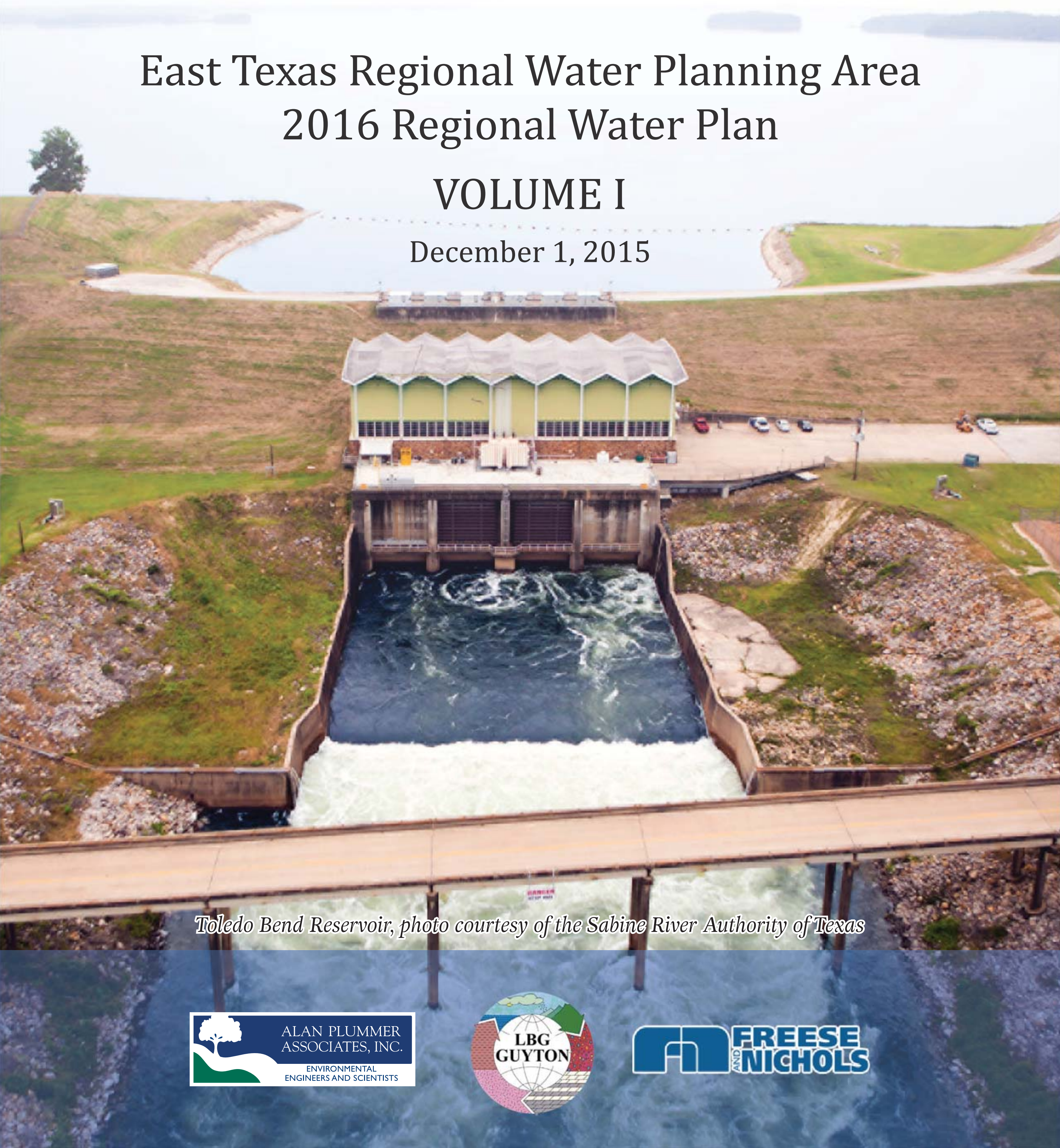
Region I
East Texas Regional
Water Planning Group

East Texas Regional Water Planning Area
2016 Regional Water Plan

VOLUME I

December 1, 2015



Toledo Bend Reservoir, photo courtesy of the Sabine River Authority of Texas

ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

LBG GUYTON

FREESE AND NICHOLS

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List of Abbreviations / Acronyms

2011 Plan	2011 East Texas Regional Water Plan
2016 Plan	2016 East Texas Regional Water Plan
2016 IPP	2016 East Texas Initially Prepared Plan
°F	degrees Fahrenheit
µg/L	micrograms per liter
ac-ft per year	acre-feet per year
AMWA	Athens Municipal Water Authority
AN WCID#1	Angelina-Nacogdoches Water Control & Improvement District No. 1
ANRA	Angelina and Neches River Authority
AWWA	American Water Works Association
bgl	below ground level
BMP	Best Management Practices
CCN	Certificate of Convenience and Necessity
cfs	cubic feet per second
CRP	Clean Rivers Program
CWA	Clean Water Act
DB17	2017 Regional Water Planning Application Web Interface
DCP	drought contingency plan
DFC	desired future condition
EDAP	Economically Distressed Areas Program
EIS	environmental impact study
ES	Executive Summary
ETRWPA	East Texas Regional Water Planning Area or Region I
ETRWPG	East Texas Regional Water Planning Group
GAM	groundwater availability model
GCD	groundwater conservation district
GMA	groundwater management areas
gpcd	gallons per capita per day
gpm	gallons per minute
HB 1763	2005 Texas House Bill 1763
HCWCID #1	Houston County Water Control & Improvement District No. 1
IFR	Infrastructure Financing Report
IWA	International Water Association
LNG	liquid natural gas
LNVA	Lower Neches Valley Authority
MAG	modeled available groundwater
mg/L	milligrams per liter
MGD	million gallons per day

MSA	Metropolitan Statistical Area
msl	mean sea level
MWA	municipal water authority
MWD	municipal water district
NEPA	National Environmental Policy Act
No.	number
NRCS	National Resources Conservation Service
PCFWSD No. 1	Panola County Freshwater Supply District No. 1
pCi/L	picocuries per liter
PHDI	Palmer Hydrological Drought Index
ppt	parts per thousand
RWP	Regional Water Plan
RWPG	Regional Water Planning Group
SB 1	1997 Texas Legislature Senate Bill 1
SB 2	2001 Texas Legislature Senate Bill 2
SB 3	2007 Texas Legislature Senate Bill 3
SDWA	Safe Drinking Water Act
SFA	Stephen F. Austin State University
SRA	Sabine River Authority of Texas
STATSGO	State Soil Geographic Database
SUD	special utility district
SWIFT	State Water Implementation Fund for Texas
SWP	State Water Plan
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TCRP	Texas Clean Rivers Program
TDS	total dissolved solids
TDSHS	Texas Department of State Health Services
THC	Texas Historical Commission
TIFP	Texas Instream Flow Program
TMDL	total maximum daily load
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TSDC	Texas State Data Center
TTWP	Trans-Texas Water Program
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board
TXBCD	Texas Biological and Conservation Data System
UNRMWA	Upper Neches River Municipal Water Authority
USACE	United States Army Corps of Engineers

USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWCD	underground water conservation district
WAM	Water Availability Model
WCID	water control & improvement district
WCITF	Water Conservation Implementation Task Force
WIF	Water Infrastructure Fund
WMA	wildlife management area
WMS	water management strategy
WSC	water supply corporation
WUG	water user group
WWP	wholesale water provider

List of Water Measurement Conversions

1 ac-ft	=	325,851 gallons
1 cfs	=	448.8 gpm
1 liter per second	=	15.85 gpm
1 MGD	=	1,120 ac-ft per year
1 MGD	=	694.444 gpm

Executive Summary

In 1997, the State Legislature, through Senate Bill 1, determined that water planning should be accomplished at a regional level rather than with the centralized approach employed previously by the Texas Water Development Board (TWDB). To accomplish this task, the TWDB divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPGs) to guide the development of each region's plan. In 2001, revised rules and guidelines from the TWDB were enacted through Senate Bill 2. The planning process is cyclic, with updated Regional Water Plans and State Water Plans produced every five years.

The designated water planning area for the east and southeast portions of Texas is the East Texas Regional Water Planning Area (ETRWPA), also known as Region I or the East Texas Region. The water planning process in the ETRWPA is guided by the East Texas Regional Water Planning Group (ETRWPG). These individuals are charged with the responsibility for development of the 2016 ETRWPA Water Plan (2016 Plan). The ETRWPG is currently comprised of the following voting members representing specific community interests:

- David Alders – Agriculture
- Josh David – Agriculture
- Jeff Branick – Counties
- Chris Davis – Counties
- Dale Peddy – Electric Power
- Dr. J. Leon Young – Environmental
- Leah Adams – Groundwater Management Areas
- John Martin – Groundwater Management Areas
- Michael Harbordt – Industries
- Darla Smith – Industries
- David Brock – Municipalities
- Gregory M. Morgan – Municipalities
- William Heugel – Public
- Bill Kimbrough – Public
- David Montagne – River Authorities
- Monty Shank – River Authorities
- Kelley Holcomb – River Authorities
- Scott Hall – River Authorities
- Mark Dunn – Small Business
- Dr. Joseph Holcomb – Small Business
- Worth Whitehead – Water Districts

The regional water planning process involves the evaluation of Texas Water Development Board projected water demands, identification of water supplies, and development of water management strategies designed to meet identified water shortages. However, the process also involves the evaluation of a broad range of issues that directly relate to water planning. Some of these issues notably include protection of natural resources and agricultural resources, water conservation and drought contingency, and water management strategy quantity, reliability, and cost.

Regional water planning in the ETRWPA is a public process, involving frequent public meetings of the ETRWPG, careful consideration of the requests and needs of various water user groups in the region, and an understanding of the need to allow for public comment throughout the planning cycle. For an in-depth discussion of any of the topics addressed in this Executive Summary, the reader is referred to the full 2016 Initially Prepared Plan (2016 IPP). An electronic copy of the 2016 IPP is available online at the ETRWPA website: http://www.etexwaterplan.org/ and at the TWDB website: http://twdb.state.tx.us.

ES.1 Regional Description

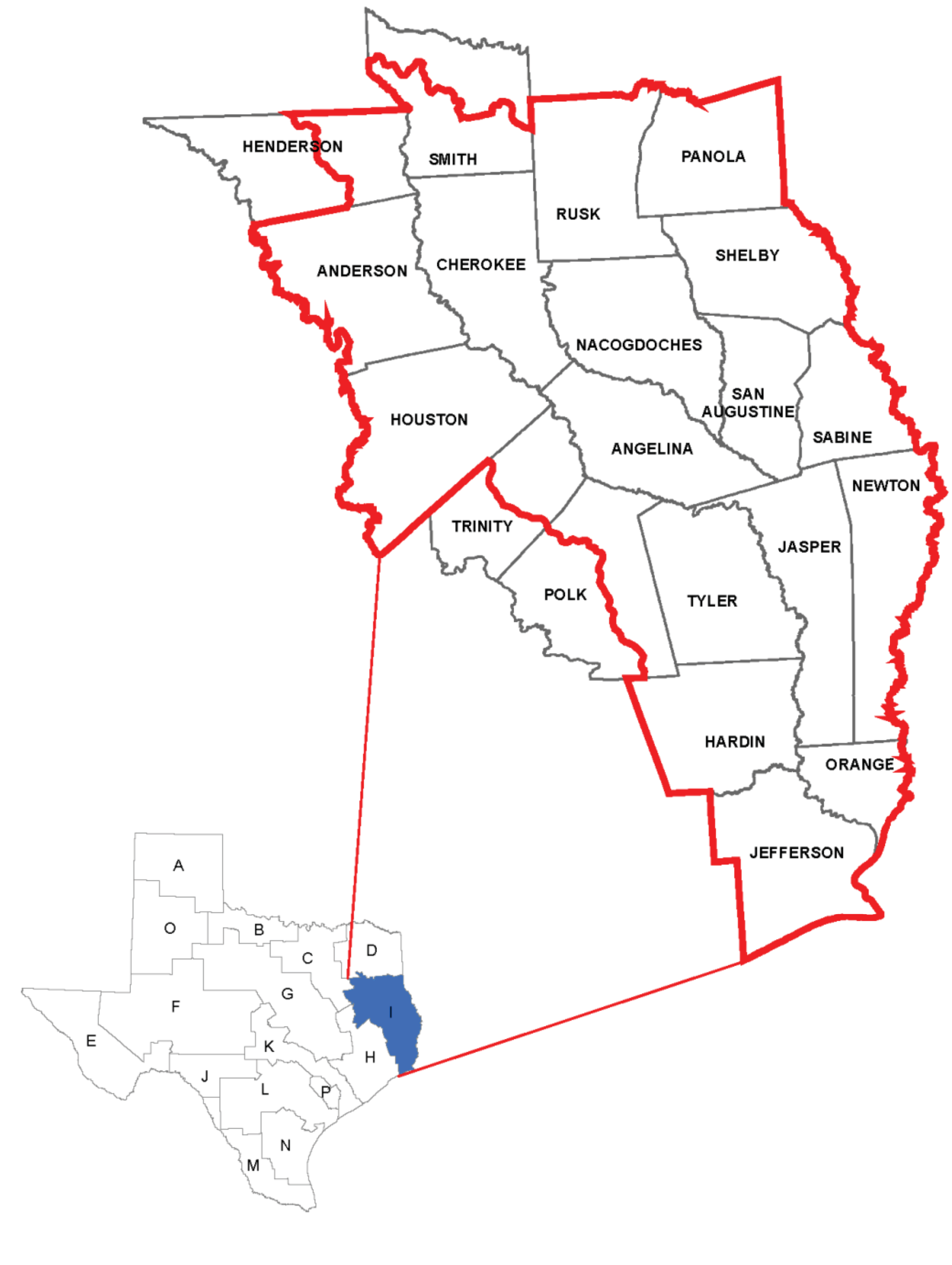
The ETRWPA consists of all or portions of the following 20 counties located in the Neches, Sabine, and Trinity River Basins, and the Neches-Trinity Coastal Basin:

Anderson	Jefferson	Sabine
Angelina	Nacogdoches	San Augustine
Cherokee	Newton	Shelby
Hardin	Orange	Smith (partial)
Henderson (partial)	Panola	Trinity (partial)
Houston	Polk (partial)	Tyler
Jasper	Rusk	

The region extends from the southeastern corner of the state for over 150 miles north and northwest as illustrated in Figure ES.1. The ETRWPA consists of approximately 10,329,800 acres of land, accounting for roughly six percent t of the total area of the State of Texas.

Much of the ETRWPA is forested, supporting various types of timber industry. Plant nurseries are common in portions of the region. Oil production is scattered through the region, and beef cattle are prominent. Poultry production and processing are prevalent and there is diverse manufacturing in addition to timber industries. Commercial fishing is an important economic characteristic of Sabine Lake. Tourism is important in many areas, especially on and around large reservoirs, Sabine Lake, and the Gulf of Mexico. Timbered areas include a number of state parks and national forests, etc., that offer recreational and hunting opportunities.

Agriculture is a vital component of the ETRWPA economy and culture. According to the United States Department of Agriculture, the 20 counties that make up the ETRWPA contain over 9,000 farms with a total of over a million acres of cropland.



SOURCE: TEXAS WATER DEVELOPMENT BOARD

0 7.5 15 30 Miles	**East Texas Regional Water Planning Area**	Location Map	**FIGURE**
DATE: DEC 2014			ES.1
SCALE: 1:1,900,800			
DESIGNED: APAI	**Location Map**		
DRAFTED: HEF			
FILE:			

ES.2 Regional Water Planning Application

The Regional Water Planning Application (DB17) is an online database created by the Texas Water Development Board (TWDB). RWPGs submit all data generated during the planning cycle to the TWDB through the DB17's web interface. Once data is entered into the DB17 by the RWPG, the data can be queried to generate various summary reports referred to as DB17 Reports. The following DB17 Reports are required by the TWDB to be included in this Executive Summary.

- Population Projection and Water Demand Summary DB17 Report
- Existing Water Supplies Summary DB17 Report
- Identified Water Need Summary DB17 Report
- Second-Tier Identified Water Need Summary DB17 Report
- Source Water Balance DB17 Report
- Unmet Needs Summary DB17 Report
- Recommended Water Management Strategy Roll-Up Summary DB17 Report
- Alternative Water Management Strategy Summary DB17 Report

The TWDB will make each report available to RWPGs after submittal of the 2016 Initially Prepared Plan (IPP).

ES.3 County Summary Sheets

Following is a two-page summary sheet for each county in the ETRWPA. Each sheet includes the county's representatives, water-dependent economy, water sources, population projections, demand projections, available supply summary, and Recommended Water Management Strategies.

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ANDERSON COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Jeb Hensarling

YOUR STATE SENATOR:
Robert Nichols

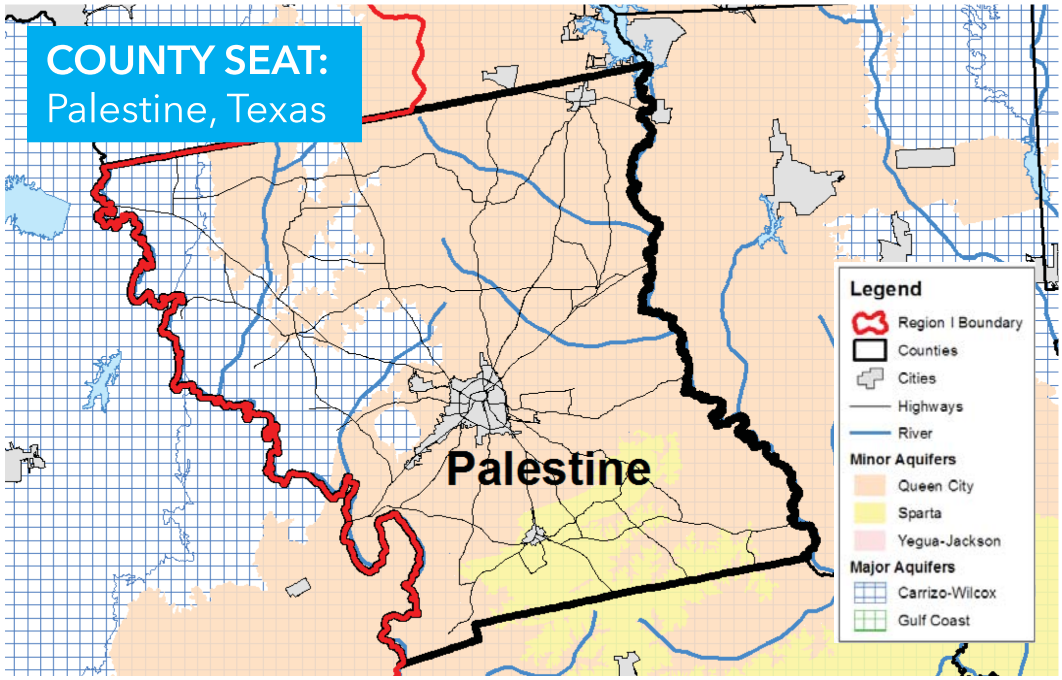
YOUR STATE REPRESENTATIVE:
Byron Cook

YOUR COUNTY JUDGE:
Robert D. Johnston

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)
Monty Shank

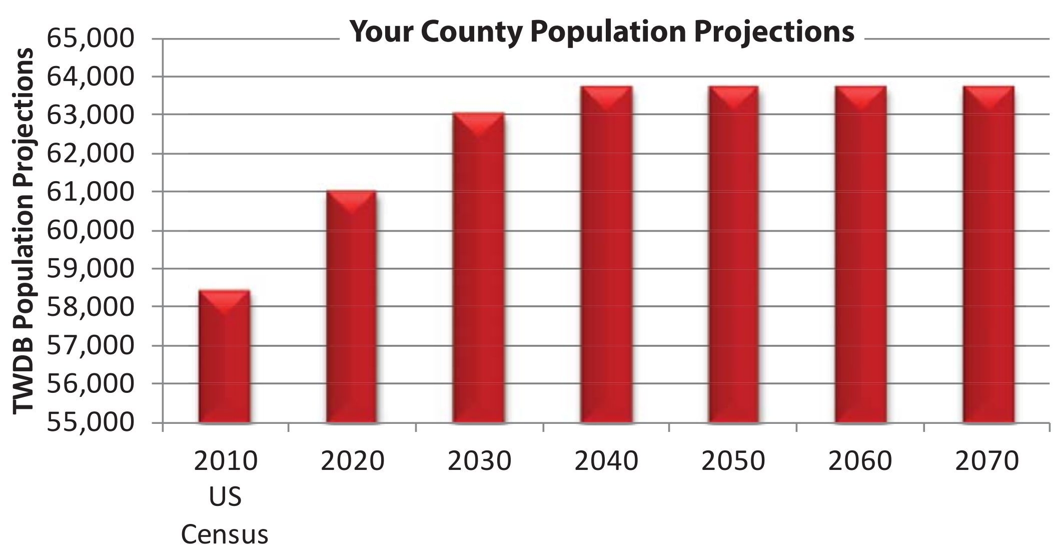
YOUR MUNICIPAL WATER USERS:
Bcy WSC
Brushy Creek WSC
Elkhart
Four Pines WSC
Frankston
Neches WSC
Palestine
The Consolidated WSC
Tucker Water Supply
Walston Spring Water Corp.
Walston Springs WSC

COUNTY SEAT:
Palestine, Texas

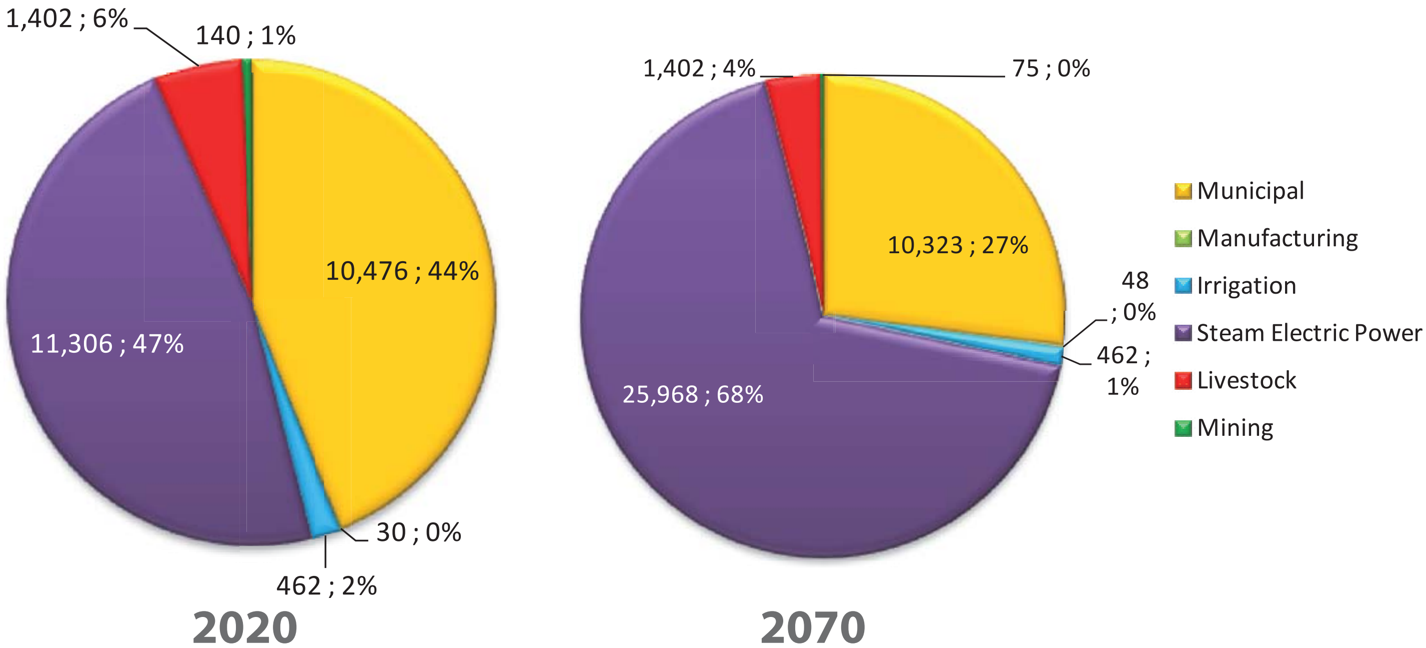


YOUR WATER-DEPENDENT ECONOMY:
Livestock
Oil & Gas Production
Recreation

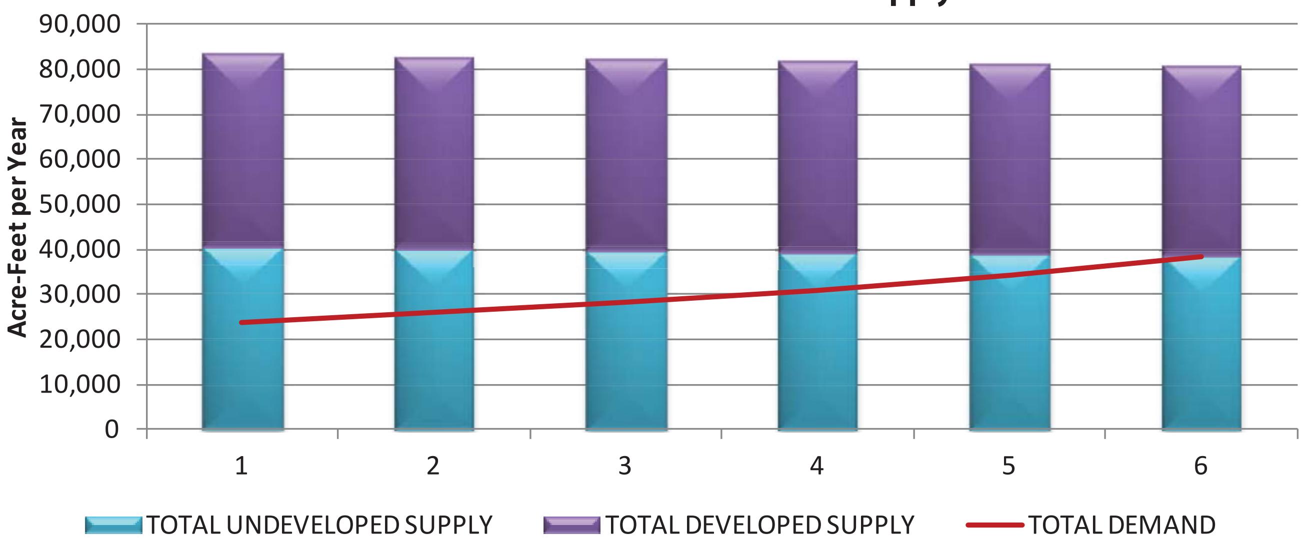
YOUR WATER SOURCE:
Groundwater Wells
Lake Palestine
Local Supplies
Neches River
Trinity River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 35% Groundwater and 65% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	Purchase from Palestine (Lake Palestine); Purchase from Upper Neches River MWA (Neches River)
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

ANGELINA COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Robert Nichols

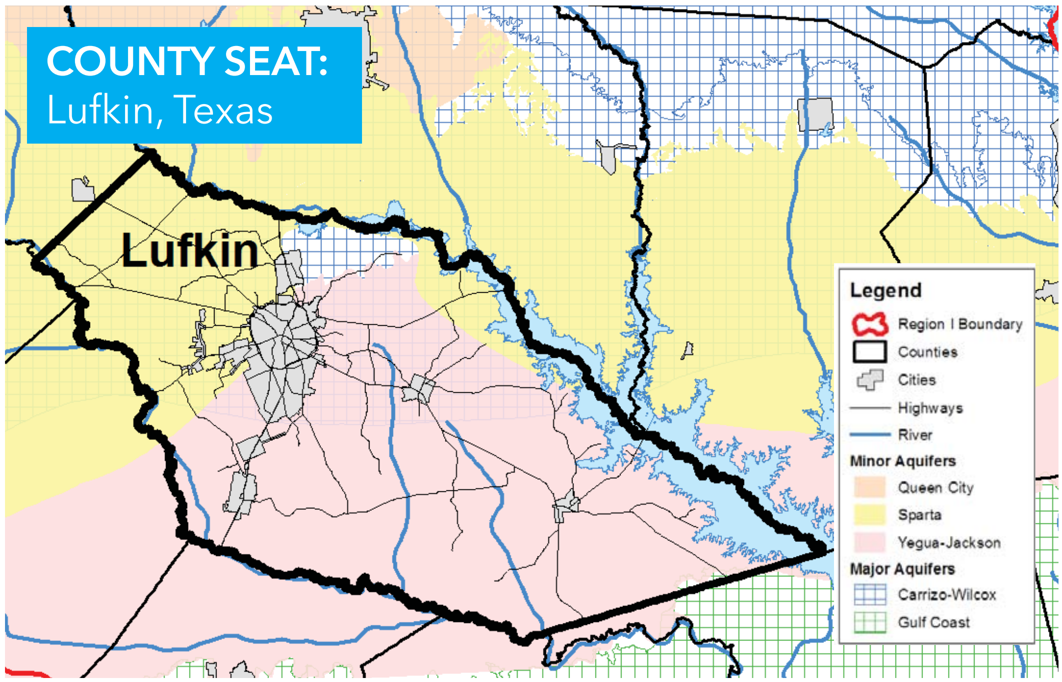
YOUR STATE REPRESENTATIVE:
Trent Ashby

YOUR COUNTY JUDGE:
Wes Suiter

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Kelley Holcomb
Leah Adams (GMA 11)
Mark Dunn

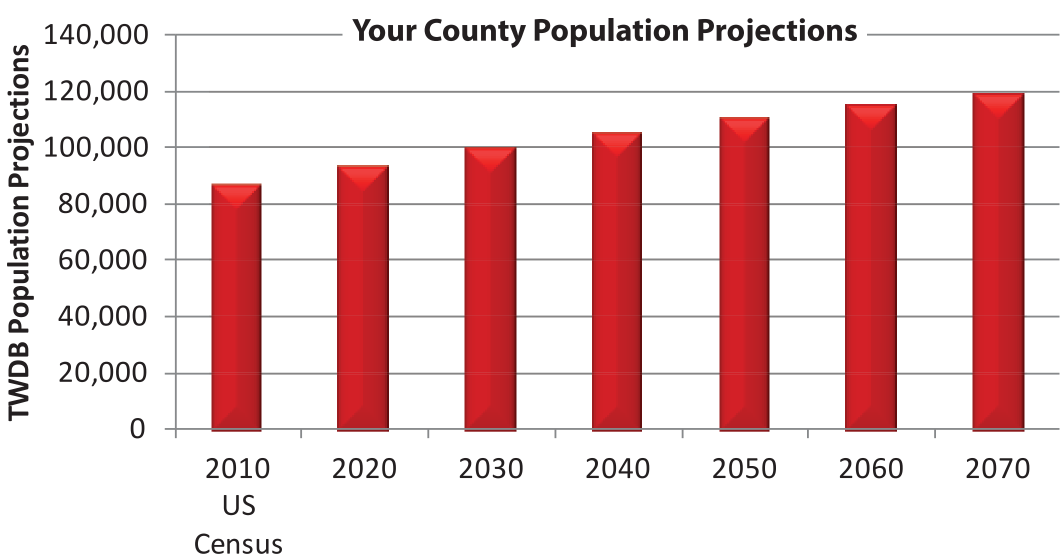
YOUR MUNICIPAL WATER USERS:
Angelina County FWSD #1
Angelina WSC
Beulah WSC
Burke
Central WCID of Angelina County
Diboll
Four Way SUD
Hudson
Hudson WSC
Huntington
Idlewood WCID
Lufkin
M&M WSC
Pleasure Point WSC
Pollok Redtown WSC
Prairie Grove WSC
Redland WSC
Woodlawn WSC
Zavalla

COUNTY SEAT:
Lufkin, Texas

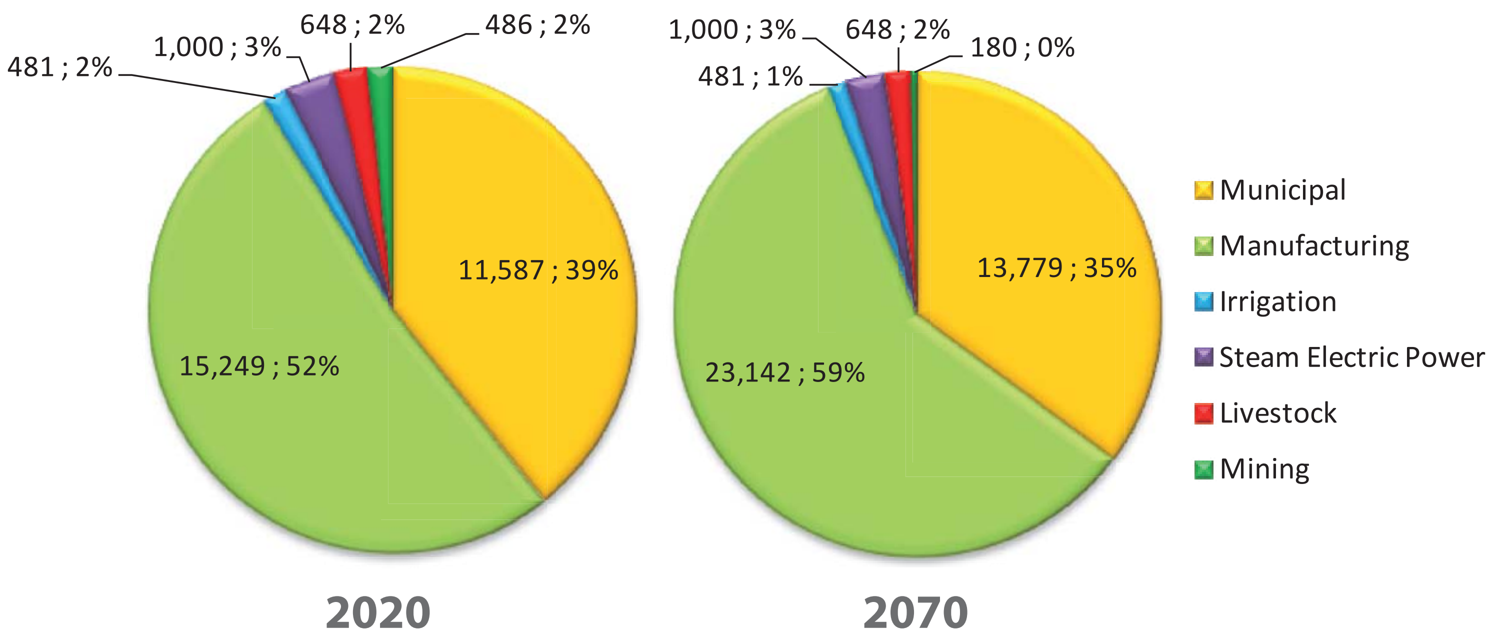


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Industry
Timber
Recreation

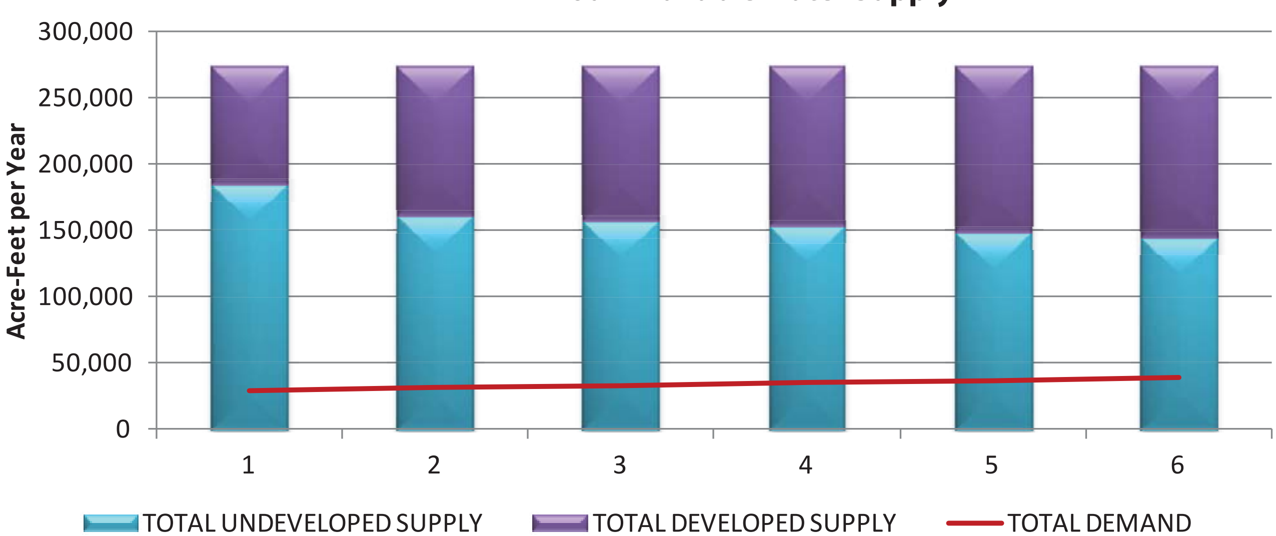
YOUR WATER SOURCE:
Groundwater Wells
Lake Kurth
Local Supplies
Neches River
Sam Rayburn Reservoir



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 18% Groundwater and 82% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	Purchase from Lufkin (Lake Kurth); Purchase from Lufkin (Sam Rayburn)
Irrigation	No Water Shortage Identified
Steam Electric Power	No Water Shortage Identified
Livestock	No Water Shortage Identified
Mining	Purchase from Angelina Neches River Authority (Angelina River)

CHEROKEE COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Jeb Hensarling

YOUR STATE SENATOR:
Robert Nichols

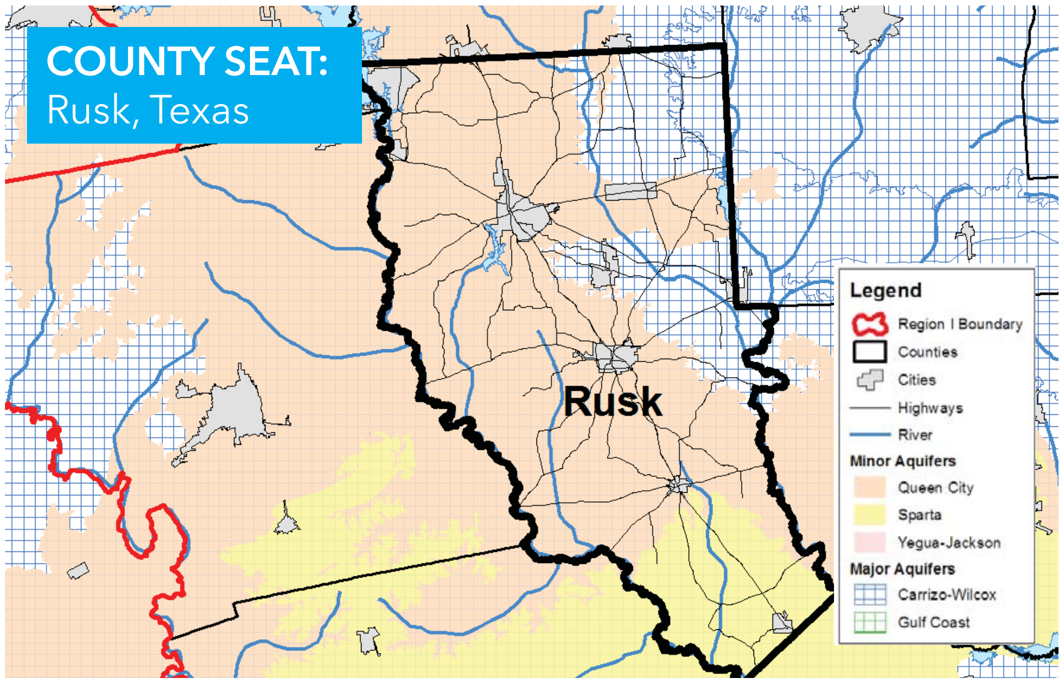
YOUR STATE REPRESENTATIVE:
Travis Clardy

YOUR COUNTY JUDGE:
Chris Davis

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Chris Davis
David Brock
Leah Adams (GMA 11)

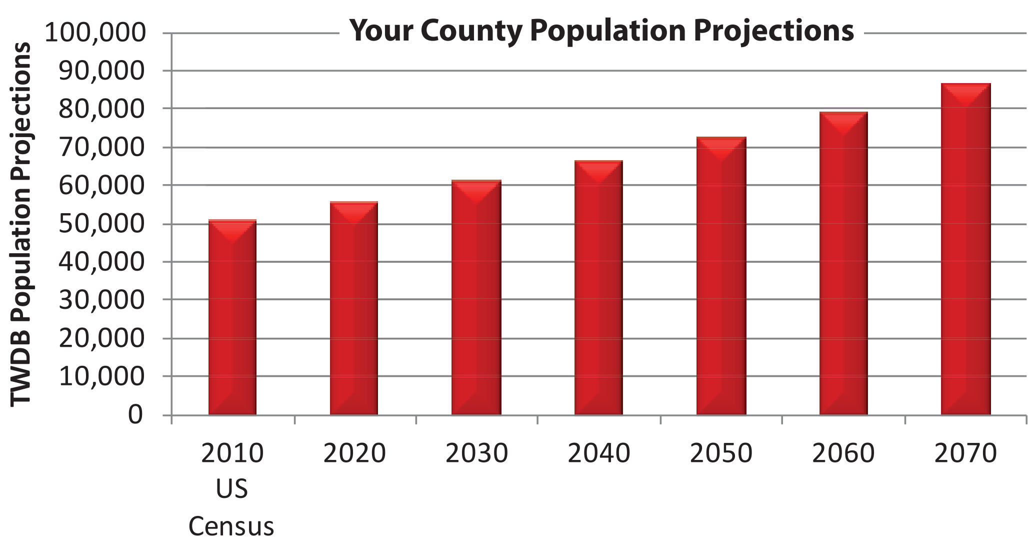
YOUR MUNICIPAL WATER USERS:
Afton Grove WSC
Alto
Alto Rural WSC
Bullard
Craft-Turney WSC
Cuney
Dialville Oakland WSC
Forest WSC
Gallatin
Gallatin WSC
Gum Creek WSC
Iron Hill WSC
Jacksonville
Maydelle WSC
New Concord WSC
New Summerfield
North Cherokee WSC
Reklaw
Rusk
Rusk Rural WSC
Southern Utilities Company
Stryker Lake WSC
Troup
Wells
West Jacksonville Water Supply
Wright City WSC

COUNTY SEAT:
Rusk, Texas

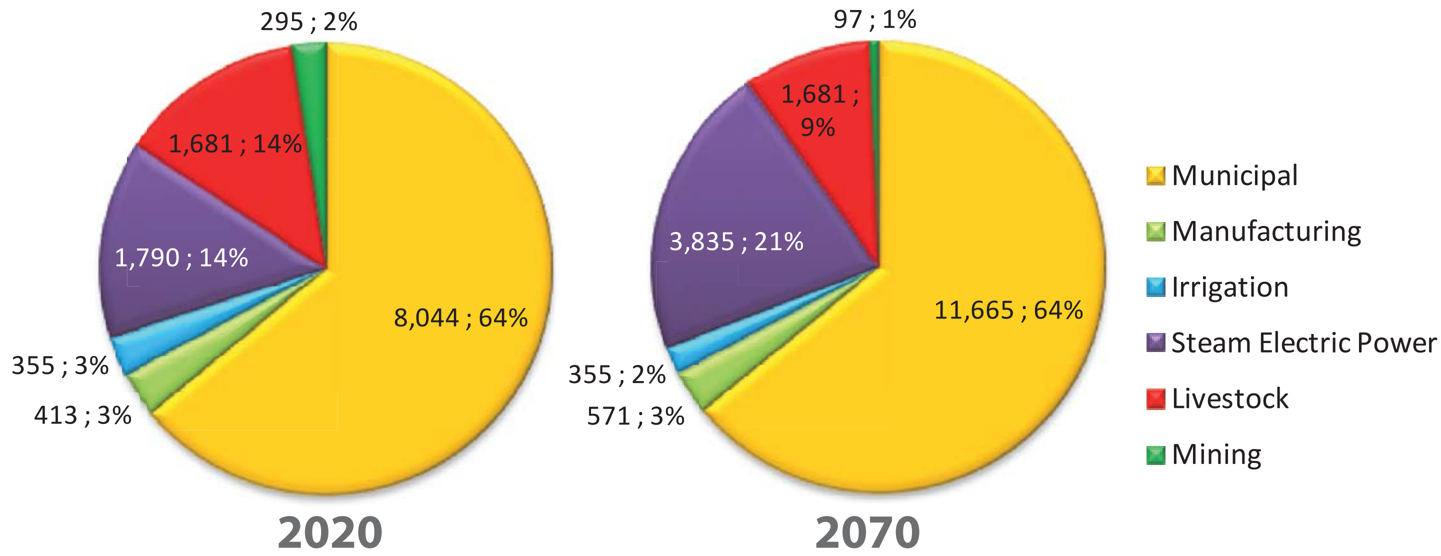


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Oil & Gas Production
Timber

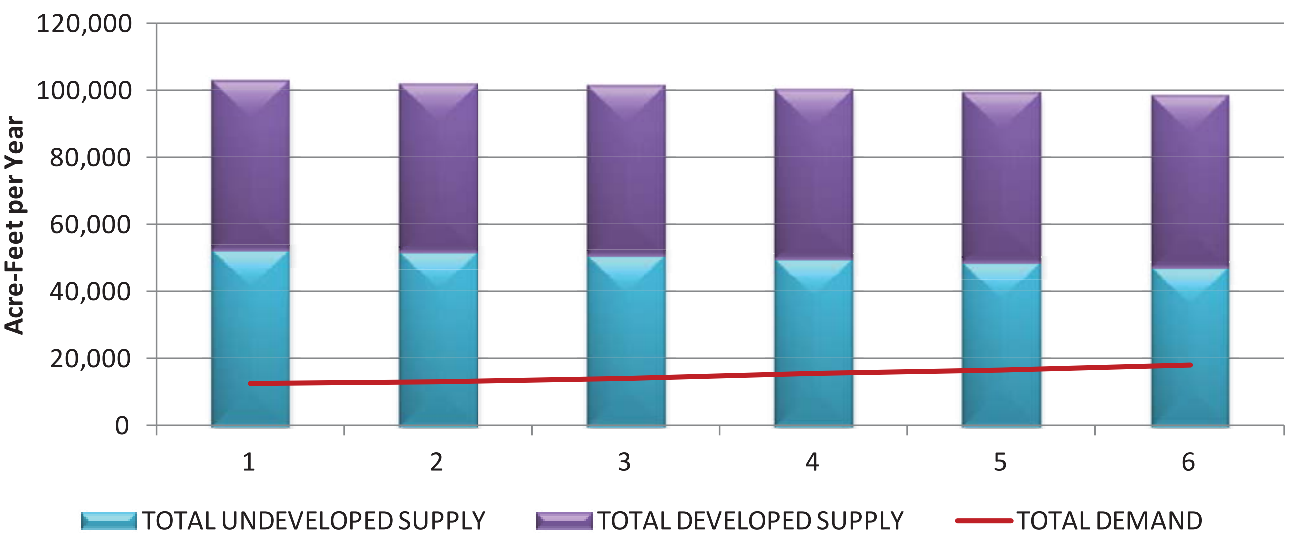
YOUR WATER SOURCE:
Groundwater Wells
Lake Jacksonville
Lake Palestine
Lake Striker
Local Supplies
Neches River
Rusk City Lake



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



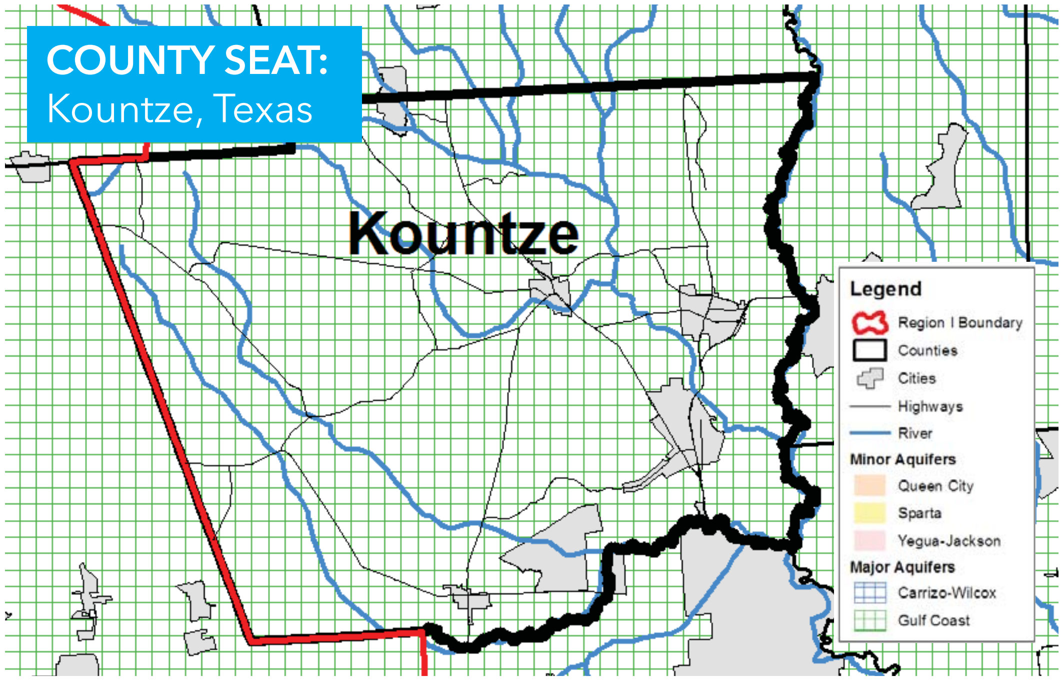
Total Available Water Supply is 33% Groundwater and 67% Surface Water.

Your Water User Groups with Identified Needs

Alto Rural WSC	New Wells (Carrizo-Wilcox Aquifer)
Bullard	Municipal Conservation
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Water Shortage Identified
Livestock	No Water Shortage Identified
Mining	Purchase from Angelina Neches River Authority (Angelina River)

HARDIN COUNTY

COUNTY SEAT:
Kountze, Texas



YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

YOUR STATE REPRESENTATIVE:
James White

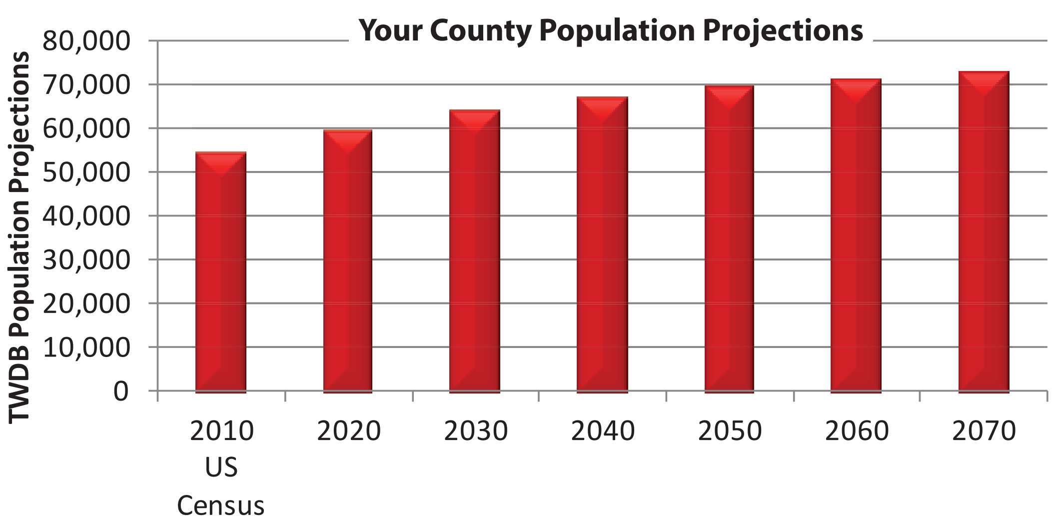
YOUR COUNTY JUDGE:
Wayne McDaniel

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
John Martin (GMA 14)

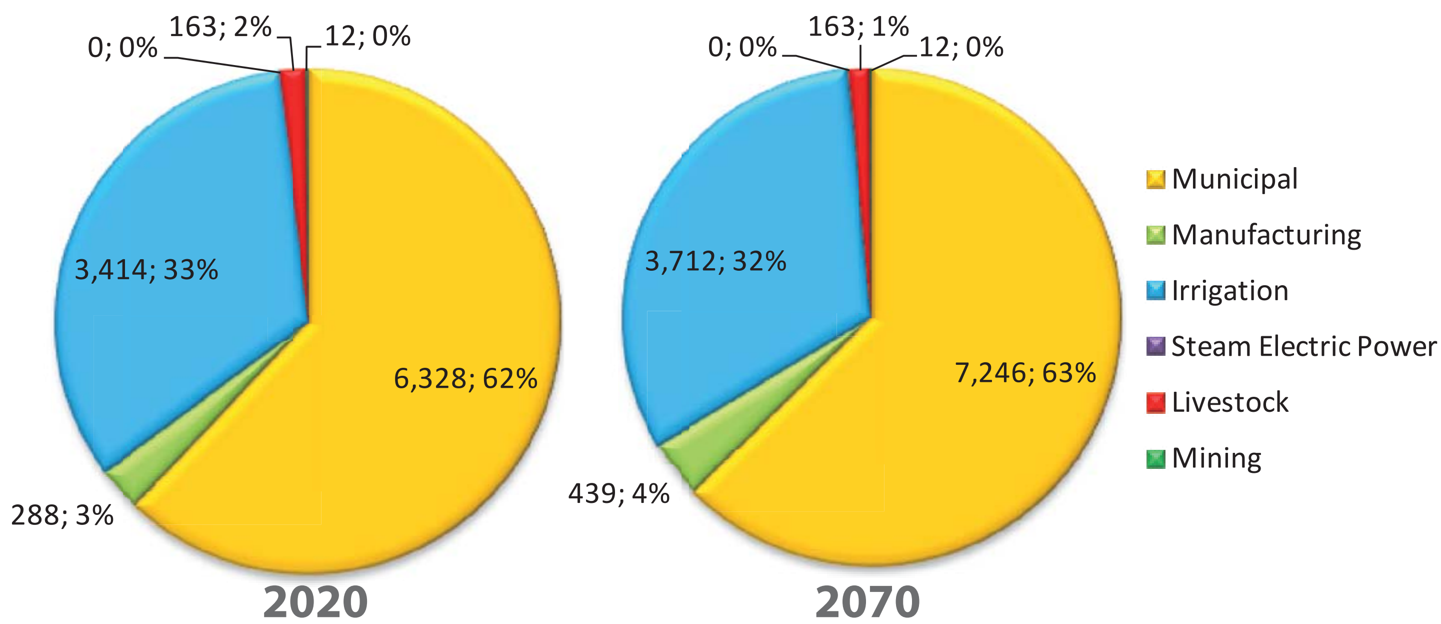
YOUR MUNICIPAL WATER USERS:
Kountze
Lake Livingston Water Supply & Sewer Service Company
Lumberton
Lumberton MUD
North Hardin Water Supply
North Hardin WSC
Rose Hill Acres
Silsbee
Sour Lake
West Hardin WSC

YOUR WATER-DEPENDENT ECONOMY:
Industry
Oil & Gas Production
Timber

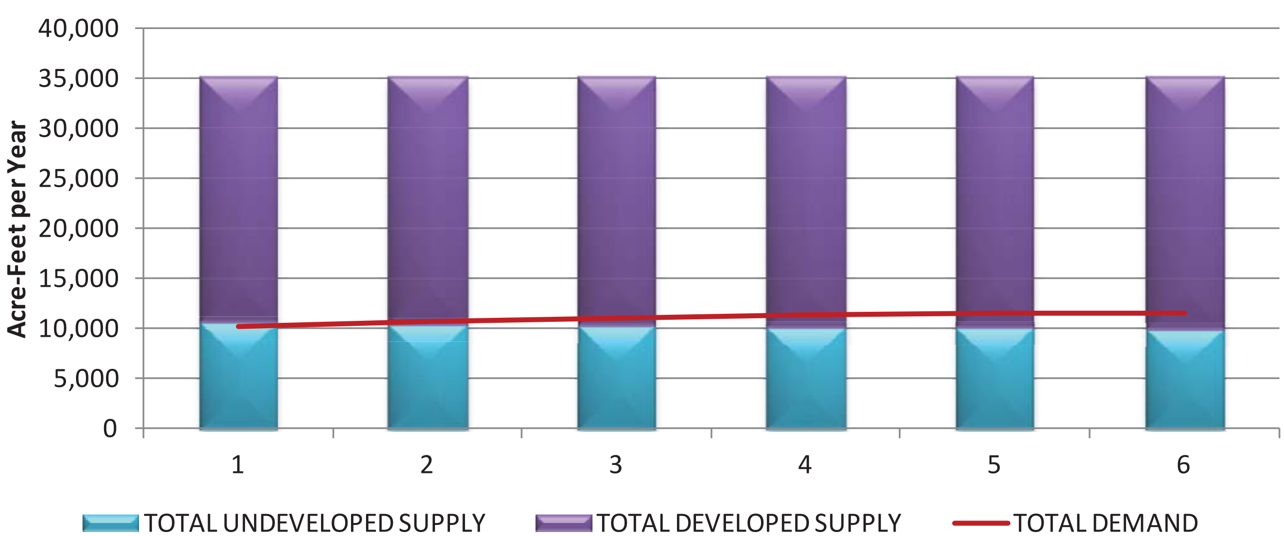
YOUR WATER SOURCE:
Groundwater Wells
Local Supplies
Neches River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 99% Groundwater and 1% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

HENDERSON COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Jeb Hensarling

YOUR STATE SENATOR:
Robert Nichols

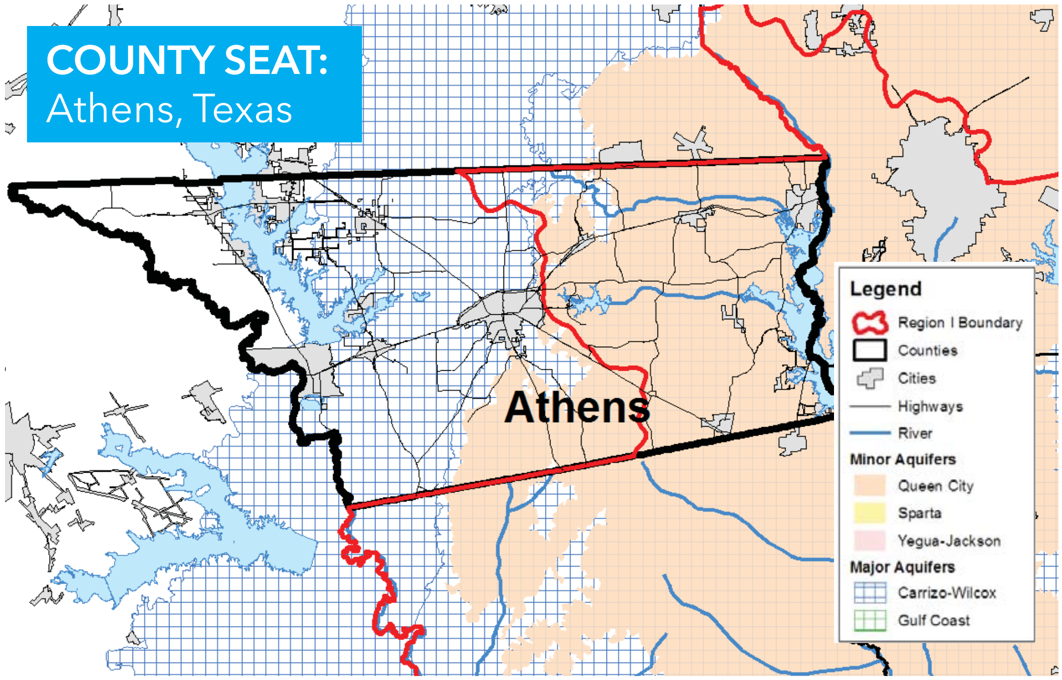
YOUR STATE REPRESENTATIVES:
Stuart Spitzer, John Wray

YOUR COUNTY JUDGE:
Richard Sanders

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)
Monty Shank

YOUR MUNICIPAL WATER USERS:
Athens
Berryville
Bethel-Ash WSC
Brownsboro
Brushy Creek WSC
Caney City
Chandler
Coffee City
East Cedar Creek FWSD
Enchanted Oaks
Eustace
Frankston
Gun Barrel City
Log Cabin
Malakoff
Moore Station
Murchison
Payne Springs
Poynor
R-P-M WSC
Seven Points
Star Harbor
Tool
Trinidad
Virginia Hill WSC
West Cedar Creek MUD

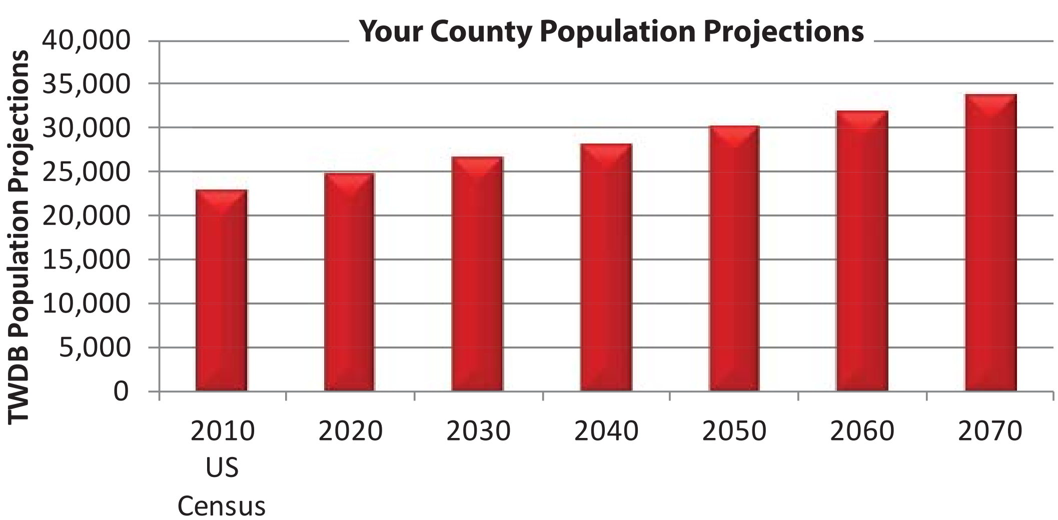
COUNTY SEAT:
Athens, Texas



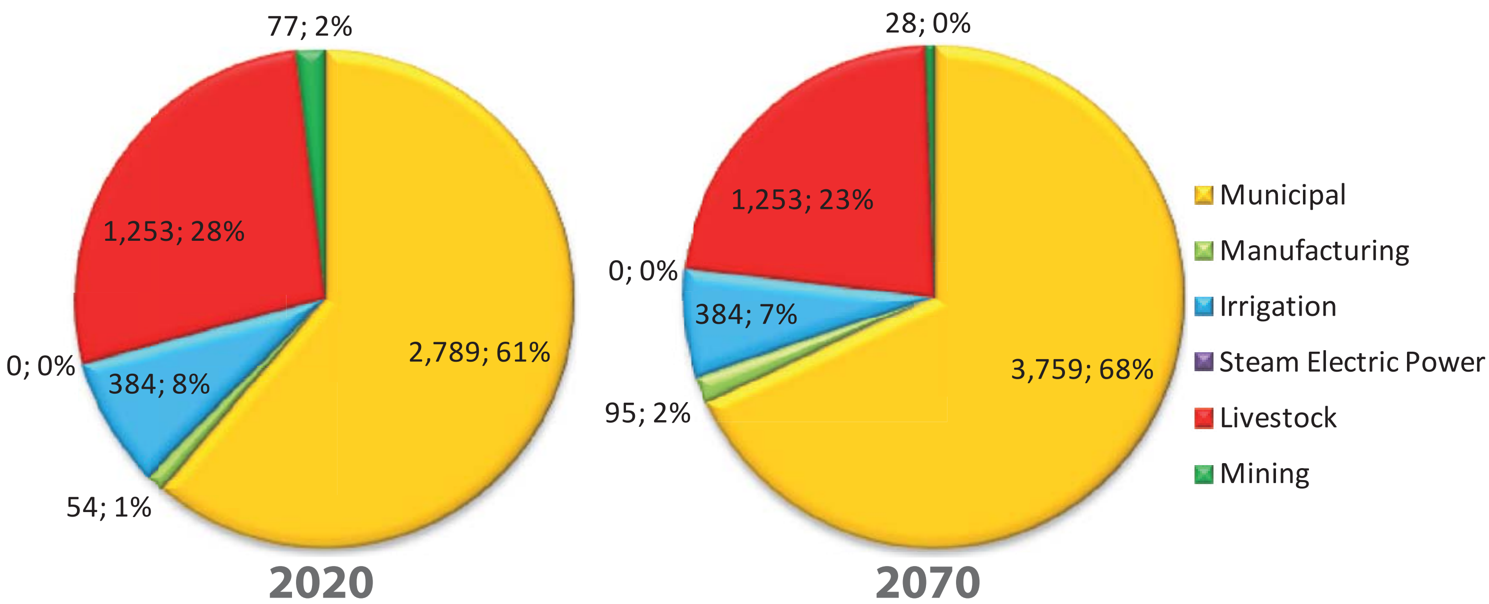
This county is split between more than one TWDB regional water planning area. The projections shown in these summary sheets represent data for the portion of the county that falls within the East Texas Regional Water Planning Area.

YOUR WATER-DEPENDENT ECONOMY:
Livestock
Oil & Gas Production
Recreation

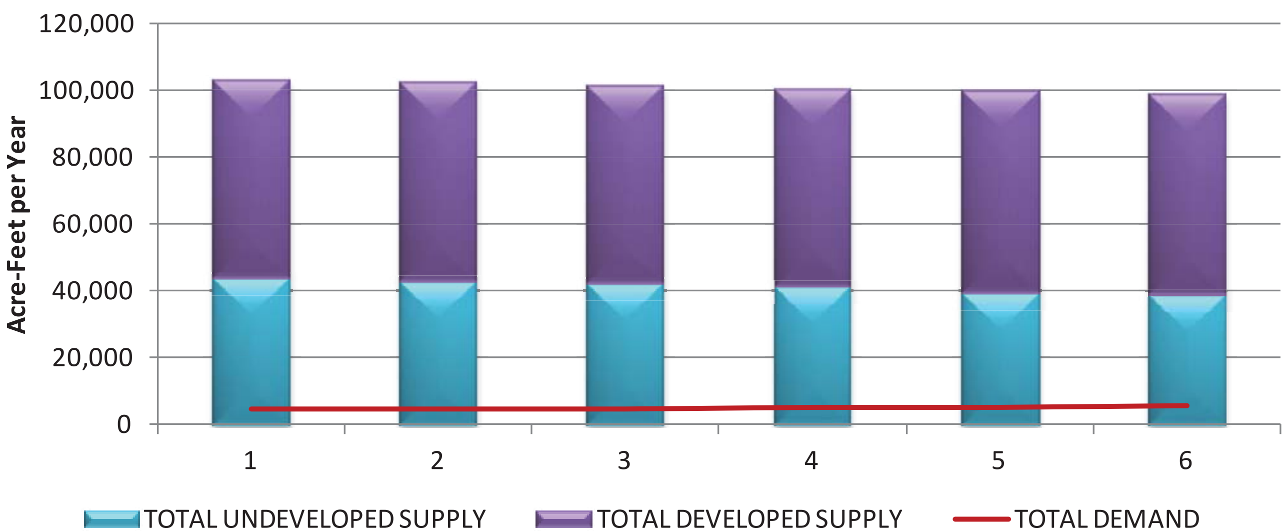
YOUR WATER SOURCE:
Groundwater Wells
Lake Athens
Lake Cherokee
Lake Palestine
Local Supplies



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 16% Groundwater and 84% Surface Water.

