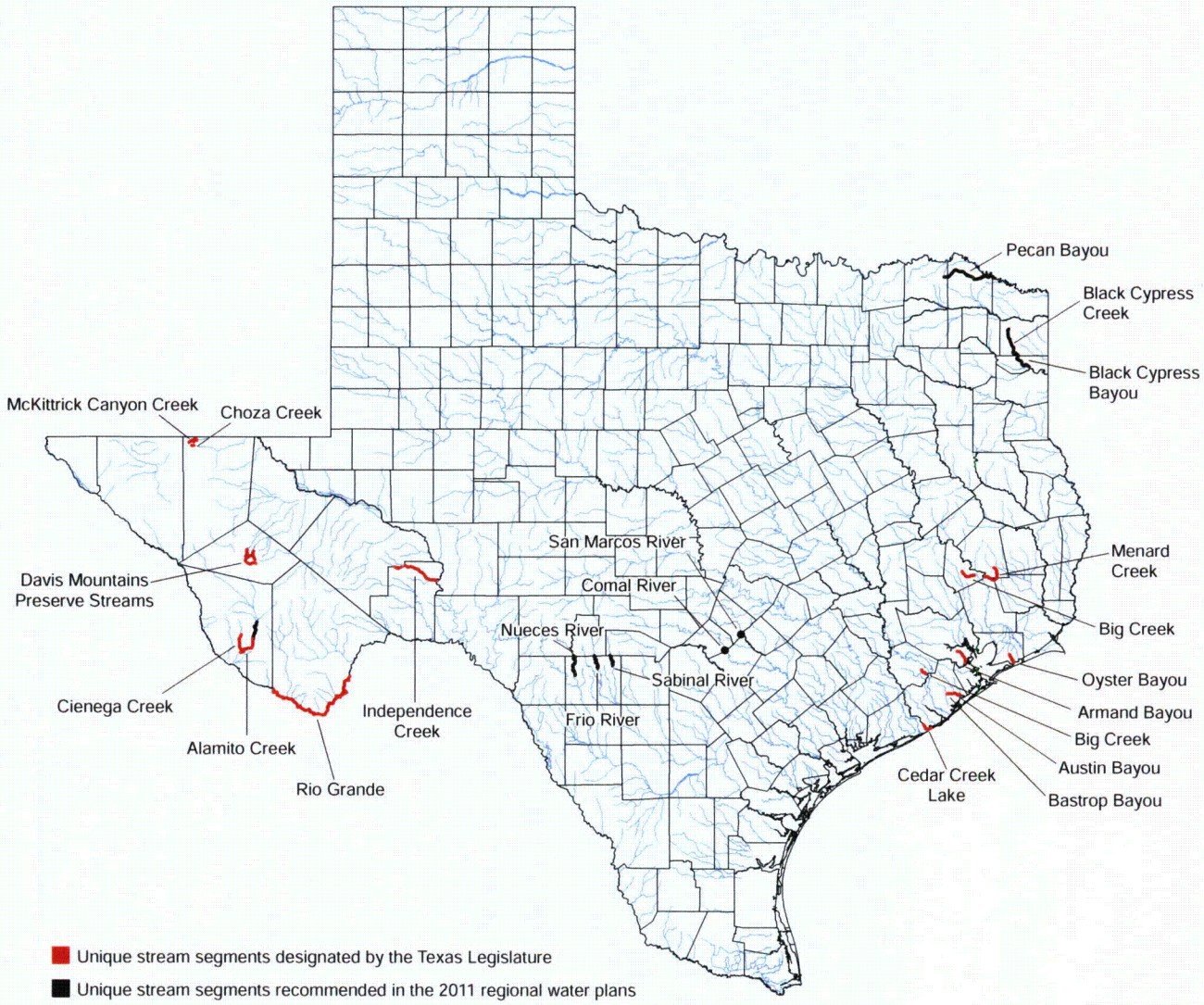


FIGURE ES.8. DESIGNATED AND RECOMMENDED UNIQUE STREAM SEGMENTS.



1 Introduction

The purpose of this plan is to ensure that all of our communities have adequate supplies of water during times of drought.

The availability of water has always influenced patterns of settlement, and communities in Texas originally grew where water was plentiful. But as many of our communities have grown, they have outgrown their water supplies, making it more and more necessary to make efficient use of our local water resources, to work cooperatively with one another on regional solutions to water problems, and to move water around the state when necessary to meet the needs of all our communities. The purpose of this plan is to ensure that all of our communities have adequate supplies of water during times of drought.

The 2012 State Water Plan is Texas' ninth state water plan and the third to be developed through the regional water planning process, initiated by the Texas Legislature in 1997. When the first state water plan was published in 1961, the population of Texas was less than half the size it is today, with 9.6 million residents. At the time the plan was adopted, only a third of Texans lived in urban areas and 79 percent of the communities in Texas obtained their water supplies from groundwater wells. Now there are over 25 million Texans. Our population has become older, less rural, and more diverse. Communities in the state obtain much more of their water supplies from surface water such as rivers and lakes, but also from new sources such as reuse and desalination. While a lot has changed since the first water plan, much remains the same. All or part of the state is often too wet or too dry, and planning for times of drought is every bit as relevant today as it was then.

The 2012 State Water Plan is based on regional water plans that are updates to the 2006 regional water plans. During this planning cycle, the regional water plans were focused primarily on changed conditions, since new population data from the U.S. Census Bureau was not available to significantly update projections of future water demands. The last state water plan, *Water for Texas—2007*, included population and water demand projections based on newly released 2000 U.S. Census data, and its adoption coincided with the 50th anniversary of TWDB and the commencement of the 80th Texas Legislative session. It also included comprehensive summaries of all of the river basins and aquifers in the state. These summaries are still current and are included by reference in the 2012 State Water Plan.

Since this plan is adopted over 50 years after the first state water plan, a special effort has been made to look back at past plans and to reflect on the evolution of water planning over time. Newer plans have placed greater emphasis on conservation and on innovative strategies that were largely unknown to the planners of the 1950s and 1960s. Plans have included everything from small local projects to importing surplus water from the Mississippi River. But the reality of drought and the needs for water to sustain our cities, rural communities, farms, ranches, businesses, industries, and our environment have remained unchanged.

This plan references numerous studies and reports with multiple findings and recommendations. Reference of these studies and reports does not constitute an endorsement by TWDB of their findings and recommendations.

1.1 A BRIEF HISTORY OF TEXAS WATER PLANNING

Droughts—periods of less than average precipitation over a period of time—have plagued Texas since well before the first Spanish and Anglo settlers began arriving in the 1700s (Dunn, 2011). While some oversight of our state's water resources began with these first settlers, the modern age of water management began around the mid to late 1800s with the earliest regulations and recordkeeping. The creation of management agencies after the turn of the past century, along with the collection of rainfall and streamflow data, began a new era of water management in the state.

When reviewing the history of weather events, it is easy to see that the major policy changes in the management of Texas' water resources have largely corresponded to cycles of droughts and floods. Droughts are unique among climate phenomena in that they develop slowly but can ultimately have consequences as economically devastating as hurricanes, tornadoes, and floods (TBWE, 1958).

In each decade of the past century, at least some part of the state has experienced a severe drought. During development of the 2012 State Water Plan, all of Texas was in some form of drought. As of September 2011, 99 percent of the state was experiencing severe, extreme, or exceptional drought conditions. The majority of Texas counties had outdoor burn bans, 902 public water supply systems were imposing voluntary or mandatory restrictions on their customers, and the Texas Commission on Environmental Quality had suspended the use of certain water rights in several of the state's river basins. As of the fall, the drought of 2011 ranks as the worst one-year drought in Texas' history.

1.1.1 EARLY HISTORY OF WATER MANAGEMENT IN TEXAS

Formal water supply planning at the state level did not begin in earnest until the 1950s, but the legislature progressively began assigning responsibility for the management and development of the state's water resources to various entities starting in the early 20th century. Partly as a result of a series of devastating droughts and floods, the early 1900s saw a flurry of activity. In 1904, a constitutional amendment was adopted authorizing the first public development of water resources. The legislature authorized the creation of drainage districts in 1905; the Texas Board of Water Engineers in 1913; conservation and reclamation districts (later known as river authorities) in 1917; freshwater supply districts in 1919; and water control and improvement districts in 1925.

The creation of the Texas Board of Water Engineers, a predecessor agency to both the Texas Commission on Environmental Quality and TWDB, played a significant role in the early history of water management in the state. The major duties of the Board of Water Engineers were to approve plans for the organization of irrigation and water supply districts, approve the issuance of bonds by these districts, issue water right permits for storage and diversion of water, and make plans for storage and use of floodwater. Later, the legislature gave the agency the authority to define and designate groundwater aquifers; authorize underground water conservation districts; conduct groundwater and surface water studies; and approve federal projects, including those constructed by the U.S. Army Corps of Engineers.

In 1949, Lyndon Johnson, then a U.S. Senator, wrote a letter to the U.S. Secretary of the Interior requesting that the federal government help guide Texas in achieving "a comprehensive water program that will take into account the needs of the people of my State." Four years later, the U.S. Bureau of Reclamation responded by publishing "Water Supply and the Texas Economy: An Appraisal of the Texas Water Problem" (USBR, 1953). The report divided the state into four planning regions and evaluated existing and projected municipal and industrial water requirements up to the year 2000. The analysis assumed an available water supply under streamflow conditions experienced in 1925, when a short drought affected most of the eastern two-thirds of the state (TBWE, 1959). The appraisal identified "problem areas," presented water supply plans as potential solutions, and made a number of observations on state and federal policy. Most significantly, it recommended that Texas consider forming a permanent water planning and policy agency to represent state interests.

The idea of a dedicated water planning agency came to fruition not long after the state experienced the worst drought in recorded history. For Texas as a whole, the drought began in 1950 and by the end of 1956, all but one of Texas' 254 counties were classified as disaster areas. Ironically, the drought ended in the spring of 1957 with massive rains that resulted in the flooding of every major river and tributary in the state. This drought represents the driest seven-year period in the state's recorded history and is still considered Texas' "drought of record" upon which most water supply planning in the state is based.

The drought of the 1950s was unique in that a majority of Texans felt the impacts of a reduced water supply during some point during the decade. Not only did they feel the impact, but residents were at times called into action to help fix water problems in their communities (see Sidebar: Byers, Texas). Small and large cities alike faced dire situations. By the fall of 1952, Dallas faced a severe water shortage and prohibited all but necessary household use of water. In 1953 alone, 28 municipalities were forced to use emergency sources of water supply, 77 were rationing water, and 8 resorted to hauling in water from neighboring towns or rural wells. The development of additional facilities during the course of the drought reduced the number of communities with shortages during later years of the drought, but still more municipalities were forced to haul in water before it was over (TBWE, 1959). The drought of the 1950s cost the state hundreds of millions of dollars, and was followed by floods that caused damages estimated at $120 million (TBWE, 1958).

1.1.2 WATER PLANNING ON THE STATE LEVEL (1957 TO 1997)

The legislature responded early in the drought by establishing the Texas Water Resources Committee in 1953 to survey the state's water problems (UT Institute of Internal Affairs, 1955). While dry conditions persisted, the joint committee of both state senators and house members worked to develop a long-range water policy in response to the emergency situations. As a result of some of the committee's recommendations, the Texas Legislature passed a resolution authorizing $200 million in state bonds to help construct water conservation and supply projects. The legislature created TWDB to administer the funds from the bond sale. Then, during a following special session called by Governor Price Daniel, the legislature passed the Water Planning Act of 1957. The act created the Texas Water Resources Planning Division of the Board of Water Engineers, which was assigned the responsibility of water resources

Byers, Texas

In April 1953, after many months of drought, the town of Byers ran out of water. With the reservoir dry, the mayor declared an emergency and cut off water service to 200 customers and the school system. Word of the emergency spread fast and offers for help quickly poured in from neighboring communities. Most of Byers' 542 residents, along with a detail of men from Sheppard Air Force Base, laid a 2-mile pipeline from a spring on a nearby farm to the town's reservoir. Disaster was averted, but the events in Byers, and in other Texas communities affected by drought, were not soon forgotten (Lewiston Evening Journal, 1953).

Byers is now considered a municipal water user group in the Region B regional water planning area. Thanks to two sources of water supply identified in the 2011 Region B Regional Water Plan—the Wichita Lake system and the Seymour Aquifer—the town is far better positioned today. If the drought of the 1950s were to recur within the next 50 years, Byers would not only be better prepared but would have a surplus of water.

planning on a statewide basis. The voters of Texas subsequently approved a constitutional amendment authorizing TWDB to administer a $200 million water development fund to help communities develop water supplies.

In June of 1960, Governor Daniel called a meeting in Austin to request that the Board of Water Engineers prepare a planning report with projects to meet the projected municipal and industrial water requirements of the state in 1980. Work quickly began on statewide studies to develop the first state water plan. The first plan—A Plan for Meeting the 1980 Water Requirements of Texas—was published in 1961. The plan described historical and present uses of surface and groundwater by municipalities, industries, and irrigation; summarized the development of reservoirs; estimated the 1980 municipal and industrial requirements of each area of the state; provided a plan for how to meet those requirements by river basin; and discussed how the plan could be implemented.

Later plans were developed by the state and adopted in 1968, 1984, 1990, 1992, and 1997. All of the plans have recognized the growth of the state's population and the need to develop future water supplies. Earlier plans placed more reliance on the federal government, while later plans developed at the state level increasingly emphasized the importance of conservation and natural resource protection. The 1968 State Water Plan recommended that the federal government continue to fund feasibility studies on the importation of surplus water from the lower Mississippi River. (A later study found that the project was not economically feasible.) The 1984 State Water Plan was the first to address water quality, water conservation and water use efficiency, and environmental water needs in detail.

While previous plans were organized by river basin, the 1990 State Water Plan projected water demands, supplies, and facility needs for eight regions in the state. The 1997 State Water Plan— developed by TWDB through a consensus process with the Texas Parks and Wildlife Department and the Texas Commission on Environmental Quality—divided the state into 16 planning regions.

RESERVOIR DEVELOPMENT IN TEXAS

Texas has 15 major river basins and 8 coastal basins along with 9 major and 21 minor groundwater aquifers, but water supplies vary widely from year to year and place to place. Because of the unpredictability of rainfall and streamflows in the state, communities have historically relied on reservoirs to supply water during times of drought, capturing a portion of normal flow as well as floodwaters. Prevention of flooding and conservation of water for use during droughts, together with an efficient distribution system, have always been important goals in water resources planning (TBWE, 1958).

When the Texas Board of Water Engineers was originally created in 1913, the state had only 8 major reservoirs—those with a total conservation storage capacity of 5,000 acre-feet or greater (TBWE, 1959). Of these eight reservoirs, three were for municipal water supply, four were for irrigation, and one was for the generation of hydroelectric power. Lake Travis, constructed between 1937 and 1941, was the first multipurpose reservoir to provide water storage for municipal, irrigation, and mining uses; recreation; hydroelectric power generation; and flood control.

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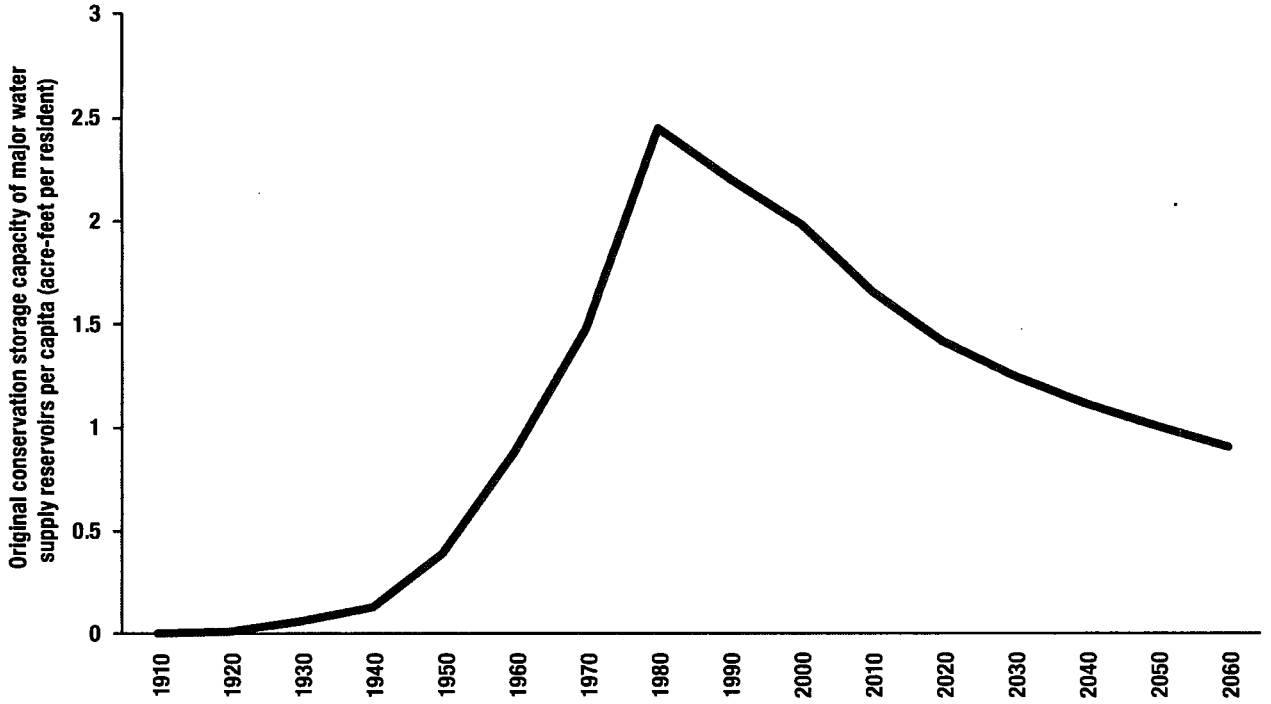
FIGURE 1.1. RESERVOIR STORAGE PER CAPITA OVER TIME.



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During the mid 20th century, the federal government constructed a number of major reservoirs primarily for flood control but also with water supply storage. In many instances these reservoirs have prevented flood losses far exceeding the cost of their construction. (Amistad Dam on the Rio Grande retained a 1954 flood shortly after it was completed, preventing catastrophic flooding in the Lower Rio Grande Valley (TBWE, 1958).) In 1950, the state had 53 major water supply reservoirs; by 1980, the state had 179; and today, Texas has 188 major water supply reservoirs, with only a handful in some stage of planning or implementation.

Reservoir construction has slowly declined since the 1980s. While fewer reservoirs are recommended now than in early state water plans, they still play an important role in meeting needs for water during a drought. The 2012 State Water Plan recommends 26 reservoirs that would provide 1.5 million acre-feet of water during a repeat of drought of record conditions in 2060. In the absence of these reservoirs, other water management strategies would simply not be enough to meet the needs of Texans during a severe drought.

As shown in Figure 1.1, reservoir storage per person in the state has declined from a peak of 2.4 acre-feet of conservation storage per person in 1980 to 1.7 acre-feet of conservation storage per person today. If no additional reservoirs are constructed in the next 50 years, the amount of reservoir storage would decline to less than 1 acre-foot per person by 2060, the lowest amount since immediately following the 1950s drought of record.

1.1.3 THE ADVENT OF REGIONAL WATER PLANNING

The same circumstances that led to the beginning of state water planning served as the impetus for one of the most significant changes in how Texas conducts water planning. In the mid 1990s, Texas suffered an intense 10-month drought. Reservoirs and aquifer levels declined sharply and farmers suffered widespread crop failure, with estimated economic losses in billions of dollars. Some cities had to ration water for several months and others ran out of water entirely.

The drought of 1996 was relatively short-lived, but it lasted long enough to remind Texans of the importance of water planning. When the legislature met in 1997, Lieutenant Governor Bob Bullock declared that the primary issue for the 75th Texas Legislature would be water. After lengthy debate and numerous amendments, Senate Bill 1 was passed to improve the development and management of the water resources in the state. Among other provisions relating to water supplies, financial assistance, water data collection and dissemination, and other water management issues, the bill established the regional water planning process: a new framework that directed that water planning be conducted from the ground up.

1.2 THE REGIONAL WATER PLANNING PROCESS TODAY

Senate Bill 1 outlined an entirely new process where local and regional stakeholders were tasked with developing consensus-based regional plans for how to meet water needs during times of drought. TWDB would then develop a comprehensive state water plan—based on the regional water plans—every five years. One of the most important aspects of the legislation specified that TWDB could provide financial assistance for water supply projects only if the needs to be addressed by the project were addressed in a manner that is consistent with the regional water plans and the state water plan. This same provision also applied to the granting of water right permits by the Texas Commission on Environmental Quality.

