Chapter 1

Description of the Region

The East Texas Regional Water Planning Area (ETRWPA) is one of sixteen areas established by the 1997 Texas legislature Senate Bill 1 for the purpose of State water resource planning at a regional level on five-year planning cycles. The first regional water plan was adopted in 2001. Since that time, it was updated in 2006, 2011, and 2016. This plan, the 2021 Regional Water Plan (2021 Plan), is the result of the 5th cycle of regional water planning.

Pursuant to the formation of the ETRWPA, the East Texas Regional Water Planning Group (ETRWPG or RWPG), was formed and charged with the responsibility to evaluate the region's population projections, water demand projections, and existing water supplies for a 50-year planning horizon. The RWPG then identifies water shortages under drought of record conditions and recommends water management strategies. This planning is performed in accordance with regional and state water planning requirements of the Texas Water Development Board (TWDB).

This chapter provides details for the ETRWPA that are relevant to water resource planning, including: a physical description of the region, climatological details, population projections, economic activities, sources of water and water demand, and regional resources. A discussion of threats to the region's resources and water supply, a general discussion of water conservation and drought preparation in the region, and a listing of ongoing state and federal programs in the ETRWPA that impact water planning efforts in the region are also provided.

1.1 General Introduction

The ETRWPA consists of all or portions of 20 counties located in the Neches, Sabine, and Trinity River Basins, and the Neches-Trinity Coastal Basin. The region extends from the southeastern corner of the state for over 150 miles north and northwest as illustrated in Figure 1.1. The ETRWPA consists of approximately 10,329,800 acres of land and accounts roughly six percent of total area of the State of Texas.

By statute, the RWPG consists of members from at least 12 of the following statutorily required interests: public, counties, municipalities, industries, agriculture, environmental, small business, electric-generating utilities, river authorities, water districts, water utilities, and groundwater management areas. These voting, and several non-voting members, collectively represent the water supply interests of the entire region.

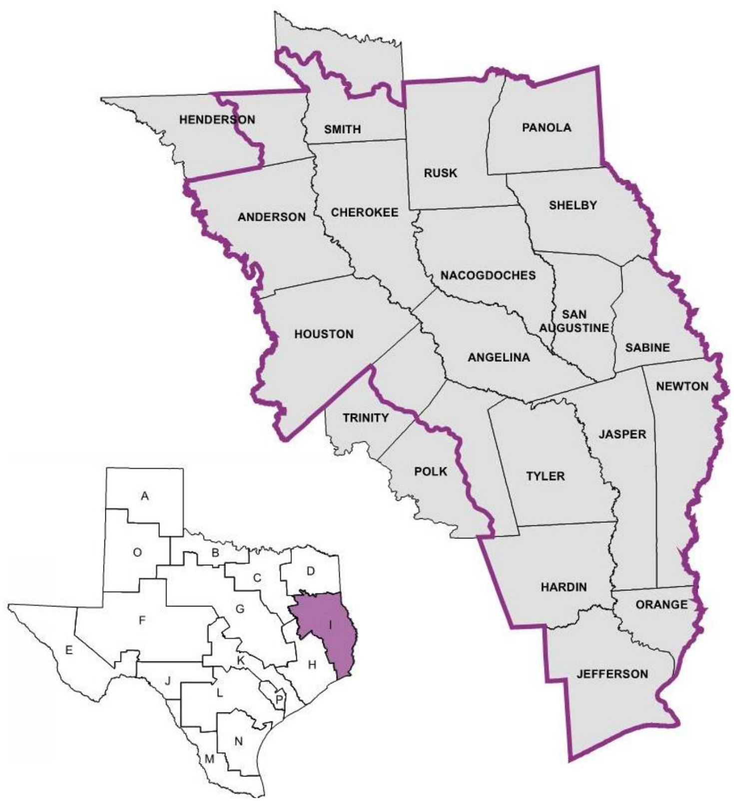

Figure 1.1 Location Map

SOURCE: TEXAS WATER DEVELOPMENT BOARD

The City of Nacogdoches is the administrative contracting agency for the RWPG. The RWPG has retained the services of a team of water-supply consulting engineering firms to prepare the 2021 Plan including Alan Plummer Associates, Inc. as the lead consultant, Freese & Nichols, Inc. as a subconsultant, and WSP USA as a subconsultant groundwater specialist. Table 1.1 provides a current list of the RWPG representatives involved in developing the 2021 Regional Water Plan.

Table 1.1 East Texas Regional Water Planning Group Members

Voting Members	
Category	**Name**
Agriculture	David Alders, *Carrizo Creek Corporation*
	Josh David, *Livestock*
Counties	Judge Chris Davis, *Cherokee County*
	Fred Jackson, *Jefferson County*
Electric Power	Randy Stanton, *Energy Services Inc.*
Environmental	Dr. Matthew McBroom, *Stephen F. Austin State University*
Groundwater Management Areas	John McFarland, *Rusk County GCD*
	John Martin, *Southeast Texas GCD*
Industries	Darla Smith, *BASF Corporation*
	David Gorsich, *Exxon Mobil Corporation*
Municipalities	David Brock, *City of Jacksonville*
	Gregory M. Morgan, *City of Tyler*
Public	Stevan Gelwicks
	Terry Stelly
River Authorities	David Montagne, *Sabine River Authority*
	Monty Shank, *Upper Neches River MWA*
	Kelley Holcomb, *Angelina-Neches River Authority*
	Scott Hall, *Lower Neches Valley Authority*
Small Business	Mark Dunn, *Dunn's Construction LLC*
	VACANT
Water Districts	Worth Whitehead*, *Rusk SWCD*
Water Utilities	Roger Fussell, *Lumberton MUD*
Non-Voting Members	
Lann Bookout, *Texas Water Development Board*	Stephan Lange, *Texas Parks & Wildlife Department*
Manuel Martinez, *Texas Department of Agriculture*	James Alford, *Trinity County*
Connie Standridge, *Region C RWPG*	Chip Kline, *Louisiana Governor's Office of Coastal Activities*
Honorable Joel Hale, *Rusk County Judge*	Ben A. Stephenson, *City of Dallas*
VACANT, Region H RWPG	Honorable Allison Harbison, *Shelby County Judge*
Walter Glenn, *Jasper County*	Terry McFall, *U.S. Department of Agriculture*
Rusty Ray, *Texas State Soil and Water Conservation Board*	

*Retired from the Regional Water Planning Group prior to final approval

Table 1.1 East Texas Regional Water Planning Group Members (Cont.)

Committees	
Executive Committee	
Chair – Kelley Holcomb 1st Vice Chair – David Brock 2nd Vice Chair – Josh David Secretary – John Martin	Assistant Secretary – David Montagne At-Large – Mark Dunn At-Large – David Alders
Nominations Committee	**By-Laws Committee**
Chair – Monty Shank Member – Chris Davis Member – Randy Stanton Ex-Officio – Kelley Holcomb	Chair – David Alders Member – Worth Whitehead Member – Darla Smith Member - Roger Fussell
Finance Committee	**Technical Committee**
Chair – Mark Dunn Member – Greg Morgan Member – Josh David Member – David Brock	Chair – Scott Hall Member – John Martin Member – Matthew McBroom

SOURCE: EAST TEXAS REGIONAL WATER PLANNING GROUP

1.1.1 Physical Description

The ETRWPA is generally characterized by rolling to hilly surface features, except near the Gulf Coast. The elevation in the region varies from sea level at its southern boundary on the Gulf of Mexico to 763 ft mean sea level at Tater Hill Mountain in Henderson County at its far northwest corner. The region is further subdivided into natural geographic areas known as the Piney Woods, the Oak Woods and Prairies, and the Coastal Prairies, described as follows.

Piney Woods. The majority of the ETRWPA falls within the Piney Woods portion of the Texas Gulf Coastal Plain. Pine is the predominant timber of this region, although some hardwood timbers can be found as well, primarily in the valleys of rivers and creeks. Longleaf, shortleaf, and loblolly pine are native to the region and slash pine, an introduced species, is widely dispersed. Hardwoods include a variety of oaks, elm, hickory, magnolia, sweetgum, and blackgum. Lumber production is the principal industry of the area and practically all of Texas' commercial timber production comes from the Piney Woods region. The soils and climate are adaptable to the production of a variety of fruit and vegetable crops. Cattle ranching is widespread and generally accompanied by the development of pastures. Economic growth in the area has also been greatly influenced by the large oil field discovered in Rusk and Smith counties in 1931. This area has a variety of clays, lignite coal, and other minerals that have potential for development.

Oak Woods and Prairies. Most of the northwestern portion of the ETRWPA (parts of Smith, Henderson, Anderson, and Houston counties) fall within the Oak Woods and Prairies portion of the Texas Gulf Coastal Plains. Principal trees of this area are hardwoods, including post oak, blackjack oak, and elm. Riparian areas often have pecan, walnut, and other trees with high water demands. Upland soils are sandy and sandy loam, while the bottomlands are sandy loam and clay. The Oak Woods and Prairies are somewhat spotty in character, with some insular areas of blackland soil and others that closely resemble those of the Piney Woods. The principal industry of the area is diversified farming and livestock raising. The Oak Woods and Prairies region also has lignite, commercial clays, and other minerals.

Coastal Prairies. The southern portion of the ETRWPA (largely Jefferson and Orange counties) is located within the segment of the Texas Gulf Coastal Plains known as the Coastal Prairies. In general, this area is covered with a heavy growth of grass, and the line of demarcation between the prairies and the Pine Belt forests is very distinct. Soil of the Coastal Prairies is predominantly heavy clay. Cattle ranching is the principal agricultural industry, although significant rice production is also present. The Coastal Prairie has seen a large degree of industrial development that continues today. The chief concentration of this development has been from the city of Orange and the areas between the cities of Beaumont and Houston; much of the development has been in petrochemical manufacturing.

Figure 1.2 depicts the boundaries of these areas within the ETRWPA. Additional description of the region is provided later in this chapter.

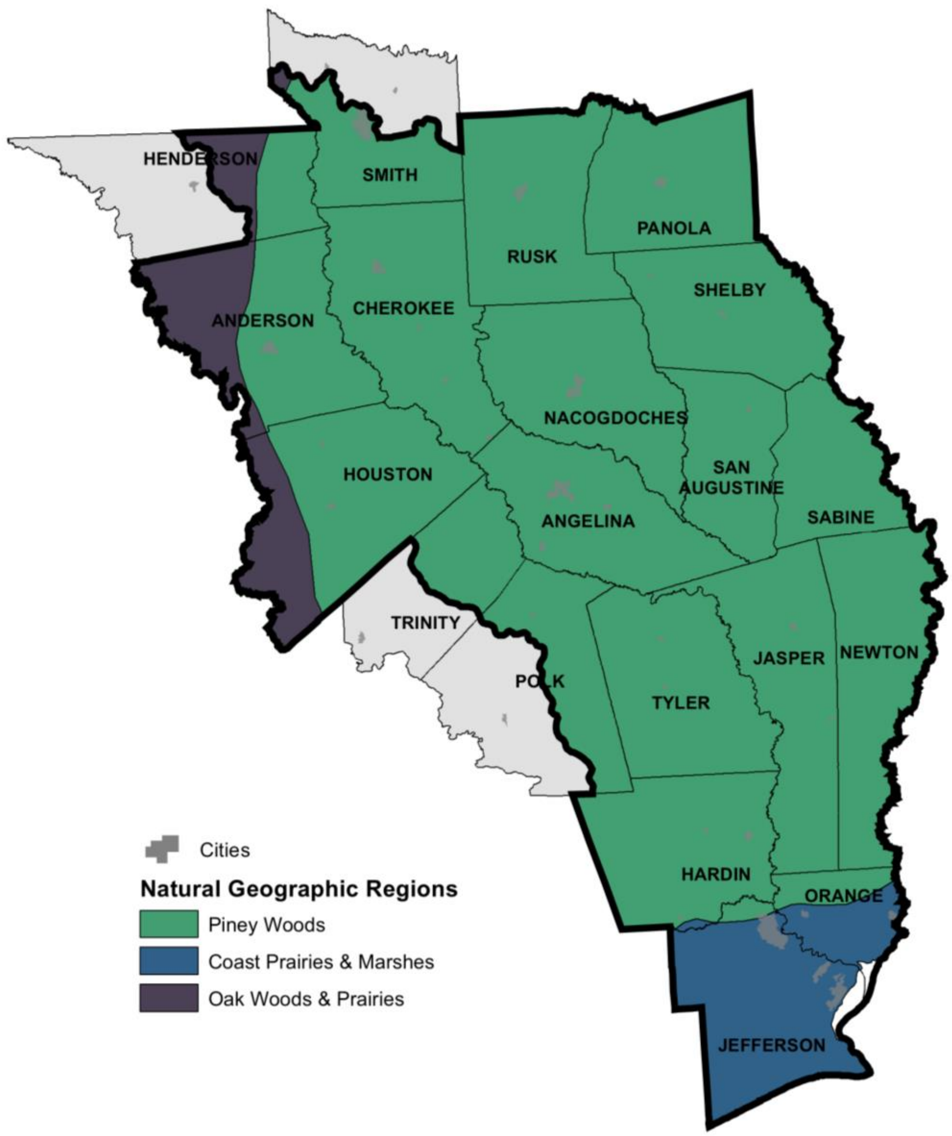

Figure 1.2 Natural Geographic Regions

SOURCE: TEXAS NATURAL RESOURCE INFORMATION SYSTEM

1.1.2 Climate

Data from National Weather Service Stations compiled by the Texas State Climatologist indicate that the mean temperatures for the entire region varied from a minimum January temperature of 35 °F in both Anderson and Henderson counties, to a maximum July temperature of 94 °F in Shelby County.[1] Similarly, the average growing season from 1981 to 2010 was 252 days in the ETRWPA.[2]

Precipitation generally increases from the northwest to southeast corners of the region, while evaporation increases in the opposite direction. Annual rainfall across the ETRWPA averaged 51.5 inches from 1981 through 2010, with the highest average rainfall (61.0 inches) being recorded in the southwest corner of Quadrant 714 and the lowest average rainfall (41.0 inches) being recorded in Quadrants 512 and 612. Average annual runoff ranges from approximately 10 inches in the northwest to 17 inches in the southeast. From 1954 to 2018 the average annual gross reservoir evaporation (the rate of evaporation from a reservoir) ranges from approximately 46 inches in the southeast to 57 inches in the northwest.[3]

Figures 1.3 through 1.5 depict mean annual temperature, mean annual precipitation, and gross reservoir evaporation, respectively for the ETRWPA.