Your Water User Groups with Identified Needs

Athens	Purchase from Athens MWA (Carrizo-Wilcox Aquifer)
Chandler	Municipal Conservation; Purchase from Upper Neches River MWA (Neches River)
R-P-M WSC	Municipal Conservation
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

HOUSTON COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Kevin Brady

YOUR STATE SENATOR:
Robert Nichols

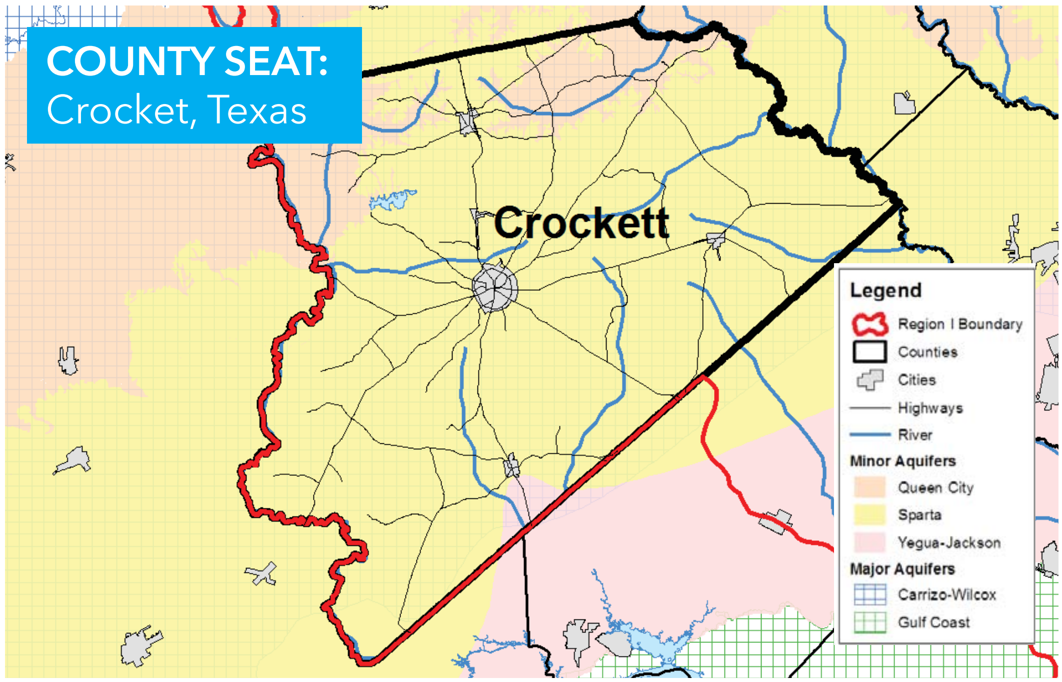
YOUR STATE REPRESENTATIVE:
Trent Ashby

YOUR COUNTY JUDGE:
Erin Ford

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Joe Holcomb
Leah Adams (GMA 11)

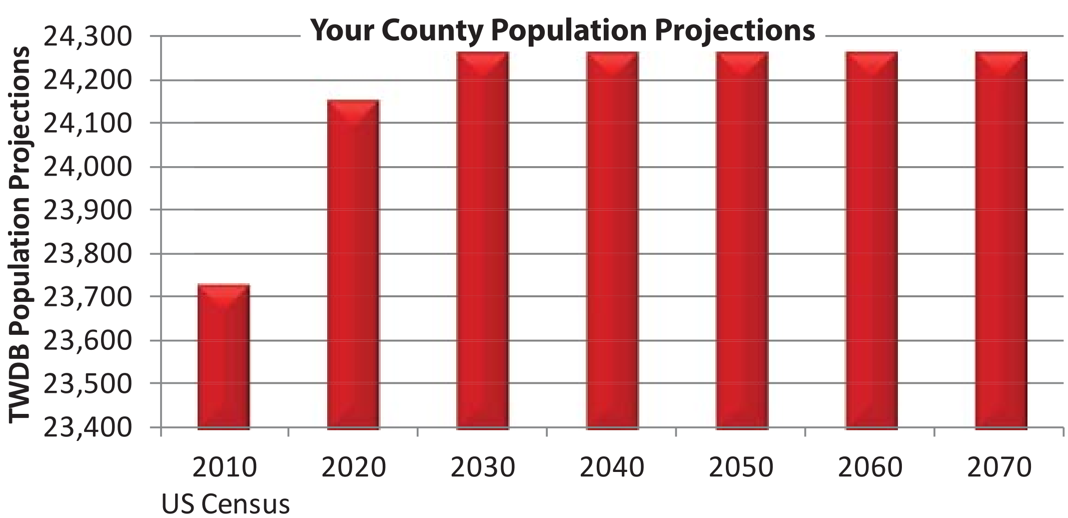
YOUR MUNICIPAL WATER USERS:
Austonio
Belott
Crockett
Germany
Grapeland
Hopewell
Houston County LID #1
Houston County WCID #1
Kennard
Latexo
Lovelady
Pennington
Porter Springs
Ratcliff
Sand Ridge
The Consolidated WSC
Weches

COUNTY SEAT:
Crocket, Texas

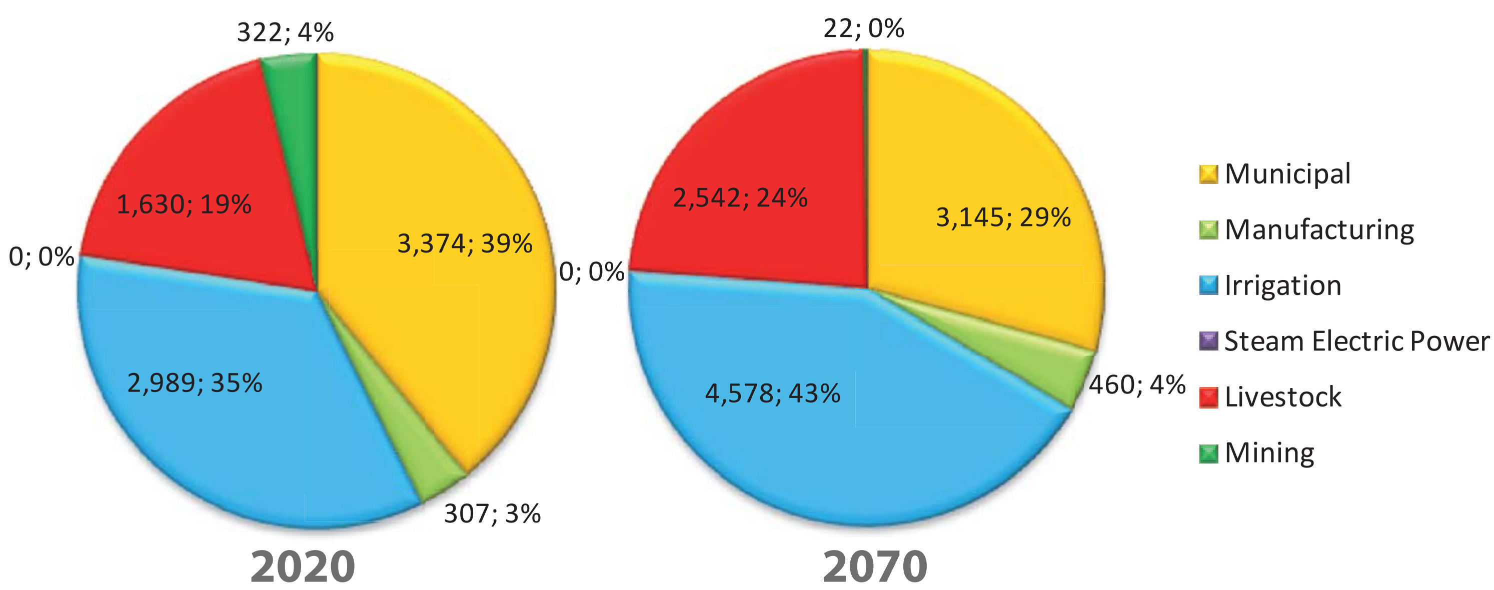


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Livestock
Oil & Gas Production

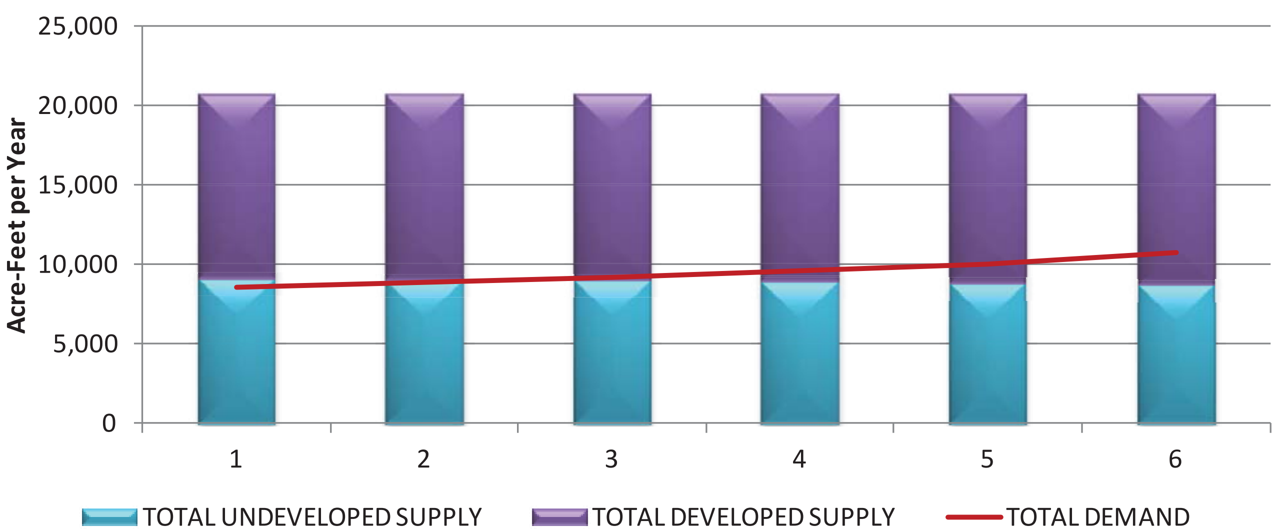
YOUR WATER SOURCE:
Groundwater Wells
Houston County Lake
Local Supplies
Neches River
Trinity River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 64% Groundwater and 36% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	New Wells (Yegua-Jackson Aquifer)
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified
Municipal	No Water Shortage Identified

JASPER COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

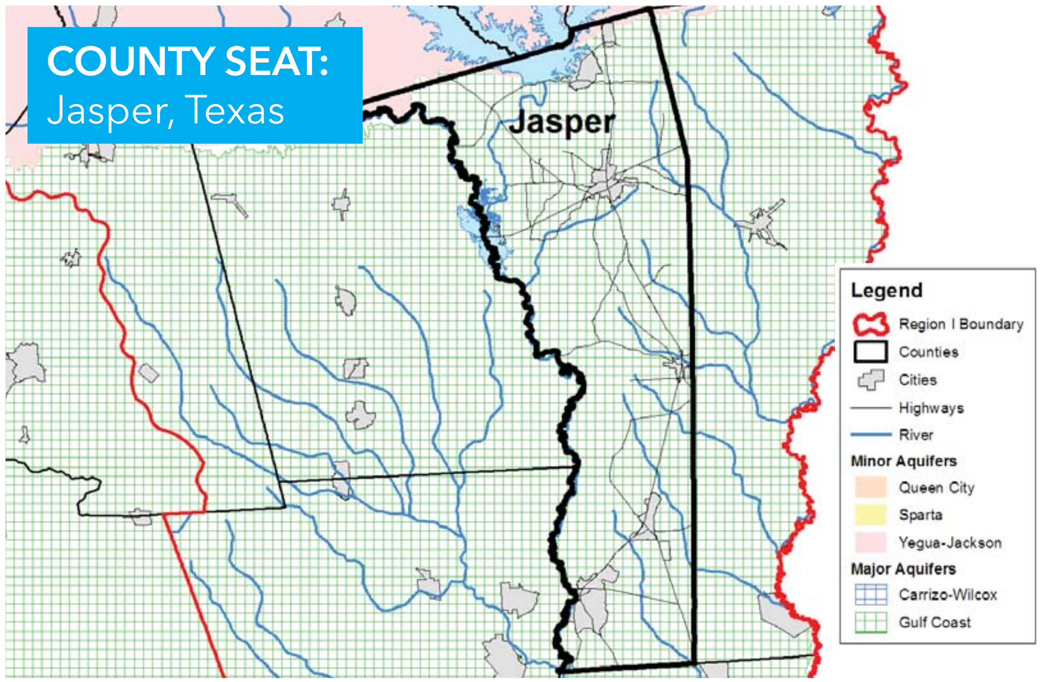
YOUR STATE REPRESENTATIVE:
James White

YOUR COUNTY JUDGE:
Mark Allen

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
John Martin (GMA 14)

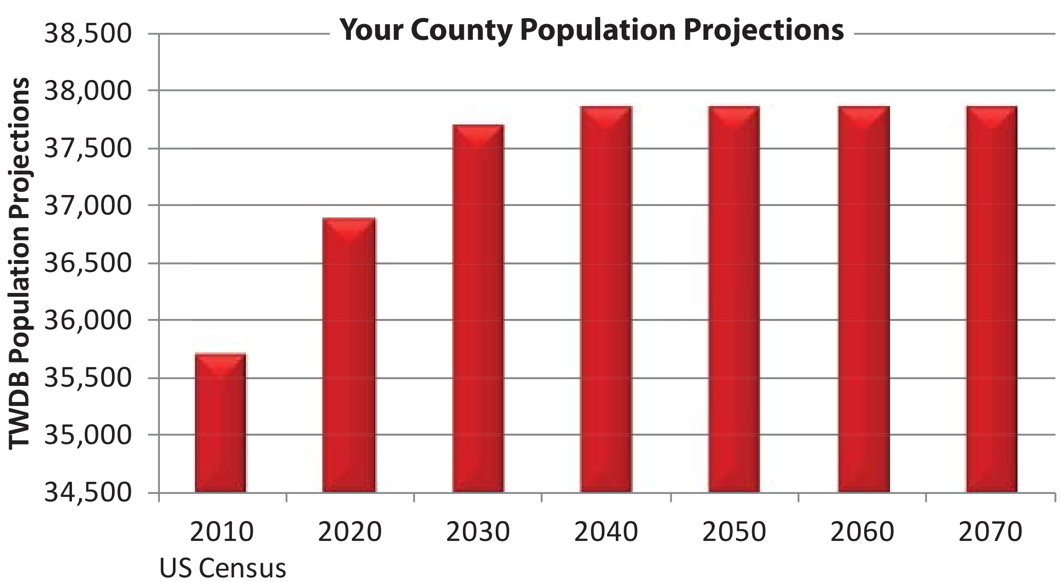
YOUR MUNICIPAL WATER USERS:
Brookeland Fresh Water Supply District
Browndell
Buna
Evadale
Jasper
Jasper County WCID #1
Kirbyville
Mauriceville SUD
Rayburn Country MUD
South Jasper County Water Supply
Upper Jasper County Water Authority

COUNTY SEAT:
Jasper, Texas

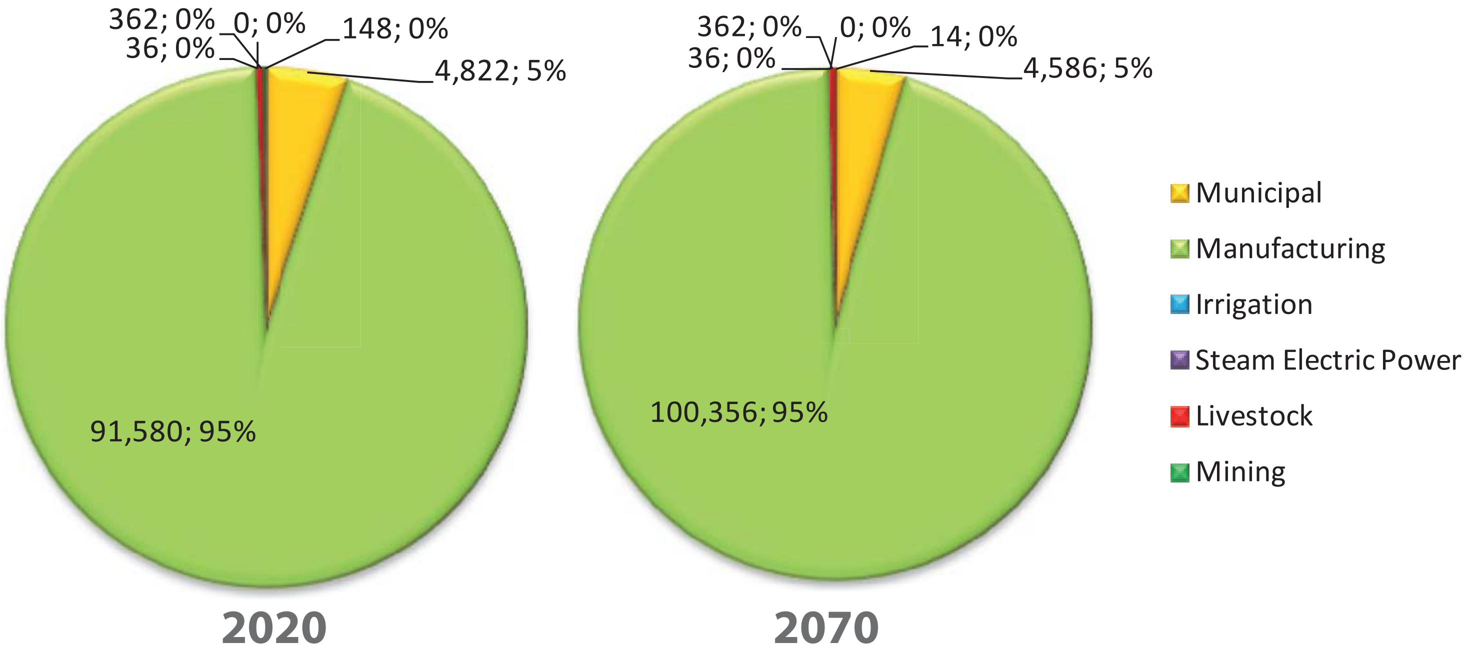


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Timber

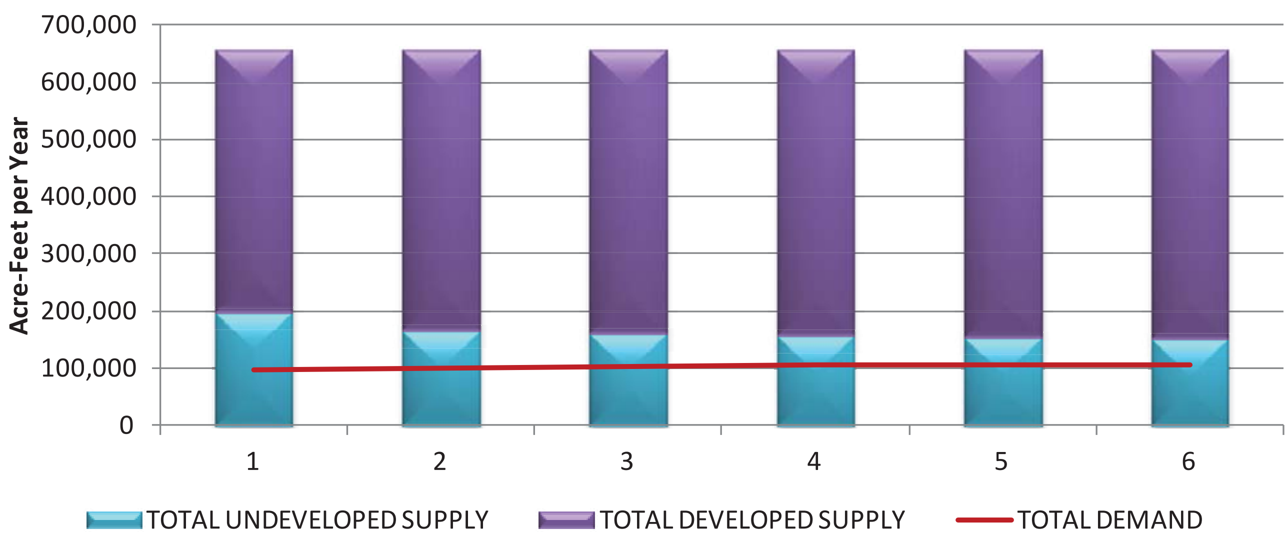
YOUR WATER SOURCE:
BA Steinhagen Lake
Groundwater Wells
Local Supplies
Neches River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 10% Groundwater and 90% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	Purchase from Lower Neches Valley Authority (Sam Rayburn)
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

JEFFERSON COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Randy Weber

YOUR STATE SENATOR:
Brandon Creighton

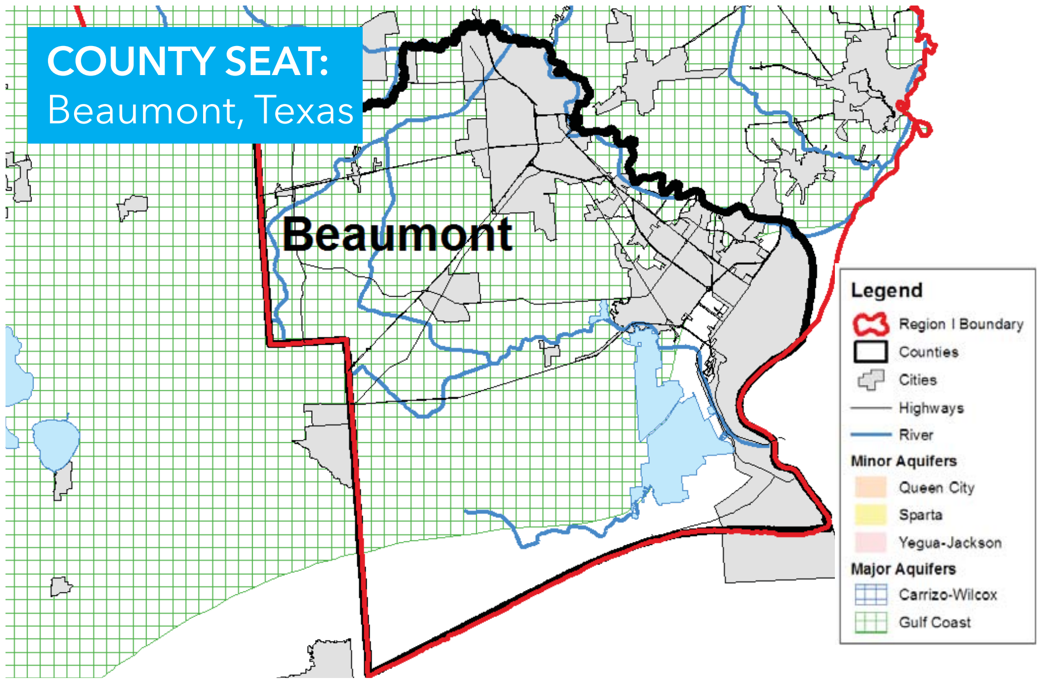
YOUR STATE REPRESENTATIVES:
Dade Phelan, Joe D. Deshotel

YOUR COUNTY JUDGE:
John Stevens

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Bill Kimbrough
Dale R. Peddy
Darla Smith
Jeff Branick
John Martin (GMA 14)
Scott Hall

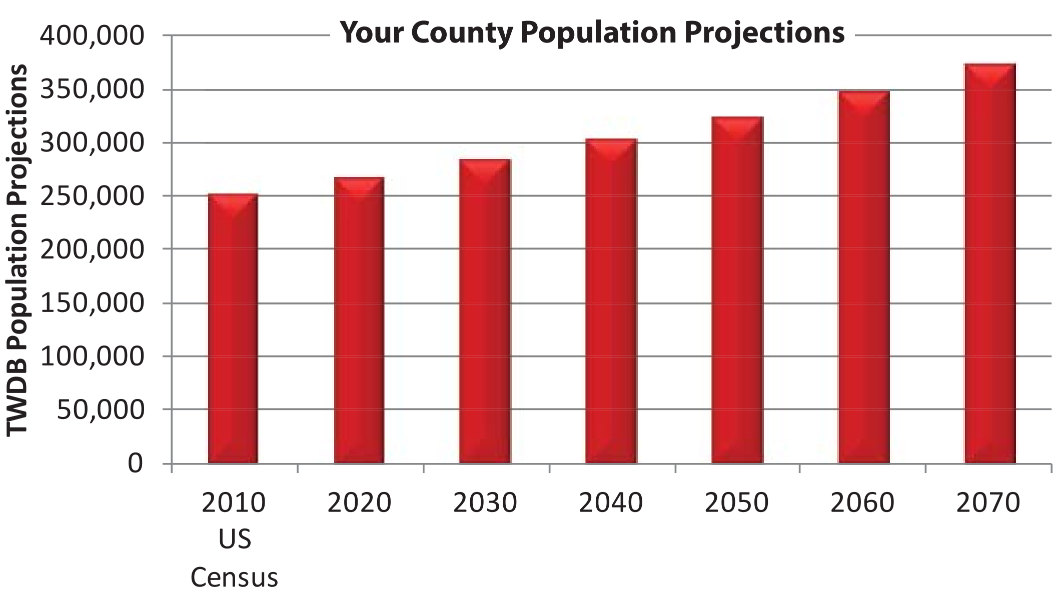
YOUR MUNICIPAL WATER USERS:
Beaumont
Bevil Oaks
Bevil Oaks MUD
China
Groves
Jefferson County WCID #10
Meeker MUD
Meeker Municipal Water District
Nederland
Nome
Port Arthur
Port Neches
West Jefferson County MWD
West Jefferson MWD

COUNTY SEAT:
Beaumont, Texas

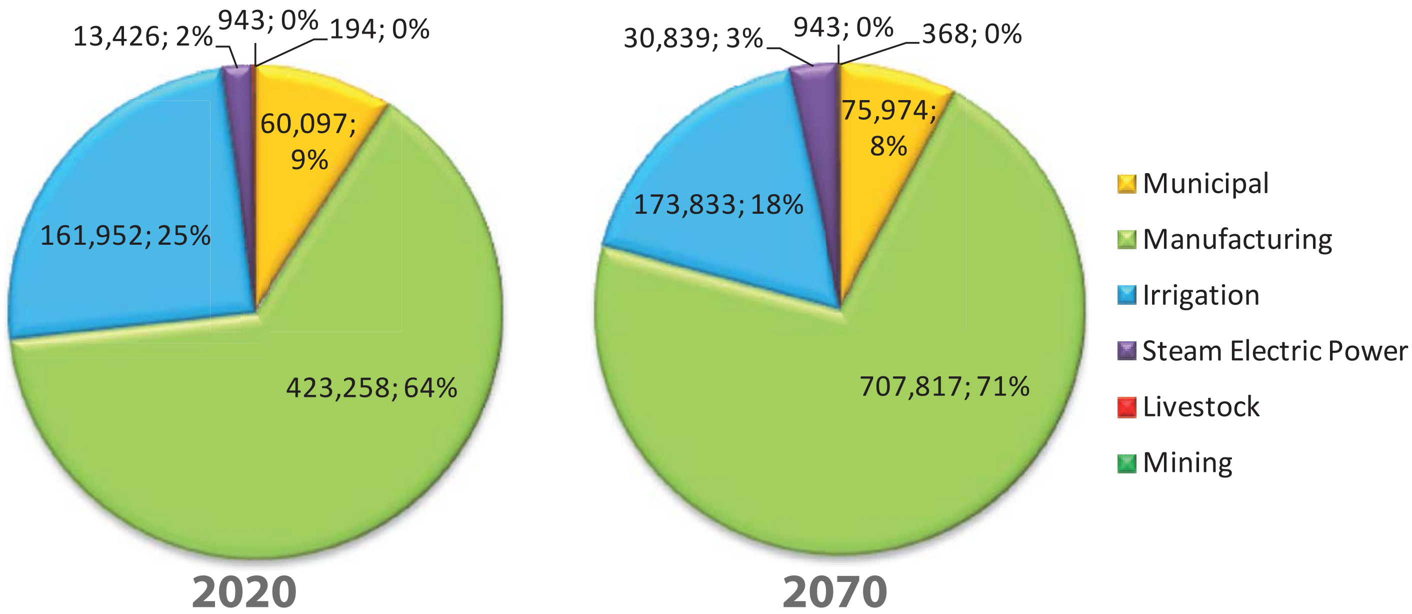


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Education
Industry
Recreation

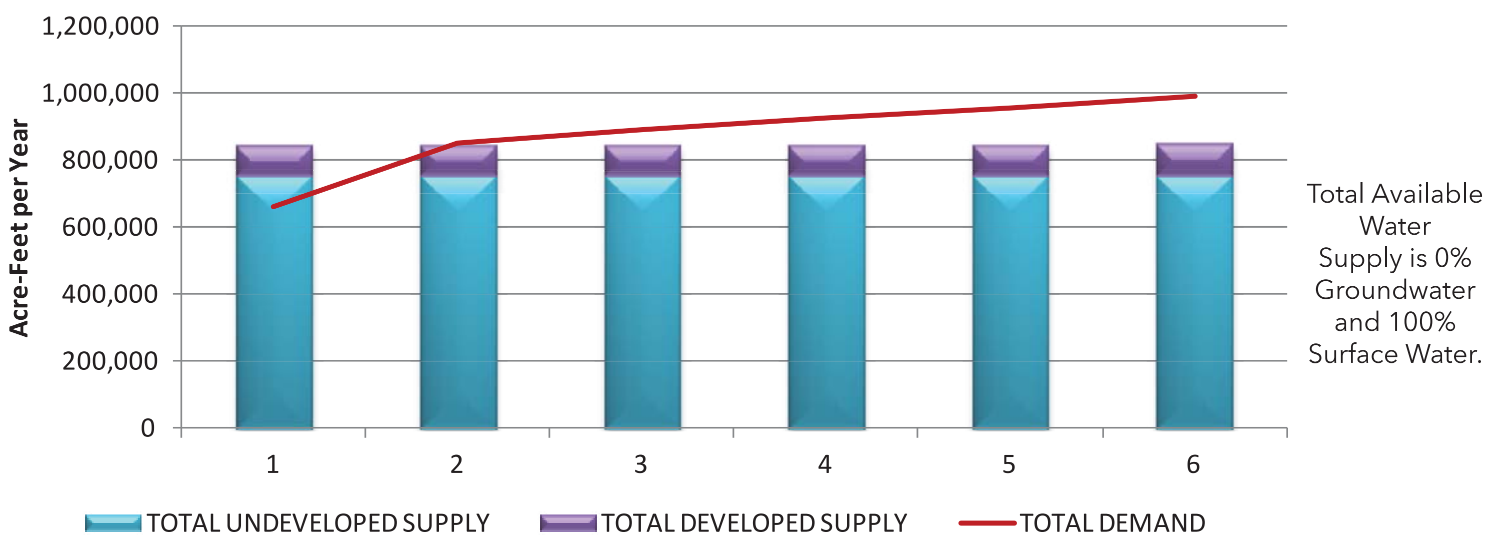
YOUR WATER SOURCE:
Groundwater Wells
Indirect Reuse
Local Supplies
Neches River
Neches-Trinity River



Your County Water Use (acre-feet ; % of total)

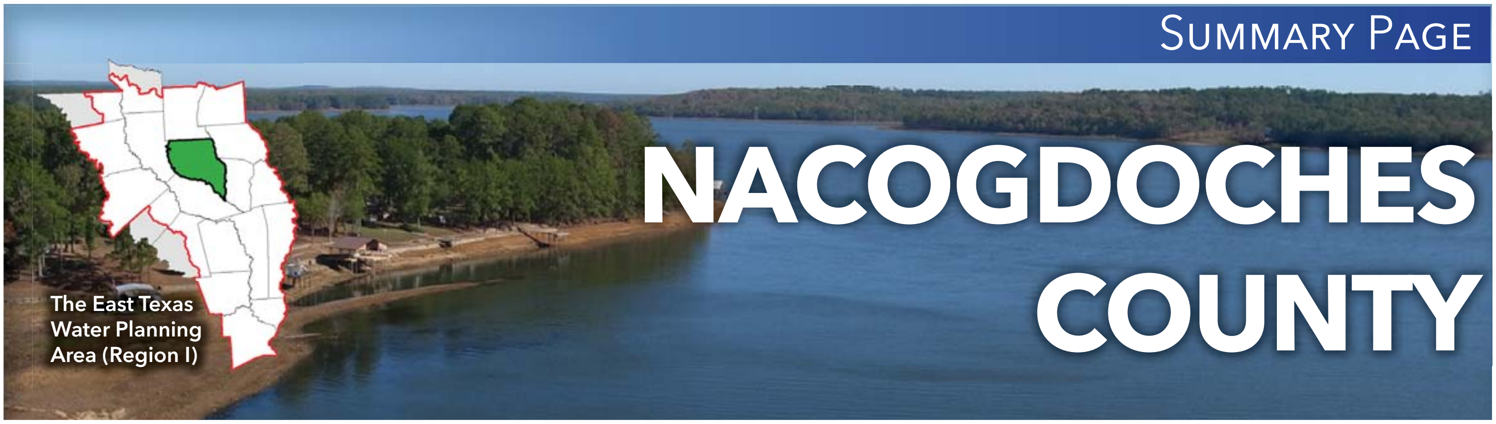


Your Available Water Supply



Your Water User Groups with Identified Needs

Beaumont	Municipal Conservation
County-Other	Purchase from Lower Neches Valley Authority (Sam Rayburn)
Manufacturing	Purchase from Lower Neches Valley Authority (Sam Rayburn)
Irrigation	No Water Shortage Identified
Steam Electric Power	Purchase from Lower Neches Valley Authority (Sam Rayburn)
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified



NACOGDOCHES COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Robert Nichols

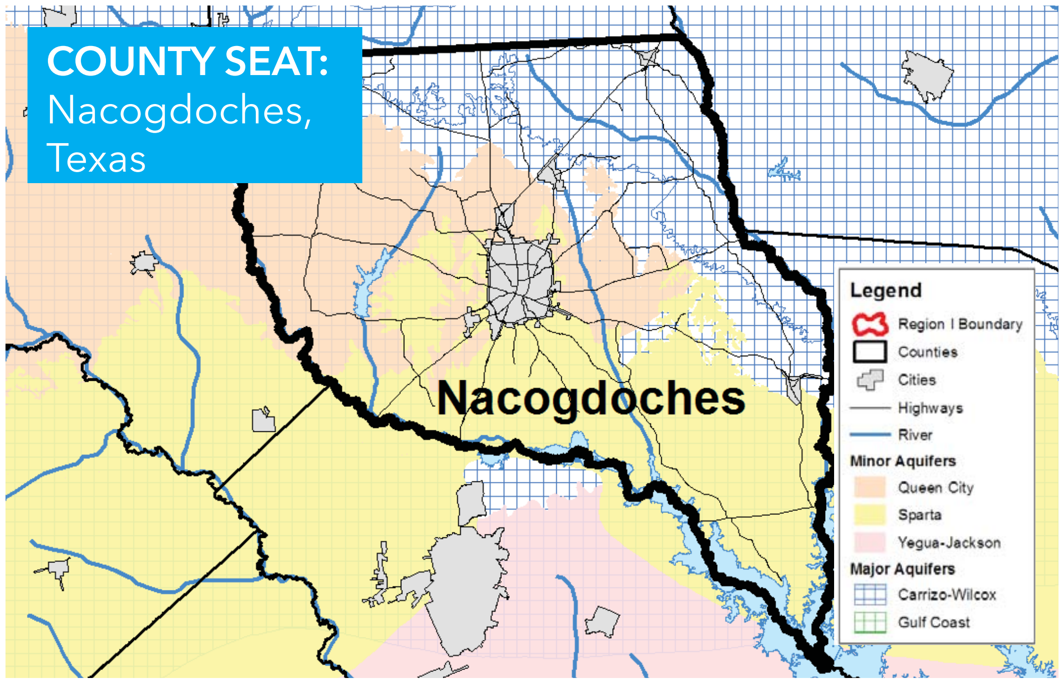
YOUR STATE REPRESENTATIVE:
Travis Clardy

YOUR COUNTY JUDGE:
Mike Perry

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
David Alders
J. Leon Young
Leah Adams (GMA 11)
Michael Harbordt

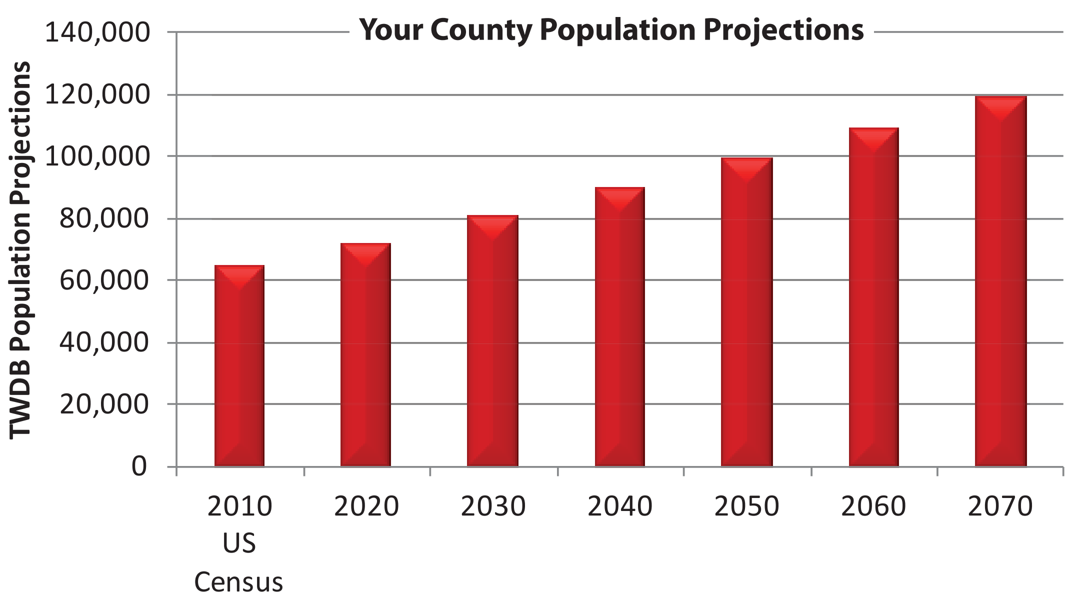
YOUR MUNICIPAL WATER USERS:
Appleby
Appleby WSC
Arlam Concord WSC
Caro WSC
Chireno
Cushing
D&M WSC
Etoile WSC
Garrison
Lilly Grove SUD
Melrose WSC
Nacogdoches
Nacogdoches County MUD 1
Sacul WSC
Swift WSC
Timpson Rural WSC
Woden WSC

COUNTY SEAT:
Nacogdoches, Texas

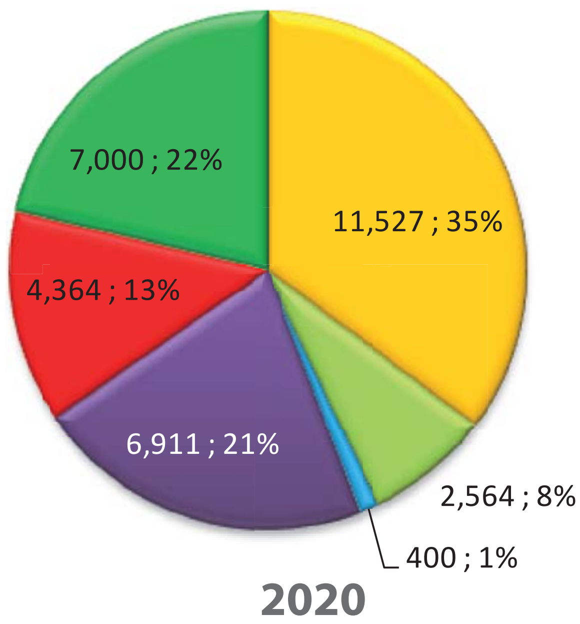


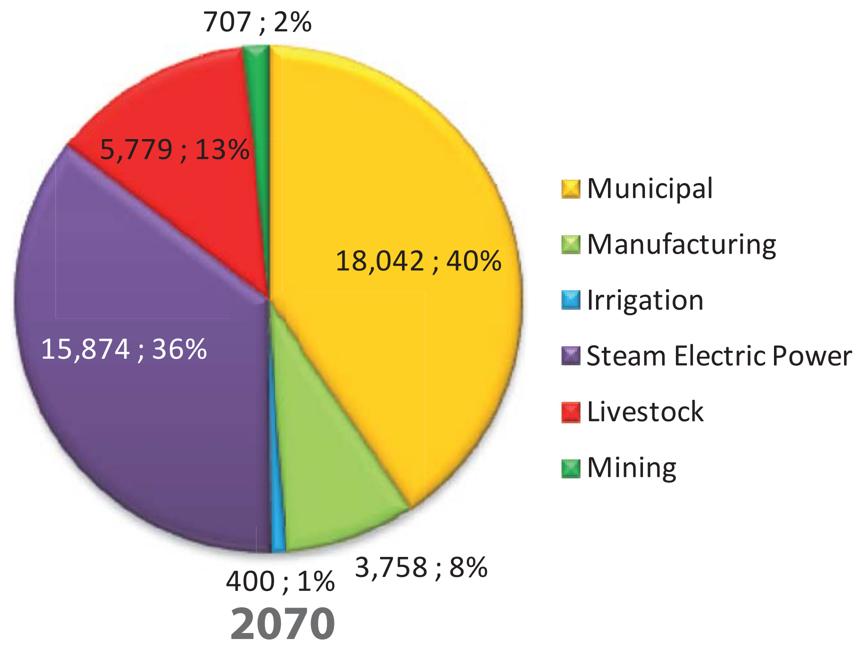
YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Education
Livestock
Timber

YOUR WATER SOURCE:
Groundwater Wells
Lake Nacogdoches
Local Supplies
Neches River
Sam Rayburn Reservoir

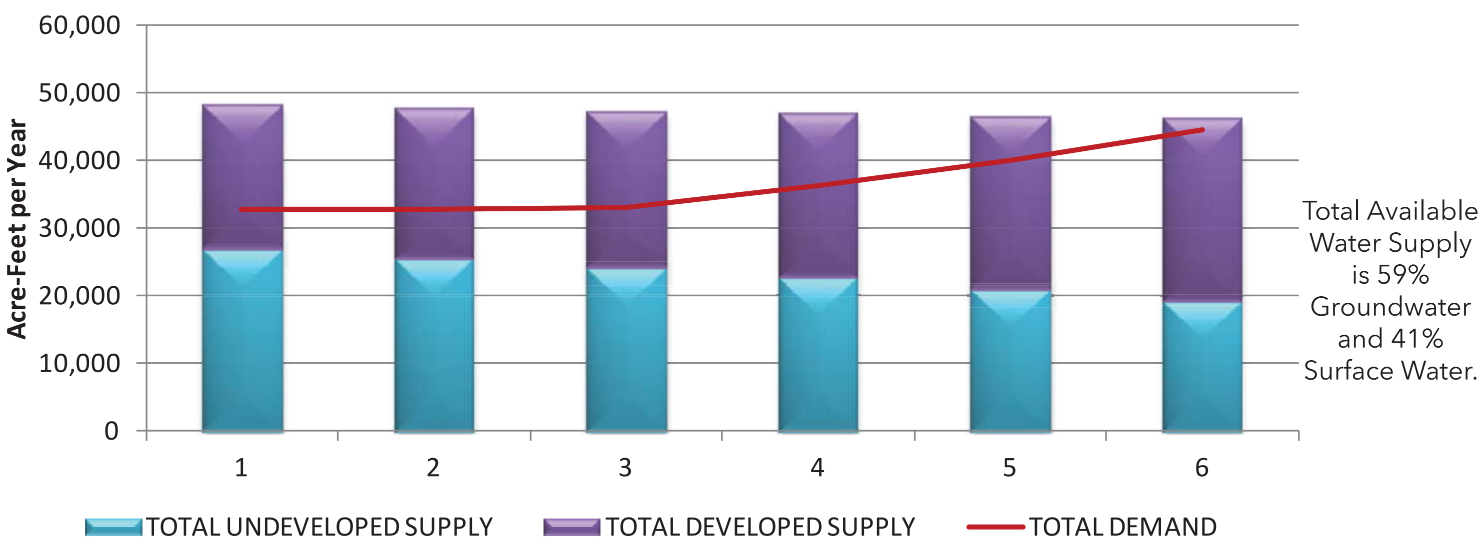


Your County Water Use (acre-feet ; % of total)



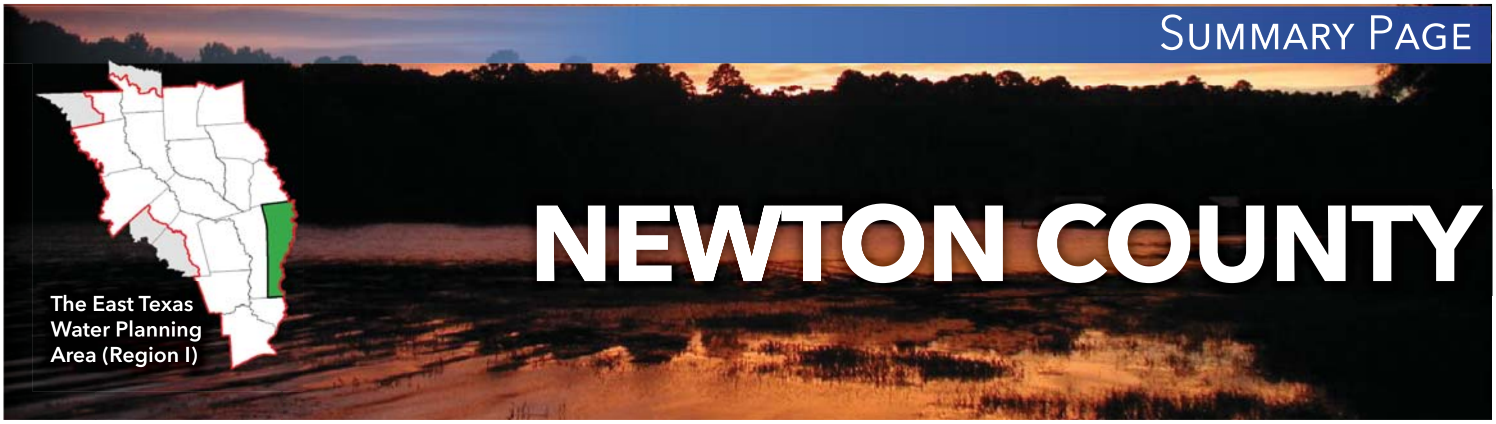


Your Available Water Supply



Your Water User Groups with Identified Needs

Multiple Users	Lake Naconiche Regional Water System
D&M WSC	New Wells (Carrizo-Wilcox Aquifer)
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	Purchase from Angelina Neches River Authority (Angelina River); New Wells (Carrizo-Wilcox Aquifer)
Livestock	New Wells (Carrizo-Wilcox Aquifer)
Mining	Purchase from Angelina Neches River Authority (Angelina River)



NEWTON COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

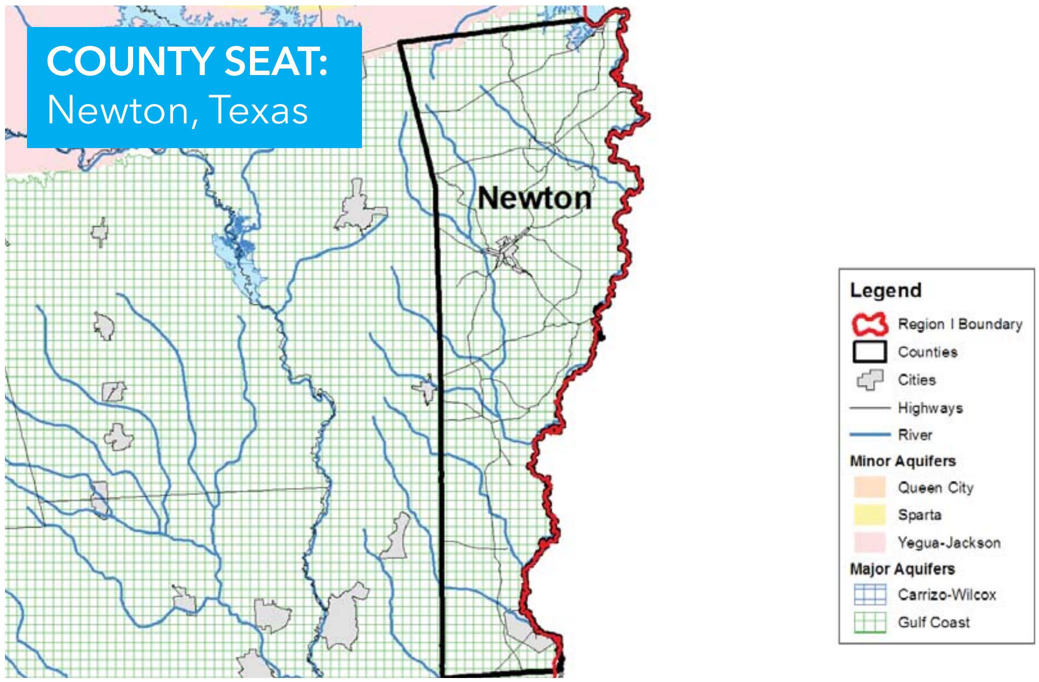
YOUR STATE REPRESENTATIVE:
James White

YOUR COUNTY JUDGE:
Ronnie W. Boyett

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
John Martin (GMA 14)

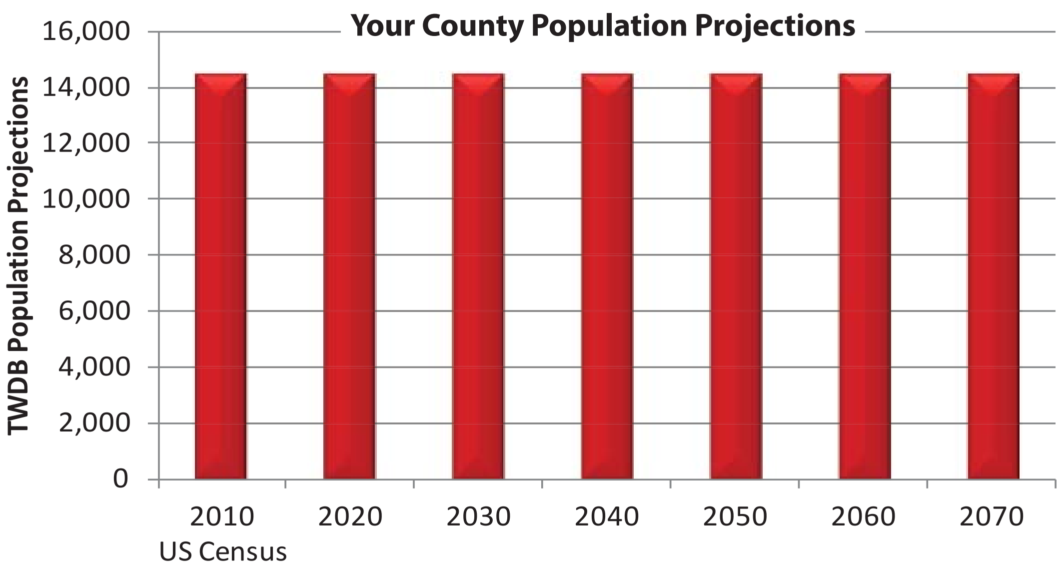
YOUR MUNICIPAL WATER USERS:
East Newton Water Supply
Biloxi
Bon Wier
Burkeville
Deweyville
Mauriceville SUD
Newton
Princeton
South Newton WSC
South Toledo Bend
Trotti
Wiergate

COUNTY SEAT:
Newton, Texas

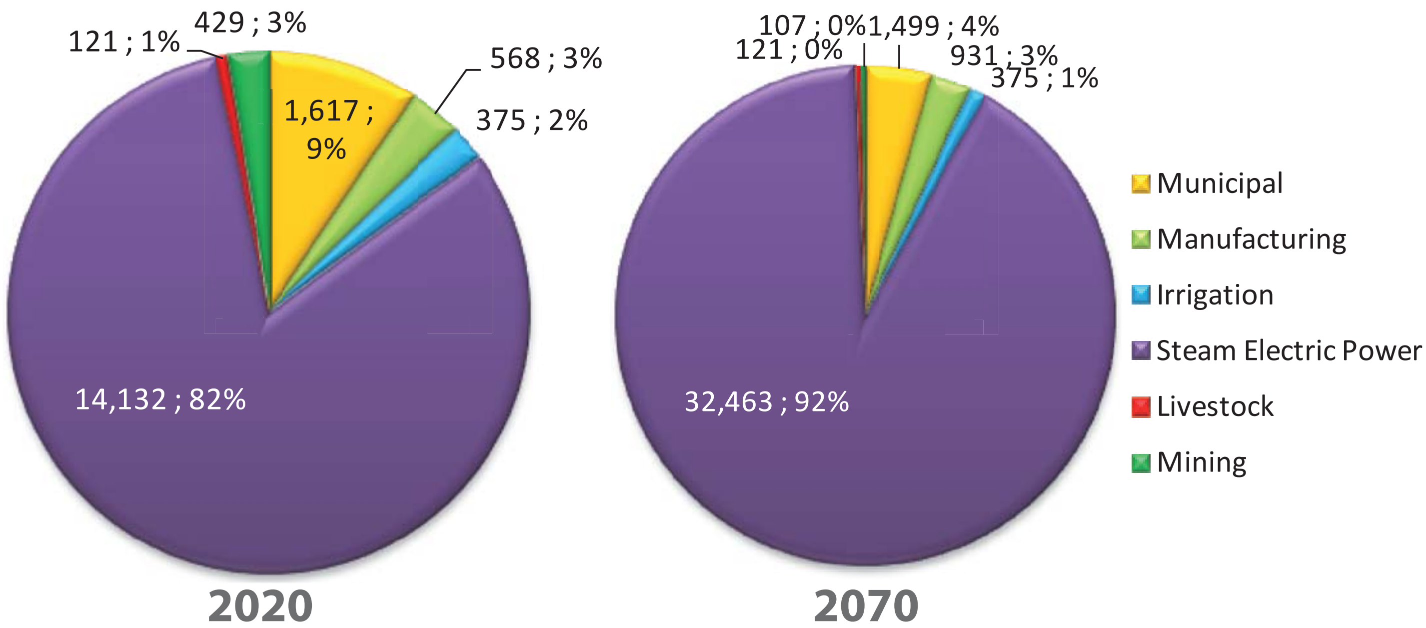


YOUR WATER-DEPENDENT ECONOMY:
Recreation
Timber

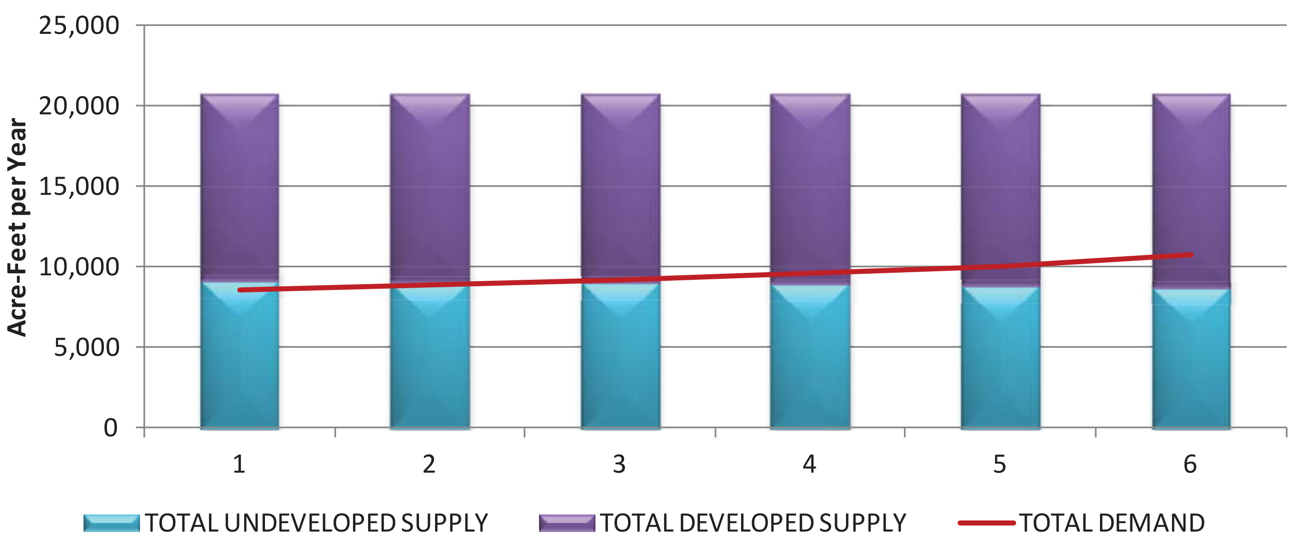
YOUR WATER SOURCE:
Groundwater Wells
Local Supplies
Sabine River
Toledo Bend Reservoir



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 19% Groundwater and 81% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	Purchase from Sabine River Authority (Toledo Bend)
Livestock	No Water Shortage Identified
Mining	Purchase from Sabine River Authority (Toledo Bend)

ORANGE COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

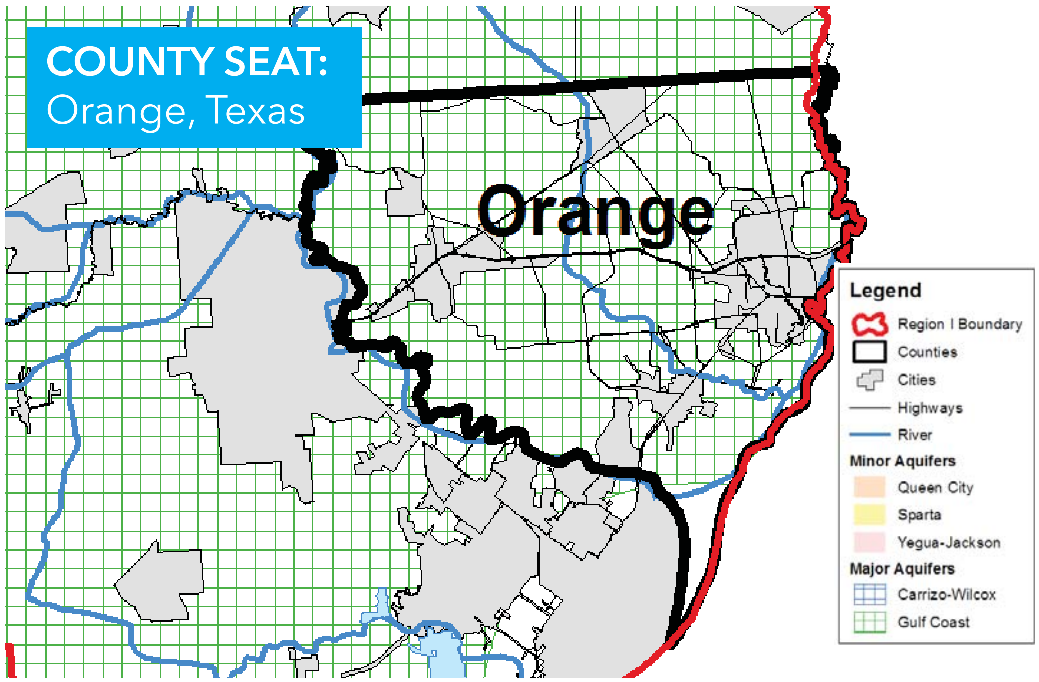
YOUR STATE REPRESENTATIVE:
Dade Phelan

YOUR COUNTY JUDGE:
Stephen Brint Carlton

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
David Montagne
John Martin (GMA 14)

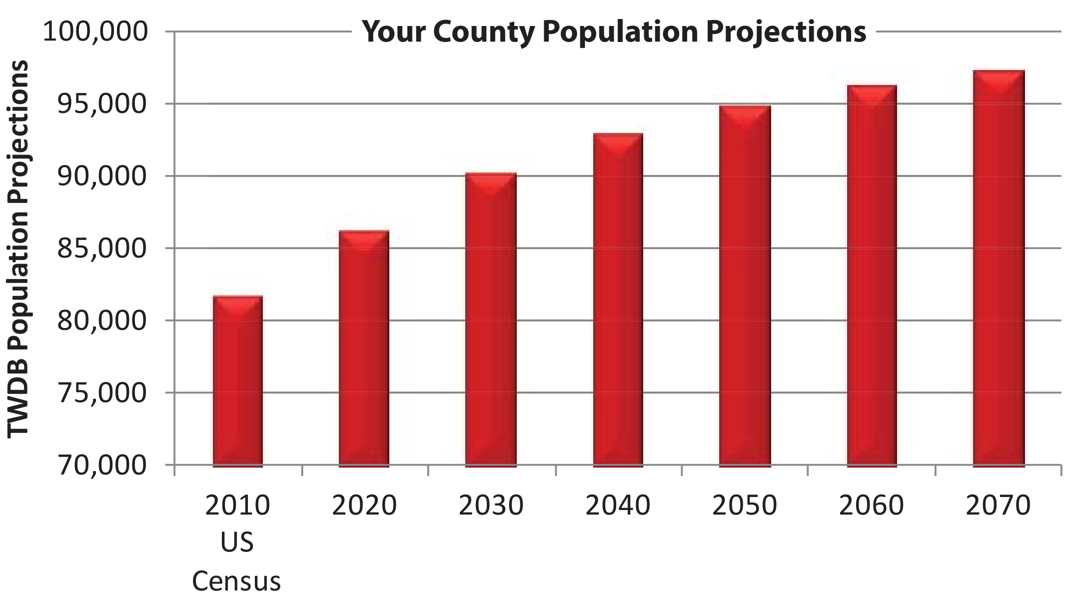
YOUR MUNICIPAL WATER USERS:
Bridge City
Mauriceville SUD
Orange
Orangefield Water Supply
Orangefield WSC
Pine Forest
Pinehurst
Port Arthur
Rose City
South Newton WSC
Vidor
West Orange

COUNTY SEAT:
Orange, Texas

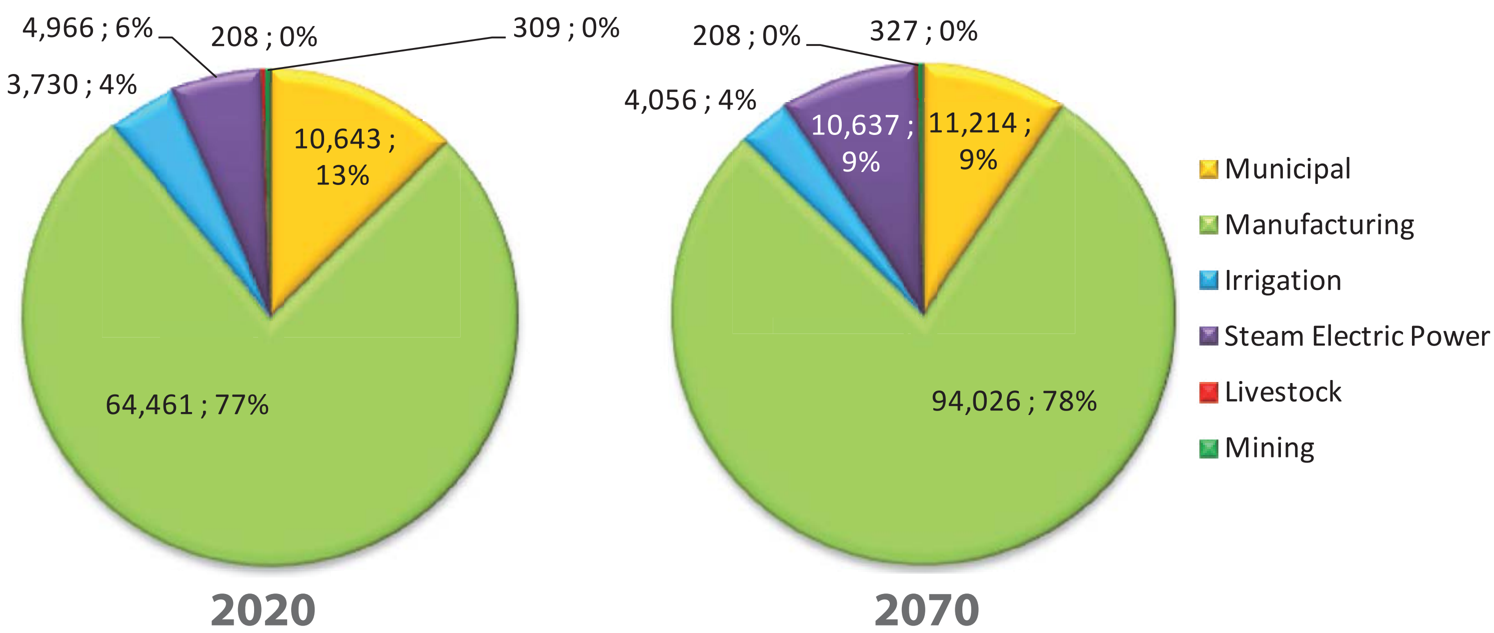


YOUR WATER-DEPENDENT ECONOMY:
Recreation
Timber
Industry

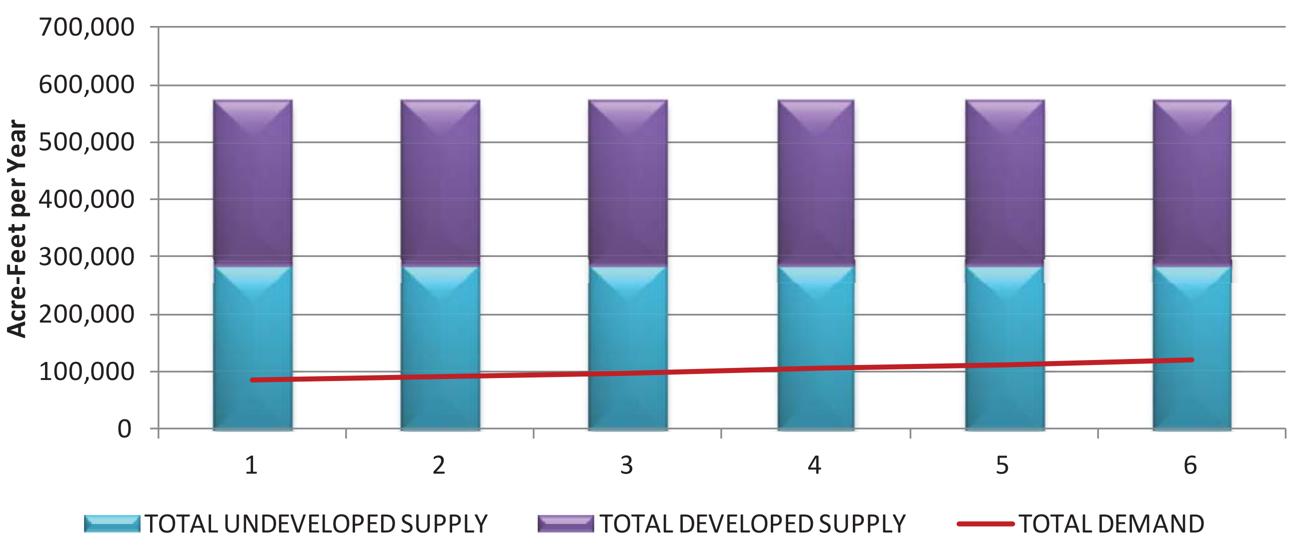
YOUR WATER SOURCE:
Direct Reuse
Groundwater Wells
Local Supplies
Neches River
Sabine River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 4% Groundwater and 96% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	Purchase from Sabine River Authority (Sabine River)
Irrigation	Purchase from Sabine River Authority (Toledo Bend)
Steam Electric Power	Purchase from Sabine River Authority (Sabine River)
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

PANOLA COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Kevin Eltife

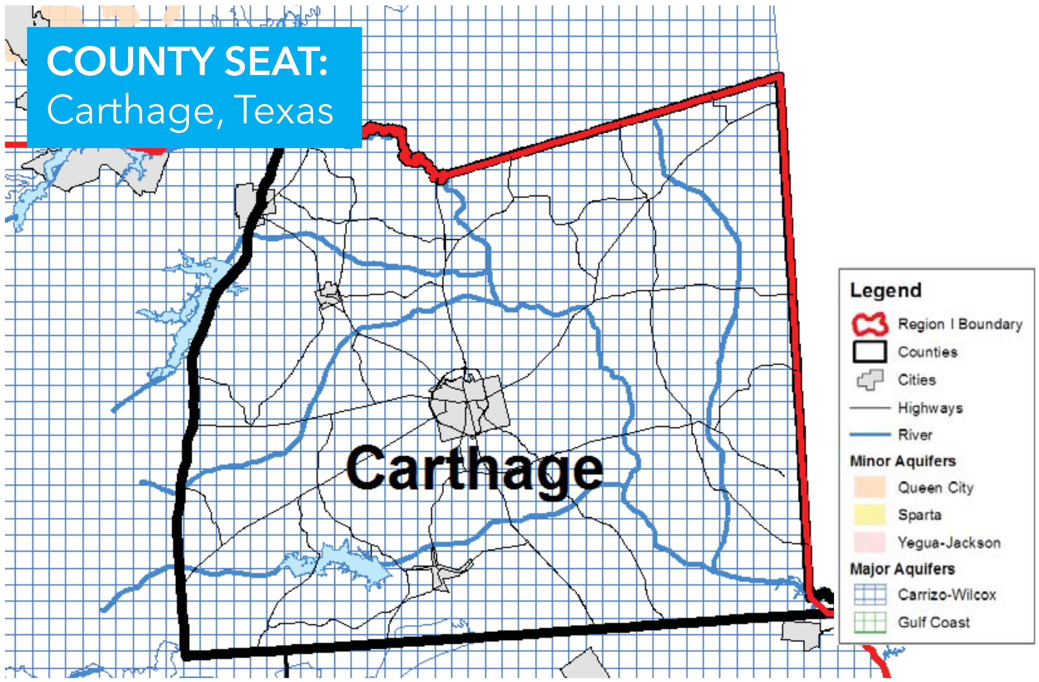
YOUR STATE REPRESENTATIVE:
Chris Paddie

YOUR COUNTY JUDGE:
LeeAnn Jones

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)