Following passage of the legislation in 1997, TWDB initiated regional water planning with administrative rules to guide the process. TWDB designated 16 regional water planning areas (Figure 2.1), taking into consideration river basin and aquifer delineations, water utility development patterns, socioeconomic characteristics, existing regional water planning areas, state political subdivision boundaries, public comments, and other factors. TWDB is required to review and update the planning area boundaries at least once every five years, but no changes have been made to date.

Each regional water planning area has its own planning group responsible for developing a regional water plan every five years. Regional water planning groups are required to have at least 11 interests represented, including the public, counties, municipalities, industries, agriculture, environment, small businesses, electric-generating utilities, river authorities, water districts, and water utilities. Planning groups must have at least one representative from each interest, and can designate representatives for other interests that are important to the planning area. Planning groups also have non-voting members from federal, state, and local agencies and have members that serve as liaisons with planning groups in adjacent areas. (Legislation passed during the 82nd Legislative Session now requires that groundwater conservation districts in each groundwater management area located in the regional water planning area to appoint one representative to serve on the regional water planning group.) Each planning group approves

bylaws to govern its methods of conducting business and designates a political subdivision of the state.

The regional water planning process consists of 10 tasks:

- **Describing the regional water planning area:** Descriptions include information on major water providers, current water use, sources of groundwater and surface water, agricultural and natural resources, the regional economy, summaries of local water plans, and other information.
- **Quantifying current and projected population and water demand over a 50-year planning horizon:** Planning groups review projections provided by TWDB and propose revisions resulting from changed conditions or new information. TWDB consults with the Texas Department of Agriculture, Texas Commission on Environmental Quality, and Texas Parks and Wildlife Department before formally approving requests for revisions.
- **Evaluating and quantifying current water supplies:** Planning groups determine the water supplies that would be physically and legally available from existing sources during a repeat of the drought of record or worse. To estimate the existing water supplies, the planning groups use the state's surface water and groundwater availability models, when available.
- **Identifying surpluses and needs:** Planning groups compare existing water supplies with current and projected water demands to identify when and where additional water supplies are needed for each identified water user group and wholesale water provider.
- **Evaluating and recommending water management strategies to meet the needs:** Planning groups must address the needs of all water users, if feasible. If existing supplies do not meet future demand, they recommend specific water management strategies to meet water supply needs, such as conservation of existing water supplies, new reservoir and groundwater development, conveyance facilities to move available or newly developed water supplies to areas of need, water reuse, and others.
- **Evaluating impacts of water management strategies on water quality:** Planning groups describe how implementing recommended and alternative water management strategies could affect water quality in Texas.
- **Describing how the plan is consistent with long-term protection of the state's water, agricultural, and natural resources:** Planning groups estimate the environmental impacts of water management strategies. They identify specific resources important to their planning areas and describe how these resources are protected through the regional water planning process.
- **Recommending regulatory, administrative, and legislative changes:** Along with general policy and statutory recommendations, planning groups make recommendations for designating unique reservoir sites and stream segments of unique ecological value. The legislature is responsible for making the official designations of these sites.
- **Describing how sponsors of water management strategies will finance projects:** Planning groups survey water providers on how they propose to pay for water infrastructure projects in the plan and identify needs for state financing.
- **Adopting the plan:** All meetings are held in accordance with the Texas Open Meetings Act. Planning groups hold public meetings when planning their work and hold hearings before adopting their regional water plans. Members

adopt plans by vote in accordance with each group's respective bylaws.

After planning groups adopt their regional water plans, they are sent to TWDB for approval. As required by statute, TWDB then begins development of the state water plan. The state water plan incorporates information from the regional water plans, but it is more than just the sum of the regional plans. The state water plan serves as a guide to state water policy; it also explains planning methodology, presents data for the state as a whole, identifies statewide trends, and provides recommendations to the state legislature. Prior to adoption of the final state water plan, TWDB releases a draft for public comment, publishes its intent to adopt the state water plan in the Texas Register, notifies the regional water planning groups, and holds a public hearing in Austin.

The 2012 State Water Plan is the third plan developed through the regional water planning process. In response to issues identified in the 2007 State Water Plan, the legislature made several policy changes that impacted water planning. The 79th Texas Legislature passed Senate Bill 3, which created a process to address environmental flows and designated unique reservoir sites and sites of unique ecological value. The legislature also provided appropriations to allow $1.2 billion of funding to implement water management strategies recommended in the 2006 regional water plans and the 2007 State Water Plan. Priority was given to entities with the earliest recommended implementation date in the state and regional water plans and that have already demonstrated significant water conservation savings or would achieve significant water conservation by implementing a proposed project. Later chapters of this plan discuss these issues in detail.

1.3 STATE AND FEDERAL WATER SUPPLY INSTITUTIONS

While TWDB is the state's primary water planning agency, a number of state and federal agencies in Texas have responsibility for the management of water resources and participate in the regional planning process directly and indirectly. Texas Parks and Wildlife Department, the Texas Commission on Environmental Quality, and the Texas Department of Agriculture all have non-voting representation on each planning group. They actively participate in the development of population projections and are given the opportunity to comment on the state water plan early in its development and are consulted in the development and amendment of rules governing the planning process. The water-related responsibilities of these agencies, along with other state and federal entities that indirectly participate in the regional water planning process, are described in the following sections.

1.3.1 STATE ENTITIES

TWDB, as created in 1957, is the state's primary water supply planning and financing agency. TWDB supports the development of the 16 regional water plans and is responsible for developing the state water plan every five years. The agency provides financial assistance to local governments for water supply and wastewater treatment projects, flood protection planning and flood control projects, agricultural water conservation projects, and groundwater district creation expenses. TWDB collects data and conducts studies of the fresh water needs of the state's bays and estuaries and is responsible for all aspects of groundwater studies. The agency also maintains the Texas Natural Resources Information System, the clearinghouse for geographic data in the state. TWDB provides technical support to the environmental flows process and is a member

of the Texas Water Conservation Advisory Council, providing administrative support to the council.

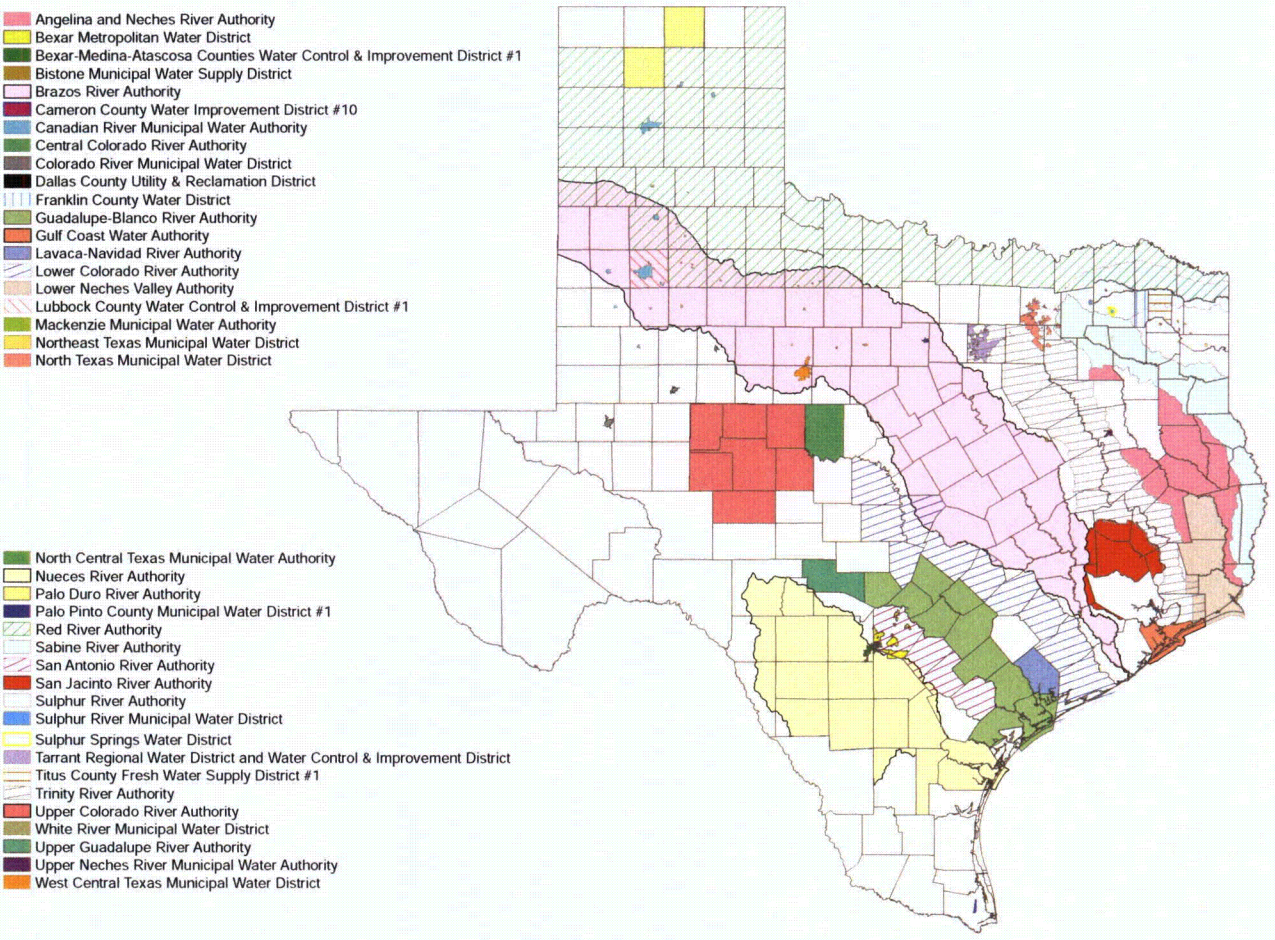
The State Parks Board, originally created in 1923, was later merged with other state entities and renamed the **Texas Parks and Wildlife Department.** Today, the agency has primary responsibility for conserving, protecting, and enhancing the state's fish and wildlife resources. It maintains a system of public lands, including state parks, historic sites, fish hatcheries, and wildlife management areas; regulates and enforces commercial and recreational fishing, hunting, boating, and nongame laws; and monitors, conserves, and enhances aquatic and wildlife habitat. Texas Parks and Wildlife Department reviews and makes recommendations to minimize or avoid impacts on fish and wildlife resources resulting from water projects. The agency works with regional and state water planning stakeholders and regulatory agencies to protect and enhance water quality and to ensure adequate environmental flows for rivers, bays, and estuaries. It also provides technical support to the environmental flows process and is a member of the Texas Water Conservation Advisory Council.

In 1992, to make natural resource protection more efficient, the legislature consolidated several programs into one large environmental agency now known as the **Texas Commission on Environmental Quality**. The Texas Commission on Environmental Quality is the environmental regulatory agency for the state, focusing on water quality and quantity through various state and federal programs. The agency issues permits for the treatment and discharge of industrial and domestic wastewater and storm water; reviews plans and specifications for public water systems; and conducts assessments of surface water and groundwater quality. The Texas Commission on Environmental Quality regulates retail water and sewer utilities, reviews rate increases by investor-owned water and wastewater utilities, and administers a portion of the Nonpoint Source Management Program. In addition, it administers the surface water rights permitting program and a dam safety program; delineates and designates Priority Groundwater Management Areas; creates some groundwater conservation districts; and enforces the requirements of groundwater management planning. The agency also regulates public drinking water systems and is the primary agency for enforcing the federal Safe Drinking Water Act. The Texas Commission on Environmental Quality provides support to the environmental flows process and adopts rules for environmental flow standards. The Texas Commission on Environmental Quality is a member of the Texas Water Conservation Advisory Council.

The **Texas Department of Agriculture**, established by the Texas Legislature in 1907, is headed by the Texas Commissioner of Agriculture. The agency supports protection of agricultural crops and livestock from harmful pests and diseases; facilitates trade and market development of agricultural commodities; provides financial assistance to farmers and ranchers; and administers consumer protection, economic development, and healthy living programs, and is a member of the Texas Water Conservation Advisory Council.

Created in 1939, the **Texas State Soil and Water Conservation Board** administers Texas' soil and water conservation law and coordinates conservation and nonpoint source pollution abatement programs. The agency also administers water quality and water supply enhancement programs and is a member of the Texas Water Conservation Advisory Council.

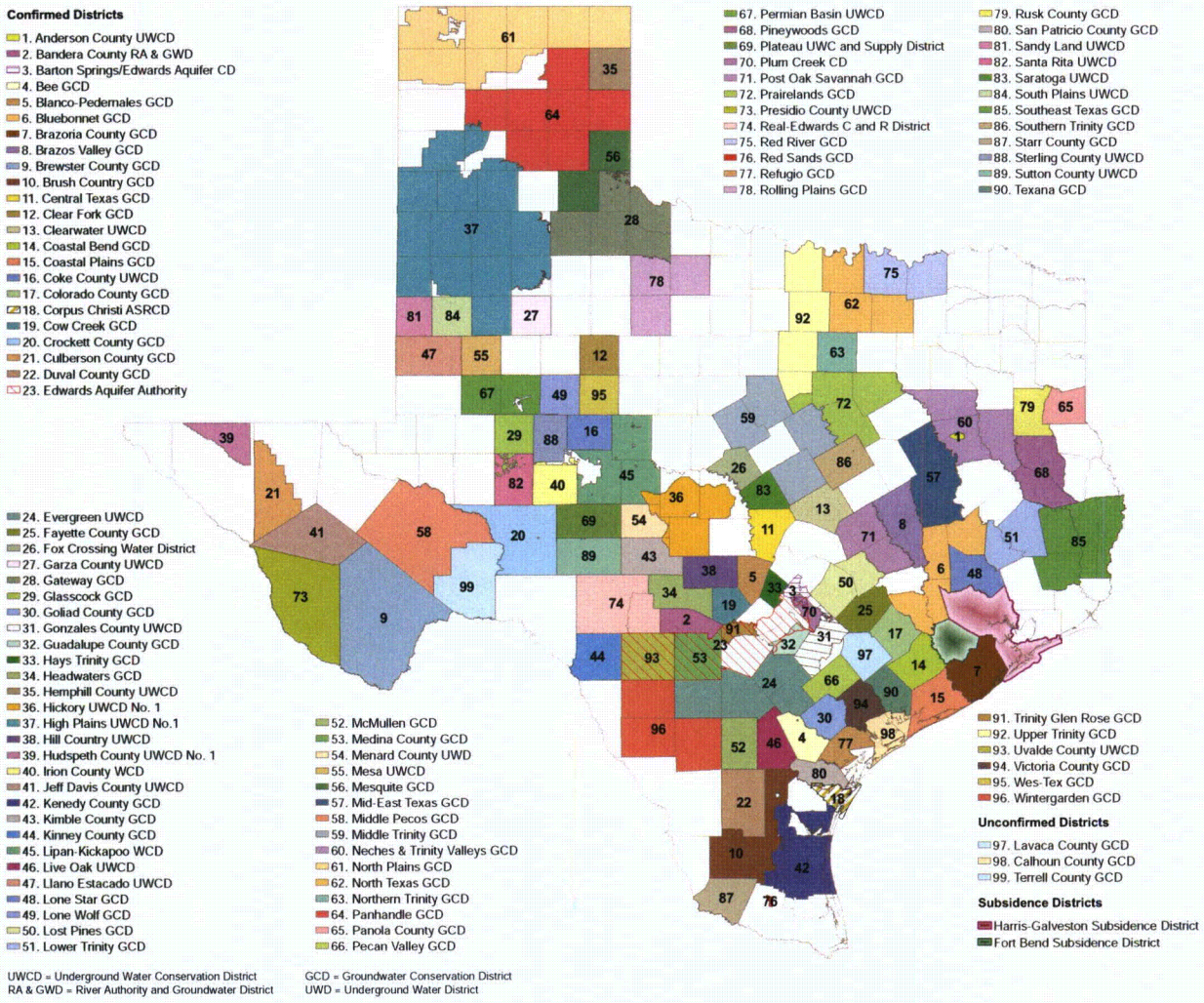
FIGURE 1.2. RIVER AUTHORITIES AND SPECIAL LAW DISTRICTS IN TEXAS.



First authorized by the legislature in 1917, river authorities could be created and assigned the conservation and reclamation of the state's natural resources, including the development and management of water. They generally operate on utility revenues generated from supplying energy, water, wastewater, and other community services. The 17 river authorities in Texas, along with similar special law districts authorized by the legislature, are shown in Figure 1.2.

The formation of **groundwater conservation districts** was first authorized by the legislature in 1949 to manage and protect groundwater at the local level. Groundwater conservation districts are governed by a local board of directors, which develops a management plan for the district with technical support from TWDB, the Texas Commission on Environmental Quality, and other state agencies. Because most groundwater conservation districts are based on county lines and do not manage an entire aquifer, one aquifer may be managed by several groundwater districts. Each district must plan with the other districts within their common groundwater management areas to determine the desired future conditions of the aquifers within the groundwater management areas. As of 2011, 96 groundwater

FIGURE 1.3. GROUNDWATER CONSERVATION DISTRICTS IN TEXAS.



conservation districts have been established in Texas covering all or part of 173 counties (Figure 1.3).

Other entities at the regional and local levels of government construct, operate, and maintain water supply and wastewater infrastructure. These include municipalities; water supply, irrigation, and municipal utility districts; flood and drainage districts; subsidence districts; and non-profit water supply and sewer service corporations.

1.3.2 FEDERAL AGENCIES

Federal civil works projects played a major role in the early development of the state's water resources (TWBE, 1958). Texas historically relied heavily on federal funds to finance water development projects, with local commitments used to repay a portion of the costs. Federal agencies such as the Soil Conservation Service, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers constructed a number of surface water reservoirs in Texas. These reservoirs were built for the primary purpose of flood control, but provide a large portion of the state's current water

supply. The pace of federal spending on reservoir construction has declined considerably since the 1950s and 1960s, and current federal policy recognizes a declining federal interest in the long-term management of water supplies.

Several federal agencies are responsible for the management of the nation's water resources. The U.S. Army Corps of Engineers investigates, develops, and maintains the nation's water and related environmental resources. Historically, the **U.S. Army Corps of Engineers** has been responsible for flood protection, dam safety, and the planning and construction of water projects, including reservoirs. Pursuant to the Clean Water Act and the Rivers and Harbors Act, the Corps operates a program that regulates construction and other work in the nation's waterways.

Within the U.S. Department of the Interior, the **U.S. Geological Survey** conducts natural resources studies and collects water-related data, and the **U.S. Bureau of Reclamation** conducts water resource planning studies and manages water resources primarily in the western United States. The **U.S. Fish and Wildlife Service**, also part of the Department of the Interior, protects fish and wildlife resources through various programs and carries out provisions of the Endangered Species Act.

The **Natural Resources Conservation Service**, part of the U.S. Department of Agriculture and successor to the Soil Conservation Service, implements soil conservation programs and works at the local level through conservation planning and assistance programs. The **U.S. Environmental Protection Agency** regulates and funds federal water quality, solid waste, drinking water, and other programs pursuant to the Clean Water Act, the Safe Drinking Water Act, and other federal laws and regulations. The **International Boundary and Water Commission** manages the waters of the Rio Grande between the United States and Mexico.

1.4 THE MANAGEMENT OF WATER IN TEXAS

Unlike scientists who recognize that all water is interconnected, Texas law divides water into several classes for the purpose of regulation. Different rules govern each class, determining who is entitled to use the water, in what amount, and for what purpose. Texas' complicated system arose from Spanish and English common law, the laws of other western states, and state and federal case law and legislation.

To understand how regional water planning groups plan for water needs during a drought, it is helpful to have some understanding of how water is managed in the state. Each regional water plan must be consistent with all laws, rules, and regulations applicable to water use in the planning area. The following sections briefly describe how the state manages surface and groundwater, water quality, drinking water, and interstate waters, all important considerations when planning for drought.