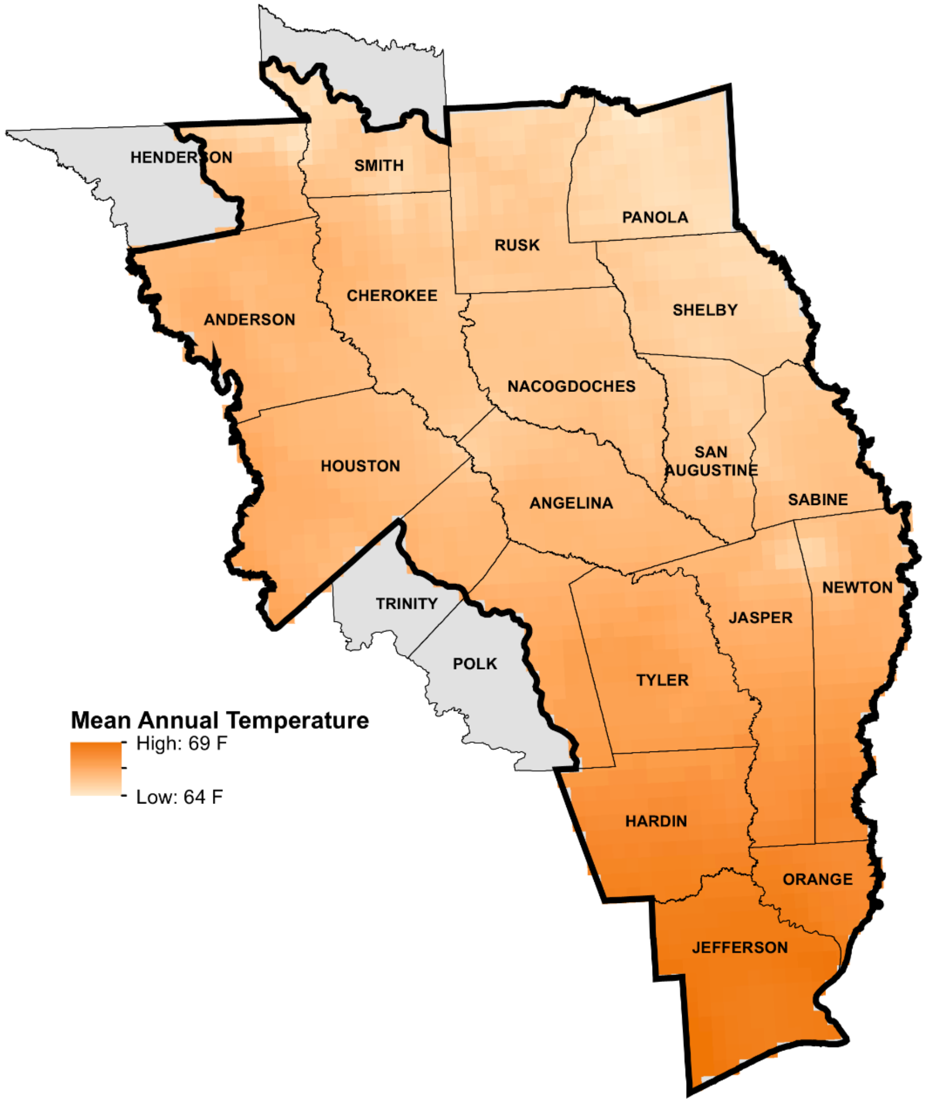

Figure 1.3 Mean Annual Temperature

SOURCE: PRISM CLIMATE GROUP

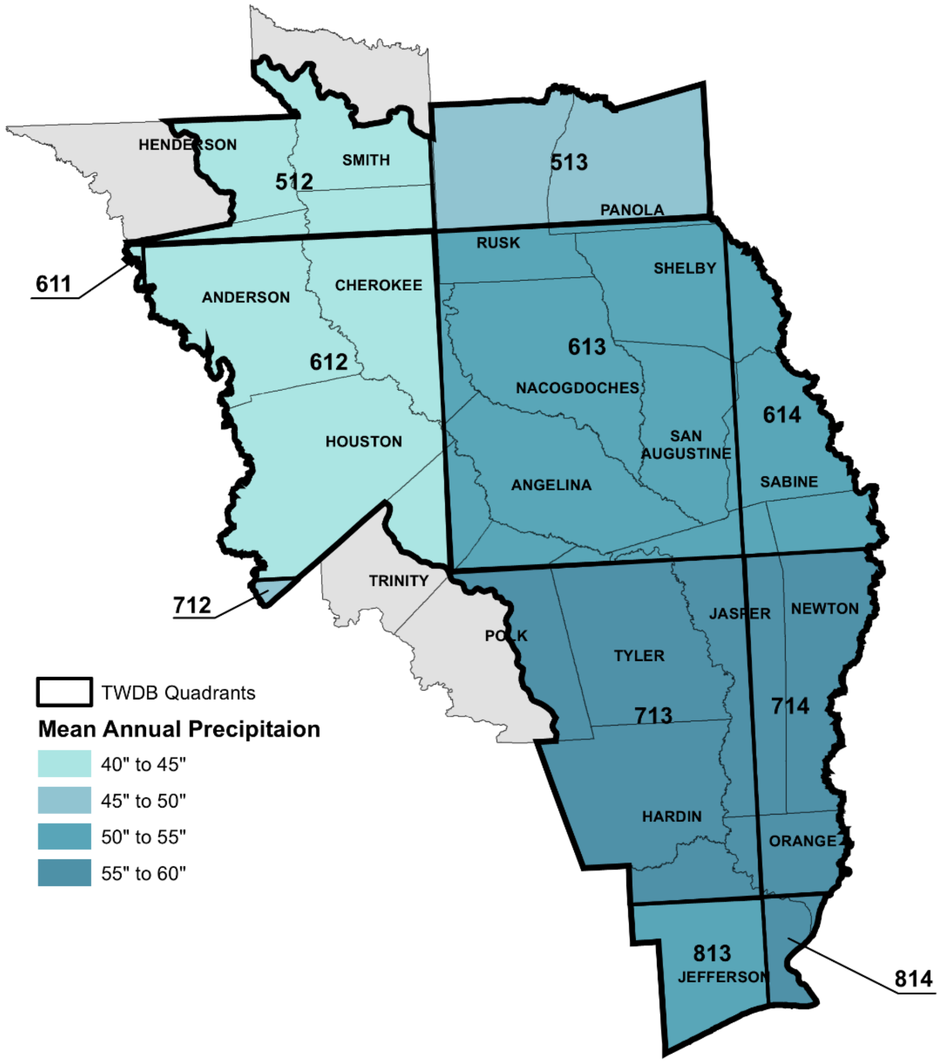

Figure 1.4 Mean Annual Precipitation

SOURCE: TEXAS WATER DEVELOPMENT BOARD

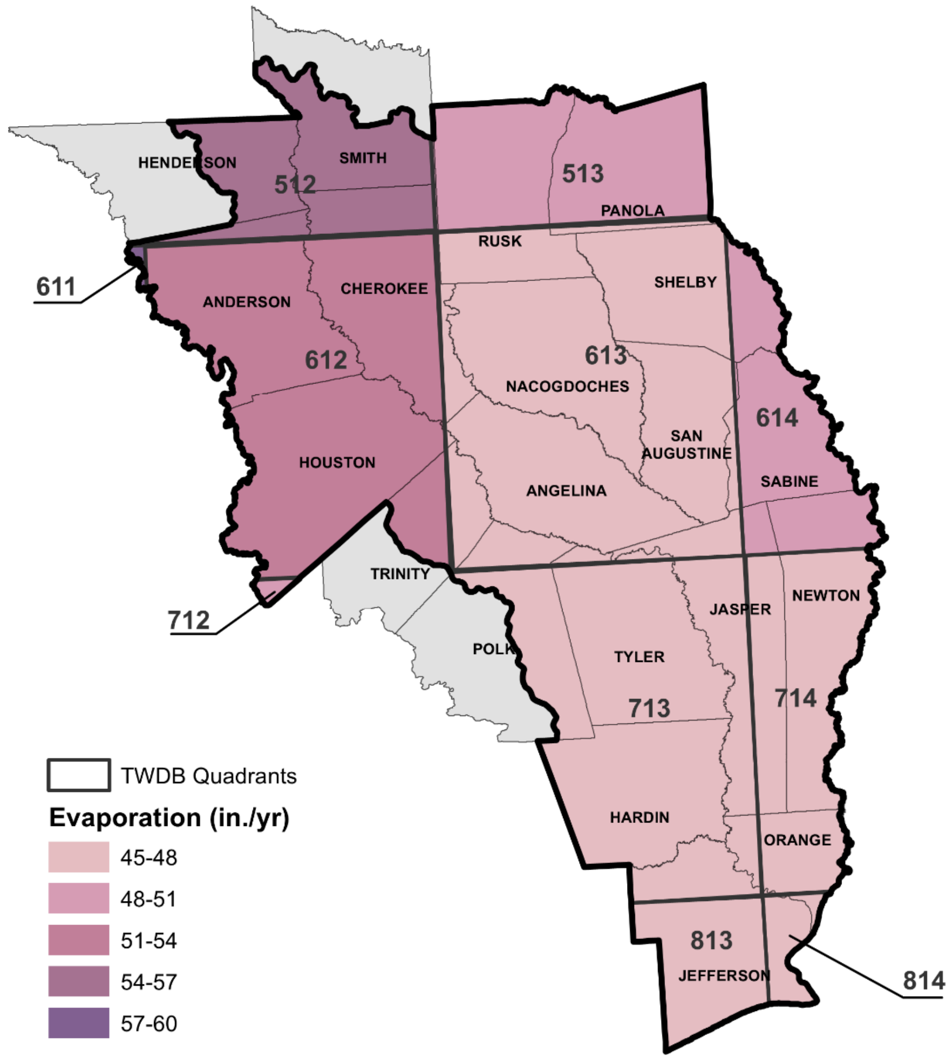

Figure 1.5 Gross Reservoir Evaporation

SOURCE: TEXAS WATER DEVELOPMENT BOARD

1.1.3 Population

The ETRWPA contains all or parts of three Metropolitan Statistical Areas (MSA) as defined by the Office of Management and Budget; an MSA is an urban area with a population of 50,000 or more.[4] The MSAs in the ETRWPA include:

- Beaumont-Port Arthur MSA (Jefferson, Orange, and Hardin counties).
- Part of the Longview MSA (Rusk County).
- Most of the Tyler MSA (portion of Smith County in Neches basin).

As of 2010, the combined population of these three MSAs is approximately 62% of the total ETRWPA population.

The population in the region increased approximately 6% from 2000 through 2010, to approximately 1.07 million people. Growth in the region is expected to continue at an average rate of approximately 6% per decade to approximately 1.61 million by 2080. The census data from 2000 and 2010 for the region's major cities are provided in Figure 1.6. Additional details on population projections developed by the TWDB are provided in Chapter 2 and Appendix ES-A, Report 01.

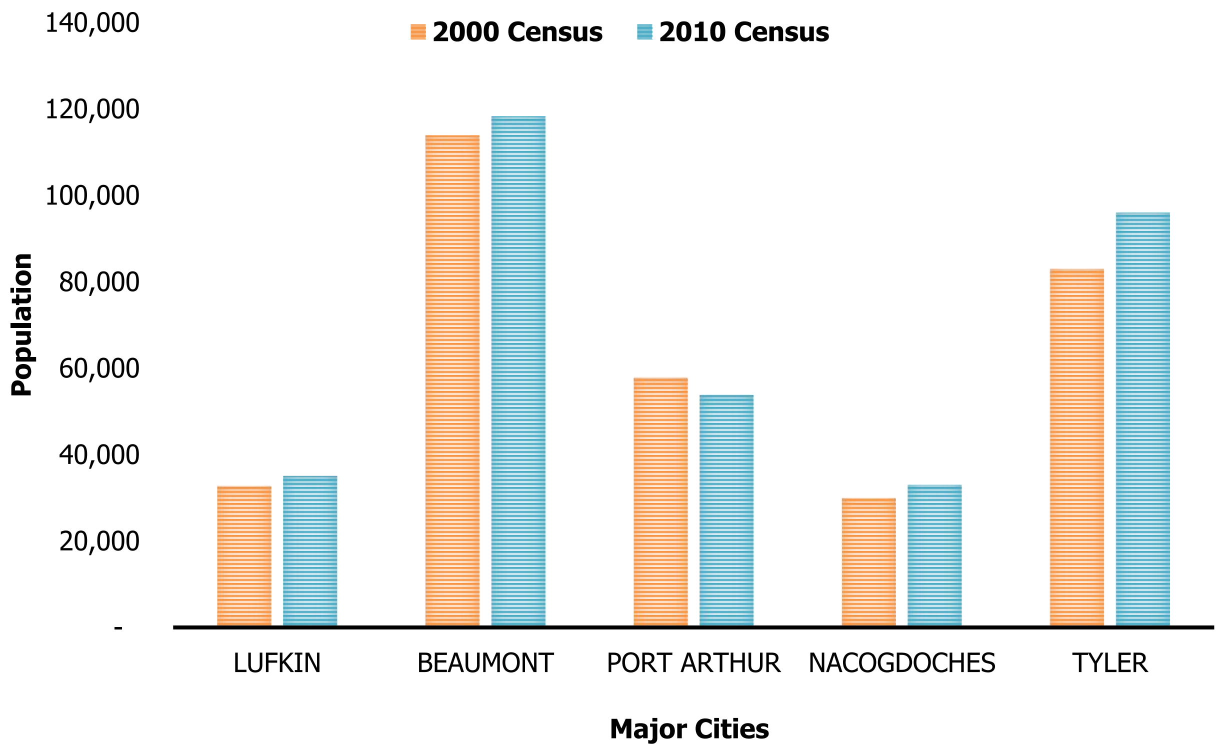

Figure 1.6 Historical Populations of Major Cities

SOURCE: U.S. CENSUS BUREAU

1.1.4 Economic Activity

The overall economy of the region consists primarily of agriculture, agribusiness, mineral production, wholesale and retail trade, and manufacturing. Manufacturing includes the timber and petrochemical industries. Major water-using industries and irrigated crops in the ETRWPA are listed in Table 1.2.

Table 1.2 Economic Sectors Heavily Dependent on Water Resources

Use Category	Detail
Irrigation	Hay
	Rice
	Soybeans
	Vegetables
Livestock	Poultry
	Cattle
Manufacturing	Timber, Pulpwood, and Forest Fiber
	Chemical and Allied Products
	Petroleum Refining
Mining	Oil and Gas Production

SOURCE: EAST TEXAS REGIONAL WATER PLANNING GROUP

The Beaumont-Port Arthur MSA, at the southern end of the region, has an economy based primarily on petroleum refining and chemical plants including petrochemicals. Other industries include a steel mill and paper mills, correctional facilities, as well as other timber products industries in Hardin and Tyler counties.

Several seaports are located in the cities of Beaumont, Port Arthur, and Orange, plus several industrial docks, along with small amounts of shipyard activity. Agriculture in the area includes cattle, rice, and soybeans. Oil and gas production are significant.

Four campuses of the university system of the State of Texas are located in the area. Beaumont contains Lamar University and the adjacent Lamar Institute of Technology. Lamar State College-Port Arthur and Lamar State College-Orange are located in Port Arthur and Orange, respectively.

The majority of the Longview MSA is located just outside the region, north of Rusk County. It is centered in Longview in Gregg County. However, the area includes very diversified manufacturing located within the ETRWPA in Rusk County. Rusk County manufacturing includes brick manufacturing, power generation, steel fabrication, fiberglass specialties, and timber industry. Rusk County also has state correctional facilities. No major ETRWPA cities are located in this area.

The Tyler MSA, consisting of Smith County, lies partially within the northern end of the region. Tyler, the only major city in the area, lies almost entirely within the ETRWPA. Local manufacturing includes air conditioning/heating equipment, cast iron pipe, tires, and meatpacking, including poultry processing. Known as the "Rose Capital," Tyler has a thriving commercial rose industry as well. Tyler is home to Tyler Junior College and the University of Texas at Tyler, and the city is a growing hub for the health-care industry and retail in East Texas. Oil production is prevalent in the area.

Lufkin and Nacogdoches, the other major cities in the ETRWPA, do not presently classify as MSAs. However, Lufkin and Nacogdoches are both projected to become MSAs by 2050 according to the current TWDB population projections. These cities, located in adjacent counties, have many similarities including timber products industries, poultry processing, higher education, and health care service providers. Nacogdoches also has manufacturers of valves, transformers, sealing products, and motor homes. Stephen F. Austin State University is located in Nacogdoches.

Economic activity for the remainder of the region includes timber industry, including numerous timber processing mills. Natural gas and some oil production are scattered throughout the region, and beef cattle production is prominent, being found in all counties in the region. Plant nurseries are common in the north part of the region. Poultry production and/or processing are prevalent in Anderson, Shelby, Nacogdoches, Angelina, San Augustine, Houston, Cherokee, Smith, Rusk, and Panola counties. There is diverse manufacturing in addition to timber industries. Commercial fishing is an important economic characteristic of Sabine Lake. Tourism, fishing, and hunting are important in many areas, especially on the large reservoirs in the center of the region, further to the south near Sabine Lake and the Gulf of Mexico, and in many forested areas.

Information from the Texas Workforce Commission shows unemployment for the region varying from 3.1% in Anderson County to 8.1% in Sabine County in 2018. Of the three workforce areas overlapping the region, the average annual wages for 2018 were as follows: [5]

- East Texas (northern counties): $43,420
- Deep East Texas (middle counties): $38,792
- South East Texas (Beaumont-Port Arthur metropolitan area): $53,560

1.2 Current Water Demands

The demand for water in the ETRWPA is expected to grow from 738,081 acre-feet per year (ac-ft/yr) in the year 2020 to a total of 839,601 ac-ft per year in 2070. The water demands considered in the regional water planning process are categorized into six major user groups: municipal, manufacturing, irrigation, steam electric, livestock and mining. A more detailed description for each user group is found in Chapter 2.

Most demand in the region centers on larger cities or metropolitan areas. Over half of the current and projected water demand lies in Jefferson and Orange counties in southeast Texas. In that area, the two dominant water usages are manufacturing and irrigation, the latter occurring mainly in Jefferson County. However, large volumes of water use can occur away from large cities too, as in the case of outlying industries and steam-electric power generating plants.

For purposes of the 2021 Plan, major demand centers have been selected according to varying criteria. A county was selected if its total water usage (without depending on a single industry) exceeded 40,000 ac-ft per year. In counties that were not selected, a single industry was selected if it had 20,000 ac-ft per year or more in 2020 and represented the majority of usage in the county. As summarized in Table 1.3, there are currently five major demand centers in the ETRWPA located in Jasper, Jefferson, Orange, Rusk, and Smith counties.

Table 1.3 Major Demand Centers

County	Water User Group	2020 Demand (ac-ft/yr)
Jasper	Manufacturing	45,973
Jefferson	Irrigation	88,536
	Manufacturing	202,902
	Municipal	60,124
Orange	Manufacturing	44,335
Rusk	Steam Electric Power	45,304
Smith	Municipal	32,979

SOURCE: TEXAS WATER DEVELOPMENT BOARD

1.3 Sources of Water

The ETRWPA obtains its supplies from groundwater and surface water sources, primarily. Springs within the region can also be an important source of water for some uses. Following is a summary of groundwater, springs, and surface water sources within the ETRWPA. Historical average pumping values for aquifers were obtained from the Historical Groundwater Pumpage Estimates report developed by the TWDB.

1.3.1 Groundwater

The TWDB has identified two major aquifers and three minor aquifers in the region. The difference between the major and minor classification, as used by the TWDB, relates to the total quantity of water produced from an aquifer and not necessarily the total volume available.

The two major aquifers that underlie the region are known as the Carrizo-Wilcox and the Gulf Coast. The three minor aquifers, the Queen City, Sparta, and Yegua-Jackson, supply lesser amounts of water to the region. Figure 1.7 and Figure 1.8 show the locations of the major and minor aquifers, respectively.

The following generalized descriptions of the characteristics and quality of major and minor aquifers in the ETRWPA are based largely on the work of TWDB. Groundwater quality is affected by natural conditions as well as man-made contamination. According to the Texas Commission on Environmental Quality (TCEQ), "natural contamination probably affects the quality of more groundwater in the state than all other sources of contamination combined."[6] A more thorough discussion of groundwater availability is provided in Chapter 3.

Gulf Coast Aquifer. The Gulf Coast is a major aquifer that forms an irregularly shaped belt along the Gulf of Mexico from Florida to Mexico. In Texas, the aquifer provides water to all or parts of 54 counties, including 8 counties in the ETRWPA. It extends from the Rio Grande northeastward to the borders with Louisiana and Arkansas. The Gulf Coast aquifer provides the sole source of groundwater in the seven southern counties of the region.

The Gulf Coast aquifer contains various interconnected layers, some of which are aquicludes (impervious clay or rock layers). From bottom to top, the four main water-producing layers are the Catahoula, Jasper, Evangeline, and Chicot layers, with the Evangeline and Chicot being the main sources of groundwater in southeast Texas. Total pumpage from the Gulf Coast aquifer in the region averaged approximately 74,557 ac-ft per year in years 2013 through 2017.

Water quality in the Gulf Coast aquifer varies significantly, depending on location. Salt water intrusion is a significant source of natural contamination because of the proximity of the Gulf of Mexico. Under natural conditions, in the absence of pumping, a layer of salt water underlies the lighter fresh water layer with a well-defined interface between the two layers. At any given point, especially near the coast, deeper aquifers may be filled with salt water, very shallow aquifers may contain all fresh water, and an intermediate aquifer may be contained in the interface between the two. In areas near the coast, dissolved salts concentrations are generally in excess of 1,000 parts per million (ppm); sometimes more than 10,000 ppm. In areas of the aquifer further from the coast, dissolved salts concentrations can drop to less than 500 ppm.

Heavy pumpage has caused an updip migration, or saltwater intrusion, of poor quality water into the aquifer beyond its natural limits. A 1990 TWDB report indicated that salt water conditions are a problem in Orange County in the heavily pumped areas around the cities of Orange and Vidor. The previously referenced TCEQ report also indicates high chloride concentrations in most of Jefferson County. Much of the migration is lateral, but some localized vertical coning occurs in wells that draw from levels above the interface between salt and fresh water. In coning, some salt water is drawn up into the pumping well from below along with the fresh water at the intake level.

In some areas, natural contamination results from substances in the soil or in the aquifer media. Radioactivity is present in groundwater from natural causes, particularly in a belt across the ETRWPA including the area lacking major or minor aquifers designations. Some areas have nuisance substances in the groundwater such as iron, manganese, and sulfates affecting the taste or color of the water.

Man-made aquifer pollution may result from improper waste disposal, leaking underground tanks, wood preservation operations, pesticide use in agriculture, and improperly constructed wells.[6, 7] There is no current evidence indicating that water quality problems are directly associated with man-made pollution.