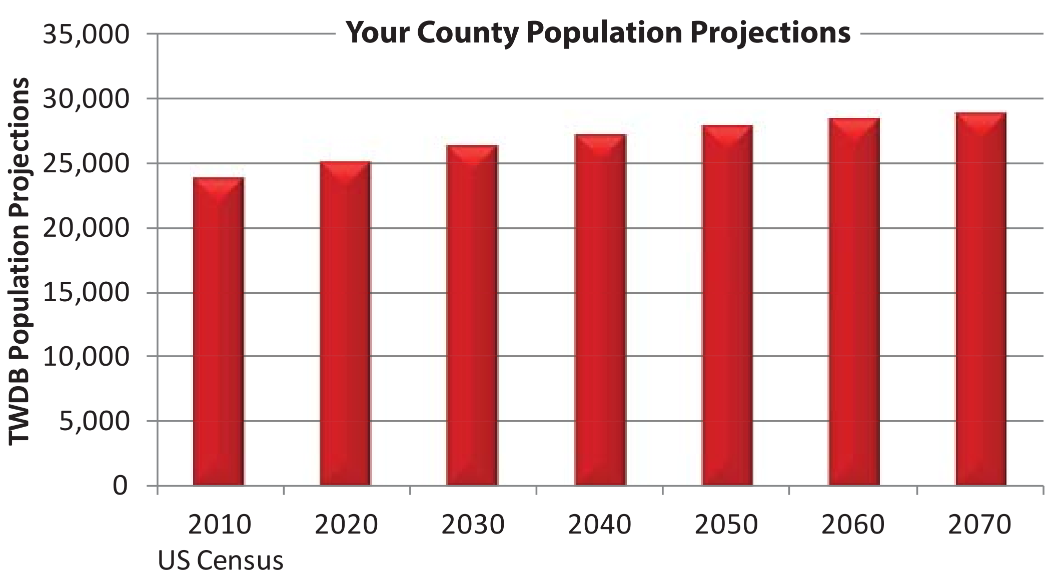
YOUR MUNICIPAL WATER USERS:
Beckville
Carthage
Clayton
Deberry
Gary
Gill WSC
Long Branch
Mineral Springs
Murvaul
Panola County FWSD #1
Tatum

COUNTY SEAT:
Carthage, Texas

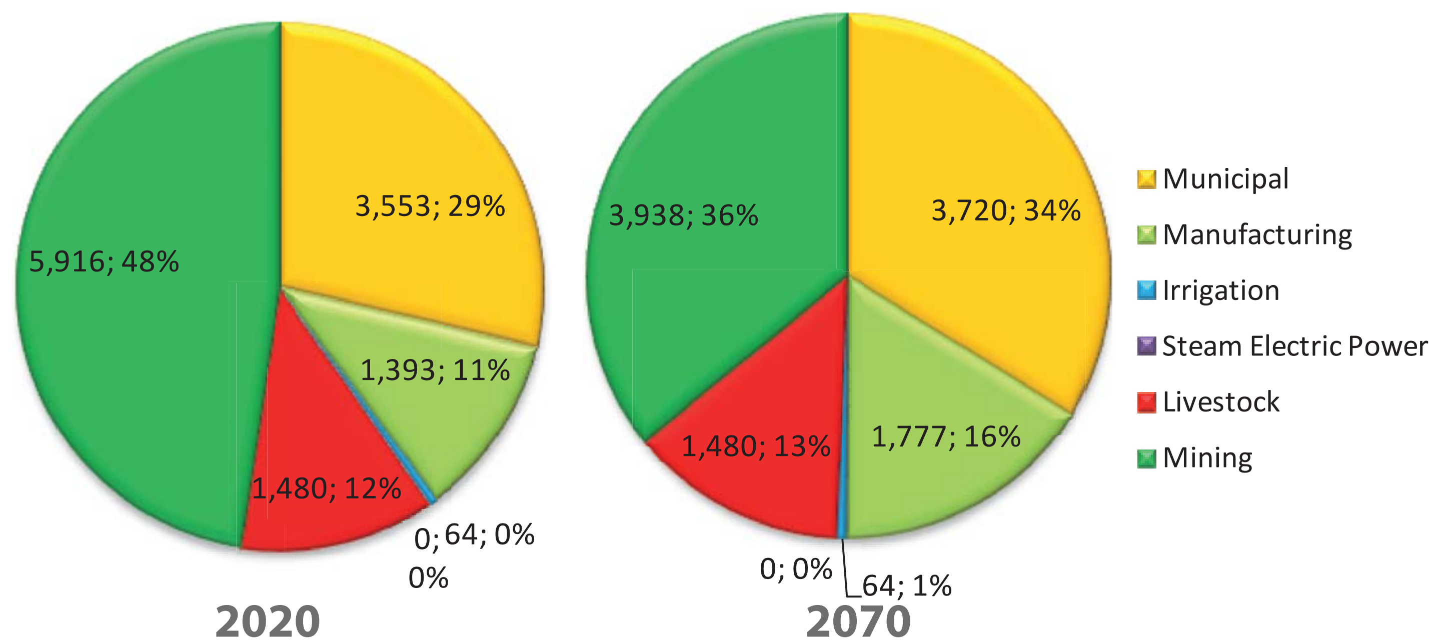


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Livestock
Oil & Gas Production

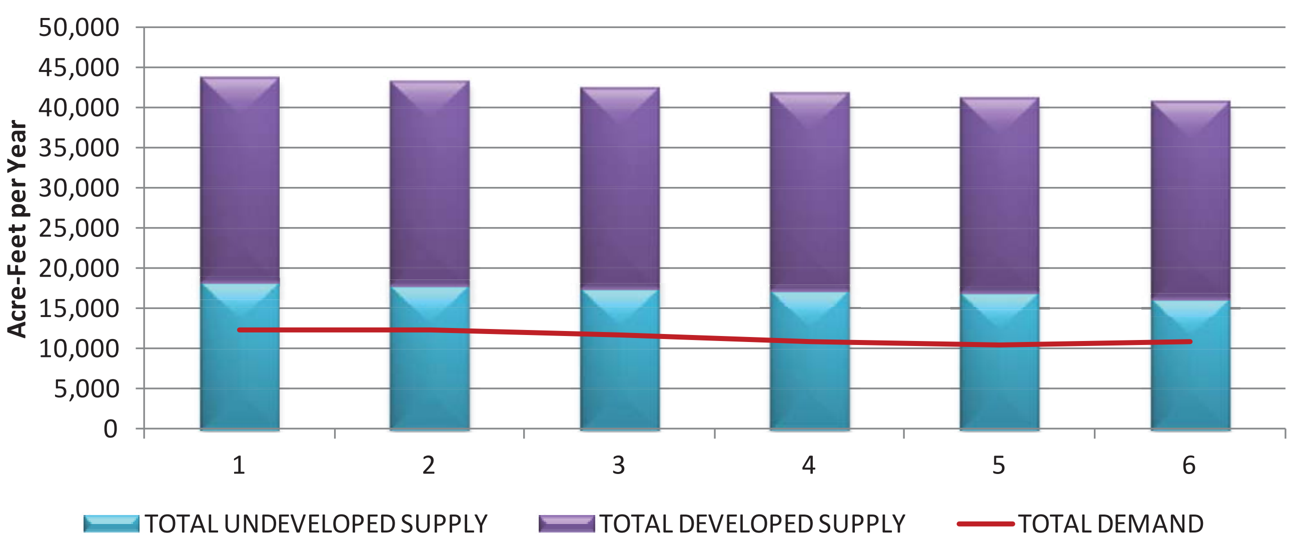
YOUR WATER SOURCE:
Groundwater Wells
Lake Murvaul
Local Supplies
Martin Lake
Sabine River



Your County Water Use (acre-feet ; % of total)



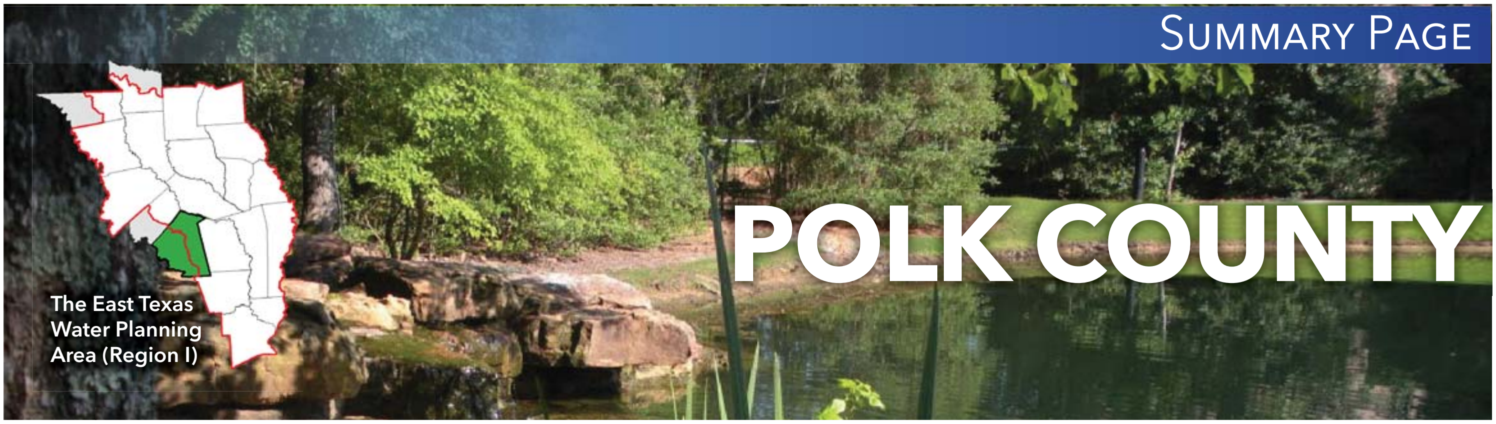
Your Available Water Supply



Total Available Water Supply is 19% Groundwater and 81% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	Purchase from Carthage (Lake Murvaul)
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified



POLK COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

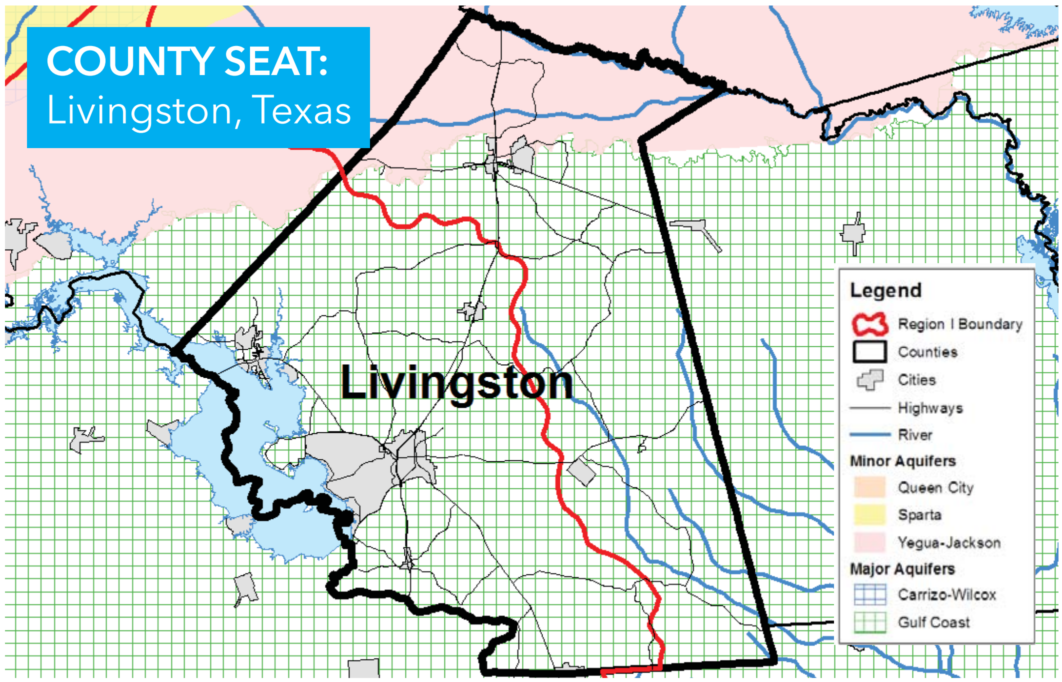
YOUR STATE REPRESENTATIVE:
James White

YOUR COUNTY JUDGE:
Sydney Murphy

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
John Martin (GMA 14)

YOUR MUNICIPAL WATER USERS:
Blanchard
Camden
Corrigan
Dallardsville
East Tempe
Goodrich
Leggett
Livingston
Moscow
Onalaska
Seven Oaks

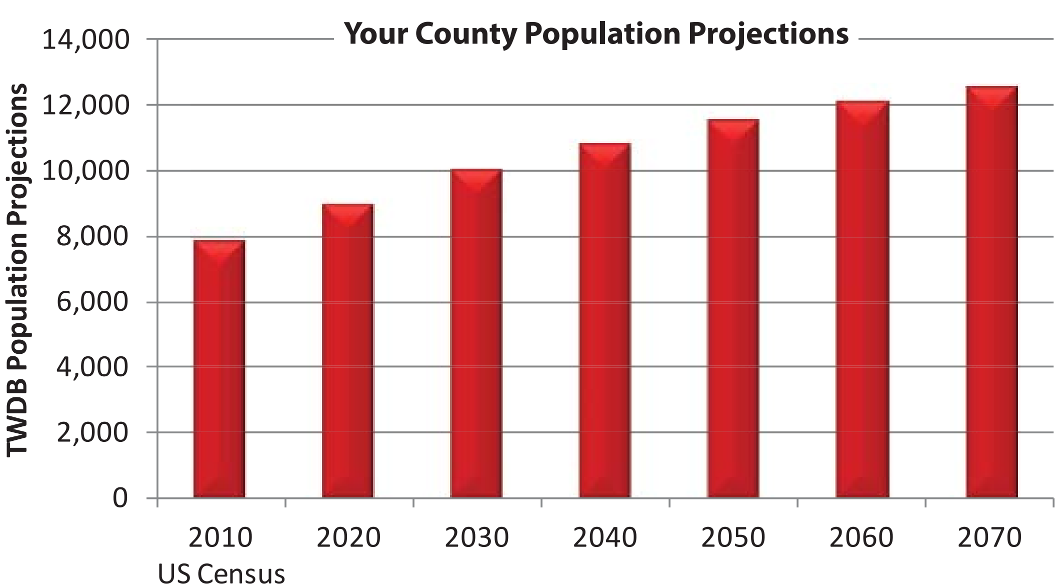
COUNTY SEAT:
Livingston, Texas



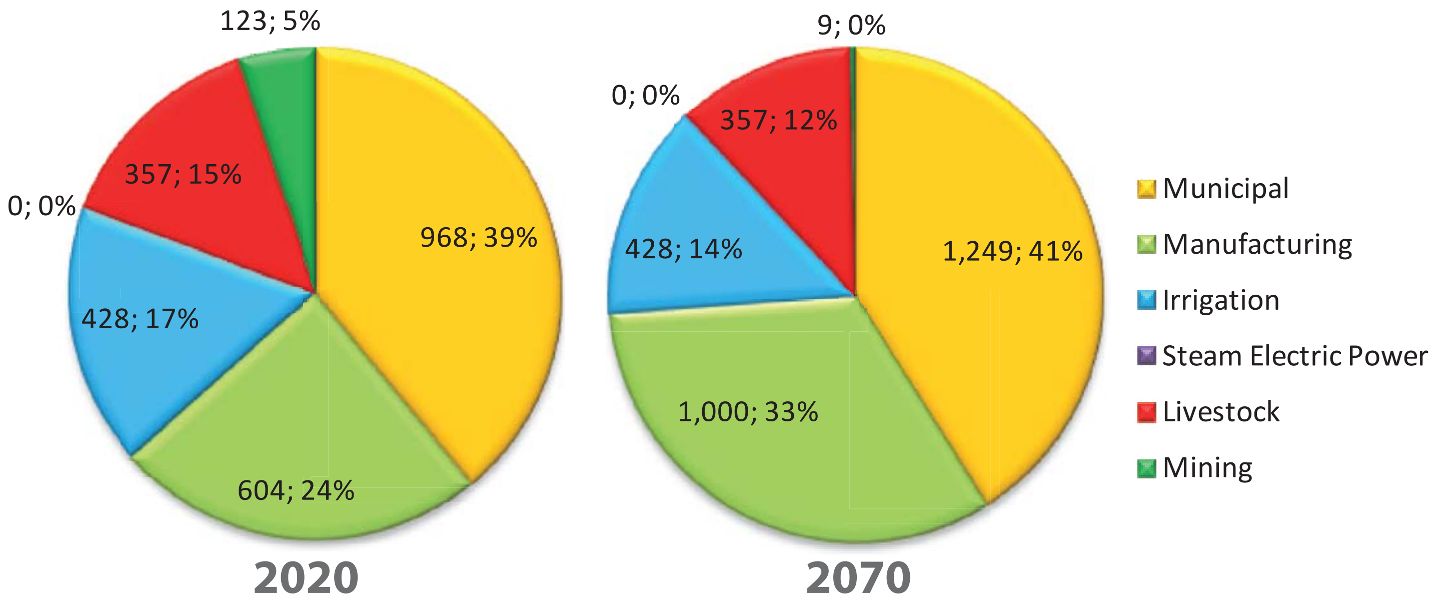
This county is split between more than one TWDB regional water planning area. The projections shown in these summary sheets represent data for the portion of the county that falls within the East Texas Regional Water Planning Area.

YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Livestock

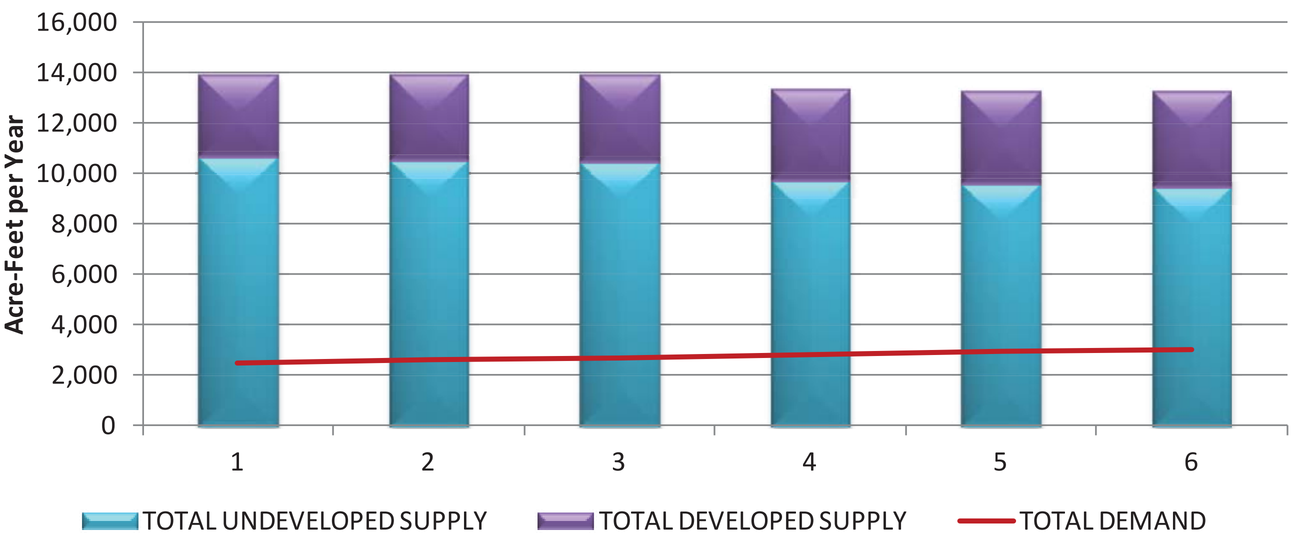
YOUR WATER SOURCE:
Groundwater Wells
Local Supplies



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 97% Groundwater and 3% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

RUSK COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Kevin Eltife

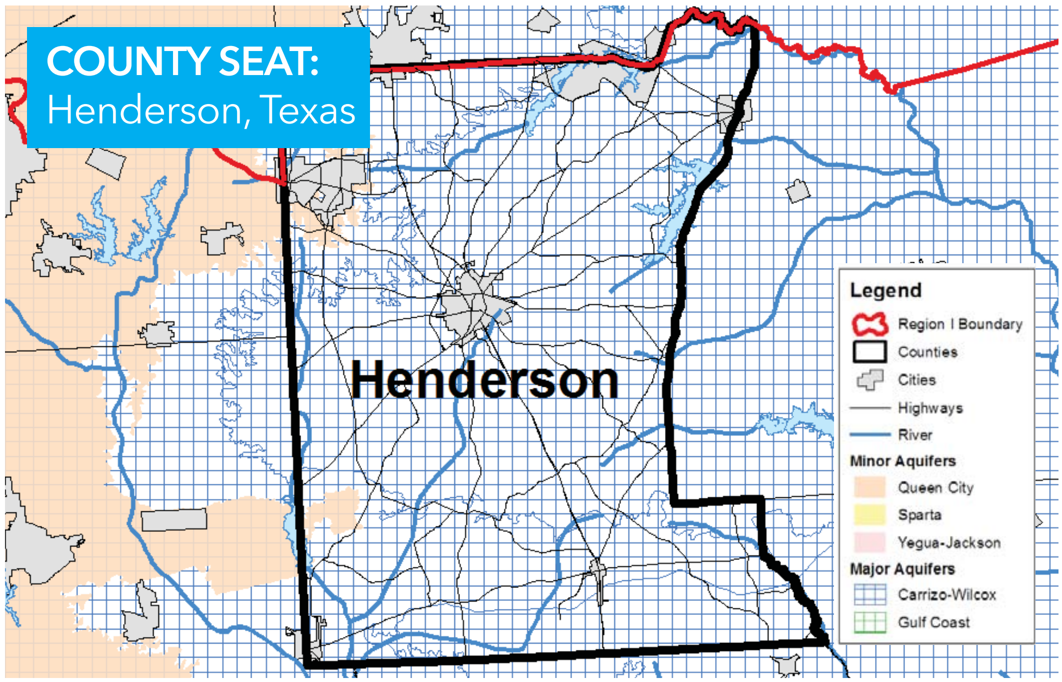
YOUR STATE REPRESENTATIVE:
Travis Clardy

YOUR COUNTY JUDGE:
Joel Hale

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)
Worth Whitehead

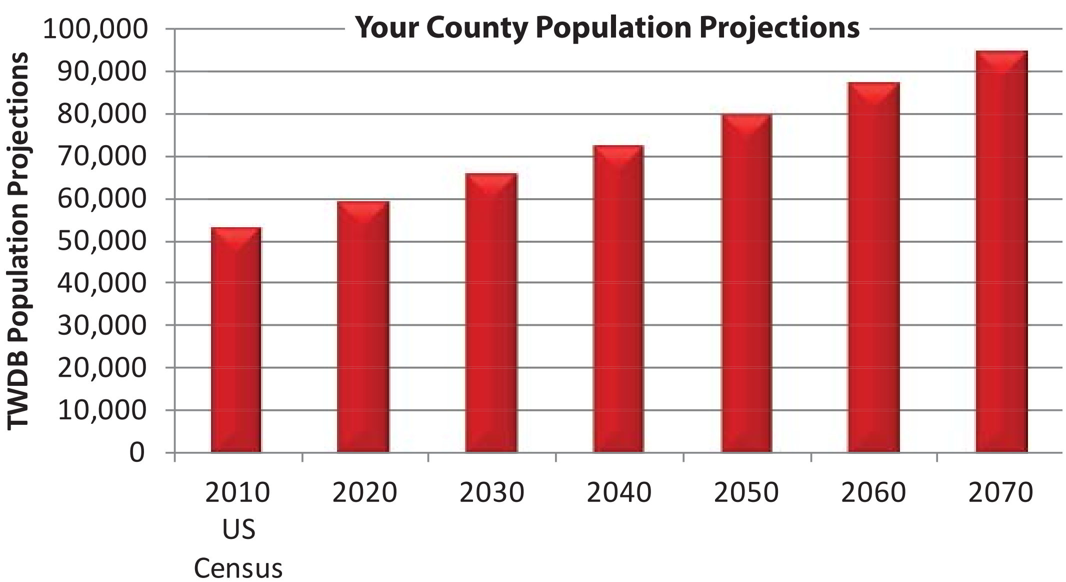
YOUR MUNICIPAL WATER USERS:
Chalk Hill SUD
Cross Roads SUD
Easton
Ebenezer WSC
Elderville WSC
Gaston WSC
Goodsprings WSC
Henderson
Kilgore
Mount Enterprise
Mt Enterprise WSC
New London
New Prospect WSC
Overton
Pleasant Hill WSC
Price WSC
Reklaw WSC
Tatum
West Gregg SUD
Wright City WSC

COUNTY SEAT:
Henderson, Texas

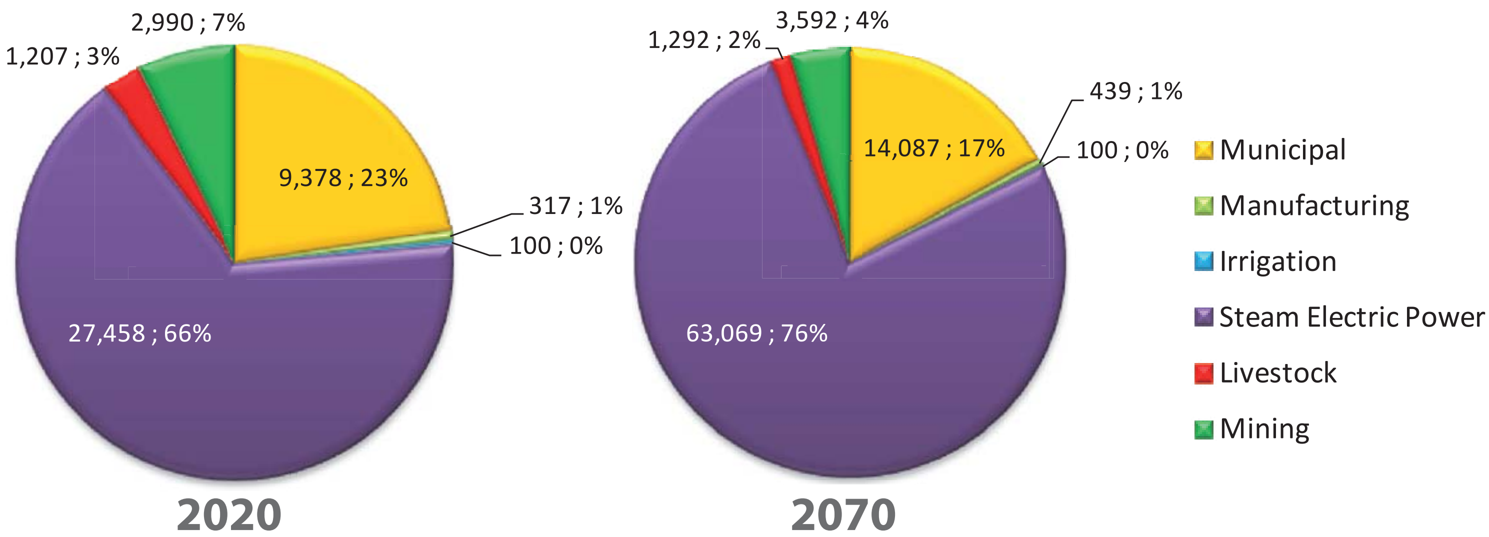


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Livestock
Oil & Gas Production

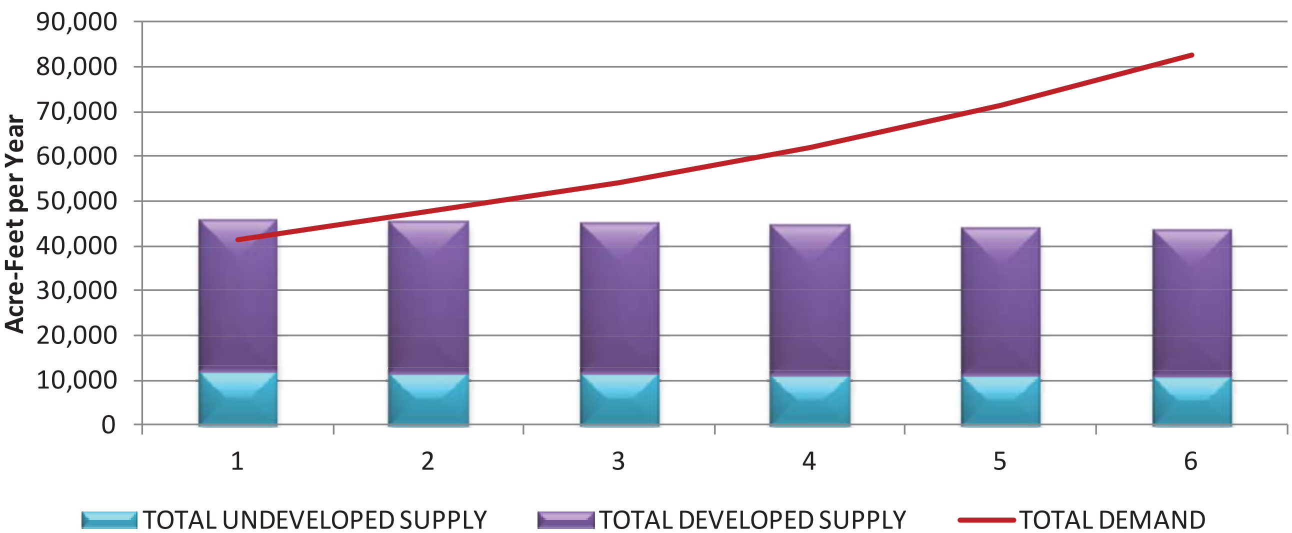
YOUR WATER SOURCE:
Groundwater Wells
Lake Striker
Local Supplies
Martin Lake
Neches River
Sabine River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 46% Groundwater and 54% Surface Water.

Your Water User Groups with Identified Needs

Overton	Municipal Conservation
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	Purchase from Sabine River Authority (Sabine River)
Livestock	No Water Shortage Identified
Mining	Purchase from Angelina Neches River Authority (Angelina River)

SABINE COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Robert Nichols

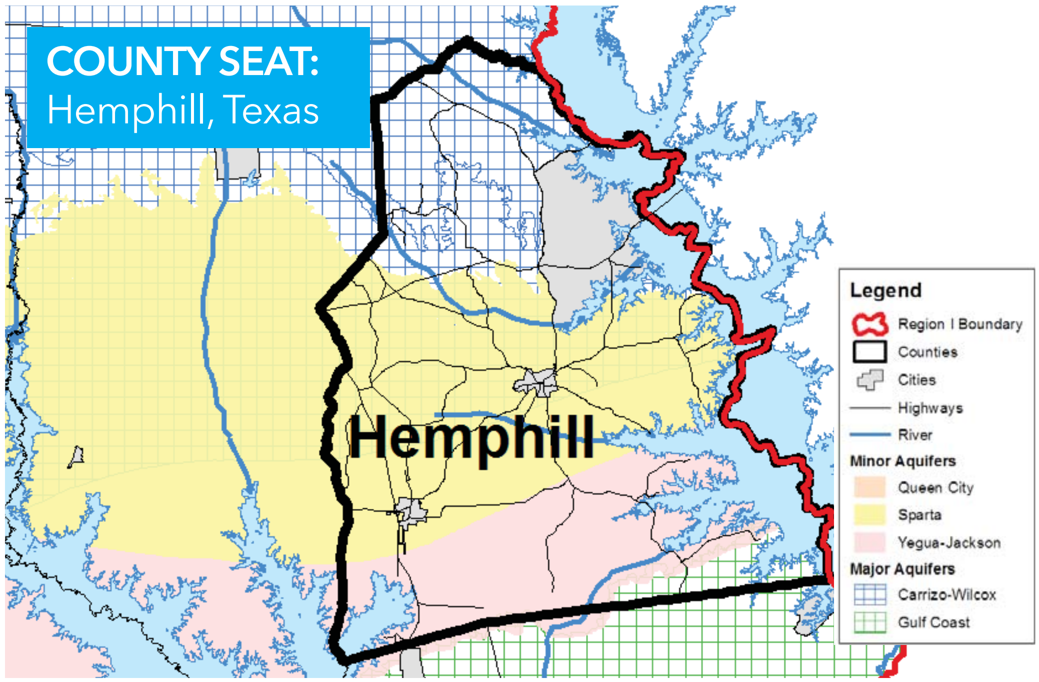
YOUR STATE REPRESENTATIVE:
Chris Paddie

YOUR COUNTY JUDGE:
Daryl Melton

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)
William Heugel

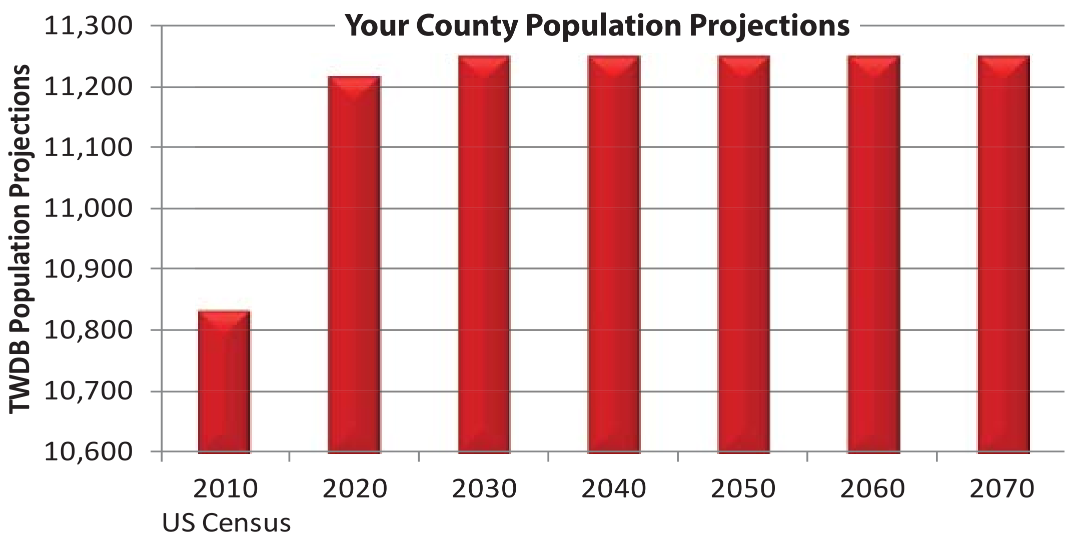
YOUR MUNICIPAL WATER USERS:
Brookeland FWSD
Bronson
Brookeland
G M WSC
Hemphill
Isla
Pineland
Rosevine

COUNTY SEAT:
Hemphill, Texas

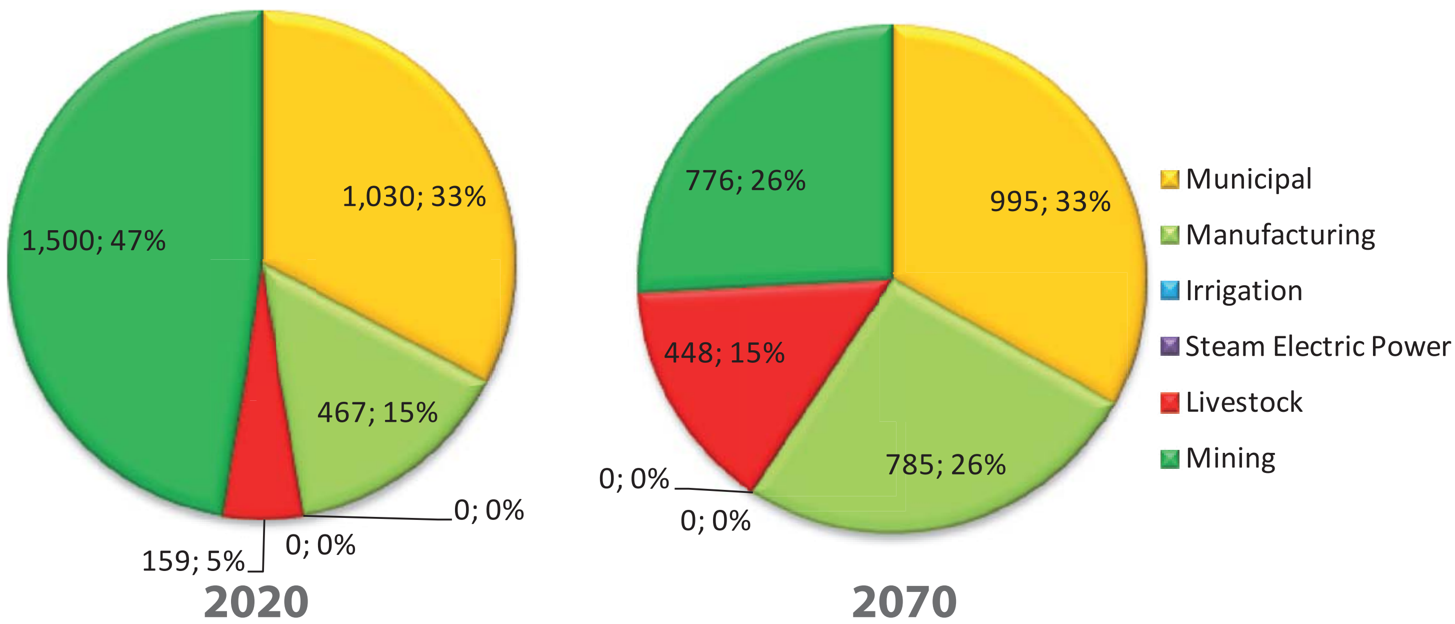


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Recreation
Timber

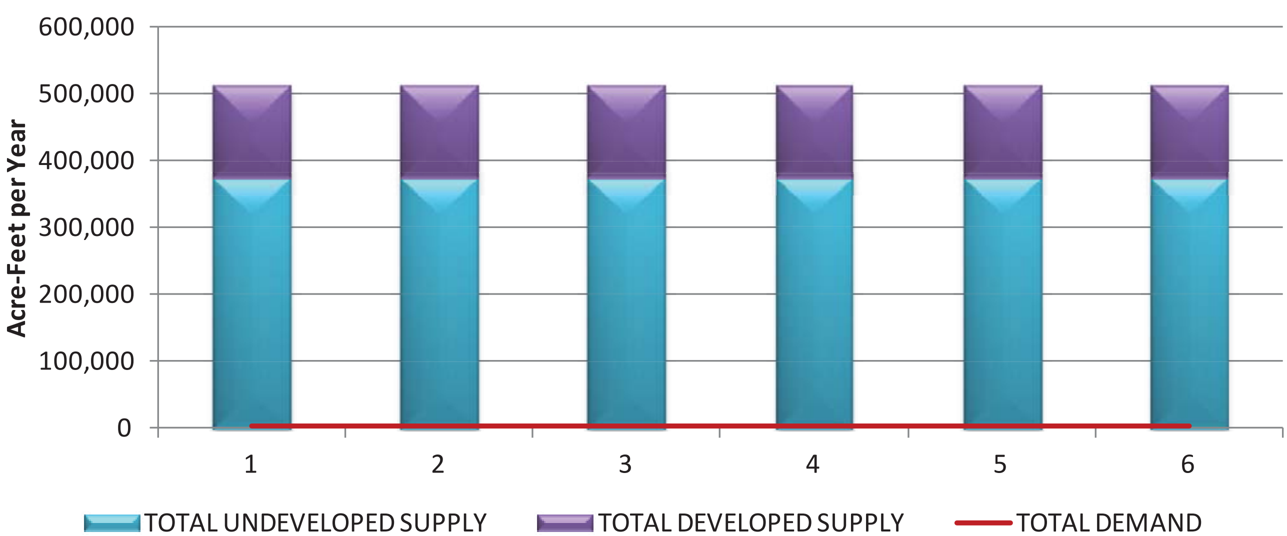
YOUR WATER SOURCE:
Direct Reuse | Manufacturing
Groundwater Wells
Local Supplies
Neches River
Sam Rayburn Reservoir
Toledo Bend Reservoir



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 2% Groundwater and 98% Surface Water.

Total Demand is 6,129 ac-ft/yr beginning in 2020 and 3,197 ac-ft/yr beginning in 2070.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Demands in This Category
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

SAN AUGUSTINE COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Robert Nichols

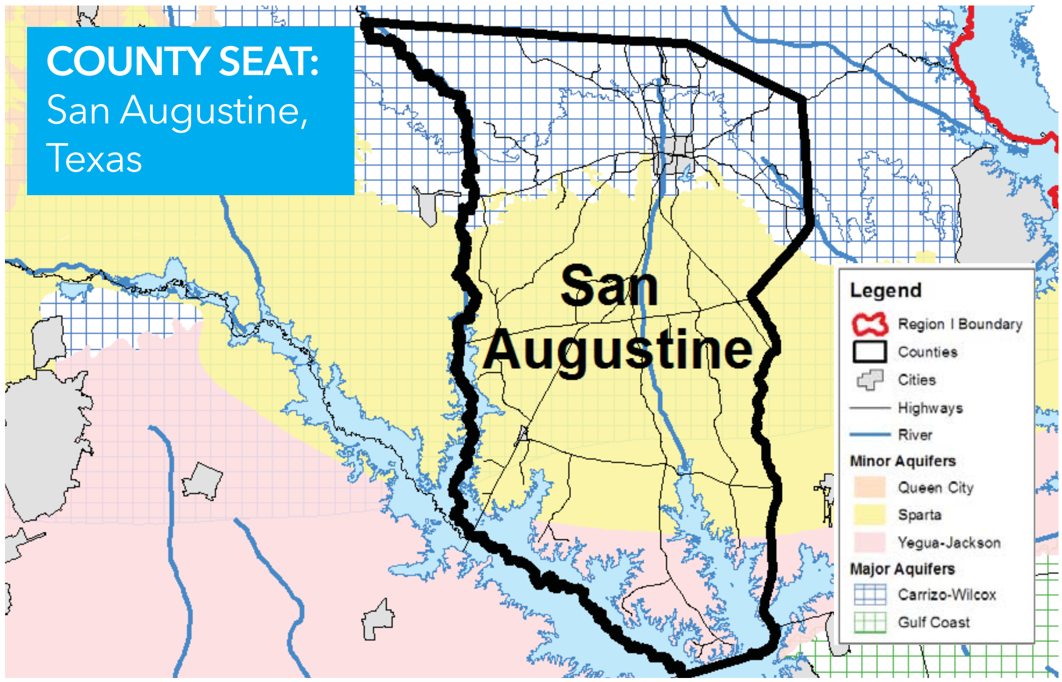
YOUR STATE REPRESENTATIVE:
Trent Ashby

YOUR COUNTY JUDGE:
Samye Johnson

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)

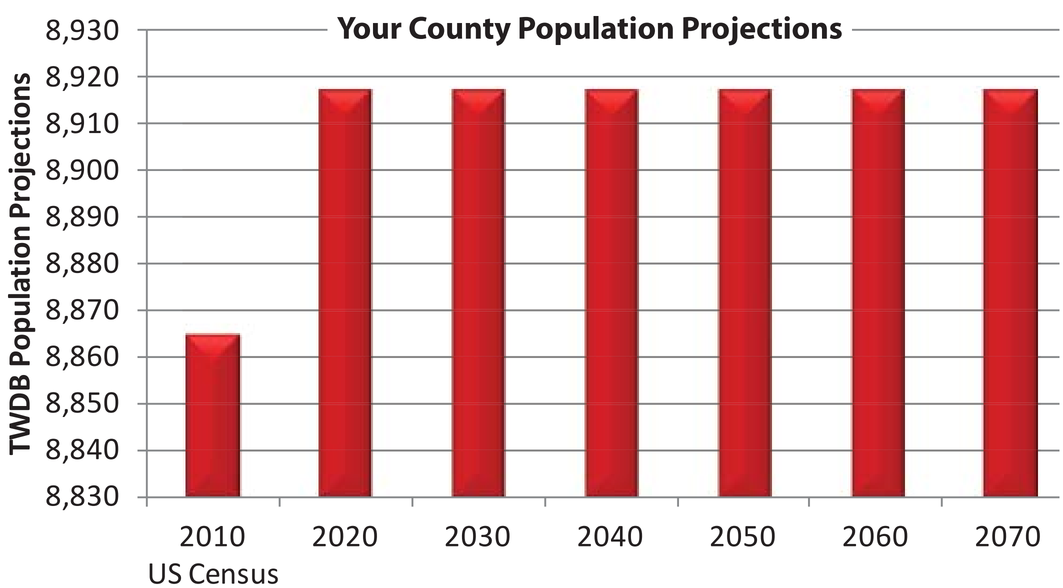
YOUR MUNICIPAL WATER USERS:
Broaddus
G M WSC
San Augustine

COUNTY SEAT:
San Augustine, Texas

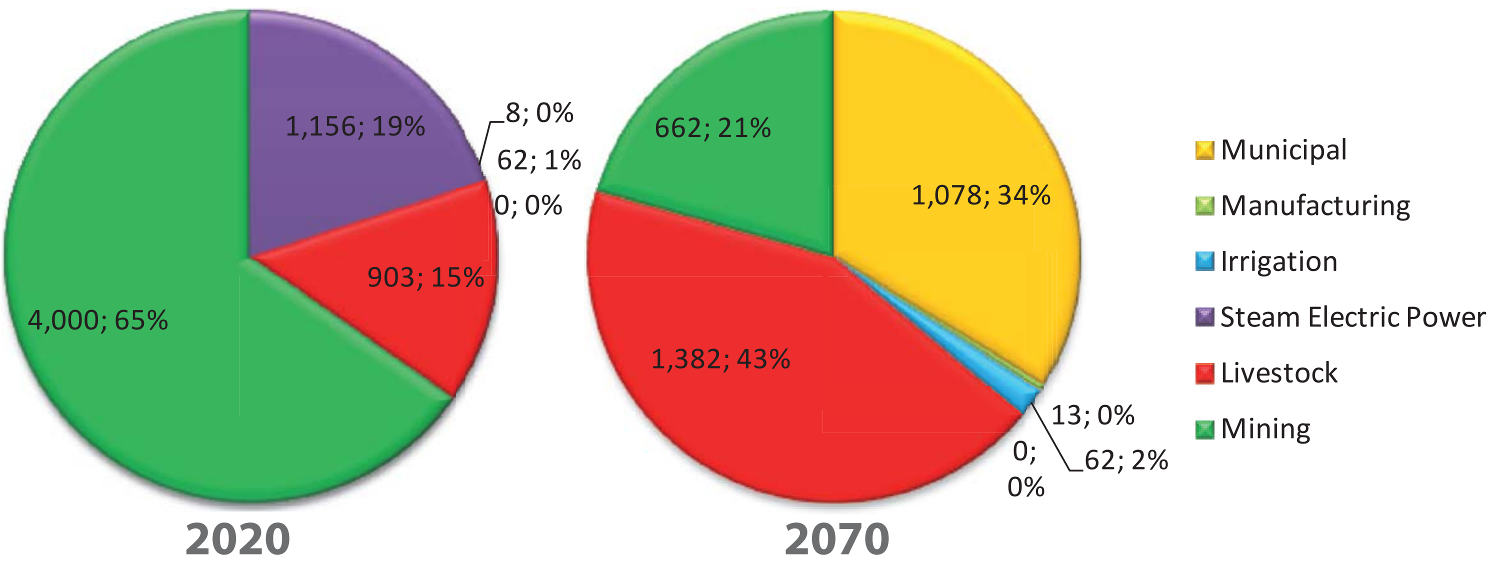


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Recreation
Timber

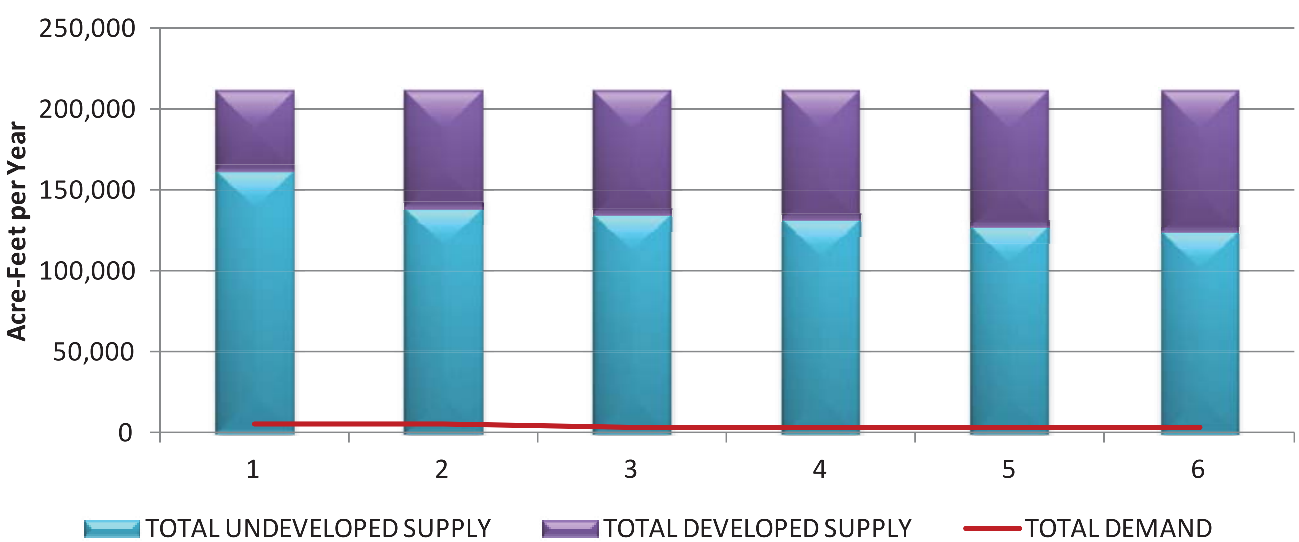
YOUR WATER SOURCE:
Groundwater Wells
Local Supplies
Sam Rayburn Reservoir
San Augustine City Lake



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 2% Groundwater and 98% Surface Water.

Total Demand is 14,495 ac-ft/yr beginning in 2020 and 19,567 ac-ft/yr beginning in 2070.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	Purchase from Angelina Neches River Authority (Angelina River)

SHELBY COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Louie Gohmert

YOUR STATE SENATOR:
Robert Nichols

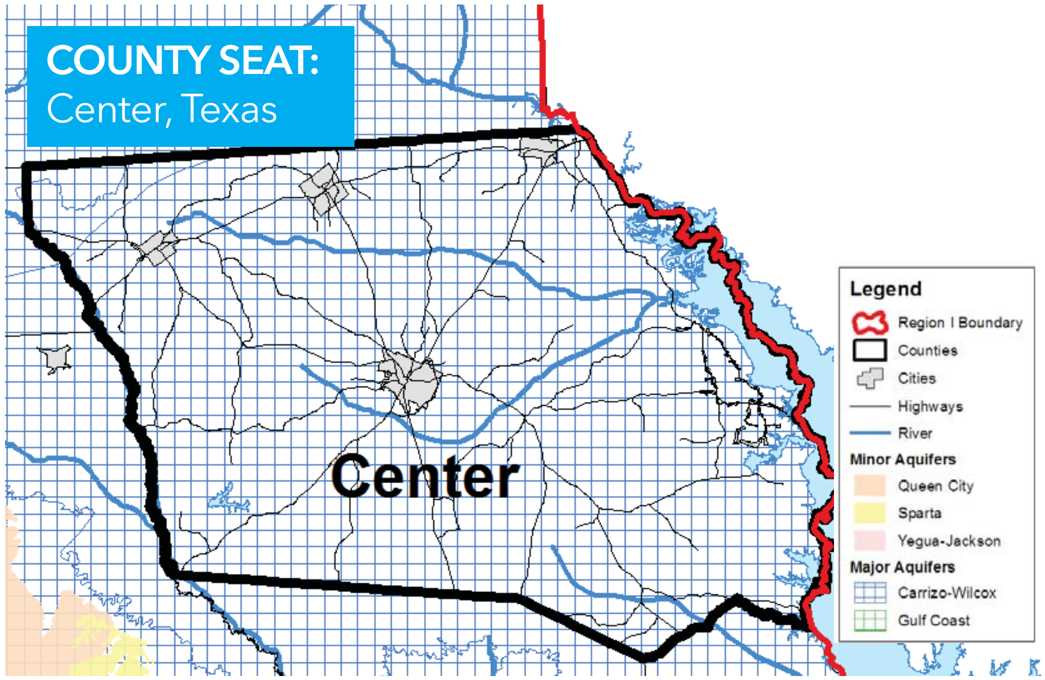
YOUR STATE REPRESENTATIVE:
Chris Paddie

YOUR COUNTY JUDGE:
Allison Harbison

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)

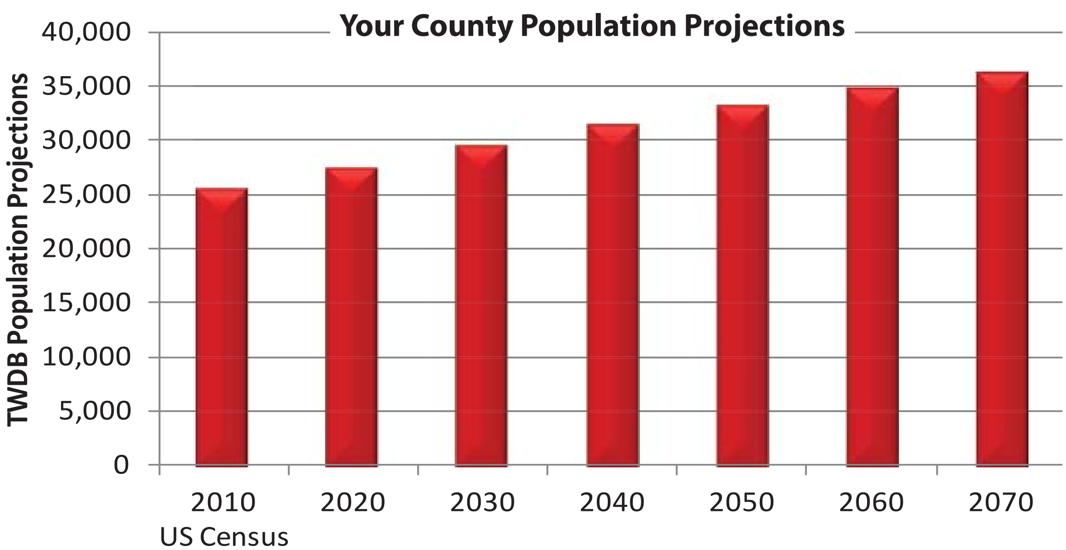
YOUR MUNICIPAL WATER USERS:
Arcadia
Center
Dreka
Huxley
Joaquin
Possum Trot
Shelby County FWSD#1
Shelbyville
Tenaha
Timpson

COUNTY SEAT:
Center, Texas

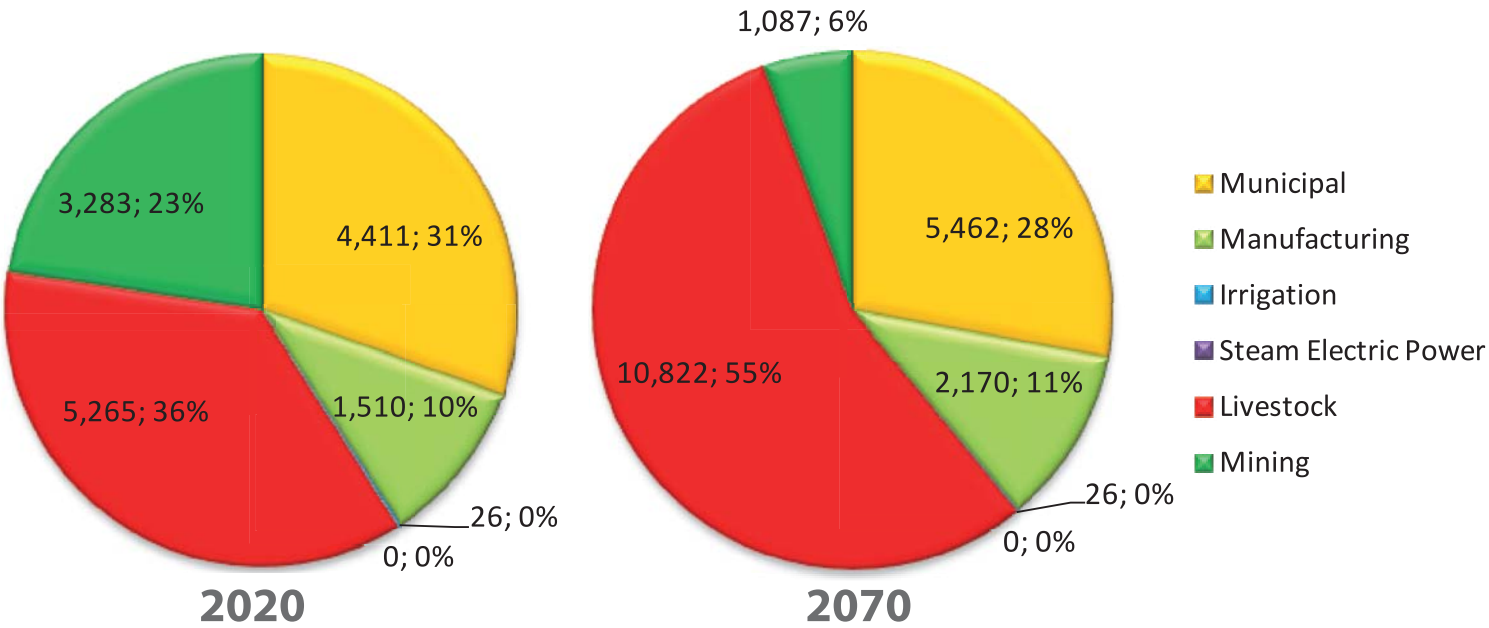


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Oil & Gas Production
Recreation

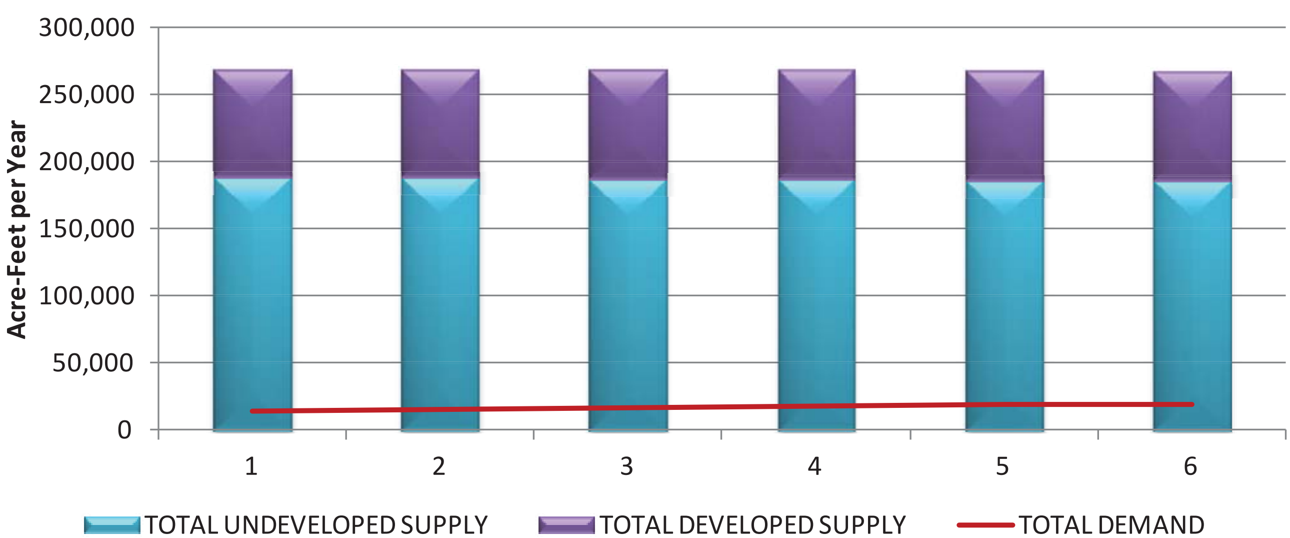
YOUR WATER SOURCE:
Direct Reuse
Groundwater Wells
Lake Center
Lake Timpson
Local Supplies
Pinkston Reservoir
Toledo Bend Reservoir



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 4% Groundwater and 96% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	Purchase from Sabine River Authority (Sabine River)
Mining	No Water Shortage Identified

SMITH COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVES:
Louie Gohmert

YOUR STATE SENATOR:
Kevin P. Eltife

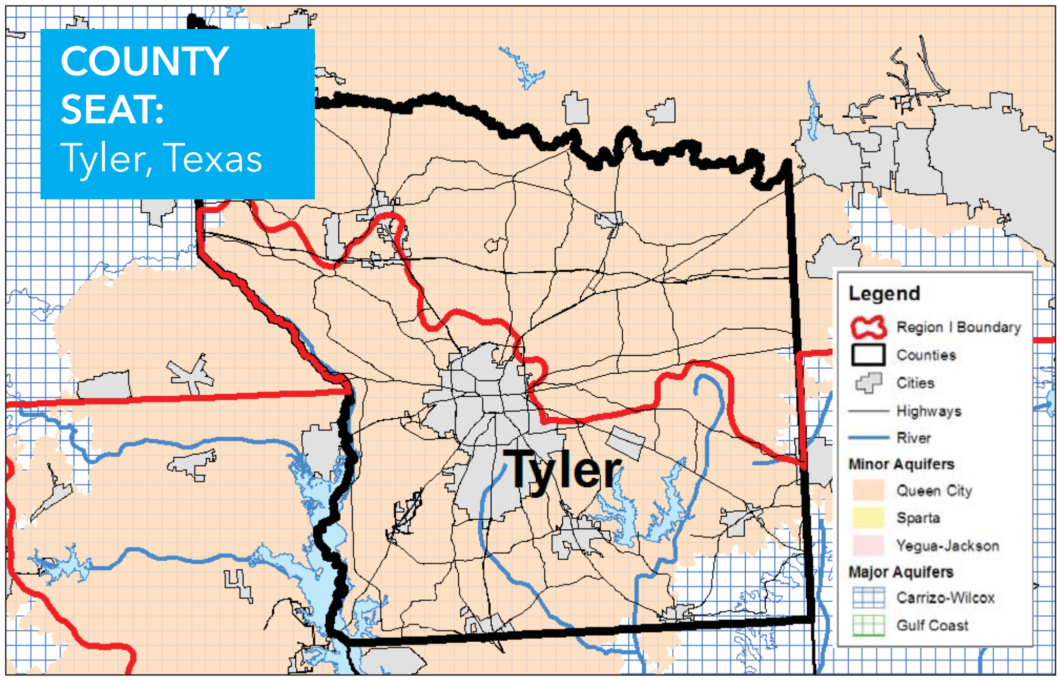
YOUR STATE REPRESENTATIVES:
Bryan Hughes and Matt Schaefer

YOUR COUNTY JUDGE:
Joel Baker

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11), Gregory M. Morgan

YOUR MUNICIPAL WATER USERS:
Arp
Blackjack WSC
Bullard
Carroll Water Supply Corp.
Crystal Systems Inc.
Dean WSC
Duck Creek WSC
Emerald Bay Municipal Utility
Hideaway
Jackson WSC
Lakeshore Utility Co. Inc.
Liberty City WSC
Lindale
Lindale Rural WSC
New Chapel Hill
Noonday
Overton
Pine Ridge WSC
R-P-M WSC
Sand Flat WSC
Smith County WCID 1
Southern Utilities Co.
Southern Utilities Company
Star Mountain WSC
Starrville Friendship WSC
Starrville WSC
Troup
Tyler
Walnut Grove WSC
Whitehouse
Winona
Wright City WSC

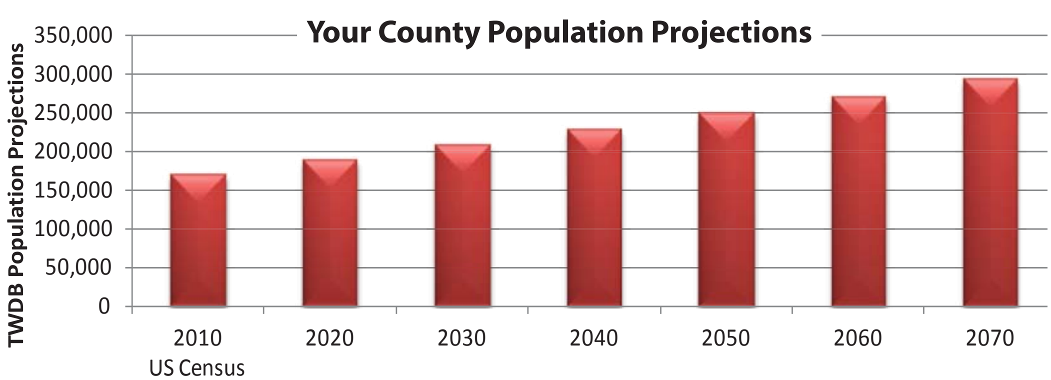
COUNTY SEAT:
Tyler, Texas



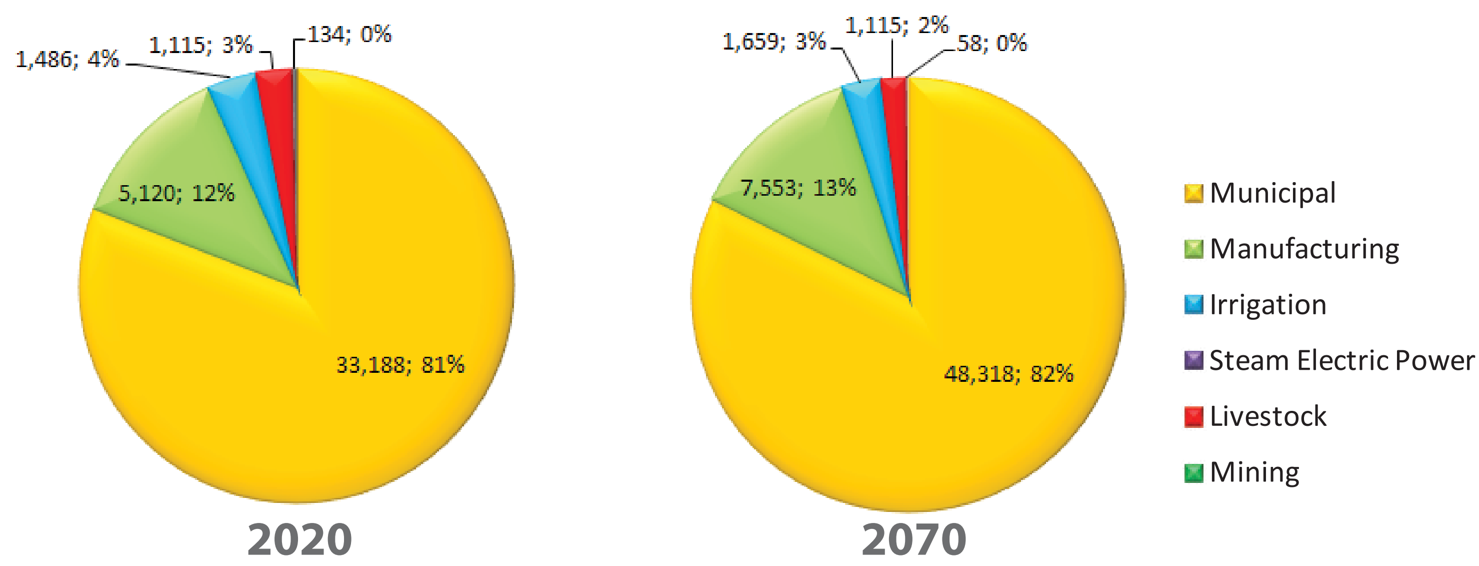
This county is split between more than one TWDB regional water planning area. The projections shown in these summary sheets represent data for the portion of the county that falls within the East Texas Regional Water Planning Area.