1.4.1 SURFACE WATER

In Texas, all surface water is held in trust by the state, which grants permission to use the water to different groups and individuals. Texas recognizes two basic doctrines of surface water rights: the riparian doctrine and the prior appropriation doctrine. Under the riparian doctrine, landowners whose property is adjacent to a river or stream have the right to make reasonable use of the water. The riparian doctrine was introduced in Texas over 200 years ago with the first Spanish settlers. In 1840, the state adopted the common law of England, which included a somewhat

different version of the riparian doctrine (Templar, 2011). The state later began to recognize the need for a prior appropriation system, which had developed in response to the scarcity of water in the western United States (BLM, 2011). The prior appropriation system, first adopted by Texas in 1895, has evolved into the modern system used today. Landowners who live on many of the water bodies in the state are allowed to divert and use water for domestic and livestock purposes (not to exceed 200 acre-feet per year), but these are some of the last riparian rights still in place.

In 1913, the legislature extended the prior appropriation system to the entire state. It also established the Texas Board of Water Engineers, the agency that had original jurisdiction over all applications for appropriated water. Because different laws governed the use of surface waters at different times in Texas history, claims to water rights often conflicted with one another. As a result of these historic conflicts, in 1967 the state began to resolve claims for water rights. A "certificate of adjudication" was issued for each approved claim, limiting riparian and other unrecorded rights to a specific quantity of water. The certificate also assigned a priority date to each claim, with some dates going back to the time of the first Spanish settlements (TCEQ, 2009).

The adjudication of surface water rights gave the state the potential for more efficient management of surface waters (Templer, 2011). With only a few exceptions, water users today need a permit in the form of an appropriated water right from the Texas Commission on Environmental Quality. The prior appropriations system recognizes the "doctrine of priority," which gives superior rights to those who first used the water, often known as "first in time, first in right." In most of the state, water rights are prioritized only by the date assigned to them and not by the purpose for which the water will be used. Only water stored in Falcon and Amistad reservoirs in the middle and lower Rio Grande river basin is prioritized by the purpose of its use, with municipal and industrial rights having priority over irrigation rights during times of drought.

When issuing a new water right, the Texas Commission on Environmental Quality assigns a priority date, specifies the volume of water that can be used each year, and may allow users to divert or impound the water. Water rights do not guarantee that water will be available, but they are considered property interests that may be bought, sold, or leased. The agency also grants term permits and temporary permits, which do not have priority dates and are not considered property rights. The water rights system works hand in hand with the regional water planning process: the agency may not issue a new water right unless it addresses a water supply need in a manner that is consistent with the regional water plans and the state water plan.

Texas relies on the honor system in most parts of the state to protect water rights during times of drought. But in three areas, the Texas Commission on Environmental Quality has appointed a "watermaster" to oversee and continuously monitor streamflows, reservoir levels, and water use. There are two watermasters in Texas: the Rio Grande Watermaster, who among other things, coordinates releases from the Amistad and Falcon reservoir system, and the South Texas Watermaster, who serves the Nueces, San Antonio, Guadalupe, and Lavaca river and coastal basins, and who also serves as the Concho Watermaster, who serves the Concho River and its tributaries in the Colorado River Basin.

In general, Texas has very little water remaining for appropriation to new users. In some river basins, water is over appropriated, meaning that the rights

already in place amount to more water than is typically available during drought. This lack of "new" surface water makes the work of water planners all the more important. Now more than ever, regional water plans must make efficient use of the water that is available during times of drought.

1.4.2 GROUNDWATER

Groundwater in the state is managed in an entirely different fashion than surface water. Historically, Texas has followed the English common law rule that landowners have the right to capture or remove all of the water that can be captured from beneath their land. This "rule of capture" doctrine was adopted by the Texas Supreme Court in its 1904 decision *Houston & T.C. Railway Co. v. East*. In part, the rule was adopted because the science of quantifying and tracking the movement of groundwater was so poorly developed at the time that it would be practically impossible to administer any set of legal rules to govern its use. The *East* case and later court rulings established that landowners, with few exceptions, may pump as much water as they choose without liability. Today, Texas is the only western state that continues to follow the rule of capture.

In an attempt to balance landowner interests with limited groundwater resources, in 1949 the legislature authorized the creation of groundwater conservation districts for local management of groundwater. While the science of groundwater is much better developed (TWDB has groundwater availability models for all of the major aquifers and most of the minor aquifers in the state that are used to support local site-specific modeling), its use is still governed by the rule of capture, unless under the authority of a groundwater conservation district. Senate Bill 1 in 1997 reaffirmed state policy that groundwater conservation districts are the state's preferred method of groundwater management.

Since the original legislation creating groundwater districts in 1949, the legislature has made several changes to the way groundwater is managed in the state while still providing for local management. Most significantly, legislation in 2005 required groundwater conservation districts to meet regularly and to define the "desired future conditions" of the groundwater resources within designated groundwater management areas. Based on these desired future conditions, TWDB delivers modeled available groundwater values to groundwater conservation districts and regional water planning groups for inclusion in their plans.

Groundwater districts can be created by four possible methods: action of the Texas Legislature, petition by property owners, initiation by the Texas Commission on Environmental Quality, or addition of territory to an existing district. Districts may regulate both the location and production of wells, with certain voluntary and mandatory exemptions. They are also required to adopt management plans that include goals that provide for the most efficient use of groundwater. The goals must also address drought, other natural resources issues, and adopted desired future conditions. The management plan must include estimates of modeled available groundwater based on desired future conditions and must address water supply needs and water management strategies in the state water plan.

Several state agencies are involved in implementing the groundwater management plan requirements, including TWDB, the Texas Commission on Environmental Quality, and others. Along

with determining values for modeled available groundwater based on desired future conditions of the aquifer, TWDB provides technical and financial support to districts, reviews and administratively approves management plans, performs groundwater availability and water-use studies, and is responsible for the delineation and designation of groundwater management areas.

The Texas Commission on Environmental Quality provides technical assistance to districts and is responsible for enforcing the adoption, approval, and implementation of management plans. The agency also evaluates designated priority groundwater management areas, areas that are experiencing or are expected to experience critical groundwater problems within 50 years, including shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies.

1.4.3 SURFACE WATER QUALITY

The Texas Commission on Environmental Quality is charged with managing the quality of the state's surface water resources. Guided by the federal Clean Water Act and state regulations, the agency classifies water bodies and sets water quality standards for managing surface water quality. Water quality standards consist of two parts: 1) the purposes for which surface water will be used (aquatic life, contact recreation, water supply, or fish consumption) and 2) criteria that will be used to determine if the use is being supported. Water quality data are gathered regularly to monitor the condition of the state's surface waters and to determine if standards are being met. Through the Texas Clean Rivers Program, the Texas Commission on Environmental Quality works in partnership with state, regional, and federal entities to coordinate water quality monitoring, assessment, and stakeholder participation to improve the quality of surface water within each river basin.

Every two years, Texas submits a report to the U.S. Environmental Protection Agency that lists the status of all the waters in the state and identifies those that do not meet water quality standards. When water bodies do not meet standards, the Texas Commission on Environmental Quality may develop a restoration plan, evaluate the appropriateness of the standard, or collect more data and information. For water bodies with significant impairments, the agency must develop a scientific allocation called a "total maximum daily load" to determine the maximum amount of a pollutant that a water body can receive from all sources, including point and nonpoint sources, and still maintain water quality standards set for its use.

1.4.4 DRINKING WATER

The Texas Commission on Environmental Quality is also responsible for protecting the quality and safety of drinking water through primary and secondary standards. In accordance with the federal Safe Drinking Water Act and state regulations, primary drinking water standards protect public health by limiting the levels of certain contaminants; secondary drinking water quality standards address taste, color, and odor. Public drinking water systems must comply with certain construction and operational standards and they must continually monitor water quality and file regular reports with the Texas Commission on Environmental Quality.

The Texas Commission on Environmental Quality is also responsible for licensing operators that supervise a public water system's production, treatment, and distribution facilities. The agency also issues certificates of convenience and necessity, which delineate the service area of a water or sewer utility and authorizes

the utility the exclusive right to provide service to that area. A utility that holds a certificate of convenience and necessity must provide continuous and adequate service to every customer who requests service in that area.

1.4.5 INTERSTATE WATERS

Texas is a member of five interstate river compacts with neighboring states for the management of the Rio Grande, Pecos, Canadian, Sabine, and Red rivers. The compacts, as ratified by the legislature of each participating state and the U.S. Congress, represent agreements that establish how water should be allocated. Each compact is administered by a commission of state representatives and, in some cases, a representative of the federal government appointed by the president. Compact commissioners protect the states' rights under the compacts, oversee water deliveries from one state to another, and work to prevent and resolve any disputes over water. The compact commissions are authorized to plan for river operations, monitor activities affecting water quantity and quality, and engage in water accounting and rulemaking. To administer the five compacts in Texas, the Texas Commission on Environmental Quality provides administrative and technical support to each commission and maintains databases of river flows, diversions, and other information.

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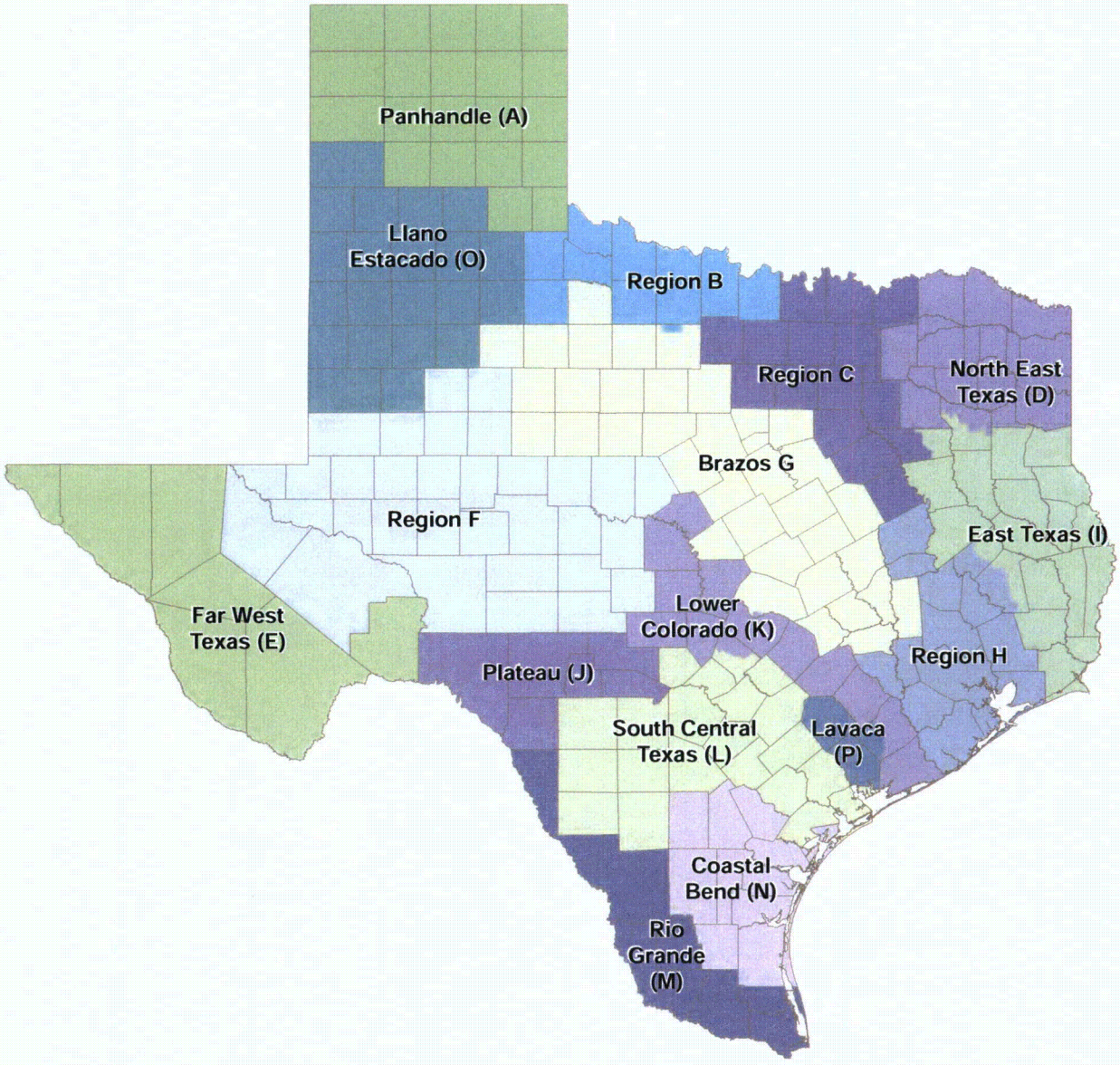
FIGURE 2.1. REGIONAL WATER PLANNING AREAS.



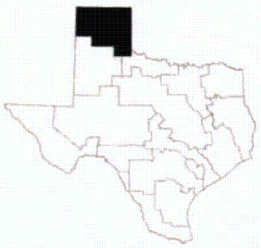
2 Regional Summaries

The 16 regional water planning groups are the foundation for developing the regional water plans and the state water plan. With technical and administrative assistance from TWDB, each group worked to create a regional water plan that would meet the water supply needs of their planning area during a drought of record. Chapter 2 of this report summarizes key findings from each regional plan including

- a brief description of each region;
- highlights of each plan;
- population and water demand projections;
- existing water supplies, including groundwater, surface water, and reuse;
- future water supply needs;
- recommended water management strategies and their costs;
- water conservation recommendations;
- select major water management strategies;
- a description of region-specific studies; and
- planning group members and interests represented.

Individual regional water plans and a comprehensive database of regional water plan information are available on the TWDB's website. In addition, Appendix A contains a detailed table of recommended and alternative water management strategies for each region, including total capital and unit costs for each strategy and water supply volumes projected for each strategy by decade.

2 Summary of the Panhandle (A) Region



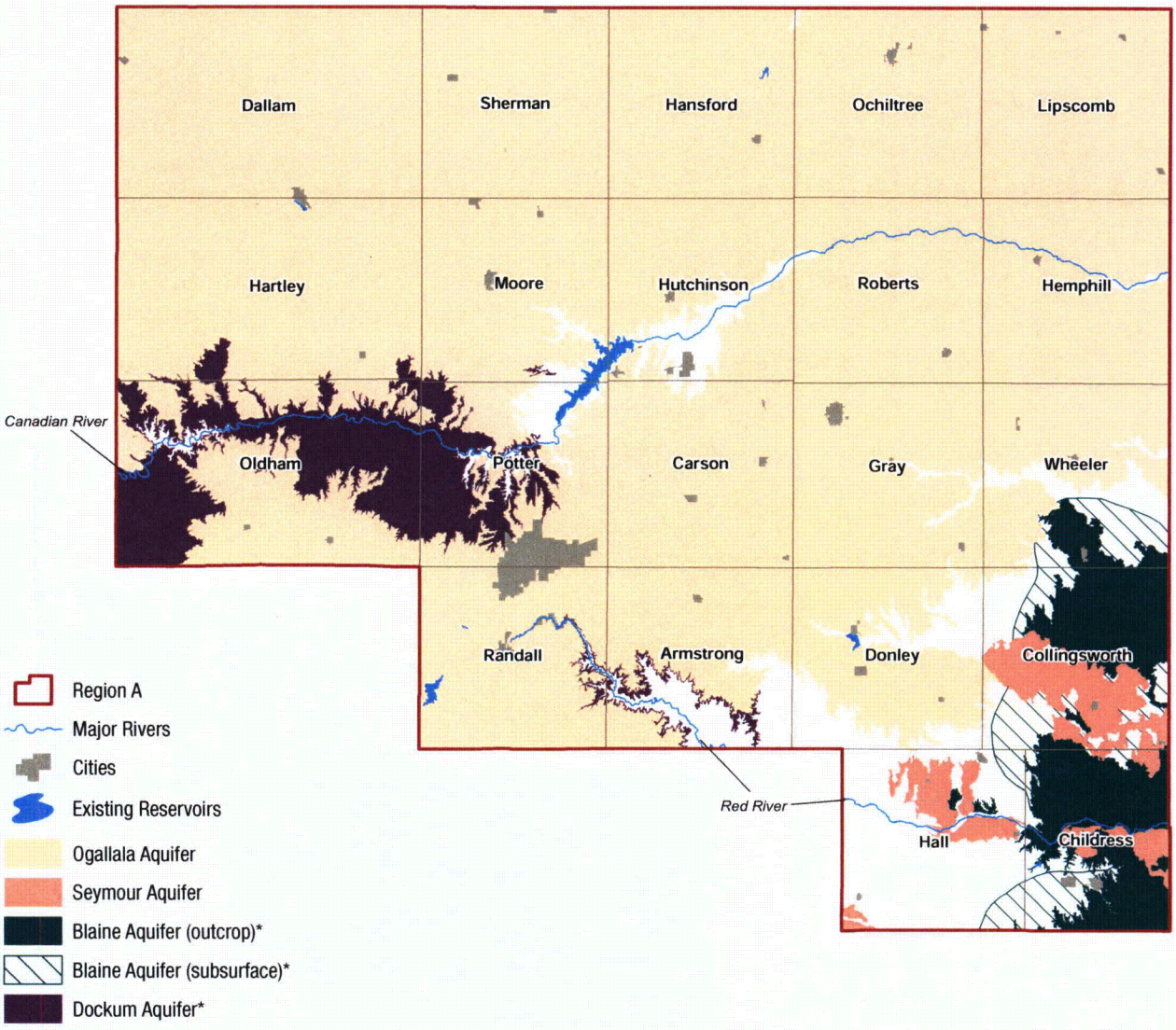
The Panhandle Regional Water Planning Area includes 21 counties split between the Canadian and Red River basins.

The Panhandle Regional Water Planning Area includes 21 counties split between the Canadian and Red River basins (Figure A.1). The major cities in the region include Amarillo, Pampa, Borger, and Dumas. Groundwater from the Ogallala Aquifer is the region's primary source of water and is used at a rate that exceeds recharge. The economy of this region is grounded in agribusiness. The 2011 Panhandle (A) Regional Water Plan can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionA/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—418,414 acre-feet per year
- Recommended water management strategy volume in 2060—648,221 acre-feet per year
- Total capital cost—$739 million
- Conservation accounts for 86 percent of 2060 strategy volumes
- Conservation primarily associated with irrigation
- Significant groundwater development
- Significant unmet irrigation needs in near-term

FIGURE A.1. PANHANDLE (A) REGIONAL WATER PLANNING AREA.



* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Approximately 2 percent of the state's total population resided in the Panhandle Region in the year 2010. Between 2010 and 2060, population is projected to increase 39 percent to 541,035. The region's total water demands, however, are projected to decrease, driven by a decline in agricultural irrigation, which is by far the largest water user in the region (Table A.1, Figure A.2).

EXISTING WATER SUPPLIES

The region primarily relies upon groundwater supply sources, with approximately 88 percent (Table A.1) of the existing water supply in the Panhandle Region coming from the Ogallala Aquifer. Other aquifers (Blaine, Dockum, Seymour, and Rita Blanca) provide approximately 7 percent of the total supply, and surface water, including Lake Meredith and Greenbelt Lake, contributes another 3 percent of supplies. Reuse contributes the remaining 2 percent of existing water supply in the planning area. Within the region, of the supplies available from the Ogallala Aquifer, 85 percent is used for irrigation purposes (Table A.1, Figure A.2). Based on the region's adopted water management policy, annual water supplies for the region from the Ogallala Aquifer are projected to decline 37 percent by 2060.

NEEDS

In the event of drought, water needs occur across the region in all decades (Table A.1, Figure A.2). The majority of the needs are in irrigation, with some other, smaller needs, primarily in municipal and manufacturing.

RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

The Panhandle Planning Group recommended water management strategies focused on conservation and groundwater development. It also recommended connecting to the Palo Duro Reservoir. In all, the strategies would provide 648,221 acre-feet of additional water supply by the year 2060 (Figure A.3) at a total capital cost of $739 million (Appendix A). However, the Canadian River Municipal Water Authority will provide some of this water to customers in the Llano Estacado Region. Because there were no economically feasible strategies identified to meet their needs, up to six counties in the region have unmet irrigation needs across the planning horizon, and 30,307 acre-feet of unmet irrigation needs in 2060.