The Gulf Coast aquifer generally contains good quality water except in portions of Jefferson and Orange counties. The Carrizo-Wilcox aquifer generally has good water quality except for high dissolved solids in a band along its southern boundary. Iron is a widespread problem and sulfates and chlorides are found in scattered locations throughout the aquifer. [6, 7]

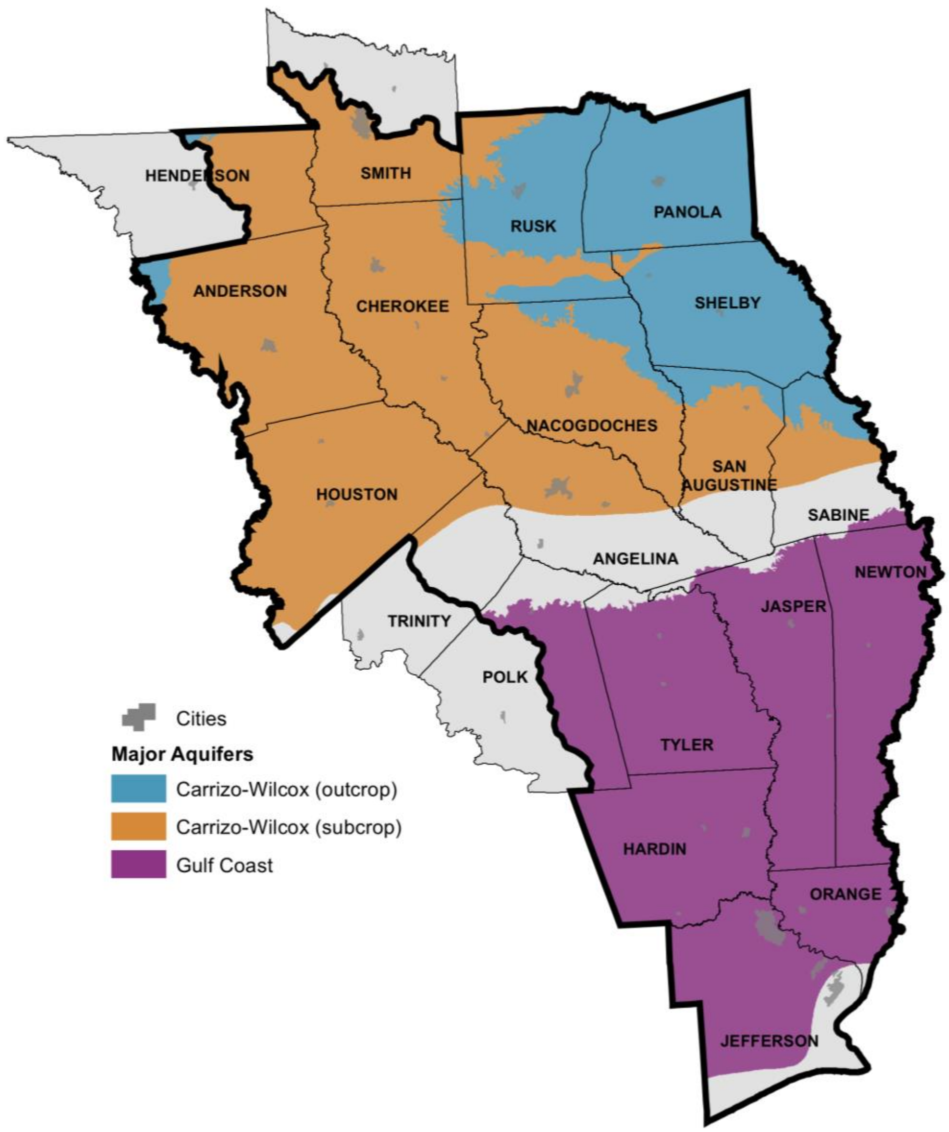

Figure 1.7 Major Aquifers

SOURCE: TEXAS WATER DEVELOPMENT BOARD

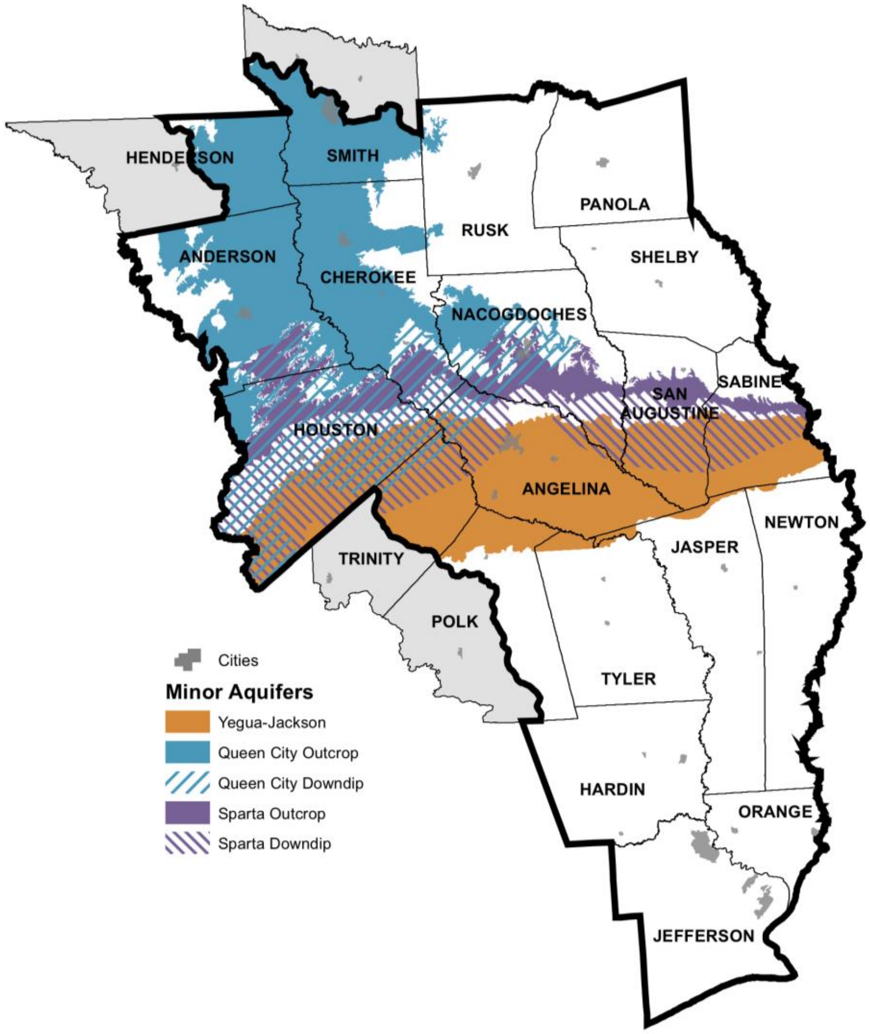

Figure 1.8 Minor Aquifers

SOURCE: TEXAS WATER DEVELOPMENT BOARD

Carrizo-Wilcox Aquifer. The Carrizo-Wilcox is a major aquifer that is formed by the hydraulically connected Wilcox Group and the overlying Carrizo Formation of the Claiborne Group. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana, providing water to all or parts of 60 counties in Texas, including 13 in the ETRWPA. The aquifer in the ETRWPA occurs as a major trough caused by the Sabine Uplift near the Texas-Louisiana border. It is a major source of water supply for the region.

Total groundwater pumpage from the Carrizo-Wilcox in the region averaged 71,612 ac-ft per year based on historical pumping for years 2013 through 2017. The largest urban areas dependent on groundwater from the Carrizo-Wilcox are located in central and northeast Texas and include the ETRWPA cities of Lufkin (Angelina County), Nacogdoches (Nacogdoches County), and Tyler (Smith County). Well yields of greater than 500 gallons per minute (gpm) are not uncommon.

In some wells, declines in the artesian portion of the Carrizo-Wilcox in this area have exceeded 300 feet. However, evaluation of 46 Carrizo-Wilcox wells scattered throughout the region that have been monitored since the 1960s indicates that the average water level decline from the 1960s to the 1990s is about 51 feet and ranges from 20 feet below ground level to 263 feet below ground level. Significant water-level declines have occurred in the region around Tyler and the Lufkin-Nacogdoches area.

Large water level declines have also occurred in Smith, Anderson, and Leon counties in the confined portions of the aquifer. Generally, wells located in the northern part of the aquifer have relatively stable groundwater levels. [8]

Much of this pumpage has been for municipal supply, but industrial pumpage is also significant. However, pumpage from industries has generally declined since the 1980s. Total pumpage from the Carrizo in Angelina and Nacogdoches counties has decreased since the 1980s and therefore, water levels have stabilized in these areas. In some wells, water levels have increased, although the wells are still being utilized.

Water quality in the Carrizo-Wilcox is generally good. Dissolved solids concentrations are typically less than 500 ppm in outcrop areas; but can be greater than 1,000 ppm in deeper zones. In addition, groundwater in deeper zones often contain iron and manganese at concentrations that exceed the secondary drinking water standards.

Sparta Aquifer. The Sparta is a minor aquifer that extends in a narrow band across the state from the Frio River in South Texas northeastward to the Louisiana border in Sabine County. The Sparta Formation is part of the Claiborne Group deposited during the Tertiary Period and consists of sand and interbedded clay with more massive sand beds in the basal section.

Yields of individual wells are generally low to moderate, although most high-capacity wells average 400 to 500 gpm. Because the Carrizo aquifer underlies the Sparta, most public water supply wells and other large production wells are completed in the Carrizo, thus limiting the total pumpage from the Sparta.

Relatively large amounts of usable quality groundwater are contained within the rocks of the Sparta aquifer. Historically, availability has been considered 5 percent of the average annual rainfall on the aquifer in the Neches and Sabine River basins.

The Sparta aquifer produces water of excellent quality throughout most of its extent in the region; however, water quality deteriorates with depth in the downdip direction. Water quality can deteriorate at depths greater than 2,000 feet below ground surface. Dissolved salts concentrations in shallower zones averages around 300 ppm; and can be around 800 ppm with depth. Iron concentrations are generally high.

Queen City Aquifer. Like the Sparta, the Queen City aquifer extends in a band across most of Texas from the Frio River in South Texas northeastward into Louisiana. The Queen City Formation is composed mainly of sand, loosely cemented sandstone, and interbedded clays. Although large amounts of usable quality groundwater are contained in the Queen City, yields are typically low. A few well yields exceed 400 gpm.

Total historical groundwater pumpage from the Queen City in the region averaged 3,376 ac-ft per year during 2013 through 2017. Groundwater levels in most Queen City wells have remained relatively stable, with variations less than 20 feet. However, the water level in a Wood County well declined approximately 100 feet between 1980 and 2016.

In the Neches, Sulphur, Sabine, and Cypress Creek basins, availability from the Queen City aquifer based on recharge has been estimated at 5 percent of average annual precipitation. Because of the relatively low well yields, overdrafting of the Queen City Aquifer is generally not a problem.

Throughout most of its extent, the chemical quality of the Queen City aquifer water is excellent; however, quality deteriorates with depth in the downdip direction. Dissolved salts concentrations in the Queen City aquifer are generally between 300 and 750 ppm. Dissolved iron concentrations can be high, particularly in northeastern areas of the aquifer.

Yegua-Jackson. The Yegua-Jackson aquifer extends in a narrow band from the Rio Grande to Louisiana. In the ETRWPA, the aquifer is located in the southern half of Sabine and San Augustine counties, the lower tip of Nacogdoches County, most of Angelina County, the southern portion of Houston County, those portions of Polk and Trinity counties located in the ETRWPA, and small northern portions of Tyler, Jasper, and Newton counties. The Yegua-Jackson aquifer is a complex association of sand, silt, and clay deposited during the Tertiary Period.

Total historical groundwater pumpage from the Yegua-Jackson in the region averaged 5,498 ac-ft per year during 2013 through 2017.

Water quality in the Yegua-Jackson aquifer varies, with dissolved salts concentrations ranging between 50 and 1,000 ppm in most cases. Iron is a problem, and the water from at least one location has been described as "sodium bicarbonate water."

Groundwater Conservation Districts. Groundwater conservation districts (GCDs) were created by the legislature for the purpose expressed in Chapter 36 of the Texas Water Code as follows:

Sec. 36.0015. PURPOSE. In order to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution, GCDs may be created as provided by this chapter. Groundwater conservation districts created as provided by this chapter are the state's preferred method of groundwater management through rules developed, adopted, and promulgated by a district in accordance with the provisions of this chapter.

More specifically, these districts are granted authority to regulate the spacing and/or production rate from water wells. In some cases, districts may regulate or prohibit exportation of groundwater from the district, provided the exportation did not begin before June 1, 1997. Districts may impose a fee for water exported from the district.

Districts are required to develop five-year groundwater management plans and to provide the plan (and any amendments) to applicable regional planning groups. Districts must establish permitting systems for new or modified wells and must keep on file copies of drilling logs.

Most counties in the ETRWPA are covered by a GCD. Following is a brief description of the county breakdown among GCDs.

Anderson, Henderson, and Cherokee Counties. The Neches and Trinity Valleys GCD, created in 2001 and headquartered at Jacksonville, covers Cherokee County and almost all of Anderson County, both in the ETRWPA, as well as Henderson County (which overlaps Regions C and the ETRWPA). The remainder of Anderson County, in the Palestine-Montalba area, is covered by the Anderson County Underground Water Conservation District, created in 1987, and headquartered at Montalba.

Angelina and Nacogdoches Counties. Angelina and Nacogdoches counties are covered by the Pineywoods GCD, created in 2001 and headquartered in Lufkin. The GCD has regulations including a permitting system for water wells within its territory.

Jasper, Newton, Tyler, and Hardin Counties. The Southeast Texas GCD, headquartered in Kirbyville, regulates groundwater in these four counties and was created by the legislature in 2003.

Sabine, San Augustine, and Shelby Counties. The Deep East Texas GCD was created in the 83rd Legislature in 2013 and needs confirmation via voter approval to become official.

Polk County. Polk County is covered by the Lower Trinity GCD that was created by the 79th Legislature in 2005.

Panola County. The Panola County GCD was created by the 80th Legislature, has been confirmed by local election in 2007, and has a management plan in place.

Rusk County. The Rusk County GCD, was created by the 78th legislature in 2003, confirmed by local election in 2004, and is headquartered in Henderson. The District has a groundwater management plan in place.

Houston, Jefferson, Orange, Smith, and Trinity counties are not covered by any confirmed or pending GCD.

Groundwater Management Areas. The TWDB has divided the state into sixteen groundwater management areas (GMAs) as required by the legislature. These areas were established on the basis of political and aquifer boundaries for the purpose of planning and regulation. (A GMA is only a designated geographic area, not an entity with board members, staff, or governing power.) GCDs within each GMA are required to share planning information, develop Desired Future Conditions, and estimate Modeled Available Groundwater for permitting purposes.

The boundaries of the ETRWPA encompass portions of GMAs 11 and 14. GMA 11 lies north of the northern lines of Polk, Tyler, Jasper, and Newton counties in Region I and generally covers the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers. GMA 14 encompasses the Gulf Coast aquifer including Polk, Tyler, Jasper, and Newton counties and counties to the south toward the Texas coast.

The GCDs and GMAs in Region I are shown in Figure 1.9.

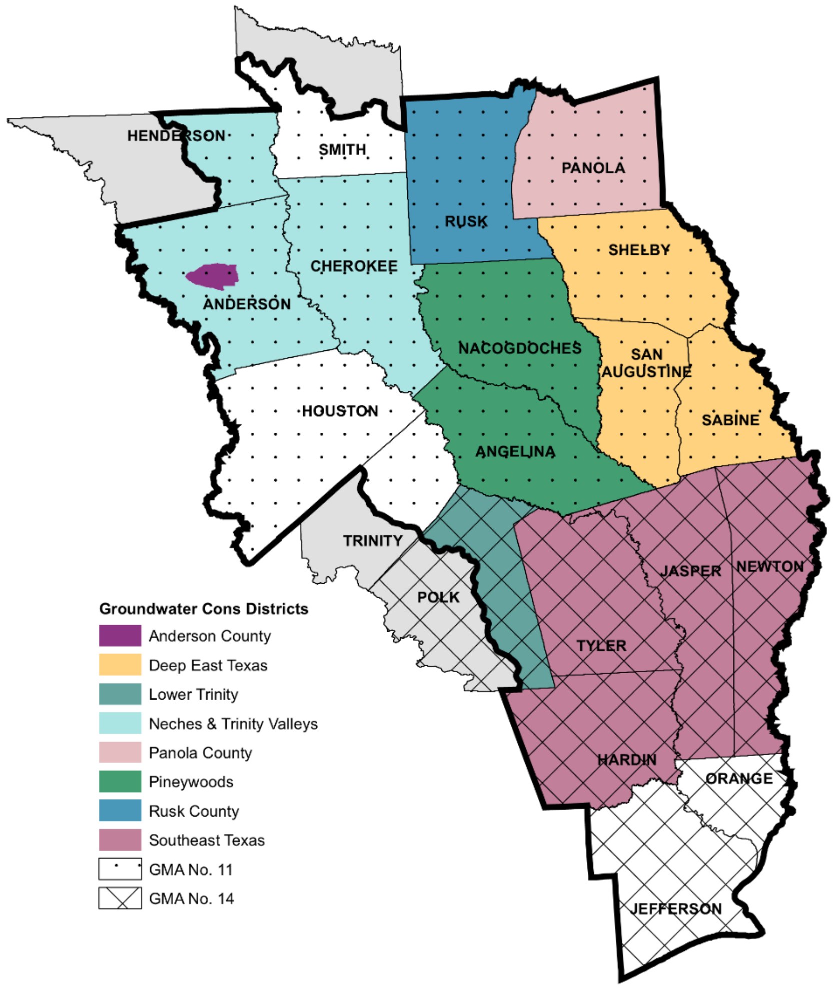

Figure 1.9 Groundwater Conservation Districts and Groundwater Management Areas

SOURCE: TEXAS WATER DEVELOPMENT BOARD

1.3.2 Springs

Over 250 springs of various sizes are documented in the ETRWPA according to the research of Gunnar M. Brune.[9] Most of the springs discharge less than 10 gpm and are inconsequential for most water supply planning purposes. However, springs are an important source of water for local supplies and provide crucial water for wildlife and, in some cases, livestock.

Based on discharge measurements collected mainly in the 1970s, 28 springs in the region discharge between 20 and 200 gpm, and there are seven springs that discharge between 200 and 2,000 gpm. It should be noted that Brune's research did not cover Anderson, Angelina, Henderson, Houston, or Trinity counties. In addition, Brune did not document any springs with flow greater than 20 gpm in Jefferson, Orange, or Panola County. U.S. Geological Survey (USGS) information was reviewed and only two springs with flows greater than 20 gpm, Black Ankle Springs in San Augustine and King's Spring in Polk County, were identified. Figure 1.10 shows the springs in the ETRWPA using USGS information.

Brune reported a flow of 5,700 gpm in the spring-fed Indian Creek in Jasper County, about five miles northwest of Jasper. This water was used at a Texas Parks and Wildlife Department (TPWD) fish hatchery.

Other notable springs are Spring Lake Springs in Smith County (570 gpm in 1979), Bailey Springs in Shelby County (620 gpm in 1976), Caney Creek Springs in Houston County (760 gpm in 1965), Hays Branch Springs in Houston County (810 gpm in 1965), and Elkhart Creek Springs in Houston County (1,500 gpm in 1965).