YOUR WATER-DEPENDENT ECONOMY:
Education
Industry
Livestock
Medical
Oil & Gas Production
Recreation

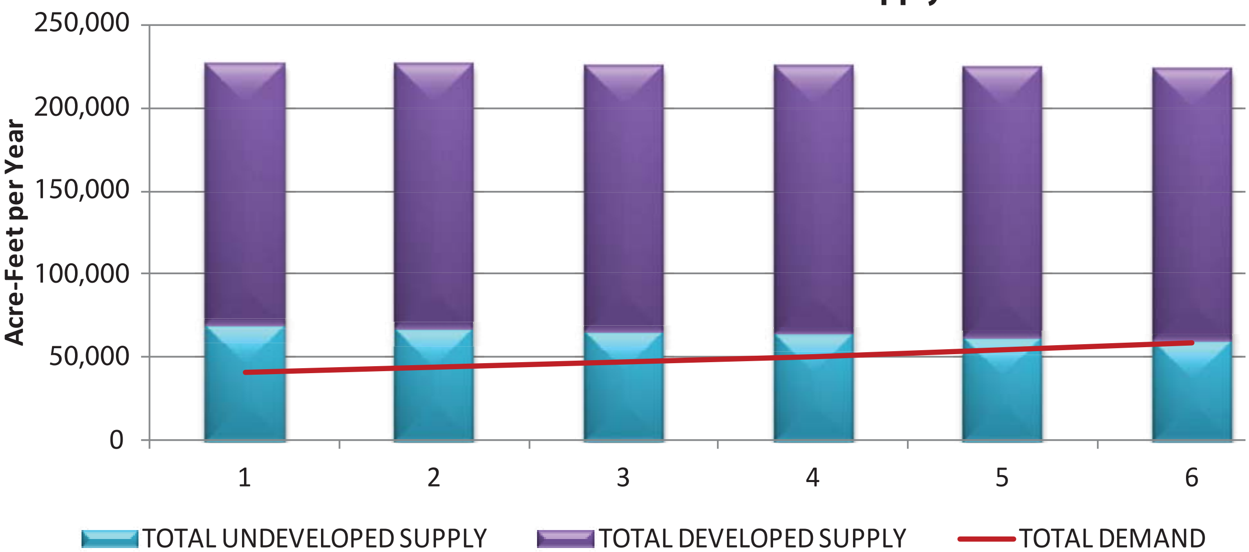
YOUR WATER SOURCES:
Bellwood Lake
Groundwater Wells
Lake Palestine
Lake Tyler
Lake Tyler East
Local Supplies
Neches River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply

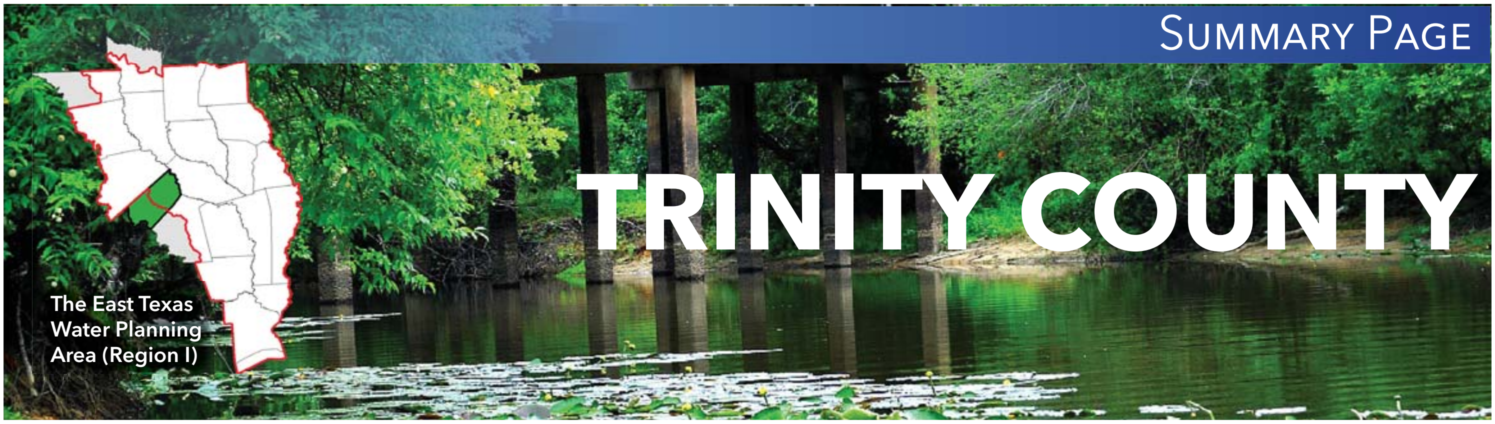


Total Available 22% Groundwater and 78% Surface Water.

Your Water User Groups with Identified Needs

Bullard	Municipal Conservation; Purchase from Tyler
Crystal Systems Inc.	Municipal Conservation; Purchase from Tyler
Lindale	Municipal Conservation; Purchase from Tyler
R-P-M WSC	Municipal Conservation
Manufacturing	Purchase from Tyler (Lake Palestine/Lake Tyler/Carrizo-Wilcox Aquifer)
Irrigation	No Water Shortage Identified
Steam Electric Power	No Demands in This Category
Livestock	No Water Shortage Identified
Mining	Purchase from Tyler (Lake Palestine/Lake Tyler/Carrizo-Wilcox Aquifer)

TRINITY COUNTY



YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Kevin Brady

YOUR STATE SENATOR:
Robert Nichols

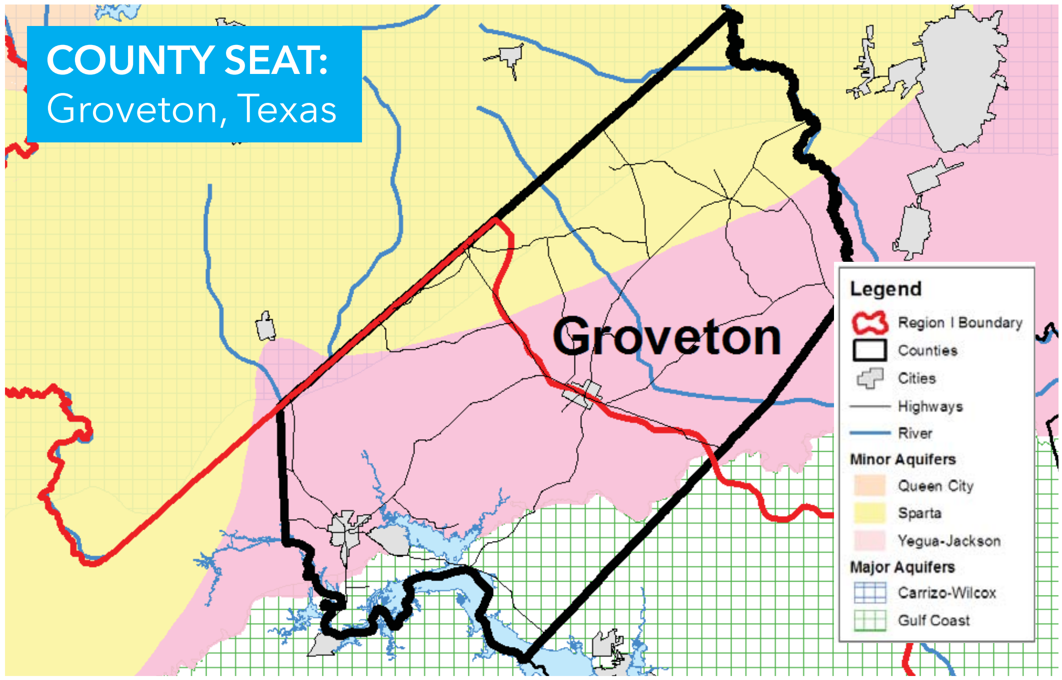
YOUR STATE REPRESENTATIVE:
Trent Ashby

YOUR COUNTY JUDGE:
Steven D. Page

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
Leah Adams (GMA 11)

YOUR MUNICIPAL WATER USERS:
Apple Springs
Carlisle
Centralia
Groveton
Helmic
Josserand
Nigton
Nogalus Prairie
Pennington
Trevat
Trinity County
Woodlake

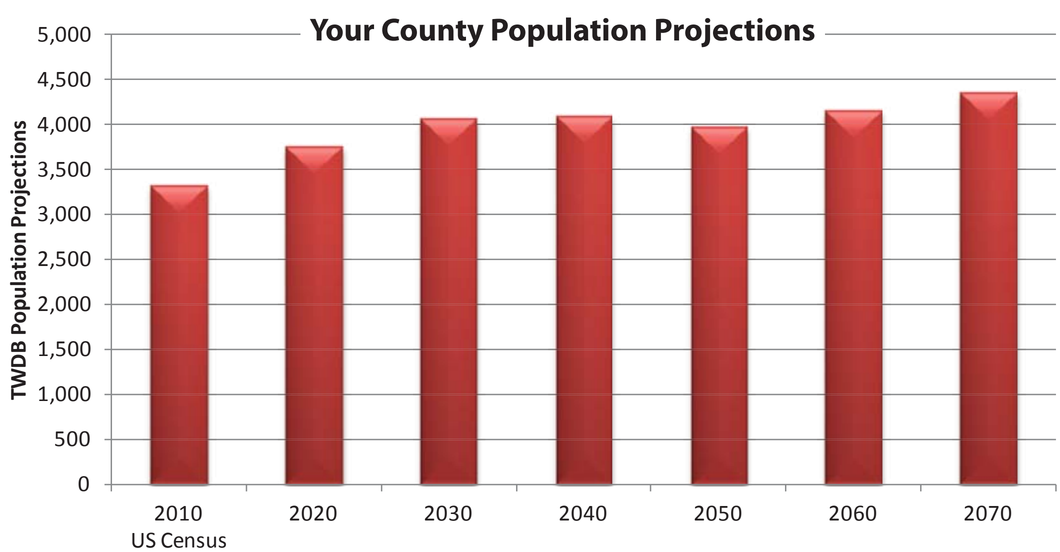
COUNTY SEAT:
Groveton, Texas



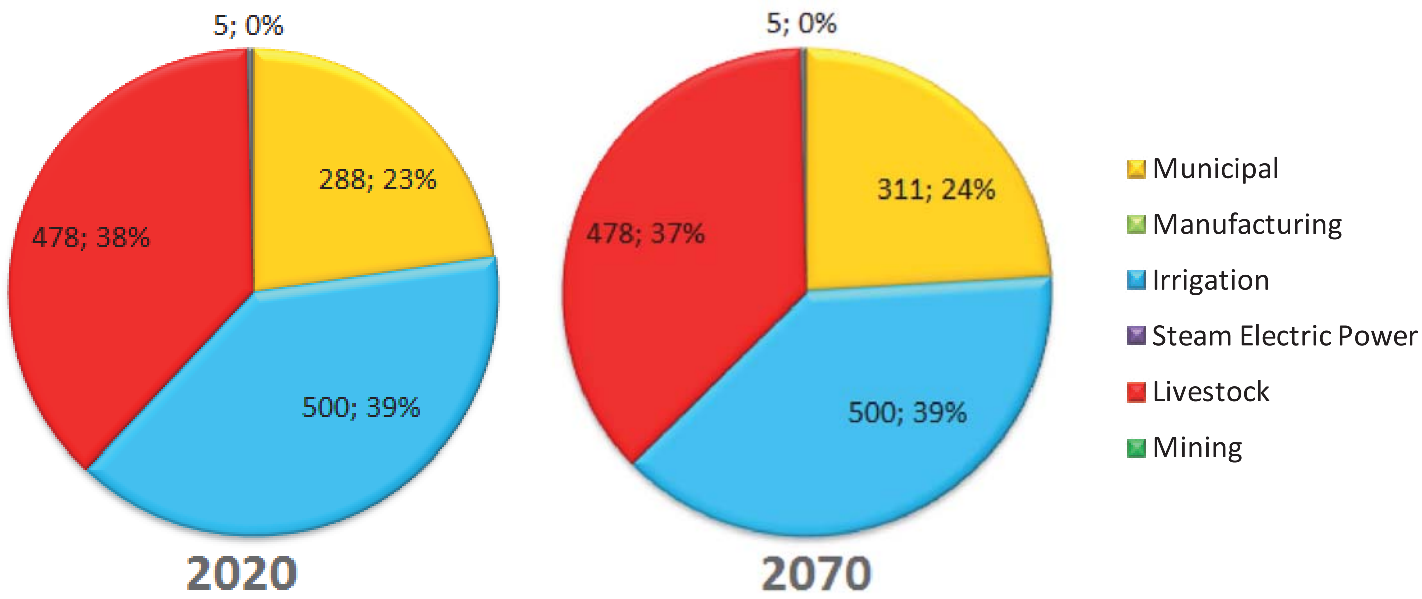
This county is split between more than one TWDB regional water planning area. The projections shown in these summary sheets represent data for the portion of the county that falls within the East Texas Regional Water Planning Area.

YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Industry
Livestock

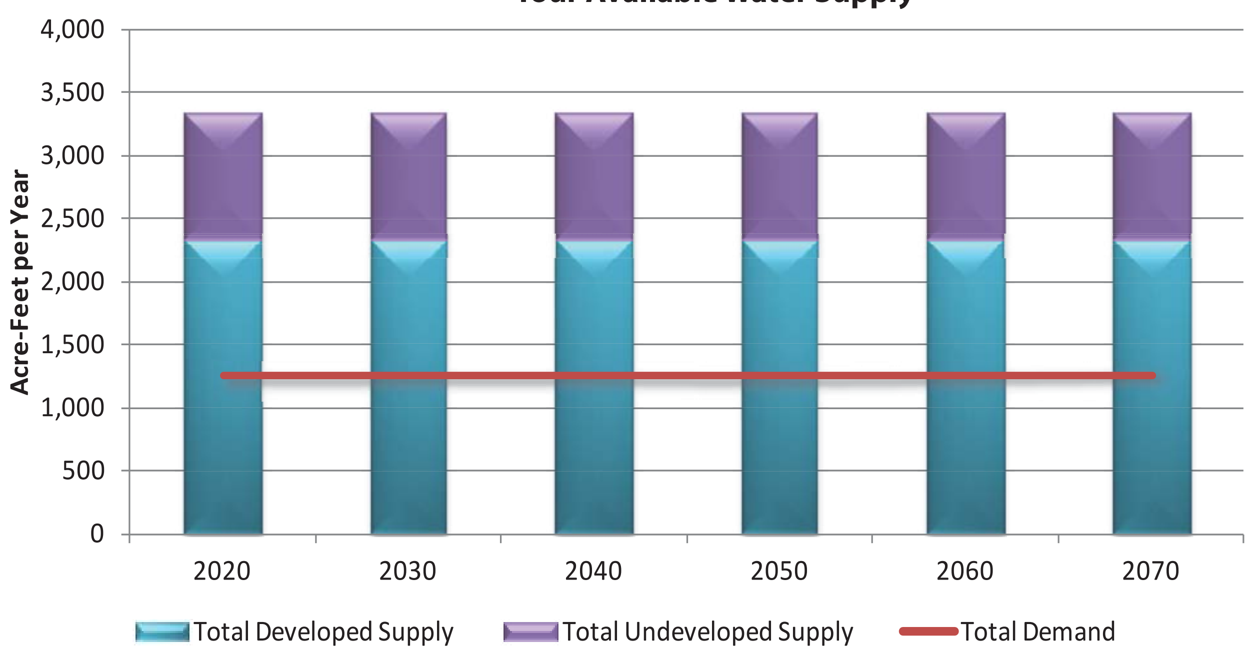
YOUR WATER SOURCE:
Groundwater Wells
Neches River
Local Supplies



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 85% Groundwater and 15% Surface Water.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Demands In This Category
Irrigation	Purchase from Trinity County-Other
Steam Electric Power	No Demands In This Category
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

TYLER COUNTY

YOUR US SENATORS:
John Cornyn
Ted Cruz

YOUR US REPRESENTATIVE:
Brian Babin

YOUR STATE SENATOR:
Robert Nichols

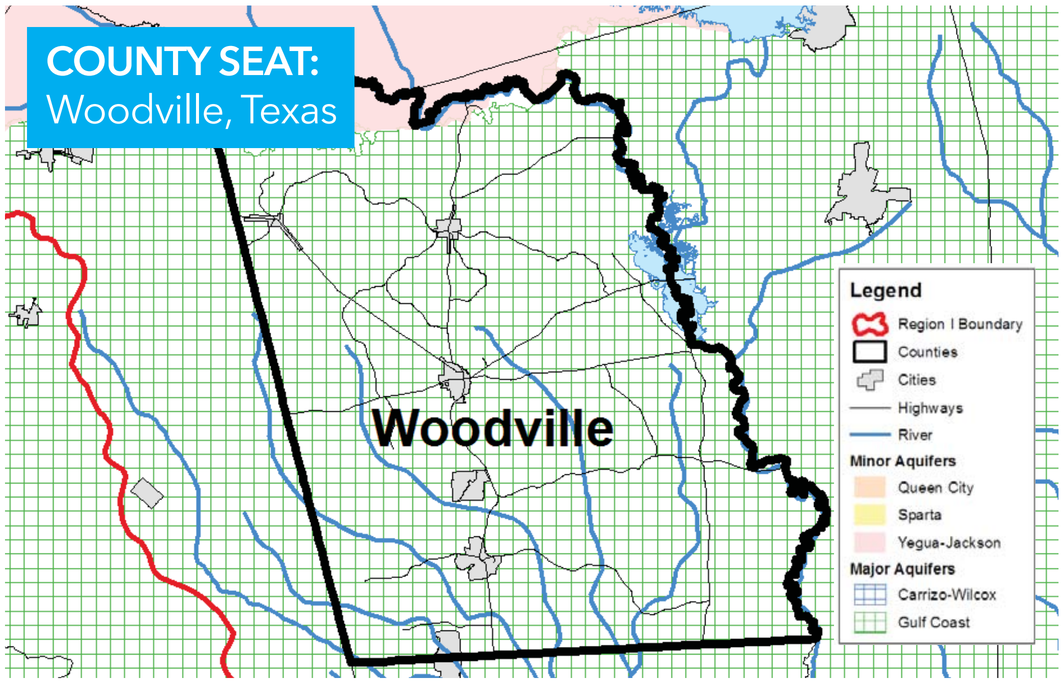
YOUR STATE REPRESENTATIVE:
James White

YOUR COUNTY JUDGE:
Jacques L. Blanchette

YOUR EAST TEXAS REGIONAL WATER PLANNING GROUP MEMBER(S):
John Martin (GMA 14)
Josh David

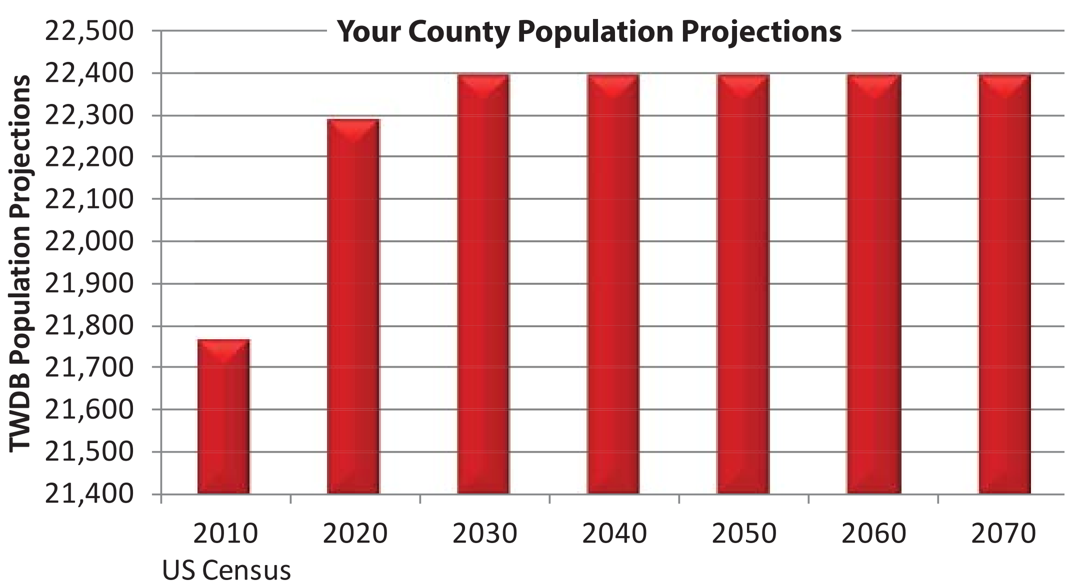
YOUR MUNICIPAL WATER USERS:
Chester
Colmesneil
Doucette
Fred
Hillister
Ivanhoe
Ivanhoe North
Lake Livingston Water Supply & Sewer Service Company
Spurger
Tyler County WSC
Warren
Woodville

COUNTY SEAT:
Woodville, Texas

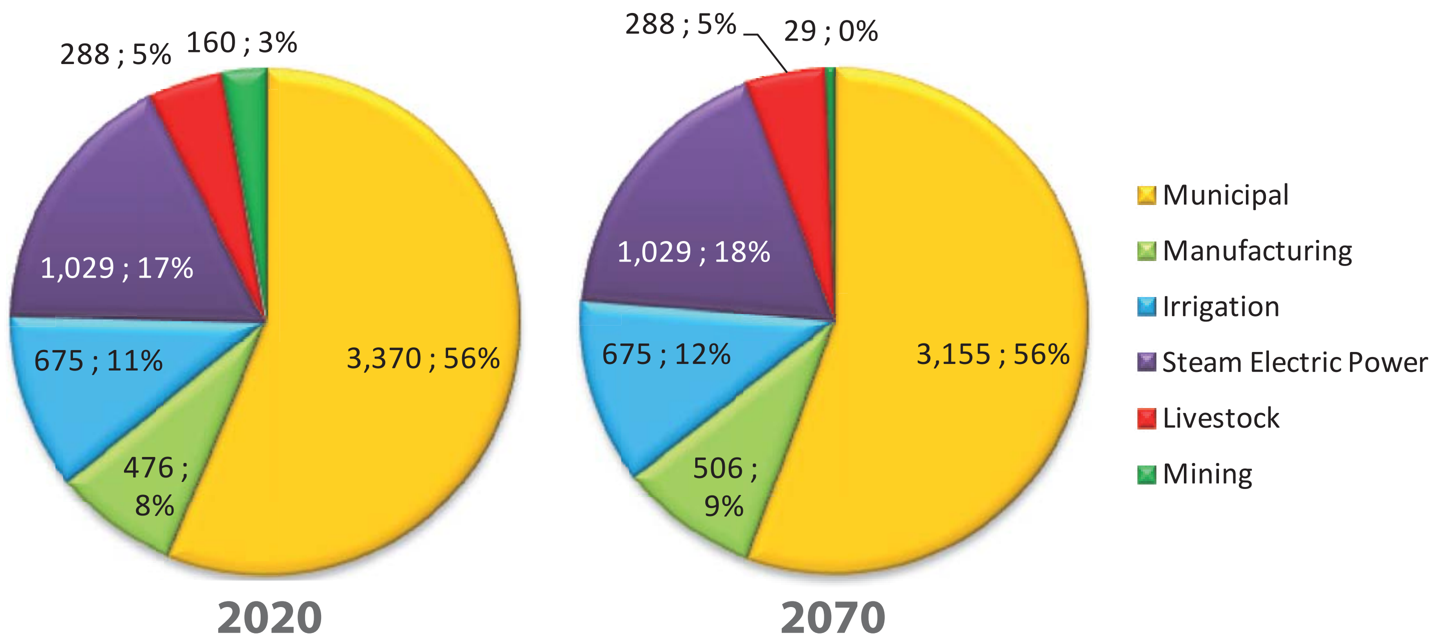


YOUR WATER-DEPENDENT ECONOMY:
Agriculture
Timber

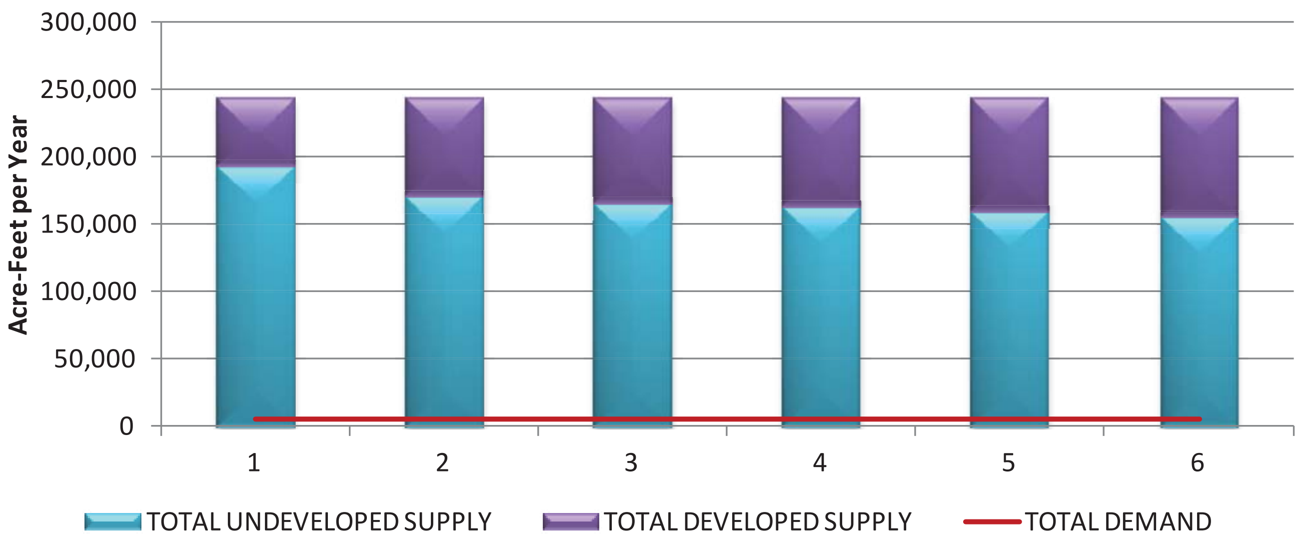
YOUR WATER SOURCE:
BA Steinhagen Lake
Groundwater Wells
Local Supplies
Neches River



Your County Water Use (acre-feet ; % of total)



Your Available Water Supply



Total Available Water Supply is 16% Groundwater and 84% Surface Water.

Total Demand is 5,998 ac-ft/yr beginning in 2020 and 5,682 ac-ft/yr beginning in 2070.

Your Water User Groups with Identified Needs

Municipal	No Water Shortage Identified
Manufacturing	No Water Shortage Identified
Irrigation	No Water Shortage Identified
Steam Electric Power	No Water Shortage Identified
Livestock	No Water Shortage Identified
Mining	No Water Shortage Identified

Chapter 1

Description of the Region

The East Texas Regional Water Planning Area (ETRWPA) was established by the 1997 Texas legislature as part of Senate Bill 1 (SB1) for the purpose of improving the process of water resource planning in the State. Pursuant to the formation of the ETRWPA, the East Texas Regional Water Planning Group (ETRWPG), was formed and charged with the responsibility to develop a plan for the management of water in the region to ensure its availability to the region's citizens for a 50-year planning horizon. Planning is performed in accordance with regional and state water planning requirements of the Texas Water Development Board (TWDB) and updates to the plan prepared every five years. The initial regional plan was adopted in 2001. Since that time, it has been updated in 2006, amended in 2008, and updated again in 2011.

This plan update (2016 Plan) will address a wide range of water planning issues, including a description of the region, population and water demand projections, water supply availability, water management strategies, water quality, conservation, regional resources, and infrastructure financing requirements. These elements may be found below and in subsequent chapters of the plan.

This chapter provides descriptive details for the ETRWPA that are relevant to water resource planning. These details include a physical description of the region, climatological details, population projections, economic activities, sources of water and water demand, and regional resources. In addition, the chapter includes 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.

1.1 General Introduction to the East Texas Regional Water Planning Area and the Regional Water Planning Group

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 ETRWPG consists of 24 voting positions and a number of non-voting positions. These members represent the interests of agriculture, counties, electric generating utilities, the environment, groundwater management areas, industries, municipalities, the public, river authorities, small businesses, water districts, and water utilities. The City of Nacogdoches is the administrative contracting agency for the ETRWPG. The ETRWPG has retained the services of a team of engineering firms and other specialists to prepare the 2016 Plan including Alan Plummer Associates, Inc. as the lead engineer, Freese & Nichols, Inc. as a subconsultant, and LBG-Guyton & Associates as a subconsultant groundwater specialist. Table 1.1 provides a current list of the ETRWPG representatives involved in developing the 2016 Plan.

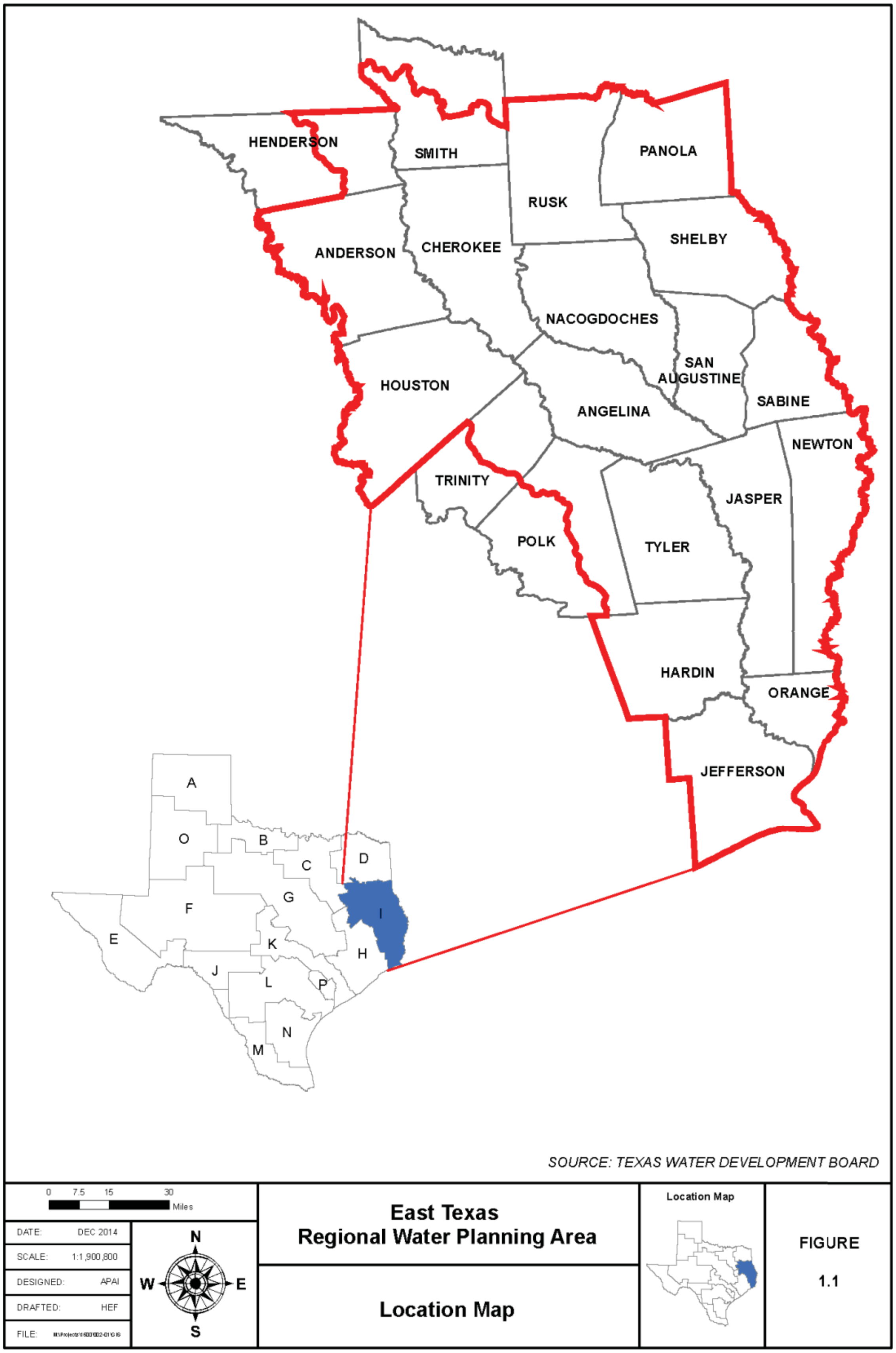

HENDERSON
SMITH
PANOLA
RUSK
SHELBY
ANDERSON
CHEROKEE
NACOGDOCHES
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
A
O
B
C
D
F
G
I
E
K
H
J
L
P
N
M
SOURCE: TEXAS WATER DEVELOPMENT BOARD
0 7.5 15 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
N
W
E
S
East Texas
Regional Water Planning Area
Location Map
Location Map
FIGURE
1.1

Table 1.1 East Texas Regional Water Planning Group Members

VOTING MEMBERS	
Category	**Name**
Agriculture	David Alders, *Carrizo Creek Corporation*
	Josh David, *Livestock*
Counties	Jeff Branick, *Jefferson County*
	Chris Davis, *Rusk County*
Electric Power	Dale Peddy, *Entergy*
Environmental	Dr. J. Leon Young, *Steven F. Austin University*
Groundwater Management Areas	Leah Adams, *Panola County GCD*
	John Martin, *Southeast Texas GCD*
Industries	Michael Harbordt, *Retired*
	Darla Smith, *BASF Corporation*
Municipalities	David Brock, *City of Jacksonville*
	Gregory M. Morgan, City of *Tyler*
Public	William Heugel, *Retired*
	Bill Kimbrough, *Retired*
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*
	Dr. Joseph Holcomb, *Holcomb Dentistry*
Water Districts	Worth Whitehead, *Rusk SWCD*
Water Utilities	*VACANT*
NON-VOTING MEMBERS	
Lann Bookout, *Texas Water Development Board*	Terry Stelly, *Texas Parks & Wildlife Department*
Manuel Martinez, *Texas Department of Agriculture*	James Alford, *Trinity County*
Connie Stanridge, *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 Rick L. Campbell, *Shelby County Judge*
Walter Glenn, *Jasper County*	Terry McFall, *U.S. Department of Agriculture*

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

<table>
<tr><th colspan="2">COMMITTEES</th></tr>
<tr><th colspan="2">Executive Committee</th></tr>
<tr><td>Chair – Kelley Holcomb
1st Vice Chair – Worth Whitehead
2nd Vice Chair – Dr. Mike Harbordt
Secretary – David Brock</td><td>Assistant Secretary – John Martin
At-Large – Dr. Leon Young
At-Large – David Alders</td></tr>
<tr><th>Nominations Committee</th><th>By-Laws Committee</th></tr>
<tr><td>Chair – Monty Shank
Member – Josh David
Member – Mark Dunn
Member – Chris Davis
Ex-Officio – Kelley Holcomb</td><td>Chair – David Alders
Member – Bill Kimbrough
Member – Worth Whitehead
Member – Dale Peddy
Member – Leah Adams</td></tr>
<tr><th>Finance Committee</th><th>Technical Committee</th></tr>
<tr><td>Chair – Darla Smith
Member – William Heugel
Member – John Martin
Member – David Brock
Member – Greg Morgan</td><td>Chair – Dr. Michael Harbordt
Member – Dr. Leon Young
Member – Monty Shank
Member – Scott Hall
Member – Joseph Holcomb
Member – David Montagne</td></tr>
</table>

1.2 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 (msl) at Tater Hill Mountain in Henderson County at its far northwest corner.

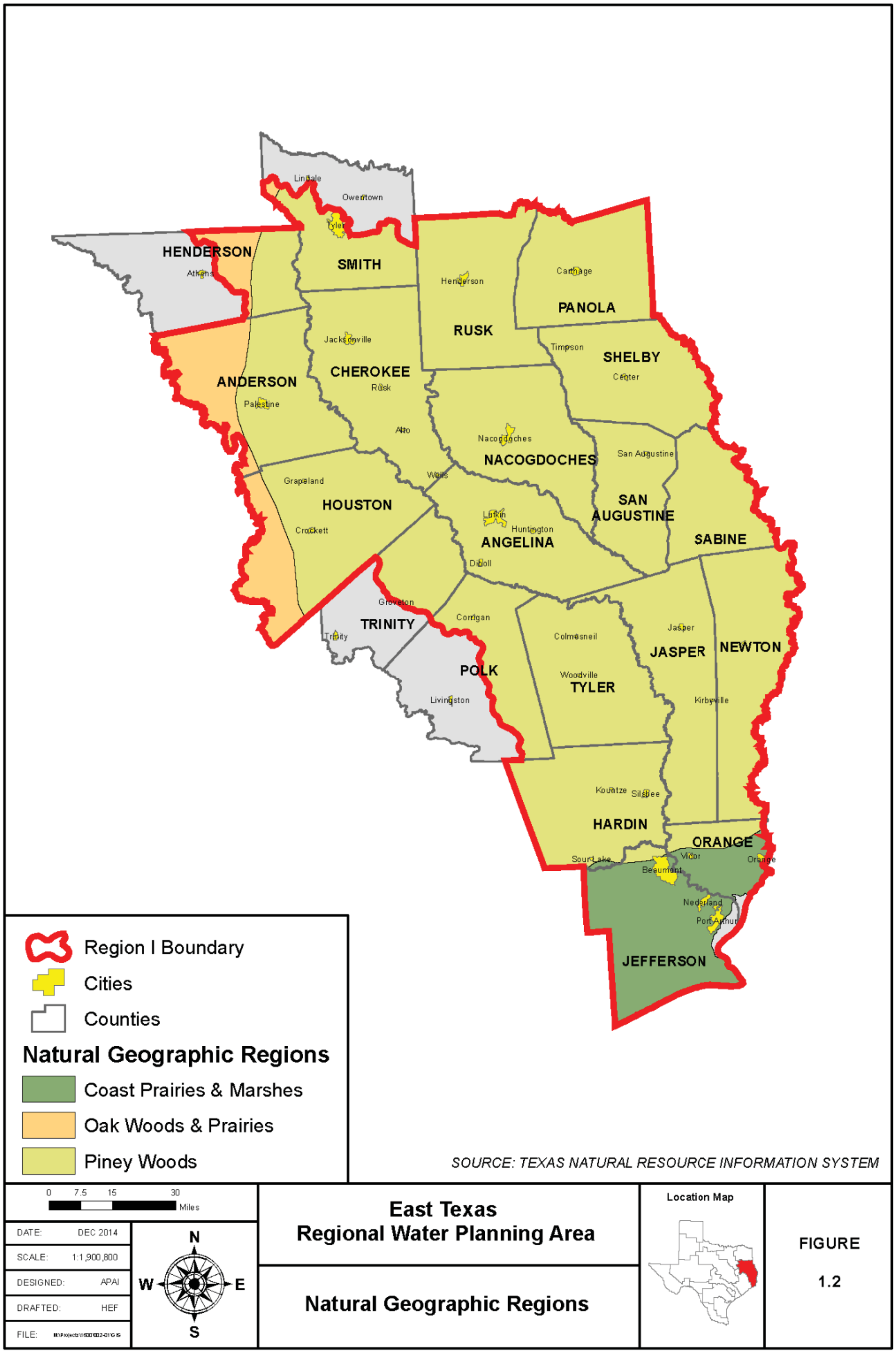
The area occupied by the counties of the region is further subdivided into natural geographic areas known as the Piney Woods, the Oak Woods and Prairies, and the Coastal Prairies. Figure 1.2 depicts the boundaries of these areas within the ETRWPA. They are further described following.

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 interspersed amongst the pines and 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 such as post oak, blackjack oak, and elm. Riparian areas often have growths of pecan, walnut, and other trees with high water demands. Area 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 some 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 since the end of World War II. 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 petrochemicals.

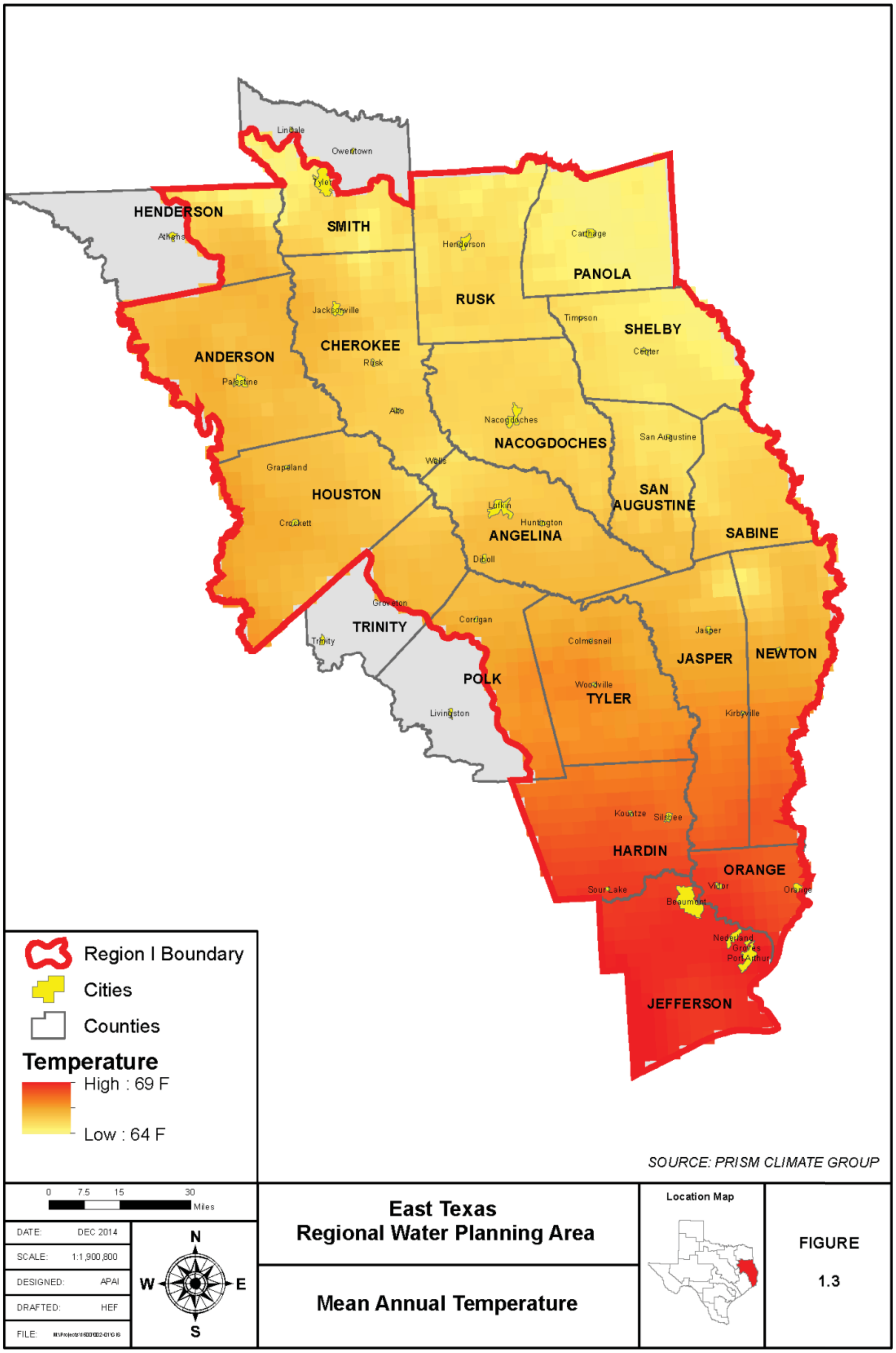

Lindale
Owentown
Tyler
HENDERSON
Athens
SMITH
Henderson
Carthage
PANOLA
RUSK
Jacksonville
CHEROKEE
Rusk
ANDERSON
Palestine
Timpson
SHELBY
Center
Alto
Nacogdoches
NACOGDOCHES
San Augustine
Wells
Grapeland
HOUSTON
Crockett
Lufkin
Huntington
ANGELINA
SAN AUGUSTINE
SABINE
Diboll
Groveton
TRINITY
Trinity
Corrigan
Colmesneil
Jasper
JASPER
NEWTON
POLK
Livingston
Woodville
TYLER
Kirbyville
Kountze
Silsbee
HARDIN
ORANGE
Sour Lake
Vidor
Orange
Beaumont
Nederland
Port Arthur
JEFFERSON
Region I Boundary
Cities
Counties
Natural Geographic Regions
Coast Prairies & Marshes
Oak Woods & Prairies
Piney Woods
SOURCE: TEXAS NATURAL RESOURCE INFORMATION SYSTEM
0 7.5 15 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
N
W
E
S
East Texas
Regional Water Planning Area
Natural Geographic Regions
Location Map
FIGURE
1.2

1.3 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 34 degrees Fahrenheit (°F) in Panola County to a maximum July temperature of 94 °F in Houston County.[1] Similarly, the average growing season from 1971 to 2000 was 246 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 for Orange County and the lowest average rainfall (41.0 inches) being recorded for Henderson County. Average annual runoff ranges from approximately 10 inches in the northwest to 17 inches in the southeast. Average annual gross reservoir evaporation (the rate of evaporation from a reservoir) ranges from approximately 41 inches in the southeast to 55 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.


HENDERSON
Athens
SMITH
Tyler
Lindale
Owentown
Henderson
RUSK
Carthage
PANOLA
Timpson
SHELBY
Center
ANDERSON
Palestine
CHEROKEE
Jacksonville
Rusk
Alto
Nacogdoches
NACOGDOCHES
San Augustine
SAN AUGUSTINE
Wells
Grapeland
HOUSTON
Crockett
Lufkin
Huntington
ANGELINA
Diboll
SABINE
Groveton
TRINITY
Trinity
Corrigan
Colmesneil
Jasper
JASPER
NEWTON
POLK
Livingston
Woodville
TYLER
Kirbyville
Kountze
Silsbee
HARDIN
ORANGE
Sour Lake
Vidor
Orange
Beaumont
Nederland
Groves
Port Arthur
JEFFERSON
Region I Boundary
Cities
Counties
Temperature
High : 69 F
Low : 64 F
SOURCE: PRISM CLIMATE GROUP
0 7.5 15 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
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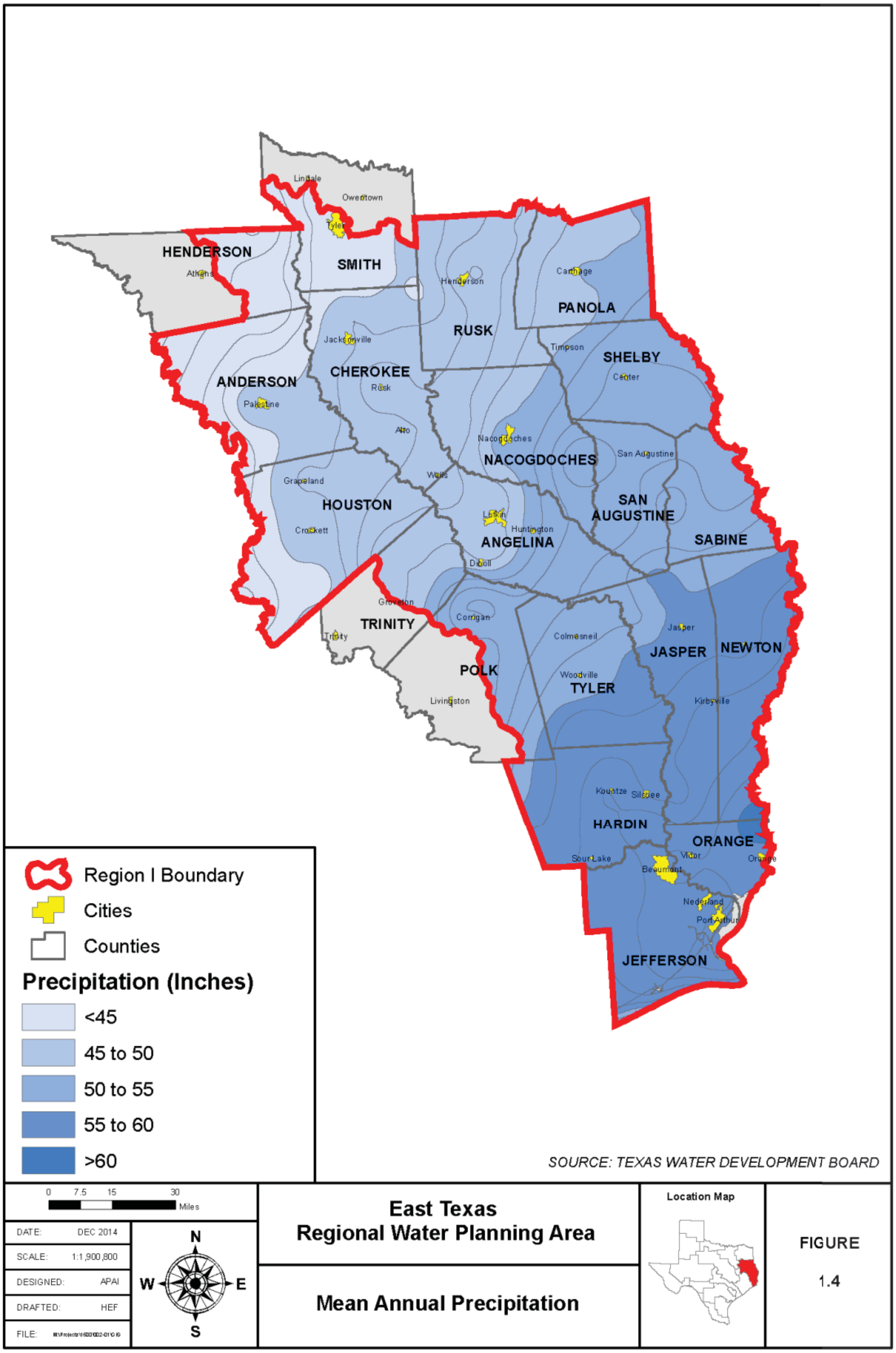
N
W
E
S
East Texas
Regional Water Planning Area
Mean Annual Temperature
Location Map
FIGURE
1.3


HENDERSON
SMITH
RUSK
PANOLA
SHELBY
CHEROKEE
ANDERSON
NACOGDOCHES
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
TRINITY
POLK
TYLER
JASPER
NEWTON
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ORANGE
JEFFERSON
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Owentown
Tyler
Athens
Henderson
Carthage
Jacksonville
Timpson
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Rusk
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Nacogdoches
San Augustine
Wells
Grapeland
Lufkin
Huntington
Crockett
Diboll
Groveton
Corrigan
Trinity
Colmesneil
Jasper
Woodville
Livingston
Kirbyville
Kountze
Silsbee
Sour Lake
Vidor
Orange
Beaumont
Nederland
Port Arthur
Region I Boundary
Cities
Counties
Precipitation (Inches)
<45
45 to 50
50 to 55
55 to 60
>60
SOURCE: TEXAS WATER DEVELOPMENT BOARD
0 7.5 15 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
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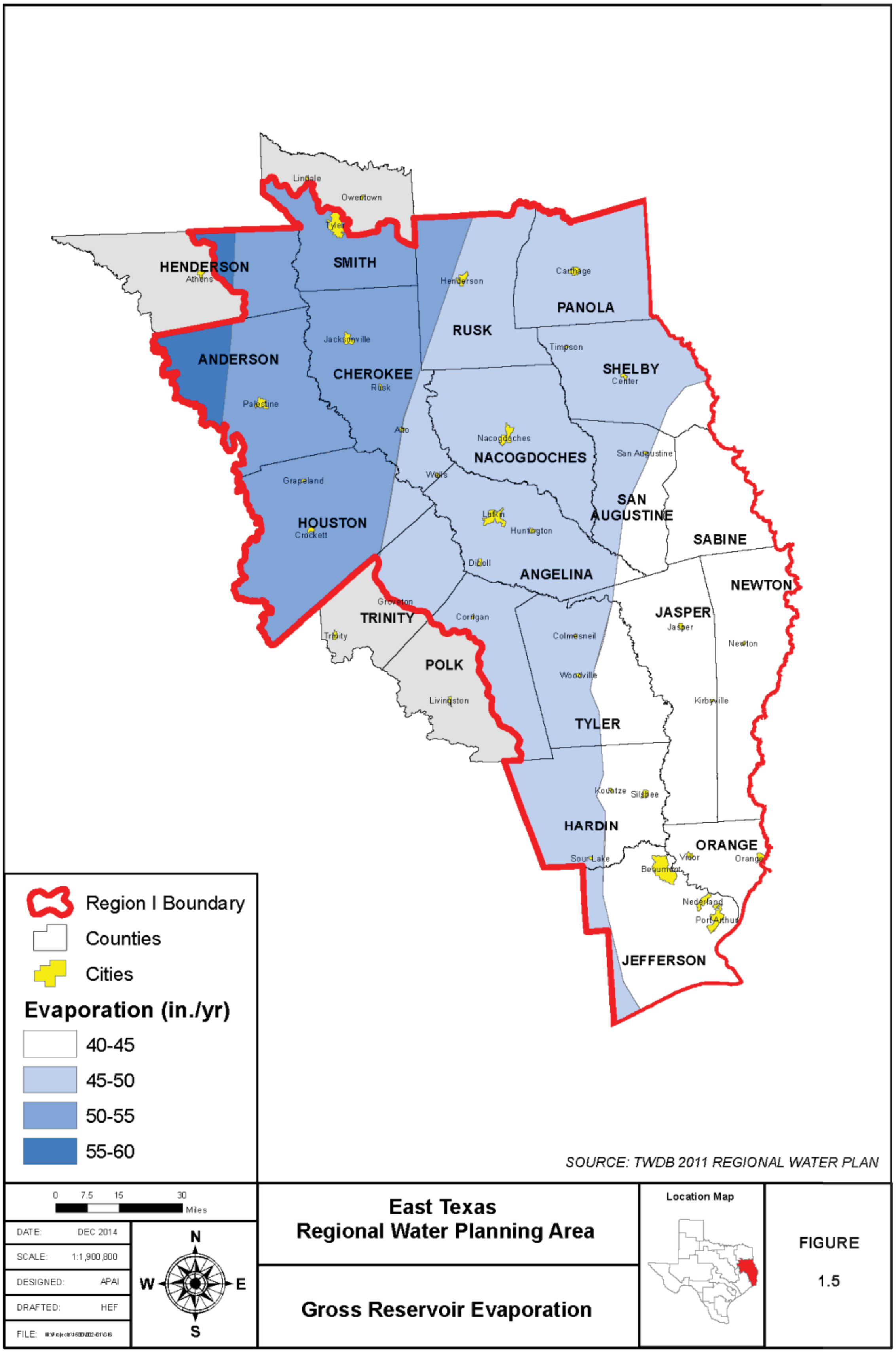
W
E
S
East Texas
Regional Water Planning Area
Mean Annual Precipitation
Location Map
FIGURE
1.4



East Texas
Regional Water Planning Area

Gross Reservoir Evaporation

FIGURE 1.5

1.4 Population

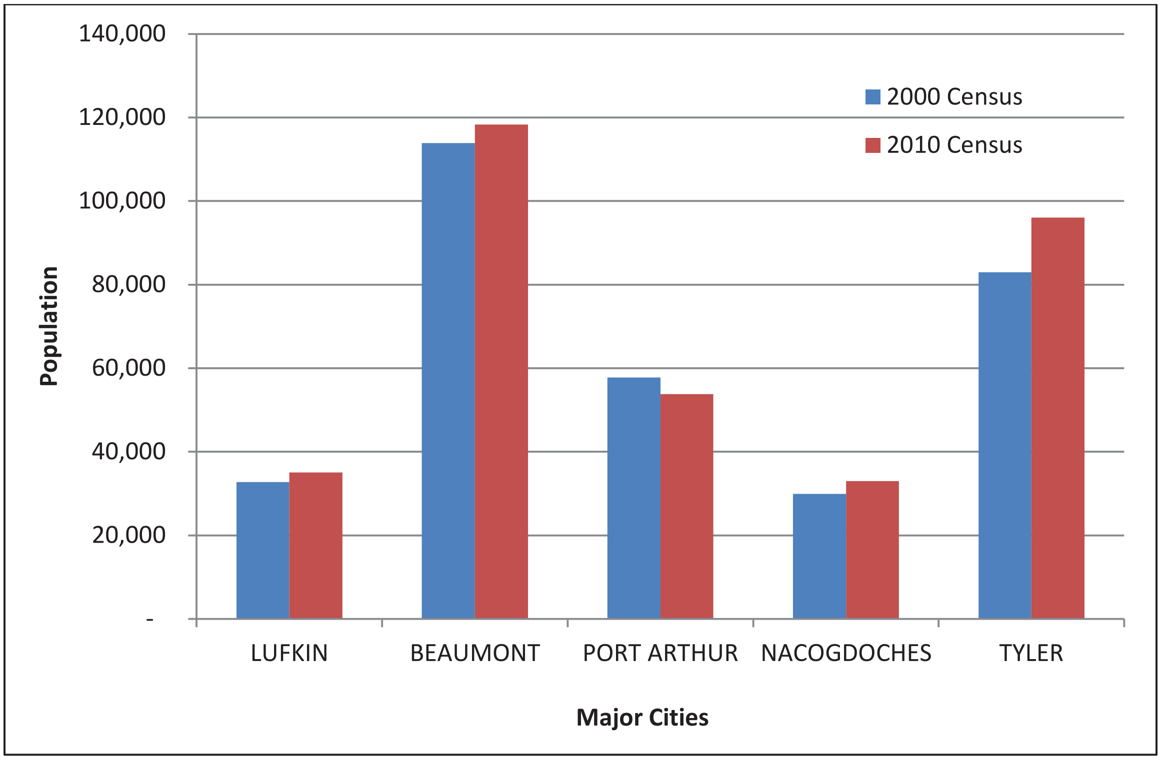
The ETRWPA contains all or parts of three Metropolitan Statistical Areas (MSA) as defined by the Office of Management and Budget; an MSA is an urban area with a population of 50,000 or more.[4] The MSAs in the ETRWPA include:

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

As of 2012, the combined population of these three MSAs is approximately 63% 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 1.55 million by 2070. The census data from 2000 and 2010 for the region's major cities are provided in Figure 1.6. Additional details on population projections are provided in Chapter 2.

Figure 1.6 Historical Populations of Major Cities



1.5 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.

The Beaumont-Port Arthur metropolitan area, 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.

There are several seaports 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.

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

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

The Tyler metropolitan area, 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 region. Local manufacturing includes air conditioning/heating equipment, cast iron pipe, tires, meatpacking, and oil platform. However, the area is largely a commercial, educational, and medical center. Oil production and rose farming are prevalent in the area. The University of Texas at Tyler is also located in the City of Tyler.

Lufkin and Nacogdoches, the other major cities in the ETRWPA, do not presently classify as metropolitan areas, but would do so by 2040 and 2060, respectively, according to the current TWDB population projections. These cities, located in adjacent micropolitan counties, have many similarities including timber products industries, poultry processing, and higher education. Lufkin also has a foundry and a truck trailer manufacturer, while Nacogdoches has manufacturers of valves, transformers, sealing products, and motor homes. Stephen F. Austin University is located in Nacogdoches.

The remainder of the region is largely forested and has various timber industries including paper mills in southeast Texas. Oil production is scattered throughout the region, and beef cattle are prominent, being found in all of the counties in the region. Plant nurseries are common in the north part of the region. Poultry production and processing are prevalent in Anderson, Shelby, Nacogdoches, Angelina, and Panola Counties. There is diverse manufacturing in addition to timber industries. Commercial fishing is an important economic characteristic of Sabine Lake. Tourism is important in many areas, especially on large reservoirs; in the southern end of the region near Sabine Lake and the Gulf of Mexico; and in many timbered areas, which offer hunting opportunities.

Information from the Texas Workforce Commission (TWC) shows unemployment for the region varying from 5.1% in Panola County to 13.4% in Sabine County in 2013. Of the three workforce areas overlapping the region, the average annual wages for 2007 were as follows: [5]

- East Texas (northern counties): $37,822
- Deep East Texas (middle counties): $35,903
- South East Texas (Beaumont-Port Arthur metropolitan area): $42,306

1.6 Current Water Demands

The demand for water in the ETRWPA is expected to grow from 1,108,800 ac-ft per year in the year 2020 to a total of 1,607,250 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 major demand in the region centers on larger cities or metropolitan areas. In particular, 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 as in the case of outlying industries and steam-electric power generating plants.

For purposes of this 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 as a whole, 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	91,580
Jefferson	Irrigation	161,952
	Manufacturing	423,258
	Municipal	60,097
Orange	Manufacturing	64,461
Rusk	Steam Electric Power	27,458
Smith	Municipal	33,188

1.7 Sources of Water

The ETRWPA obtains its supplies from both groundwater and surface water sources. Each source is described following.

1.7.1 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.

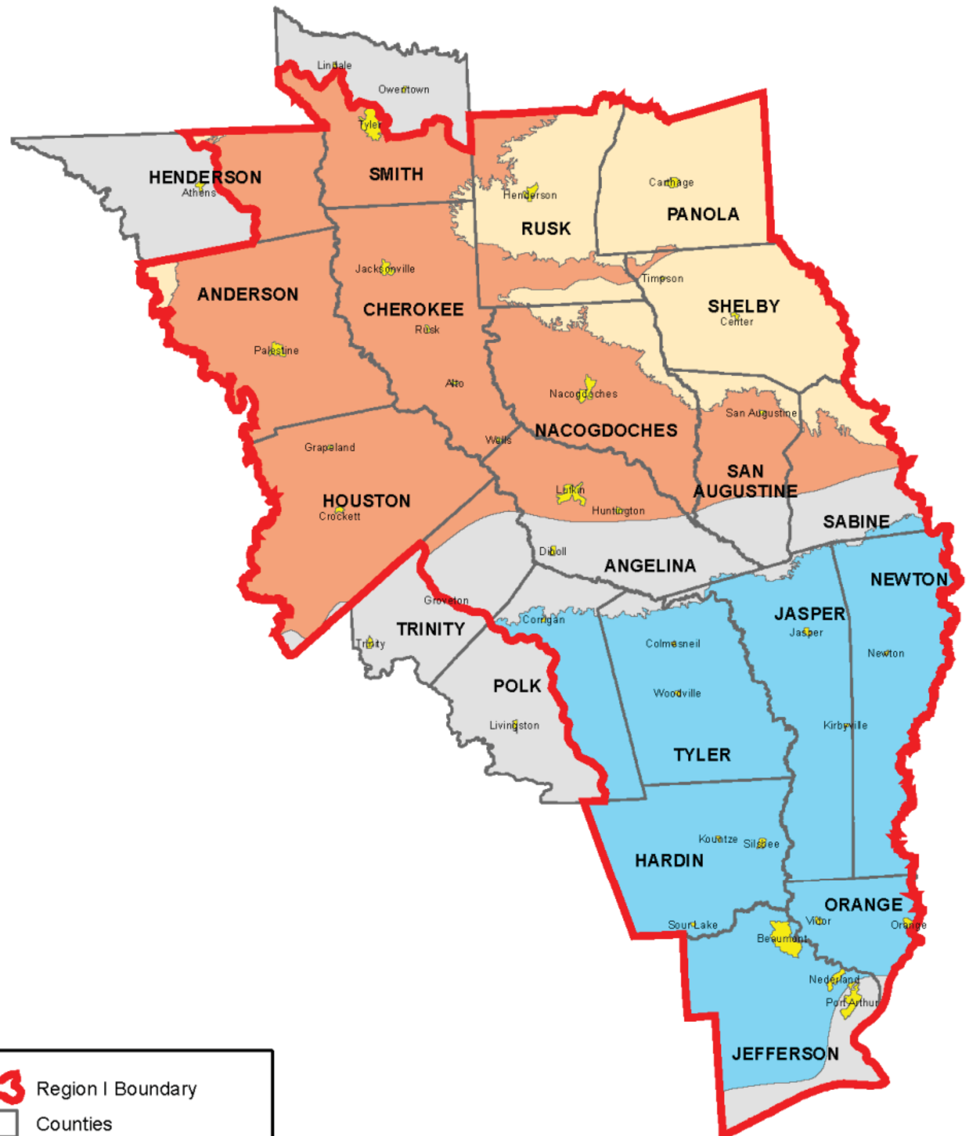
The two major aquifers that underlie the region are known as the Carrizo-Wilcox and the Gulf Coast aquifer. The three minor aquifers, the Queen City, Sparta, and Yegua-Jackson aquifers, supply lesser amounts of water to the region. Figures 1.7 and 1.8 show the locations of the major and minor aquifers,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

The following generalized descriptions of the major and minor aquifers and springs are based largely on the work of TWDB. A more thorough discussion of groundwater availability is provided in Chapter 3.

Gulf Coast Aquifer. The Gulf Coast aquifer 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 10 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 74,822 acre-feet per year (ac-ft per year) during 2010, 2011, and 2012.



Region I Boundary
Counties
Cities

Major Aquifers

Carrizo-Wilcox (outcrop)
Carrizo-Wilcox (subcrop)
Gulf Coast

SOURCE: TEXAS WATER DEVELOPMENT BOARD

0 5 10 20 30 Miles

DATE:	DEC 2014
SCALE:	1:1,900,800
DESIGNED:	APAI
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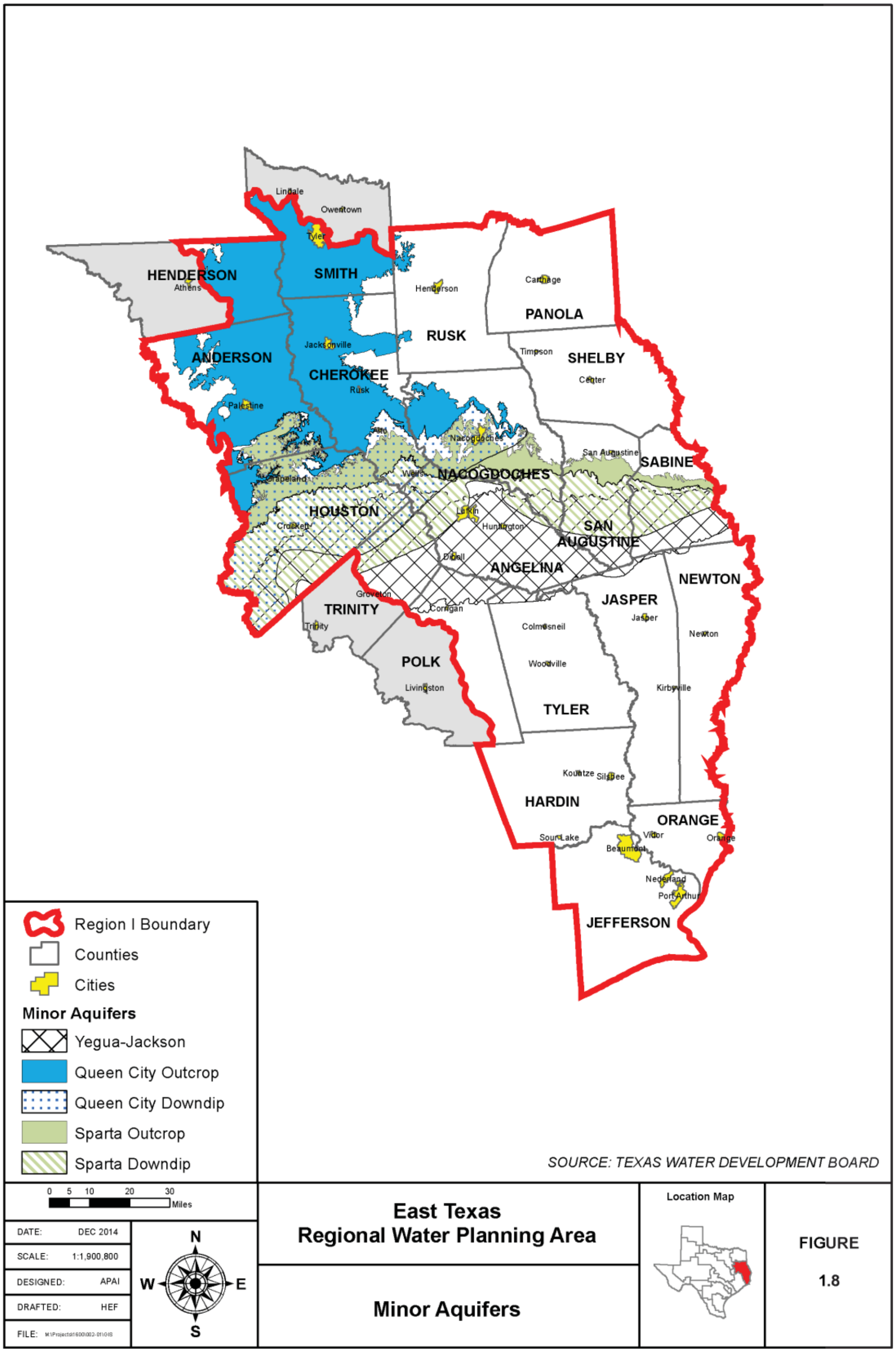
N W E S

East Texas Regional Water Planning Area

Major Aquifers

Location Map

FIGURE 1.7


HENDERSON
Athens
SMITH
Lindale
Owentown
Tyler
RUSK
Henderson
PANOLA
Carthage
ANDERSON
Palestine
CHEROKEE
Jacksonville
Rusk
Alto
SHELBY
Timpson
Center
SAN AUGUSTINE
San Augustine
SABINE
NACOGDOCHES
Nacogdoches
Wells
HOUSTON
Crockett
Grapeland
Lufkin
Huntington
ANGELINA
Diboll
TRINITY
Groveton
Trinity
Corrigan
POLK
Livingston
JASPER
Jasper
Colmesneil
Woodville
TYLER
NEWTON
Newton
Kirbyville
HARDIN
Kountze
Silsbee
Sour Lake
ORANGE
Vidor
Orange
Beaumont
Nederland
Port Arthur
JEFFERSON
Region I Boundary
Counties
Cities
Minor Aquifers
Yegua-Jackson
Queen City Outcrop
Queen City Downdip
Sparta Outcrop
Sparta Downdip
SOURCE: TEXAS WATER DEVELOPMENT BOARD
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
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E
S
East Texas
Regional Water Planning Area
Minor Aquifers
Location Map
FIGURE
1.8

Carrizo-Wilcox Aquifer. The Carrizo-Wilcox aquifer 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 Carrizo-Wilcox aquifer in the region occurs as a major trough caused by the Sabine Uplift near the Texas-Louisiana border.

Total groundwater pumpage from the Carrizo-Wilcox in the region averaged 76,037 ac-ft per year during 2010, 2011, and 2012. 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 200 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 (bgl) to 263 feet bgl. Significant water-level declines have occurred in the region around Tyler and the Lufkin-Nacogdoches area.

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 actually increased, although the wells are still being utilized.

Sparta Aquifer. The Sparta aquifer 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.

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.

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.

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.

Groundwater Quality. Groundwater quality is affected by natural conditions as well as man-made contamination. According to the Texas Water Commission (predecessor agency to the Texas Commission on Environmental Quality), "natural contamination affects the quality of more groundwater in the state than all other sources of contamination combined." [6]

In the Gulf Coast aquifer, 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.

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 Texas Water Commission 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.

Salt water is also found farther inland, but usually at greater depths than in coastal areas. Salinity problems also occur in the vicinity of salt domes.

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 may all contribute to man-made aquifer pollution.[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. [7]

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. 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.

The Yegua aquifer produces good water quality only in a limited area. Iron is a problem, and the water from at least one location has been described as "sodium bicarbonate water."

Groundwater Conservation Districts and Groundwater Management Areas. 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 ten-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.