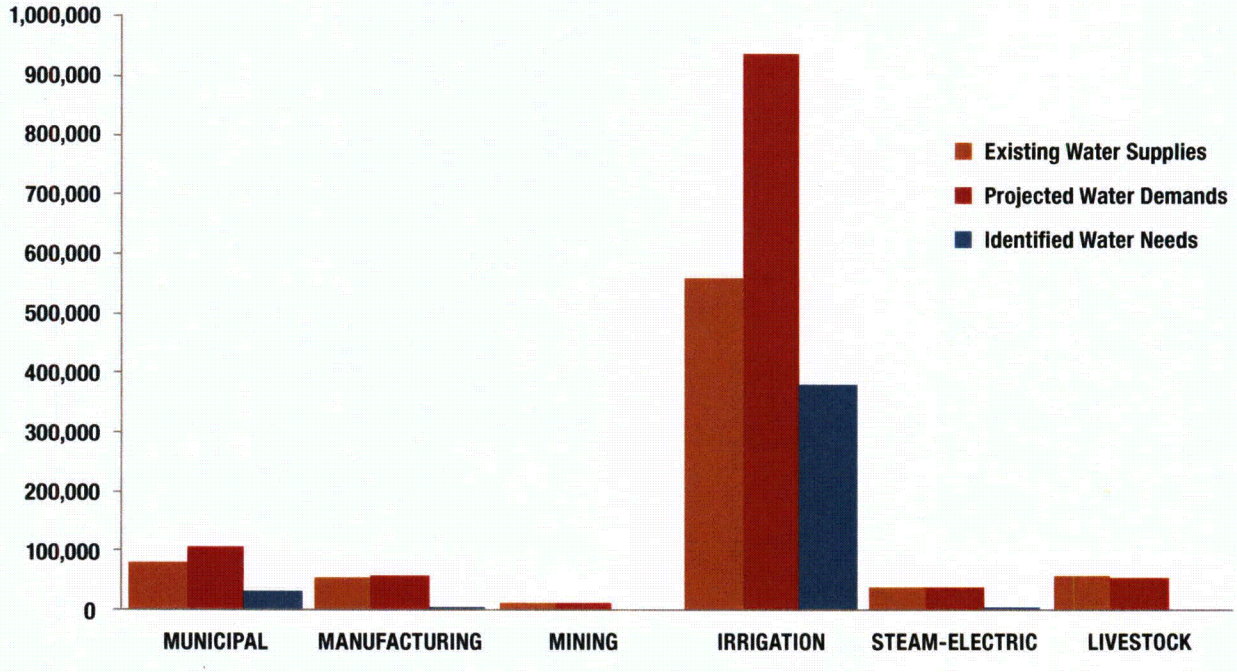
CONSERVATION RECOMMENDATIONS

Conservation strategies represent 86 percent of the total volume of water associated with all recommended strategies (Figures A.3 and A.4). Water conservation was recommended for every municipal need and for all irrigation water user groups in the region. Irrigation conservation would be achieved through irrigation equipment improvements, conservation tillage practices, and the adoption of drought-resistant crop varieties.

TABLE A.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	388,104	423,380	453,354	484,954	516,729	541,035
Existing Supplies (acre-feet per year)						
Surface water	40,636	47,381	47,348	47,284	47,189	47,043
Groundwater	1,131,151	1,018,554	951,799	877,961	790,795	714,438
Reuse	25,129	28,928	30,620	32,528	34,598	37,577
Total Water Supply	**1,196,916**	**1,094,863**	**1,029,767**	**957,773**	**872,582**	**799,058**
Demands (acre-feet per year)						
Municipal	68,137	72,793	76,638	80,648	84,614	87,658
County-other	9,468	11,097	12,550	14,035	15,516	16,584
Manufacturing	43,930	47,275	49,998	52,612	54,860	58,231
Mining	14,012	14,065	13,218	11,696	10,495	9,542
Irrigation	1,429,990	1,311,372	1,271,548	1,203,332	1,066,736	936,929
Steam-electric	25,139	26,996	29,116	30,907	33,163	37,415
Livestock	37,668	43,345	45,487	47,842	50,436	53,285
Total Water Demands	**1,628,344**	**1,526,943**	**1,498,555**	**1,441,072**	**1,315,820**	**1,199,644**
Needs (acre-feet per year)						
Municipal	0	967	7,354	13,968	20,492	25,712
County-other	0	108	1,190	2,663	4,235	5,502
Manufacturing	173	800	1,317	2,845	4,212	5,866
Irrigation	454,628	452,144	477,338	482,226	433,155	381,180
Steam-electric	75	99	117	128	136	154
Total Water Needs	**454,876**	**454,118**	**487,316**	**501,830**	**462,230**	**418,414**

FIGURE A.2. 2060 PANHANDLE REGION EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Roberts County Well Field (City of Amarillo) would provide up to 22,420 acre-feet per year of groundwater in the year 2060 with a capital cost of $287 million.
- Roberts County Well Field (Canadian River Municipal Water Authority) would provide 15,000 acre-feet per year of groundwater starting in 2030 with a capital cost of $22 million.
- Potter County Well Field would provide up to 11,182 acre-feet per year of groundwater starting in 2020 with a capital cost of $129 million.
- Irrigation conservation would provide up to 552,385 acre-feet per year of water in 2060 with no capital cost.

REGION-SPECIFIC STUDIES

The Regional Water Planning Group developed one region-specific study during the initial phase of the third planning cycle. The final report documenting the findings can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#a.

- Ogallala Recharge Study – Groundwater Recharge in Central High Plains of Texas: Roberts and Hemphill Counties

PANHANDLE PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

C. E. Williams (Chair), water districts; Emmett Autry, municipalities; Tom Bailiff, water districts; Joe Baumgardner, agriculture; Cole Camp, environmental; Nolan Clark, environmental; Vernon Cook, county; Charles Cooke, water utilities; Jim Derington, river authorities; Rusty Gilmore, small business; Janet Guthrie, public; Bill Hallerberg, industries; Kendall Harris, agriculture; Gale Henslee, electric generating utilities; Denise Jett, industries; David Landis, municipalities; Grady Skaggs, environmental; John M. Sweeten, higher education; Janet Tregellas, agriculture; Steve Walthour, water districts; Ben Weinheimer, agriculture; John C. Williams, water districts

Former voting members during the 2006 – 2011 planning cycle:

Richard Bowers, water districts; Dan Coffey, municipalities; B.A. Donelson, agriculture; Bobbie Kidd, water districts; Inge Brady Rapstine, environmental; Rudie Tate, agriculture

FIGURE A.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

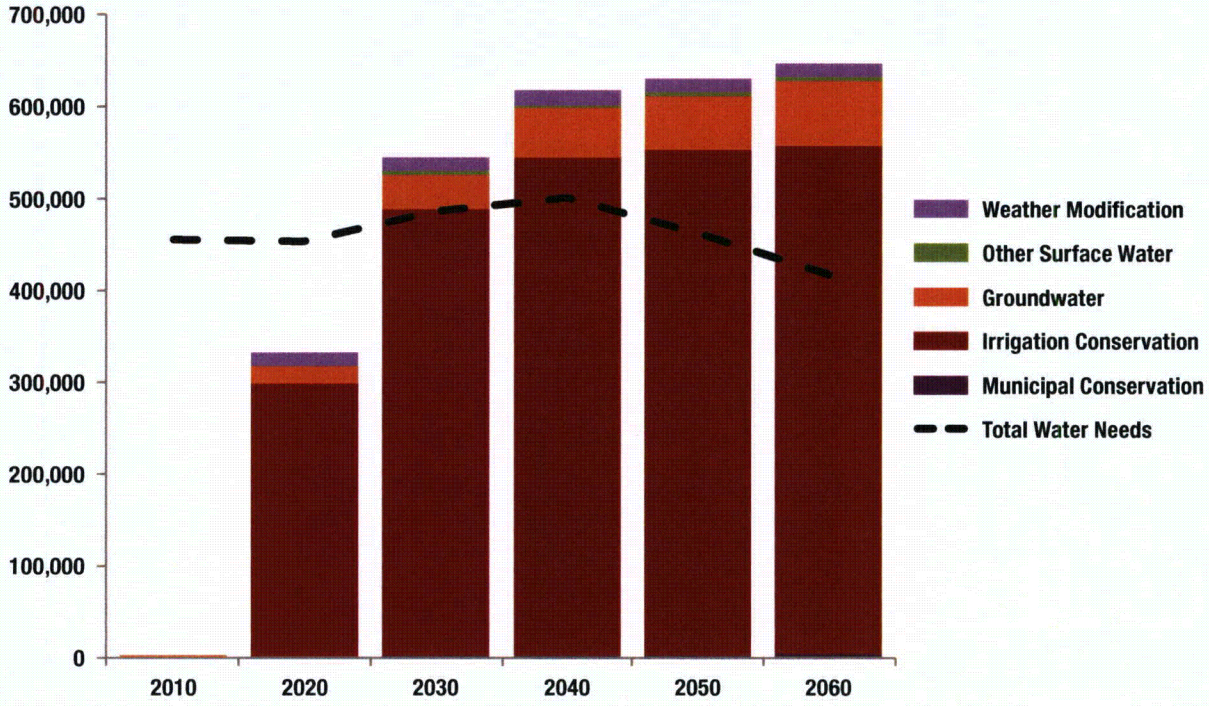
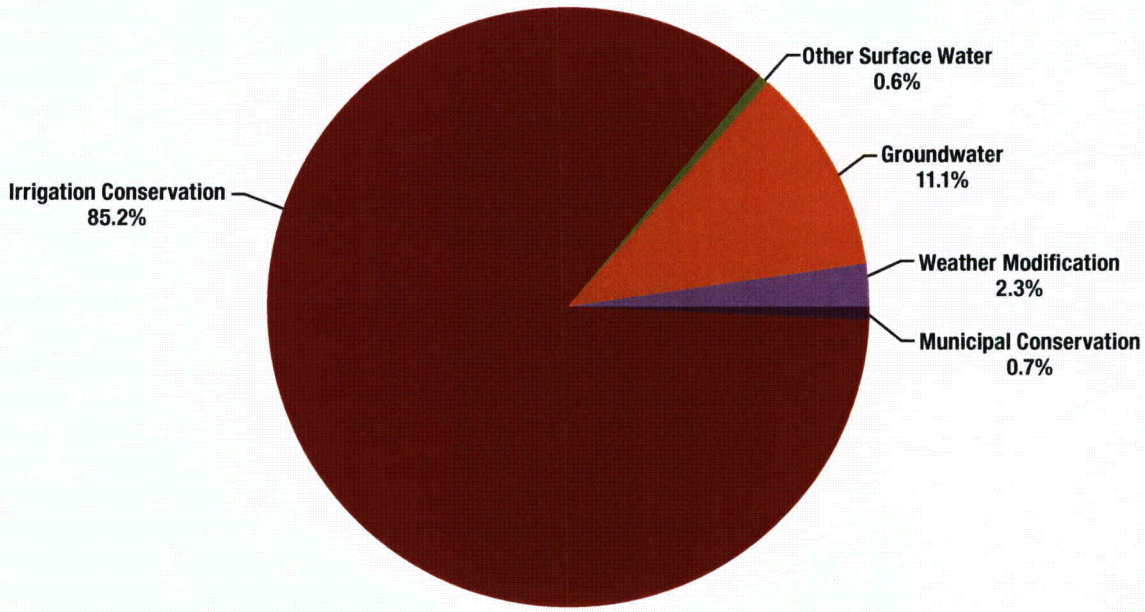
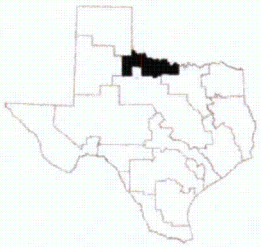


FIGURE A.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.



2 Summary of Region B



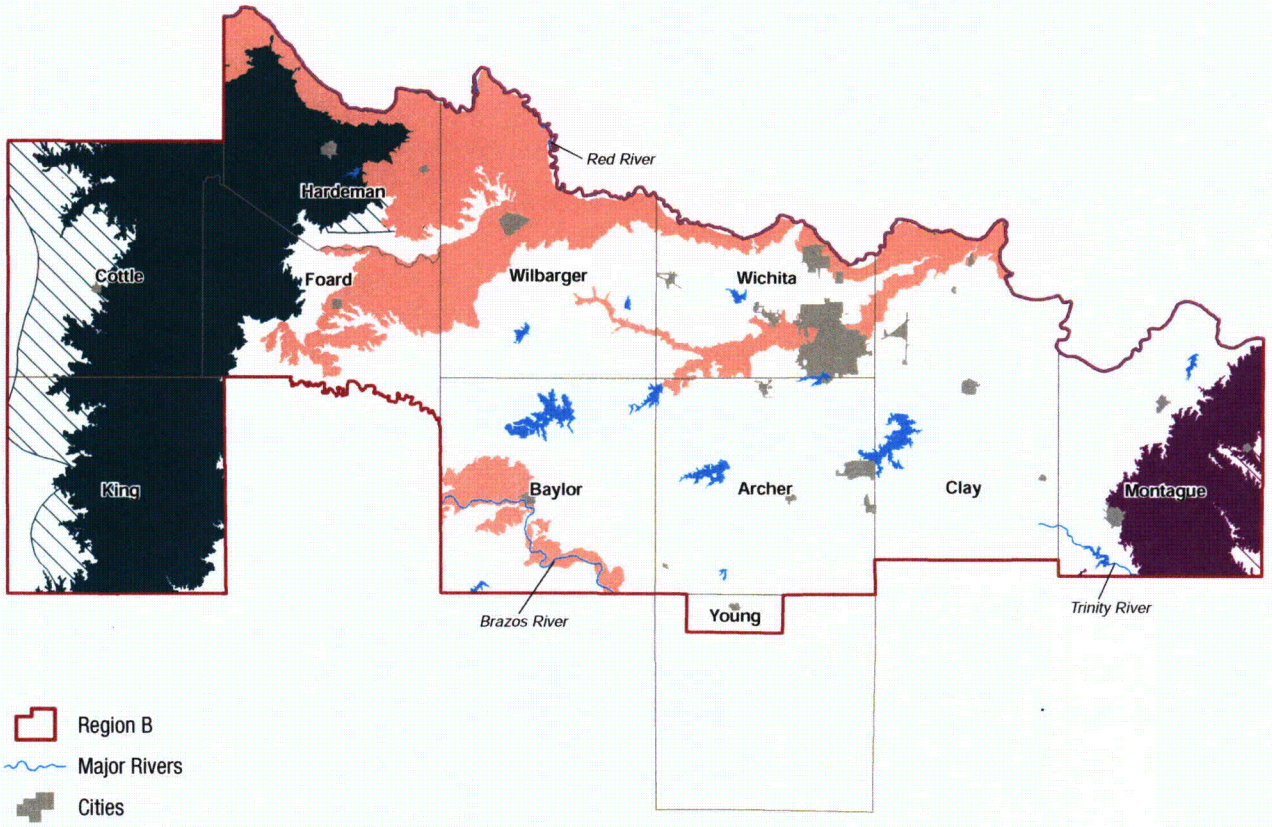
The Region B Regional Water Planning Area encompasses all or parts of 11 counties in north central Texas bordering the Red River.

The Region B Regional Water Planning Area encompasses all or parts of 11 counties in north central Texas bordering the Red River. Parts of three river basins (Red, Brazos, and Trinity) lie within the region (Figure B.1). The major cities in the region include Wichita Falls, Burkburnett, and Vernon. The main components of the region's economy are farming, mineral production, and ranching. The 2011 Region B Regional Water Plan can be found on the TWDB Web site at: https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionB/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—40,397 acre-feet per year
- Recommended water management strategy volume in 2060—77,003 acre-feet per year
- Total capital cost—$499 million
- Conservation accounts for 19 percent of 2060 strategy volumes
- One new major reservoir (Ringgold)
- Limited unmet irrigation needs in 2010

FIGURE B.1. REGION B REGIONAL WATER PLANNING AREA.



* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Just less than 1 percent of the state's total population resided in Region B in the year 2010. Between 2010 and 2060, its population is projected to increase 5 percent to 221,734. However, total water demands are projected to decrease slightly, by approximately 1 percent (Table B.1, Figure B.2.) Agricultural irrigation is the largest share of the regional demand but decreases over the planning period by 9 percent due to anticipated future irrigation efficiency. Municipal water demands account for the second largest water use in Region B and are expected to decrease by 5 percent over the planning cycle.

EXISTING WATER SUPPLIES

The region relies on both surface and groundwater sources. Its total existing water supply is projected to decline by 12 percent to 152,582 acre-feet in 2060 (Table B.1, Figure B.2). Surface water supplies to the region come from 12 reservoirs within the region and one reservoir (Greenbelt) located in the Panhandle Region. The Lake Kemp and Lake Diversion System represent the largest single source of surface water to Region B, providing 33 percent of the region's supplies in 2010.

The Seymour Aquifer is the source of the majority of the groundwater in the region, providing 29 percent of the region's projected supplies in 2060. Other aquifers, including the Blaine and Trinity aquifers, are projected to provide 9 percent of the region's supply in 2060. Significant water quality issues impact both surface and groundwater sources in the region. In the headwater region of the Wichita River, saline springs affect the quality of surface water supplies. In addition, users of the Seymour Aquifer have had to treat for elevated nitrate concentrations in the water.

NEEDS

The majority of Region B water needs are associated with irrigation and steam-electric uses. Irrigation water needs account for 97 percent of Region B water needs in 2010. By 2060 irrigation water use will account for 72 percent of needs and 27 percent of needs will be associated with steam-electric (Table B.1, Figure B.2). County-other and mining needs also exist throughout the planning cycle.

The region also emphasized planning for municipal and manufacturing entities that had little or no supplies above their projected water demands. This additional planning was considered necessary because of uncertainty related to the potential for droughts worse than the drought of record and for uncertainty associated with potential climate change. For these entities, Region B considered providing additional supplies equivalent to 20 percent of their projected demands. This Region B planning criterion identified water needs for six additional water user groups.

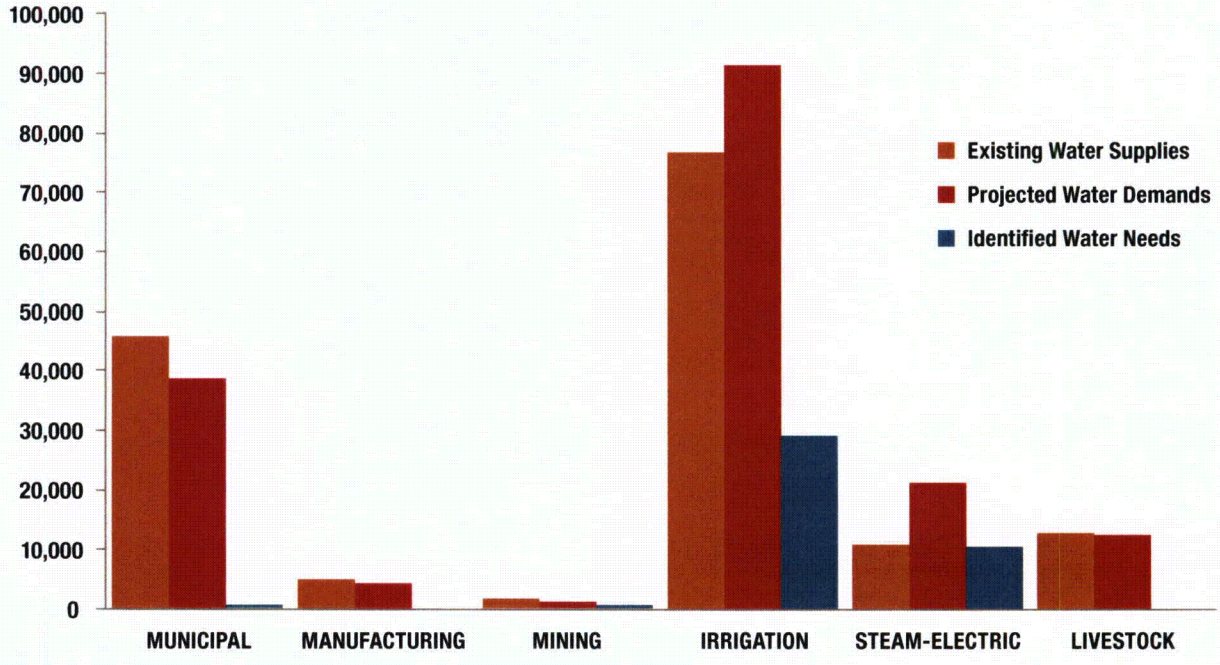
RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

The Region B Planning Group recommended water management strategies including groundwater development, direct reuse, reservoir system operation changes, and construction of Lake Ringgold. In all, the strategies would provide 77,003 acre-feet of additional water supply by the year 2060 (Figures B.3 and B.4) at a total capital cost of

TABLE B.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	210,642	218,918	223,251	224,165	223,215	221,734
Existing Supplies (acre-feet per year)						
Surface water	115,509	111,239	106,991	102,724	98,477	94,179
Groundwater	58,456	58,439	58,431	58,410	58,403	58,403
Total Water Supply	**173,965**	**169,678**	**165,422**	**161,134**	**156,880**	**152,582**
Demands (acre-feet per year)						
Municipal	36,695	35,394	35,964	35,532	35,107	34,964
County-other	4,269	4,261	4,232	4,132	3,855	3,732
Manufacturing	3,547	3,755	3,968	4,260	4,524	4,524
Mining	909	845	811	785	792	792
Irrigation	99,895	97,702	95,537	93,400	91,292	91,292
Steam-electric	13,360	17,360	21,360	21,360	21,360	21,360
Livestock	12,489	12,489	12,489	12,489	12,489	12,489
Total Water Demands	**171,164**	**171,806**	**174,361**	**171,958**	**169,419**	**169,153**
Needs (acre-feet per year)						
County-other	437	468	491	502	460	462
Mining	177	153	145	149	162	162
Irrigation	22,945	23,926	24,909	25,893	26,876	29,058
Steam-electric	0	3,800	8,529	9,258	9,987	10,715
Total Water Needs	**23,559**	**28,347**	**34,074**	**35,802**	**37,485**	**40,397**

FIGURE B.2. 2060 REGION B EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



$499.2 million (Appendix A). Implementing the recommended water management strategies will meet regional needs projected to occur for 2020 and beyond.