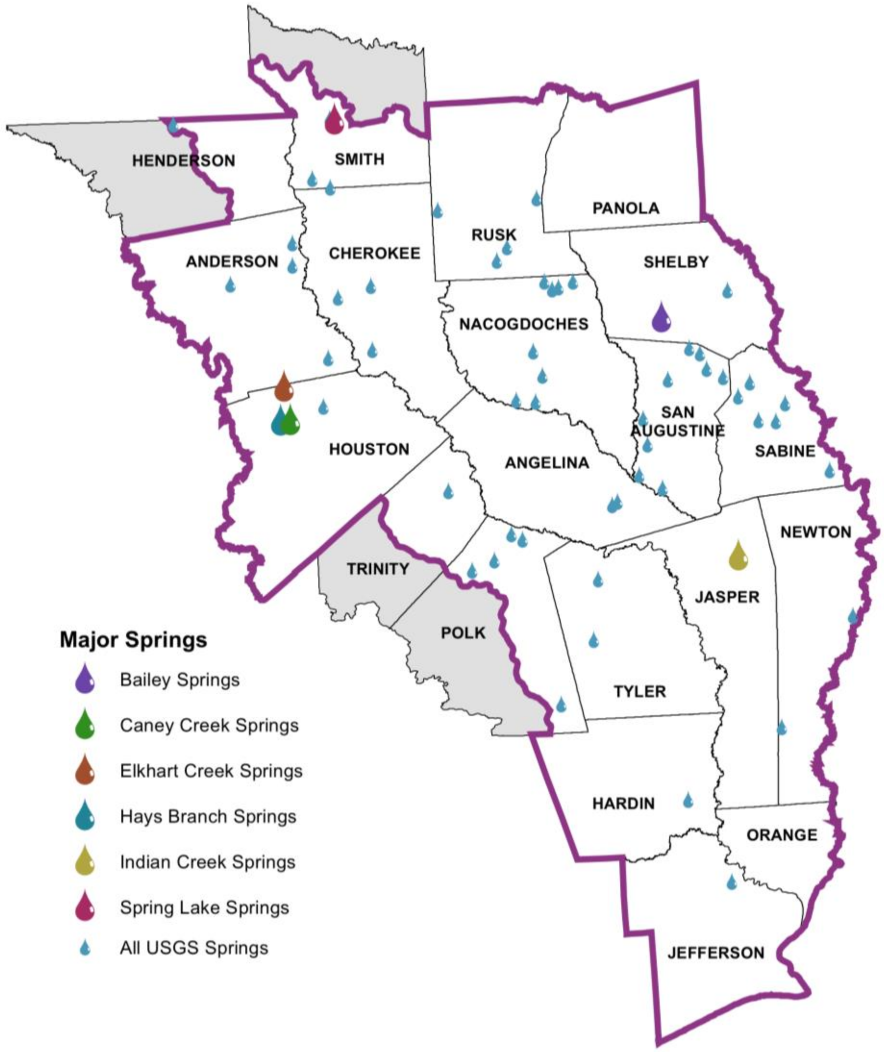

Figure 1.10 U.S. Geographical Survey Identified Springs

SOURCE: U.S. GEOGRAPHICAL SURVEY

1.3.3 Surface Water

Surface water includes water that may be obtained directly from streams, rivers, or reservoirs. Surface water sources within the ETRWPA include portions of three major river basins, and one coastal basin. Most of the region falls within the Neches River Basin. In fact, the majority of the Neches River Basin is located in the ETRWPA. The region also includes much of the Texas portion of the Sabine River Basin; portions of the Trinity River Basin in two counties; and a portion of the Neches-Trinity Coastal Basin in Jefferson County. Approximately one square mile of the Cypress Creek Basin lies in the northeastern portion of Panola County. Figure 1.11 indicates the locations of the major river basins within the ETRWPA. Additional descriptions of the Neches, Sabine, and Trinity River Basins follow. The current water supplies associated with each basin are described in detail in Chapter 3.

Neches River. The Neches River Basin originates in Van Zandt County, Texas, and flows for a distance of approximately 416 miles to Sabine Lake. In its course, the river passes through or forms a boundary for 14 counties in Texas. These include the ETRWPA counties of Smith, Henderson, Cherokee, Anderson, Houston, Angelina, Trinity, Polk, Tyler, Jasper, Hardin, Orange, and Jefferson.

The drainage area for the entire basin is approximately 10,000 square miles. Approximately 9,585 square miles of the basin are located within the ETRWPA. Approximately one-third of the basin area is comprised of the Angelina River Basin. Significant tributaries to the Neches River Basin include Pine Island Bayou and Village Creek. The Neches River Basin contributes nearly six million acre-feet of water to Sabine Lake annually.

Sabine River

The Sabine River originates in Hunt County, Texas, in Region C. It flows for a distance of approximately 550 miles in a generally southeast direction to Sabine Lake. The river passes through or forms a boundary for five counties in the ETRWPA: Panola, Shelby, Sabine, Newton, and Orange counties. Most of the river's course within the ETRWPA forms the boundary between Texas and Louisiana. The Sabine River Basin covers approximately 9,750 square miles, of which approximately 76% is in Texas. The remainder of the basin is located in Louisiana. Approximately 3,930 square miles of the basin are located within the ETRWPA. The Sabine River Basin contributes approximately 6.4 million acre-feet of water to Sabine Lake annually.

Neches-Trinity Basin. The coastal plain between the Neches River and Trinity River forms the Neches-Trinity Coastal Basin. The area is mostly located in Jefferson County (in the ETRWPA) and Chambers County (in Region H). Maximum elevation in the basin is approximately 50 feet, although most of the basin is less than 25 feet in elevation. Total basin drainage area is approximately 1,692 square miles. Approximately 858 square miles of the basin are located within the ETRWPA. In Jefferson County, the basin drains primarily to the Gulf Coast and to Sabine Lake.

Trinity River. The Trinity River is the longest river that flows entirely within Texas, and while a major water body in the State, only a small portion is located in the ETRWPA. The Trinity River has reaches that meet the legal definition of navigable waters, but it is not currently used for this purpose due to a cost-benefit analysis performed by the U.S. Army Corps of Engineers in the 1970s. The Trinity River basin falls almost entirely within the political boundary of the Trinity River Authority, a wholesale water provider in Regions C and H. In the ETRWPA, it forms a western boundary for Anderson and Houston counties. Approximately 1,420 square miles of the Trinity River basin are located within the ETRWPA.

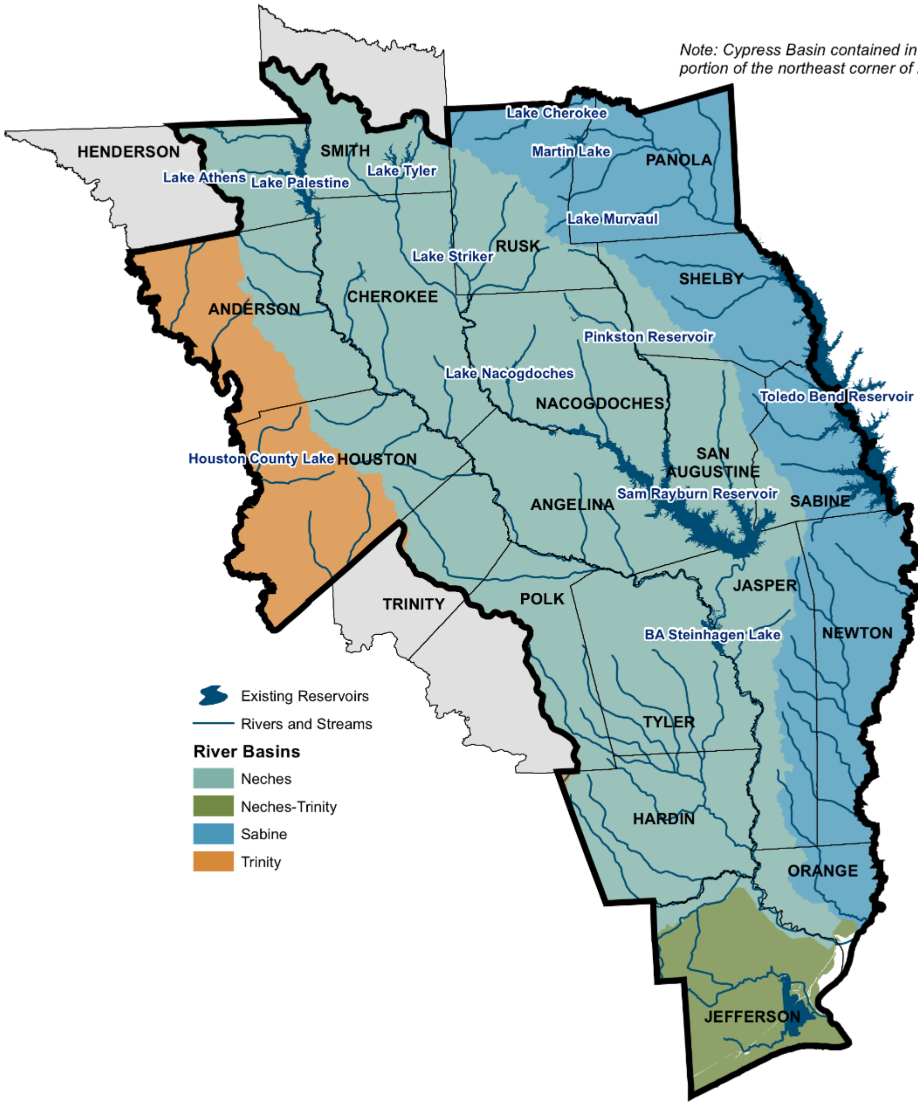

Figure 1.11 Surface Water Sources

SOURCE: TEXAS WATER DEVELOPMENT BOARD & U.S. CENSUS BUREAU

Reservoirs. In the ETRWPA, most surface water is provided by one of fourteen existing water supply reservoirs. Locations of major reservoirs in the region are shown on Figure 1.11. Details regarding these reservoirs are provided in Chapter 3.

Surface water quality in the region varies between water bodies but is generally considered to be very good for water supply purposes. Stream and lake segments with water quality impairments, as identified by the Texas Commission on Environmental Quality (TCEQ), are discussed in Section 1.10 of this chapter. While none of the segments in the region indicate problems as drinking water sources, aquatic life uses, fish consumption, and recreational uses are sometimes not supported in the water bodies.

Fish consumption is the subject of Texas Department of State Health Services advisories in a number of segments, mostly in reservoirs as a result of mercury found in certain species of fish.[10] The mercury concentration in the water is negligible and does not present problems for recreation or water supply.[11, 12]

Even though the water in the reservoirs and streams is usable as a drinking water source, surface water generally requires more extensive treatment than groundwater. This additional treatment for surface water generally includes sedimentation, filtration, and disinfection. Other more advanced treatment methods for surface water are uncommon in the ETRWPA.

Tidal Sources of Surface Water. Salt water intrusion can be a major concern in the tidal reaches of streams. Salt water, being denser than fresh water, tends to settle on the bottom of the channel. The horizontal and vertical extent of the salt water layer varies according to several factors including fresh water inflow and tidal influence.

In the ETRWPA, salt water has become a significant concern for Sabine Lake and the lower reaches of the Neches and Sabine Rivers, since a ship channel between the Gulf of Mexico and Sabine Lake (i.e., the Sabine-Neches Waterway) was dredged around the beginning of the twentieth century. Salt water intrusion, exacerbated by dredging of the Sabine-Neches Waterway, has disqualified the lower segments of the Sabine and Neches Rivers from use as drinking water supplies without addition of advanced treatment to remove salts. There are still some industrial uses, including cooling, that may be available.

At times of low flow in the rivers, the 0.5 parts per thousand (ppt) isohaline (the dividing line between "freshwater" and "saltwater") moves upstream; conversely, at times of high flow in the rivers, the 0.5 ppt isohaline moves downstream. Upstream saltwater encroachment can adversely affect freshwater habitat and the suitability of water quality for water supply purposes.

In line with the recommendations of the 1997 State Water Plan, the Neches River Salt Water Barrier has been constructed at a location north of Beaumont below the confluence of the Neches River and Pine Island Bayou. The project, completed in 2003, prevents saltwater from reaching the freshwater intakes of Lower Neches River cities, industries, and farms during periods of low flow. The project is a gated structure, allowing adjustment to prevent saltwater intrusion while maintaining flows. It is also equipped with a gated navigation channel to enable the passage of watercraft around the barrier.

Pollution from industrial discharges was historically a major concern in the tidal areas of the lower Neches and Sabine Rivers. However, largely due to strengthened environmental regulation and to increased environmental awareness, industries in the region have made significant improvements to the quality of their effluent discharges.

1.3.4 Reuse

Reuse of effluent from wastewater treatment plants (i.e., water reuse) is another water source for the region, but the current use of reuse supplies in the ETRWPA is small as compared to groundwater and surface water supplies. Water reuse supplies are assessed based on historical and current use and total approximately 14,000 ac-ft per year during the planning period. Currently, reuse is used only for non-potable applications by Manufacturing and Irrigation industries. Additional discussion of water reuse in the ETRWPA is found in Chapter 3.

1.3.5 Special Water Resources

Special water resources are defined by the Texas Administrative Code as surface water resources where the water rights are owned in whole or in part by an entity in another region, water supply contract, or existing water supply option agreement results in water from the surface water resource being supplied to an entity in another regional water planning area. Special water resources within the ETRWPA include Lake Athens, Lake Cherokee, and Lake Palestine.

Planning for these resources was coordinated with water rights holders and regions where the water is currently being used or planned to be used. Water plan development considered special water resources in the ETRWPA in order to protect the water rights, water supply contracts, and water supply option agreements associated with the special water resources to ensure that water supplies obligated to meet demands outside the ETRWPA are not adversely impacted.

1.3.6 Threats and Constraints on Water Supply

Water supplies in the ETRWPA may be threatened by conditions outside of the region. Some significant potential threats and constraints are discussed following. A more detailed discussion of potential threats to water supplies may be found in Chapter 3.

Interstate Allocation. The allocation of water in the Sabine River Basin between Texas and Louisiana is a vital factor in any water study involving the Texas portion of the basin. As noted earlier, the river forms the state line for the downstream half of its length after heading in Texas far from the state line. Almost the entire basin upstream from the state line is in Texas. However, Texas does not have completely unrestricted access to the water in the basin because of allocation restrictions with Louisiana.

The Sabine River Compact, executed in 1953, provides for allotment of the water between Texas and Louisiana.[13] This agreement was not only ratified by the two state legislatures but also approved by Congress.

Texas has unrestricted access to the water in the upper reach of the river except for the requirement of a minimum flow of 36 cfs at the junction between the river and the state line. Texas may construct reservoirs in the upper reach and use their water either there or in the downstream reach without loss of ownership.

Any reservoir constructed on the downstream reach must be approved by both states. The ownership, operating cost, and water yield are proportional to the portions of the construction cost paid by the two states. To date, Toledo Bend is the only reservoir constructed in the lower reach. In the case of Toledo Bend, the states split the cost equally and have equal ownership of the lake and its yield.

Any unappropriated water in the lower reach (not contained in or released from a reservoir) is divided equally between the two states. Since Toledo Bend extends to a point upstream from the junction of the river and the state line, the only water in that category is the water entering the river downstream from the dam.

The water in any reservoir on a tributary to the downstream reach can be used in the state where it is located, but that usage comes out of the state's share of the water in the river.

Inter-region Diversions. The City of Dallas (Region C) has contractual rights to 114,337 acre-feet of water from Lake Palestine in the Neches basin. The City does not presently have the facilities to transport and treat the water but anticipates the required construction to be complete by 2030. A long-range potential strategy to transfer water from Toledo Bend Reservoir to reservoirs located in Region C is under consideration.

Interception in Other Regions. It should be noted that large portions of the Sabine and Trinity basins are located upstream from the ETRWPA, as well as a small portion of the Neches basin. The upper Trinity basin includes the Dallas-Fort Worth area and falls within Region C and Region H to a large extent. The upper Sabine basin falls within both Region C and Region D and contains numerous medium sized cities as well as smaller communities east of the Dallas-Fort Worth area. Large amounts of surface water are already being used by the upstream communities, and this usage can be expected to increase dramatically in the future along with population growth. The Sabine River Authority of Texas (SRA) has contracts to provide over 300,000 ac-ft per year to the Dallas area from reservoirs in the upper Sabine basin.

1.4 Water User Groups and Major Water Providers

Water User Groups. Previous rounds of regional water planning have used city populations to calculate water usage in gallons per capita daily (GPCD); however, in this round of regional water planning, 31 TAC §357.30 includes a new utility-based definition for WUGs as follows that uses utility service area populations to calculate GPCD:

Water User Group (WUG) – Identified user or group of users for which Water Demands and Existing Water Supplies have been identified and analyzed and plans developed to meet Water Needs. These include:

> *(A) Privately-owned utilities that provide an average of more than 100 acre-feet per year for municipal use for all owned water systems;*
>
> *(B) Water systems serving institutions or facilities owned by the state or federal government that provide more than 100 acre-feet per year for municipal use;*
>
> *(C) All other Retail Public Utilities not covered in subparagraphs (A) and (B) of this paragraph that provide more than 100 acre-feet per year for municipal use;*
>
> *(D) Collective Reporting Units, or groups of Retail Public Utilities that have a common association and are requested for inclusion by the RWPG;*
>
> *(E) Municipal and domestic water use, referred to as County-Other, not included in subparagraphs (A) - (D) of this paragraph; and*
>
> *(F) Non-municipal water use including manufacturing, irrigation, steam electric power generation, mining, and livestock watering for each county or portion of a county in an RWPA.*

This change in definition resulted in 12 municipal WUG designations that were aggregated into County-Other and 64 municipal WUGs that were separated out of County-Other compared to the 2016 Regional Water Plan (2016 Plan).

WUGs in the 2021 Plan fall into one of six water use categories: Municipal; Manufacturing; Mining; Steam Electric Power; Livestock; and Irrigation. The ETRWPA has 194 municipal WUGs and 84 non-municipal WUGs. Water demands and supplies associated with each WUG are described in detail in Chapters 2 and 3, respectively.

Major Water Providers. WUGs either have direct access to water supplies or they purchase wholesale water from a Wholesale Water Provider (WWP). In this round of planning, the definition for a WWP was updated to the following:

Wholesale Water Provider (WWP) – Any person or entity, including river authorities and irrigation districts, that delivers or sells water wholesale (treated or raw) to WUGs or other WWPs or that the RWPG expects or recommends to deliver or sell water wholesale to WUGs or other WWPs during the period covered by the plan. The RWPGs shall identify the WWPs within each region to be evaluated for plan development.

In previous regional water plans, all demand and water supply data were presented in the plan summarized by WUGs and WWPs. However, in addition to the change in WWP designation outlined above, the designation of a Major Water Provider (MWP) was added to the regional water planning process intended to be a subset of WUGs and/or WWPs in the ETRWPA as identified by the RWPG to be of particular significance to the region's water supply. Throughout this plan, entities are discussed with data summarized by WUG, WWP, or MWP as required by recent rule changes.

Major Water Provider (MWP) – A water user group or a wholesale water provider of particular significance to the region's water supply as determined by the regional water planning group. This may include public or private entities that provide water for any water use category.