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 (DFCs), and estimate Modeled Available Groundwater (MAG) for permitting purposes.

The boundaries of the ETRWPA encompass 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.

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 headquarted 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.

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

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, headquartered northeast of Henderson, covers Rusk County. The District was created by the legislature in 2003.

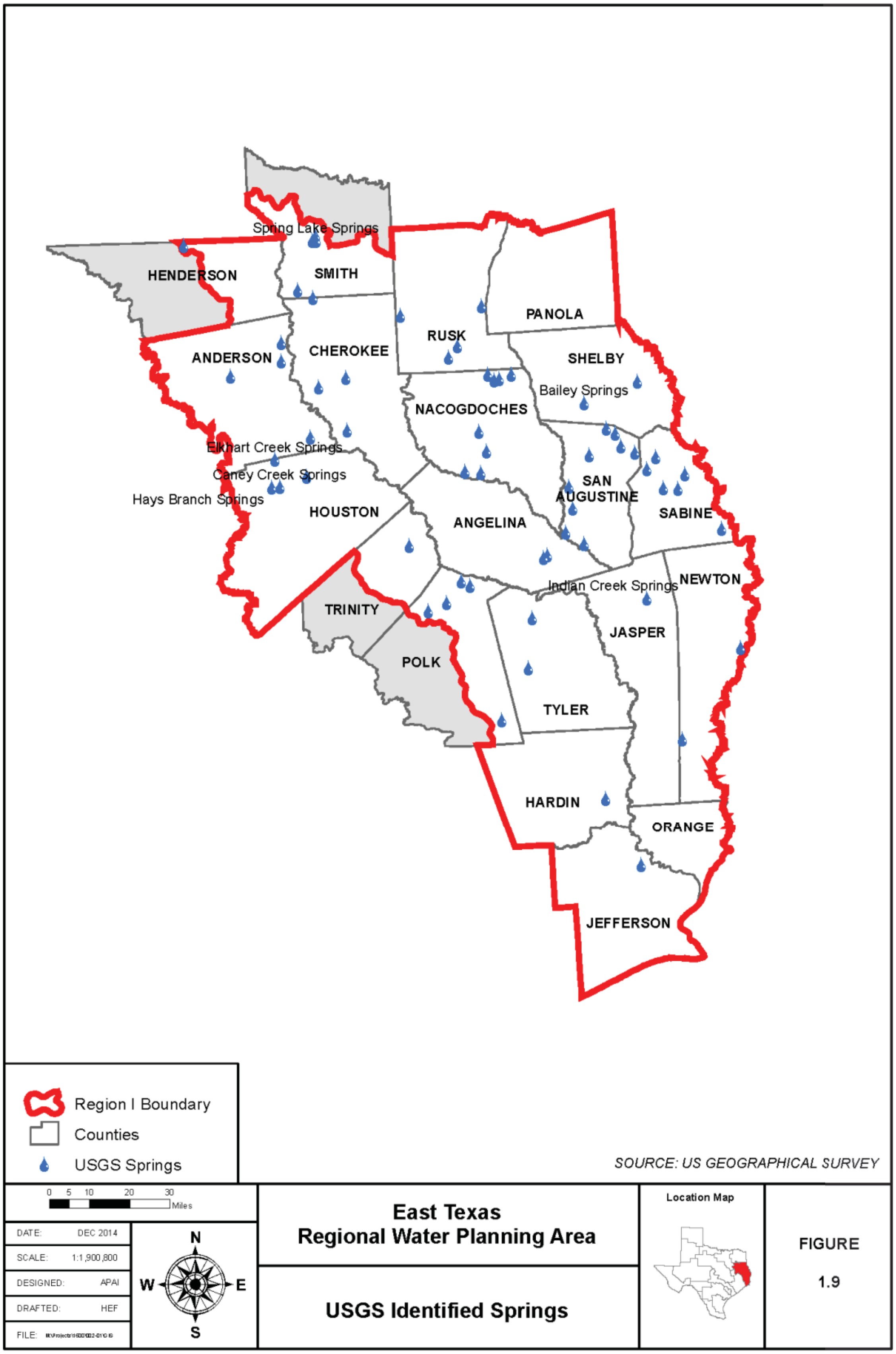
Counties Not Covered by Groundwater Conservation Districts. Houston, Jefferson, Orange, Smith, Sabine, San Augustine, Shelby, and Trinity Counties are not covered by any confirmed or pending GCD.

1.7.2 Springs. Over 250 springs of various sizes are documented in the ETRWPA according to the research of Gunnar M. Brune.[8] 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 1.9 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 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), Elkhart Creek Springs in Houston County (1,500 gpm in 1965).


Spring Lake Springs
HENDERSON
SMITH
PANOLA
RUSK
ANDERSON
CHEROKEE
SHELBY
Bailey Springs
NACOGDOCHES
Elkhart Creek Springs
Caney Creek Springs
Hays Branch Springs
HOUSTON
SAN AUGUSTINE
SABINE
ANGELINA
Indian Creek Springs
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Counties
USGS Springs
SOURCE: US GEOGRAPHICAL SURVEY
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
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East Texas
Regional Water Planning Area
USGS Identified Springs
Location Map
FIGURE
1.9

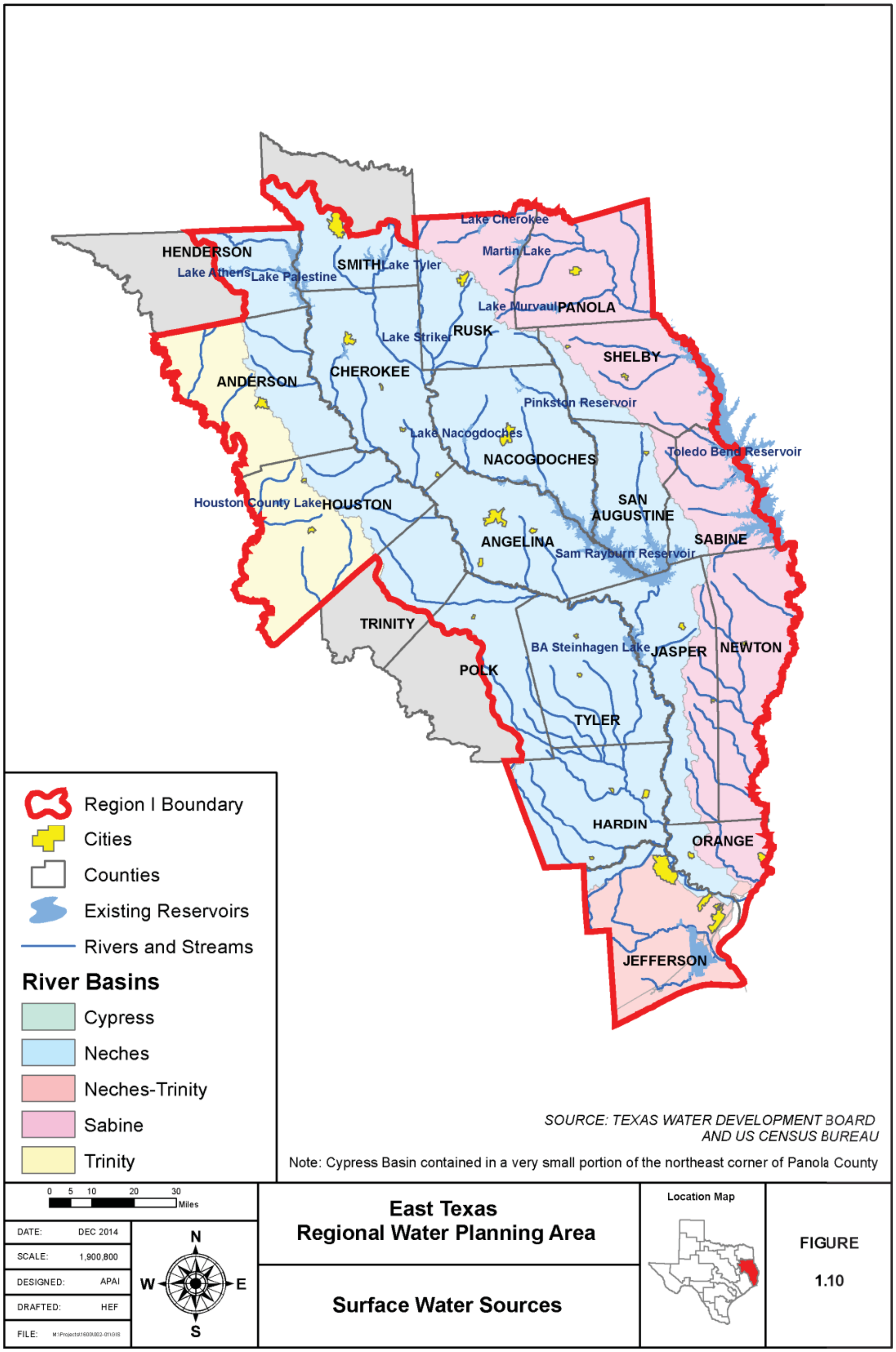
1.7.3 Surface Water. Surface water may be obtained directly from streams, rivers, or reservoirs. The ETRWPA includes portions of three major river basins, and one coastal basin. Most of the region falls within the Neches River Basin. In fact, the majority of the Neches River Basin is located in the ETRWPA. 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. Additional descriptions of the Neches, Sabine, and Trinity River Basins, as well as of Sabine Lake, 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 one-third of the basin area is comprised of the Angelina River Basin. Significant tributaries to the 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 six counties in the ETRWPA: Panola, Shelby, Sabine, Newton, Orange, and Jefferson 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. 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 770 square miles. 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.


HENDERSON
Lake Athens
Lake Palestine
SMITH
Lake Tyler
Lake Cherokee
Martin Lake
Lake Murvaul
PANOLA
RUSK
Lake Striker
CHEROKEE
ANDERSON
SHELBY
Pinkston Reservoir
Lake Nacogdoches
NACOGDOCHES
Toledo Bend Reservoir
Houston County Lake
HOUSTON
SAN AUGUSTINE
ANGELINA
Sam Rayburn Reservoir
SABINE
TRINITY
BA Steinhagen Lake
JASPER
NEWTON
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Cities
Counties
Existing Reservoirs
Rivers and Streams
River Basins
Cypress
Neches
Neches-Trinity
Sabine
Trinity
SOURCE: TEXAS WATER DEVELOPMENT BOARD AND US CENSUS BUREAU
Note: Cypress Basin contained in a very small portion of the northeast corner of Panola County
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
N
W
E
S
East Texas
Regional Water Planning Area
Surface Water Sources
Location Map
FIGURE
1.10

Reservoirs. In the ETRWPA, most surface water is provided by one of fourteen existing water supply reservoirs. Locations of major reservoirs and geographical features are shown on Figure 1.10. Details regarding these reservoirs are provided in Chapter 3 of the 2016 Plan.

Surface water quality in the region varies between water bodies. Stream and lake segments with water quality problems identified by the Texas Commission on Environmental Quality (TCEQ) as impaired are discussed in Section 1.10. None of the segments in the region indicates problems as drinking water sources. Aquatic life, fish consumption, and recreation uses are sometimes not supported in the water bodies.

Fish consumption is the subject of Texas Department of State Health Services (TDSHS) advisories in a number of segments, mostly in reservoirs as a result of mercury found in certain species of fish.[9] The mercury concentration in the water was negligible and did not present problems for recreation or water supply.[10, 11]

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 includes sedimentation, filtration, and disinfection.

Tidally driven salt water intrusion is a major concern in the tidal reaches of streams, especially since ship channels between the Gulf of Mexico and Sabine Lake were dredged around the beginning of the twentieth century. The salt water, being denser than fresh water, tends to settle on the bottom of the channel similar to the way it underlies fresh water in aquifers. The horizontal and vertical extent of the salt water layer varies according to several factors including fresh water inflow and tidal influence. Salt water intrusion, which was 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. However, the salt water barrier constructed by LNVA in the Neches River prevents salt water from reaching Lower Neches Valley Authority (LNVA) and the city of Beaumont raw water supply intakes.

Pollution from industrial discharges was historically a major concern in the industrial 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.

1.7.4 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.

1.7.5 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 impacted.

1.7.6 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.

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 that area.

The Sabine River Compact, executed in 1953, provides for allotment of the water between Texas and Louisiana.[12] 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 the water rights.

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 upstream from the ETRWPA, as well as a small portion of the Neches basin. The upper Trinity basin includes the Dallas-Fort Worth area. The upper Sabine basin contains numerous medium sized cities as well as smaller communities. 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 SRA has contracts to provide over 300,000 ac-ft per year to the Dallas area from reservoirs in the upper Sabine basin.

1.8 Water User Groups and Wholesale Water Providers

For the purposes of regional water planning, the TWDB defines a Water User Group (WUG) as an entity for which water demands and supplies have been identified and analyzed. All WUGs with projected demands in the 2016 Plan fall into one of six water use categories: Municipal; Manufacturing; Mining; Steam Electric Power; Livestock; and Irrigation. The ETRWPA has 142 municipal WUGs and 87 non-municipal WUGs. Water demands and supplies associated with each WUG are described in detail in Chapters 2 and 3, respectively.

WUGs either have direct access to water supplies or they purchase retail or wholesale water from water providers. Title 31 of the Texas Administrative Code (31 TAC) Chapter 357.10(29) defines a WUG as follows:

> *Water User Group (WUG)--Identified user or group of users for which water demands and water supplies have been identified and analyzed and plans developed to meet water needs. These include:*
>
> *(A) Incorporated Census places of a population greater than 500, including select Census Designated Places, such as significant military bases or cases in which the Census Designated Place is the only Census place in the county;*
>
> *(B) Retail public utilities providing more than 280 acre-feet per year for municipal use;*

(C) Collective Reporting Units, or groups of retail public utilities that have a common association;

(D) Municipal and domestic water use, referred to as county-other, not included in subparagraphs (A) - (C) of this paragraph; and

(E) Non-municipal water use including manufacturing, irrigation, steam electric power generation, mining, and livestock watering for each county or portion of a county in a RWPA.

In addition, 31 TAC Chapter 357.10(30) defines a Wholesale Water Provider (WWP) as follows:

Wholesale water provider - Any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. The regional water planning groups shall include as wholesale water providers, other persons and entities that enter or that the regional water planning group expects or recommends to enter contracts to sell more than 1,000 acre-feet of water wholesale during the period covered by the plan."

The sixteen WWPs in the ETRWPA 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

For further discussion relevant to these WWPs, refer to Chapters 2, 3, 4, 5, and 7 of the 2016 Plan.

1.9 Agricultural and Natural Resources

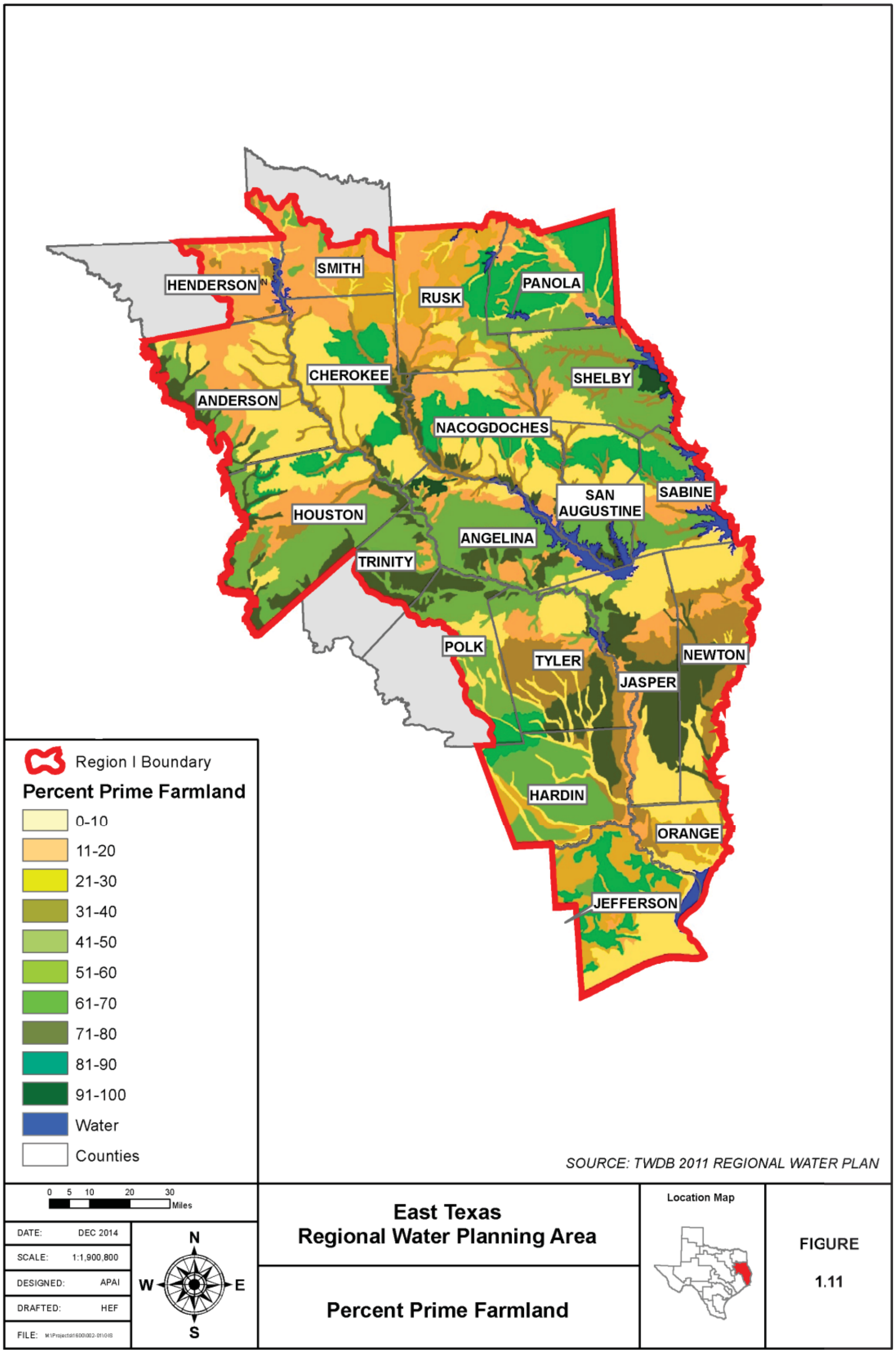
For the purposes of this evaluation, the ETRWPA's agricultural resources are defined as prime farmland. Natural resources within the ETRWPA include timber, wetlands, estuaries, endangered or threatened species, ecologically significant streams, springs, and state or federal parkland and preserves. Groundwater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

1.9.1 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."[13] As part of the National Resources Inventory, the NRCS has identified prime farmland throughout the country.

Figure 1.11 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 (STATSGO) 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) 2012 agriculture statistics for the counties in the ETRWPA[14] (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 2007 to 2012, the total acres of farm land increased by 1.7% while the total acres of crop land decreased by over 20%.
- In any one year, approximately 20% of farm land is crop land.
- In any one year, approximately 65% of crop land is harvested.
- Excluding Jefferson County, approximately 3% of crop land is irrigated. In Jefferson County, approximately 20% 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 generates the largest agricultural product sales in Anderson, Cherokee, Henderson, and Houston Counties.


SMITH
HENDERSON
RUSK
PANOLA
CHEROKEE
SHELBY
ANDERSON
NACOGDOCHES
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
TRINITY
POLK
TYLER
NEWTON
JASPER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Percent Prime Farmland
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
Water
Counties
SOURCE: TWDB 2011 REGIONAL WATER PLAN
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
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W
E
S
East Texas
Regional Water Planning Area
Percent Prime Farmland
Location Map
FIGURE
1.11

Table 1.4 USDA 2012 Agricultural Statistics[16]

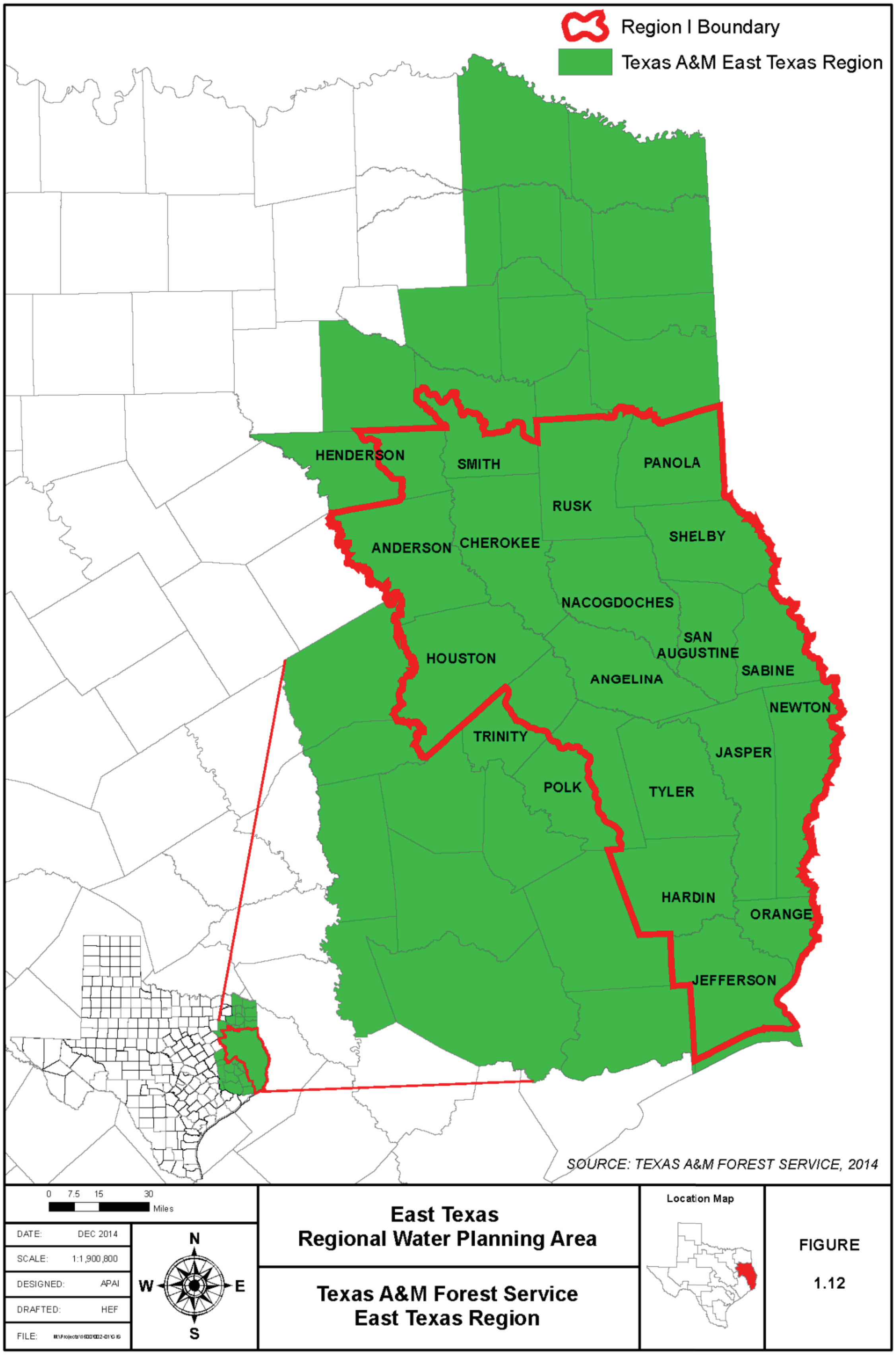
Category	Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoches	Newton
Farms	2,001	975	1,574	660	1,961	1,505	894	764	1,196	450
Total Farm Land (acres)	375,110	116,977	301,338	68,508	345,628	467,883	88,130	353,971	264,818	58,782
Crop Land (acres)	70,333	21,687	67,789	22,708	81,924	83,560	16,337	112,735	43,706	8,902
Harvested Crop Land (acres)	54,581	16,549	55,167	8,285	60,344	53,743	12,332	37,388	29,778	6,896
Irrigated Crop Land (acres)	896	157	1,405	1,671	1,399	5,958	357	22,387	343	45
Market Value Crops ($1,000)	13,645	4,292	89,696	3,219	17,357	13,915	5,618	21,590	5,718	1,043
Market Value Livestock ($1,000)	30,934	42,156	44,287	(D)	32,165	35,665	4,451	16,440	316,656	1,906
Total Market Value ($1,000)	44,579	46,448	133,984	(D)	49,521	49,581	10,069	38,030	322,374	2,948
Livestock and Poultry:										
Cattle and Calves Inventory	51,523	16,124	47,174	8,484	53,402	70,714	12,706	41,254	40,852	4,783
Hogs and Pigs Inventory	(D)	344	162	232	665	9102	347	142	38	34
Sheep and Lambs Inventory	431	230	354	340	610	991	92	331	190	54
Layers and Pullets Inventory	4,271	(D)	2,199	2,310	5,154	214,086	2,143	1,839	272,176	1,469
Broilers and Meat-Type Chickens Sold	148	12,278,448	6,191,877	268	116	119	168	301	82,186,713	83
Crops Harvested (acres):										
Corn for Grain or Seed	640	0	(D)	0	0	1636	(D)	0	(D)	0
Cotton	933	0	0	0	0	1894	0	(D)	0	0
Rice	(D)	0	0	0	0	282	0	(D)	0	(D)
Sorghum for Grain or Seed	(D)	0	0	0	0	0	0	(D)	(D)	0
Soybeans for beans	(D)	0	1501	0	0	(D)	0	0	0	0
Wheat for Grain	640	0	(D)	0	0	1,636	(D)	0	(D)	0

Table 1.4 USDA 2012 Agricultural Statistics[16] (Cont.)

Category	Orange	Panola	Polk	Rusk	Sabine	San Augustine	Shelby	Smith	Trinity	Tyler
Farms	671	1,079	738	1,390	201	305	1,048	2,961	604	727
Total Farm Land (acres)	52,799	227,367	139,199	274,327	29,035	72,890	197,189	302,339	111,262	90,670
Crop Land (acres)	6,718	38,625	23,208	47,469	4,603	8,922	36,385	77,116	17,913	16,390
Harvested Crop Land (acres)	5,231	31,057	15,348	31,876	3,662	6,755	25,901	61,238	13,888	12,385
Irrigated Crop Land (acres)	388	697	443	373	221	31	1,830	2,465	152	580
Market Value Crops ($1,000)	1,918	5,626	2,409	19,263	566	1,243	9,715	59,512	1,696	14,293
Market Value Livestock ($1,000)	2,417	87,671	5,427	56,040	14,162	61,971	463,571	17,278	5,354	4,851
Total Market Value ($1,000)	4,335	93,297	7,836	75,303	14,728	63,215	473,287	76,790	7,050	19,144
Livestock and Poultry:										
Cattle and Calves Inventory	8,268	33,563	14,839	36,731	5,354	10,555	38,099	42,885	16,053	10,982
Hogs and Pigs Inventory	128	244	250	182	74	-	92	401	76	413
Sheep and Lambs Inventory	160	307	33	263	29	22	257	706	284	369
Layers and Pullets Inventory	3,455	1,264	31,872	(D)	254	(D)	1,119,086	6,028	745	1,861
Broilers and Meat-Type Chickens Sold	291	26,058,981	406	13,690,689	4,037,000	19,000,775	124,937,005	1,272	(D)	420
Crops Harvested (acres):										
Corn for Grain or Seed	0	24	0	(D)	0	60	(D)	14	0	(D)
Cotton	0	0	0	0	0	0	0	0	0	0
Rice	0	0	0	0	0	0	0	0	0	0
Sorghum for Grain or Seed	0	(D)	0	0	0	0	890	0	0	0
Soybeans for beans	0	0	0	0	0	0	(D)	0	0	0
Wheat for Grain	0	(D)	0	0	0	0	0	(D)	0	0

TOTALS FOR ALL COUNTIES:		SPECIAL FOR JEFFERSON COUNTY:	
Total Farm Land (acres)	3,938,222	Irrigated/ Total Crop Land (%)	19.86%
Crop Land (acres)	807,030		
Crop Land/Total Farm Land (%)	20.49%	COUNTIES OTHER THAN JEFFERSON:	
Harvested Crop Land (acres)	542,404	Irrigated Crop Land (acres)	19,411
Harvested/Total Crop Land (%)	67.21%	Irrigated/ Total Crop Land (%)	2.80%
Irrigated Crop Land (acres)	41,798	(D) – Withheld to avoid disclosing data for individual farms	
Irrigated/ Total Crop Land (%)	5.18%		

1.9.2 Timber, Pulpwood, and Forest Fiber. The primary natural resources in the ETRWPA are timber, pulpwood, and forest fiber; according to the Texas A&M Forest Service, 71% of the Texas output from forestry, logging, and solid wood industries was from East Texas in 2012. In this same year, the forest industry contributed $17.8 billion to the Texas economy employing over 59,400 people with a payroll of $3.8 billion.[17] With over 60 million acres of forestland in the State, 23% of that is timberland. The total volumes of timber harvests declined by 19% from 2007 to 2012 due to lower economic activity in the housing market. Other economic benefits to the ETRWPA provided by timberlands and forests include water quality protection and recreational opportunities. 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 pine and hardwoods. Figure 1.12 shows the ETRWPA compared to the Texas A&M Forest Service's East Texas region.


Region I Boundary
Texas A&M East Texas Region
HENDERSON
SMITH
PANOLA
RUSK
SHELBY
ANDERSON
CHEROKEE
NACOGDOCHES
SAN AUGUSTINE
HOUSTON
SABINE
ANGELINA
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
SOURCE: TEXAS A&M FOREST SERVICE, 2014
0 7.5 15 30
Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
N
W
E
S
East Texas
Regional Water Planning Area
Texas A&M Forest Service
East Texas Region
Location Map
FIGURE
1.12

1.9.3 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.[18] 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.[18] 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.[18] 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,[19] 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.[19] The TPWD identified specific stream segments in the region that they classify as being priority bottomland hardwood habitat; these segments will be discussed in later sections.[20]

Table 1.5 Texas Wetland Types and Characteristics

Wetland Classifications	Definition	Vegetation / Habitat Types
Palustrine	Freshwater bodies and intermittently or permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet dep.	Predominantly trees; shrubs; emergent, rooted herbaceous plants; or submersed/floating plants.
Estuarine	Tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 parts per thousand (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; subtitdal open water bays (deep water habitat).
Lacustrine	Wetlands and deepwater 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.	Nonpersistent emergent plants, submersed plants, and floating plants.
Riverine	Freshwater wetlands within a channel, with two exceptions: wetlands dominated by trees, shrubs, persistent emergents, 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).

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 located in ETRWPA.
Angelina River	88,000	All

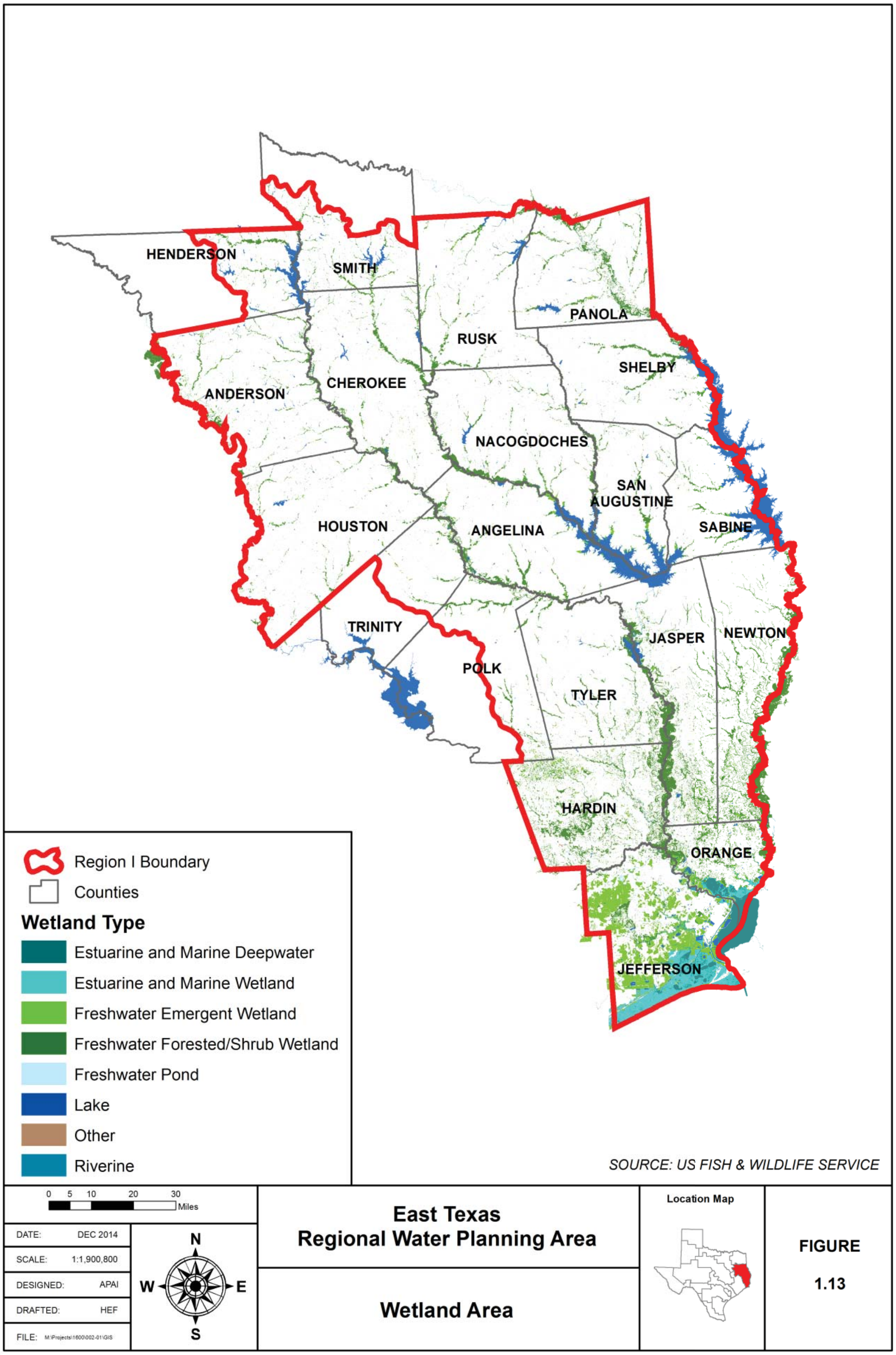
*** Information obtained from [6].**

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.[18] Much of the palustrine wetlands area in Jefferson County is farmed wetlands used for rice growing. Figure 1.13 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 1.13 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,[21] particularly the emergent kind.

Three other kinds of wetlands cover a smaller area in the region but are ecologically significant:[21] lacustrine, riverine, and marine wetlands. See Table 1.5 above for a detailed description of these types of wetlands.

Section 404 of the Clean Water Act 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 may include restoration and rehabilitation of native wetlands or construction of new wetlands. One wetland mitigation project, the Blue Elbow Swamp Mitigation Project, was identified near the mouth of the Sabine River. This mitigation project was established by the Texas Department of Transportation to compensate for future impacts to wetlands.[22]

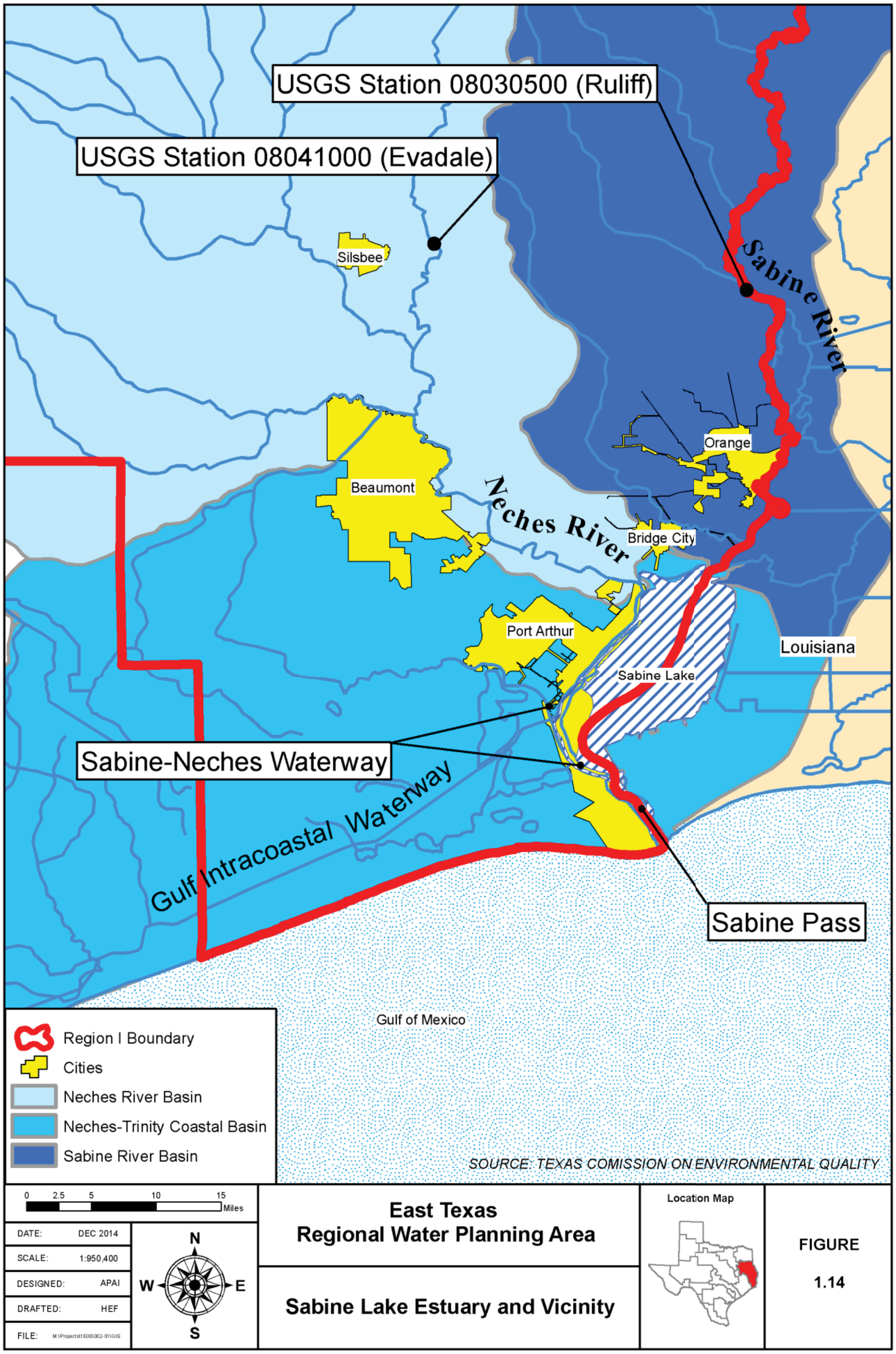

HENDERSON
SMITH
PANOLA
RUSK
SHELBY
CHEROKEE
ANDERSON
NACOGDOCHES
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
TRINITY
JASPER
NEWTON
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Counties
Wetland Type
Estuarine and Marine Deepwater
Estuarine and Marine Wetland
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Other
Riverine
SOURCE: US FISH & WILDLIFE SERVICE
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
N
W
E
S
East Texas
Regional Water Planning Area
Wetland Area
Location Map
FIGURE
1.13

1.9.4 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 flow to the estuary.[23]

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 waves 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 making it one of the smallest estuaries on the Texas Coast. The lake supports an extensive coastal wetland (i.e., salt marsh) system around much of the perimeter. Its small volume coupled with large freshwater inflows from the Sabine and Neches Rivers result in a turnover rate of around 50 times per year. A map of Sabine Lake and vicinity is provided on Figure 1.14.

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.


USGS Station 08030500 (Ruliff)
USGS Station 08041000 (Evadale)
Silsbee
Sabine River
Orange
Beaumont
Neches River
Bridge City
Port Arthur
Louisiana
Sabine Lake
Sabine-Neches Waterway
Gulf Intracoastal Waterway
Sabine Pass
Gulf of Mexico
Region I Boundary
Cities
Neches River Basin
Neches-Trinity Coastal Basin
Sabine River Basin
SOURCE: TEXAS COMISSION ON ENVIRONMENTAL QUALITY
0 2.5 5 10 15 Miles
DATE: DEC 2014
SCALE: 1:950,400
DESIGNED: APAI
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S
East Texas
Regional Water Planning Area
Sabine Lake Estuary and Vicinity
Location Map
FIGURE
1.14

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 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.

1.9.5 Endangered or Threatened Species. The TPWD has identified species of special concern in the region (See Appendix 1-A). Included are 19 species of birds, eight insects, six mammals, 15 reptiles/amphibians, nine fish, 13 mollusks, 22 vascular plants, and two crustaceans. These species are listed either as 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 Biological and Conservation Data System (TXBCD).

1.9.6 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.[24] 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 1.15 shows geographically where the stream segments are located. Additional discussion of ecological significant stream segments in the ETRWPA is found in Chapter 8.

1.9.7 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 TPWD 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

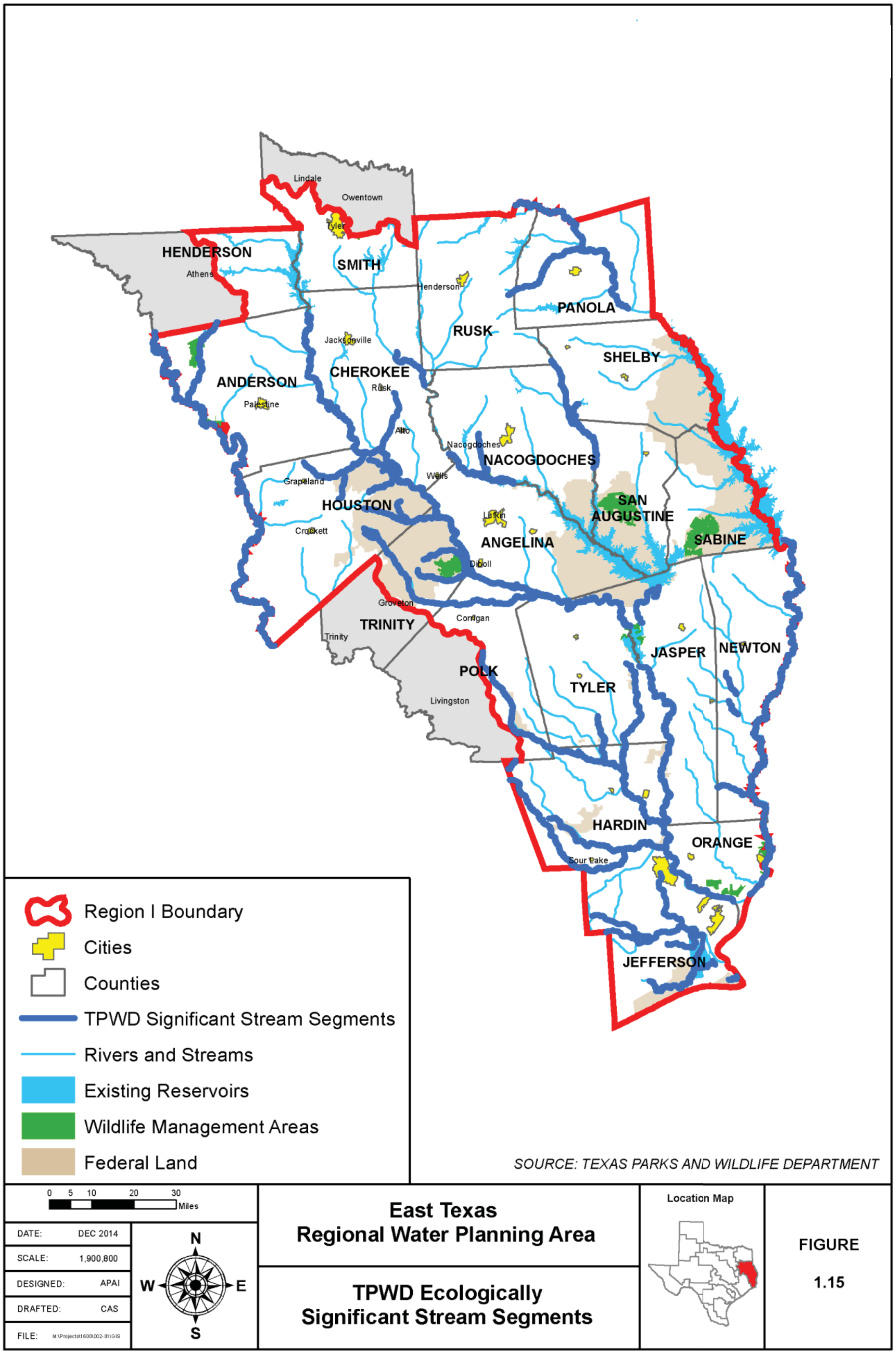

Lindale
Owentown
Tyler
HENDERSON
Athens
SMITH
Henderson
PANOLA
RUSK
Jacksonville
SHELBY
CHEROKEE
ANDERSON
Rusk
Palestine
Alto
Nacogdoches
NACOGDOCHES
Wells
Grapeland
HOUSTON
SAN AUGUSTINE
Lufkin
Crockett
SABINE
ANGELINA
Diboll
Groveton
Corrigan
TRINITY
Trinity
JASPER
NEWTON
POLK
TYLER
Livingston
HARDIN
ORANGE
Sour Lake
JEFFERSON
Region I Boundary
Cities
Counties
TPWD Significant Stream Segments
Rivers and Streams
Existing Reservoirs
Wildlife Management Areas
Federal Land
SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1,900,800
DESIGNED: APAI
DRAFTED: CAS
FILE:
N
W
E
S
East Texas
Regional Water Planning Area
TPWD Ecologically
Significant Stream Segments
Location Map
FIGURE
1.15

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

Owner/Operator	Name	County
Texas Parks and Wildlife Dept.	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
	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
	J.D. Murphree Wildlife Management Area	Jefferson
	Alazan Bayou Wildlife Management Area	Nacogdoches
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
	Sabine Pass Battleground State Historical Site	Jefferson
U.S. Army Corps of Engineers (USACE)	Sam Rayburn Reservoir	
	Town Bluff Dam, B.A. Steinhagen Lake	
U.S. Fish and Wildlife Service (USFWS)	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

1.9.8 Archeological Resources. The Texas Historical Commission (THC) maintains the Texas Historic Sites Atlas, a database containing historic county courthouses, National Register properties, historical markers, museums, sawmills, and neighborhood surveys.[25] This database contains a very large amount of data. The THC does not release information on archeological sites to the general public.

The most prominent archeological site in the ETRWPA is Caddoan Mounds State Historic Site, a 94-acre park in Cherokee County west of Nacogdoches. 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.[26]

1.9.9 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. There are low densities of producing oil wells in each county in the region. The East Texas Oil Field, a portion of which is located in Rusk County, ranked third in Texas in oil production in 1997. There are high densities of producing natural gas wells in Rusk, Panola, Nacogdoches, Jasper, and Newton Counties, with lesser densities in the other counties in the region. In 1997, four of the top 20 producing natural gas fields in the state are located in the region.[27]

- Carthage Gas Field in Panola County
- Oak Hill Gas Field in Rusk County
- Double A Wells Gas Field in Polk and Tyler Counties

Brookeland Gas Field in Jasper and Newton CountiesFigures 1.16 through 1.18 depict oil and gas resources in the state, including the ETRWPA.

Lignite Coal Fields. Figure 1.19 shows lignite coal resources located in the region.[28] 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 1.16 Top Producing Oil Wells

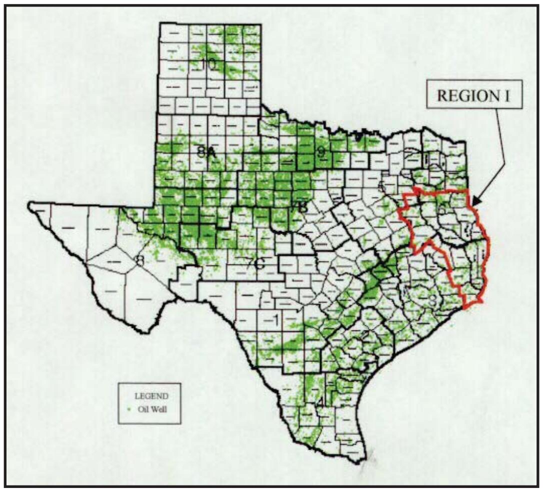


Figure 1.17 Top Producing Oil and Gas Fields

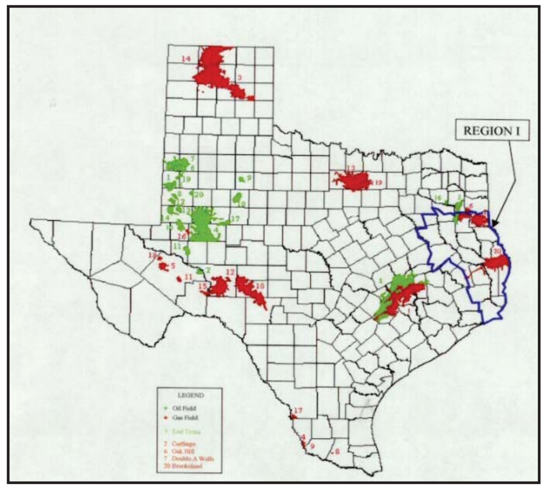


Figure 1.18 Top Producing Gas Wells

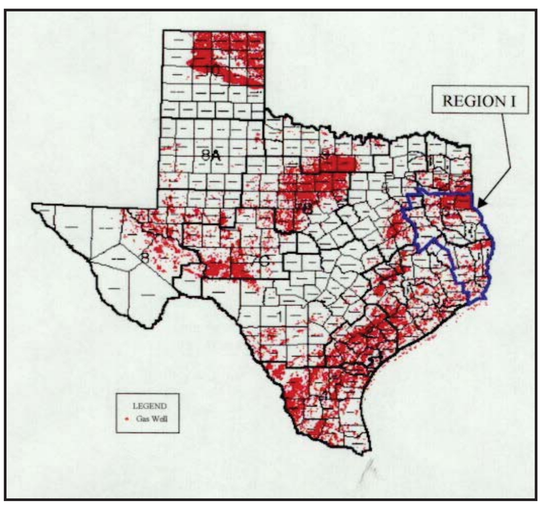
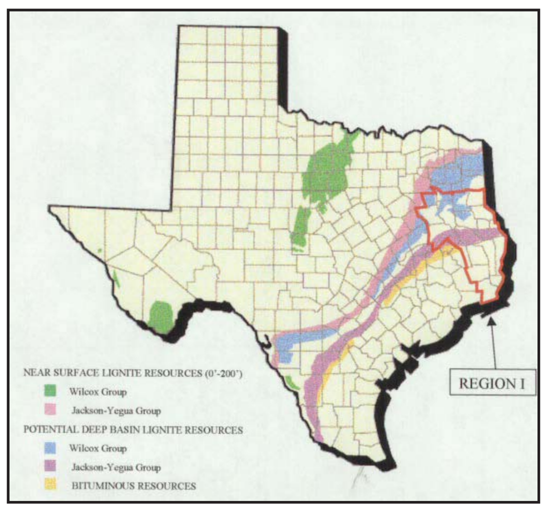


Figure 1.19 Texas Lignite Coal Resources



1.10 Threats to Agricultural and Natural Resources

A lack of water or lack of water of adequate quality can present a significant threat to agricultural and natural resources. Some of the most significant potential threats in the ETRWPA are described below.

1.10.1 Water Quality. In 1972, the Clean Water Act (CWA) became law setting wastewater standards for industry and water quality standards for contaminants in surface water, and, therefore, enabling the documentation of threats to the nation's water resources through various programs within the CWA. The CWA is a cornerstone of the water planning process in the United States and central to the planning process for the 2016 Plan.

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.[20]

In 1991, the Texas Clean Rivers Program (CRP) was created. As a part of the CRP, the TCEQ partners with regional water authorities to improve the quality of surface water within each river basin in the State. The TCEQ and regional river authorities conduct water quality monitoring and assessment and coordinate stakeholder participation. The regional water authorities within the ETRWPA that have contracts with the TCEQ to participate as a CRP partner include the Angelina Neches River Authority, Lower Neches Valley Authority, and Sabine River Authority of Texas. To learn more about CRP stakeholder meetings or download basin reports, visit https://www.tceq.texas.gov/waterquality/clean-rivers.

1.10.2 Drawdown of Aquifers. Overpumping of aquifers poses a small 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,[29] 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.[21] 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[29] and Jefferson County.

1.10.3 Insufficient Instream/Environmental Flows. Certain flow quantities and frequencies 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. Additionally, certain flow quantities or a physical barrier are required to control upstream encroachment of saltwater. Additional discussion of environmental flows is provided in Chapter 3.

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.

1.10.4 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 (previously 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 and/or no waterfowl benefits."[30]

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

Potential Impacts		Potential Reservoir Site: Columbia [31]	Rockland	Bon Weir	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	**10,133**	**99,500**	**35,100**	**85,100**
Endangered Species Potentially Impacted	Arctic peregrine falcon	•	•	•	•
	Black-capped vireo				•
	Eskimo Curlew				•
	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	•	•	•	•
	Reddish egret		•	•	
	Sandbank pocketbook	•	•	•	•
	Southern hickorynut	•	•	•	•
	Texas heelsplitter	•	•	•	•
	Texas horned lizard	•	•	•	•
	Texas pigtoe	•	•	•	•
	Timber rattlesnake	•	•	•	•
	White-faced ibis	•	•	•	•
	Wood stork	•	•	•	•

Construction of the Tennessee Colony Reservoir would inundate approximately 13,800 acres of bottomland, which comprise the Richland Creek Wildlife Management Area (WMA) 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.[30] The WMA is located in Freestone County on the west side of the Trinity River within the boundaries of the proposed Tennessee Colony Reservoir.

The USACE designed the Tennessee Colony Reservoir in 1979, but the projected 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.

1.10.5 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 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.

1.11 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.

1.12 Drought Preparation, Water Conservation, and Water Loss

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.

Water Loss and Water Audit. 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.

The first set of water loss data was to be submitted to the TWDB by March 31, 2006. The TWDB funded a study to evaluate water loss survey responses from all retail utilities in Texas, and published the report, *An Analysis of Water Loss as Reported by Public Water Suppliers in Texas*[32] in 2007. The report evaluated water loss survey responses to determine water loss performance by regional water planning area, and recommends that regions with high average non-revenue water percentages consider steps to recover lost revenue from unbilled authorized consumption.

A statewide water loss audit summary was prepared for the public utility audits submitted for 2010. In addition, there is entity-specific data available for 2011, 2012, and 2013. The 2010 summary by region of water loss audit data prepared by the TWDB appears in Appendix 1-B. Based on data from responding utilities, the ETRWPA demonstrates an average non-revenue water percentage at 19.4% (the state average for non-revenue water is 19.3%). Of this percentage, 2.1% is attributed to unbilled consumption, 2.6% to apparent losses, and 14.6% to real losses due to breaks, leaks, and other unreported loss. Unbilled consumption includes both metered and 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 19 entities that submitted water loss audits in 2010 and have a base GPCD greater than the state recommended consumption rate of 140 gpcd. More detail regarding these strategies and their development is provided in Chapters 5A, 5B, and 5C.

1.13 Consideration of Existing Local and Regional Water Planning Efforts

The ETRWPA published its first round of regional water planning in 2001. This plan was updated according to schedule in 2006 and again in 2011. The 2016 Plan makes up the third update to the regional water plan. 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. Following is a summary of planning efforts and existing programs that have been considered and utilized by the ETRWPG.

1.13.1 State, Regional, and Local Water Management Planning. Water planning in the ETRWPA incorporates a mixture of 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 economic or environmentally appropriate 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 SB1 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 ETRWPG 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. In addition, groundwater conservation districts within the region have prepared groundwater management plans as well as 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.

1.13.2 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. 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.

1.13.3 Trinity River Basin Master Plan. This study was originally adopted by the Trinity River Authority of Texas (TRA) in 1958 and has been updated various times since then, most recently in 2010. 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 (TIFP) established by Senate Bill 2 in 2001 by the 77th Texas Legislature and TRA are currently in the process of undergoing the Middle Trinity River Instream Flow Study in order to developing 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

1.14 Special Studies

The following study was undertaken by the ETRWPG consulting team in order to recommend revised irrigation projections to the TWDB for the planning period.

1.14.1 Rice Water Demand Projections. The purpose of this study was to provide appropriate justification for revising the original TWDB irrigation projections. The TWDB's original projections represented a 41% decrease in irrigation demand for the planning period beginning in 2020 and ending in 2070. The ETRWPG believed the rice production in Hardin, Jefferson, and Orange Counties was underestimated and the irrigation demands may actually increase in the future. As a result, the consultant team developed a model to project irrigation demands for rice in the counties of interest for every decade from 2020 to 2070. The revisions proposed were based on historical and current rice production in Texas, global rice supply demand, and estimates of global population growth. Attachment 4 of Appendix 2-A contains a copy of the Technical Memorandum prepared for this study. Ultimately, the TWDB increased the irrigation demand in all three counties.

1.14.2 Consideration of Other Publically Available Plans. The ETRWPG 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 2016 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.

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Chapter 2

Current and Projected Population and Water Demand

An understanding of the demand for water in the region is a basic requirement of water planning. The municipal demand for water is based, in part, on population projections for the region. In this chapter, projected population growth for the East Texas Regional Water Planning Area (ETRWPA) is examined. Water demand projections have also been developed for the various non-municipal categories of water use (manufacturing, irrigation, steam electric power, livestock, and mining) and for Wholesale Water Providers (WWPs).

2.1 Methodology for Updating Demands

For the 2016 Plan, the Texas Water Development Board (TWDB) provided initial population and demand projections for water users in the region. The East Texas Regional Water Planning Group (ETRWPG) forwarded the population projections to the respective entities within the ETRWPA for review. Considering the comments received, the projections were revised and adopted by the ETRWPG and the TWDB.

Municipal water demands were calculated based on projections of the Texas State Data Centers (TSDC) population and the 2011 gallons per capita per day (gpcd) usages. for the projections also incorporate anticipated reduction in demands associated with water conservation achieved through eventual compliance with plumbing codes.

The ETRWPA includes 246 water user groups (WUGs). Since developing the 2011 Plan, three entities have lost the designation of a WUG, generally due to incorporation or acquisition by another WUG. Nine new WUGs were identified in the region. The new WUGs are either water supply corporations or municipalities that were found to meet the TWDB criteria for designation as a WUG. New population and demands projections were developed by the TWDB and the TSDC for these entities.

Demands for other non-municipal use categories were developed with input from representatives of these areas. The TWDB provided initial projections of demand for the non-municipal use categories. These draft projections were reviewed by the ETRWPG and the group made a number of requested changes to projections, based primarily on local knowledge. The following changes were made to the TWDB's initial demand projections and are included in the 2016 Plan:

- Increased irrigation demand in every county except Sabine County.
- Increased manufacturing demand in Tyler County.
- Changed mining demand in Nacogdoches, Panola, Rusk, Sabine, San Augustine, and Shelby Counties (net demand increase on a region-wide basis).
- Increased steam electric power demand in Tyler County.
- Changed livestock demands in every county except Tyler and Hardin Counties (net demand increase on a region-wide basis).

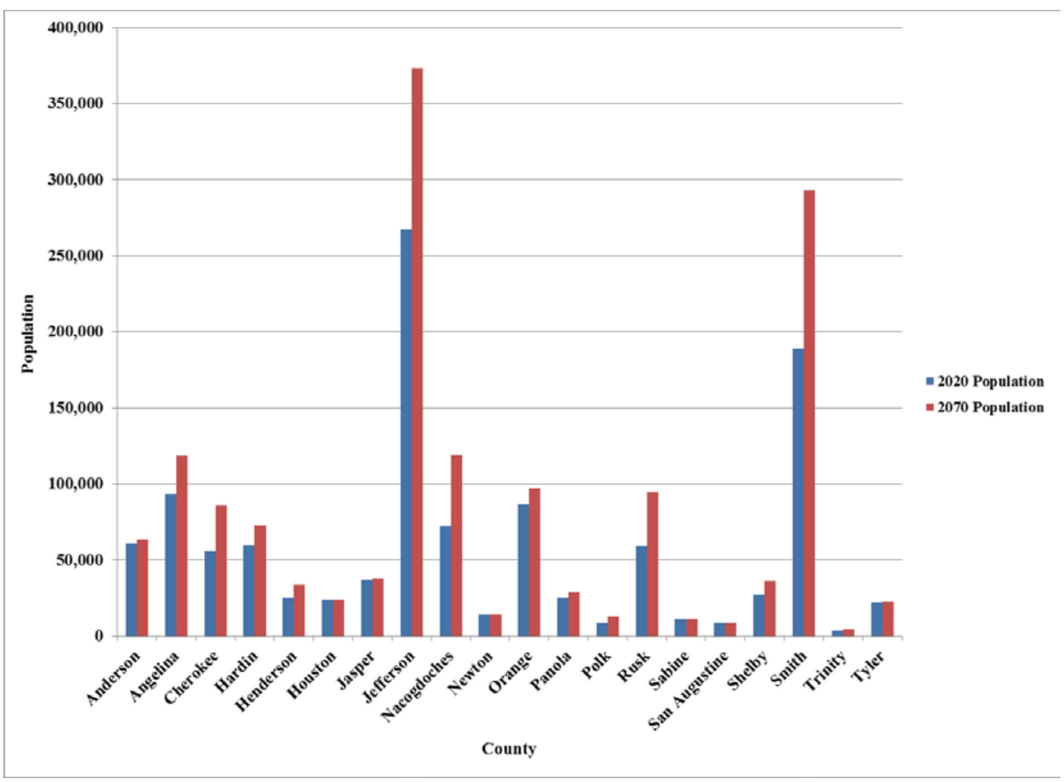
Correspondence related to these changes is provided in Appendix 2-A. A summary of population projections and water demands by county and basin are presented as TWDB DB17 reports in Appendix 2-B.

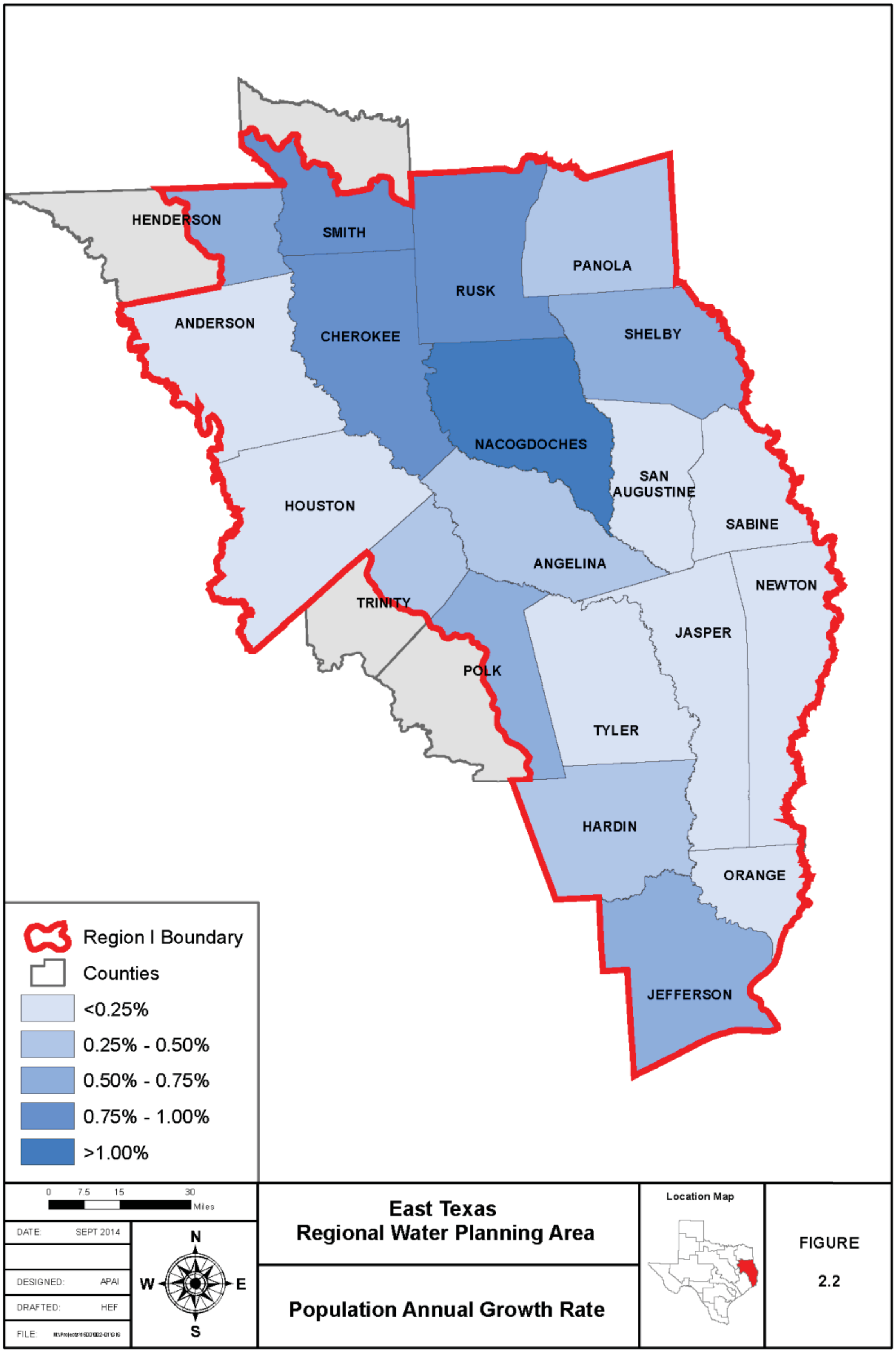
Following this section is a discussion of population growth and municipal water demand on a county-by-county basis. In addition, discussion of anticipated water demands for the various non-municipal categories of water use is provided.

2.2 Population Growth Projections

The population in the ETRWPA is projected to increase from 1,151,556 in 2020 to 1,553,652 in 2070. The major centers of population – Angelina, Jefferson, and Smith Counties – comprise nearly 50% of the population throughout the entire planning period. The projection of population growth from 2020 to 2070 by county is presented on Figure 2.1. The expected annual change in population for each county, using average annual growth during the planning period, is presented on Figure 2.2. The largest change in percentage growth is expected in the Nacogdoches, Rusk, and Smith County areas. The distribution of population by county and individual entity is provided in Table 2.1. As discussed in Chapter 1 (Section 1.8), a WUG is defined as a utility serving a population in excess of 500 persons. The WUGs identified in Table 2.1 meet the definition; however, where a lesser population is shown, the WUG is split between counties within the region or split between regions.