CONSERVATION RECOMMENDATIONS

Conservation strategies for municipal and irrigation water users represent 19 percent of the total volume of water associated with all recommended strategies in 2060. Municipal water conservation was recommended for every municipal and county-other water user group with a need. Irrigation conservation is planned to be accomplished through an irrigation canal lining strategy.

SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Construction of Lake Ringgold would provide 27,000 acre-feet per year of water starting in the year 2050 with a capital cost of $383 million.
- Increasing the water conservation pool at Lake Kemp would provide up to 24,834 acre-feet per year of water in 2020 with a capital cost of $130,000.
- Enclosing canal laterals for surface water conveyance in pipe would provide 13,034 acre-feet per year starting in the year 2010 with a capital cost of $7.7 million.
- Wichita Basin Chloride Control Project would contribute to the provision of 26,500 acre-feet per year of surface water starting in 2010 with a capital cost of $95 million.

REGION-SPECIFIC STUDIES

The Regional Water Planning Group developed one region-specific study during the initial phase of the third planning cycle. The final report documenting the findings can be found on the TWDB Web-site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#b .

- Wichita County Water Improvement District Number 2 Water Conservation Implementation Plan

REGION B PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

Curtis Campbell (Chair), river authorities; Jimmy Banks, water districts; Charlie Bell, counties; J.K. Rooter Brite, environmental; Ed Garnett, municipalities; Dale Hughes, agriculture; Robert Kincaid, municipalities; Kenneth Liggett, counties; Mike McGuire, water districts; Dean Myers, small business; Kenneth Patton, electric generating utilities; Jerry Payne, public; Wilson Scaling, agriculture; Tom Stephens, industries; Pamela Stephens, environmental; Russell Schreiber, municipalities; Jeff Watts, water utilities

Former voting members during the 2006 – 2011 planning cycle:

Mark Barton, electric generating utilities; Kelly Couch, municipalities; Paul Hawkins, public; Tommy Holub, water utilities; Norman Horner, environmental; Joe Johnson, Jr., industries; Kenneth McNabb, counties

FIGURE B.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

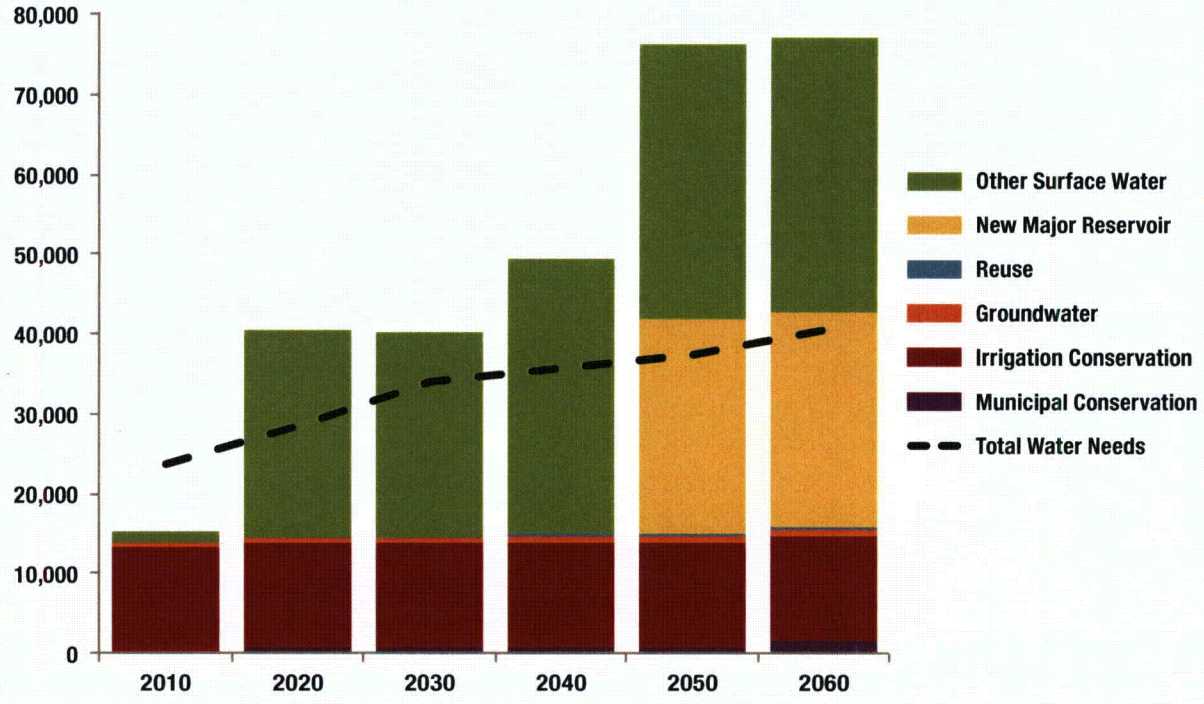
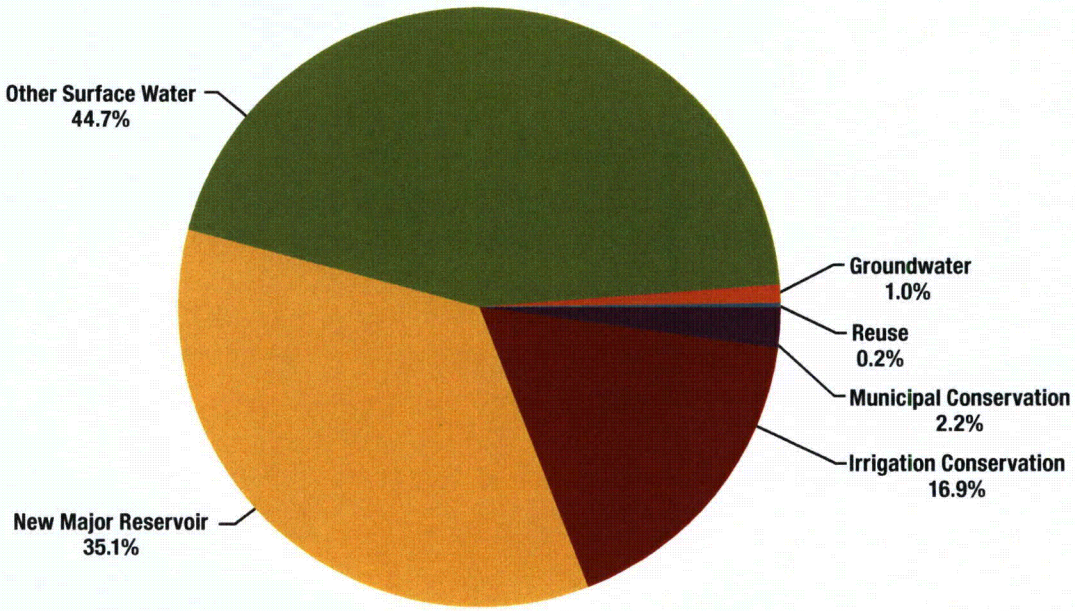
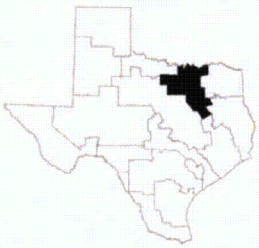


FIGURE B.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.



2 Summary of Region C



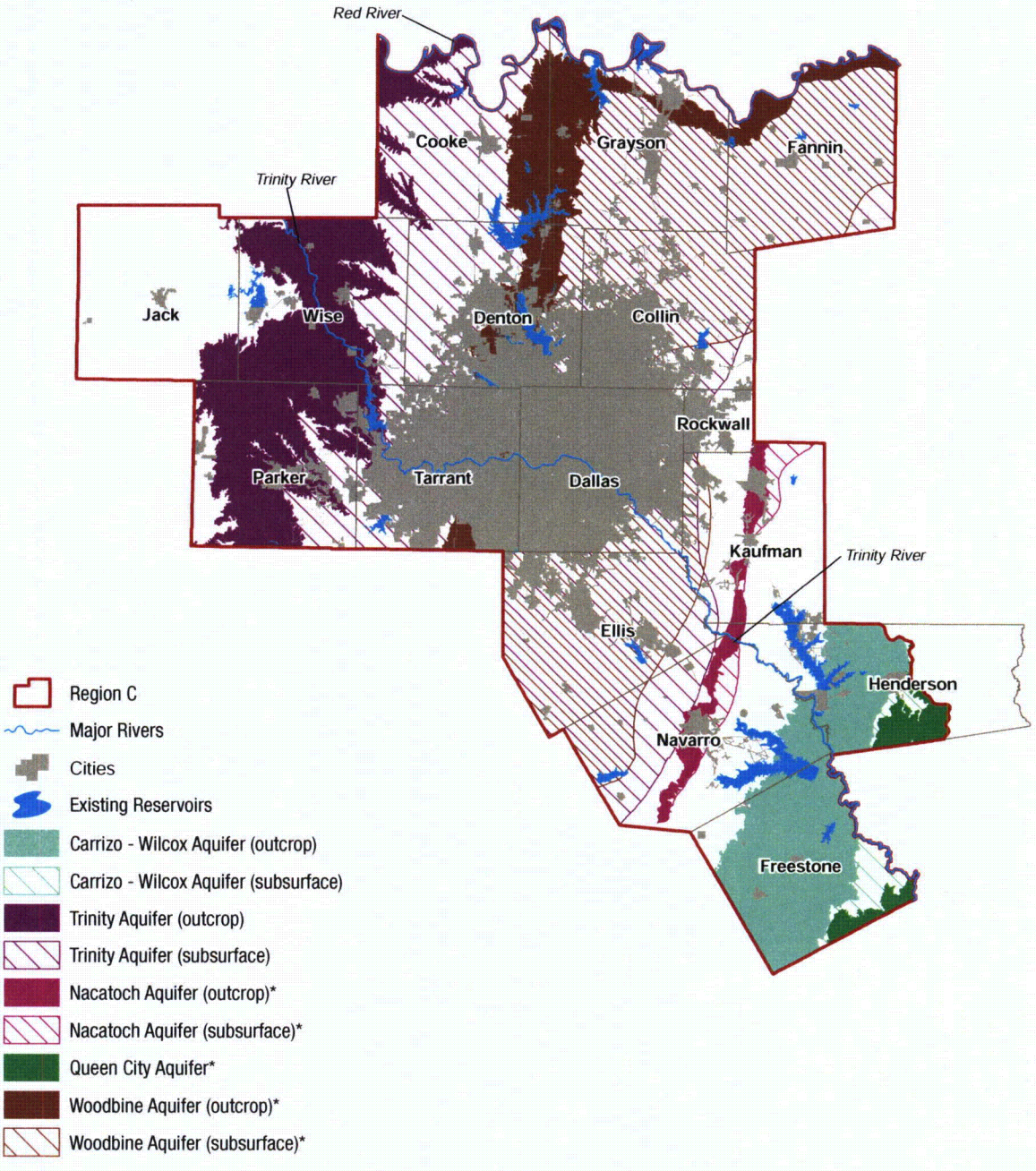
The Region C Regional Water Planning Area includes all or parts of 16 counties.

The Region C Regional Water Planning Area includes all or parts of 16 counties (Figure C.1). Overlapping much of the upper portion of the Trinity River Basin, Region C also includes smaller parts of the Red, Brazos, Sulphur, and Sabine river basins. The Dallas-Fort Worth metropolitan area is centrally located in the region, and its surrounding counties are among the fastest growing in the state. Major economic sectors in the region include service, trade, manufacturing, and government. The 2011 Region C Regional Water Plan can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionC/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—1,588,236 acre-feet per year
- Recommended water management strategy volume in 2060—2,360,302 acre-feet per year
- Total capital cost—$21.5 billion
- Conservation accounts for 12 percent of 2060 strategy volumes
- Reuse accounts for 11 percent of 2060 strategy volumes
- Four new major reservoirs (Ralph Hall, Lower Bois d'Arc, Marvin Nichols, Fastrill Replacement Project)
- Significant costs associated with numerous conveyance projects

FIGURE C.1. REGION C REGIONAL WATER PLANNING AREA.



* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Approximately 26 percent of Texas' population resided in Region C in the year 2010. By 2060, the population of the region is projected to grow 96 percent to 13,045,592. Projections indicate that by 2060 Region C water demands will increase 86 percent (Table C.1). Municipal demands are projected to increase by 91 percent by 2060 and will account for 88 percent of the total projected Region C demands. With the exception of livestock demands, which remain constant, all categories of water demands are projected to increase over the planning horizon (Table C.1, Figure C.2).

EXISTING WATER SUPPLIES

The total water supply in Region C is projected to decline by about 3 percent by 2060 (Table C.1, Figure C.2). This projected decline is due to reservoir sedimentation. Existing reservoirs within Region C are projected to provide nearly 58 percent of total water supplies in the region, while surface water supplies located outside of the region account for another 22 percent. Groundwater from the Trinity Aquifer and several minor aquifers provides approximately 7 percent of supplies. Currently authorized reuse provides 10 percent of the available supply to Region C. The remaining 2 percent of the water supply comes from local sources, such as run-of-river permits.

NEEDS

The majority of water supply needs in Region C are for municipal uses (Table C.1, Figure C.2). By 2060, water supply needs in the region are projected to total 1,588,236 acre-feet. Ninety-two percent of this projected need (1,459,025 acre-feet) is for municipal users and county-other.

RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

Region C considered a variety of water management strategies to meet needs. In all, the strategies provide an additional 2.4 million acre-feet by 2060 (Figures C.3 and C.4), with a total capital cost of $21.5 billion (Appendix A) if all the recommended water management strategies are implemented. The plan recommends four new major reservoirs: Lower Bois d'Arc, Ralph Hall, Marvin Nichols, and Fastrill Replacement Project.

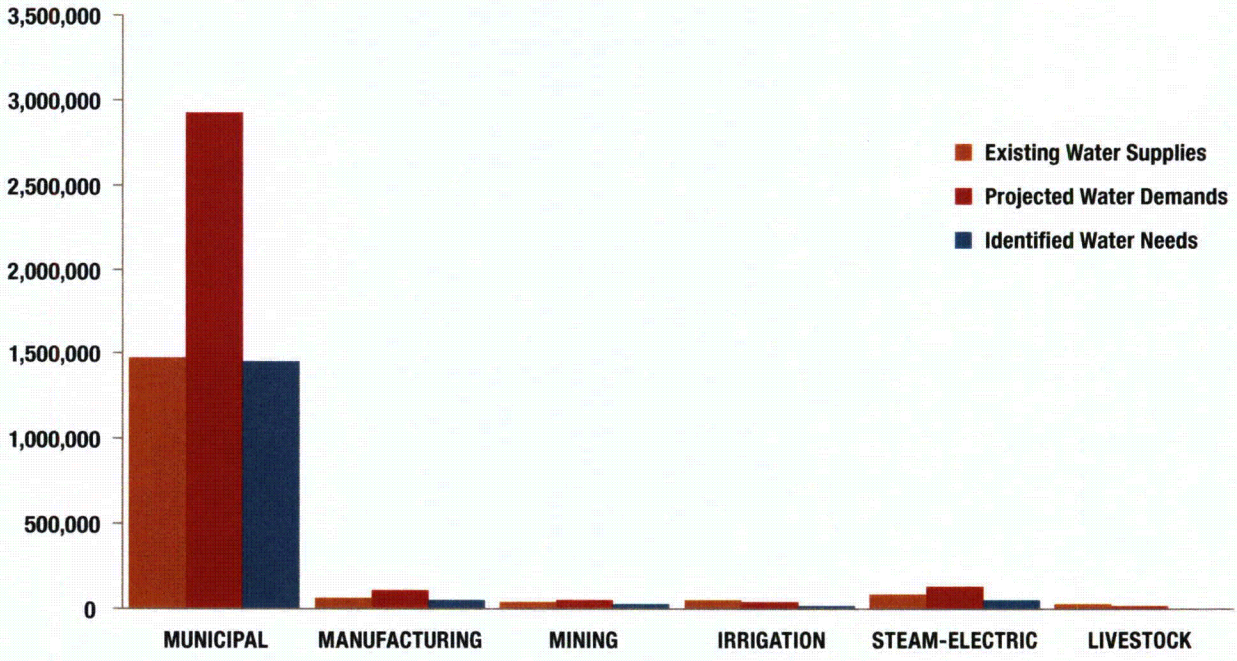
CONSERVATION RECOMMENDATIONS

Conservation strategies account for approximately 12 percent (290,709 acre-feet) of the total volume of water associated with all recommended strategies. A basic conservation package, including education, pricing structure, water waste prohibitions, water system audits, and plumbing code changes, was recommended for all municipal water user groups in Region C. An expanded conservation package, including additional strategies such as landscape irrigation restrictions and residential water audits, was recommended for some municipal water user groups.

TABLE C.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	6,670,493	7,971,728	9,171,650	10,399,038	11,645,686	13,045,592
Existing Supplies (acre-feet per year)						
Surface water	1,481,272	1,406,598	1,359,808	1,343,319	1,328,097	1,305,588
Groundwater	125,939	121,827	121,916	122,074	122,117	122,106
Reuse	182,686	231,816	273,003	293,292	300,143	307,129
Total Water Supplies	**1,789,897**	**1,760,241**	**1,754,727**	**1,758,685**	**1,750,357**	**1,734,823**
Demands (acre-feet per year)						
Municipal	1,512,231	1,796,086	2,048,664	2,304,240	2,571,450	2,882,356
County-other	34,738	37,584	38,932	39,874	40,725	41,800
Manufacturing	72,026	81,273	90,010	98,486	105,808	110,597
Mining	41,520	38,961	41,630	44,486	47,435	50,200
Irrigation	40,776	40,966	41,165	41,373	41,596	41,831
Steam-electric	40,813	64,625	98,088	107,394	116,058	126,428
Livestock	19,248	19,248	19,248	19,248	19,248	19,248
Total Water Demands	**1,761,352**	**2,078,743**	**2,377,737**	**2,655,101**	**2,942,320**	**3,272,460**
Needs (acre-feet per year)						
Municipal	67,519	362,099	614,610	859,838	1,127,749	1,445,025
County-other	87	5,158	7,931	10,118	12,295	14,302
Manufacturing	557	11,946	21,151	30,369	39,640	48,894
Mining	414	4,909	10,036	14,782	19,445	23,779
Irrigation	510	2,588	3,412	4,007	4,492	4,913
Steam-electric	0	13,217	29,696	34,835	40,997	51,323
Total Water Needs	**69,087**	**399,917**	**686,836**	**953,949**	**1,244,618**	**1,588,236**

FIGURE C.2. 2060 REGION C EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Toledo Bend Reservoir supply would provide up to 400,229 acre-feet per year of water with a capital cost of $2.4 billion (with Region I entities responsible for 20 percent of cost).
- Marvin Nichols Reservoir would provide up to 472,300 acre-feet per year of water with a capital cost of $3.4 billion.
- Reallocation of the flood pool of Wright Patman Lake would provide 112,100 acre-feet per year of water starting in the year 2040 with a capital cost of $897 million.
- The Lake Tawakoni pipeline project would provide up to 77,994 acre-feet per year of water in 2010 with a capital cost of $496 million.