The RWPG discussed the designations for WWPs and MWPs in the ETRWPA and determined that all WWPs included in the 2016 Plan shall receive the designation of WWP and MWP in the 2021 Plan and include:

- Angelina and Neches River Authority
- Angelina-Nacogdoches Water Control & Improvement District No. 1
- Athens Municipal Water Authority
- City of Beaumont
- City of Carthage
- City of Center
- City of Jacksonville
- City of Lufkin
- City of Nacogdoches
- City of Port Arthur
- City of Tyler
- Houston County Water Control & Improvement District No. 1
- Lower Neches Valley Authority
- Panola County Freshwater Supply District No. 1
- Sabine River Authority of Texas
- Upper Neches River Municipal Water Authority

1.5 Agricultural and Natural Resources

For the purposes of this discussion, the ETRWPA's agricultural resources are defined as prime farmland. Natural resources within the ETRWPA include timber, wetlands, estuaries, endangered or threatened species, ecologically significant streams, springs, and state or federal parkland and preserves. Other natural resources include oil, natural gas, sand and gravel, lignite, salt, and clay. Various major natural resources are described in the following subsections.

1.5.1 Prime Farmland

Prime farmland is defined by the National Resources Conservation Service (NRCS) as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses."[14] As part of the National Resources Inventory, the NRCS has identified prime farmland throughout the country.

Figure 1.12 shows the distribution of prime farmland in the ETRWPA. Each color in this figure represents the percentage of prime farmland of any type. There are four categories of prime farmland in the NRCS State Soil Geographic Database for Texas: prime farmland, prime farmland if drained, prime farmland if protected from flooding or not frequently flooded during the growing season, and prime farmland where irrigated. Most counties in the region have significant prime farmland areas.

Table 1.4 shows the U.S. Department of Agriculture (USDA) 2017 agriculture statistics for the counties in the ETRWPA [15] (portions of Henderson, Smith, Polk, and Trinity counties are located in other Regions). The following general statements may be made regarding the region:[15]

- From 2012 to 2017, the total acres of farmland decreased by 6.3% while the total acres of crop land decreased by 5.9%.
- In any one year, approximately 20% of farmland is crop land.
- In any one year, approximately 63% of crop land is harvested.
- Excluding Jefferson County, approximately 3% of crop land is irrigated. In Jefferson County, approximately 18% of crop land is irrigated.
- Poultry production generates the largest agricultural product sales in Nacogdoches, Panola, San Augustine, and Shelby counties.
- Cattle and calf production generate the largest agricultural product sales in Henderson, Houston, and Smith counties.

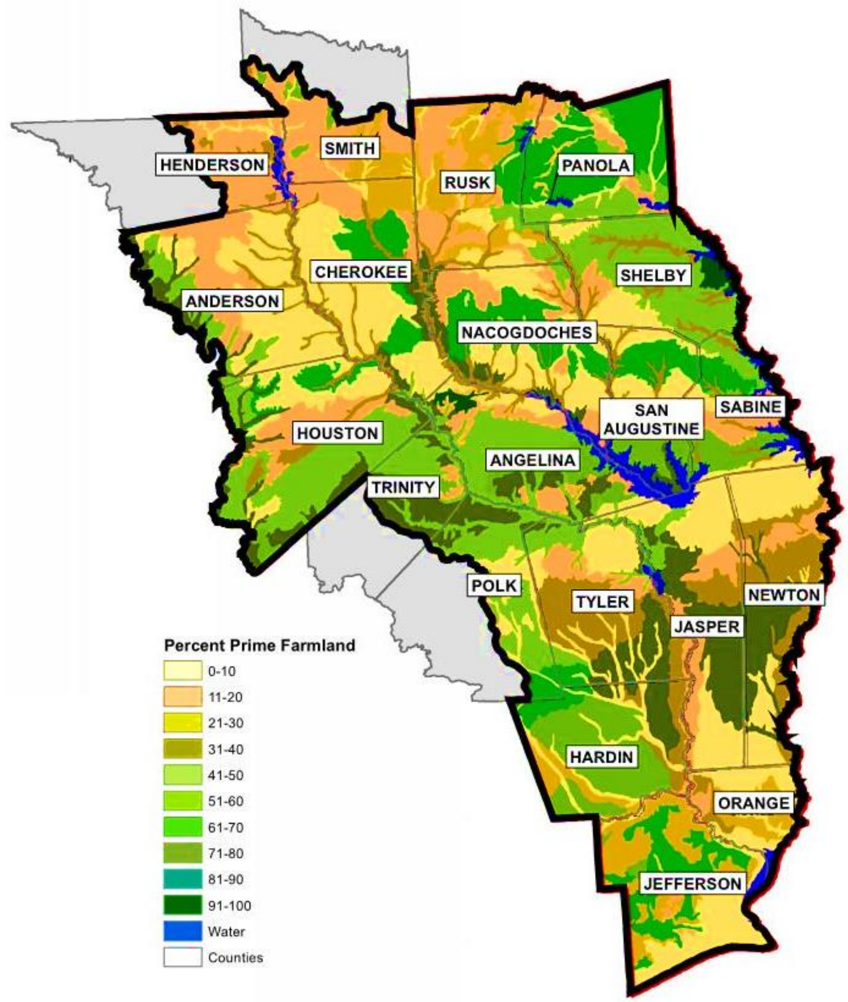

Figure 1.12 Percent Prime Farmland

SOURCE: TEXAS WATER DEVELOPMENT BOARD 2011 REGIONAL WATER PLAN

Table 1.4 U.S. Department of Agriculture 2017 Agricultural Statistics [15]

Category	Anderson	Angelina	Cherokee	Hardin	Henderson
Farms	1,754	1,028	1,587	661	1,988
Total Farmland (acres)	400,571	103,947	275,568	65,087	310,355
Crop Land (acres)	63,774	21,632	58,303	13,124	86,645
Harvested Crop Land (acres)	52,601	15,104	43,860	8,606	58,826
Irrigated Crop Land (acres)	3,089	453	978	1,081	1,614
Market Value Crops ($1,000)	15,551	2,594	66,491	2,366	11,645
Market Value Livestock ($1,000)	77,392	58,815	49,201	2,328	28,538
Total Market Value ($1,000)	92,943	61,409	115,692	4,694	40,183
Livestock and Poultry:					
Cattle and Calves Inventory	65,048	19,274	19,274	8,005	59,076
Hogs and Pigs Inventory	(D)	147	118	582	652
Sheep and Lambs Inventory	412	291	322	302	555
Layers and Pullets Inventory	3,494	2,597	2,992	3,446	6,051
Broilers and Meat-Type Chickens Sold	6,198,444	14,977,816	6,373,832	(D)	74
Crops Harvested (acres):					
Corn for Grain or Seed	2,416	0	0	5	18
Cotton	(D)	0	0	0	0
Rice	0	0	0	(D)	0
Sorghum for Grain or Seed	0	0	0	0	0
Soybeans for beans	0	0	0	(D)	(D)
Wheat for Grain	0	0	0	0	(D)

Category	Houston	Jasper	Jefferson	Nacogdoches	Newton
Farms	1,422	896	729	1,123	430
Total Farmland (acres)	394,543	91,437	358,934	264,750	58,793
Crop Land (acres)	70,772	13,375	137,267	29,502	5,484
Harvested Crop Land (acres)	44,044	10,743	38,047	20,450	4,105
Irrigated Crop Land (acres)	3,522	305	24,885	313	57
Market Value Crops ($1,000)	6,802	4,007	17,688	3,156	485
Market Value Livestock ($1,000)	57,716	5,132	14,629	367,586	1,102
Total Market Value ($1,000)	64,518	9,139	32,317	370,742	1,587
Livestock and Poultry:					
Cattle and Calves Inventory	68,987	14,268	37,189	34,172	4,212
Hogs and Pigs Inventory	4,762	259	511	48	177
Sheep and Lambs Inventory	1,781	372	340	198	266
Layers and Pullets Inventory	(D)	4,123	3,957	279,527	1,855
Broilers and Meat-Type Chickens Sold	7,160,115	(D)	66	84,656,731	51
Crops Harvested (acres):					
Corn for Grain or Seed	(D)	17	0	(D)	29
Cotton	(D)	0	0	0	0
Rice	0	0	20,698	0	0
Sorghum for Grain or Seed	0	0	(D)	0	0
Soybeans for beans	0	0	0	0	0
Wheat for Grain	0	0	(D)	(D)	0

Table 1.4 USDA 2017 Agricultural Statistics [15] (Cont.)

Category	Orange	Panola	Polk	Rusk	Sabine
Farms	663	978	742	1,441	200
Total Farmland (acres)	52,912	205,961	125,133	242,767	38,304
Crop Land (acres)	4,685	39,766	22,586	46,094	5,553
Harvested Crop Land (acres)	2,861	27,156	15,207	29,841	3,332
Irrigated Crop Land (acres)	342	781	281	530	56
Market Value Crops ($1,000)	1,489	4,626	2,291	5,956	450
Market Value Livestock ($1,000)	3,478	96,094	4,540	94,201	17,265
Total Market Value ($1,000)	4,967	100,720	6,831	100,157	17,715
Livestock and Poultry:					
Cattle and Calves Inventory	9,839	31,045	13,135	40,801	11,525
Hogs and Pigs Inventory	450	581	103	370	87
Sheep and Lambs Inventory	366	270	61	272	-
Layers and Pullets Inventory	8,630	1,388	1,885	25,945	359
Broilers and Meat-Type Chickens Sold	1,810	24,393,040	(D)	21,637,138	(D)
Crops Harvested (acres):					
Corn for Grain or Seed	6	(D)	14	26	(D)
Cotton	0	0	0	0	0
Rice	0	0	0	0	0
Sorghum for Grain or Seed	0	0	0	0	0
Soybeans for beans	0	(D)	0	0	0
Wheat for Grain	0	0	106	0	0
Category	**San Augustine**	**Shelby**	**Smith**	**Trinity**	**Tyler**
Farms	293	995	2,928	601	778
Total Farmland (acres)	61,806	179,084	271,765	98,887	91,143
Crop Land (acres)	9,196	28,551	64,308	20,051	18,847
Harvested Crop Land (acres)	7,177	20,457	49,260	13,138	13,398
Irrigated Crop Land (acres)	40	383	1,932	266	794
Market Value Crops ($1,000)	1,296	2,837	36,759	2,108	9,643
Market Value Livestock ($1,000)	55,380	464,720	16,846	6,120	5,243
Total Market Value ($1,000)	56,676	467,557	53,605	8,228	14,886
Livestock and Poultry:					
Cattle and Calves Inventory	9,853	43,354	43,874	19,464	14,052
Hogs and Pigs Inventory	153	193	559	627	351
Sheep and Lambs Inventory	39	329	1,255	27	381
Layers and Pullets Inventory	125,933	1,238,783	12,602	2,372	4,061
Broilers and Meat-Type Chickens Sold	13,552,362	103,631,416	959	(D)	295
Crops Harvested (acres):					
Corn for Grain or Seed	13	(D)	18	(D)	0
Cotton	0	0	0	0	0
Rice	0	0	0	0	0
Sorghum for Grain or Seed	0	(D)	0	0	0
Soybeans for beans	0	(D)	0	0	0
Wheat for Grain	(D)	0	(D)	0	0

Table 1.4 USDA 2017 Agricultural Statistics [15] (Cont.)

TOTALS FOR ALL COUNTIES:		SPECIAL FOR JEFFERSON COUNTY:	
Total Farmland (acres)	3,691,747	Irrigated / Total Crop Land (%)	18.13%
Crop Land (acres)	759,515		
Crop Land / Total Farmland (%)	20.57%	**COUNTIES OTHER THAN JEFFERSON:**	
Harvested Crop Land (acres)	478,213	Irrigated Crop Land (acres)	16,817
Harvested / Total Crop Land (%)	62.96%	Irrigated / Total Crop Land (%)	2.70%
Irrigated Crop Land (acres)	41,702	(D) – Withheld to avoid disclosing data for individual farms	
Irrigated / Total Crop Land (%)	5.49%		

SOURCE: U.S. DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURAL STATISTICS SERVICE

1.5.2 Forest Products and Timberland Ecosystem Services

Some of the primary wood products produced from the timberlands in the ETRWPA include solid wood (sawtimber and chip-n-saw), engineered products (plywood, oriented strandboard, particleboard, and cross-laminated panels and timbers), fiber products (paper and fiberboard), and woody biomass (wood pellets, bioenergy, and mulch). According to the Texas A&M Forest Service, there are over 60 million acres of forestland in Texas but only about 23% of that is productive timberland. About 85% of this productive timberland is in East Texas.[16] In spite of rapid urbanization particularly in southeast Texas, overall forest acreage has slightly increased in the region due to conversion of marginal agricultural lands to forest over the past couple of decades. In terms of economic value, timber is the ninth most valuable agricultural commodity in Texas. In 2015, the forest industry contributed $18.3 billion to the Texas economy employing over 66,000 people with a payroll of $3.7 billion.[17] This resource is being sustainably managed, with overall growth rates exceeding removals since the 1980s and pine growth in particular being about 30% above removals. The total volumes of timber harvests declined by 15% from 2007 to 2015 due to lower economic activity in the housing market. This indicates that there is good potential for additional development of this resource through future wood processing facilities in the region. Other economic and environmental benefits to the ETRWPA provided by timberlands and forests include water quality protection, fish and wildlife management, carbon sequestration, and recreational opportunities. For water quality protection, Texas has a nationally recognized forestry best management practices (BMP) program for water quality management from forest operations. These voluntary forestry water quality BMPs have about a 94% compliance rate and have been shown to be very effective in minimizing potential water quality degradation from forest management activities like clearcutting and forest regeneration.[18] About 92% of the forestland in East Texas is privately owned but numerous national and state parks and forests exist including the Angelina National Forest, Big Thicket National Preserve, Davy Crockett National Forest, and Sabine National Forest among others. These areas have an abundance of scenic pine and hardwood forests with numerous public hiking trails, paddling trails, and campgrounds. Figure 1.13 shows the ETRWPA compared to the Texas A&M Forest Service's East Texas region.

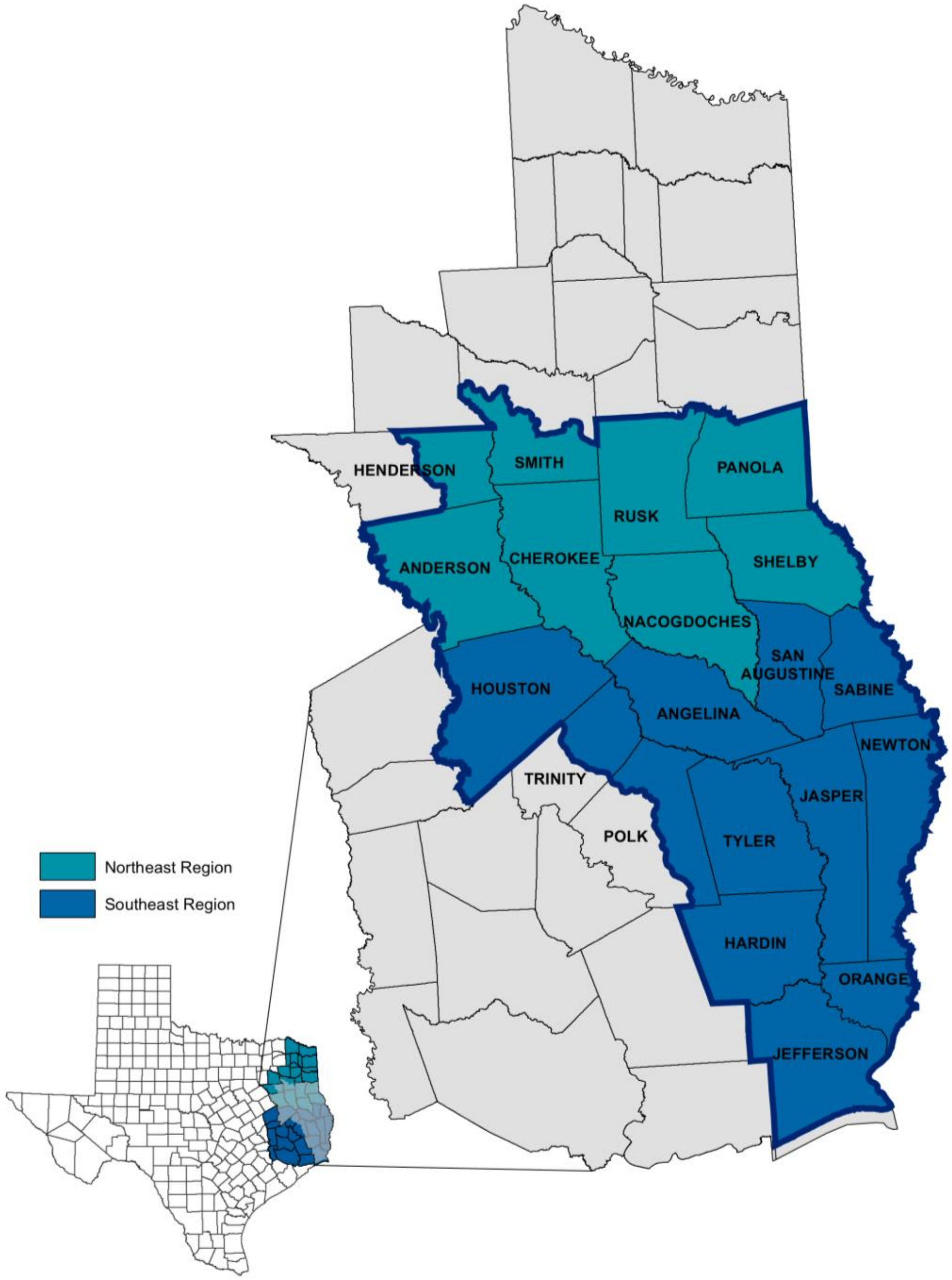

Figure 1.13 Texas A&M Forest Service Northeast and Southeast Regions

SOURCE: TEXAS A&M FOREST SERVICE, 2015

1.5.3 Wetlands

Wetlands are areas characterized by a degree of flooding or soil saturation, hydric soils, and plants adapted to growing in water or hydric soils.[19] Wetlands are beneficial in several ways; they provide flood attenuation, bank stabilization, water-quality maintenance, fish and wildlife habitat, and opportunities for hunting, fishing, and other recreational activities.[19] There are significant wetland resources in the region, especially near rivers, lakes, and reservoirs.

Texas wetlands types and characteristics are summarized in Table 1.5. Most Texas wetlands are palustrine bottomland hardwood forests and swamps, and most of the State's palustrine wetlands are located in the flood plains of East Texas rivers.[19] Table 1.6 shows the bottomland hardwood acreage associated with the four major rivers in the region.