Figure 2.1 Population Projections for the East Texas Regional Water Planning Area by County (2020-2070)




HENDERSON
SMITH
RUSK
PANOLA
ANDERSON
CHEROKEE
SHELBY
NACOGDOCHES
SAN AUGUSTINE
HOUSTON
SABINE
ANGELINA
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Counties
<0.25%
0.25% - 0.50%
0.50% - 0.75%
0.75% - 1.00%
>1.00%
0 7.5 15 30 Miles
DATE: SEPT 2014
DESIGNED: APAI
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N
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East Texas
Regional Water Planning Area
Population Annual Growth Rate
Location Map
FIGURE
2.2

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity

County/Entity	US Census	Projections					
Anderson County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Brushy Creek WSC [c]	2,662	2,779	2,870	2,903	2,903	2,903	2,903
County-Other [d]	25,626	26,746	27,621	27,941	27,941	27,941	27,941
Elkhart	1,371	1,431	1,478	1,496	1,496	1,496	1,496
Four Pines WSC	3,444	3,595	3,713	3,756	3,756	3,756	3,756
Frankston [c]	1,210	1,263	1,305	1,320	1,320	1,320	1,320
Palestine	18,712	19,531	20,172	20,405	20,405	20,405	20,405
The Consolidated WSC [c]	1,599	1,669	1,724	1,744	1,744	1,744	1,744
Walston Springs WSC	3,834	4,002	4,134	4,181	4,181	4,181	4,181
Anderson County Total	***58,458***	***61,016***	***63,017***	***63,746***	***63,746***	***63,746***	***63,746***
Angelina County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Angelina WSC [d]	2,788	2,999	3,209	3,385	3,546	3,689	3,817
Burke [e]	737	793	849	895	938	976	1,009
Central WCID of Angelina County	6,393	6,876	7,357	7,761	8,129	8,459	8,751
County-Other [d]	16,147	17,360	18,575	19,596	20,526	21,358	22,097
Diboll	4,776	5,137	5,496	5,798	6,073	6,320	6,538
Four Way SUD	5,268	5,666	6,062	6,395	6,699	6,971	7,211
Hudson	4,731	5,088	5,444	5,743	6,016	6,260	6,476
Hudson WSC	5,621	6,045	6,469	6,824	7,148	7,438	7,695
Huntington	2,118	2,278	2,438	2,571	2,694	2,803	2,900
Lufkin	35,067	37,713	40,352	42,567	44,589	46,398	48,000
Redland WSC [d]	2,412	2,594	2,776	2,928	3,067	3,192	3,302
Zavalla	713	767	821	866	907	944	976
Angelina County Total	***86,771***	***93,316***	***99,848***	***105,329***	***110,332***	***114,808***	***118,772***
Cherokee County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Alto	1,225	1,341	1,470	1,597	1,749	1,907	2,079
Alto Rural WSC	2,990	3,272	3,588	3,898	4,267	4,655	5,074
Bullard [c]	47	52	57	62	68	74	80
County-Other [d]	8,906	9,739	10,678	11,603	12,703	13,859	15,104
Craft-Turney WSC	4,747	5,195	5,696	6,188	6,775	7,390	8,055
Jacksonville	14,544	15,914	17,451	18,959	20,756	22,640	24,677
New Summerfield	1,111	1,216	1,334	1,449	1,586	1,730	1,886

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
Cherokee County (Cont.)	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
North Cherokee WSC	4,479	4,901	5,375	5,839	6,392	6,973	7,600
Rusk	5,551	6,074	6,661	7,236	7,922	8,641	9,419
Rusk Rural WSC	3,282	3,592	3,938	4,279	4,684	5,109	5,569
Southern Utilities Co. [c]	2,563	2,805	3,076	3,341	3,658	3,990	4,349
Troup [c]	61	67	74	80	88	95	104
Wells	790	865	948	1,030	1,128	1,230	1,341
Wright City WSC [ce]	549	601	659	716	784	855	932
Cherokee County Total	***50,845***	***55,634***	***61,005***	***66,277***	***72,560***	***79,148***	***86,269***
Hardin County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	12,738	13,787	14,763	15,457	15,967	16,364	16,662
Kountze	2,123	2,129	2,135	2,139	2,142	2,145	2,147
Lake Livingston Water Supply & Sewer [c]	114	134	152	165	175	183	189
Lumberton	11,943	14,314	16,522	18,093	19,252	20,158	20,838
Lumberton MUD	8,004	8,547	9,053	9,413	9,679	9,887	10,043
North Hardin WSC	7,260	7,821	8,344	8,716	8,991	9,206	9,367
Silsbee	6,611	6,772	6,922	7,029	7,108	7,170	7,217
Sour Lake	1,813	1,921	2,022	2,094	2,147	2,189	2,220
West Hardin WSC [c]	4,029	4,052	4,073	4,088	4,099	4,108	4,115
Hardin County Total	***54,635***	***59,477***	***63,986***	***67,194***	***69,560***	***71,410***	***72,798***
Henderson County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Athens [c]	253	275	295	312	334	353	372
Berryville	975	1,088	1,191	1,277	1,390	1,488	1,583
Bethel-Ash WSC [c]	2,730	3,186	3,602	3,949	4,407	4,803	5,187
Brownsboro	1,039	1,366	1,664	1,913	2,241	2,525	2,800
Brushy Creek WSC [c]	697	758	814	861	923	977	1,028
Chandler	2,734	3,589	4,370	5,020	5,878	6,620	7,339
County-Other [d]	11,665	11,374	11,109	10,887	10,594	10,340	10,096
Frankston [c]	19	44	67	86	111	133	154
Murchison	594	596	598	600	602	604	606
R-P-M WSC [c]	554	703	839	952	1,102	1,231	1,356
Virginia Hill WSC [c]	1,529	1,825	2,095	2,320	2,617	2,874	3,123
Henderson County Total	***22,789***	***24,804***	***26,644***	***28,177***	***30,199***	***31,948***	***33,644***

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
Houston County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	1,189	1,047	1,009	1,007	1,007	1,007	1,007
Crockett	6,950	7,073	7,105	7,105	7,105	7,105	7,105
Grapeland	1,489	1,519	1,527	1,528	1,528	1,528	1,528
Lovelady	649	681	690	690	690	690	690
The Consolidated WSC [bc]	13,455	13,831	13,929	13,930	13,930	13,930	13,930
Houston County Total	***23,732***	***24,151***	***24,260***	***24,260***	***24,260***	***24,260***	***24,260***
Jasper County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	22,663	23,402	23,920	24,019	24,019	24,019	24,019
Jasper	7,590	7,839	8,012	8,045	8,045	8,045	8,045
Jasper County WCID No. 1	2,900	2,995	3,062	3,074	3,074	3,074	3,074
Kirbyville	2,142	2,213	2,262	2,271	2,271	2,271	2,271
Mauriceville SUD [c]	415	429	439	440	440	440	440
Jasper County Total	***35,710***	***36,878***	***37,695***	***37,849***	***37,849***	***37,849***	***37,849***
Jefferson County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Beaumont	118,296	125,380	133,465	141,963	151,838	162,730	174,927
Bevil Oaks	1,274	1,351	1,438	1,529	1,636	1,753	1,884
China	1,160	1,230	1,309	1,393	1,489	1,596	1,716
County-Other [d]	14,362	16,183	21,228	27,286	34,324	42,090	50,781
Groves	16,144	16,144	16,144	16,144	16,144	16,144	16,144
Jefferson County WCID No. 10	4,834	5,124	5,454	5,802	6,205	6,650	7,149
Meeker MUD	3,144	3,333	3,548	3,774	4,036	4,325	4,650
Nederland	17,547	18,598	19,797	21,058	22,523	24,138	25,948
Nome [d]	588	624	664	706	755	809	870
Port Arthur [c]	53,814	57,037	57,755	57,755	57,755	57,755	57,755
Port Neches	13,040	13,821	14,713	15,649	16,738	17,938	19,283
West Jefferson County MWD	8,070	8,554	9,105	9,685	10,359	11,102	11,934
Jefferson County Total	***252,273***	***267,379***	***284,620***	***302,744***	***323,802***	***347,030***	***373,041***

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
Nacogdoches County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Appleby WSC	3,254	3,638	4,087	4,530	5,001	5,499	6,020
County-Other [d]	10,426	11,652	13,091	14,509	16,019	17,614	19,283
Cushing	612	685	769	852	941	1,035	1,133
D&M WSC [d]	5,580	6,239	7,009	7,768	8,575	9,430	10,323
Garrison	895	1,001	1,125	1,246	1,376	1,513	1,656
Lilly Grove SUD	2,750	3,075	3,454	3,828	4,226	4,648	5,088
Melrose WSC [d]	3,102	3,468	3,897	4,318	4,767	5,242	5,739
Nacogdoches	32,996	36,889	41,442	45,930	50,706	55,758	61,040
Swift WSC	2,500	2,795	3,140	3,480	3,842	4,225	4,625
Woden WSC	2,409	2,694	3,026	3,354	3,702	4,071	4,457
Nacogdoches County Total	***64,524***	***72,136***	***81,040***	***89,815***	***99,155***	***109,035***	***119,364***
Newton County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	8,956	8,955	8,955	8,955	8,955	8,955	8,955
Mauriceville SUD [c]	389	390	390	390	390	390	390
Newton	2,478	2,478	2,478	2,478	2,478	2,478	2,478
South Newton WSC [cd]	2,622	2,622	2,622	2,622	2,622	2,622	2,622
Newton County Total	***14,445***	***14,445***	***14,445***	***14,445***	***14,445***	***14,445***	***14,445***
Orange County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Bridge City	7,840	8,271	8,645	8,908	9,087	9,223	9,322
County-Other [d]	23,813	25,114	26,251	27,053	27,594	28,008	28,306
Mauriceville SUD [c]	8,634	9,108	9,520	9,811	10,007	10,157	10,266
Orange	18,595	19,616	20,503	21,128	21,552	21,875	22,109
Orangefield WSC [e]	4,932	5,203	5,438	5,604	5,717	5,802	5,864
Pinehurst	2,097	2,213	2,313	2,383	2,431	2,467	2,494
Port Arthur [c]	4	5	5	5	5	5	5
Rose City	502	530	554	571	582	591	597
South Newton WSC [cd]	1,398	1,475	1,542	1,589	1,621	1,645	1,663
Vidor	10,579	11,160	11,665	12,020	12,261	12,445	12,578
West Orange	3,443	3,632	3,797	3,912	3,991	4,051	4,094
Orange County Total	***81,837***	***86,327***	***90,233***	***92,984***	***94,848***	***96,269***	***97,298***

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
Panola County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Beckville	847	968	1,084	1,155	1,221	1,271	1,310
Carthage	6,779	6,925	7,066	7,152	7,232	7,292	7,339
County-Other [d]	15,192	16,151	17,075	17,641	18,165	18,557	18,862
Gill WSC [c]	711	734	756	770	783	793	801
Tatum [c]	267	333	397	436	472	499	520
Panola County Total	***23,796***	***25,111***	***26,378***	***27,154***	***27,873***	***28,412***	***28,832***
Polk County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Corrigan	1,595	1,821	2,035	2,202	2,345	2,462	2,556
County-Other [d]	6,249	7,138	7,973	8,632	9,192	9,650	10,018
Polk County Total	***7,844***	***8,959***	***10,008***	***10,834***	***11,537***	***12,112***	***12,574***
Rusk County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Chalk Hill SUD [e]	3,324	3,695	4,118	4,530	4,972	5,432	5,908
County-Other [d]	23,959	26,624	29,676	32,642	35,829	39,142	42,575
Cross Roads SUD [ce]	2,584	2,872	3,202	3,522	3,865	4,223	4,593
Easton [c]	52	58	65	71	78	85	93
Elderville WSC [c]	1,580	1,757	1,958	2,153	2,364	2,582	2,809
Henderson	13,712	15,240	16,987	18,685	20,509	22,405	24,370
Kilgore [c]	3,013	3,349	3,733	4,106	4,507	4,924	5,355
New London	998	1,110	1,237	1,360	1,493	1,631	1,774
Overton [cd]	2,374	2,639	2,941	3,235	3,551	3,879	4,220
Tatum [c]	1,118	1,243	1,386	1,524	1,673	1,827	1,987
West Gregg SUD [c]	169	188	210	231	253	277	301
Wright City WSC [ce]	447	497	554	610	669	731	795
Rusk County Total	***53,330***	***59,272***	***66,067***	***72,669***	***79,763***	***87,138***	***94,780***
Sabine County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	1,814	1,723	1,715	1,714	1,714	1,714	1,714
G M WSC [cd]	6,972	7,318	7,347	7,348	7,348	7,348	7,348
Hemphill	1,198	1,295	1,304	1,304	1,304	1,304	1,304
Pineland	850	881	883	883	883	883	883
Sabine County Total	***10,834***	***11,217***	***11,249***	***11,249***	***11,249***	***11,249***	***11,249***

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
San Augustine County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	6,048	6,082	6,082	6,082	6,082	6,082	6,082
G M WSC [cd]	709	714	714	714	714	714	714
San Augustine	2,108	2,121	2,121	2,121	2,121	2,121	2,121
San Augustine County Total	***8,865***	***8,917***	***8,917***	***8,917***	***8,917***	***8,917***	***8,917***
Shelby County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Center	5,193	5,604	6,027	6,400	6,754	7,085	7,390
County-Other [d]	17,116	18,468	19,860	21,092	22,257	23,346	24,355
Joaquin	824	890	957	1,016	1,072	1,125	1,173
Tenaha	1,160	1,252	1,347	1,430	1,509	1,583	1,651
Timpson	1,155	1,247	1,341	1,424	1,503	1,576	1,644
Shelby County Total	***25,448***	***27,461***	***29,532***	***31,362***	***33,095***	***34,715***	***36,213***
Smith County [b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Arp	970	1,017	1,066	1,115	1,168	1,222	1,278
Bullard [c]	2,416	3,299	4,233	5,170	6,179	7,206	8,259
County-Other [d]	5,290	6,986	8,783	10,582	12,521	14,495	16,522
Crystal Systems, Inc. [c]	609	832	1,068	1,305	1,560	1,820	2,086
Dean WSC	4,565	4,736	4,917	5,099	5,294	5,493	5,697
Jackson WSC [c]	1,946	2,158	2,381	2,605	2,846	3,091	3,342
Lindale [c]	1,527	2,099	2,704	3,311	3,964	4,629	5,311
Lindale Rural WSC [c]	2,596	2,831	3,079	3,328	3,596	3,869	4,149
New Chapel Hill	594	622	652	682	714	746	779
Noonday	777	953	1,139	1,326	1,527	1,731	1,941
Overton [cd]	113	151	191	231	274	318	363
R-P-M WSC [c]	255	292	331	370	412	455	499
Southern Utilities Co. [c]	34,470	36,455	38,555	40,661	42,928	45,235	47,603
Troup [c]	1,808	2,005	2,212	2,420	2,644	2,872	3,105
Tyler [c]	96,021	104,786	114,056	123,354	133,362	143,548	154,002
Walnut Grove WSC [e]	6,802	8,208	9,695	11,187	12,793	14,427	16,104
Whitehouse	7,660	9,209	10,848	12,492	14,261	16,061	17,909
Wright City WSC [ce]	2,109	2,381	2,669	2,958	3,269	3,585	3,910
Smith County Total	***170,528***	***189,020***	***208,579***	***228,196***	***249,312***	***270,803***	***292,859***

Table 2. 1 Distribution of Population for the East Texas Regional Water Planning Area by County/Entity (Cont.)

County/Entity	US Census	Projections					
Trinity County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	2,835	3,208	3,470	3,495	3,397	3,554	3,719
Groveton [c]	478	540	584	589	572	599	627
Trinity County Total	***3,313***	***3,748***	***4,054***	***4,084***	***3,969***	***4,153***	***4,346***
Tyler County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Colmesneil	596	611	614	614	614	614	614
County-Other [d]	11,546	11,819	11,878	11,878	11,878	11,878	11,878
Ivanhoe [e]	887	909	913	913	913	913	913
Ivanhoe North [e]	538	551	554	554	554	554	554
Lake Livingston Water Supply & Sewer [c]	63	65	65	65	65	65	65
Tyler County WSC	5,550	5,684	5,711	5,711	5,711	5,711	5,711
Woodville	2,586	2,649	2,661	2,661	2,661	2,661	2,661
Tyler County Total	***21,766***	***22,288***	***22,396***	***22,396***	***22,396***	***22,396***	***22,396***
Total for ETRWPA	**1,071,743**	**1,151,556**	**1,233,973**	**1,309,681**	**1,388,867**	**1,469,843**	**1,553,652**

[a] Historical WUG population data was retrieved from the United States Census Bureau for the 2010 Population Census.

[b] These counties are split between more than one TWDB regional water planning area. The water use and demands shown represent the portion that fall within the East Texas Regional Water Planning Area (ETRWPA).

[c] These WUGs are split between more than one TWDB regional water planning area and/or more than one county. The water use and demands shown represent the portion that fall within the ETRWPA and the county indicated.

[d] These WUGs did not submit, or were not required to submit, a water use report for the year 2010. The values presented in the 2010 Water Use column are municipal water demand projections for the year 2010 taken from the 2011 Regional Water Plan.

[e] These entities have gained the designation of a WUG since the last round of planning and therefore did not submit a 2010 water use survey and do not have 2010 projected demands.

2.3 Water Demands

For the ETRWPA, water demand is expected to increase from 1,108,800 ac-ft per year in 2020 to 1,607,250 ac-ft per year in 2070. Table 2.2 shows a summary of the water usage by water use category for each decade of the planning period and Table 2.3 shows the projected change within each category and each category's contribution to the total demand. Details of each water use category are provided in subsequent sections.

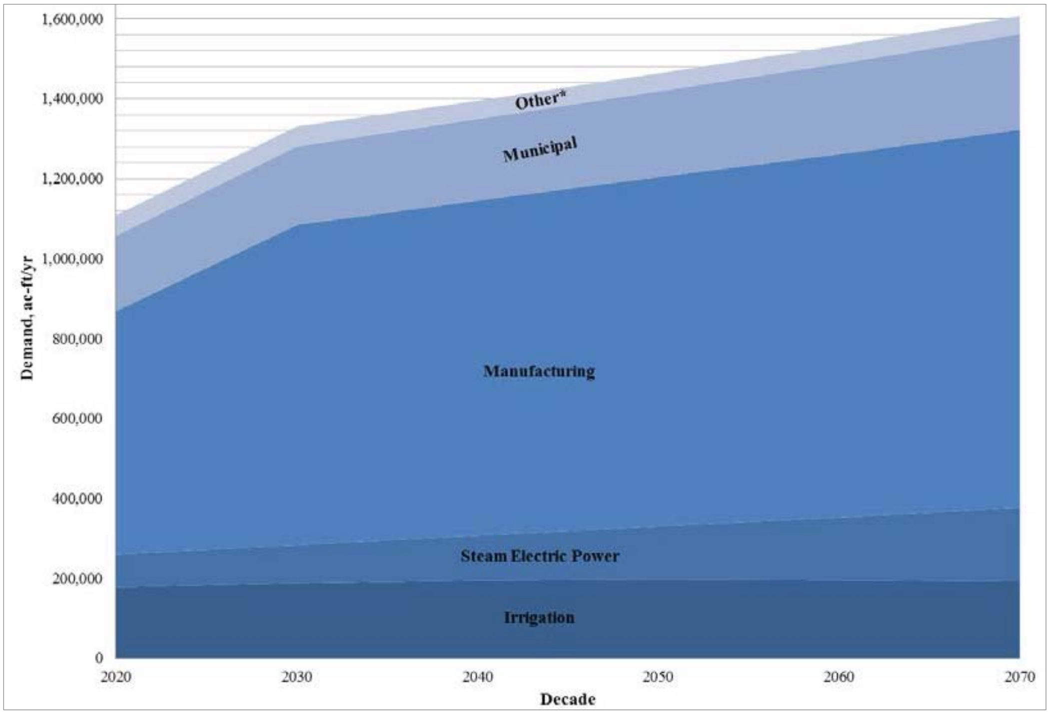
Table 2.2 Summary of Water Usage for the East Texas Regional Water Planning Area by Use Category and Decade (ac-ft/yr)

Water Use Category	2020	2030	2040	2050	2060	2070
Municipal	188,646	196,302	204,157	214,540	226,622	239,607
Manufacturing	608,667	800,989	838,639	874,546	909,373	945,886
Mining	27,523	24,547	18,169	15,488	12,986	12,093
Steam Electric Power	82,018	95,544	112,035	132,137	156,640	184,714
Livestock	24,027	25,549	27,361	29,521	32,081	32,764
Irrigation	177,919	187,894	194,851	197,546	195,445	192,186
Total for ETRWPA	**1,108,800**	**1,330,825**	**1,395,212**	**1,463,778**	**1,533,147**	**1,607,250**

Table 2.3 Demand Projection Percentages for the East Texas Regional Water Planning Area by Category

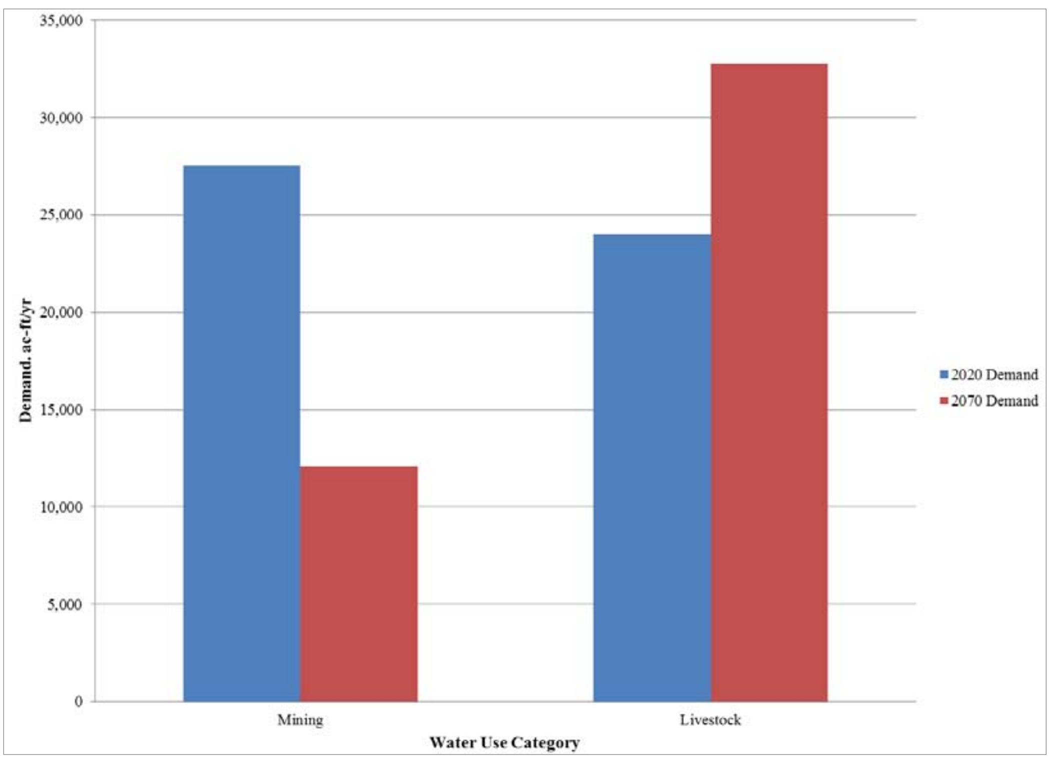
Water User Category	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Municipal	27.0%	17.0%	14.9%
Manufacturing	55.4%	54.9%	58.9%
Mining	-56.1%	2.5%	0.8%
Steam Electric Power	125.2%	7.4%	11.5%
Livestock	36.4%	2.2%	2.0%
Irrigation	8.0%	16.0%	12.0%

Figure 2.3 Water Usage in the East Texas Regional Water Planning Area Greater than 50,000 ac-ft/yr by Use Category



*For a breakdown of Other Water Usage by Use Category see Figure 2.4.

Figure 2.4 Water Usage in the East Texas Regional Water Planning Area Less than 50,000 ac-ft/yr by Use Category



2.3.1 Municipal Demands. Municipal water use includes both residential and commercial use. Residential use includes single and multi-family housing. Commercial demand is composed of water used by small businesses, institutions, and public offices. It does not include water used by industry. Municipal water demand projections are estimated by multiplying the projected population of an entity by the entity's 2011 gpcd. Table 2.4 provides a summary of the calculated municipal use by entities in the ETRWPA. The projected changes in municipal water demands are presented in Table 2.5.

Municipal water use is expected to grow from 188,646 ac-ft per year to 239,607 ac-ft per year during the planning period. This represents an approximate 27% increase in municipal water demand. The projected increase for each county is illustrated on Figure 2.5. Counties with the most growth in municipal demand include Nacogdoches, Rusk, and Smith Counties. The average annual percent increase in each county for municipal demand over the planning period is represented on Figure 2.6.

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Areaby County (ac-ft/yr)

County/Water User Group	Water Use[a]	Projections					
Anderson County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Brushy Creek WSC [c]	242	238	233	225	220	219	219
County-Other [d]	5,459	3,772	3,777	3,730	3,681	3,671	3,671
Elkhart	135	249	251	250	247	246	246
Four Pines WSC	286	336	336	331	327	326	325
Frankston [c]	191	239	240	238	236	236	236
Palestine	3,641	5,045	5,118	5,104	5,065	5,058	5,058
The Consolidated WSC [c]	172	189	189	185	182	181	181
Walston Springs WSC	348	408	404	396	388	387	387
Anderson County Total	***10,474***	***10,476***	***10,548***	***10,459***	***10,346***	***10,324***	***10,323***
Angelina County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Angelina WSC [d]	424	251	251	255	265	275	284
Burke [e]	N/A	156	165	172	180	186	193
Central WCID of Angelina County	541	480	495	522	547	569	589
County-Other [d]	1,819	1,961	1,999	2,045	2,134	2,214	2,289
Diboll	740	672	690	707	738	766	792
Four Way SUD	498	490	509	527	546	566	585
Hudson	392	388	397	406	418	433	448
Hudson WSC	396	407	435	459	481	500	518
Huntington	215	231	236	241	247	257	265
Lufkin	5,761	6,271	6,523	6,736	6,979	7,246	7,494
Redland WSC [d]	287	201	199	208	217	225	232
Zavalla	95	79	81	82	84	87	90
Angelina County Total	***11,168***	***11,587***	***11,980***	***12,360***	***12,836***	***13,324***	***13,779***
Cherokee County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Alto	246	249	266	284	308	335	366
Alto Rural WSC	529	638	678	734	802	873	951
Bullard [c]	8	11	12	13	14	15	16
County-Other [d]	902	1,139	1,205	1,277	1,379	1,500	1,633
Craft-Turney WSC	493	483	502	523	560	609	663
Jacksonville	2,520	2,680	2,858	3,042	3,297	3,588	3,908

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
Cherokee County (Cont.)	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
New Summerfield	118	156	166	177	192	209	228
North Cherokee WSC	438	602	640	681	737	801	873
Rusk	957	1,019	1,089	1,162	1,260	1,371	1,494
Rusk Rural WSC	311	365	383	402	433	470	512
Southern Utilities Co. [c]	428	480	513	546	592	644	701
Troup [c]	8	14	15	16	17	18	20
Wells	113	139	148	157	170	185	201
Wright City WSC [ce]	N/A	69	73	78	84	91	99
Cherokee County Total	***7,071***	***8,044***	***8,548***	***9,092***	***9,845***	***10,709***	***11,665***
Hardin County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	1,853	1,636	1,675	1,695	1,745	1,783	1,815
Kountze	278	255	246	238	234	234	234
Lake Livingston Water Supply & Sewer [c]	9	10	11	12	12	13	13
Lumberton	1,357	1,656	1,852	1,990	2,097	2,191	2,263
Lumberton MUD	803	781	794	802	811	826	838
North Hardin WSC	559	544	561	586	605	619	630
Silsbee	894	893	881	869	864	869	875
Sour Lake	284	280	285	289	292	297	301
West Hardin WSC [c]	276	273	274	275	276	277	277
Hardin County Total	***6,313***	***6,328***	***6,579***	***6,756***	***6,936***	***7,109***	***7,246***
Henderson County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Athens [c]	49	57	59	62	66	69	73
Berryville	91	118	124	128	137	147	156
Bethel-Ash WSC [c]	2,055	325	354	380	419	455	491
Brownsboro	220	218	260	295	343	386	428
Brushy Creek WSC [c]	64	65	66	67	70	74	78
Chandler	475	608	723	820	954	1,073	1,189
County-Other [d]	2,761	1,043	957	890	862	837	817
Frankston [c]	6	9	13	16	20	24	28
Murchison	101	93	91	89	88	88	88
R-P-M WSC [c]	53	77	89	98	113	126	138
Virginia Hill WSC [c]	143	176	193	207	230	252	273
Henderson County Total	***6,018***	***2,789***	***2,929***	***3,052***	***3,302***	***3,531***	***3,759***

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
Houston County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	178	184	172	170	169	169	169
Crockett	1,178	1,281	1,253	1,226	1,211	1,209	1,209
Grapeland	230	211	206	200	197	196	196
Lovelady	84	131	130	128	127	126	126
The Consolidated WSC [bc]	1,380	1,567	1,520	1,475	1,450	1,445	1,445
Houston County Total	***3,050***	***3,374***	***3,281***	***3,199***	***3,154***	***3,145***	***3,145***
Jasper County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	2,815	2,467	2,422	2,354	2,311	2,302	2,302
Jasper	1,454	1,699	1,699	1,676	1,660	1,657	1,657
Jasper County WCID No. 1	233	224	212	207	207	207	207
Kirbyville	388	402	401	395	390	390	390
Mauriceville SUD [c]	27	30	30	30	30	30	30
Jasper County Total	***4,917***	***4,822***	***4,764***	***4,662***	***4,598***	***4,586***	***4,586***
Jefferson County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Beaumont	26,608	29,689	30,963	32,423	34,398	36,805	39,548
Bevil Oaks	128	135	137	139	147	157	169
China	124	143	146	150	158	168	181
County-Other [d]	1,880	2,560	3,246	4,093	5,107	6,251	7,537
Groves	2,047	2,238	2,160	2,094	2,069	2,063	2,063
Jefferson County WCID No. 10	488	448	453	463	485	517	555
Meeker MUD	342	431	445	462	488	522	560
Nederland	2,382	2,404	2,464	2,546	2,682	2,865	3,077
Nome [d]	127	75	77	80	84	90	96
Port Arthur [c]	13,47069	19,805	19,775	19,548	19,501	19,482	19,481
Port Neches	1,614	1,428	1,447	1,481	1,553	1,658	1,780
West Jefferson County MWD	669	741	752	772	809	863	927
Jefferson County Total	***49,879***	***60,097***	***62,065***	***64,251***	***67,481***	***71,441***	***75,974***

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
Nacogdoches County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Appleby WSC	114	655	718	783	858	941	1,030
County-Other [d]	1,120	1,185	1,294	1,427	1,570	1,720	1,881
Cushing	69	124	135	147	160	176	192
D&M WSC [d]	656	905	994	1,086	1,190	1,306	1,428
Garrison	143	225	247	269	295	324	354
Lilly Grove SUD	405	429	469	511	559	613	671
Melrose WSC [d]	386	504	549	595	650	713	780
Nacogdoches	4,909	6,742	7,376	8,027	8,781	9,638	10,545
Swift WSC	397	428	465	503	550	603	660
Woden WSC	290	330	356	384	418	458	501
Nacogdoches County Total	***8,489***	***11,527***	***12,603***	***13,732***	***15,031***	***16,492***	***18,042***
Newton County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	1,128	969	925	887	878	875	875
Mauriceville SUD [c]	27	28	27	27	27	27	27
Newton	440	443	434	426	421	420	420
South Newton WSC [cd]	257	177	177	177	177	177	177
Newton County Total	***1,852***	***1,617***	***1,563***	***1,517***	***1,503***	***1,499***	***1,499***
Orange County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Bridge City	698	733	722	709	716	724	731
County-Other [d]	4,559	2,899	2,872	2,950	2,999	3,035	3,066
Mauriceville SUD [c]	627	637	640	660	673	683	690
Orange	2,703	2,619	2,638	2,639	2,657	2,689	2,717
Orangefield WSC [e]	N/A	481	491	499	505	510	516
Pinehurst	283	282	283	284	289	292	295
Port Arthur [c]	1	2	2	2	2	2	2
Rose City	88	86	87	87	89	90	91
South Newton WSC [cd]	97	100	104	107	109	111	112
Vidor	1,403	2,252	2,295	2,319	2,352	2,383	2,408
West Orange	423	552	557	562	572	580	586
Orange County Total	***10,954***	***10,643***	***10,691***	***10,818***	***10,963***	***11,099***	***11,214***

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
Panola County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Beckville	115	133	144	150	156	162	167
Carthage	1,586	1,650	1,651	1,644	1,648	1,659	1,670
County-Other [d]	1,698	1,620	1,635	1,629	1,645	1,675	1,702
Gill WSC [c]	93	85	84	82	83	84	85
Tatum [c]	66	65	75	81	87	92	96
Panola County Total	***3,558***	***3,553***	***3,589***	***3,586***	***3,619***	***3,672***	***3,720***
Polk County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Corrigan	220	225	241	253	269	281	292
County-Other [d]	1,110	743	797	840	882	923	957
Polk County Total	***1,330***	***968***	***1,038***	***1,093***	***1,151***	***1,204***	***1,249***
Rusk County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Chalk Hill SUD [e]	N/A	323	343	364	393	428	464
County-Other [d]	2,660	2,889	3,070	3,262	3,526	3,839	4,172
Cross Roads SUD [ce]	N/A	238	251	265	285	310	336
Easton [c]	6	4	5	5	6	6	7
Elderville WSC [c]	172	119	132	145	159	174	189
Henderson	2,808	3,820	4,184	4,547	4,961	5,412	5,885
Kilgore [c]	740	723	789	855	931	1,016	1,104
New London	199	388	426	464	507	553	601
Overton [cd]	413	560	611	662	721	786	855
Tatum [c]	247	240	261	283	308	336	365
West Gregg SUD [c]	16	17	18	19	20	22	24
Wright City WSC [ce]	N/A	57	62	66	72	78	85
Rusk County Total	***10,168***	***9,378***	***10,152***	***10,937***	***11,889***	***12,960***	***14,087***
Sabine County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	449	149	139	133	132	132	132
G M WSC [cd]	665	492	494	494	494	494	494
Hemphill	338	306	302	298	295	295	295
Pineland	90	83	78	75	74	74	74
Sabine County Total	***1,542***	***1,030***	***1,013***	***1,000***	***995***	***995***	***995***

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
San Augustine County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	625	589	565	545	535	532	532
G M WSC [cd]	77	48	48	48	48	48	48
San Augustine	735	519	508	500	499	498	498
San Augustine County Total	***1,437***	***1,156***	***1,121***	***1,093***	***1,082***	***1,078***	***1,078***
Shelby County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Center	1,893	1,847	1,958	2,056	2,158	2,262	2,358
County-Other [d]	2,087	2,021	2,086	2,149	2,232	2,333	2,433
Joaquin	101	137	142	147	155	162	169
Tenaha	153	227	238	248	259	271	283
Timpson	191	179	186	193	201	210	219
Shelby County Total	***4,425***	***4,411***	***4,610***	***4,793***	***5,005***	***5,238***	***5,462***
Smith County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Arp	164	164	168	171	178	185	194
Bullard [c]	415	654	827	1,002	1,193	1,390	1,592
County-Other [d]	929	823	1,000	1,180	1,382	1,595	1,816
Crystal Systems, Inc. [c]	305	260	330	403	481	560	642
Dean WSC	536	765	774	786	808	836	867
Jackson WSC [c]	196	197	207	218	234	253	274
Lindale [c]	184	476	604	734	875	1,020	1,170
Lindale Rural WSC [c]	319	221	229	239	253	271	290
New Chapel Hill	140	237	246	255	266	277	289
Noonday	139	189	221	254	291	330	369
Overton [cd]	11	33	40	48	56	65	74
R-P-M WSC [c]	23	32	35	39	42	47	51
Southern Utilities Co. [c]	6,078	6,234	6,420	6,638	6,937	7,294	7,671
Troup [c]	251	398	428	459	497	539	582
Tyler [c]	15,608	20,049	21,331	22,696	24,331	26,141	28,031
Walnut Grove WSC [e]	N/A	1,018	1,162	1,313	1,486	1,671	1,864
Whitehouse	923	1,165	1,330	1,503	1,699	1,909	2,127
Wright City WSC [ce]	N/A	273	295	319	348	381	415
Smith County Total	***26,221***	***33,188***	***35,647***	***38,257***	***41,357***	***44,764***	***48,318***

Table 2.4 Historical Water Use and Projected Municipal Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

County/Water User Group	Water Use[a]	Projections					
Trinity County[b]	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
County-Other [d]	585	230	234	235	229	239	250
Groveton [c]	58	58	59	58	56	58	61
Trinity County Total	***643***	***288***	***293***	***293***	***285***	***297***	***311***
Tyler County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Colmesneil	64	148	146	143	142	142	142
County-Other [d]	1,422	1,494	1,448	1,404	1,380	1,376	1,376
Ivanhoe [e]	N/A	92	90	88	87	87	87
Ivanhoe North [e]	N/A	62	60	59	58	58	58
Lake Livingston Water Supply & Sewer [c]	4	5	5	5	5	5	5
Tyler County WSC	693	661	639	618	606	604	604
Woodville	998	908	900	890	884	883	883
Tyler County Total	***3,181***	***3,370***	***3,288***	***3,207***	***3,162***	***3,155***	***3,155***
Total for ETRWPA	**164,402**	**188,646**	**196,302**	**204,157**	**214,540**	**226,622**	**239,607**

[a] The Historical Water Use is based on 2010 water use survey responses submitted to the Texas Water Development Board (TWDB) from each Water User Group (WUG).

[b] These counties are split between more than one TWDB regional water planning area. The water use and demands shown represent the portion that fall within the East Texas Regional Water Planning Area (ETRWPA).

[c] These WUGs are split between more than one TWDB regional water planning area and/or more than one county. The water use and demands shown represent the portion that fall within the ETRWPA and the county indicated.

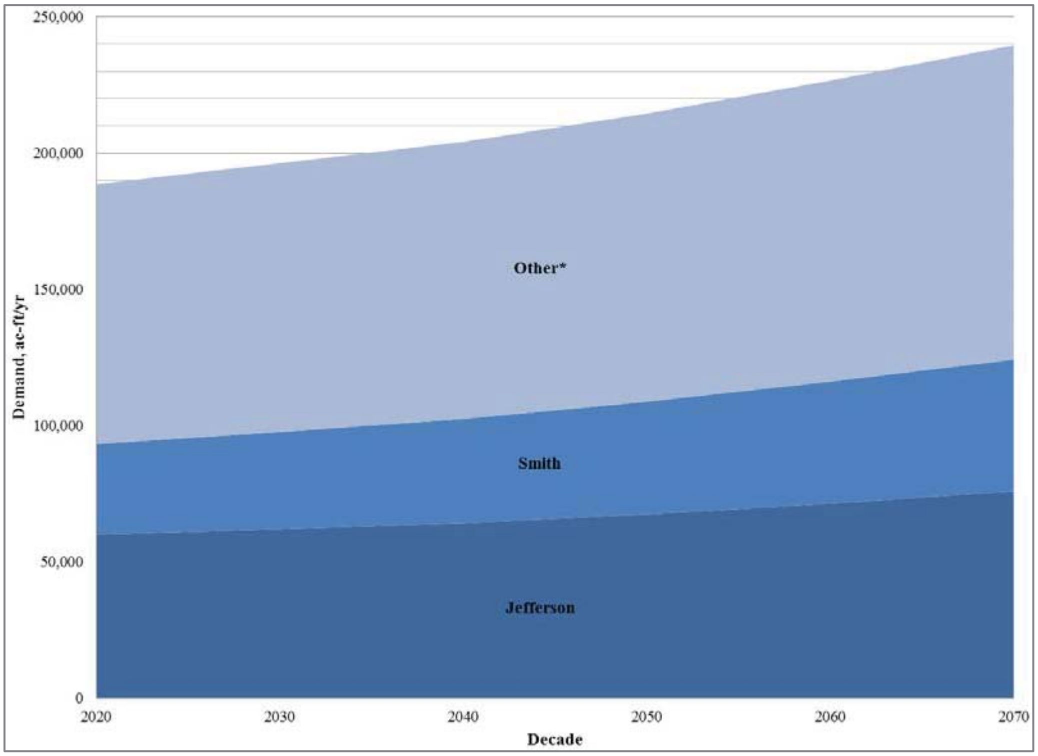
[d] These WUGs did not submit, or were not required to submit, a water use report for the year 2010. The values presented in the 2010 Water Use column are municipal water demand projections for the year 2010 taken from the 2011 Regional Water Plan.

[e] These entities have gained the designation of a WUG since the last round of planning and therefore did not submit a 2010 water use survey and do not have 2010 projected demands.

Table 2.5 Municipal Demand Projection Percentages in the East Texas Regional Water Planning Area by County

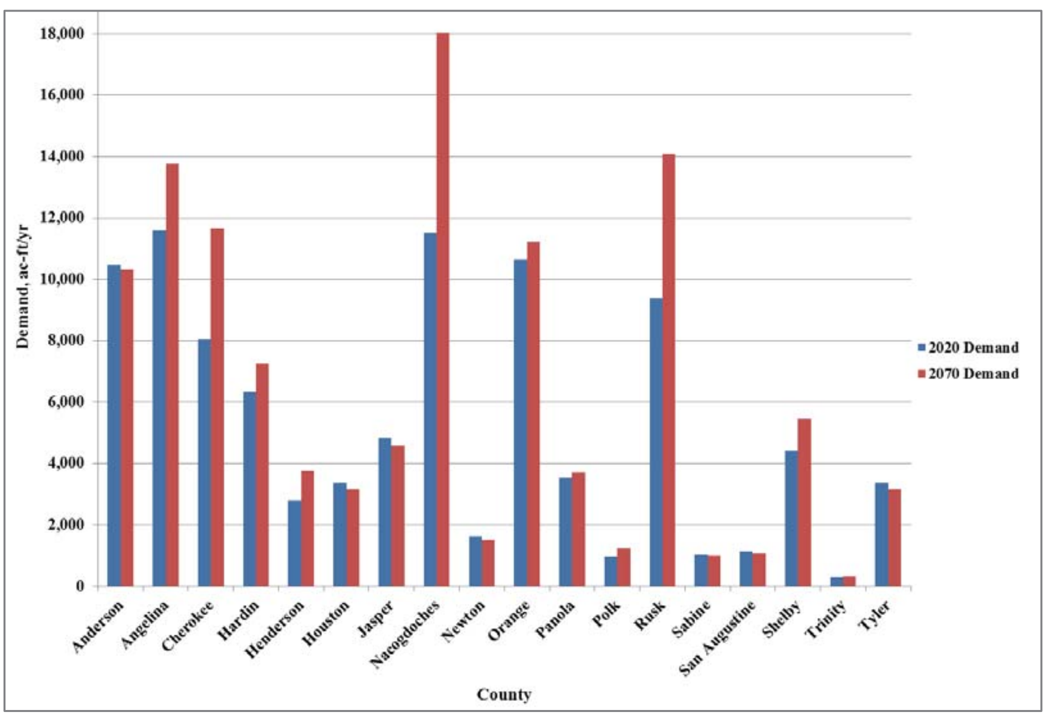
County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	-1.5%	5.6%	4.3%
Angelina	18.9%	6.1%	5.8%
Cherokee	45.0%	4.3%	4.9%
Hardin	14.5%	3.4%	3.0%
Henderson	34.8%	1.5%	1.6%
Houston	-6.8%	1.8%	1.3%
Jasper	-4.9%	2.6%	1.9%
Jefferson	26.4%	31.9%	31.7%
Nacogdoches	56.5%	6.1%	7.5%
Newton	-7.3%	0.9%	0.6%
Orange	5.4%	5.6%	4.7%
Panola	4.7%	1.9%	1.6%
Polk	29.0%	0.5%	0.5%
Rusk	50.2%	5.0%	5.9%
Sabine	-3.4%	0.5%	0.4%
San Augustine	-6.7%	0.6%	0.4%
Shelby	23.8%	2.3%	2.3%
Smith	45.6%	17.6%	20.2%
Trinity	8.0%	0.2%	0.1%
Tyler	-6.4%	1.8%	1.3%

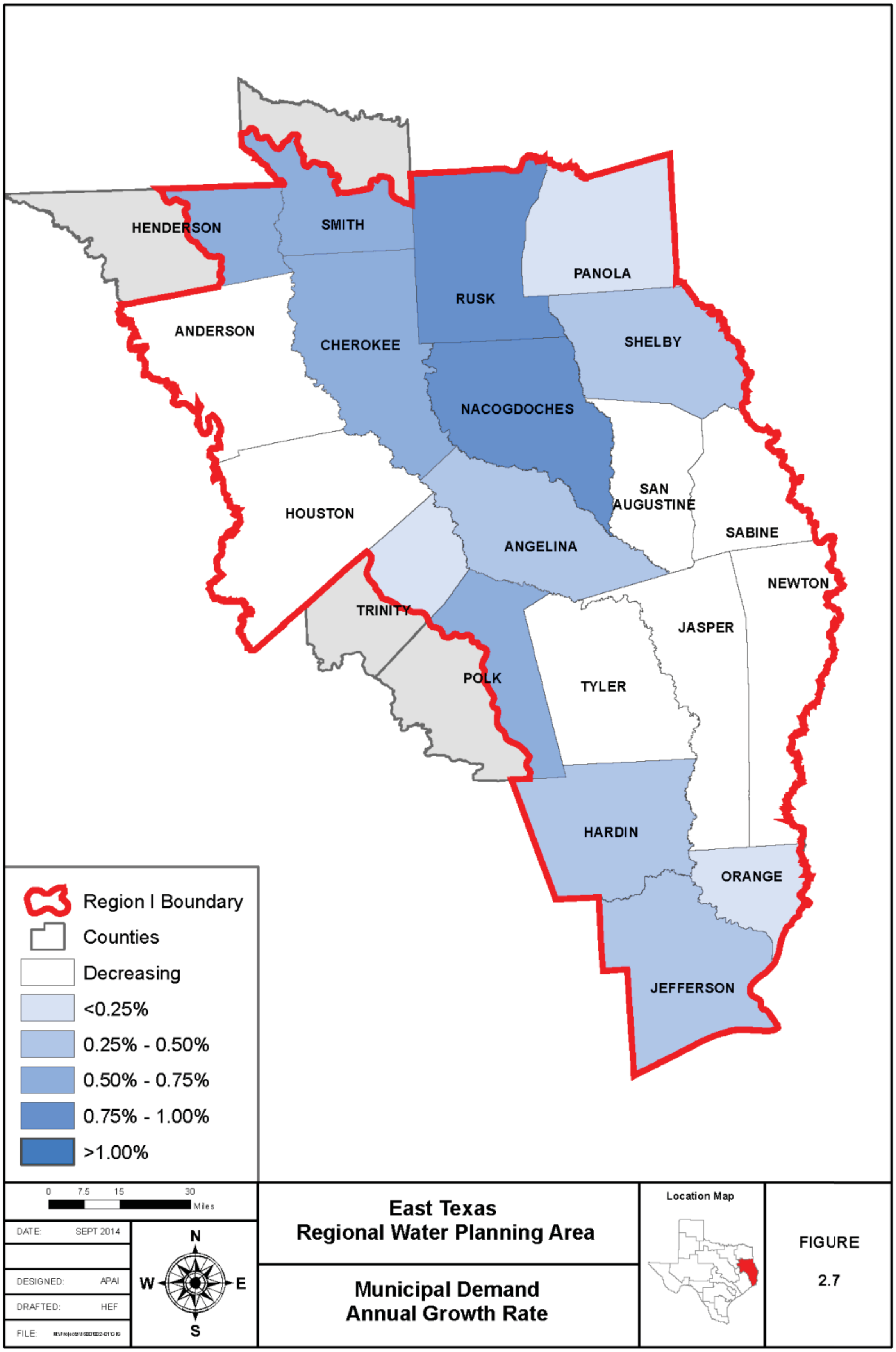
Figure 2.5 Municipal Demand Projections in the East Texas Regional Water Planning Area Greater than 20,000 ac-ft/yr by County



*For a breakdown of Other Municipal Demand Projections by County see Figure 2.6.

Figure 2.6 Municipal Demand Projections in the East Texas Regional Water Planning Area Less than 20,000 ac-ft/yr by County




HENDERSON
SMITH
RUSK
PANOLA
ANDERSON
CHEROKEE
SHELBY
NACOGDOCHES
HOUSTON
SAN AUGUSTINE
SABINE
ANGELINA
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Counties
Decreasing
<0.25%
0.25% - 0.50%
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East Texas
Regional Water Planning Area
Municipal Demand
Annual Growth Rate
Location Map
FIGURE
2.7

2.3.2 Manufacturing Demands. Manufacturing demands are expected to increase from 608,667 ac-ft per year to 945,886 ac-ft per year during the planning period. Table 2.6 summarizes the manufacturing usage by each county. The present change in manufacturing demand by county is presented in Table 2.7. Counties with projected demands over 10,000 ac-ft per year are summarized on Figure 2.7. All other counties are summarized on Figure 2.8. The average annual projected growth for manufacturing water use is shown on Figure 2.9.

Manufacturing water demand in the ETRWPA is concentrated primarily in Jefferson County, which accounts for almost 70% of all manufacturing water demand in 2020, and nearly 75% in 2070. Use is primarily in the petrochemical industry. The Lower Neches Valley Authority (LNVA) meets over 96% of this demand; a large percentage of this demand was not under contract at the time the 2016 Plan was developed and appears as a Water Management Strategy (WMS) in Chapter 5B.

Angelina, Jasper, and Orange Counties are projected to comprise an additional 28% of use in 2020. Although manufacturing water demand will increase in these three counties over the planning period, their collective percentage of use in the region will decrease to approximately 23% by 2070.

Table 2.6 Historical and Projected Manufacturing Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr)

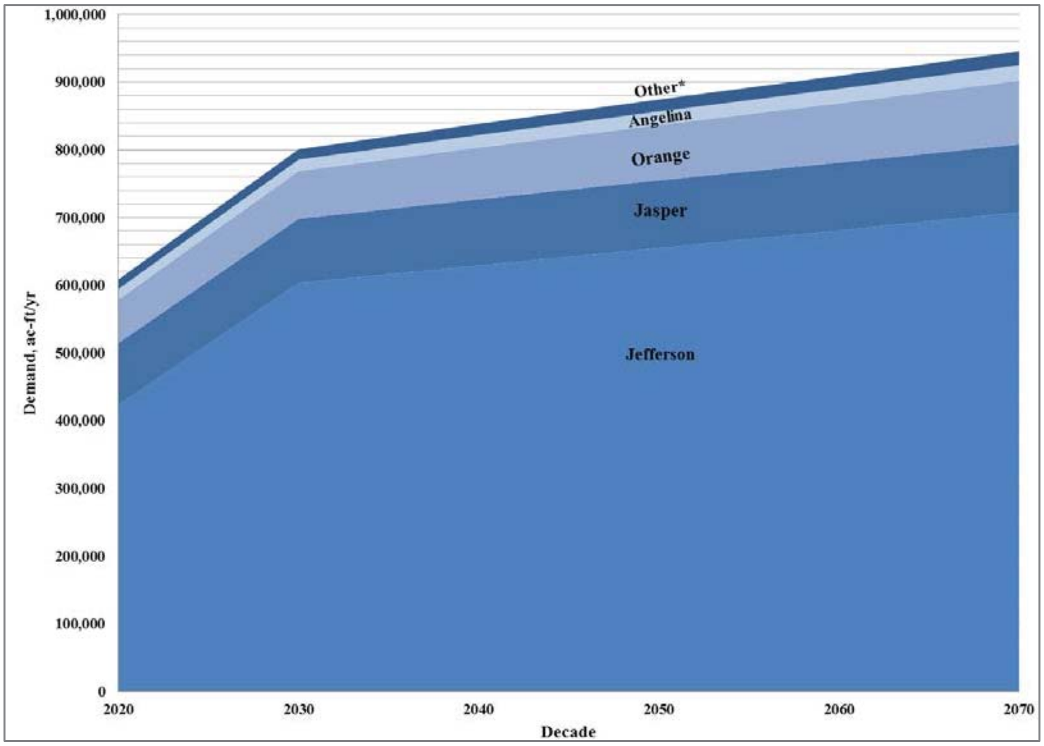
County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Anderson	0	30	40	42	44	46	48
Angelina	3,631	15,249	16,858	18,487	19,934	21,478	23,142
Cherokee	111	413	442	469	492	530	571
Hardin	40	288	318	349	377	407	439
Henderson	484	54	62	70	78	86	95
Houston	142	307	338	367	393	425	460
Jasper	43,922	91,580	94,982	97,956	100,186	100,271	100,356
Jefferson	105,286	423,258	603,321	629,171	655,034	680,914	707,817
Nacogdoches	2,471	2,564	2,798	3,029	3,228	3,483	3,758
Newton	52	568	644	721	791	858	931
Orange	42,980	64,461	70,439	76,399	81,690	87,641	94,026
Panola	784	1,393	1,454	1513	1,564	1,667	1,777
Polk	238	604	687	774	854	924	1,000
Rusk	32	317	342	363	381	409	439
Sabine	218	467	536	606	668	724	785
San Augustine	5	8	9	10	11	12	13
Shelby	1,592	1,510	1,639	1,768	1882	2,021	2,170
Smith	2,780	5,120	5,597	6,055	6,443	6,976	7,553
Trinity	0	-	-	-	-	-	-
Tyler	3	476	483	490	496	501	506
Total for ETRWPA	***204,771***	***608,667***	***800,989***	***838,639***	***874,546***	***909,373***	***945,886***

*Source: TWBD Water Use Survey: Historical Summary Estimates by County

Table 2.7 Manufacturing Demand Projection Percentages in the East Texas Regional Water Planning Area by County

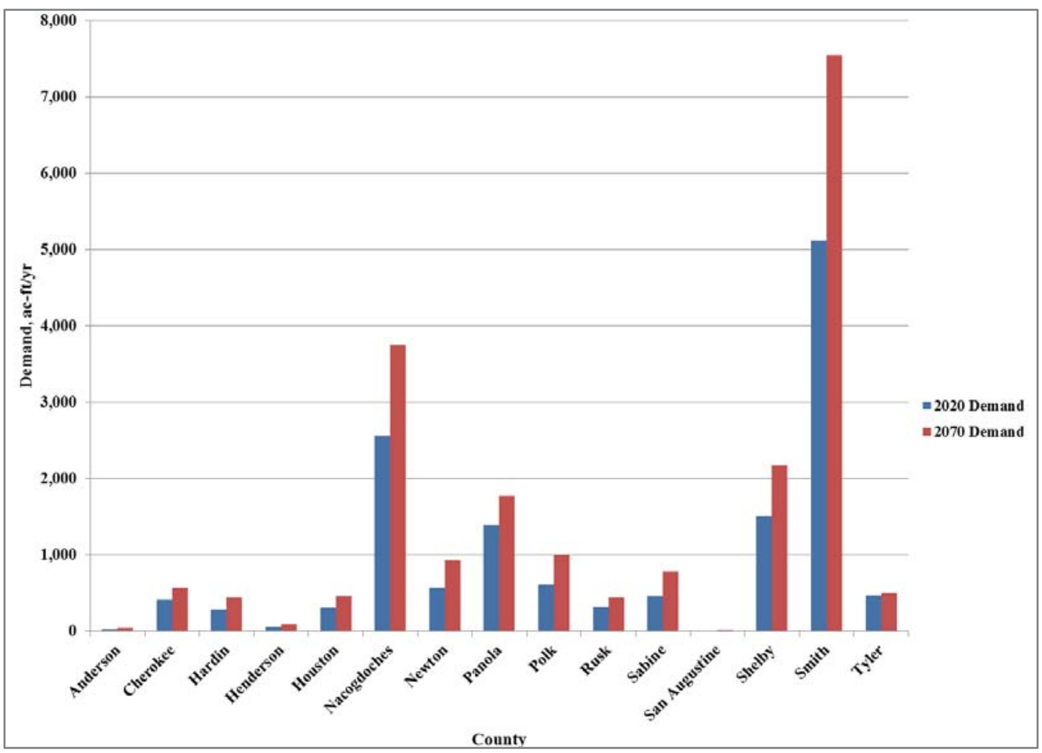
County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	60.0%	<0.1%	<0.1%
Angelina	51.8%	2.5%	2.4%
Cherokee	38.3%	0.1%	0.1%
Hardin	52.4%	<0.1%	<0.1%
Henderson	75.9%	<0.1%	<0.1%
Houston	49.8%	0.1%	<0.1%
Jasper	9.6%	15.0%	10.6%
Jefferson	67.2%	69.5%	74.8%
Nacogdoches	46.6%	0.4%	0.4%
Newton	63.9%	0.1%	0.1%
Orange	45.9%	10.6%	9.9%
Panola	27.6%	0.2%	0.2%
Polk	65.6%	0.1%	0.1%
Rusk	38.5%	0.1%	<0.1%
Sabine	68.1%	0.1%	0.1%
San Augustine	62.5%	<0.1%	<0.1%
Shelby	43.7%	0.2%	0.2%
Smith	47.5%	0.8%	0.8%
Tyler	6.3%	0.1%	0.1%

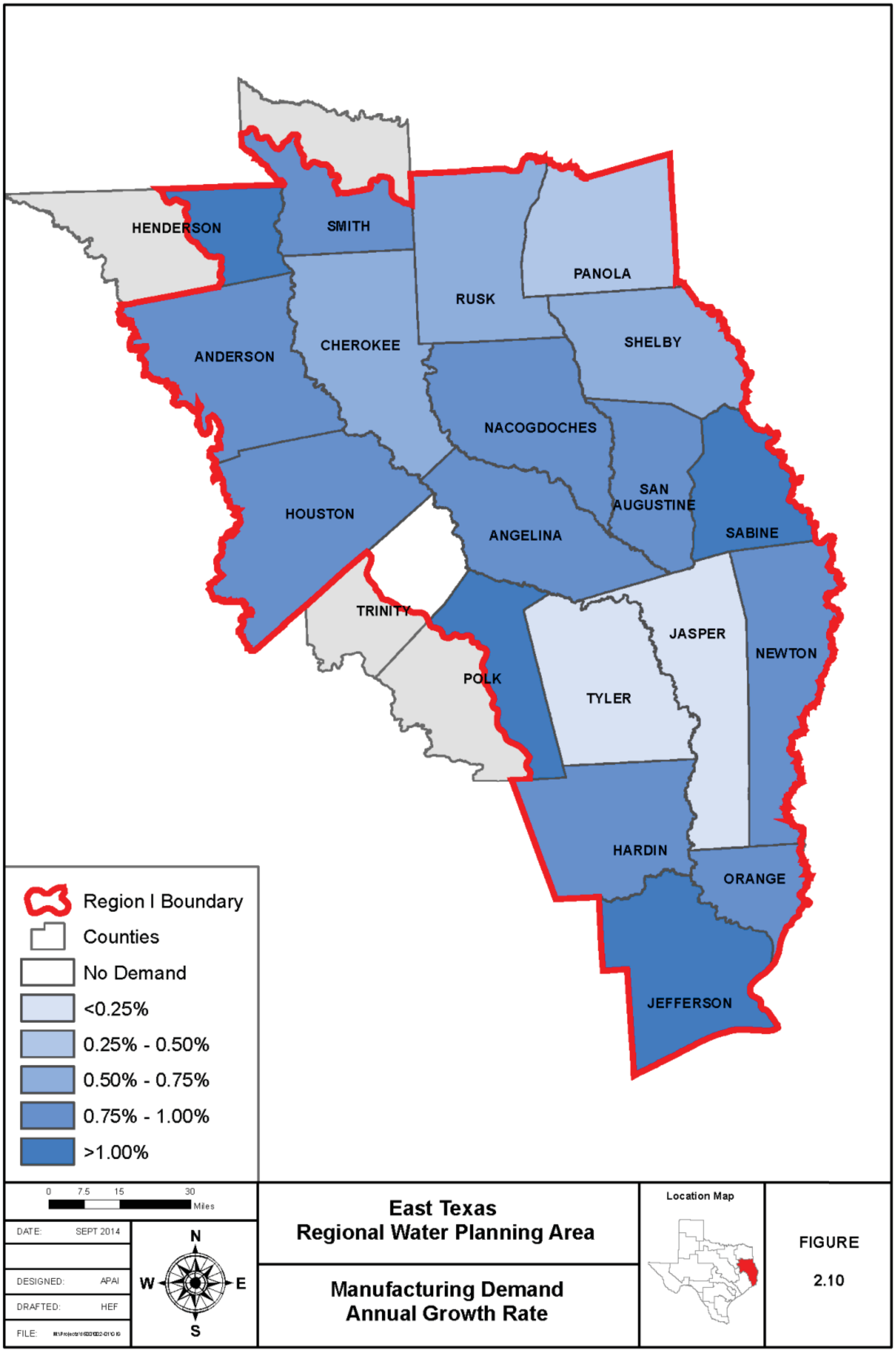
Figure 2.8 Manufacturing Demand Projections in the East Texas Regional Water Planning Area Greater than 10,000 ac-ft/yr by County



*For a breakdown of Other Manufacturing Demand Projections by County see Figure 2.9.

Figure 2.9 Manufacturing Demand Projections in the East Texas Regional Water Planning Area Less than 10,000 ac-ft/yr by County





East Texas
Regional Water Planning Area

Manufacturing Demand
Annual Growth Rate

FIGURE
2.10

2.3.3 Irrigation Demands. In the 2011 Plan, irrigation demands were projected in 16 of the 20 counties in the ETRWPA. Demand over the planning period was relatively flat at about 152,000 ac-ft per year.

The 2016 Plan projects irrigation demands in 19 of the 20 counties in the region, with a substantial overall increase in demand over the planning period. Jefferson County accounts for most of the increase in irrigation demand. Water use for irrigation is presented in Tables 2.8 and 2.9. Other major irrigation counties in the ETRWPA, after Jefferson County, are Hardin, Houston, Orange, and Smith Counties. The projection of irrigation use for these counties is presented on Figure 2.10. The usage for the remaining counties is shown on Figure 2.11.

Table 2.8 Historical and Projected Irrigation Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr)

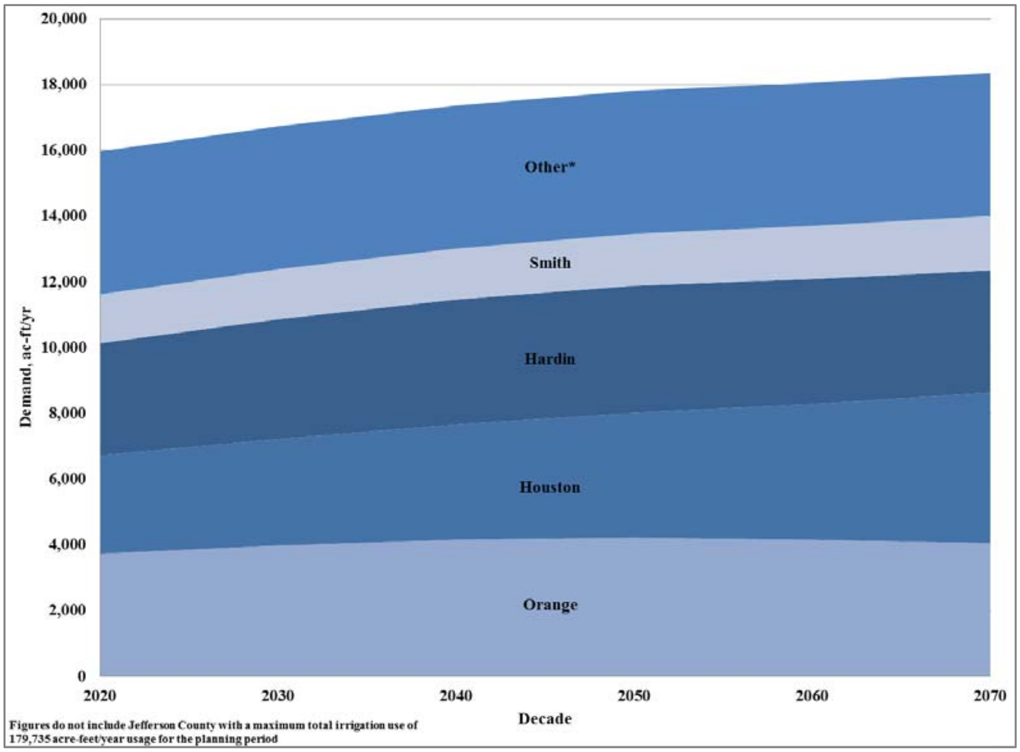
County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Anderson	409	462	462	462	462	462	462
Angelina	1,140	481	481	481	481	481	481
Cherokee	471	355	355	355	355	355	355
Hardin	1,633	3,414	3,645	3,804	3,861	3,802	3,712
Henderson	282	384	384	384	384	384	384
Houston	1,723	2,989	3,235	3,503	3,801	4,130	4,578
Jasper	0	36	36	36	36	36	36
Jefferson	86,125	161,952	171,165	177,490	179,735	177,394	173,833
Nacogdoches	304	400	400	400	400	400	400
Newton	137	375	375	375	375	375	375
Orange	0	3,730	3,983	4,156	4,218	4,153	4,056
Panola	396	64	64	64	64	64	64
Polk	595	428	428	428	428	428	428
Rusk	0	100	100	100	100	100	100
Sabine	0	-	-	-	-	-	-
San Augustine	0	62	62	62	62	62	62
Shelby	0	26	26	26	26	26	26
Smith	818	1,486	1,518	1,550	1,583	1,618	1,659
Trinity	0	500	500	500	500	500	500
Tyler	393	675	675	675	675	675	675
Total for ETRWPA	***94,426***	***177,919***	***187,894***	***194,851***	***197,546***	***195,445***	***192,186***

*Source: TWBD Water Use Survey: Historical Summary Estimates by County

Table 2.9 Irrigation Demand Projection Percentages in the East Texas Regional Water Planning Area by County

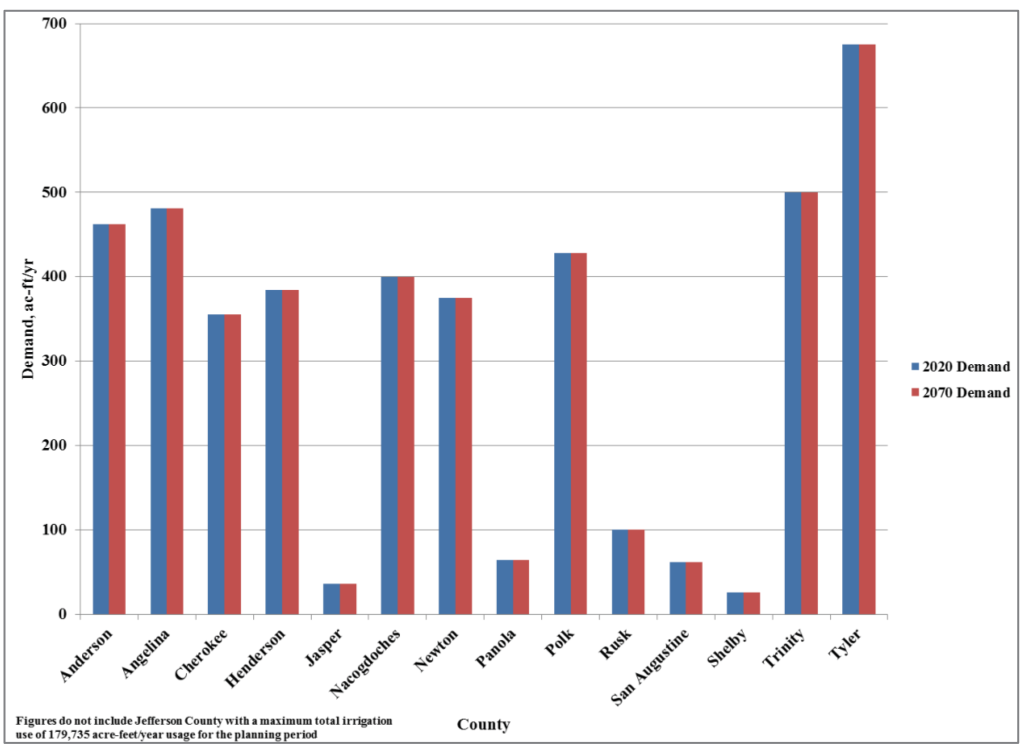
County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	0.0%	0.3%	0.2%
Angelina	0.0%	0.3%	0.3%
Cherokee	0.0%	0.2%	0.2%
Hardin	8.7%	1.9%	1.9%
Henderson	0.0%	0.2%	0.2%
Houston	53.2%	1.7%	2.4%
Jasper	0.0%	<0.1%	<0.1%
Jefferson	7.3%	91.0%	90.5%
Nacogdoches	0.0%	0.2%	0.2%
Newton	0.0%	0.2%	0.2%
Orange	8.7%	2.1%	2.1%
Panola	0.0%	<0.1%	<0.1%
Polk	0.0%	0.2%	0.2%
Rusk	0.0%	0.1%	0.1%
San Augustine	0.0%	<0.1%	<0.1%
Shelby	0.0%	<0.1%	<0.1%
Smith	11.6%	0.8%	0.9%
Trinity	0.0%	0.3%	0.3%
Tyler	0.0%	0.4%	0.4%

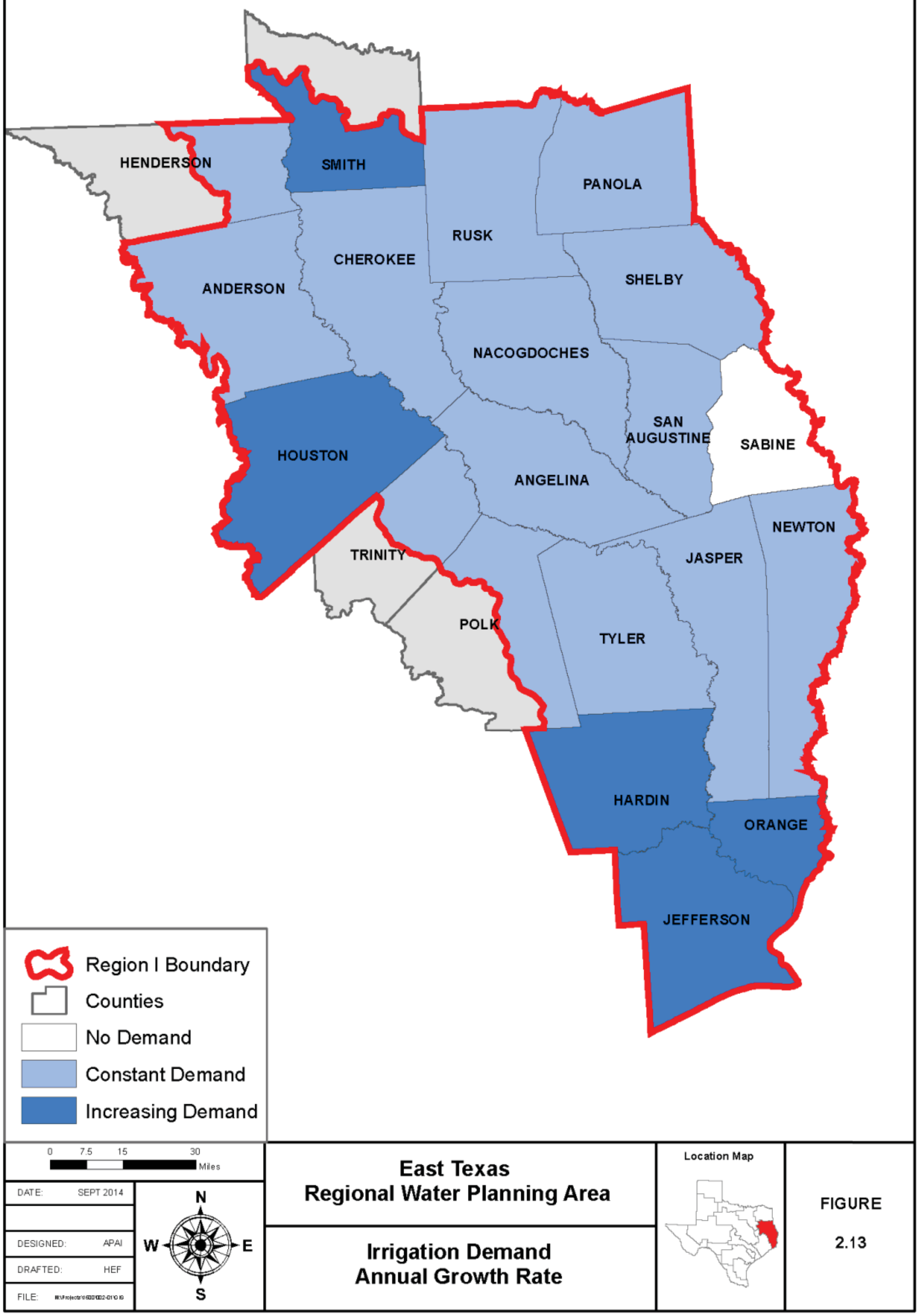
Figure 2.11 Irrigation Demand Projections in the East Texas Regional Water Planning Area Greater than 1,000 ac-ft/yr by County



*For a breakdown of Other Irrigation Demand Projections by County see Figure 2.12.