REGION-SPECIFIC STUDIES

The Regional Water Planning Group developed seven region-specific studies during the initial phase of the third planning cycle. The final reports documenting the findings can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#c.

- Water Supply Study for Ellis County, Johnson County, Southern Dallas County, and Southern Tarrant County
- Water Supply Study for Parker and Wise Counties
- Direct, Non-Potable Reuse Guidance Document
- Indirect Reuse Guidance Document
- Region C Water Conservation and Reuse Study
- County-Wide Meetings Memorandum
- Toledo Bend Pipeline Project Coordination Activities Technical Memorandum

REGION C PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

James (Jim) Parks (Chair), water districts; Steve Berry, environmental; Bill Ceverha, public; Jerry W. Chapman, water districts; Frank Crumb, municipalities; Russell Laughlin, industries; Bill Lewis, small business; G.K. Maenius, counties; Howard Martin, municipalities; Jim McCarter, water utilities; Paul Phillips, municipalities; Jody Puckett, municipalities; Robert O. Scott, environmental; Gary Spicer, electric generating utilities; Connie Standridge, water utilities; Jack Stevens, water districts; Danny Vance, river authorities; Mary E. Vogelson, public; Tom Woodward, agriculture

Former voting members during the 2006 – 2011 planning cycle:

Brad Barnes, agriculture; Roy Eaton, small business; Dale Fisseler, municipalities; Bob Johnson, municipalities; Jerry Johnson, electric generating utilities; Elaine Petrus, environmental; Marsh Rice, public; Paul Zweicker, electric generating utilities

FIGURE C.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

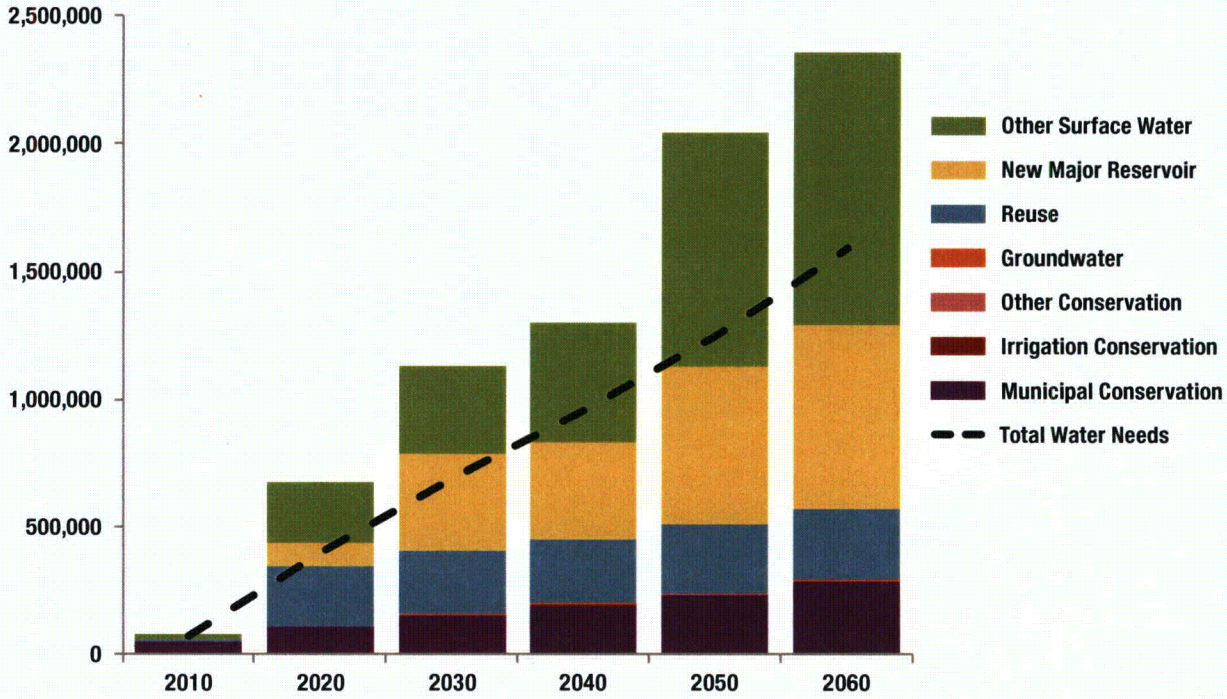
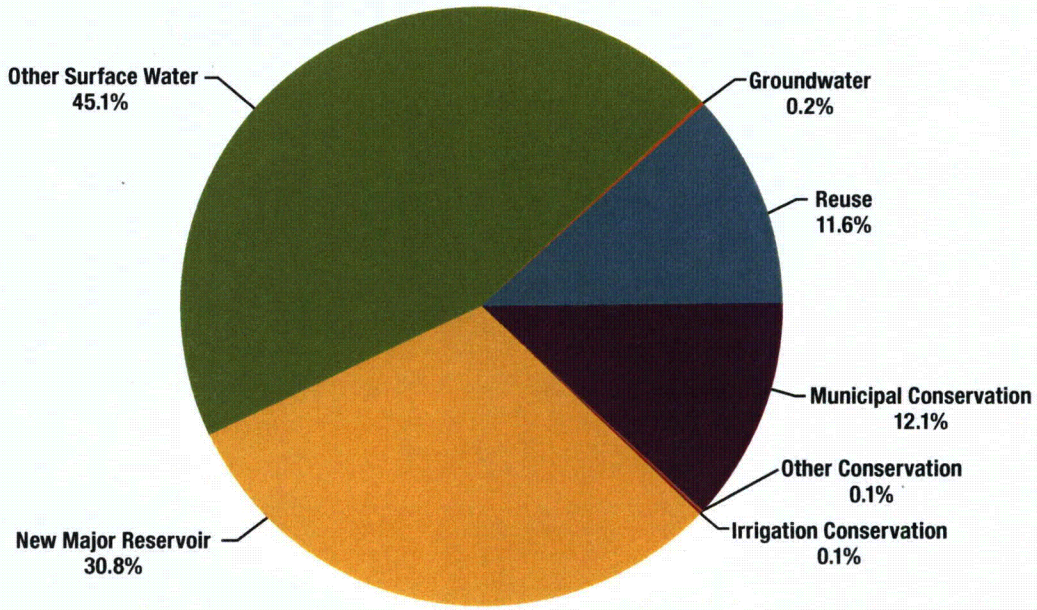
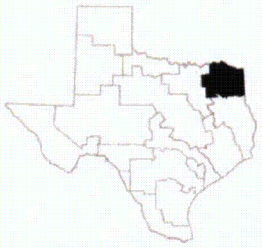


FIGURE C.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.



2 Summary of North East Texas (D) Region



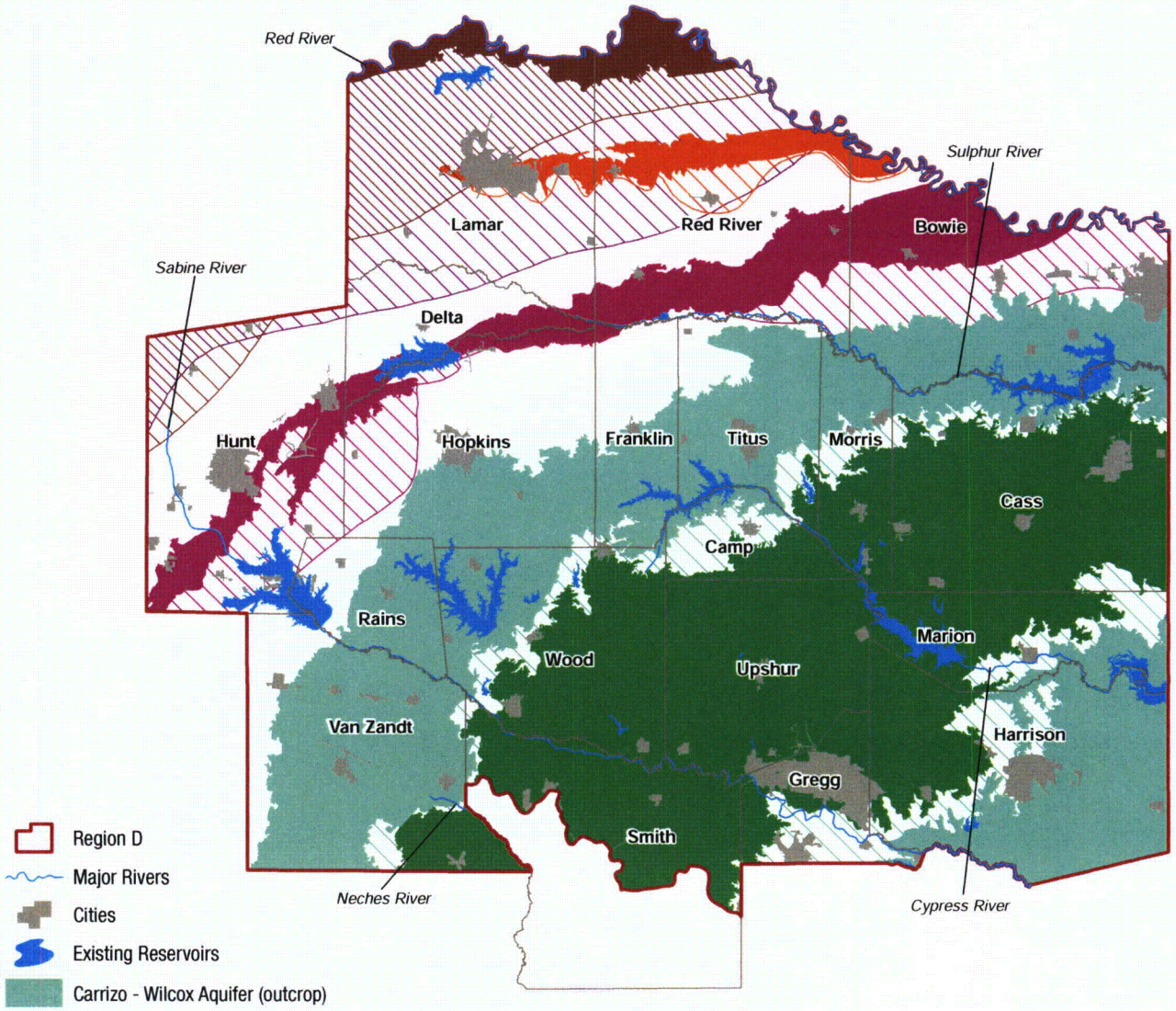
The North East Texas Regional Water Planning Area encompasses all or parts of 19 counties.

The North East Texas Regional Water Planning Area encompasses all or parts of 19 counties (Figure D.1). While largely rural, the region includes the cities of Longview, Texarkana, and Greenville. The planning area overlaps large portions of the Red, Sulphur, Cypress, and Sabine river basins and smaller parts of the Trinity and Neches river basins. The North East Texas Region's main economic base is agribusiness, including a variety of crops, as well as cattle and poultry production. Timber, oil and gas, and mining are significant industries in the eastern portion of the region. In the western portion of the region, many residents are employed in the Dallas-Fort Worth metropolitan area. The 2011 North East Texas (D) Regional Water Plan can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionD/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—96,142 acre-feet per year
- Recommended water management strategy volume in 2060—98,466 acre-feet per year
- Total capital cost—$39 million
- Limited unmet irrigation needs
- Surface water contract strategies to meet most needs including contracting for water from new reservoir in Region C
- Opposition to Marvin Nichols Reservoir
- Three unique stream segments recommended for designation (Figure ES.8)

FIGURE D.1. NORTH EAST TEXAS (D) REGIONAL WATER PLANNING AREA.



* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Approximately 3 percent of the state's total population resided in the North East Texas Region in the year 2010. By 2060, the region's population is projected to grow 57 percent to 1,213,095. Water demands for the region are projected to increase 50 percent (Table D.1). Throughout the planning period, manufacturing makes up the largest portion of demands, with the total volume of its demands increasing by 40 percent (Table D.1). Steam-electric and municipal demands will also increase significantly. By 2060, demand for steam-electric power generation is projected to more than double, and municipal demand will increase about 51 percent (Table D.1, Figure D.2).

EXISTING WATER SUPPLIES

The total existing water supply for the North East Texas Region was estimated to be approximately 999,745 acre-feet in 2010, increasing to 1,036,488 acre-feet in 2060 (Table D.1, Figure D.2). Existing supplies increase over the planning horizon to reflect new uses, including groundwater wells and surface water contracts. In 2010, surface water, primarily from the Sabine, Cypress, and Sulphur river basins, was projected to provide 83 percent of existing supplies, and the remaining 17 percent was equally divided between groundwater and reuse. Major aquifers include the Carrizo-Wilcox Aquifer in the central and southern part of the region and the Trinity Aquifer in the north.

NEEDS

In 2010, the total water supply volume was not accessible to all users in the region. As a result, the North East Texas Region was projected to have a water supply need of 10,252 acre-feet, with steam-electric power generation needs making up approximately 84 percent of the total, or 8,639 acre-feet (Table D.1, Figure D.2). By 2060, water supply needs are projected to total 96,142 acre-feet. Steam-electric power generation needs will account for nearly 81 percent of the total needs, while the remaining needs will affect municipal, rural, and irrigated agriculture users.

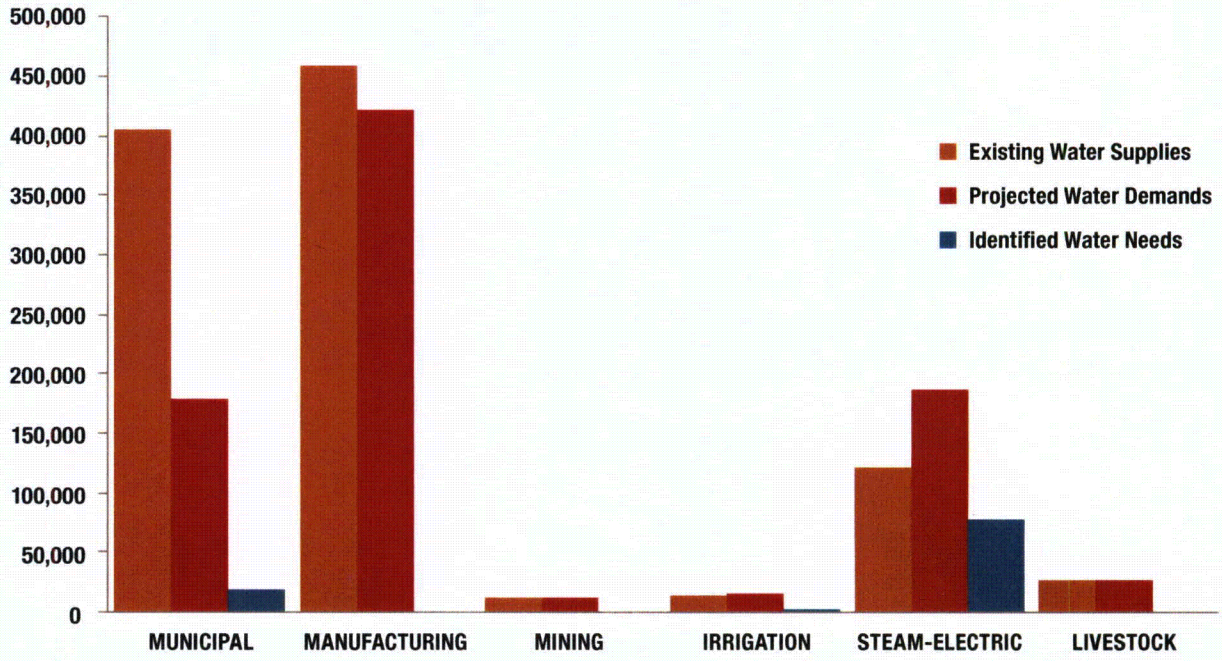
RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

Of the 61 identified shortages in the region, 21 are the result of contract expirations. However, the planning group assumed that all contracts would be renewed. For the remaining projected shortages, the planning group recommended two types of water management strategies to meet needs: new groundwater wells and new surface water purchases. If fully implemented, recommended water management strategies would provide an additional 98,466 acre-feet of supply in the year 2060 (Figures D.3 and D.4) at a total capital cost of $38.5 million (Appendix A). Although groundwater will provide more individual water user groups with water, surface water constitutes approximately 93 percent of the total volume of supply from recommended water management strategies (Figure D.4).

TABLE D.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	772,163	843,027	908,748	978,298	1,073,570	1,213,095
Existing Supplies (acre-feet per year)						
Surface water	831,239	838,379	843,707	848,652	855,180	864,067
Groundwater	84,864	87,501	89,332	90,800	92,361	94,786
Reuse	83,642	78,247	72,821	67,505	68,761	77,635
Total Water Supplies	**999,745**	**1,004,127**	**1,005,860**	**1,006,957**	**1,016,302**	**1,036,488**
Demands (acre-feet per year)						
Municipal	90,171	96,359	102,345	109,227	119,821	135,811
County-other	29,780	32,352	34,404	36,177	38,637	42,367
Manufacturing	301,091	328,568	351,427	373,504	392,387	421,496
Mining	8,802	9,605	10,108	10,595	11,111	11,625
Irrigation	15,504	15,415	15,329	15,182	14,949	14,728
Steam-electric	89,038	96,492	112,809	132,703	156,951	186,509
Livestock	26,690	26,736	26,785	26,698	26,554	26,441
Total Water Demands	**561,076**	**605,527**	**653,207**	**704,086**	**760,410**	**838,977**
Needs (acre-feet per year)						
Municipal	1,404	2,082	2,834	3,856	8,190	16,711
County-other	153	276	411	587	748	1,574
Irrigation	56	0	14	115	238	388
Steam-electric	8,639	12,366	15,437	27,396	50,829	77,469
Total Water Needs	**10,252**	**14,724**	**18,696**	**31,954**	**60,005**	**96,142**

FIGURE D.2. 2060 NORTH EAST TEXAS (D) EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



CONSERVATION RECOMMENDATIONS

The North East Texas Planning Group considered conservation strategies for each water user group with a need and a per capita water use greater than 140 gallons per capita per day. Because costs of conservation strategies were relatively high due to the small size of the entities and amounts of water involved, the region did not recommend conservation as a water management strategy.

SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Increasing existing contracts would provide up to 59,473 acre-feet per year of surface water, and some groundwater, in the year 2060 with no capital costs, only annual costs of contracts.
- New surface water contracts would provide up to 32,231 acre-feet per year of water in 2060 with a capital cost of $6.3 million.
- Drilling new wells would provide 6,757 acre-feet per year of water in 2060 with a capital cost of $32.3 million.

REGION-SPECIFIC STUDIES

The Regional Water Planning Group developed two region-specific studies during the initial phase of the third planning cycle. The final reports documenting the findings can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#d.