The TPWD, in a study of natural resources in Smith, Cherokee, Rusk, Nacogdoches, and Angelina counties,[20] found the most extensive wetlands in the study area were water oak-willow and oak-blackgum forests along the Neches, Angelina, and Sabine Rivers. In the same study, TPWD noted the presence of a significant bald cypress-water tupelo swamp along the Neches River in Angelina County.[20] The TPWD identified specific stream segments in the region that they classify as being priority bottomland hardwood habitat.[10]

Table 1.5 Texas Wetland Types and Characteristics

Wetland Classifications	Definition	Vegetation / Habitat Types
Palustrine	Freshwater vegetated wetlands and intermittently or permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet deep, and salinity due to ocean-derived salts always is always less than 0.5 parts per thousand (ppt).	Predominantly trees; shrubs; emergent, rooted herbaceous plants; or submersed/floating plants.
Estuarine	Deep-water tidal habitats and adjacent tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 ppt and is variable due to evaporation and mixing of freshwater and seawater.	Emergent plants; intertidal unvegetated mud or sand flats and bars; estuarine shrubs; subtidal open water bays (deep water habitat).
Lacustrine	Wetlands and deep-water habitats with all of the following characteristics: situated in a topographical depression or in a dammed river channel; lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; total area exceeds 20 acres unless water depth at the deepest point exceeds 6.6 feet or active wave-formed or bedrock shoreline makes up all or part of the boundary; ocean-derived salinity is always less than 0.5 ppt.	Nonpersistent emergent plants, submersed plants, and floating plants.
Riverine	All freshwater wetlands and deep water habitats contained within a channel, with two exceptions: wetlands dominated by trees, shrubs, persistent, emergent mosses, or lichens, and habitats with salinity greater than 0.5 ppt.	Nonpersistent emergent plants, submersed plants, and floating plants.
Marine	Tidal wetlands that are exposed to waves and currents of the Gulf of Mexico and to water having salinity greater than 30 ppt.	Intertidal beaches, subtidal open water (deep water habitat).

SOURCE: U.S. GEOLOGICAL SURVEY [21]

Table 1.6 1980 Geographical Distribution of Bottomland Hardwood Associated with Selected Rivers

River	Area (acres)	Amount Located in ETRWPA
Trinity River	305,000	Small portion
Neches River	257,000	Almost all
Sabine River	255,000	Approximately half of the Texas portion of the Sabine River Basin is in ETRWPA.
Angelina River	88,000	All

SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT

Section 404 of the Clean Water Act (CWA) mandates that, when impacts to wetlands are unavoidable, the impacts to wetlands must be mitigated by replacing the impacted wetland with a similar type of wetland. Mitigation banking, as defined by the National Mitigation Banking Association, is the restoration, creation, enhancement, or preservation of a wetland, stream, or other habitat area undertaken expressly for the purpose of compensating for unavoidable resource losses in advance of development actions, when such compensation cannot be achieved at the development site or not be as environmentally beneficial. The United States Army Corps of Engineers (USACE) districts and mitigation banks located within the ETRWPA are presented in Figure 1.14. The Blue Elbow Swamp Mitigation Bank, near the mouth of the Sabine River, was established by the Texas Department of Transportation to compensate for future impacts to wetlands.[23]

In the coastal part of the region, palustrine wetlands such as swamps and fresh marshes occupy flood plains and line the shores of tidal freshwater reaches of sluggish coastal rivers.[19] Much of the palustrine wetland area in Jefferson County is farmed for rice growing. Figure 1.15 shows the density of palustrine wetlands in the coastal part of the region. In the U.S. Fish and Wildlife Service (USFWS) study area, palustrine emergent wetlands were most prevalent in Jefferson County, palustrine forested wetlands were most prevalent in Newton, Jasper, Orange, and Hardin counties, and palustrine scrub-shrub was most prevalent in Newton, Jasper, Orange, and Hardin counties. Some concentrations of palustrine shrub wetlands were also found in Jefferson County. Ponds, Freshwater Lakes, Freshwater Forested/Shrub Wetlands, and Freshwater Emergent Wetlands also appear in other counties of the ETRWPA; however, only the coastal area of the ETRWPA is presented in Figure 1.15 because the wetlands in this area are more concentrated and diverse.

Estuarine wetlands such as salt marshes and tidal flats are the next most prevalent type of wetland areas. Estuarine wetlands are very common in the area around Sabine Lake,[22] particularly those dominated by emergent vegetation.

Three other kinds of wetlands cover a smaller area in the region but are ecologically significant:[22] lacustrine, riverine, and marine wetlands. See Table 1.5 above for a detailed description of these types of wetlands.

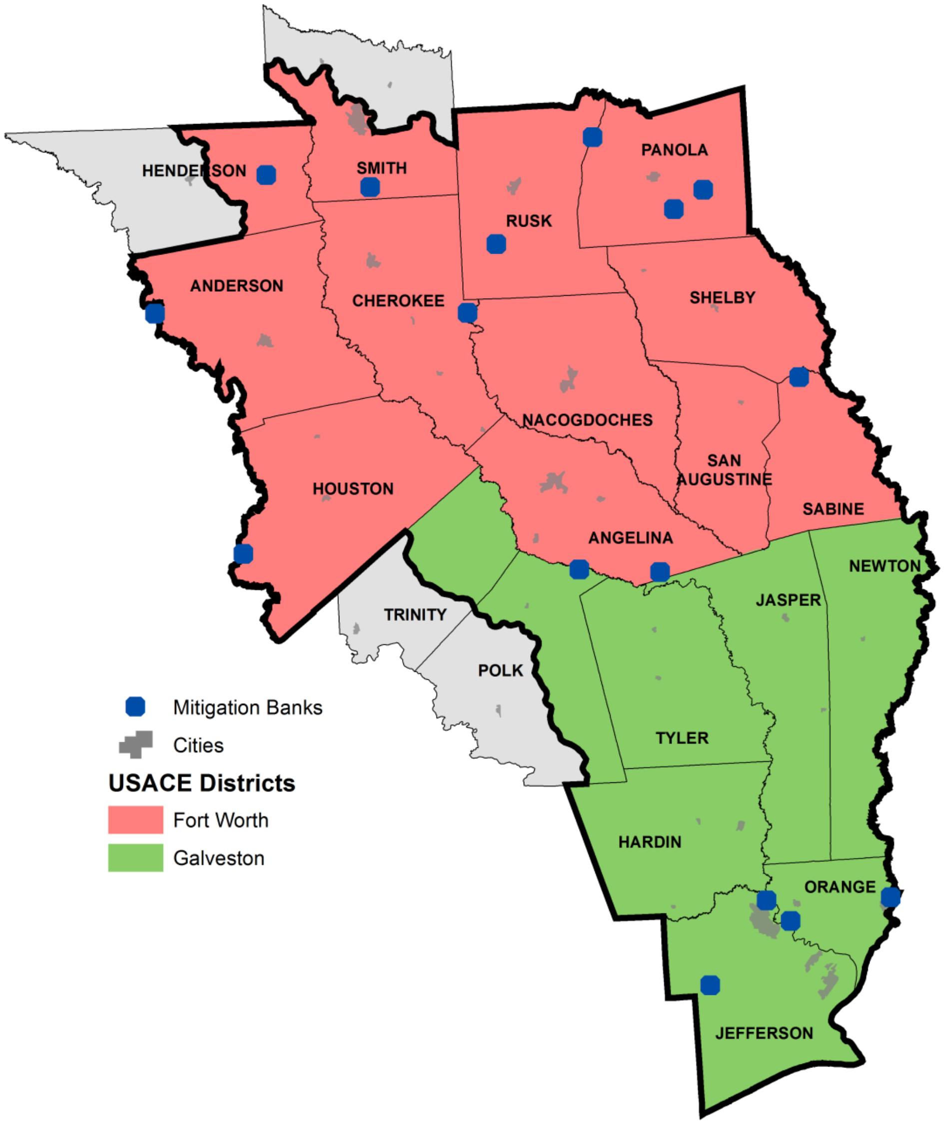

Figure 1.14 Mitigation Banks

SOURCE: U.S. ARMY CORPS OF ENGINEERS

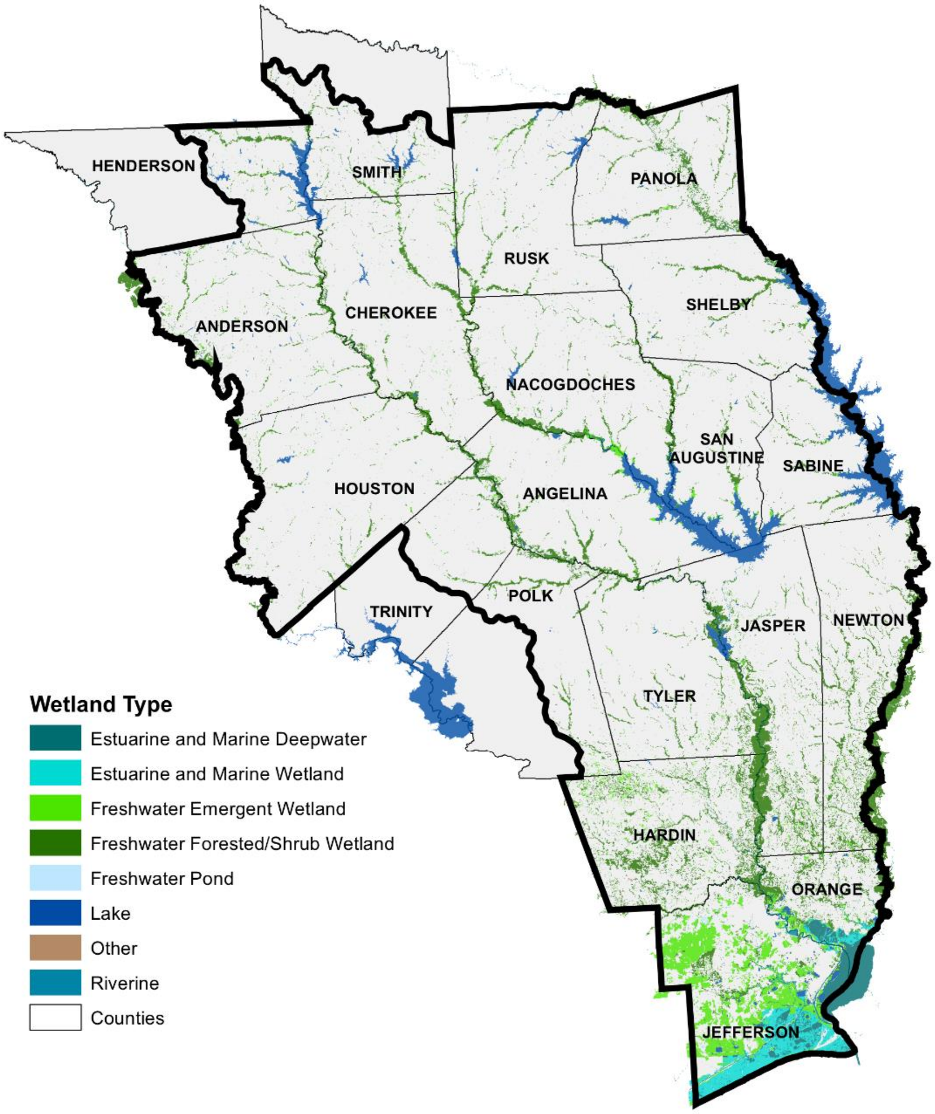

Figure 1.15 Wetland Area

SOURCE: U.S. FISH & WILDLIFE SERVICE

1.5.4 Estuaries

The Sabine-Neches Estuary includes Sabine Lake, the Sabine-Neches and Port Arthur Canals, and Sabine Pass. The Sabine-Neches Estuary covers about 100 square miles. The Neches and Sabine River Basins and part of the Neches-Trinity Coastal Basin contribute freshwater flow to the estuary.[24] The Sabine-Neches Estuary within the ETRWPA is depicted on Figure 1.16.

In the estuary, freshwater from the Sabine and the Neches Rivers meets saltwater from the Gulf of Mexico. Although the estuary is influenced by the tide, it is protected from the full force of Gulf wave action and storms due to its inland location. The Sabine-Neches Estuary is important for fish, shellfish, and wildlife habitat and for sport and commercial fishing.

Sabine Lake is a natural water body located on the Texas-Louisiana border in southeast Texas, approximately seven miles from the Gulf of Mexico. According to SRA, the surface area for the main body of the lake is approximately 54,300 acres. The lake supports an extensive coastal wetland (i.e., salt marsh) system around much of the perimeter. The lake's small volume coupled with large freshwater inflows from the Sabine and Neches Rivers result in a turnover rate of around 50 times per year.

Sabine Lake is hydraulically connected to the Gulf of Mexico via Sabine Pass, a seven-mile long tidal inlet between the Gulf and the southern end of the lake. Historically, Sabine Pass was a narrow, shallow waterway. However, in the latter part of the 19th century, a ship channel (generally known today as the Sabine-Neches Waterway) was dredged in the pass and lake to enable deep-water navigation to inland ports. Over ensuing years, the Sabine-Neches Waterway has been expanded in length, depth, and width, and extended up into the Neches and Sabine Rivers.

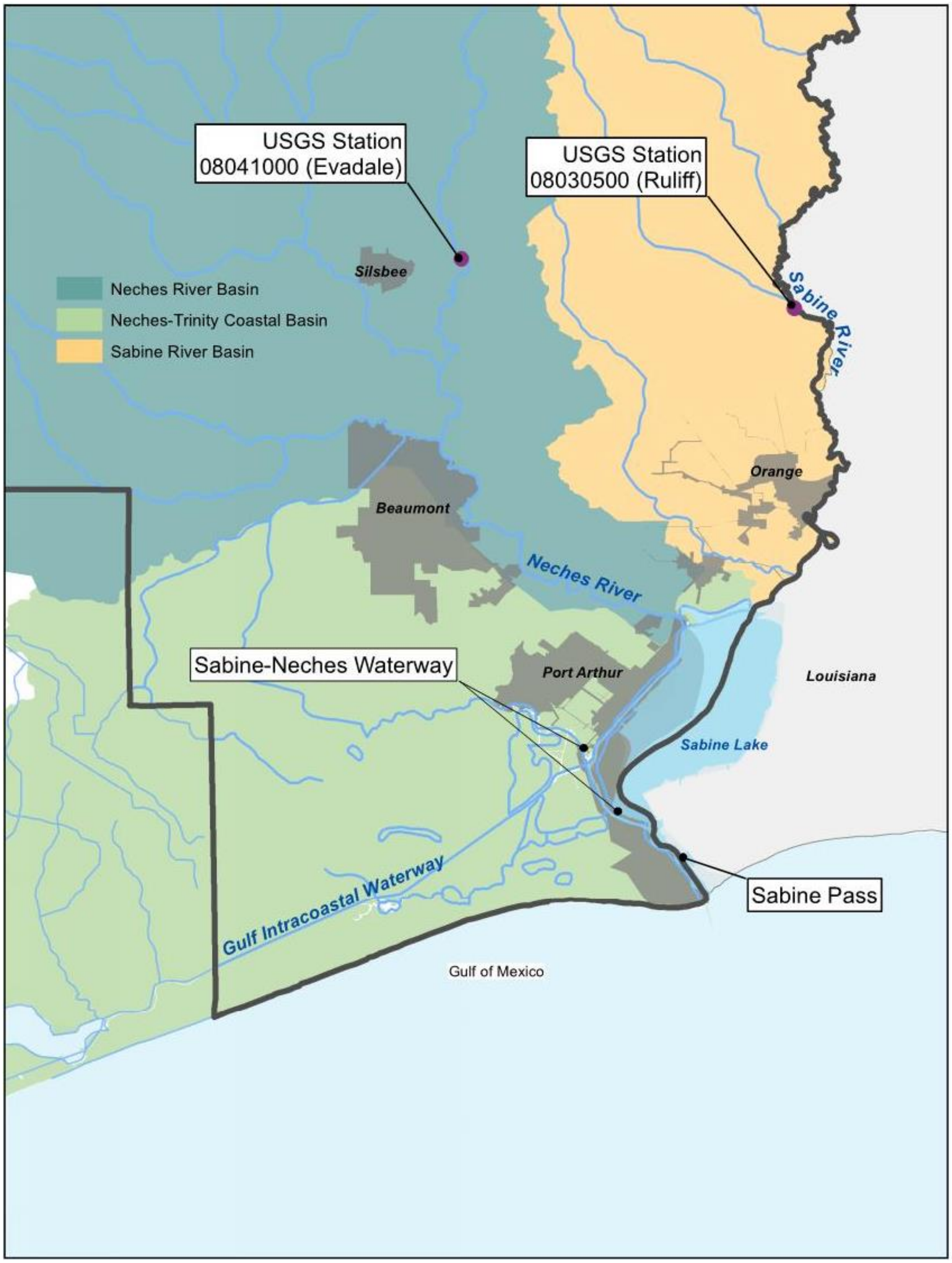

Figure 1.16 Sabine Lake Estuary and Vicinity

SOURCE: TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Today, the Sabine-Neches Waterway extends from the Gulf of Mexico to Port Arthur on the western shore of Sabine Lake; to Beaumont upstream on the Neches River; and to Orange, upstream on the Sabine River. The waterway is some 400 feet wide and 40 feet deep. In 2014, the U.S. House of Representatives passed the Water Resources Reform and Development Act, H.R. 3080, authorizing 34 water projects including the widening of the Sabine-Neches Waterway. The expansion could deepen the channel to 48 feet and widen it to as much as 700 feet.

1.5.5 Rare, Threatened and Endangered Species

In 2019, the TPWD identified rare, threatened, and endangered species of the region (See Appendix 1-A). Included are 14 species of birds, 11 insects, 22 mammals, 24 reptiles/amphibians, 16 fish, six mollusks, 55 vascular plants, and three crustaceans. These species are listed as rare, threatened, or endangered at the state level or have limited range within the state. The TPWD maintains a list of species of special concern in the Texas Natural Diversity Database.

1.5.6 Ecologically Significant River and Stream Segments

In each river basin in Texas, the TPWD has identified stream segments that it classifies as being ecologically unique.[25] Stream segments have been placed on this list because they have met criteria based on factors related to biological function, hydrologic function, presence of riparian conservation areas, high water quality/exceptional aquatic life/high aesthetic value, and threatened or endangered species/unique communities. Table 1.7 lists stream segments within the ETRWPA, meeting one or more of the criteria. Figure 1.17 shows geographically where the stream segments are located. Additional discussion of ecological significant stream segments in the ETRWPA is found in Chapter 8.

1.5.7 State and Federal Parks, Management Areas, and Preserves

The state and federal governments own and operate a number of parks, management areas, and preserves in the Region. Table 1.8 summarizes these facilities.