Figure 2.12 Irrigation Demand Projections in the East Texas Regional Water Planning Area Less than 1,000 ac-ft/yr by County





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East Texas
Regional Water Planning Area

Irrigation Demand
Annual Growth Rate

FIGURE
2.13

2.3.4 Steam Electric Power Demands. For all but one county in the ETRWPG, steam electric power demand for water has not changed from the 2011 Plan. The one change is in Tyler County, where projected demand was zero throughout the planning period in the 2011 Plan. For the 2016 Plan, the projected demand in Tyler County for each decade of the plan is 1,029 ac-ft per year. Region-wide steam-electric demands range from 82,018 ac-ft per year in 2020, to 184,714 ac-ft per year in 2070. Projected demands for each county are summarized in Tables 2.10 and 2.11. Figure 2.13 graphically depicts the demand projections for the nine counties in the region with steam-electric demands. Figure 2.14 shows the distribution of steam-electric demand in the region.

Table 2.10 Historical and Projected Steam Electric Power Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr)

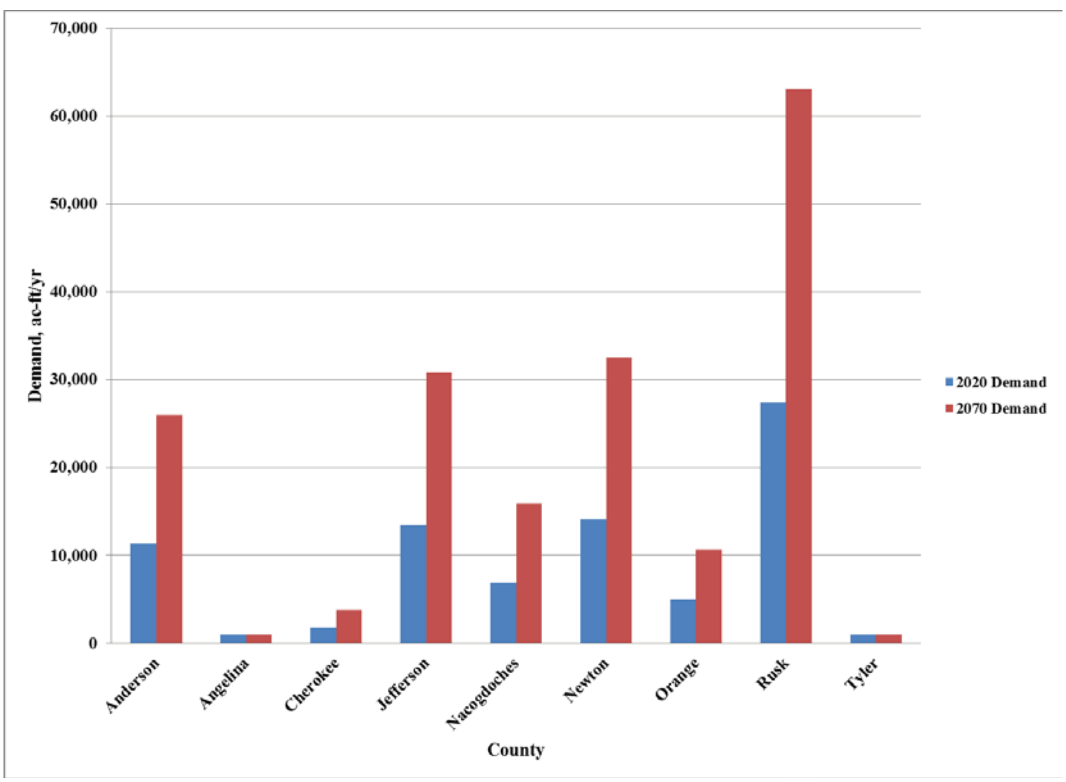
County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Anderson	0	11,306	13,218	15,549	18,390	21,853	25,968
Angelina	0	1,000	1,000	1,000	1,000	1,000	1,000
Cherokee	213	1,790	2,093	2,462	2,912	3,460	3,835
Hardin	0	0	0	0	0	0	0
Henderson	65	0	0	0	0	0	0
Houston	0	0	0	0	0	0	0
Jasper	0	0	0	0	0	0	0
Jefferson	0	13,426	15,696	18,464	21,838	25,951	30,839
Nacogdoches	0	6,911	8,079	9,504	11,241	13,358	15,874
Newton	0	14,132	16,522	19,436	22,987	27,317	32,463
Orange	4,298	4,966	5,805	6,829	8,077	9,598	10,637
Panola	0	0	0	0	0	0	0
Polk	0	0	0	0	0	0	0
Rusk	21,487	27,458	32,102	37,762	44,663	53,074	63,069
Sabine	0	0	0	0	0	0	0
San Augustine	0	0	0	0	0	0	0
Shelby	0	0	0	0	0	0	0
Smith	0	0	0	0	0	0	0
Trinity	0	0	0	0	0	0	0
Tyler	0	1,029	1,029	1,029	1,029	1,029	1,029
Total for ETRWPA	***26,063***	***82,018***	***95,544***	***112,035***	***132,137***	***156,640***	***184,714***

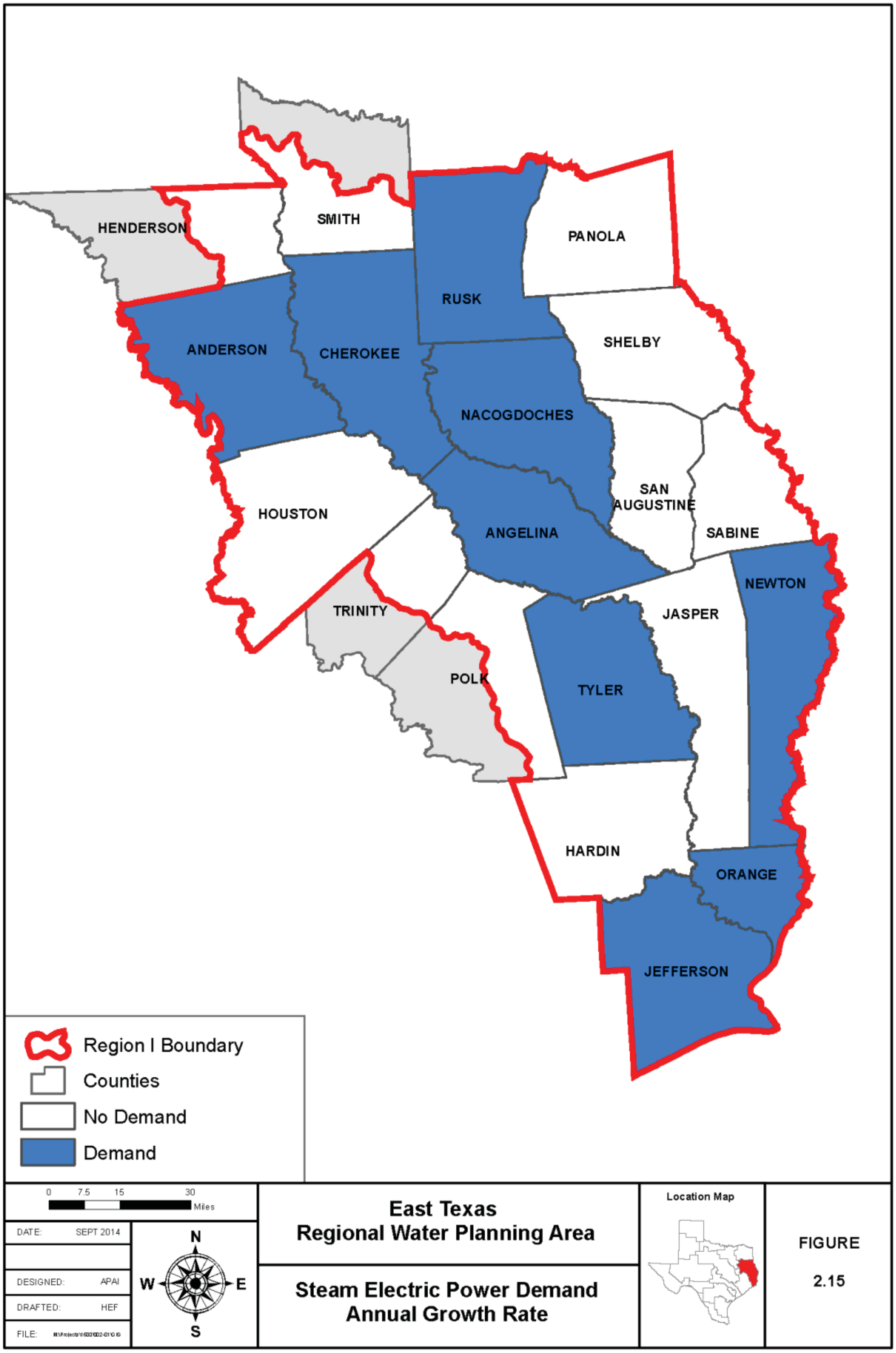
*Source: TWBD Water Use Survey: Historical Summary Estimates by County

Table 2.11 Steam Electric Power Demand Projection Percentages in the East Texas Regional Water Planning Area by County

County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	129.7%	13.8%	14.1%
Angelina	0.0%	1.2%	0.5%
Cherokee	114.2%	2.2%	2.1%
Jefferson	129.7%	16.4%	16.7%
Nacogdoches	129.7%	8.4%	8.6%
Newton	129.7%	17.2%	17.6%
Orange	114.2%	6.1%	5.8%
Rusk	129.7%	33.5%	34.1%
Tyler	0.0%	1.3%	0.6%

Figure 2.14 Steam Electric Power Demand Projections in the East Texas Regional Water Planning Area by County





East Texas
Regional Water Planning Area

Steam Electric Power Demand
Annual Growth Rate

FIGURE 2.15

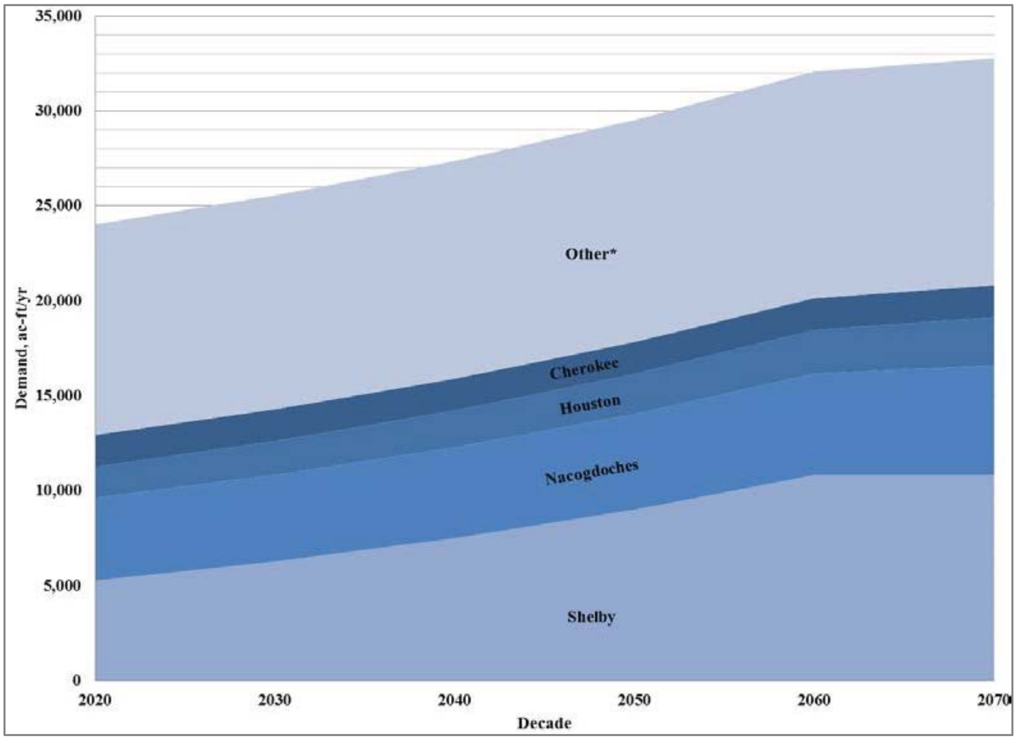
2.3.5 Livestock Demands. Shelby County presently accounts for 22% of the livestock usage in the ETRWPA and is expected to account for 33% of the livestock usage by the end of the planning period. Other counties with projected livestock demands greater than 1,500 ac-ft per year include Cherokee, Houston, and Nacogdoches and account for over 33% of usage during the planning period. The total usage is expected to increase from 24,027 ac-ft per year to 32,764 ac-ft per year. The projected usage by county during the planning period is presented in Table 2.12. Figures 2.15 and 2.16 show the livestock demand by counties separated by usage greater than or less than 1,500 ac-ft/yr, respectively. The largest percentage change in total demand is expected to occur in Rusk and Shelby Counties. Additional percent changes can be seen in Table 2.13. Figure 2.17 illustrates the average annual projected growth by county in the ETRWPA during the planning period.

Table 2.12 Historical and Projected Livestock Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr)

County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Anderson	1,082	1,402	1,402	1,402	1,402	1,402	1,402
Angelina	595	648	648	648	648	648	648
Cherokee	1,358	1,681	1,681	1,681	1,681	1,681	1,681
Hardin	210	163	163	163	163	163	163
Henderson	1,279	1,253	1,253	1,253	1,253	1,253	1,253
Houston	1,896	1,630	1,779	1,939	2,113	2,301	2,542
Jasper	789	362	362	362	362	362	362
Jefferson	951	943	943	943	943	943	943
Nacogdoches	2,683	4,364	4,557	4,781	5,040	5,337	5,779
Newton	241	121	121	121	121	121	121
Orange	273	208	208	208	208	208	208
Panola	1,362	1,480	1,480	1,480	1,480	1,480	1,480
Polk	441	357	357	357	357	357	357
Rusk	1,118	1,207	1,224	1,246	1,269	1,292	1,292
Sabine	122	159	217	285	363	448	448
San Augustine	603	903	1,000	1,111	1,240	1,382	1,382
Shelby	3,059	5,265	6,273	7,500	8,997	10,822	10,822
Smith	1,201	1,115	1,115	1,115	1,115	1,115	1,115
Trinity	467	478	478	478	478	478	478
Tyler	295	288	288	288	288	288	288
Total for ETGWPA	***20,025***	***24,027***	***25,549***	***27,361***	***29,521***	***32,081***	***32,764***

*Source: TWBD Water Use Survey: Historical Summary Estimates by County

Figure 2.16 Livestock Demand Projections in the East Texas Regional Water Planning Area Greater than 1,500 ac-ft/yr by County



*For a breakdown of Other Livestock Demand Projections by County see Figure 2.17.

Figure 2.17 Livestock Demand Projections in the East Texas Regional Water Planning Area Less than by 1,500 ac-ft/yr by County

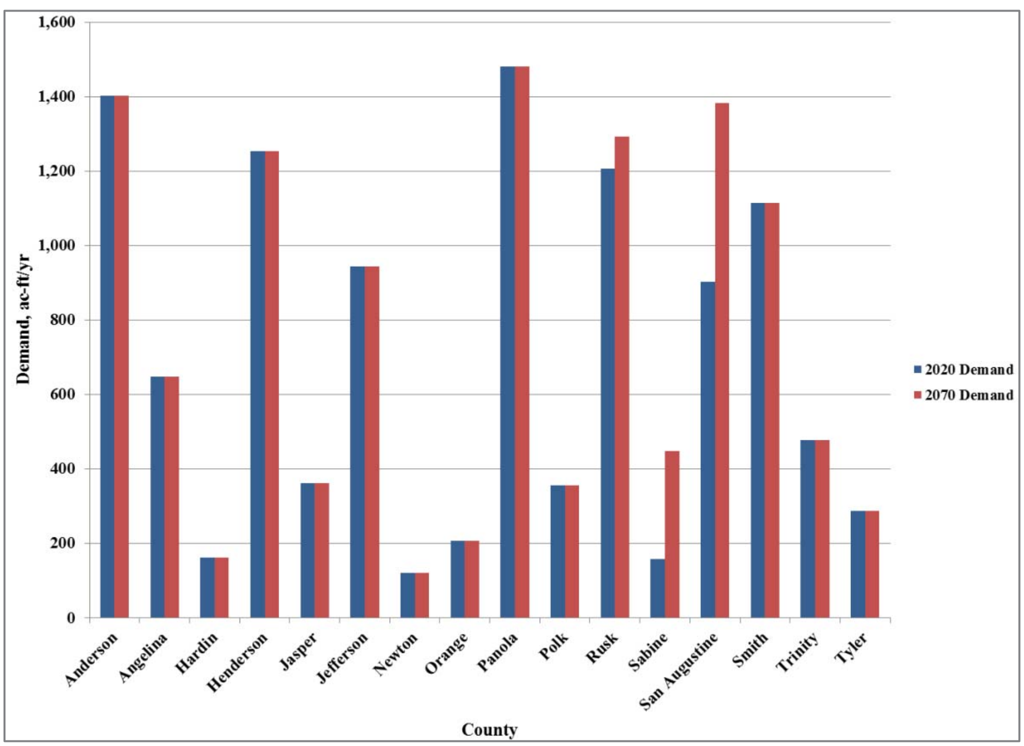
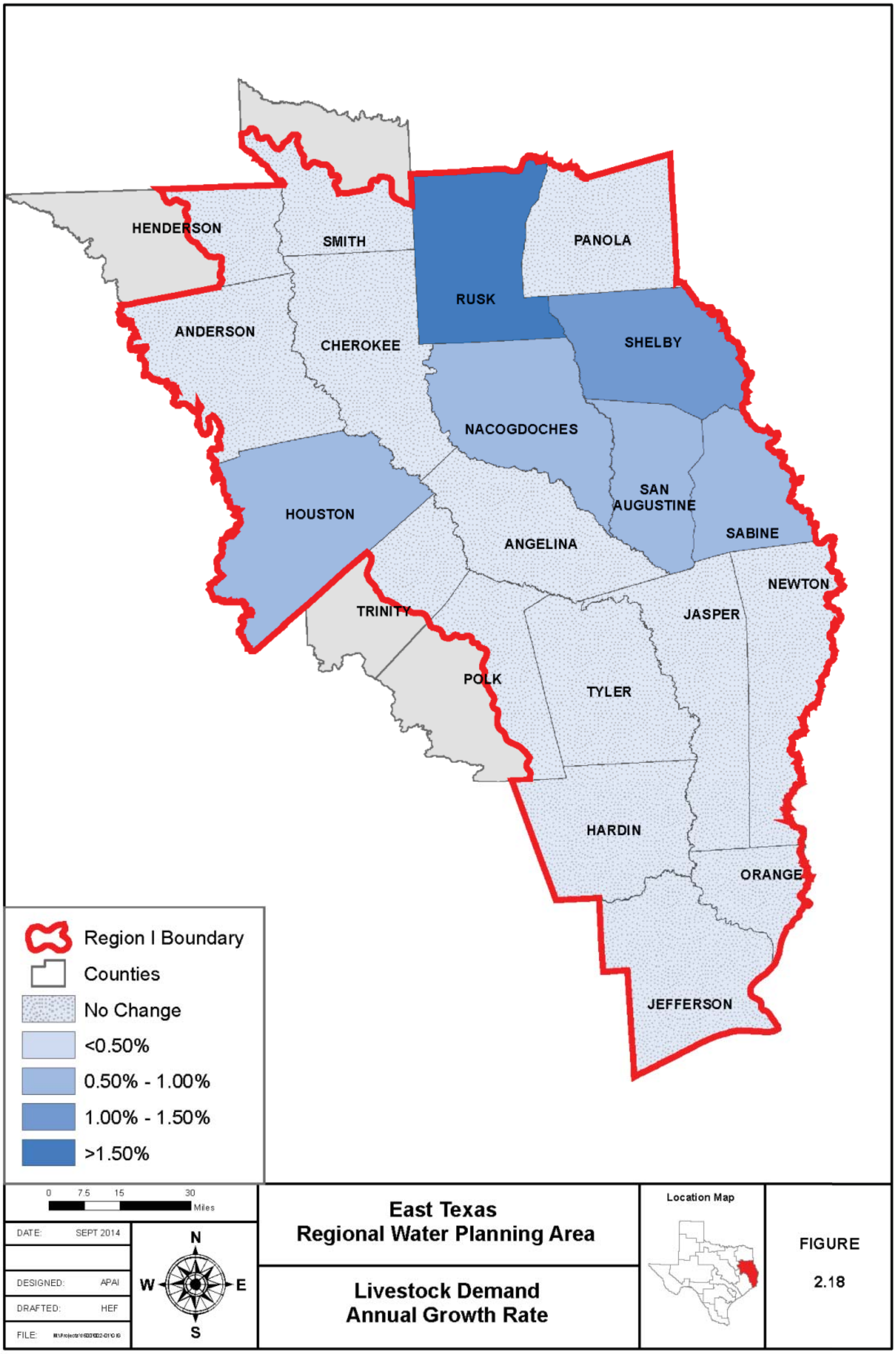


Table 2.13 Livestock Demand Projection Percentages in the East Texas Regional Water Planning Area by County

County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	0.0%	6.0%	4.3%
Angelina	0.0%	2.8%	2.0%
Cherokee	0.0%	7.2%	5.2%
Hardin	0.0%	0.7%	0.5%
Henderson	0.0%	5.3%	3.9%
Houston	56.0%	6.9%	7.8%
Jasper	0.0%	1.5%	1.1%
Jefferson	0.0%	4.0%	2.9%
Nacogdoches	32.4%	18.6%	17.8%
Newton	0.0%	0.5%	0.4%
Orange	0.0%	0.9%	0.6%
Panola	0.0%	6.3%	4.6%
Polk	0.0%	1.5%	1.1%
Rusk	181.8%	0.7%	1.4%
Sabine	43.0%	2.8%	2.9%
San Augustine	53.0%	3.8%	4.3%
Shelby	105.5%	22.4%	33.4%
Smith	0.0%	4.7%	3.4%
Trinity	0.0%	2.0%	1.5%
Tyler	0.0%	1.2%	0.9%


HENDERSON
SMITH
PANOLA
RUSK
ANDERSON
CHEROKEE
SHELBY
NACOGDOCHES
SAN AUGUSTINE
HOUSTON
ANGELINA
SABINE
NEWTON
TRINITY
JASPER
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Counties
No Change
<0.50%
0.50% - 1.00%
1.00% - 1.50%
>1.50%
0 7.5 15 30 Miles
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East Texas
Regional Water Planning Area
Livestock Demand
Annual Growth Rate
Location Map
FIGURE
2.18

2.3.6 Mining Demands. In the 2011 Plan, mining demands were identified in 16 of the 20 counties in the ETRWPA. Much of the demand (approximately 38,000 ac-ft per year in 2020 and declining to approximately 20,000 ac-ft per year in 2060) was related to the expanding shale-gas play located within much of the region. Since 2011, the natural gas exploration industry has focused on the Eagle Ford shale in South Texas, resulting in lower projections for water demand in the ETRWPA. Nonetheless, gas exploration has continued in the region and is expected to comprise the majority of the mining demand for the region. For the 2016 Plan, mining water demand is anticipated for all counties in the region. Total mining water demand in the ETRWPA is expected to be at 27,523 ac-ft per year in 2020 and decline to 12,093 ac-ft per year in 2070.

Table 2.14 provides mining water projections and Table 2.15 shows the percent changes for each county in the ETRWPA. Demands for counties with projections greater than 600 ac-ft per year are depicted on Figure 2.18. Those counties with lower projected demands are shown on Figure 2.19. Figure 2.20 illustrates the annual percent change for mining water in each county in the ETRWPA.

Table 2.14 Historical and Projected Mining Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr)

County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Anderson	62	140	177	185	147	105	75
Angelina	23	486	585	410	312	237	180
Cherokee	80	295	304	267	204	141	97
Hardin	14	12	12	12	12	12	12
Henderson	209	77	86	77	59	40	28
Houston	31	322	254	187	119	51	22
Jasper	15	148	118	88	58	28	14
Jefferson	768	194	216	244	294	329	368
Nacogdoches	531	7,000	4,500	1,643	1,299	958	707
Newton	155	429	373	279	209	146	107
Orange	240	309	314	313	314	319	327
Panola	3,169	5,916	5,859	5,049	4,268	3,620	3,938

Table 2.14 Historical and Projected Mining Water Demand in the East Texas Regional Water Planning Area by County (ac-ft/yr) (Cont.)

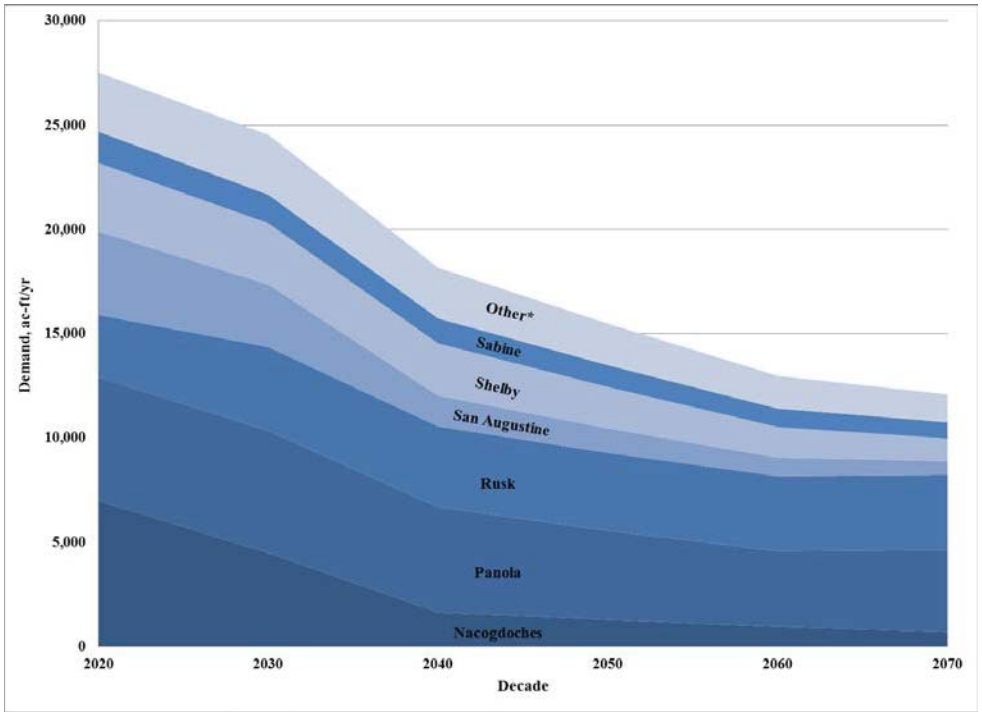
County	2010 Historical*	Projections					
		2020	2030	2040	2050	2060	2070
Polk	18	123	97	72	46	20	9
Rusk	2,316	2,990	4,007	3,870	3,724	3,601	3,592
Sabine	538	1,500	1,365	1,203	1,046	888	776
San Augustine	469	4,000	3,000	1,479	1,180	884	662
Shelby	712	3,283	2,938	2,496	1,980	1,467	1,087
Smith	253	134	139	140	109	80	58
Trinity	11	5	5	5	5	5	5
Tyler	15	160	198	150	103	55	29
Total for ETRGWA	***9,629***	***27,523***	***24,547***	***18,169***	***15,488***	***12,986***	***12,093***

*Source: TWBD Water Use Survey: Historical Summary Estimates by County

Table 2.15 Mining Demand Projection Percentages in the East Texas Regional Water Planning Area by County

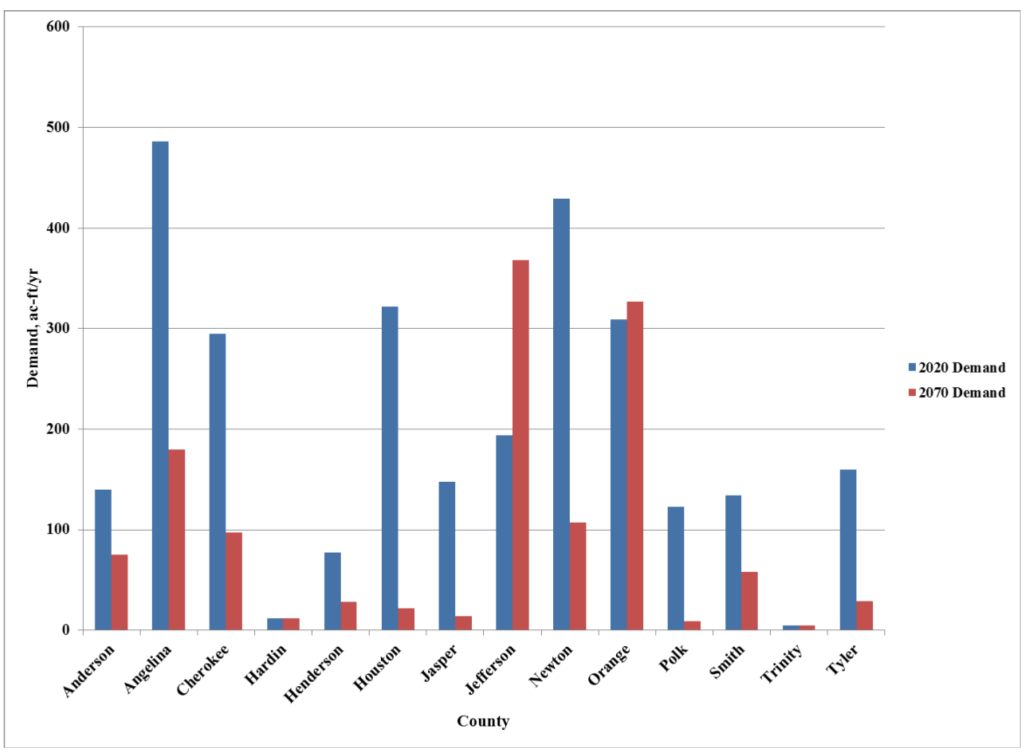
County	Percent Change in Demand 2020 to 2070	Percent of Total ETRWPA Demand in:	
		2020	2070
Anderson	-46.4%	0.5%	0.6%
Angelina	-63.0%	1.8%	1.5%
Cherokee	-67.1%	1.1%	0.8%
Hardin	0.0%	<0.1%	0.1%
Henderson	-63.6%	0.3%	0.2%
Houston	-93.2%	1.2%	0.2%
Jasper	-90.5%	0.5%	0.1%
Jefferson	89.7%	0.7%	3.0%
Nacogdoches	-89.9%	25.4%	5.8%
Newton	-75.1%	1.6%	0.9%
Orange	5.8%	1.1%	2.7%
Panola	-33.4%	21.5%	32.6%
Polk	-92.7%	0.4%	0.1%
Rusk	20.1%	10.9%	29.7%
Sabine	-48.3%	5.4%	6.4%
San Augustine	-83.5%	14.5%	5.5%
Shelby	-66.9%	11.9%	9.0%
Smith	-56.7%	0.5%	0.5%
Trinity	0.0%	<0.1%	<0.1%
Tyler	-81.9%	0.6%	0.2%

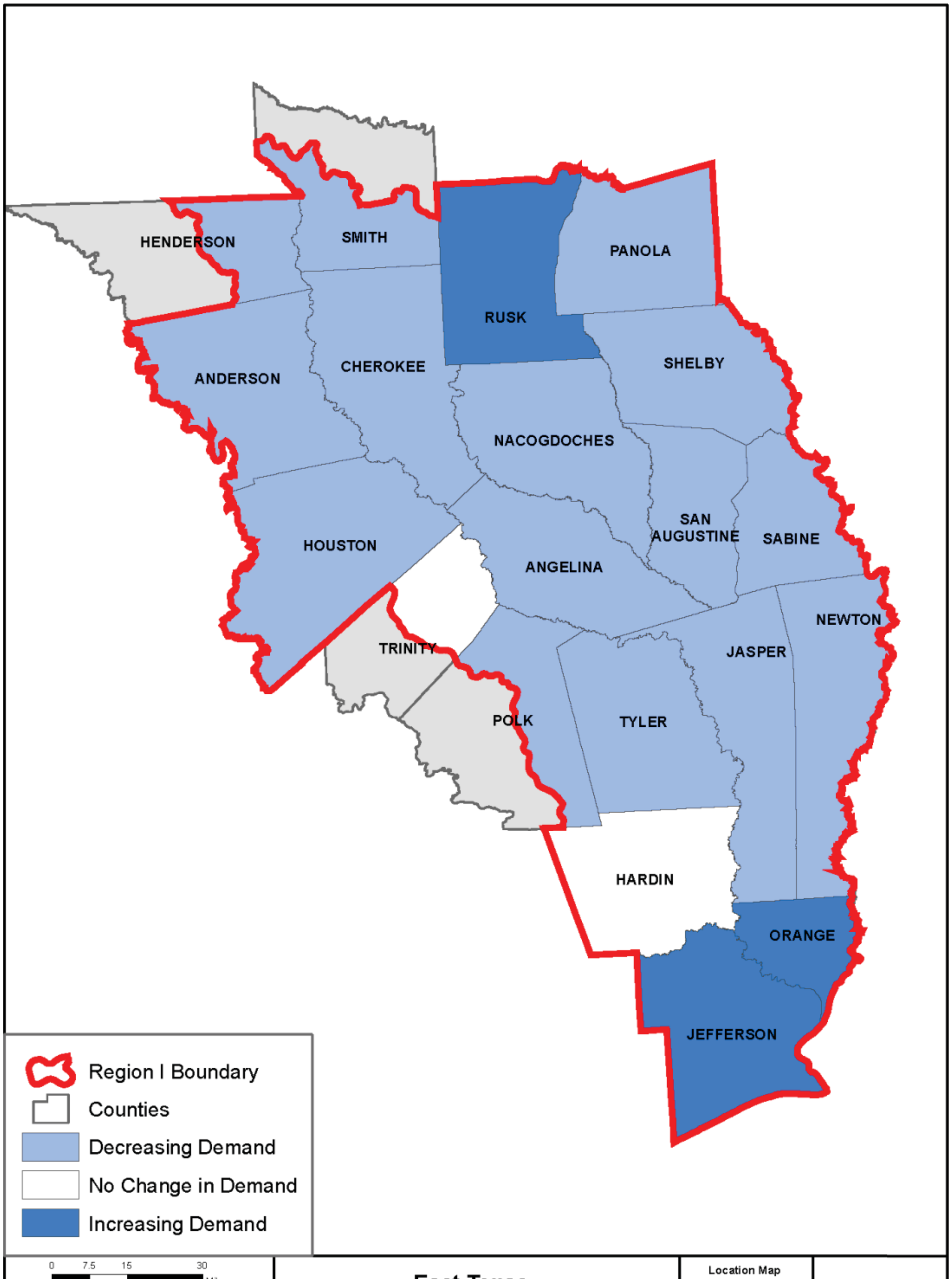
Figure 2.19 Mining Demand Projections in the East Texas Regional Water Planning Area Greater than 600 ac-ft/yr by County



*For a breakdown of Other Mining Demand Projections by County see Figure 2.20.

Figure 2.20 Mining Demand Projections in the East Texas Regional Water Planning Area Less than 600 ac-ft/yr by County





DATE: SEPT 2014

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East Texas
Regional Water Planning Area

Mining Demand
Annual Growth Rate

Location Map

FIGURE
2.21

2.3.7 Sales Between Water User Groups. The 2016 Plan is required to present the current contractual obligations of WUGs in the ETRWPA to supply water to other WUGs. Appendix 2-C presents WUG demand projections by county and river basin. Table 2.16 summarizes this information by decade; the table does not include sales from WUGs who are also WWPs.

Table 2.16 Contractual Obligations of Water User Groups in the East Texas Regional Water Planning Area (ac-ft/yr)

WUG/Customer	Demands					
Hemphill	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
G M WSC	560	560	560	560	560	560
Joaquin	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Shelby County-Other	100	95	90	82	75	68
Lumberton MUD	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Lumberton	1,656	1,852	1,990	2,097	2,191	2,263
Orangefield WSC	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Bridge City	7	7	7	7	7	7
Pineland	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
G M WSC	270	270	270	270	270	270
Woodville	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Tyler Steam Electric Power	838	838	838	838	838	838

2.4 Demands for Wholesale Water Providers

As part of the development of the regional water plan, current water demands were identified for the WWPs in the ETRWPA. The WWPs are as follows:

- Angelina and Neches River Authority
- Angelina-Nacogdoches Water Control and Improvements 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 WCID No. 1
- Lower Neches Valley Authority
- Panola County Freshwater Supply District No. 1
- Sabine River Authority
- Upper Neches River Municipal Water Authority.

Chapter 1 provides a description of each WWP in the ETRWPA. For details regarding WWP supplies and water management strategies, see Chapters 3 and 5 respectively. The expected demands of each customer on each WWP can be found in Table 2.17 on the following pages; where applicable, the expected demand is equal to the contract volume. Appendix 2-D will present WWP demand projections divided by category, county, and river basin as a DB17 Report; the TWDB will make this report available to the RWPG after submittal of the IPP. As a placeholder, Table 2.18 presents WWP demands by water use category for 2020.

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr)

WWP/Customer	Demands					
Angelina and Neches River Authority	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Alto [2]	428	428	428	428	428	428
City of Arp [2]	428	428	428	428	428	428
Afton Grove WSC	855	855	855	855	855	855
Stryker Lake WSC	428	428	428	428	428	428
County-Other, Cherokee	2,565	2,565	2,565	2,565	2,565	2,565
Caro WSC	428	428	428	428	428	428
Blackjack WSC	855	855	855	855	855	855
Jackson WSC	855	855	855	855	855	855
City of Jacksonville [1]	4,275	4,275	4,275	4,275	4,275	4,275
City of Nacogdoches [2]	8,551	8,551	8,551	8,551	8,551	8,551
City of New London [2]	855	855	855	855	855	855
City of New Summerfield [2]	2,565	2,565	2,565	2,565	2,565	2,565
North Cherokee WSC	4,275	4,275	4,275	4,275	4,275	4,275
City of Rusk [2]	4,275	4,275	4,275	4,275	4,275	4,275
Rusk Rural WSC	855	855	855	855	855	855
City of Troup [1]	4,275	4,275	4,275	4,275	4,275	4,275
City of Whitehouse [2]	8,551	8,551	8,551	8,551	8,551	8,551
Total Demand- Lake Columbia	*45,319*	*45,319*	*45,319*	*45,319*	*45,319*	*45,319*
Holmwood Utility	65	70	70	70	70	70
Angelina and Neches River Authority Total Demand	***45,384***	***45,389***	***45,389***	***45,389***	***45,389***	***45,389***
Angelina-Nacogdoches Water Control and Improvement District No. 1	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Luminant Energy	5,000	5,000	5,000	5,000	5,000	5,000
Nacogdoches / Southern Power	7,280	7,280	7,280	7,280	7,280	7,280
City of Henderson (Future) [2]	8,289	8,289	8,289	8,289	8,289	8,289
Angelina-Nacogdoches Water Control and Improvement District No. 1 Total Demand	***20,569***	***20,569***	***20,569***	***20,569***	***20,569***	***20,569***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
Athens Municipal Water Authority	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Athens [3]	2,973	3,244	3,473	3,809	6,484	9,782
Lakeside Irrigation	170	170	170	170	170	170
TPWD Fish Hatchery	3,023	3,023	3,023	3,023	3,023	3,023
Manufacturing, Henderson (Region C)	345	356	368	380	391	403
Athens Municipal Water Authority Total Demand	***6,511***	***6,793***	***7,034***	***7,382***	***10,068***	***13,378***
City of Beaumont	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Beaumont [2]	29,689	30,963	32,423	34,398	36,805	39,548
County-Other, Jefferson	1,280	1,623	2,047	2,554	3,126	3,769
Manufacturing, Jefferson	1,642	1,658	1,675	1,692	1,709	1,726
Meeker MUD	4	4	5	5	5	6
City of Beaumont Total Demand	***32,615***	***34,248***	***36,150***	***38,649***	***41,645***	***45,049***
City of Carthage	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Carthage [2]	1,650	1,651	1,644	1,648	1,659	1,670
County-Other, Panola	300	300	300	300	300	300
Manufacturing, Panola	905	945	983	1,017	1,084	1,155
City of Carthage Total Demand	***2,855***	***2,896***	***2,927***	***2,965***	***3,043***	***3,125***
City of Center	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Sand Hills WSC	162	167	172	179	187	195
Shelbyville WSC	20	21	21	22	23	24
Manufacturing, Shelby	1,495	1,623	1,750	1,863	2,001	2,148
City of Center [2]	1,847	1,958	2,056	2,158	2,262	2,358
City of Center Total Demand	***3,524***	***3,769***	***3,999***	***4,222***	***4,473***	***4,725***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
Houston County Water Control and Improvement District No. 1	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Existing Customers						
County-Other, Houston	92	86	85	85	85	85
City of Crockett [3]	2,148	2,148	2,148	2,148	2,148	2,148
City of Grapeland [1]	123	123	123	123	123	123
City of Lovelady [1]	37	37	37	37	37	37
Manufacturing	301	331	360	385	417	451
The Consolidated WSC	1,043	1,043	1,043	1,043	1,043	1,043
Total Demand for Existing Customers	*3,744*	*3,768*	*3,796*	*3,821*	*3,853*	*3,887*
Future Customers						
Mining, Houston	-	-	250	250	500	500
The Consolidated WSC	522	522	522	522	522	522
Nacogdoches Power	1,000	1,000	1,000	1,000	1,000	1,000
Total Demand for Future Customers	*1,522*	*1,522*	*1,772*	*1,772*	*2,022*	*2,022*
Houston County Water Control and Improvement District No. 1 Total Demand	***5,266***	***5,290***	***5,568***	***5,593***	***5,875***	***5,909***
City of Jacksonville	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Afton Grove WSC, Gum Creek WSC	285	301	319	345	375	408
Craft-Turney WSC	483	502	523	560	609	663
City of Jacksonville [2]	2,680	2,858	3,042	3,297	3,588	3,908
Manufacturing, Cherokee	413	442	469	492	530	571
North Cherokee WSC	602	640	681	737	801	873
City of Jacksonville Total Demand	***4,463***	***4,743***	***5,034***	***5,431***	***5,903***	***6,423***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
Lower Neches Valley Authority	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Region I						
City of Beaumont - Contract and Supplemental Reserve [1]	8,411	9,575	10,933	11,718	12,712	13,718
County-Other, Jefferson	256	325	409	511	625	754
City of Groves [2]	2,238	2,160	2,094	2,069	2,063	2,063
Irrigation, Jefferson	140,000	140,000	140,000	140,000	140,000	140,000
Jefferson County WCID #10	448	453	463	485	517	555
Manufacturing, Jasper	60,000	60,000	60,000	60,000	60,000	60,000
Manufacturing, Jefferson	232,792	331,827	346,044	360,269	374,503	389,299
Manufacturing, Nacogdoches	10,000	10,000	10,000	10,000	10,000	10,000
City of Nederland [2]	2,404	2,464	2,546	2,682	2,865	3,077
City of Nome [2]	75	77	80	84	90	96
City of Port Arthur [3]	26,253	26,223	25,996	25,949	25,930	25,929
City of Port Neches [2]	1,428	1,447	1,481	1,553	1,658	1,780
West Jefferson County MWD	741	752	772	809	863	927
City of Woodville – Contract [3]	5,600	5,600	5,600	5,600	5,600	5,600
Region H						
Trinity Bay Conservation District	2,262	2,637	3,037	3,488	3,988	4,518
Bolivar Peninsula SUD	6,000	6,000	6,000	6,000	6,000	6,000
Irrigation, Chambers	37,000	37,000	37,000	37,000	37,000	37,000
Irrigation, Liberty	23,000	23,000	23,000	23,000	23,000	23,000
Delivery Losses	69,864	82,442	84,432	86,402	88,427	90,540
Lower Neches Valley Authority Total Demand	***628,772***	***741,982***	***759,887***	***777,619***	***795,841***	***814,856***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
City of Lufkin	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Burke [2]	156	165	172	180	186	193
Angelina Fresh Water	74	74	74	74	74	74
Woodlawn WSC	221	221	221	221	221	221
City of Diboll [3]	1,940	1,940	1,940	1,940	1,940	1,940
City of Huntington [3]	448	448	448	448	448	448
Irrigation, Angelina	481	481	481	481	481	481
Lower Neches Valley Authority	28,000	28,000	11,200	11,200	11,200	11,200
City of Lufkin [2]	6,271	6,523	6,736	6,979	7,246	7,494
Manufacturing, Angelina	3,050	3,372	3,697	3,987	4,296	4,628
Redland WSC	307	307	307	307	307	307
Power Plants	16,802	16,802	16,802	16,802	16,802	16,802
City of Lufkin Total Demand	***57,750***	***58,333***	***42,078***	***42,619***	***43,201***	***43,788***
City of Nacogdoches	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Appleby WSC	93	93	93	93	93	93
Nacogdoches MUD#1, Lilly Grove SUD	67	67	67	67	67	67
D&M WSC	258	258	258	258	258	258
Manufacturing, Nacogdoches	2,564	2,798	3,029	3,228	3,483	3,758
Melrose WSC	37	37	37	37	37	37
City of Nacogdoches [2]	6,742	7,376	8,027	8,781	9,638	10,545
City of Nacogdoches Total Demand	***9,761***	***10,629***	***11,511***	***12,464***	***13,576***	***14,758***
Panola County Freshwater Supply District No. 1	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
City of Carthage [3]	13,452	13,452	13,452	13,452	13,452	13,452
Mining, Panola	3,550	3,515	3,029	2,561	2,172	2,363
Panola County Freshwater Supply District No. 1 Total Demand	***17,002***	***16,967***	***16,481***	***16,013***	***15,624***	***15,815***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
City of Port Arthur	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Texas Parks and Wildlife	5	5	5	5	5	5
BASF Total Petrochemicals LLC	57	57	57	57	57	57
Cheniere LNG	5,646	5,646	5,646	5,646	5,646	5,646
Flint Hills Resources	55	55	55	55	55	55
Golden Pass LNG	28	28	28	28	28	28
Manufacturing, Jefferson	282	282	282	282	282	282
Motiva	280	280	280	280	280	280
Total Petrochemicals	95	95	95	95	95	95
City of Port Arthur [2]	19,805	19,775	19,548	19,501	19,482	19,481
City of Port Arthur Total Demand	***26,253***	***26,223***	***25,996***	***25,949***	***25,930***	***25,929***
Sabine River Authority	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Toledo Bend						
Beechwood WSC	190	190	190	190	190	190
El Camino WSC	36	36	36	36	36	36
Huxley	280	280	280	280	280	280
G M WSC	560	560	560	560	560	560
City of Hemphill [3]	743	743	743	743	743	743
Invista	31	31	31	31	31	31
XTO	7,500	7,500	7,500	7,500	7,500	7,500
Tenaska	17,922	17,922	17,922	17,922	17,922	17,922
Canal (Gulf Coast Division)						
Irrigation, Orange	1,255	1,255	1,255	1,255	1,255	1,255
Gerdau Areristeel US Inc.	1,120	1,120	1,120	1,120	1,120	1,120
Honeywell	1,120	1,120	1,120	1,120	1,120	1,120
Chevron Phillips	1,841	1,841	1,841	1,841	1,841	1,841
E.I. Dupont	24,643	24,643	24,643	24,643	24,643	24,643
Firestone	1,473	1,473	1,473	1,473	1,473	1,473
International Paper	22,403	22,403	22,403	22,403	22,403	22,403
Lanxess	4,480	4,480	4,480	4,480	4,480	4,480

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.17 Expected Demands for each Wholesale Water Provider in the East Texas Regional Water Planning Area (ac-ft/yr) (Cont.)

WWP/Customer	Demands					
Sabine River Authority (Cont.)	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Rose City [3]	478	478	478	478	478	478
Entergy	4,481	4,481	4,481	4,481	4,481	4,481
NRG Cottonwood	13,442	13,442	13,442	13,442	13,442	13,442
Sabine River Authority Total Demand	***103,998***	***103,998***	***103,998***	***103,998***	***103,998***	***103,998***
City of Tyler	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Community Water	239	239	239	239	239	239
Golf Course Irrigation	400	400	400	400	400	400
Manufacturing, Smith	3,072	3,358	3,633	3,866	4,186	4,532
Southern Utilities Company	312	321	332	347	365	384
Tyler (Region I)	20,049	21,331	22,696	24,331	26,141	28,031
Tyler (Region D)	192	214	239	272	311	359
Walnut Grove WSC	1,495	1,495	1,495	1,495	1,495	1,495
City of Whitehouse [3]	747	747	747	747	747	747
City of Tyler Total Demand	***26,506***	***28,105***	***29,781***	***31,697***	***33,884***	***36,187***
Upper Neches River Municipal Water Authority	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Monarch Utilities	100	100	100	100	100	100
City of Dallas (No Connection)	114,337	114,337	114,337	114,337	114,337	114,337
Arborgen Super Tree Farm	300	300	300	300	300	300
Irrigation, Cherokee	41	36	32	28	25	25
Irrigation, Henderson	82	73	64	57	51	51
Irrigation, Smith	82	73	64	57	51	51
Emerald Bay Golf Course	105	105	105	105	105	105
City of Palestine [1, 3]	28,000	28,000	28,000	28,000	28,000	28,000
City of Tyler [3]	67,200	67,200	67,200	67,200	67,200	67,200
Upper Neches River Municipal Water Authority Total Demand	***210,247***	***210,224***	***210,202***	***210,184***	***210,169***	***210,169***

[1]The contract demand is less than the municipal demand shown in Table 2.4
[2]Municipal demand projected by the TWDB
[3]The contract demand is greater than the municipal demand shown in Table 2.4

Table 2.18 2020 Wholesale Water Provider Demands in the East Texas Regional Water Planning Area by Water Use Category

Wholesale Water Provider	Municipal	Manufacturing	Irrigation	Steam Electric Power	Mining	Livestock	To Other Wholesale Water Provider*
Angelina and Neches River Authority	31,703						12,826
Angelina-Nacogdoches WCID #1	8,289			12,280			
Athens Municipal Water Authority			170			3,023	
City of Beaumont	2,513	1,642					
City of Carthage	300	905					
City of Center	182	1,495					
City of Jacksonville	1,370	413					
City of Lufkin	2,990	3,050	481	16,802			28,000
City of Nacogdoches	455	2,564					
City of Port Arthur	5	6,443					
City of Tyler	2,554	3,072	400				
Houston County WCID #1	3,965	301		1,000			
Lower Neches Valley Authority	13,190	302,792	140,000				53,217
Panola County FWSD #1					3,550		13,452
Sabine River Authority	2,287	57,111	1,255	35,845	7,500		
Upper Neches River MWA	28,000	100	610				67,200

*The water use category for sales To Other Wholesale Water Providers is captured in the recipient Wholesale Water Provider demands. For recipient Wholesale Water Provider details, see table 2.17.

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Chapter 3

Evaluation of Current Water Supplies in the Region

Under regional water planning guidelines, each region is to identify currently available water supplies to the region by 1) source and 2) user. The supplies available by source are based on the supply available during drought-of-record conditions. Surface water and groundwater represent the primary types of water supply sources. Reuse of effluent from wastewater treatment plants (i.e., water reuse) is also considered a source of supply. However, reuse in the ETRWPA is small as compared to groundwater and surface water supplies.

Existing water supplies that are available to each user include those that have been permitted or contracted, with infrastructure in place to transport and treat (if necessary). Some water supplies are permitted or are contracted for use, but the infrastructure is not yet in place or some other water supply limitation exists. Water supply limitations considered in this analysis include raw water source availability, well field production capacities, permit limits, contract amounts, water quality, transmission infrastructure, and water treatment capacities. In this case, connecting such supplies is considered a water management strategy for future use.

The following sections discuss the water available in the ETRWPA by source (Section 3.1), by water user (Section 3.4), and by wholesale water provider (Section 3.5). Section 3.2 discusses water quality of water supplies in the ETRWPA and Section 3.3 discusses the status of the State environmental flow process for the Sabine and Neches River Basins. The TWDB data reports pertaining to water availability and water supplies are included in Appendix 3-A and 3-B respectively. These reports include a listing of total available supply by source, existing supplies available to water users, and the amount of water by source that may be available for future use.

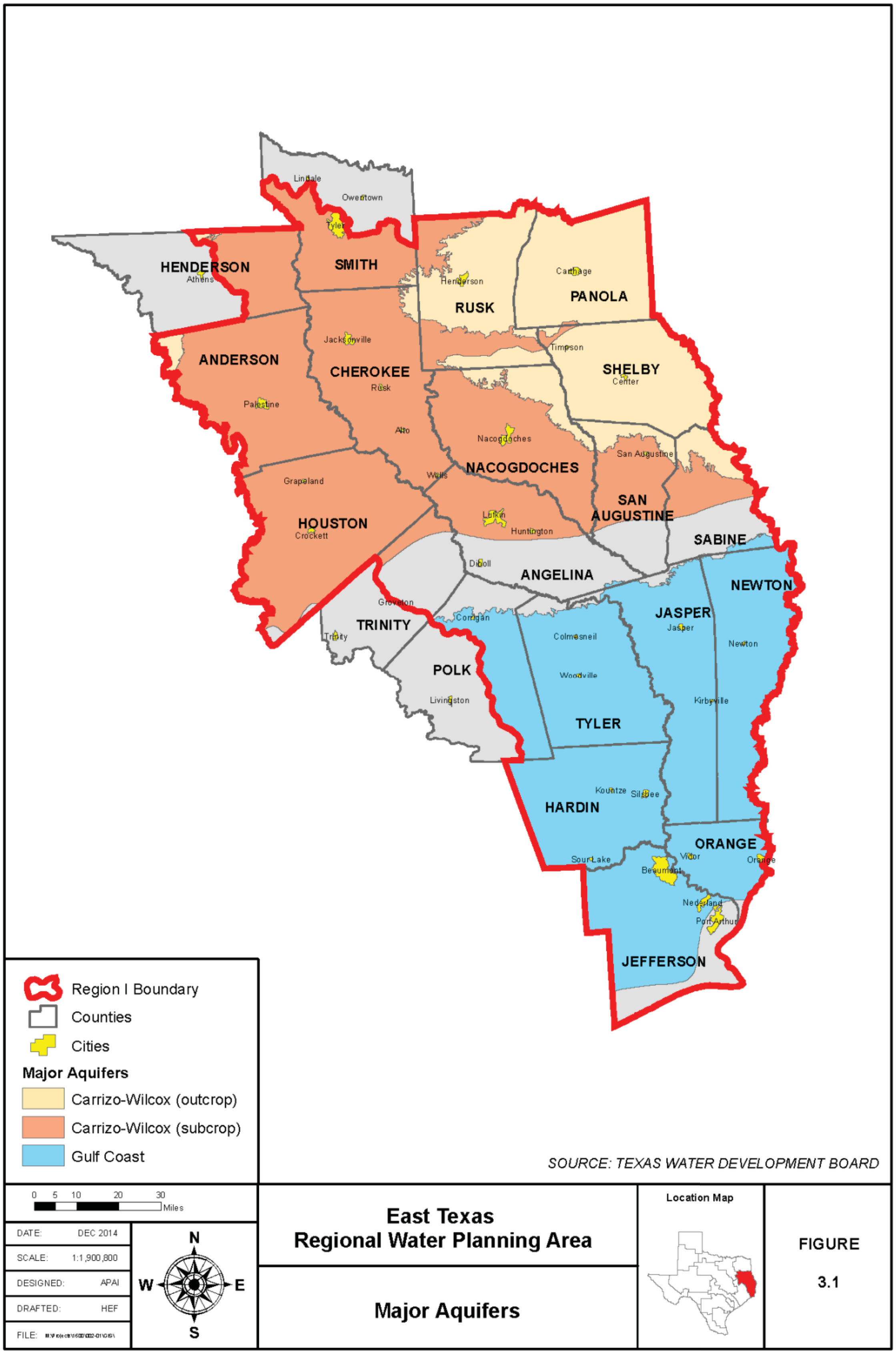
3.1 Regional Water Supplies

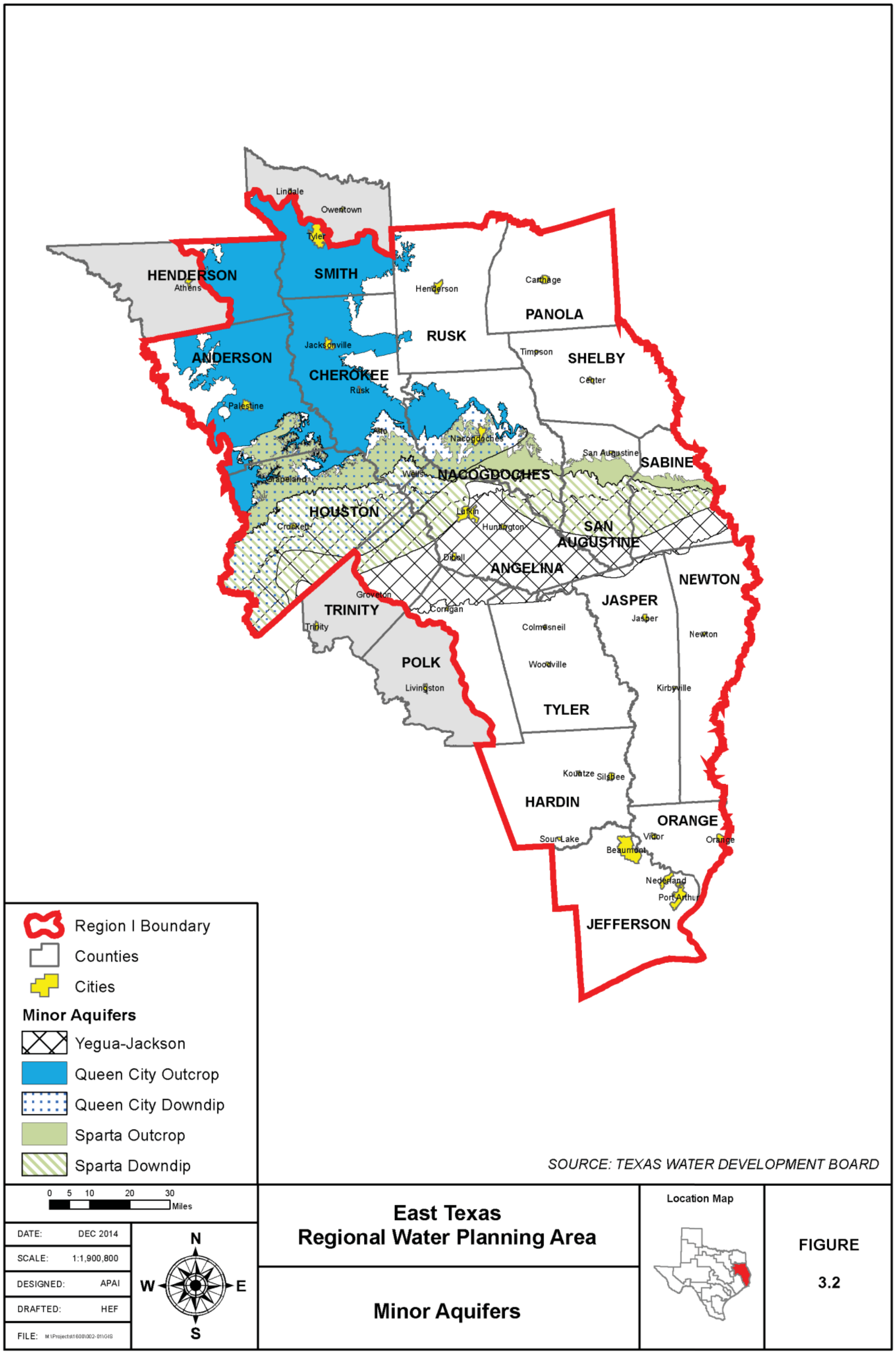
Most of the available water in the ETRWPA is surface water. Approximately 15 percent of the total freshwater supply is groundwater. However, groundwater is a very important resource in the region and is used to supply much of the municipal and rural water needs of the region.

Groundwater resources in the region consist of two major aquifers and three minor aquifers. The two major aquifers are the Gulf Coast aquifer and the Carrizo Wilcox aquifer (Figure 3.1). The three minor aquifers are the Sparta, Queen City, and Yegua-Jackson (Figure 3.2). A small amount of water is also available from “non-relevant” and “other” local aquifers that have not been designated as major or minor aquifers by the TWDB.

Surface water includes reservoirs, run-of-river supplies, and local surface water (such as stock ponds). For surface water reservoirs, the reliable supply by source is the equivalent of firm yield supply or permitted amount (whichever is lower). For run-of-the-river supplies, this is the minimum supply available in a year over the historical hydrologic record. For both of these types of surface water supplies, the water availability models (WAMs) are used to determine reliable supplies. For local surface water, estimates of historical use as reported by the TWDB are the basis for these supply quantities. Figure 3.3 presents the major surface water sources in the ETRWPA, including river basins and water supply reservoirs.

Other water supplies considered for planning purposes include reuse of treated wastewater and saline or brackish surface water sources. Reuse supplies are assessed based on historical and current use. Saline or brackish surface water is based on water right permits granted by the TCEQ. Generally, saline or brackish surface water is not distributed to water users because the demands developed in Chapter 2 are freshwater demands. However, in the ETRWPA several industries use these brackish water supplies for manufacturing processes. These demands are not included in the region’s manufacturing demands. Generally, the brackish supplies in ETRWPA are run-of-river supplies associated with tidally influenced segments of river and are not based on brackish groundwater supplies.


HENDERSON
Athens
SMITH
Tyler
Lindale
Owentown
RUSK
Henderson
PANOLA
Carthage
ANDERSON
Palestine
CHEROKEE
Jacksonville
Rusk
Alto
SHELBY
Center
Timpson
NACOGDOCHES
Nacogdoches
San Augustine
SAN AUGUSTINE
Wells
Grapeland
HOUSTON
Crockett
Lufkin
Huntington
SABINE
Diboll
ANGELINA
NEWTON
Newton
JASPER
Jasper
TRINITY
Groveton
Trinity
Corrigan
Colmesneil
Woodville
POLK
Livingston
Kirbyville
TYLER
HARDIN
Kountze
Silsbee
ORANGE
Vidor
Orange
Sour Lake
Beaumont
Nederland
Port Arthur
JEFFERSON
Region I Boundary
Counties
Cities
Major Aquifers
Carrizo-Wilcox (outcrop)
Carrizo-Wilcox (subcrop)
Gulf Coast
SOURCE: TEXAS WATER DEVELOPMENT BOARD
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
N
W
E
S
East Texas
Regional Water Planning Area
Major Aquifers
Location Map
FIGURE
3.1


HENDERSON
Athens
SMITH
Lindale
Owentown
Tyler
Henderson
Carthage
PANOLA
RUSK
ANDERSON
Jacksonville
CHEROKEE
Rusk
Palestine
Timpson
SHELBY
Center
Nacogdoches
San Augustine
SABINE
Wells
NACOGDOCHES
Grapeland
HOUSTON
Crockett
Lufkin
Huntington
SAN
AUGUSTINE
Diboll
ANGELINA
NEWTON
Groveton
JASPER
Jasper
TRINITY
Corrigan
Trinity
Colmesneil
Newton
POLK
Woodville
Livingston
Kirbyville
TYLER
Kountze
Silsbee
HARDIN
ORANGE
Vidor
Orange
Sour Lake
Beaumont
Nederland
Port Arthur
JEFFERSON
Region I Boundary
Counties
Cities
Minor Aquifers
Yegua-Jackson
Queen City Outcrop
Queen City Downdip
Sparta Outcrop
Sparta Downdip
SOURCE: TEXAS WATER DEVELOPMENT BOARD
0 5 10 20 30
Miles
DATE: DEC 2014
SCALE: 1:1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
N
W
E
S
East Texas
Regional Water Planning Area
Minor Aquifers
Location Map
FIGURE
3.2

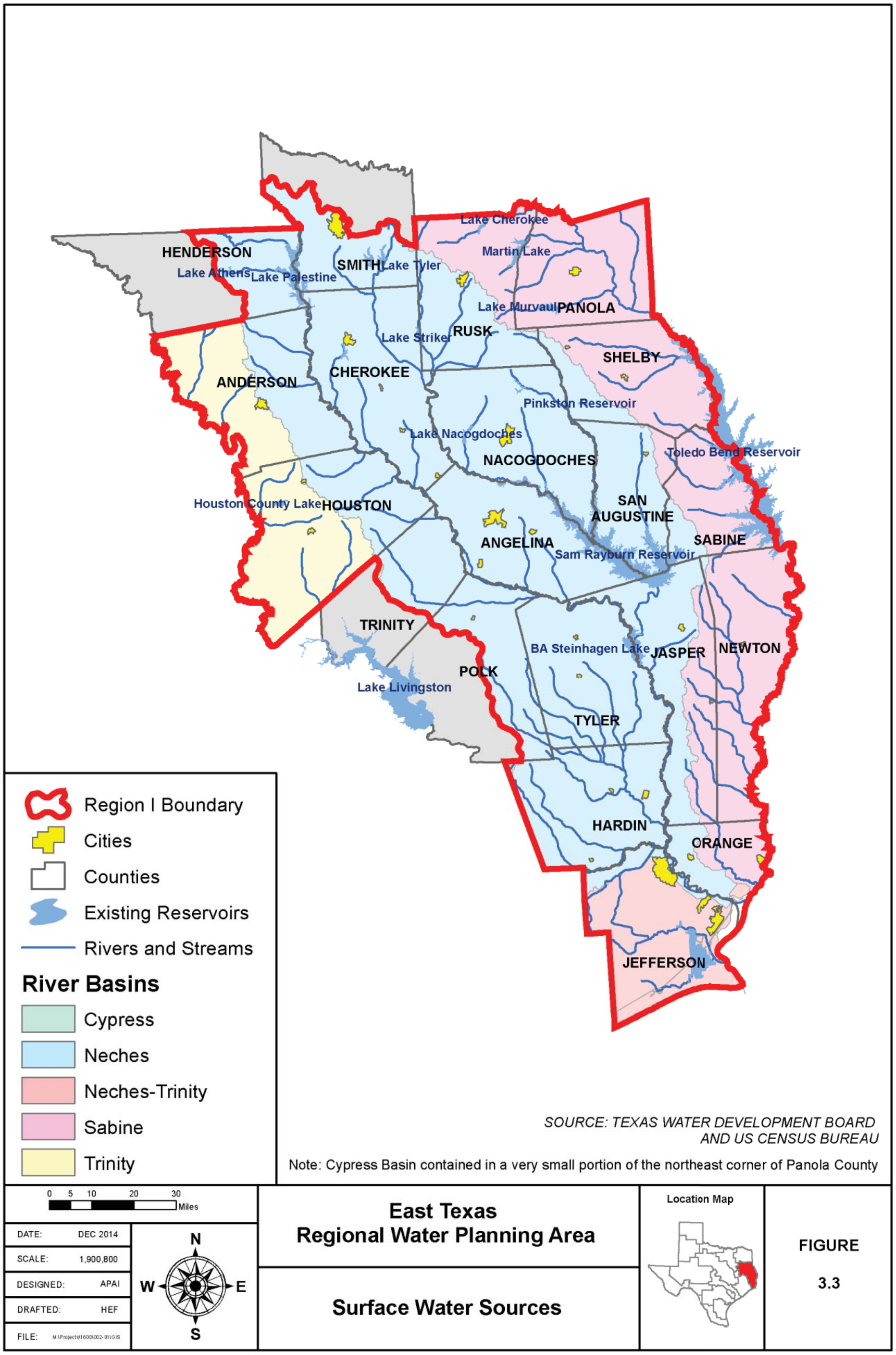

HENDERSON
Lake Athens
Lake Palestine
SMITH
Lake Tyler
Lake Cherokee
Martin Lake
Lake Murvaul
PANOLA
Lake Striker
RUSK
SHELBY
ANDERSON
CHEROKEE
Pinkston Reservoir
Lake Nacogdoches
Toledo Bend Reservoir
NACOGDOCHES
SAN AUGUSTINE
Houston County Lake
HOUSTON
ANGELINA
SABINE
Sam Rayburn Reservoir
TRINITY
BA Steinhagen Lake
JASPER
NEWTON
POLK
Lake Livingston
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Cities
Counties
Existing Reservoirs
Rivers and Streams
River Basins
Cypress
Neches
Neches-Trinity
Sabine
Trinity
SOURCE: TEXAS WATER DEVELOPMENT BOARD AND US CENSUS BUREAU
Note: Cypress Basin contained in a very small portion of the northeast corner of Panola County
0 5 10 20 30 Miles
DATE: DEC 2014
SCALE: 1,900,800
DESIGNED: APAI
DRAFTED: HEF
FILE:
N
W
E
S
East Texas Regional Water Planning Area
Surface Water Sources
Location Map
FIGURE 3.3

Table 3.1 and Figure 3.4 summarize overall water supply availability in the ETRWPA. Approximately 3.6 million ac-ft per year of surface water supplies are available in the region. Of this amount, approximately 2.6 million ac-ft per year is considered to be freshwater supplies. Groundwater availability in ETRWPA is slightly less than 500,000 ac-ft per year. Reuse supplies total approximately 14,000 ac-ft per year.