- Further Evaluation of Sub-Regional Water Supply Master Plans
- Brackish Groundwater Study

NORTH EAST TEXAS PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

Richard LeTourneau (Chair), environmental; Max Bain, counties; Keith Bonds, municipalities; Adam Bradley, agriculture; Greg Carter, electric generating utilities; Gary Cheatwood, public; Nancy Clements, agriculture; Darwin Douthit, agriculture; Mike Dunn, municipalities; Jim Eidson, environmental; Scott Hammer, industries; Troy Henry, river authorities; Don Hightower, counties; Sam Long, counties; Bret McCoy, small business; Sharron Nabors, agriculture; Jim Nickerson, industries; Don Patterson, counties; Ken Shaw, industries; Shirley Shumake, public; Bob Staton, small business; Doug Wadley, industries; David Weidman, water districts; Richard Zachary, water utilities

Former voting members during the 2006 – 2011 planning cycle:

John Bryan, public; Larry Calvin, environmental; Dean Carrell, municipalities; Jimmy Clark, environmental; George Frost, public; Mendy Rabicoff, small business; Jim Thompson, agriculture

FIGURE D.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

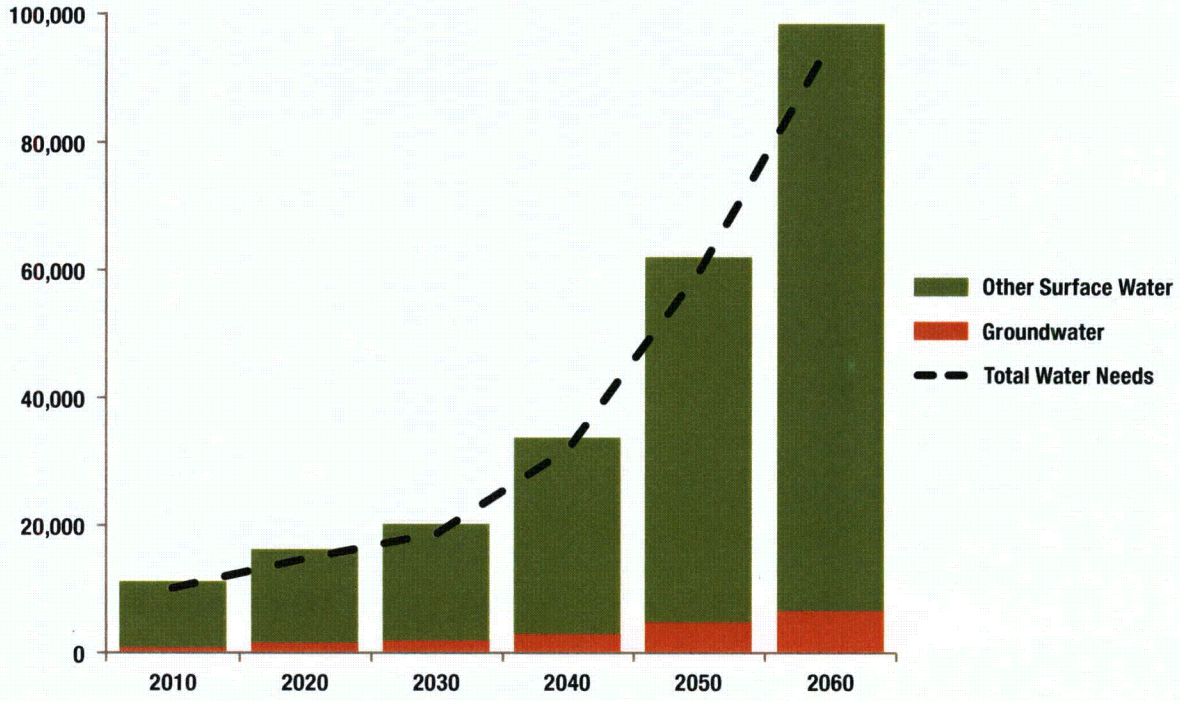
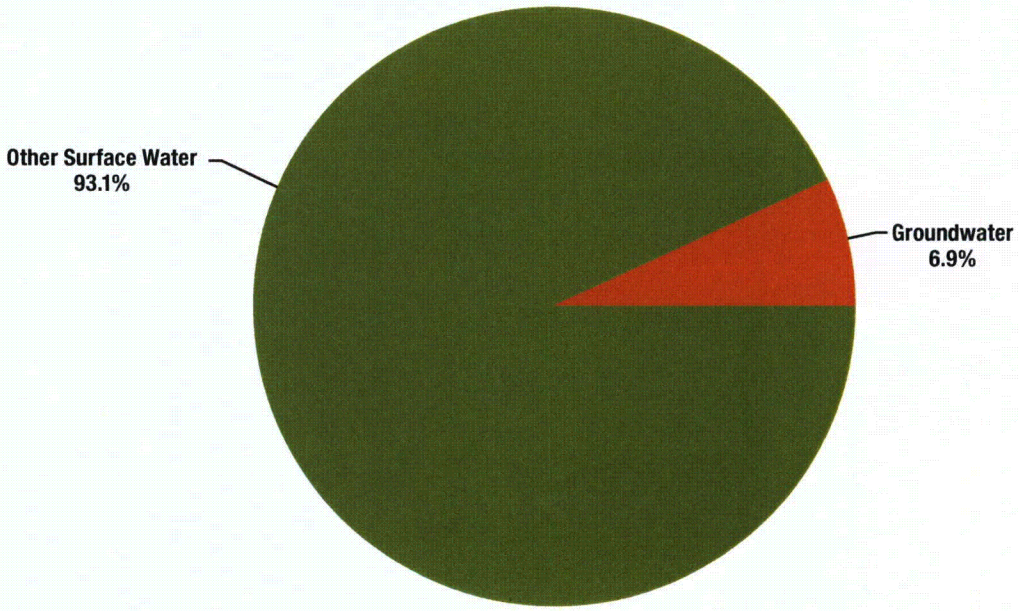
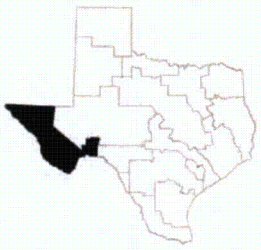


FIGURE D.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.



2 Summary of Far West Texas (E) Region



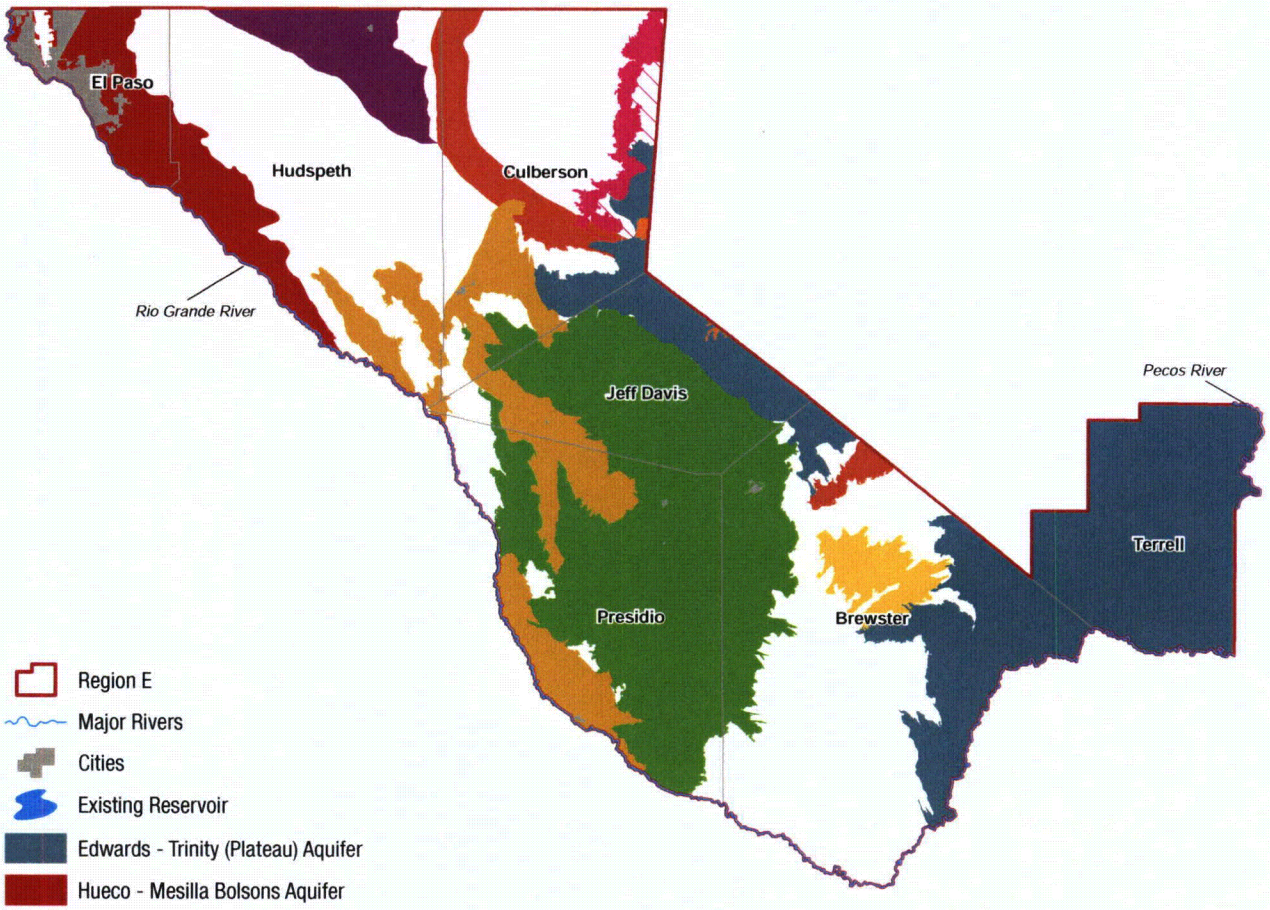
The Far West Texas Regional Water Planning Area includes seven counties and lies within the Rio Grande Basin.

The Far West Texas Regional Water Planning Area includes seven counties and lies within the Rio Grande Basin (Figure E.1). The largest economic sectors in the region are agriculture, agribusiness, manufacturing, tourism, wholesale and retail trade, government, and military. About 97 percent of the people in this planning area reside in El Paso County. The 2011 Far West Texas (E) Regional Water Plan can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionE/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—226,569 acre-feet per year
- Recommended water management strategy volume in 2060—130,526 acre-feet per year
- Total capital cost—$842 million
- Conservation accounts for 40 percent of 2060 strategy volumes
- Significant unmet irrigation needs
- Groundwater desalination accounts for 21 percent of 2060 strategy volumes
- One additional unique stream segment recommended for designation (Figure ES.8)

FIGURE E.1. FAR WEST TEXAS (E) REGIONAL WATER PLANNING AREA.



* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Less than 4 percent of the state's total population resided in the Far West Texas Region in 2010. By 2060, the regional population is projected to increase 79 percent (Table E.1). Regional water demands, however, will increase less dramatically. By 2060, the total water demands for the region are projected to increase 8 percent (Table E.1). Agricultural irrigation water use makes up the largest share of these demands in all decades even though it is projected to decrease 10 percent over the planning period (Table E.1). Municipal water demand is projected to increase 60 percent by 2060 (Table E.1, Figure E.2).

EXISTING WATER SUPPLIES

The total water supply for 2010 is estimated to be 514,593 acre-feet (Table E.1, Figure E.2). Other than some irrigation use and El Paso municipal use, the region relies on groundwater for most of its water supply. Approximately 75 percent of the region's existing water supply consists of groundwater from two major aquifers (Edwards-Trinity [Plateau] outcrop and the Hueco-Mesilla Bolsons) and six minor aquifers. The principal surface water sources are the Rio Grande and the Pecos River, although both are limited, by river system operations and water quality, respectively. Although no reservoirs are located in the planning area, a reservoir system in New Mexico, administered by the U.S. Bureau of Reclamation, regulates the Rio Grande and, thus, a portion of the area's water supplies. Direct reuse provides another 6,000 acre-feet. Because of treaty and compact agreements, as well as groundwater management district regulations, the total surface and groundwater supply is projected to remain relatively constant throughout the planning period.

NEEDS

In 2010, total water needs during drought of record conditions for the region were projected to be an estimated 209,591 acre-feet, all in irrigation (Table E.1, Figure E.2). By 2060, water needs are projected to increase to 226,569 acre-feet, with irrigation making up the largest share of the needs (75 percent). Municipal needs are projected to constitute 14 percent of the total 2060 needs (Table E.1). Manufacturing, steam-electric power generation, and county-other categories are also projected to face needs.

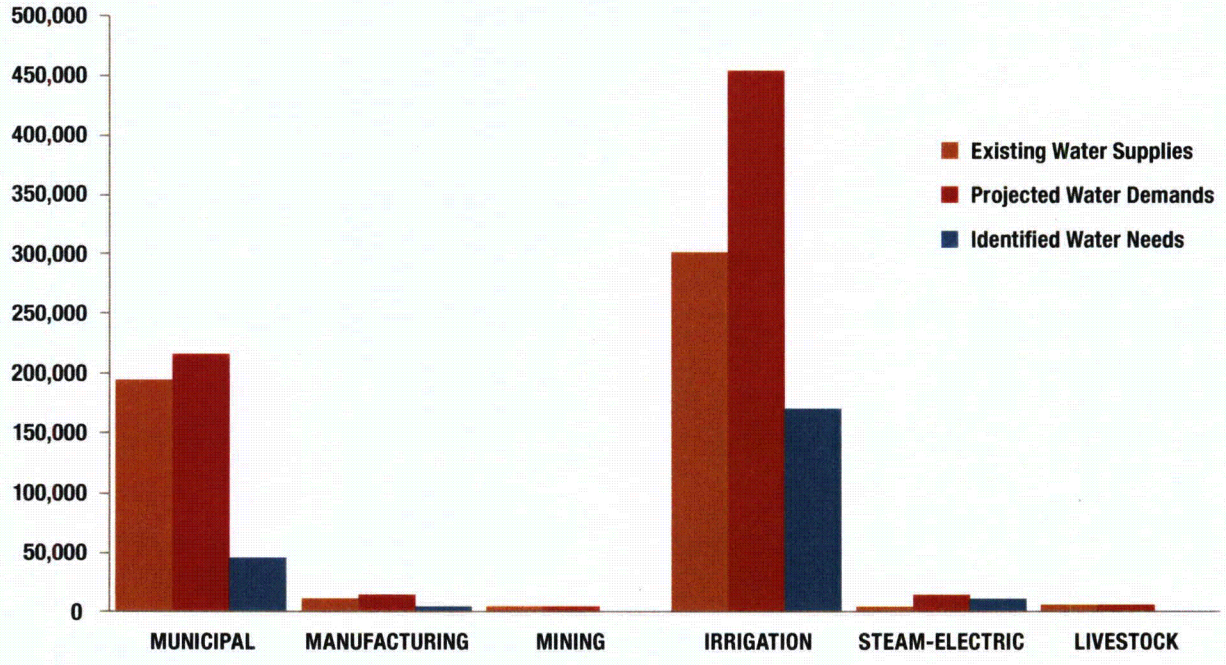
RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

The Far West Texas Planning Group recommended a variety of water management strategies, including municipal conservation, direct reuse of reclaimed water, increases from the Rio Grande managed conjunctively with local groundwater, and imports of additional desalinated groundwater from more remote parts of the planning area. In all, the strategies would provide 130,526 acre-feet of additional water supply by the year 2060 (Figures E.3 and E.4) at a total capital cost of $842.1 million (Appendix A). The Far West Texas Region recommended an integrated water management strategy to meet needs in El Paso, which represents combinations of various sources. Because there were no economically feasible strategies identified, three counties have unmet irrigation needs during drought of record conditions ranging from 209,591 acre-feet in 2010 to 161,775 acre-feet by 2060.

TABLE E.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	863,190	1,032,970	1,175,743	1,298,436	1,420,877	1,542,824
Existing Supplies (acre-feet per year)						
Surface water	85,912	85,912	85,912	85,912	85,912	85,912
Groundwater	384,650	384,650	384,650	384,650	384,650	384,650
Reuse	44,031	44,031	44,031	44,031	44,031	44,031
Total Water Supplies	**514,593**	**514,593**	**514,593**	**514,593**	**514,593**	**514,593**
Demands (acre-feet per year)						
Municipal	122,105	140,829	156,086	168,970	181,995	194,972
County-other	7,371	10,479	12,968	14,894	16,877	19,167
Manufacturing	9,187	10,000	10,698	11,373	11,947	12,861
Mining	2,397	2,417	2,424	2,432	2,439	2,451
Irrigation	499,092	489,579	482,538	469,084	460,402	451,882
Steam-electric	3,131	6,937	8,111	9,541	11,284	13,410
Livestock	4,843	4,843	4,843	4,843	4,843	4,843
Total Water Demands	**648,126**	**665,084**	**677,668**	**681,137**	**689,787**	**699,586**
Needs (acre-feet per year)						
Municipal	0	3,867	7,675	10,875	19,239	31,584
County-other	0	3,114	5,625	7,589	9,584	11,876
Manufacturing	0	813	1,511	2,186	2,760	3,674
Irrigation	209,591	201,491	195,833	183,734	176,377	169,156
Steam-electric	0	3,806	4,980	6,410	8,153	10,279
Total Water Needs	**209,591**	**213,091**	**215,624**	**210,794**	**216,113**	**226,569**

FIGURE E.2. 2060 FAR WEST TEXAS EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



CONSERVATION RECOMMENDATIONS

Conservation strategies for municipal and irrigation water users represent 40 percent of the total volume of water associated with all recommended water management strategies in 2060. Municipal conservation strategies recommended for the City of El Paso have a goal of 140 gallons per capita per day of water use. Total water conservation savings in the plan, including savings from efficient plumbing fixtures as well as improved irrigation scheduling, are projected to be 52,275 acre-feet by 2060.

SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Importation of groundwater from Dell Valley is expected to produce up to 20,000 acre-feet per year in the year 2060 with a capital cost of $214 million.
- Importation of groundwater from Diablo Farms is projected to produce 10,000 acre-feet per year of water starting in 2040 with a capital cost of $246 million.
- Irrigation District surface water system delivery improvements are anticipated to produce 25,000 acre-feet per year of water starting in 2020 with a capital cost of $148 million.
- Conjunctive use with additional surface water is projected to produce 20,000 acre-feet per year of water with a capital cost of $140 million.

REGION-SPECIFIC STUDIES

The Far West Texas Regional Water Planning Group developed four region-specific studies during the initial phase of the third planning cycle. The final reports documenting the findings can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#e.

- Water Conservation Conference for Far West Texas Water Plan Region E
- Evaluation of Irrigation Efficiency Strategies for Far West Texas: Feasibility, Water Savings, and Cost Considerations
- Conceptual Evaluation of Surface Water Storage in El Paso County
- Groundwater Data Acquisition in Far West Texas

FAR WEST TEXAS PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

Tom Beard (Chair), agriculture; Janet Adams, groundwater districts; Ann Allen, industries; Ed Archuleta, municipalities; Randy Barker, groundwater districts; Jeff Bennett, environmental; Rebecca L. Brewster, municipalities; Sterry Butcher, public; Michael Davidson, travel/tourism; David Etzold, building/real estate; Sylvia Borunda Firth, municipalities; Willie Gandara, counties; Dave Hall, public; Mike Livingston, small business; Albert Miller, water utilities; Jim Ed Miller, water districts; Kenn Norris, counties; Juana Padilla, legislative representative; Jesus "Chuy" Reyes, water districts; Rick Tate, agriculture; Teresa Todd, legislative representative; Teodora Trujillo, public; Paige Waggoner, economic development; Carlos Zuazua, electric generating utilities

Former voting members during the 2006 – 2011 planning cycle:

Jesse Acosta, counties; Loretta Akers, other; Jerry Agan, counties; Cedric Banks, Fort Bliss; Elza Cushing, public; Howard Goldberg, industries; Luis Ito, electric generating utilities; Carl Lieb, environmental; E. Anthony Martinez, legislative representative; Ralph Meriwether, small business; Brad Newton, counties; Adrian Ocegueda, municipalities; Al Riera, Fort Bliss; Charles Stegall, counties; Jim Voorhies, electric generating utilities