Table 1.7 Texas Parks and Wildlife Department Ecologically Significant Segments in East Texas

River or Stream Segment	Biological Function	Hydrologic Function	Riparian Conservation Area	High Water Quality/ Aesthetic Value	Endangered Species/ Unique Communities	Total Number of Criteria Met
Alabama Creek			•			1
Alazan Bayou	•		•		•	3
Upper Angelina River	•		•		•	3
Lower Angelina River	•		•		•	3
Attoyac Bayou					•	1
Austin Branch			•			1
Beech Creek			•	•		2
Big Cypress Creek				•		1
Big Hill Bayou	•		•			2
Big Sandy Creek	•		•	•	•	4
Bowles Creek			•			1
Camp Creek			•		•	2
Catfish Creek			•	•	•	3
Cochino Bayou			•			1
Hackberry Creek			•		•	2
Hager Creek			•			1
Hickory Creek			•			1
Hillebrandt Bayou			•			1
Irons Bayou				•		1
Little Pine Island Bayou			•			1
Lynch Creek			•		•	2
Menard Creek			•			1
Mud Creek	•				•	2
Upper Neches River	•		•	•	•	4
Lower Neches River	•		•	•	•	4
Pine Island Bayou			•			1
Piney Creek			•	•	•	3
Upper Sabine River	•			•	•	3
Middle Sabine River	•			•		2
Lower Sabine River	•		•			2
Salt Bayou	•		•			2
San Pedro Creek			•			1
Sandy Creek (Trinity Co.)			•		•	2
Sandy Creek (Shelby Co.)					•	1
Taylor Bayou			•			2
Texas Bayou			•			1
Trinity River	•		•		•	3
Trout Creek			•			1
Turkey Creek			•			1
Village Creek	•		•	•	•	4
White Oak Creek				•		1

SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT

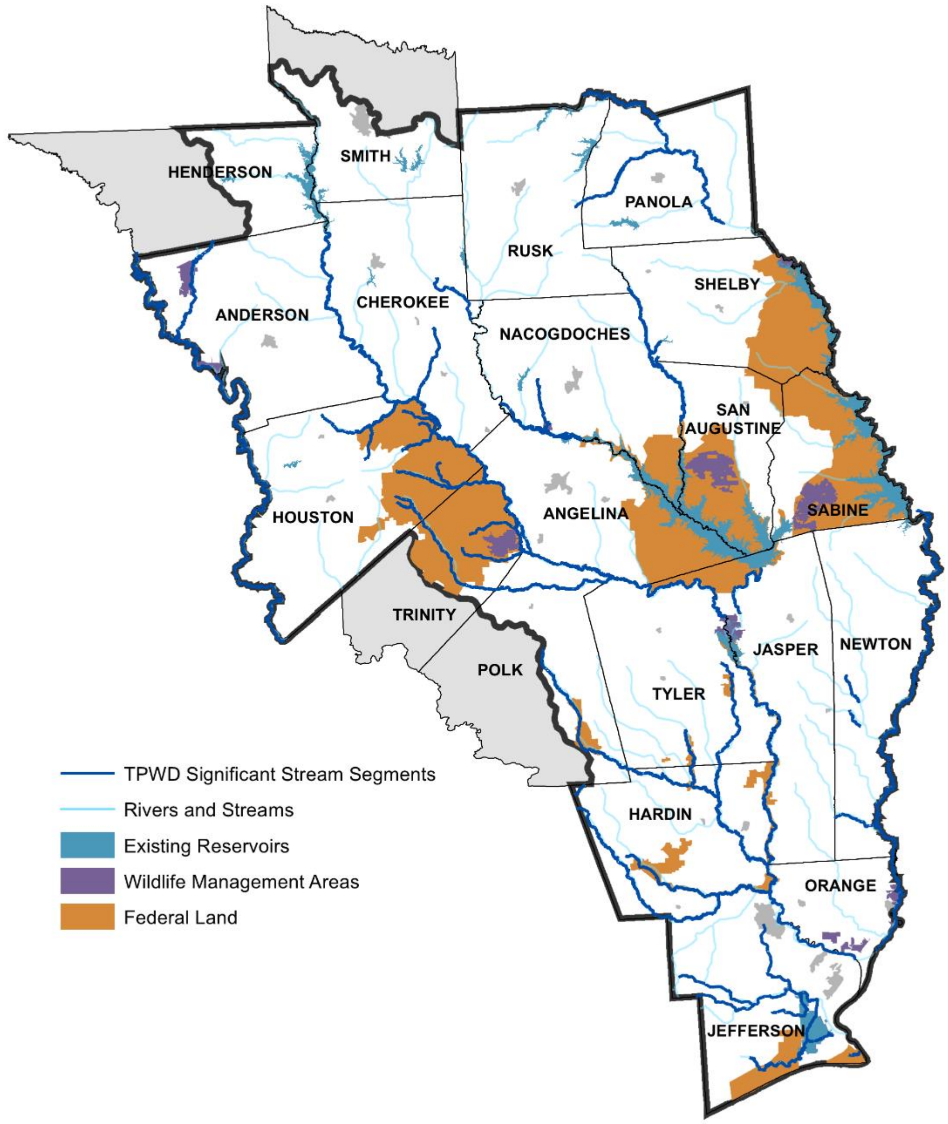

Figure 1.17 Ecologically Significant Stream Segments

SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT

Table 1.8 State and Federal Parks, Management Areas, and Preserves

Owner/Operator	Name	County
Texas Parks and Wildlife Department	Martin Creek Lake State Park	Rusk
	Rusk/Palestine State Park	Cherokee and Anderson
	Mission Tejas State Park	Houston
	Martin Dies Jr. State Park	Jasper and Tyler
	Village Creek State Park	Hardin
	Sea Rim State Park	Jefferson
	Gus Engeling Wildlife Management Area	Anderson
	Big Lake Bottom Wildlife Management Area	Anderson
	North Toledo Bend Wildlife Management Area	Shelby
	Bannister Wildlife Management Area	San Augustine
	Moore Plantation Wildlife Management Area	Sabine and Jasper
	Angelina Neches/Dam B. Wildlife Management Area	Jasper and Tyler
	Lower Neches Wildlife Management Area	Orange
	Tony Houseman Wildlife Management Area	Orange
	J.D. Murphree Wildlife Management Area	Jefferson
	Alabama Creek Wildlife Management Area	Trinity
	Alazan Bayou Wildlife Management Area	Nacogdoches
	East Texas Conservation Center	Jasper
Texas Forest Service	E.O. Siecke State Forest	Newton
	Masterson State Forest	Jasper
	John Henry Kirby Memorial State Forest	Tyler
	I.D. Fairchild State Forest	Cherokee
Texas State Historical Commission	Caddoan Mounds State Historical Park	Cherokee
	Mission Dolores State Historic Site	San Augustine
	Sabine Pass Battleground State Historical Site	Jefferson
U.S. Army Corps of Engineers	Sam Rayburn Reservoir	
	Town Bluff Dam, B.A. Steinhagen Lake	
U.S. Fish and Wildlife Service	Neches National Wildlife Refuge	Anderson, Cherokee
	Texas Point National Wildlife Refuge	Jefferson
	McFaddin National Wildlife Refuge	Jefferson
National Forest Service	Angelina National Forest	San Augustine, Angelina, Jasper, and Nacogdoches
	Davy Crockett National Forest	Houston and Trinity
	Sabine National Forest	Sabine, Shelby, San Augustine, Newton, and Jasper
National Park Service	Big Thicket National Preserve	Polk, Tyler, Jasper, Hardin, Jefferson, and Orange

SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT, TEXAS A&M FOREST SERVICE, TEXAS HISTORICAL COMMISSION, U.S. ARMY CORPS OF ENGINEERS, U.S. FISH AND WILDLIFE SERVICE, U.S. FOREST SERVICE, AND NATIONAL PARK SERVICE

1.5.8 Archeological Resources

The east Texas area, including the ETRWPA, is rich in cultural, historical, and archeological resources. Its abundant water, timber, and other natural resources made it ideal for native American settlement. The eastern portion of Texas was explored and settled early by European cultures. The ETRWPA, from Sabine Pass to the northern extent of the region has been a significant center of Texas historical development over the past two centuries.

Texas Historical Commission maintains the Texas Historic Sites Atlas, a database containing historic county courthouses, National Register properties, historical markers, museums, sawmills, and neighborhood surveys.[26] This database contains a very large amount of data. The Texas Historical Commission does not release information on archeological sites to the general public.

The most prominent archeological site in the ETRWPA is Caddo Mounds State Historic Site, a 94-acre park in Cherokee County west of Alto. This area was the home of Mound Builders of Caddo origin who lived in the region for 500 years beginning about 800 A.D. The site offers exhibits and interpretive trails through its reconstructed sites of Caddo dwellings and ceremonial areas, including two temple mounds, a burial mound, and a village area.[27]

1.5.9 Mineral Resources

Mineral resources include petroleum production and coal mining operations. Various types of mineral resources in the ETRWPA are described below.

Petroleum Production. Oil and natural gas fields are significant natural resources in portions of the region. With the exception of Angelina County, producing oil wells may be found in each county in the region. A portion of the region is located within the Haynesville/Bossier Shale Formation. The Haynesville/Bossier Shale Formation is a hydrocarbon-producing geological formation capable of producing large amounts of gas. There are high densities of producing oil wells in Anderson, Hardin, and Rusk counties and high densities of natural gas wells in Nacogdoches, Panola, and Rusk, counties, with lesser densities in the other counties in the region. The Region I counties which are impacted by the Haynesville/Bossier Shale Formation include Angelina, Nacogdoches, Panola, Rusk, Sabine, San Augustine, and Shelby.

Figure 1.18 and Figure 1.19 depict oil and gas resources in the ETRWPA.[28]

Starting around 2008, the East Texas petroleum industry was revitalized when multi-stage hydraulic fracturing (fracking) and horizontal drilling of the Haynesville/Bossier Shale became technologically and economically feasible. According to the USGS's 2016 assessment, this natural gas field is estimated contain in excess of 304 trillion cubic feet (TCF) of natural gas making it among the largest gas reserves in the lower 48 states.[29] This is an increase of 240 TCF over USGS's 2011 estimate of 61 TCF. An additional 4 billion barrels of oil are estimated to be in the strata associated with this formation.[29] In Region I, Angelina, Nacogdoches, Panola, Rusk, Sabine, San Augustine, and Shelby counties overlie the Haynesville/Bossier Shale. Conventional oil and gas reserves underlie the other counties in the region, with significant well densities in Nacogdoches, Anderson, Cherokee, and Rusk counties. With recent increases in pipelines, refinery capacity, and liquefied natural gas (LNG) export terminals along the Gulf Coast, demands for East Texas oil and gas are predicted to continue to increase over the coming decades.

Concerns have arisen about the large volumes of water used by the petroleum industry, especially during fracking, and the potential degradation of surface and ground water quality in Region I from oil and gas drilling and production. In terms of water use, the total volume of water used during fracking is less than 1% of the total water used in Texas.[30] Furthermore, due to the great depths separating drinking water aquifers and shales undergoing fracking and the improvements in drilling technology, it is unlikely that fracking will degrade Region I's groundwater resources. The movement of fracking fluids into drinking water aquifers has not been observed in Texas.[31] Surface spills and nonpoint stormwater discharges can result in impacts to surface waters when appropriate best management practices are not implemented.[32] However, effective stormwater and spill management practices have been shown to significantly reduce potential impacts from oil and gas development to water resources (McBroom et al., 2012).[33]

Lignite Coal Fields. Figure 1.20 shows lignite coal resources located in the region.[34] The Wilcox Group of potential deep basin lignite (200-2,000 feet in depth) underlies significant portions of Henderson, Smith, Cherokee, Rusk, and Nacogdoches counties. The Jackson-Yegua Group of potential deep basin lignite underlies significant portions of Houston, Trinity, Polk, Angelina, Nacogdoches, San Augustine, and Sabine counties. Finally, bituminous coal underlies a small portion of Polk County in the region.

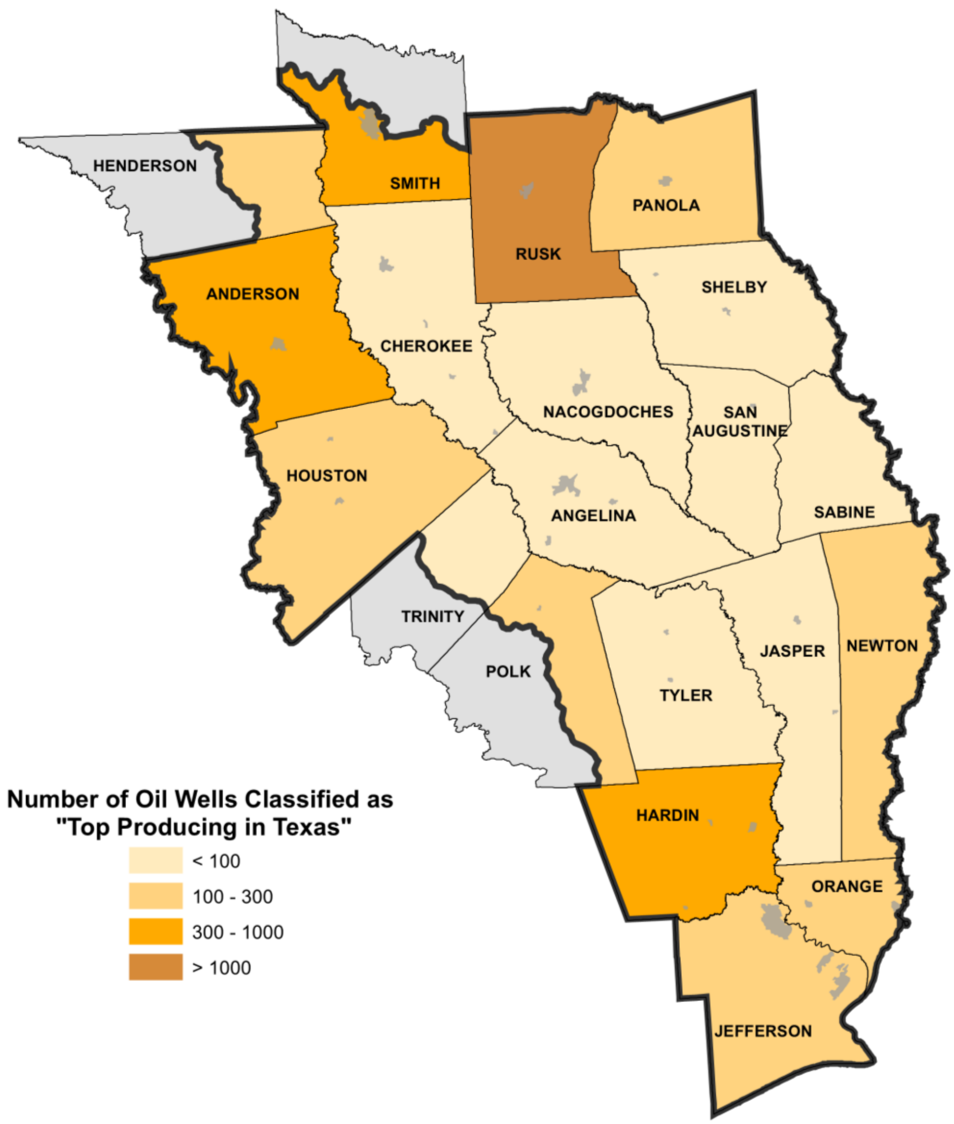

Figure 1.18 Top Producing Oil Wells

SOURCE: RAILROAD COMISSION OF TEXAS, SEPTEMBER 2018

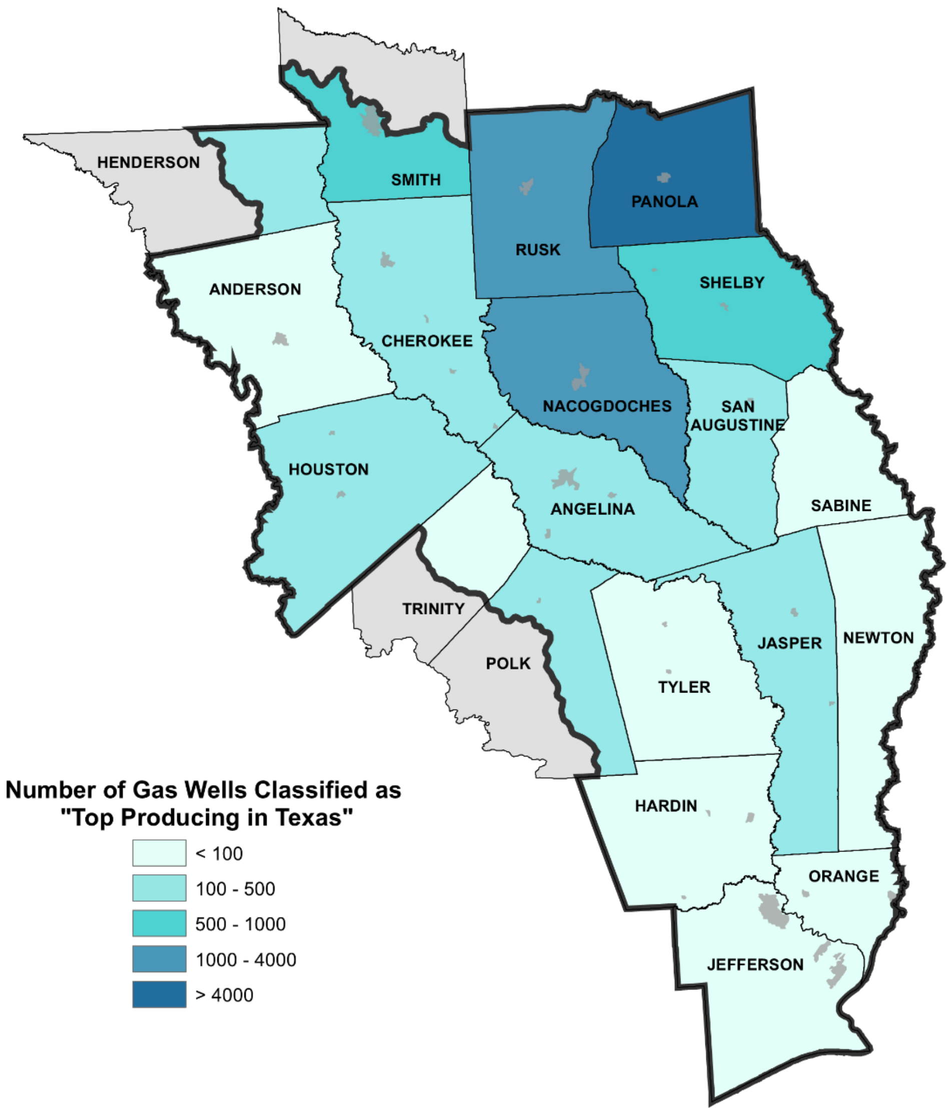

Figure 1.19 Top Producing Gas Wells

SOURCE: RAILROAD COMISSION OF TEXAS, SEPTEMBER 2018

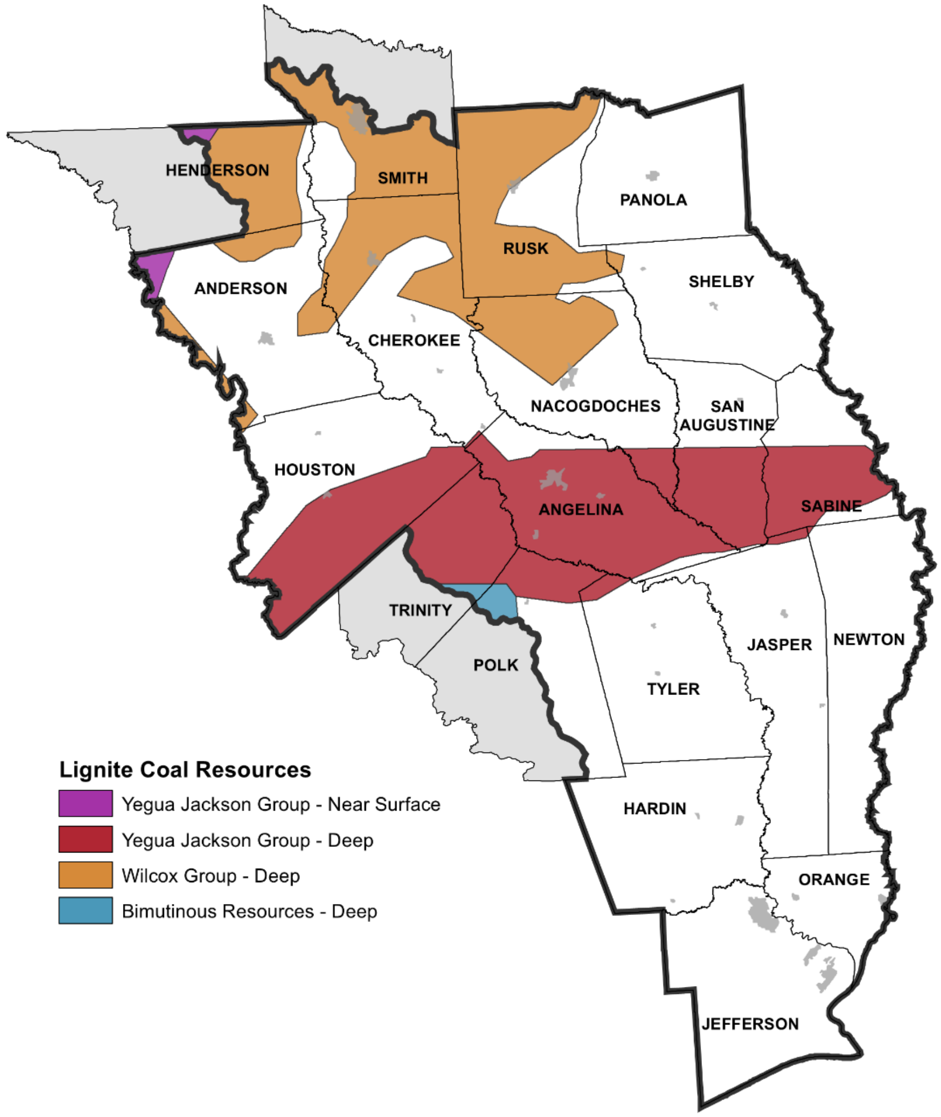

Figure 1.20 Lignite Coal Resources

SOURCE: TEXAS ALMANAC

1.6 Threats to Water Quality

1.6.1 Surface Water Quality

The first major U.S. Law to address water pollution was the Federal Water Pollution Control Act of 1948. This law was amended in 1972, in what became known as the Clean Water Act (CWA). The preamble of the CWA states that the objective of the Act is to "restore and maintain the chemical, physical, and biological integrity of the Nations waters." The 1972 amendments to the act included the following sweeping new changes to the approach to water pollution control:

- Established the structure for the regulation of pollutant discharges to Waters of the United States.