FIGURE E.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

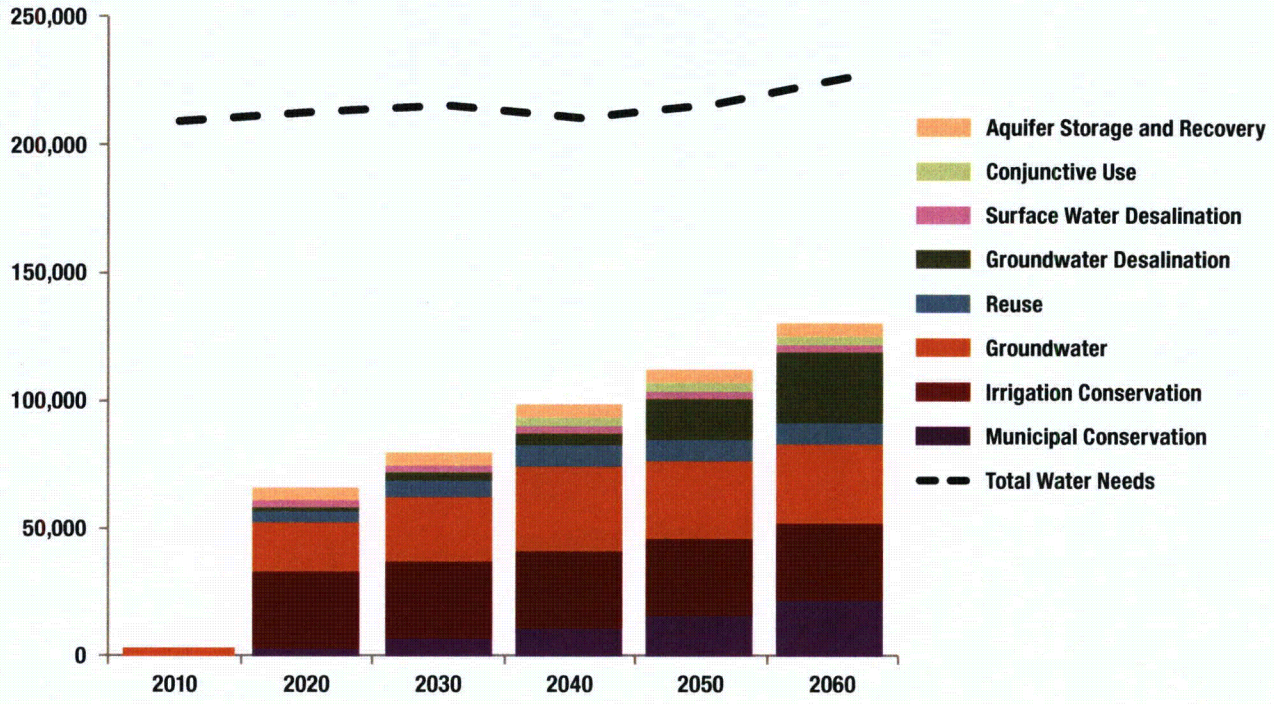
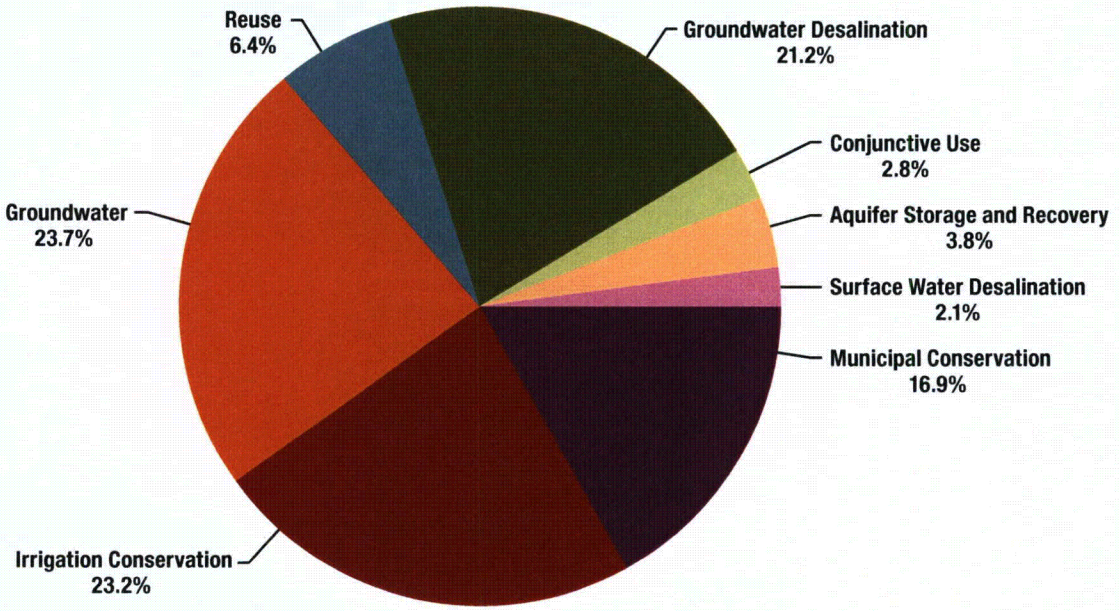
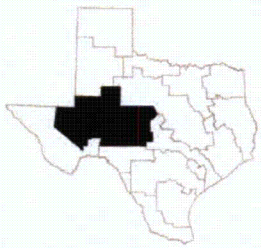


FIGURE E.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.



2 Summary of Region F



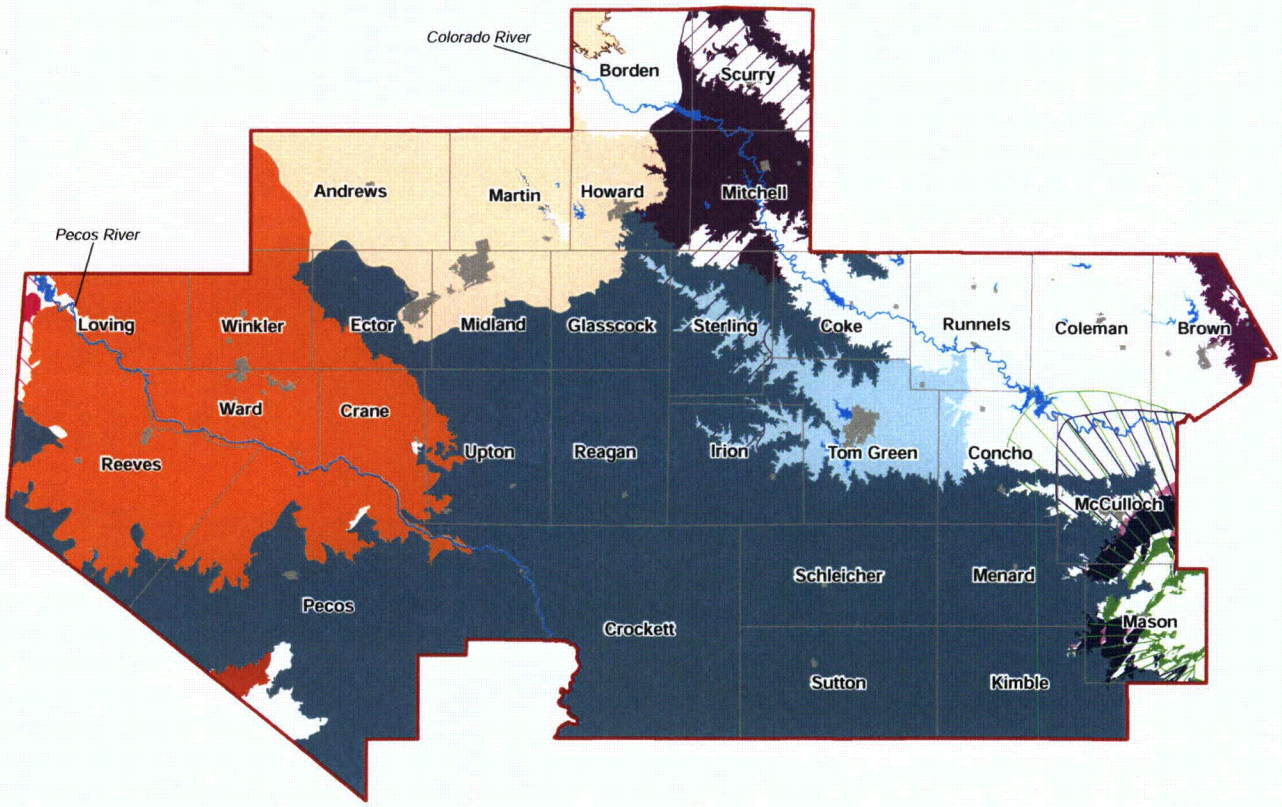
The Region F Regional Water Planning Area is located in the Edwards Plateau and encompasses 32 counties.

The Region F Regional Water Planning Area is located in the Edwards Plateau encompassing 32 counties (Figure F.1). Intersected by the Pecos River to the south and the Colorado River to the north, most of the region is located in the upper portion of the Colorado River Basin and Pecos portion of the Rio Grande Basin; a small portion is in the Brazos Basin. The major cities in the region include Midland, Odessa, and San Angelo. The region's economy relies heavily on healthcare and social assistance, mining, manufacturing, agriculture, and oil and gas employment sectors. The 2011 Region F Regional Water Plan can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/3rdRound/2011_RWP/RegionF/.

PLAN HIGHLIGHTS

- Additional supply needed in 2060—219,995 acre-feet per year
- Recommended water management strategy volume in 2060—235,198 acre-feet per year
- Total capital cost—$915 million
- Conservation accounts for 35 percent of 2060 strategy volumes
- Subordination of downstream senior water rights as strategy to increase reliability of significant supply volume
- Unmet needs in irrigation and steam-electric power

FIGURE F.1. REGION F REGIONAL WATER PLANNING AREA.



- Region F
- Major Rivers
- Cities
- Existing Reservoirs
- Edwards - Trinity (Plateau) Aquifer (outcrop)
- Ogallala Aquifer
- Pecos Valley Aquifer
- Trinity Aquifer (outcrop)
- Trinity Aquifer (subsurface)
- Capitan Reef Complex Aquifer*
- Dockum Aquifer (outcrop)*
- Dockum Aquifer (subsurface)*
- Edwards -Trinity (High Plains) Aquifer*
- Ellenburger - San Saba Aquifer (outcrop)*
- Ellenburger - San Saba Aquifer (subsurface)*
- Hickory Aquifer (outcrop)*
- Hickory Aquifer (subsurface)*
- Lipan Aquifer (outcrop)*
- Marble Falls Aquifer*
- Rustler Aquifer (outcrop)*
- Rustler Aquifer (subsurface)*
- Igneous Aquifer*

* Minor aquifer (only shown where there is no major aquifer)

POPULATION AND WATER DEMANDS

Approximately 2 percent of the state's total population lived in Region F in 2010, and between 2010 and 2060 its population is projected to increase by 17 percent (Table F.1). Despite projected population growth in the region, total water demands for the region are projected to remain relatively constant throughout the planning period. Agricultural irrigation makes up the largest share of these demands in all decades, although it is projected to decrease 5 percent by 2060 (Table F.1). Steam-electric generation demands are projected to have the greatest increase (84 percent), while municipal demands are projected to increase 11 percent (Table F.1, Figure F.2).

EXISTING WATER SUPPLIES

Seventy-five percent of the region's existing water supply in 2010 is projected to consist of groundwater from four major aquifers (Ogallala, Edwards-Trinity [Plateau], Trinity, and Pecos Valley) and seven minor aquifers (Table F.1, Figure F.2). Reservoirs provide 17 percent of supply and run-of-river supplies and alternative sources, such as desalination and wastewater reuse, account for 7 percent.

NEEDS

Total regional needs are projected to increase 15 percent by 2060 (Table F.1). Irrigation is projected to have the largest need in all decades, but decline in magnitude to 144,276 acre-feet in 2060. By 2060, municipal needs are projected to account for 23 percent of total needs and steam-electric 9 percent (Table F.1, Figure F.2).

RECOMMENDED WATER MANAGEMENT STRATEGIES AND COST

Region F recommended a variety of water management strategies to meet water supply needs (Figures F.3 and F.4). In all, the strategies would provide 235,198 acre-feet of additional water supply by the year 2060 at a total capital cost of $914.6 million (Appendix A). Because economically feasible strategies could not be identified, 94,108 acre-feet of irrigation needs in 15 counties and steam-electric needs of 14,935 acre-feet in three counties are unmet in 2060.

CONSERVATION RECOMMENDATIONS

Conservation strategies, including municipal and advanced irrigation, provide the largest volume of supply for all strategies in the region. By 2060, they account for 35 percent of the total volume associated with all recommended strategies. The bulk of conservation savings are provided by advanced irrigation strategies that represent over 72,244 acre-feet of savings, 31 percent of the total in 2060.

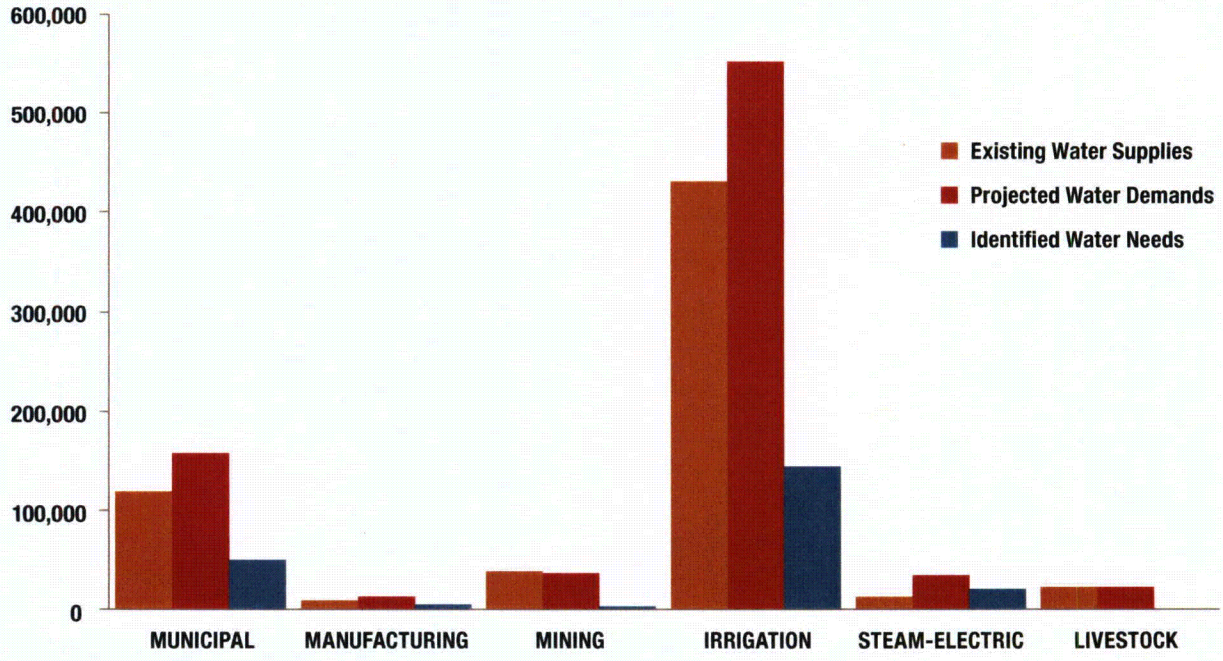
SELECT MAJOR WATER MANAGEMENT STRATEGIES

- Irrigation conservation would provide up to 72,244 acre-feet per year of water starting in 2030 with a capital cost of $69 million.
- Groundwater desalination would provide up to 16,050 acre-feet per year of water in 2060 with a capital cost of $214 million.
- Reuse projects would provide up to 12,490 acre-feet per year of water starting in 2040 with a capital cost of $131 million.

TABLE F.1. POPULATION, WATER SUPPLY, DEMAND, AND NEEDS 2010–2060

	2010	2020	2030	2040	2050	2060
Projected Population	618,889	656,480	682,132	700,806	714,045	724,094
Existing Supplies (acre-feet per year)						
Surface water	138,352	137,285	136,063	134,929	133,840	132,821
Groundwater	483,937	480,479	481,658	478,331	478,624	478,805
Reuse	19,015	19,309	19,459	19,609	19,759	19,909
Total Water Supplies	**641,304**	**637,073**	**637,180**	**632,869**	**632,223**	**631,535**
Demands (acre-feet per year)						
Municipal	122,593	127,135	129,747	131,320	133,361	135,597
County-other	19,372	20,693	21,533	21,886	21,979	22,035
Manufacturing	9,757	10,595	11,294	11,960	12,524	13,313
Mining	31,850	33,097	33,795	34,479	35,154	35,794
Irrigation	578,606	573,227	567,846	562,461	557,080	551,774
Steam-electric	18,138	19,995	22,380	25,324	28,954	33,418
Livestock	23,060	23,060	23,060	23,060	23,060	23,060
Total Water Demands	**803,376**	**807,802**	**809,655**	**810,490**	**812,112**	**814,991**
Needs (acre-feet per year)						
Municipal	21,537	30,464	35,442	43,088	45,923	49,060
County-other	501	811	658	618	588	559
Manufacturing	3,537	4,138	3,747	4,403	4,707	5,152
Mining	503	660	29	143	232	375
Irrigation	157,884	154,955	152,930	149,472	146,995	144,276
Steam-electric	7,095	9,840	11,380	13,294	16,347	20,573
Total Water Needs	**191,057**	**200,868**	**204,186**	**211,018**	**214,792**	**219,995**

FIGURE F.2. 2060 REGION F EXISTING SUPPLIES, PROJECTED DEMANDS, AND IDENTIFIED WATER NEEDS BY WATER USE CATEGORY (ACRE-FEET PER YEAR).



REGION-SPECIFIC STUDIES

The Regional Water Planning Group developed six region-specific studies during the initial phase of the third planning cycle. The final reports documenting the findings can be found on the TWDB Web site at https://www.twdb.state.tx.us/wrpi/rwp/rwp_study.asp#f.

- Irrigation Survey: Glasscock, Midland, Regan, Pecos, Reeves, and Tom Green Counties
- Refinement of Groundwater Supplies and Identification of Potential Projects
- Evaluation of Supplies in the Pecan Bayou Watershed
- Municipal Conservation Survey
- Region K Surface Water Availability Coordination
- Study of the Economics of Rural Water Distribution and Integrated Water Supply Study

REGION F PLANNING GROUP MEMBERS AND INTERESTS REPRESENTED

Voting members during adoption of the 2011 Regional Water Plan:

John Grant (Chair), water districts; Woody Anderson, agriculture; Stephen Brown, river authorities; Kenneth Dierschke, agriculture; Richard Gist, water utilities; Charles Hagood, small business; Scott Holland, water districts; Wendell Moody, public; Robert Moore, counties; Caroline Runge, environmental; John Shepard, municipalities; Ben Sheppard, industries; Terry Scott, agriculture; Merle Taylor, municipalities; Larry Turnbough, water districts; Tim Warren, electric generating utilities; Paul Weatherby, water districts; Will Wilde, municipalities; Len Wilson, public

Former voting members during the 2006 – 2011 planning cycle:

Jerry Bearden, counties; Dennis Clark, water districts; Stuart Coleman, small business; Marilyn Egan, counties; Steven Hofer, environmental; Jared Miller, municipalities; Buddy Sipes, industries; Andrew Valencia, electric generating utilities

FIGURE F.3. RECOMMENDED WATER MANAGEMENT STRATEGY WATER SUPPLY VOLUMES FOR 2010–2060 (ACRE-FEET PER YEAR).

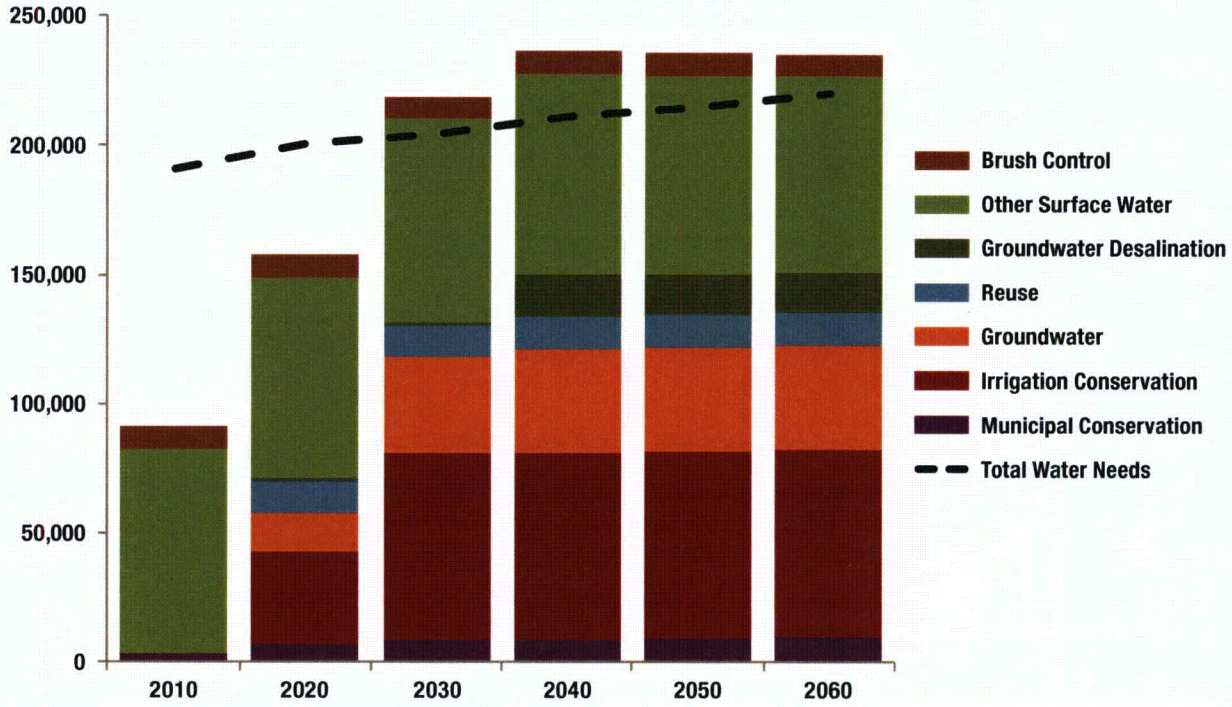


FIGURE F.4. 2060 RECOMMENDED WATER MANAGEMENT STRATEGIES–RELATIVE SHARE OF SUPPLY.