- Gave authority to the United States Environmental Protection Agency to implement control programs (i.e., permitting requirements) for discharges of pollutants from point sources.
- Funded construction of wastewater treatment facilities.
- Recognized the need for planning to address concerns about pollution from non-point sources.
- Established a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands.

The CWA is a cornerstone of the water planning process in the United States and central to the regional planning process.

Water quality in the region is generally very good. The TCEQ monitors surface water quality and documents quality through its water quality inventory. Concerns about water quality impacts to aquatic life, contact recreation, or fish consumption are documented by the TCEQ.[10]

Texas Clean Rivers Program was created in 1991 by the Texas Legislature to provide a network for monitoring water quality in the State's surface water bodies. The program is administered by the TCEQ; and the TCEQ partners with river authorities to improve the quality of surface water within each river basin in the State. The TCEQ and river authorities conduct water quality monitoring and assessment of streams, rivers, and lakes within their jurisdiction, and coordinate stakeholder participation in the process. The regional water authorities within the ETRWPA that have contracts with the TCEQ to participate as a Texas Clean Rivers Program partner include the Angelina Neches River Authority, Lower Neches Valley Authority, and Sabine River Authority of Texas.

1.7 Threats to Agricultural and Natural Resources

Water is essential to the ETRWPA's natural resources. A lack of water of adequate quality can present a significant threat to such resources. Some of the most significant potential threats in the ETRWPA are described below.

1.7.1 Drawdown of Aquifers

Overpumping of aquifers can pose a risk to household water use and livestock watering in localized rural areas. If water levels decline, the cost of pumping water increases, and water quality may change. In some cases, wells that are completed in the outcrop may go dry or wells constructed in a way that restricts the lowering of pumps may not be usable. These wells may need to be redrilled to deeper portions of the aquifer or abandoned altogether. Significant water level declines have been reported in localized areas in both the Carrizo-Wilcox and Gulf Coast aquifers,[35] the major aquifers in the region. Groundwater conservation districts work to ensure that the risk of excessive drawdown is minimized.

Overpumping of aquifers also poses a threat to estuarine wetlands. Between 1955 and 1992, approximately 19,900 acres of estuarine intertidal emergent wetlands were lost in Texas as a result of submergence (drowning) and erosion, probably due to faulting and land subsidence resulting from the withdrawal of underground water and oil and gas.[22] These losses occurred primarily between Freeport and Port Arthur. The risk of land subsidence is smaller for inland areas than for coastal areas due to the difference in compaction characteristics of the aquifers. In addition, groundwater conservation districts work to ensure that subsidence risks are minimized.

Overpumping of aquifers in coastal regions can lead to saltwater intrusion, where saltwater is drawn updip into the aquifer or moves vertically into fresh water portions of the aquifer and degrades the aquifer water quality. Saltwater intrusion into the Gulf Coast aquifer has occurred previously in central and southern Orange County [35] and Jefferson County.

1.7.2 Insufficient Instream/Environmental Flows

Flow quantities and frequencies in rivers and streams are necessary to maintain the fish and wildlife habitat in the region. Insufficient flow quantities and patterns could pose a threat to fish and wildlife habitat. Additional discussion of environmental flows is provided in Chapter 3.

1.7.3 Inundation Due to Reservoir Development

Reservoir development causes unavoidable losses to wildlife resources. In 1990, the TPWD and USFWS developed preliminary data on the acreage of land and species impacted by 44 proposed reservoirs in Texas that appeared to be the most likely to be constructed. The four projects included in this report that affect the ETRWPA include Columbia (formerly called Eastex), Rockland, Bon Wier, and Tennessee Colony reservoir projects. Table 1.9 shows the impacts of new reservoir development on the surrounding land and on protected species. For a complete list of potential reservoirs, refer to Chapter 8.

The USFWS has defined the following site priorities used to preserve bottomland hardwood forests and forested riparian vegetation:

- Priority 1 - excellent quality bottomlands of high value to waterfowl;
- Priority 2 - good quality bottomlands with moderate waterfowl benefits;
- Priority 3 - excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4 - moderate quality bottomlands with minor waterfowl benefits;
- Priority 5 - sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and Priority 6- sites recommended for future study.

The proposed Rockland Reservoir would impact the bottomland hardwood site known as the "Middle Neches River," which USFWS has identified as a Priority 1 preservation area. In addition, three USFWS Priority 2 bottomland hardwood preservation areas would be impacted: Neches River South, Piney Creek, and Russell Creek.

The USFWS has identified two preservation areas that would be affected by construction of the Tennessee Colony Reservoir. The first is an area known as "Boone Fields," located adjacent to the Trinity River between Saline Branch Creek and Catfish Creek, which contains upland forest and some bottomlands. The USFWS has classified this site as a Priority 5 preservation site. The reservoir would also affect a hardwood bottom in Region C known as "Tehuacana Creek." The USFWS has also classified this site as a Priority 5 preservation site. The USFWS defines Priority 5 as "sites proposed for elimination from further study because of low quality and/or no waterfowl benefits." [36]

Table 1.9 Potential Impacts of Development on Land Reservoir Area and Protected Species

Potential Impacts		Potential Reservoir Site			
		Columbia [37]	Rockland	Bon Wier	Tennessee Colony
Inundated Land (acres)	Mixed bottomland hardwood forest (2)	5,351	27,300	14,600	34,800
	Swamp/Flooded Hardwood Forest (2)	NA	NA	2,300	NA
	Pine-hardwood forest (3)	2,247	50,800	10,400	NA
	Post Oak-Water Oak-Elm Forest (3)	NA	NA	NA	19,200
	Grassland (4)	2,616	NA	NA	9,600
	Other	409	21,400	7,800	21,500
	TOTAL	**10,623**	**99,500**	**35,100**	**85,100**
Endangered Species Potentially Impacted	Interior least tern		•		
	Red-cockaded woodpecker	•	•	•	•
	Whooping crane				•
Threatened Species Potentially Impacted	Alligator snapping turtle	•	•	•	•
	American swallow-tailed kite	•	•	•	•
	Bachman's sparrow	•	•	•	•
	Bald Eagle	•	•	•	•
	Black bear	•	•	•	•
	Blue sucker		•	•	
	Creek chubsucker	•	•	•	
	Louisiana pigtoe	•	•	•	•
	Louisiana pine snake	•	•	•	•
	Northern scarlet snake	•	•	•	•
	Paddlefish	•	•	•	•
	Rafinesque's big-eared bat	•	•	•	
	Reddish egret		•	•	
	Sandbank pocketbook	•	•	•	•
	Southern hickorynut	•	•	•	•
	Texas heelsplitter	•	•	•	•
	Texas horned lizard	•	•	•	•
	Texas pigtoe	•	•	•	•
	Timber rattlesnake	•	•	•	•
	White-faced ibis	•	•	•	•
	Wood stork	•	•	•	•

SOURCE: U.S. ARMY CORPS OF ENGINEERS, U.S. FISH AND WILDLIFE SERVICE, TEXAS PARKS AND WILDLIFE DEPARTMENT

Construction of the Tennessee Colony Reservoir would inundate approximately 13,800 acres of bottomland, which comprise the Richland Creek Wildlife Management Area in Region C. The TPWD acquired this area as mitigation for wildlife losses associated with the construction of Richland-Chambers Dam and Reservoir in Region C.[38] The Wildlife Management Area is located in Freestone County on the west side of the Trinity River within the boundaries of the proposed Tennessee Colony Reservoir.

The U.S. Army Corps of Engineers designed the Tennessee Colony Reservoir in 1979, but the project encountered numerous concerns about conflicts with development of lignite in the area and with existing communities and water supply lakes. The project has been deferred pending removal of the lignite.

1.8 Consideration of Existing Water Planning Efforts

The ETRWPA published its first round of regional water planning in 2001. This plan was updated according to legislative and TWDB requirements in 2006, 2011, and again in 2016. The 2021 Plan makes up the 4th update to the regional water plan during this 5th cycle of regional water planning. Over the course of these planning efforts, other ongoing planning efforts, as well as existing water resource programs, have been an integral part of the process. Coordination efforts with TWDB Regions C, D, and H (all adjacent to the ETRWPA) have occurred for consistency across plans. In addition, water plans specific to WUGs and WWPs were considered in the evaluation of WMSs included in Chapter 5B. Following is a summary of planning efforts and existing programs that have been considered and utilized by the RWPG.

1.8.1 State, Regional, and Local Water Management Planning

Water planning in the ETRWPA incorporates a combination of published plans summarizing water planning efforts, past and present. The 1990 Texas Water Plan, a state-level planning effort, determined that there was a geographic disparity in water availability. As a result of that finding, the Trans-Texas Water Program (TTWP) was created. The TTWP developed sound regional WMSs for areas of southeast, south-central, and west-central Texas. It considered issues associated with the rapid growth of the Houston, San Antonio, Austin, and Corpus Christi areas and the possibility of moving water from the water-rich areas of southeast Texas (essentially the ETRWPA now) to these more urbanized demand centers. In 1998, the Phase II Report of the TTWP determined that southeast Texas could play an important role in meeting expected regional demands by exporting water to central Texas. The report looked at a 50-year planning horizon and identified 13 WMSs that could be implemented to satisfy long-range demands in the study area. Among the conclusions of the TTWP were the following:

- Southeast Texas (essentially the ETRWPA) possessed adequate surface and groundwater resources to supply its own demands and support meeting demands of other areas of south-central and west-central Texas.
- Water conservation, wastewater reclamation, and systems operations can extend the period of adequate supply and delay the need for new resources development in the Houston metropolitan area.
- The Neches Salt Water Barrier would create additional supply from existing resources.
- Contractual transfers of existing supplies can result in additional reduced conveyance requirements.
- Interbasin transfer of water will be needed to meet future water requirements of both the southeast and central Texas areas.
- Desalination is not an appropriate economic or environmental strategy for use in the southeast area.

The TTWP was a turning point in regional water planning in Texas. The TTWP resulted in the adoption of Texas legislature Senate Bill 1 in 1997, which mandated regional water planning for the entire state and was the inception of Region I, or the ETRWPA.

Since 1997, the area known as the ETRWPA has relied largely on the regional water planning process for development of long-range water plans. However, there are a number of ongoing efforts within the region aimed at planning for future water needs. These efforts have been recognized by the RWPG and their results incorporated into the regional planning process.

Local planning efforts within the region have included water conservation plans developed by water user groups and wholesale water providers. Chapter 6 includes further discussion of these plans. Groundwater conservation districts within the region have prepared groundwater management plans and water conservation plans aimed at providing a degree of long-range planning for groundwater resources under their jurisdiction. Groundwater conservation districts are identified in Section 1.10.4 of Chapter 1.

1.8.2 Comprehensive Sabine Watershed Management Plan

This report was completed in December 1999. It was prepared for the SRA of Texas in conjunction with the TWDB, Contract # 97-483-214; Freese and Nichols, Inc., Brown and Root, Inc., and LBG-Guyton Associates (now WSP USA). This plan was developed over a period from 1996 through 1999 as an update to a 1985 master plan for the basin. The plan points out the two distinct geographic regions of the basin, upstream and downstream from the upstream end of Toledo Bend Reservoir in Panola County.

TWDB consensus planning population and water use projections showed water use in the Upper Basin to increase from 197,000 to 457,000 ac-ft per year from 1990 to 2050. Lower Basin use was shown to increase from 79,000 to 164,000 ac-ft per year from 1990 to 2050. No new water supplies for the Lower Basin were recommended. A total of 93,000 ac-ft per year of new supplies were recommended for the Upper Basin, including a proposed Prairie Creek Reservoir.

1.8.3 Trinity River Basin Master Plan

This study was originally adopted by the Trinity River Authority of Texas in 1958 and has been updated various times since then, most recently in 2016. This most recent plan revisions added new sections on Reuse of Reclaimed Water and on Regional Water Planning in Regions C and H. Nearly 81% of the Trinity River Basin falls into Regions C or H while less than 8% of this basin is located within the ETRWPA.

In 2010, the sum of the firm yield of existing reservoirs and the currently permitted inter-basin water transfer amounts within the Trinity River Basin was 2,994 mgd, or 3,354,000 ac-ft per year. Several new reservoirs were recommended in this master plan, including Tennessee Colony, a reservoir needed for flood control. The construction of the Tennessee Colony reservoir (located partially within the ETRWPA) has been deferred due to costs, environmental conflicts, lack of local sponsor commitments, and other factors. The Texas Instream Flow Program established by Senate Bill 2 in 2001 by the 77th Texas Legislature and the Trinity River Authority of Texas are currently in the process of undergoing the Middle Trinity River Instream Flow Study in order to develop flow recommendations that will support the ecological environment around the proposed reservoir site.

A number of other recommended reservoirs are included in the plan as needed for water supplies, including four smaller reservoirs within the ETRWPA in Houston County:

- Big Elkhart Reservoir
- Hurricane Reservoir

- Gail Reservoir
- Mustang Reservoir

1.8.4 Consideration of Other Publicly Available Plans

The RWPG provided significant outreach to various municipal, agricultural, and manufacturing water users in the current round of planning to ensure that existing plans for water conservation, water resource planning, drought contingency, and other planning tools were appropriately considered in the 2021 Plan. Municipal WUGs and wholesale water providers were specifically queried regarding the existence of planning documents. Existing Plans have been requested of industries as well.

1.9 Drought of Record

In regional water planning, the availability of water supplies is determined for drought of record conditions. The drought of the 1950s is widely considered to be the drought of record, but on regional or sub-regional bases, other periods of time may have been more severe. Chapter 7 presents the current drought of record for each major reservoir in the ETRWPA and evaluates more recent droughts of record in the region. The discussion suggests that the 2010-2012 period was one of significant drought for the ETRWPA. However, more localized hydrologic information is necessary to evaluate whether accounting for a more recent drought would change the estimates of available water supplies.

1.10 Current Drought Preparations

Drought contingency and water conservation planning represent important components of the water planning process. Water conservation includes measures that may be taken to reduce water consumption under all conditions and at all times. While water conservation does not generally eliminate the need for future water supply sources, it can result in the ability to delay development of costly strategies. Water conservation improves the effective use of existing sources. Drought management is designed to preserve existing water supplies during extreme dry periods. Drought management strategies are, therefore, temporary measures intended to result in significantly reduced water use in a short period of time. Drought contingency and water conservation are discussed further in Chapters 7 and 5C, respectively.

1.11 Water Loss and Water Audits

The 78th Texas Legislature passed legislation in 2005 requiring retail public utilities that provide potable water to perform a water audit, computing the utility's most recent annual water loss every five years. Since then, the TWDB established new requirements for water audit reporting; these requirements are summarized as follows:

- Retail water suppliers with an active financial obligation with the TWDB are required to submit a water loss audit annually.
- Retail water suppliers with more than 3,300 connections are required to submit a water loss audit annually.
- All public utilities are required to submit a water loss audit once every five years.

Statewide water loss audit summaries for public utility audits submitted for 2017 were performed. Appendix 1-B contains the 2017 water loss audit data reported by ETRWPA utilities and a summary of 2017 water loss audit data by planning region. Based on data from responding utilities, the ETRWPA demonstrates an average non-revenue water percentage at 27.7% (the state average for non-revenue water is 16.6%). Of this percentage, 5.2% is attributed to unbilled authorized consumption, 3.4% to apparent losses, and . Unbilled authorized consumption includes both unbilled metered and unbilled unmetered water use, and apparent loss includes unauthorized consumption, meter inaccuracies, and data discrepancies.

The RWPG used the water loss audits to determine what type of water management strategy was needed for each entity with a calculated water need. In addition, conservation WMSs were recommended for the 57 entities that have a base gallon per capita per day water usage greater than the state recommended consumption rate of 140 gallons per capita day. More detail regarding these strategies and their development is provided in Chapters 5A, 5B, and 5C.

1.12 Threats Addressed or Affected by Water Management Strategies

Water management strategies (WMS) were evaluated for impacts as addressed in Chapter 5B of this Plan. The evaluation was based on a numeric evaluation from most desirable (1) to least desirable (5). The major potential impact was determined to be the crossing of wetlands during the construction process. The long-term impact after construction was expected to be minimal. The results of this study were considered and incorporated as appropriate into the development of WMSs in Chapter 5B. For discussion on drawdown on aquifers, insufficient instream/environmental flows, and inundation due to reservoir development, see Section 1.7 of this chapter.