Table 3.1 Summary of Currently Available Water Supplies in the ETRWPA (ac-ft/yr)

Source of Supply	2020	2030	2040	2050	2060	2070
Reservoirs (permitted)	1,958,512	1,954,328	1,950,141	1,945,955	1,941,769	1,937,675
Run-of-the-River (freshwater)	606,346	607,145	608,083	609,290	610,720	612,001
Run-of-the-River (brackish)	1,036,462	1,036,462	1,036,462	1,036,462	1,036,462	1,036,462
Groundwater	489,876	490,090	489,478	488,732	487,696	487,696
Local Supplies	19,367	19,367	19,367	19,367	19,367	19,367
Reuse	13,955	13,955	13,955	13,955	13,955	13,955
Total	**4,124,518**	**4,121,347**	**4,117,486**	**4,113,761**	**4,109,969**	**4,107,155**

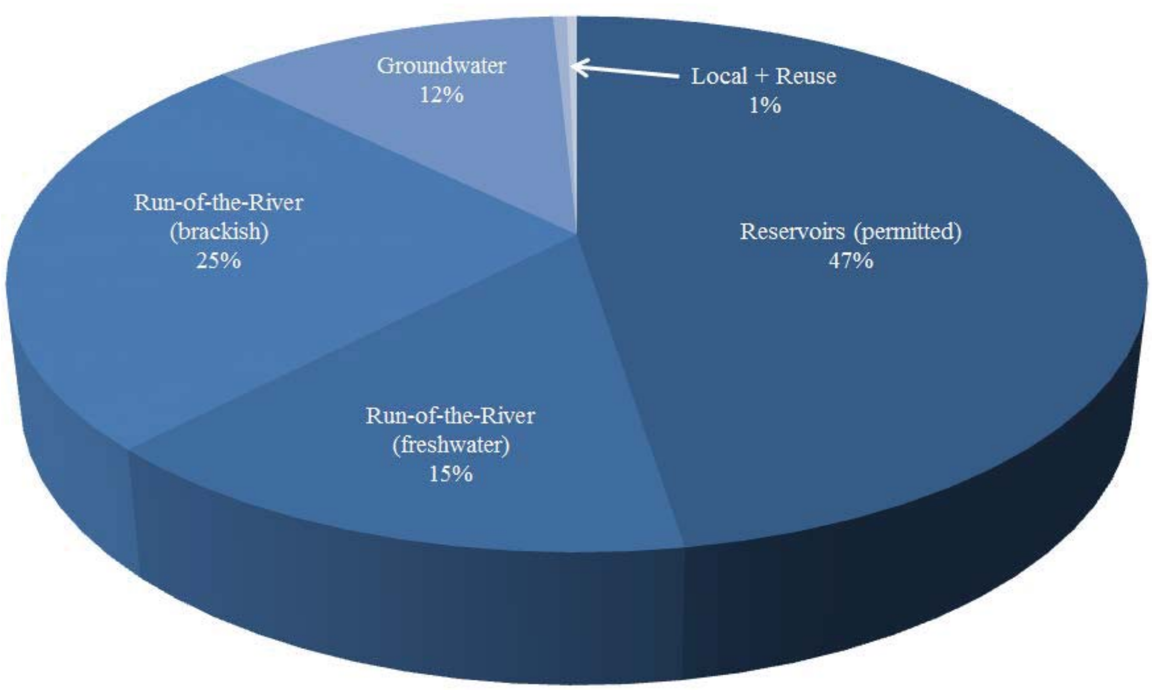


Figure 3.4 Year 2020 Available Supplies by Source Type

3.1.1 Surface Water Availability. In accordance with established procedures of the TWDB, the surface water supplies for the regional water plans were determined using the Water Availability Models (WAM). In the ETRWPA, four basins were evaluated: Neches, Neches-Trinity, Trinity, and Sabine (See Figure 3.3).

The WAMs were developed for the purpose of reviewing and granting new surface water rights permits using a hypothetical repetition of historical hydrology. The results from the modeling for regional water planning are used for planning purposes only and do not affect the right of an existing water right holder to divert and use the full amount of water authorized by its permit. The assumptions in the WAMs are based in part on the legal interpretation of water rights, and in some cases do not accurately reflect current operations. For planning purposes, adjustments were made to the TCEQ WAMs to better reflect current and future surface water conditions in the region. WAM Run 3, as modified below, was used to assess surface water supplies. The principal assumptions of Run 3 are that all water right holders divert the full permitted amount of their right by priority date order and do not return any of the diversion to the watershed unless an amount is specified in the permit. This assumption provides a conservative estimate of surface water supplies in the ETRWPA. The WAM models developed for the 2011 Plan and the yield results were adopted for all reservoir yields and run of the river supplies for the 2016 Plan with the exception of the City of Beaumont's river supply. A separate analysis for Beaumont was conducted to better reflect the limitations of the infrastructure and daily variations of the run-of-river supply. Generally, changes to the TCEQ WAMs include the following:

- Assessment of reservoir sedimentation rates, and the calculation of area-capacity conditions for current (2000) and future (2060) conditions. Reservoir supplies for 2070 conditions were estimated using a straight line interpolation of the reservoir yields for 2050 to 2060.
- Inclusion of subordination agreements that are currently in place
- Inclusion of system operations where appropriate
- Basin-specific modifications

The specific changes to each river basin are described below. The modified Trinity WAM for Region C was used to assess the supplies in the ETRWPA from the Trinity Basin. There were no changes specific to the region's sources. In addition, no changes were made to the Neches-Trinity WAM.

Neches River Basin WAM. Changes made to the Neches WAM (downloaded from TCEQ website, 2-26-2009) include the following:

- Modeled the UNRMWA's water rights as a system (Lake Palestine and Rocky Point dam). This assumption is now incorporated into the current Neches WAM.
- Sam Rayburn/Steinhagen water right was modeled subordinate to flow upstream above the Ponta Dam site (which is now Lake Columbia) and Weches Dam site (special condition (d) of Certificate of Adjudication 4411)[1].
- Sam Rayburn/Steinhagen industrial and irrigation water use was modeled subordinate to municipal rights located below the Ponta and Weches dam sites and above the reservoirs. This included Lake Nacogdoches, Pinkston Reservoir and the water rights for San Augustine Lake that are junior to 1963.
- The TCEQ input file did not consider hydropower use in Sam Rayburn. Hydropower was included in the model.
- The operation of LNVA's water rights was modeled as a system by including backup of LNVA's Pine Island water rights with storage from Sam Rayburn.
- The firm yield of Sam Rayburn/Steinhagen included a minimum elevation in Sam Rayburn of 149 ft. msl., and all storage available in Sam Rayburn up to elevation 164.4 ft. msl.

[1]Lake Columbia and the Weches Dam have not been constructed to date. Lake Columbia has a water right permit for 85,507 ac-ft per year.

Sabine River Basin WAM. The changes made to Sabine WAM (downloaded from the TCEQ website, 6-17-2004) include the following:

- The SRA's water rights in the lower basin were modeled as a system by backing up the Authority's canal water rights with releases from Toledo Bend Reservoir.
- The remainder of the yield of Toledo Bend was evaluated assuming all diversions were taken lakeside.
- The TCEQ Sabine WAM models Toledo Bend with hydropower. For purposes of finding total available supply for Toledo Bend, hydropower was excluded. Hydropower was included in the evaluation of supplies for all other reservoirs and run-of-the-river supplies.

Reservoirs. Reservoirs in the ETRWPA with over 5,000 ac-ft of conservation storage (i.e., major reservoirs) were evaluated, as were some smaller reservoirs that are used for municipal supply. The available water supply from reservoirs is limited to currently permitted diversions or firm yield. The firm yield is the greatest amount of water a reservoir could have supplied on an annual basis without shortage during a repeat of historical hydrologic conditions, particularly the drought of record.

Both Sam Rayburn and Toledo Bend Reservoirs were constructed for multiple purposes, and include hydropower generation. Hydropower is not considered a consumptive use of water, but it is an operational consideration. The inclusion of hydropower in the firm yield analyses was an operating decision by the reservoir owner. For this plan, hydropower is not considered in the yield determination of Toledo Bend Reservoir. Hydropower is included for the Sam Rayburn/Lake B. A. Steinhagen System; however, the actual operation of hydropower may differ from the assumptions in the WAM models. A summary of the available supplies for reservoirs in the ETRWPA is shown in Table 3.2.

Table 3.2 Currently Available Supplies from Permitted Reservoirs Serving the ETRWPA (ac-ft/yr)

Reservoir	Water Right Numbers	Priority Date	Basin	County	Permitted Diversion	Currently Available Supply[1]					
						2020	2030	2040	2050	2060	2070
Lake Athens	CA- 3256	01/17/1955	Neches	Henderson	8,500	5,983	5,903	5,822	5,741	5,660	5,580
Bellwood Lake	CA-3237	11/10/1915 10/10/1978	Neches	Smith	2,200	950	950	950	950	950	950
Lake Kurth	CA-4393	09/01/1957	Neches	Angelina	19,100	18,417	18,413	18,408	18,404	18,400	18,396
Lake Columbia	CA-4537	01/22/1985	Neches	Cherokee	85,507	0	0	0	0	0	0
Lake Jacksonville	CA-3274	06/13/1955	Neches	Cherokee	6,200	6,200	6,200	6,200	6,200	6,200	6,200
Lake Nacogdoches	CA-4864	05/24/1988	Neches	Nacogdoches	22,000	16,683	16,300	15,917	15,533	15,150	14,776
Lake Palestine system	CA-3254	01/05/1970 06/27/1977	Neches	Anderson	238,110	205,417	203,375	201,333	199,292	197,250	195,229
Lake Tyler/Tyler East	CA-4853	Multiple	Neches	Smith	40,325	30,900	30,875	30,850	30,825	30,800	30,775
Pinkston Reservoir	CA-4404	02/07/1972	Neches	Shelby	3,800	3,800	3,800	3,800	3,800	3,800	3,800
Rusk City Lake	CA-4219	06/01/1982	Neches	Cherokee	160	63	63	62	61	60	59
San Augustine City Lake	CA-4409	11/01/1957	Neches	San Augustine	1,285	1,285	1,285	1,285	1,285	1,285	1,285
Sam Rayburn & Steinhagen System	CA-4411	Multiple	Neches	Jasper	820,000	820,000	820,000	820,000	820,000	820,000	820,000
Striker Lake	CA-4847	01/10/1984	Neches	Rusk	20,600	19,357	18,530	17,703	16,877	16,050	15,264
Lake Timpson	A-4399	05/09/1955	Neches	Shelby	350	350	350	350	350	350	350
Lake Cherokee[2]	CA-4642	10/05/1946	Sabine	Cherokee/ Gregg	62,400	28,650	28,415	28,180	27,945	27,710	27,477
Lake Center	CA-4657	08/04/1922 08/14/1952	Sabine	Shelby	1,460	485	485	485	485	485	485
Lake Murvaul	CA-4654	07/19/1956	Sabine	Panola	22,400	21,203	20,615	20,027	19,438	18,850	18,279
Martin Lake	CA-4649	07/19/1971	Sabine	Rusk	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Toledo Bend	CA-4658	03/05/1958 01/22/1986	Sabine	Sabine	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Houston County Lake	CA-5097	03/03/0965	Trinity	Houston	3,500	3,500	3,500	3,500	3,500	3,500	3,500
TOTAL – PERMITTED RESERVOIRS						**1,958,243**	**1,954,059**	**1,949,872**	**1,945,686**	**1,941,500**	**1,936,920**

1 Supplies are determined by modified WAM Run 3. Supply for Lake Columbia is shown as "0" because the lake has not been constructed to date.
2 Lake Cherokee is located in both ETRWPA and Northeast Texas region. Most of the water from this source is used in the Northeast Texas region.

Run-of-the-River Diversion. Table 3.3 presents the run-of-the-river supplies by county and basin. The run-of-the-river supplies were calculated using the TCEQ WAM Run 3. The firm supply was determined as the minimum annual diversion from the river for all use types (municipal, industrial, mining, recreational, and irrigation). Since all municipal users in ETRWPA have multiple sources of water, it was assumed that the run-of-the-river supplies would be used conjunctively with these sources and a monthly analysis was not appropriate to determine availability. The run of river supplies associated with City of Beaumont (WR 4415) increase over time because of this reason. Appendix 3-D includes a memorandum summarizing the WAM analysis for this municipal water right. Generally, brackish run-of-the-river water supplies are located in tidally influenced river segments and are not expected to be developed beyond current levels of use. These supplies are shown in red italics on Table 3.3.

Table 3.3 Summary of the Available Supply from Run-of-River Diversions (ac-ft/yr)

County	Basin/ River	Use	Water Right Number	Owner	2020	2030	2040	2050	2060	2070
Anderson	Neches	Irrigation	3261, 3266, 3280, 3282, 3283, 3284, 3285, 3286, 5228	Multiple	197	197	197	197	197	197
Anderson	Trinity	Irrigation	5036	Edwin Cox	1,060	1,060	1,060	1,060	1,060	1,060
Angelina	Neches	Industrial	4384	Temple Inland	57	57	57	57	57	57
Angelina	Neches	Irrigation	4383	Crown Colony Country Club, Inc.	17	17	17	17	17	17
Cherokee	Neches	Irrigation	4356	Zane Blanton and Ann Blanton	182	182	182	182	182	182
Hardin	Neches	Irrigation	4432	Pinewood Management Corp.	57	57	57	57	57	57
Henderson	Neches	Irrigation	3250	Mary Nelms Roberts, R.C. Nelms, Robert A. Nelms	0	0	0	0	0	0
Houston	Neches	Irrigation	3289, 3290	W.P. Buckthal, E. Hubert Brimberry	287	287	287	287	287	287
Houston	Trinity	Irrigation	5093	Charles Wendell Warner, Eva Bode Webb, and Shellie Mae Wallace	1,783	1,783	1,783	1,783	1,783	1,783
Jasper	Neches	Industrial	4412	TPWD (hatchery)	604	604	604	604	604	604
Jasper	Neches	Industrial	5027	Louisiana Pacific	12	12	12	12	12	12
Jasper	Neches	Irrigation	4413		127	127	127	127	127	127
Jefferson	Neches	Multi-use	4411	LNVA	381,876	381,876	381,876	381,876	381,876	381,876
Jefferson	Neches	Industrial	4437	Huntsman Corp.	*434,400*	*434,400*	*434,400*	*434,400*	*434,400*	*434,400*
Jefferson	Neches	Industrial	4436	Independent Refining	*2,700*	*2,700*	*2,700*	*2,700*	*2,700*	*2,700*
Jefferson	Neches	Industrial	4435	Union Oil	*4,300*	*4,300*	*4,300*	*4,300*	*4,300*	*4,300*

Table 3.3 Summary of the Available Supply from Run-of-River Diversions (ac-ft/yr)

County	Basin/ River	Use	Water Right Number	Owner	2020	2030	2040	2050	2060	2070
Jefferson	Neches	Industrial	4434	Mobil Oil	*17,922*	*17,922*	*17,922*	*17,922*	*17,922*	*17,922*
Jefferson	Neches	Industrial	4433, 5206, 5213	Trinity Industries, Atofina, PD Glycol	*319*	*319*	*319*	*319*	*319*	*319*
Jefferson	Neches	Industrial	4415	Beaumont	526	552	583	623	670	712
Jefferson	Neches	Industrial	4196	Motiva	*12,900*	*12,900*	*12,900*	*12,900*	*12,900*	*12,900*
Jefferson	Neches	Industrial	4186	Gulf States Utilities	*279,131*	*279,131*	*279,131*	*279,131*	*279,131*	*279,131*
Jefferson	Neches - Trinity	Industrial	4390	Premcor Refining	*480*	*480*	*480*	*480*	*480*	*480*
Jefferson	Neches - Trinity	Irrigation	Multiple	Multiple	54,746	54,746	54,746	54,746	54,746	54,746
Jefferson	Neches - Trinity	Industrial	4390	US Department of Energy	680	680	680	680	680	680
Jefferson	Neches - Trinity	Mining	4390		34	34	34	34	34	34
Jefferson	Neches	Municipal	4415	Beaumont	15,407	16,810	17,087	18,254	19,637	20,876
Nacogdoches	Neches	Industrial	4401		2	2	2	2	2	2
Nacogdoches	Neches	Irrigation	4401		136	136	136	136	136	136
Orange	Neches	Industrial	5091	TE Products	*100*	*100*	*100*	*100*	*100*	*100*
Orange	Neches	Industrial	4438	Gulf States Utilities	*17,210*	*17,210*	*17,210*	*17,210*	*17,210*	*17,210*
Rusk	Neches	Irrigation	5629	Homer Boase, Jonell Boase	86	86	86	86	86	86
Rusk	Neches	Industrial	4839, 5314	CR Kelley Estate	2	2	2	2	2	2
Sabine	Neches	Industrial	4410	Temple Inland	182	182	182	182	182	182
Smith	Neches	Irrigation	3224	Garden Valley Sports Resort Inc.	50	50	50	50	50	50

Table 3.3 Summary of the Available Supply from Run-of-River Diversions (ac-ft/yr)

County	Basin/ River	Use	Water Right Number	Owner	2020	2030	2040	2050	2060	2070
Smith	Neches	Mining	3230, 3231	P E Kersh and Bell Sand Company	0	0	0	0	0	0
Trinity	Neches	Irrigation	4380	Temple Inland	62	62	62	62	62	62
Tyler	Neches	Irrigation			123	123	123	123	123	123
Newton	Sabine	Industrial	4659	Weirgate Lumber	135	135	135	135	135	135
Newton	Sabine	Irrigation	4662	SRA	46,700	46,700	46,700	46,700	46,700	46,700
Newton	Sabine	Irrigation	4660	Temple Inland	50	50	50	50	50	50
Newton	Sabine	Industrial	4662	SRA	100,400	100,400	100,400	100,400	100,400	100,400
Orange	Sabine	Industrial	4664	E.I. DuPont Nemours	*267,000*	*267,000*	*267,000*	*267,000*	*267,000*	*267,000*
Orange	Sabine	Irrigation	4663		28	28	28	28	28	28
Panola	Sabine	Industrial	4652	Hills Lake Fishing Club	114	114	114	114	114	114
Panola	Sabine	Industrial	5219	TXU	129	129	129	129	129	129
Panola	Sabine	Irrigation			191	191	191	191	191	191
Panola	Sabine	Mining	5747	TXU	167	167	167	167	167	167
Rusk	Sabine	Irrigation	4627, 4638, 4639, 4640	Patricia Philips, Alex Pope Jr., Margene Tuthill, CJ Bennett, Et. Al	127	127	127	127	127	127
Rusk	Sabine	Municipal	5578	Henderson	10	10	10	10	10	10
				TOTAL	**1,642,808**	**1,644,607**	**1,644,545**	**1,645,752**	**1,647,182**	**1,648,463**
				Subtotal Freshwater	**606,346**	**607,145**	**608,083**	**609,290**	**610,720**	**612,001**
				Subtotal Brackish water	***1,036,462***	***1,036,462***	***1,036,462***	***1,036,462***	***1,036,462***	***1,036,462***

Supplies shown in red italics are brackish water supplies and are generally not considered to meet the projected demands.

3.1.2 Groundwater Regulatory Framework. Groundwater availability is intrinsically linked to groundwater regulation and permitting throughout Texas and in the ETRWPA. It is difficult to discuss groundwater availability without understanding the basic regulatory framework that controls those supplies. Therefore, the discussion of regional groundwater supplies begins with a discussion of the regulatory framework for groundwater.

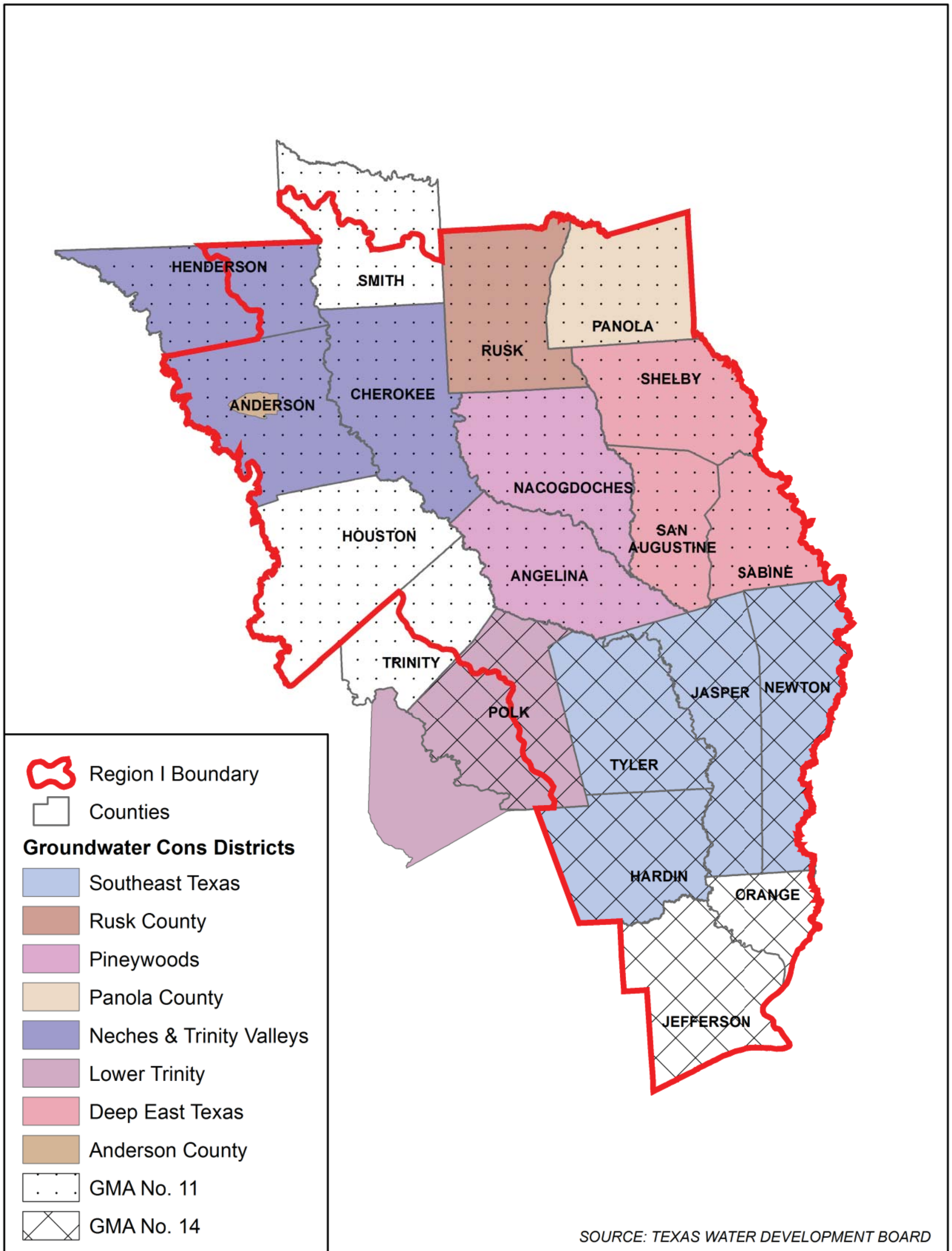
In June 1997, the 75th Texas Legislature enacted Senate Bill 1 (SB 1) to establish a comprehensive statewide water planning process to help ensure that the water needs of all Texans are met. SB 1 mandated that representatives serve as members of Regional Water Planning Groups (RWPGs) to prepare regional water plans for their respective areas. These plans map out how to conserve water supplies, meet future water supply needs and respond to future droughts in the planning areas. Additionally, SB 1 established that groundwater conservation districts (GCDs) were the preferred entities for groundwater management and contained provisions that required the GCDs to prepare management plans.

In 2001, the Texas Legislature enacted Senate Bill 2 (SB 2) to build on the planning requirements of SB 1 and to further clarify the actions necessary for GCDs to manage and conserve groundwater resources. As part of SB 2, the Legislature called for the creation of Groundwater Management Areas (GMAs) which were based largely on hydrogeologic and aquifer boundaries instead of political boundaries. The TWDB divided Texas into 16 GMAs, and most contain multiple GCDs. One of the purposes for GMAs was to manage groundwater resources on a more aquifer-wide basis. Figure 3.5 shows the regulatory boundaries of the GCDs and GMAs within the ETRWPA.

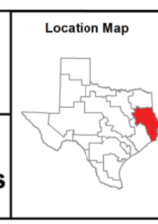
The Texas Legislature enacted significant changes to the management of groundwater resources in Texas with the passage of House Bill 1763 (HB 1763) in 2005. A main goal of HB 1763 was intended to clarify the authority and conflicts between GCDs and RWPGs. The new law clarified that GCDs would be responsible for aquifer planning and developing the amount of groundwater available for use and/or development by the RWPGs. To accomplish this, the law directed that all GCDs within each GMA to meet and participate in joint groundwater planning efforts. The focus of joint groundwater planning was to determine the Desired Future Conditions (DFCs) for the groundwater resources within the GMA boundaries (before September 1, 2010, and at least once every 5 years after that).

Desired Future Conditions were defined by statute to be "the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts within a groundwater management area as part of the joint groundwater planning process." DFCs are quantifiable management goals that reflect what the GCDs want to protect in their particular area. The most common DFCs are based on the volume of groundwater in storage over time, water levels (limiting decline within the aquifer), water quality (limiting deterioration of quality) or spring flow (defining a minimum flow to sustain).

After the DFCs are determined by the GMAs, the TWDB performs quantitative analysis to determine the amount of groundwater available for production to meet the DFC. For aquifers where a Groundwater Availability Model (GAM) exists, the GAM is used to develop the Modeled Available Groundwater (MAG). For aquifers without a GAM, another quantitative approach is used to estimate the MAG.



Location Map



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East Texas Regional Water Planning Area

Groundwater Conservation Districts and Groundwater Management Areas

FIGURE 3.5

In 2011, Senate Bill 660 required that GMA representatives must participate within each applicable RWPG. It also required the Regional Water Plans be consistent with the DFCs in place when the regional plans are initially developed. TWDB technical guidelines for the current round of planning establishes that the MAG (within each county and basin) is the maximum amount of groundwater that can be used for existing uses and new strategies in Regional Water Plans. In other words, the MAG volumes are a cap on groundwater production for TWDB planning purposes.

In the ETRWPA, GAM Run 10-016 (Version 2) for GMA-11 and GAM Run 10-038 for GMA-14 were used to develop the MAG volumes. Both models meet the desired future conditions adopted by the members of each groundwater management area. The TWDB Reports documenting the Desired Future Conditions (DFCs) and Modeled Available Groundwater (MAGs) for aquifers in Region I are included in Appendix 3-C.

GAM Run 10-016 MAG (Version 2). Two groundwater availability models for GMA-11 were applied for simulating the following aquifers: Yegua-Jackson, Sparta, Queen City, and Carrizo-Wilcox. One model was used for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Fryar and others, 2003; Kelley and others, 2004) and one for the Yegua-Jackson aquifer (Deeds and others, 2010). The Trinity, Nacatoch, and Gulf Coast aquifers are not included in GMA-11 DFCs.

On April 13, 2010, GMA-11 adopted DFCs intended to protect and conserve groundwater resources within the GMA, while allowing for anticipated growth in the area. The GMA adopted a DFC of 17 feet of average drawdown based on 178 individual drawdowns by aquifer by county. Model runs were conducted to determine an amount and distribution of pumping that would stimulate the adopted DFC; this pumping amount was then reported as the MAG for the GMA, RWPA, Districts, counties and river basins.

GAM Run 10-038 MAG. Resolution No. 2010-01 by GMA-14 provided the DFCs for each county in the GMA as the average modeled drawdown in the Chicot, Evangeline, and Jasper aquifers, as well as the Burkeville confining unit. On August 25, 2010, GMA-14 adopted the DFCs in Table 3.4 for each county within the ETRWPA.

**Table 3.4 Desired Future Conditions in GMA-14
(Modeled Drawdowns by County and Aquifer)**

	Chicot Aquifer	Evangeline Aquifer	Burkeville Confining Unit	Jasper Aquifer
Hardin	17	27	23	37
Jasper	10	23	24	21
Jefferson	25	26	0	0
Newton	9	20	22	18
Orange	14	19	0	0
Polk	4	4	20	41
Tyler	3	16	19	33

Simulated drawdown in feet after 52 years of pumping.

Prior to the resolution by GMA-14, the TWDB had conducted several model runs using the GAM for the northern part of the Gulf Coast Aquifer. The DFCs presented in the resolution are the simulated drawdown in each aquifer at the end of the year 2060 from the end of the year 2008. To determine the MAG, the TWDB used one of the previously conducted GAM runs (namely, Scenario 3 of GAM Run 10-023) and extracted the pumping from the simulation.

3.1.3 Regional Groundwater Availability. Groundwater supplies in the ETRWPA may be divided into the northern and southern regions. The northern region is generally consistent with GMA-11 and the southern region is generally consistent with GMA-14. The conditions and available information for each region are presented separately. A limited supply of groundwater in the region is also found in what are known as "non-relevant" portions of known aquifers and "other" aquifers. These local supplies are addressed at the end of this section.

Northern Region. The Carrizo-Wilcox Aquifer provides the majority of the groundwater supply in the northern region. Minor aquifers in the northern region include the Queen City, Sparta, and Yegua-Jackson. In some areas, the Queen City aquifer provides a significant quantity of water, although the well yields are typically smaller than in the underlying Carrizo-Wilcox aquifer. Because it has a relatively large surface area, the Queen City aquifer also receives a significant volume of recharge from precipitation and thus provides significant baseflow to creeks and rivers in the region. The Yegua-Jackson aquifer provides water in the area between the downdip extent of the Carrizo-Wilcox and the outcrop area of the Gulf Coast aquifer (See Figures 3.1 and 3.2).

The modeled available groundwater volumes for the counties in the northern region are provided in Table 3.5. MAG volumes are the largest amount of water that can be withdrawn from a given source without violating DFCs. Table 3.6 presents the total MAG volumes by aquifer in the ETRWPA.

Southern Region. The Gulf Coast Aquifer provides most of the groundwater supply in the southern region (Figure 3.1) and has the largest amount of modeled available groundwater in the ETRWPA (Table 3.6). The Southeast Texas GCD (Jasper, Newton, Tyler, and Hardin Counties), is the only groundwater conservation district located in the southern region. Table 3.5 also contains a summary of modeled available groundwater volumes in the southern region.

Table 3.5 Modeled Available Groundwater by Aquifer (ac-ft/yr)

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Northern Region								
Anderson	Carrizo-Wilcox	Neches	4,393	4,393	4,393	4,393	4,393	4,393
		Trinity	5,684	5,684	5,684	5,684	5,684	5,684
	Queen City	Neches	9,762	9,762	9,762	9,762	9,762	9,762
		Trinity	9,039	9,039	9,039	9,039	9,039	9,039
	Sparta	Neches	344	344	344	344	344	344
		Trinity	272	272	272	272	272	272
Angelina	Carrizo-Wilcox	Neches	26,414	26,414	26,414	26,414	26,414	26,414
	Queen City	Neches	1,093	1,093	1,093	1,093	1,093	1,093
	Sparta	Neches	689	689	689	689	689	689
	Yegua-Jackson	Neches	16,890	16,890	16,890	16,890	16,507	16,507
Cherokee	Carrizo-Wilcox	Neches	11,222	11,222	11,222	11,222	11,222	11,222
	Queen City	Neches	22,396	22,396	22,396	22,396	22,396	22,396
	Sparta	Neches	359	359	359	359	359	359
Henderson	Carrizo-Wilcox	Neches	3,999	3,999	3,999	3,999	3,999	3,999
	Queen City	Neches	12,316	12,316	12,316	12,316	12,316	12,316
Houston	Carrizo-Wilcox	Neches	1,924	1,924	1,924	1,924	1,924	1,924
		Trinity	3,432	3,432	3,432	3,432	3,432	3,432
	Queen City	Neches	131	131	131	131	131	131
		Trinity	279	279	279	279	279	279
	Sparta	Neches	302	302	302	302	302	302
		Trinity	594	594	594	594	594	594
	Yegua-Jackson	Neches	1,324	1,324	1,324	1,324	1,324	1,324
		Trinity	4,061	4,061	4,061	4,061	4,061	4,061
Nacogdoches	Carrizo-Wilcox	Neches	21,385	21,385	21,385	21,385	21,385	21,385
	Queen City	Neches	5,002	5,002	5,002	5,002	5,002	5,002
	Sparta	Neches	409	409	409	409	409	409
	Yegua-Jackson	Neches	235	235	235	235	235	235

Table 3.5 Modeled Available Groundwater by Aquifer (ac-ft/yr) (Cont.)

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Northern Region (Cont.)								
Panola	Carrizo-Wilcox	Cypress	6	6	6	6	6	6
		Sabine	8,221	8,221	8,063	8,063	8,063	8,063
	Queen City	Sabine	0	0	0	0	0	0
Rusk	Carrizo-Wilcox	Neches	11,776	11,766	11,766	11,766	11,747	11,747
		Sabine	9,067	9,067	9,067	9,067	9,067	9,067
	Queen City	Neches	40	40	40	40	40	40
		Sabine	18	18	18	18	18	18
	Sparta	Neches	0	0	0	0	0	0
Sabine	Carrizo-Wilcox	Neches	1,254	1,254	1,254	1,254	1,254	1,254
		Sabine	5,604	5,604	5,604	5,604	5,604	5,604
	Queen City	Neches	0	0	0	0	0	0
		Sabine	0	0	0	0	0	0
	Sparta	Neches	61	61	61	61	61	61
		Sabine	235	235	235	235	235	235
	Yegua-Jackson	Neches	3,724	3,724	3,724	3,724	3,724	3,724
		Sabine	575	575	575	575	575	575
San Augustine	Carrizo-Wilcox	Neches	1,490	1,490	1,490	1,490	1,490	1,490
		Sabine	291	291	291	291	291	291
	Queen City	Neches	7	7	7	7	7	7
		Sabine	0	0	0	0	0	0
	Sparta	Neches	202	202	202	202	202	202
		Sabine	3	3	3	3	3	3
	Yegua-Jackson	Neches	2,102	2,102	2,102	2,102	2,102	2,102
		Sabine	9	9	9	9	9	9
Shelby	Carrizo-Wilcox	Neches	2,736	2,578	2,288	2,152	2,019	2,019
		Sabine	8,481	8,323	8,159	8,159	7,710	7,710
	Queen City	Sabine	0	0	0	0	0	0

Table 3.5 Modeled Available Groundwater by Aquifer (ac-ft/yr) (Cont.)

County	Aquifer	Basin	2020	2030	2040	2050	2060	2070
Northern Region (Cont.)								
Smith	Carrizo-Wilcox	Neches	21,004	21,004	51,004	21,004	21,004	21,004
		Sabine	12,245	12,245	12,235	12,221	12,221	12,221
	Queen City	Neches	28,259	28,259	28,259	28,259	28,259	28,259
	Sparta	Neches	0	0	0	0	0	0
Trinity	Carrizo-Wilcox	Neches	1,114	1,114	1,114	1,114	1,114	1,114
	Queen City	Neches	0	0	0	0	0	0
	Sparta	Neches	313	313	313	313	313	313
	Yegua-Jackson	Neches	700	700	700	700	700	700
Southern Region								
Hardin	Gulf Coast	Neches	34,821	34,821	34,821	34,821	34,821	34,821
		Trinity	138	138	138	138	138	138
Jasper	Gulf Coast	Neches	37,620	37,541	37,541	37,541	37,541	37,541
		Sabine	29,953	29,953	29,953	29,953	29,953	29,953
Jefferson	Gulf Coast	Neches	804	804	804	804	804	804
		Neches-Trinity	1,641	1,641	1,641	1,641	1,641	1,641
Newton	Gulf Coast	Neches	176	176	176	176	176	176
		Sabine	34,001	33,963	33,963	33,963	33,963	33,963
Orange	Gulf Coast	Neches	3,925	3,925	3,925	3,925	3,925	3,925
		Neches-Trinity	256	256	256	256	256	256
		Sabine	15,832	15,832	15,832	15,832	15,832	15,832
Polk	Gulf Coast	Neches	11,886	11,886	11,886	11,276	11,224	11,224
Tyler	Gulf Coast	Neches	38,199	38,156	38,156	38,156	38,156	38,156

Table 3.6 presents the total MAG volumes by aquifer for planning years 2020 through 2070. The Gulf Coast aquifer has the largest volume of modeled available groundwater at 209,252 ac-ft per year in the ETRWPA.

Table 3.6 Modeled Available Groundwater Aquifer Totals (ac-ft/yr)

Region	Carrizo-Wilcox	Queen City	Sparta	Yegua-Jackson	Gulf Coast
Northern Region					
TOTAL	161,742	88,342	3,783	29,620	N/A
Southern Region					
TOTAL	N/A	N/A	N/A	N/A	209,252

Source: Data Provided by TWDB GAM Run 10-038 MAG; GAM Run 10-016 MAG (ver.2)

Groundwater Local Supplies (Non-Relevant Aquifer) Availability. Non-relevant aquifers are areas determined by the GCDs that have aquifer characteristics, groundwater demands, and current groundwater uses that do not warrant adoption of a DFC. Generally, if a groundwater conservation district determines an aquifer (or portions of an aquifer) to be non-relevant, it is anticipated that there will be no large-scale production from non-relevant aquifers prior to the next round of joint groundwater planning. Additionally, it is assumed that what production does occur will not affect conditions in relevant portions of the aquifer(s). Based on the analyses by the TWDB, only the non-relevant portion of the Yegua-Jackson aquifer in Tyler County was found to have available supply. The supply amount of 180 ac-ft per year was published by the TWDB as “DFC-compatible availability values.”

Groundwater Local Supplies (Other Aquifer) Availability. Groundwater from ‘other aquifer’ local supplies refers to localized pockets of groundwater that are not classified as either a major or a minor aquifer of the state. These areas are generally small but can be locally significant. The 2016 estimates are based upon available historical pumping data for years 2007 through 2011. To derive these estimates, the volume for the year with the highest historical pumping was multiplied by 1.5. The 50 percent increase in availability above the recently estimated maximum use indicates that there is likely higher capacity in existing wells or higher capacity in areas of the aquifer that have not been drilled yet. Table 3.7 includes availability estimates for other aquifers.

Table 3.7 Groundwater Availability from Other Undifferentiated Aquifers

County	Basin	Amount (ac-ft/yr)
Anderson	Trinity	298
Angelina	Neches	812
Cherokee	Neches	268
Henderson	Neches	5
Henderson	Trinity	680
Houston	Neches	378
Houston	Trinity	888
Nacogdoches	Neches	1,131
Polk	Neches	1,270
Rusk	Neches	270
Rusk	Sabine	469
Sabine	Sabine	236
San Augustine	Neches	1,395
Smith	Neches	922
Trinity	Neches	700
TOTAL		**9,722**

3.1.4 Local Supply Availability. Local supply generally includes small surface water supplies that are not associated with a water right. Most of the local supply is surface water used from livestock ponds. A small amount of local supply is for mining purposes. These stock ponds are generally filled using groundwater supplies or recycled water captured from surface flow that has not entered the waters of the State. The maximum recent historical use from these sources (according to TWDB records) is assumed to be available in the future. Local supplies are listed on Table 3.8.

Table 3.8 Summary of Available Local Supply (ac-ft/yr)

County	Basin	Use	Supply (ac-ft/yr)
Local Supplies			
Anderson	Neches	Livestock	333
Anderson	Trinity	Livestock	684
Angelina	Neches	Livestock	661
Cherokee	Neches	Livestock	1,555
Cherokee	Neches	Mining	19
Hardin	Neches	Livestock	155
Hardin	Trinity	Livestock	0
Henderson	Neches	Livestock	770
Houston	Neches	Livestock	1,007
Houston	Trinity	Livestock	783
Jasper	Neches	Livestock	332
Jasper	Sabine	Livestock	215
Jefferson	Neches	Livestock	0
Jefferson	Neches-Trinity	Livestock	800
Jefferson	Neches	Mining	110
Nacogdoches	Neches	Livestock	2,386
Nacogdoches	Neches	Mining	494
Newton	Sabine	Livestock	155
Newton	Sabine	Mining	0
Orange	Neches	Livestock	56
Orange	Sabine	Livestock	42
Orange	Sabine	Mining	178
Panola	Cypress	Livestock	30
Panola	Sabine	Livestock	1,224
Polk	Neches	Livestock	396
Rusk	Neches	Livestock	808
Rusk	Sabine	Livestock	308
Sabine	Neches	Livestock	71
Sabine	Sabine	Livestock	634
San Augustine	Neches	Livestock	465
San Augustine	Sabine	Livestock	71
Shelby	Neches	Livestock	334
Shelby	Sabine	Livestock	2,998
Smith	Neches	Livestock	605
Trinity	Neches	Livestock	449
Tyler	Neches	Livestock	239
		Total Local Supply	**19,367**

3.1.5 Reuse Availability. There are two types of reuse: direct reuse and indirect reuse. Direct reuse is treated wastewater effluent that is beneficially reused directly from the treatment facility and is not discharged to a State water course. Indirect reuse is treated effluent that is discharged to a State water course and then re-diverted by the owner for beneficial use. The reuse listed as available to the region is for existing projects based on current permits and authorizations. Categories of reuse include (1) currently operating indirect reuse projects for non-industrial purposes, in which water is reused after being returned to the stream; and (2) authorized direct reuse projects for which facilities are already developed. The specific reuse projects are listed in Table 3.9. The indirect reuse project in Jefferson County is associated with irrigation tail water that is returned to the basin for subsequent irrigation use.

Table 3.9 Summary of Available Reuse Supply (ac-ft/yr)

County	Basin	Use	Supply (ac-ft/yr)
Direct Reuse Supplies			
Sabine	Neches	Manufacturing	20
Orange	Sabine	Irrigation	15
Shelby	Sabine	Irrigation	82
Shelby	Sabine	Manufacturing	151
Indirect Reuse Supplies			
Jefferson	Neches-Trinity	Irrigation	13,687
		Total Reuse Supply	**13,955**

3.1.6 Imports and Exports. There are several small imported supplies to the ETRWPA from adjoining regions and Louisiana. Water from Lake Fork in the Northeast Region is used by the Cities of Henderson and Kilgore and their customers. Other surface water imports include water from Lake o' the Pines to Gill WSC, Lake Livingston to Groveton and surface water for the City of Joaquin from the City of Logansport, Louisiana. The specific source for this import is the Louisiana portion of the Toledo Bend Reservoir.

There are also uses of groundwater from sources located outside of the ETRWPA. Most are associated with entities that extend over multiple regions. Groundwater from the Carrizo-Wilcox Aquifer in the Northeast Region (Region D) is provided to Gill WSC, Kilgore, West Gregg SUD, Jackson WSC and Smith County-Other. Groundwater in the Region C portion of Henderson County is provided to the small portion of the City of Athens that lies in the ETRWPA and Virginia Hill WSC. A small amount of groundwater from Yegua-Jackson in Trinity County (Region H) is provided to the city of Groveton and mining.

Some water from the ETRWPA is exported to users outside of the region. This supply is included in the total available supply in the ETRWPA, but is not available to water users in the region. Water from the ETRWPA is used to supply the City of Tyler's customers in the Northeast Region, City of Athens in Region C and several customers of the LNVA in Region H. Water from Lake Cherokee is provided to customers in both the Northeast Region and ETRWPA through the Cherokee Water Company and the City of Longview. There is also an existing contract to supply water to Dallas from Lake Palestine for an amount 114,337 ac-ft per year. The infrastructure for this supply has not been constructed. A summary of exports and imports is provided in Table 3.10.

Table 3.10 Summary of Existing Exports and Imports in ETRWPA (ac-ft/yr)

Source	2020	2030	2040	2050	2060	2070
Exports						
Lake Athens – Region C	2432	2,711	2,949	3,293	4,534	4,759
Sam Rayburn/B.A. Steinhagen – Region H	68,262	68,637	69,037	69,488	69,988	70,518
Lake Cherokee – Region D	28,650	28,415	28,180	27,945	27,710	27,477
Lake Tyler – Region D	192	214	239	272	311	359
TOTAL	**99,536**	**99,977**	**100,405**	**100,998**	**102,543**	**103,113**
Imports						
Carrizo-Wilcox Aquifer – Region C	346	345	344	345	338	329
Carrizo-Wilcox Aquifer – Region D	1,248	1,259	1,270	1,285	1,304	1,325
Yegua-Jackson Aquifer – Region H	34	35	34	33	34	36
Lake of the Pines Reservoir – Region D	33	33	33	33	33	33
Lake Fork – Region D	4,791	4,805	4,805	4,805	4,805	4,805
Lake Livingston – Region H	718	717	719	721	718	721
Toledo Bend - Louisiana	237	237	237	237	237	237
TOTAL	**7,439**	**7,463**	**7,474**	**7,491**	**7,501**	**7,518**

3.2 Impacts of Water Quality on Supplies

The quality of a surface water body or groundwater aquifer can be a significant factor in the ability to use the water for specific purposes. Water quality dictates the level of treatment necessary to render a water body available for its intended use, which can affect the quantity of produced water. In cases of severe contamination, it is possible that a water supply source could be considered untreatable and, hence, unusable for some specific uses. The water quality impacts for sources within the ETRWPA are generally minor with respect to their effect on availability and treatability.

Key water quality parameters for the ETRWPA are identified and discussed in Chapter 6. These parameters are generally a consideration for surface waters. Some of these parameters could be an issue for groundwater as well. The key water quality parameters identified include the following:

- Total Dissolved Solids (TDS)
- Dissolved Oxygen
- Nutrients
- Metals
- Turbidity

These parameters can potentially affect some aspect of aquatic life or the use of the water for recreation. However, in some cases they could affect its availability for water supply as well. Water quality impacts for surface water and groundwater as they relate to availability and treatment requirements are discussed below. Overall, surface water quality in the ETRWPA is addressed in Chapter 1.

Generally, the water quality impairments identified for surface water sources through the TCEQ's Clean Rivers Program does not limit the availability of surface water or the treatability of these sources. The brackish or saline run-of-the-river water rights are limited to uses that are compatible with high TDS water. This plan assumes that these water rights are being used for such purposes.

Based on water quality data for aquifers within the ETRWPA the limitations on water supply availability or treatability are rare for groundwater supplies in the ETRWPA. The most prevalent of the primary drinking water contaminants was found to be nitrate (as nitrogen), which exceeded the standard of 10 mg/L in about 4% of samples from all aquifers. However, the median concentration of nitrate (as nitrogen) was less than 0.25 mg/L and the average less than 3 mg/L. Nitrate can be removed from water using advanced treatment processes such as reverse osmosis or ion exchange. Given the low incidence of nitrate contamination, it is unlikely that it would become a significant issue for the ETRWPA.

Secondary drinking water contaminants evaluated included copper, fluoride, chloride, iron, manganese, pH, sulfate, and TDS. Of these, iron, manganese, and pH were commonly found in excess of secondary standards in some samples from all aquifers. Iron and manganese are naturally occurring constituents in groundwater. In excess, they can cause taste and odor problems in drinking water, but not significant health problems. This is commonly treated by aeration. Industrial users of water with excessive levels of iron or manganese may require significant removal prior to using the water in industrial processes.

The well data also indicated that it is relatively common for pH concentrations in groundwater to be outside the allowable range (i.e., 6.5 to 8.5 standard units) for the four aquifers evaluated. However, neither the median nor the average values were found outside the range for any of the aquifers. Control of pH is easily accomplished through the addition of pH adjusting chemicals. This indicates that the pH concerns for groundwater in the ETRWPA are not a significant limiting factor in availability or treatability.

TDS was found to exceed the Texas secondary standard of 1,000 mg/L in only the Yegua-Jackson Aquifer. While the concentration of TDS in the Yegua-Jackson Aquifer was found to exceed the Texas secondary standard in approximately 18% of the groundwater samples evaluated, the average concentration for all wells in the aquifer was only approximately 672 mg/L. This indicates that TDS concerns for the Yegua-Jackson Aquifer are probably minimal.

3.3 Impact of Environmental Flow Policies on Water Rights, water Availability, and Water Planning

With the passage of Senate Bill 3 (SB3) in the 2007 80th Regular Session, the State created a basin-by-basin process for developing recommendations to meet the instream flow needs of rivers as well as freshwater inflow needs of affected bays and estuaries and required TCEQ to adopt the recommendations in the form of environmental flow standards. Standards for the Neches and Sabine River Basins were adopted by the TCEQ on April 20, 2011. These standards are utilized in the decision-making process for new water right applications and in establishing an amount of unappropriated water to be set aside for the environment. Existing water rights at the time of the adoption are not subject to the environmental flow standards. These water rights were evaluated on a case by case basis to assess the effect of authorizing a new use of water with the need for that water to maintain a sound ecological system as part of the water rights permitting process. The environmental flow requirements set forth through SB3 do not impact the region's currently available supplies shown in Tables 3.2 and 3.3.

The implementation of environmental flow recommendations will result in a need to more carefully consider environmental flow needs during the development of surface water management strategies. Environmental flow requirements are one component that is considered when assessing the long-term protection of the region's water resources in Chapter 6.

3.4 Existing Water Supplies by Water User Group

The water availability by WUG is limited by the ability to deliver and/or use the water. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions, raw water delivery infrastructure and water treatment capacities where appropriate. Appendix 3-B presents the current water supplies for each WUG by county. (WUGs are cities, water supply corporations, county-other municipal users and county-wide manufacturing, irrigation, mining, livestock, and steam electric uses.) For county-wide user groups, historical use was considered in the determination of currently available supplies.

The table in Appendix 3-B shows the amount of supply available to each user group from each source by decade based on existing facilities. The supplies by county are shown in Table 3.11.

Table 3.11 Summary of Existing Water Supplies of Water User Groups by County (ac-ft/yr)

	2020	2030	2040	2050	2060	2070
Anderson	15,372	15,473	15,411	15,299	15,257	15,239
Angelina	40,719	41,304	41,850	42,393	42,978	43,590
Cherokee	17,454	17,563	17,683	17,922	18,243	18,852
Hardin	17,934	18,232	18,441	18,573	18,581	18,552
Henderson*	7,842	7,705	7,603	7,561	7,154	6,891
Houston	11,448	11,488	11,540	11,604	11,680	11,830
Jasper	102,073	102,015	101,942	101,884	101,847	101,833
Jefferson	512,147	613,229	629,139	643,731	658,509	673,965
Nacogdoches	28,089	28,713	29,436	30,239	31,210	32,363
Newton	17,260	17,333	17,409	17,477	17,544	17,616
Orange	80,249	80,307	80,430	80,557	80,675	80,776
Panola	16,993	17,308	17,160	16,735	17,429	17,666
Polk*	3,217	3,354	3,484	3,606	3,717	3,838
Rusk	64,294	64,652	64,668	64,677	64,693	64,738
Sabine	5,850	5,850	5,850	5,850	5,850	5,850
San Augustine	4,573	4,670	4,781	4,910	5,052	5,052
Shelby	14,667	14,677	14,670	14,972	14,317	14,663
Smith*	40,131	42,343	44,662	47,352	50,396	53,634
Trinity*	1,960	1,960	1,961	1,962	1,960	1,965
Tyler	11,998	11,959	11,922	11,904	11,905	11,910
TOTAL	**1,014,270**	**1,120,135**	**1,140,042**	**1,159,208**	**1,178,997**	**1,200,823**

* The counties marked with an asterisk are split between two water planning regions. The available supply presented in this table represents only the portion of those counties that are within the boundaries of Region I.

3.5 Existing Water Supplies by Wholesale Water Provider

There are 16 designated WWPs in the ETRWP area. A WWP is a provider that has wholesale water contracts for 1,000 ac-ft per year or is expected to contract for 1,000 ac-ft per year or more during the planning period. Similar to the available supply to WUGs, the water availability for each WWP is limited by the ability to deliver the raw water. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions, and infrastructure. Total available supply by decade for each wholesale provider is shown in Table 3.12.

Table 3.12 Summary of Existing Water Supplies for Wholesale Water Provider (ac-ft/yr)

Water Provider	Currently Available Supply					
	2020	2030	2040	2050	2060	2070
ANRA	65	70	70	70	70	70
A-N WCID 1	19,357	18,530	17,703	16,877	16,050	15,264
Athens MWA	6,949	6,869	6,788	6,707	6,626	6,546
Beaumont	33,844	35,807	37,525	37,525	37,525	37,525
Carthage	5,695	5,695	5,695	5,695	5,695	5,695
Center	4,285	4,285	4,285	4,285	4,285	4,285
Houston Co. WCID 1	3,500	3,500	3,500	3,500	3,500	3,501
Jacksonville	7,391	7,391	7,391	7,391	7,391	7,391
LNVA	1,201,876	1,173,876	1,173,876	1,173,876	1,173,876	1,173,876
Lufkin	38,644	38,640	38,635	38,631	38,627	38,623
Nacogdoches	23,176	22,792	22,409	22,026	21,642	21,268
Panola Co. FWSD 1	21,203	20,615	20,027	19,438	18,850	18,279
Port Arthur	26,253	26,223	25,996	25,949	25,930	25,929
SRA	897,100	897,100	897,100	897,100	897,100	897,100
Tyler	40,756	40,756	40,756	40,756	40,756	40,756
UNRMWA	205,417	203,375	201,333	199,292	197,250	195,229
Wholesale Water Provider Totals	**2,535,511**	**2,505,524**	**2,503,089**	**2,499,118**	**2,495,173**	**2,491,337**

A brief description of the supply sources for each WWP is presented below. The analyses of the available supplies by source were determined using the assumptions outlined in Section 3.1.1. The results of these analyses are for planning purposes and do not affect the right of a water holder to divert and use the full amount of water authorized by its permit.

3.5.1 Angelina and Neches River Authority. ANRA has a state water right permit to construct Lake Columbia on Mud Creek in the Neches River Basin and divert 85,507 ac-ft per year. No currently available supply is shown since the reservoir is not constructed. The estimated firm yield using the modified Neches WAM Run 3 is 75,600 ac-ft per year in 2020. The supply shown In Table 3.13 for ANRA is groundwater for the Holmwood Utility.

3.5.2 Angelina-Nacogdoches Water Control Improvement District No 1. The Angelina-Nacogdoches WCID No. 1 owns and operates Lake Striker in Rusk and Cherokee Counties. The firm yield from Lake Striker in 2020 is estimated at 19,357 ac-ft per year, which is expected to decrease to 15,264 ac-ft per year by 2070.

3.5.3 Athens Municipal Water Authority. Athens MWA has 8,500 ac-ft per year of water rights in Lake Athens. The firm yield of the lake using the modified Neches WAM Run 3 was estimated at 5,983 ac-ft per year in 2020. Athens MWA has one existing groundwater well near the WTP with a capacity of 967 ac-ft per year. Athens MWA has not used the supplies from the groundwater well but plans to do so shortly. The Athens MWA also has a wastewater reuse permit for 2,677 ac-ft per year, but the infrastructure is not in place to utilize this source. The City of Athens and Athens MWA continue to study indirect reuse as a supplement to the yield of Lake Athens. The Athens MWA is also proposing to develop additional groundwater supplies to supplement the surface water, but these supplies are not available at this time.

3.5.4 City of Beaumont. The City of Beaumont obtains water from the Neches River, groundwater wells from the Gulf Coast Aquifer in Hardin County and a contract with LNVA for surface water. The City currently uses about 9,500 ac-ft per year of groundwater with a current well capacity of about 23 MGD. However, due to aquifer availability, the estimated reliable groundwater supply for Beaumont is limited to 9,500 ac-ft per year. The reliable Neches River supplies are estimated at 15,933 ac-ft per year for 2020 based on the daily analysis of the City's run-of-the-river water rights. This supply increases over time as demands increase, whereby additional surface water is utilized during periods with sufficient flows. By 2070, the amount of available run-of-the-river water is 21,588 ac-ft per year. The City also has a contract with LNVA to supplement its surface water supplies with releases from the Sam Rayburn/Steinhagen system. It is assumed that the LNVA contract is used to meet the remainder of the City's projected demands, provided the City has available treatment capacity. The City's current water treatment system is rated for 50 MGD, limiting the available treated surface water to 28,025 ac-ft per year. Considering both its groundwater and surface water sources the City's currently available treated water supplies total 33,844 ac-ft per year for 2020.

3.5.5 City of Carthage. The City of Carthage obtains its water from groundwater from the Carrizo-Wilcox Aquifer and surface water from Panola County FWSD. The City has a contract with Panola County FWSD for 12 MGD of water from Lake Murvaul. Considering its current water system capacities, the city of Carthage has approximately 5,695 ac-ft per year of reliable supply.

3.5.6 City of Center. The City of Center currently obtains water from Lake Center and Lake Pinkston for use within the City and for distribution to its municipal and industrial customers. The City owns and operates Lake Center, with a firm yield of 754 ac-ft of municipal water. Water from Lake Pinkston is pumped from the Neches River Basin to the City, located in the Sabine River Basin. The City holds rights to 3,800 ac-ft per year of water in Lake Pinkston. The total available supply for the City of Center is 4,554 ac-ft per year.

3.5.7 Houston County Water Control Improvement District No. 1. Houston County WCID No. 1's water rights to Houston County Lake include a right to divert 3,500 ac-ft per year at a rate not to exceed 6,300 gpm. The entity originally had a right to divert 7,000 ac-ft per year, which was reduced to the current right of 3,500 ac-ft per year. Houston County WCID No. 1 has applied for a water right permit to access the additional 3,500 ac-ft per year supplies in 2007. Supplies to Houston County WCID No. 1 are limited to its permitted diversions.

3.5.8 City of Jacksonville. The City of Jacksonville obtains water supplies from Lake Jacksonville and the Carrizo-Wilcox Aquifer. The City holds 6,200 ac-ft per year in water rights in Lake Jacksonville. The ability to use this water for municipal purposes is limited by the City's water treatment capacity (estimated at 5,173 ac-ft per year). The groundwater supplies are estimated at 2,218 ac-ft per year based on current well field production. The total supply available to Jacksonville is 7,391 ac-ft per year.

3.5.9 Lower Neches Valley Authority. The LNVA maintains water rights from Lake Sam Rayburn/Lake B.A. Steinhagen and run-of-the-river diversion from the Neches River. LNVA has an agreement to use full amount of Lufkin's share of supplies (28,000 ac-ft per year) from Lake Sam Rayburn/Lake B.A. Steinhagen through 2040, and then reducing the supplies to 11,200 ac-ft per year after 2040. LNVA's water rights total 1,201,876 ac-ft per year in 2020 and 1,185,076 ac-ft per year after 2040. The LNVA currently possesses the infrastructure to divert these water rights to its municipal, manufacturing, mining, and irrigation users.

3.5.10 City of Lufkin. The City of Lufkin presently obtains groundwater from the Carrizo-Aquifer in Angelina County and surface water from Lake Kurth. Groundwater supplies for the City of Lufkin are based on its well field pumping capacity. Lufkin also has a water right for 28,000 ac-ft per year of water from Lake Sam Rayburn. Currently there are no transmission facilities from Lake Sam Rayburn to use this water.

3.5.11 City of Nacogdoches. The City of Nacogdoches obtains groundwater from the Carrizo-Wilcox aquifer and surface water from Lake Nacogdoches. The groundwater supply of 6,492 ac-ft per year is based on the average annual current well field pumping capacity. The City currently has water rights to divert 22,000 ac-ft per year of water from Lake Nacogdoches. The modified Neches WAM Run 3 shows the current firm yield of this lake to be 16,683 ac-ft per year in 2020, and reducing to 14,776 ac-ft per year by 2070. The total supply to Nacogdoches in 2020 is 23,176 ac-ft per year.

3.5.12 Panola County Freshwater Supply District No. 1. The Panola County FWSD 1 owns and operates Lake Murvaul in the ETRWPA. The estimated firm yield of Lake Murvaul using the modified Sabine WAM Run 3 is 21,203 ac-ft per year in year 2020, decreasing to 18,279 ac-ft per year by 2070.

3.5.13 City of Port Arthur. The City of Port Arthur receives raw water supply from the LNVA. Treated water is supplied to industrial users in addition to its citizens. It is assumed that LNVA will provide for 100% of the City's demands. The projected supply from LNVA is 26,263 ac-ft per year in 2020, decreasing to 25,929 ac-ft per year by 2070.

3.5.14 Sabine River Authority of Texas. The SRA owns and operates Lake Tawakoni, Lake Fork, and the Toledo Bend Reservoir. In addition, the SRA maintains run-of-the-river rights from the Sabine in Newton and Orange County. The SRA provides water to municipal and industrial customers in Region C and Region D from Lake Fork and Lake Tawakoni, located outside of the ETRWPA. Some customers in the ETRWPA receive water from Lake Fork through downstream releases and riverine diversions. Most of the water in the ETRWPA from SRA is provided from Toledo Bend Reservoir and diversions from the Sabine River through the SRA Canal System. SRA holds water rights of 238,100 ac-ft per year from Lake Tawakoni, 188,660 ac-ft per year from Lake Fork, 750,000 ac-ft per year from Toledo Bend Reservoir and 147,100 ac-ft per year from the Sabine River. The reliable supply from SRA's Lower Basin sources (Toledo Bend Reservoir and the Canal System) is 897,100 ac-ft per year.

3.5.15 City of Tyler. The City of Tyler receives raw water supply from Lake Tyler and Tyler East with a firm yield of 30,900 ac-ft per year in 2020. Supply from these reservoirs is limited to 19,057 ac-ft per year by the water treatment plant capacity (34 MGD). The City also has a contract with the UNRMWA for 60 MGD from Lake

Palestine. The City of Tyler has constructed a 30 MGD treatment facility at the lake and currently can use 16,815 ac-ft per year from Lake Palestine. The City possesses water rights to Lake Bellwood; however, the raw water from this source is used only for irrigation. Water is not treated by the City from this source. The City also obtains water from the Carrizo-Wilcox aquifer. The estimated reliable supply from groundwater is 4,484 ac-ft per year, which was reduced from its production capacity due to limited aquifer availability. Collectively, the City has a total of 40,356 ac-ft per year of treated water and an additional 400 ac-ft per year of raw water from Lake Bellwood.

3.5.16 Upper Neches River Municipal Water Authority. The UNRMWA maintains a total water right of 238,110 ac-ft per year for diversions from Lake Palestine and a downstream location at Rocky Point Dam. The UNRMWA operates these rights as a system. Available supply using the modified Neches WAM Run 3 is estimated at 205,417 ac-ft per year in year 2020, decreasing to 195,229 ac-ft per year by 2070.

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Chapter 4

Comparison of Water Demands with Water Supplies to Determine Needs

This chapter describes the comparison of estimated current water supply for drought-of-record conditions (from Chapter 3) and projected water demand (from Chapter 2). From this comparison, water shortages or surpluses under drought-of-record conditions have been estimated. This comparison is called the first tier water needs. To better understand the water needs after conservation and direct reuse strategies have been implemented, a secondary needs analysis was also conducted. Listings of the first tier and second tier water needs by water user group are included in Appendices 4-A and 4-B respectively.

As discussed in Chapter 3, allocations of existing water supplies were based on the most restrictive of current water rights, contracts, water treatment capacities, available yields for surface water, and production capacities for groundwater. The allocation process did not directly address water quality issues, which were found to be minimal for the ETRWPA. Water quality issues could potentially impact local usability of some water supplies, nonetheless.

The comparison of current water supply and projected water demand in the ETRWPA is evaluated on a regional basis, by county, by WUG and by WWP. Section 4.1 presents a regional comparison of current supply and projected demand. Section 4.2 presents a county-by-county comparison of current supply and projected demand. Section 4.3 presents the comparison of current supply and projected demand for each WUG. Section 4.4 discusses shortages for the WWPs in the region. An economic impact analysis of not meeting the region's projected water shortages is summarized in Section 4.5.

4.1 Regional Comparison of Supply and Demand

Table 4.1 and Figure 4.1 summarize the comparison of total currently developed water supply and total projected water demand for the ETRWPA. The region as a whole has a currently available surplus of developed supplies of 8,049 acre-feet per year (ac-ft per year) in 2020, changing to a shortage of nearly 96,634 ac-ft per year by 2030, and increasing to a shortage of 279,402 by 2070. The actual total of the shortages of individual WUGs are greater, totaling approximately 513,000 ac-ft per year by 2070. The individual shortages by water user are discussed in Section 4.3.

As shown on Figure 4.1, the region has supplies available to meet these needs. Undeveloped (i.e. unconnected) water supplies are identified by comparing the supplies available to each city and category to the current regional water supply sources. The difference between the total fresh water supply reported in Chapter 3 and the supply available to WUGs is between 2.1 and 1.8 million ac-ft per year in each decade of the planning period. Additional infrastructure and/or contracts are needed to utilize these sources.

Table 4.1 Summary of Supply and Demand for the ETRWPA (ac-ft/yr)

	2020	2030	2040	2050	2060	2070
Demands	1,014,137	1,225,764	1,284,749	1,348,611	1,418,176	1,497,139
Developed Supplies	1,022,186	1,129,130	1,150,233	1,172,772	1,196,406	1,217,737
Difference	8,049	-96,634	-134,516	-175,839	-221,770	-279,402

Figure 4.1 Comparison of Regional Water Supplies to Demands

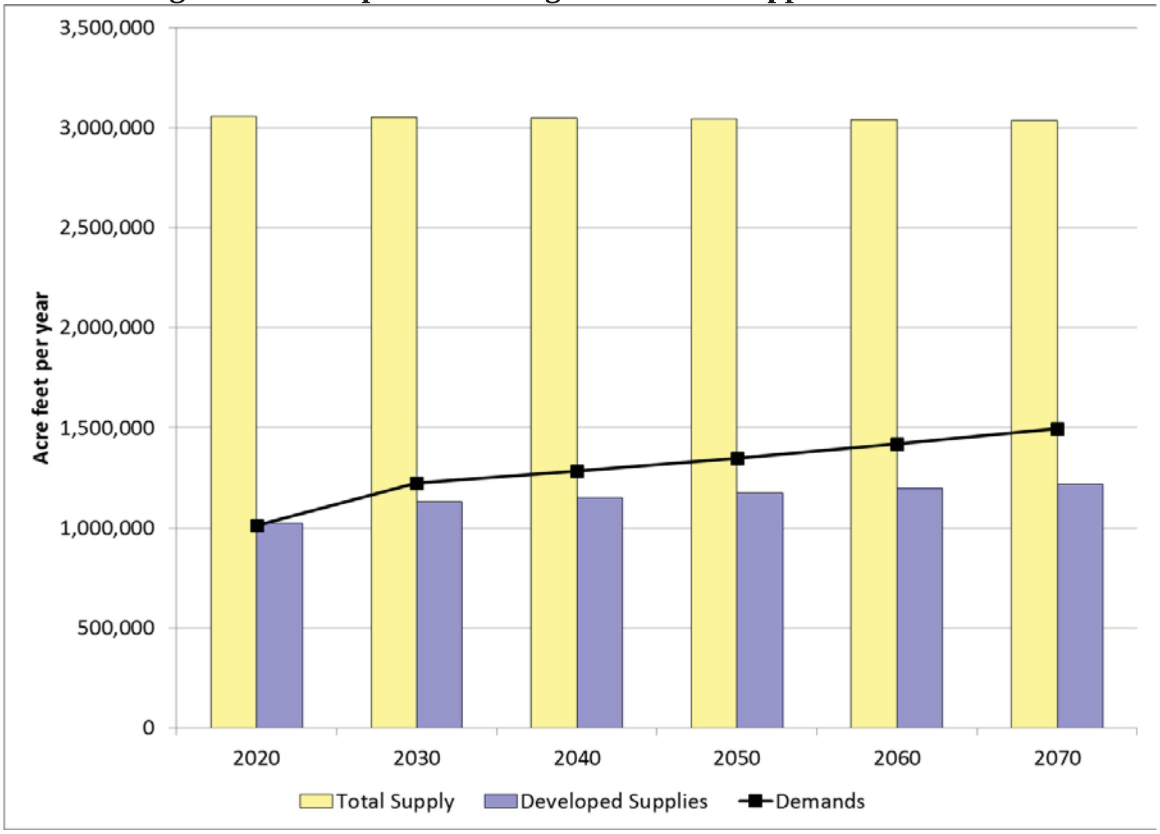


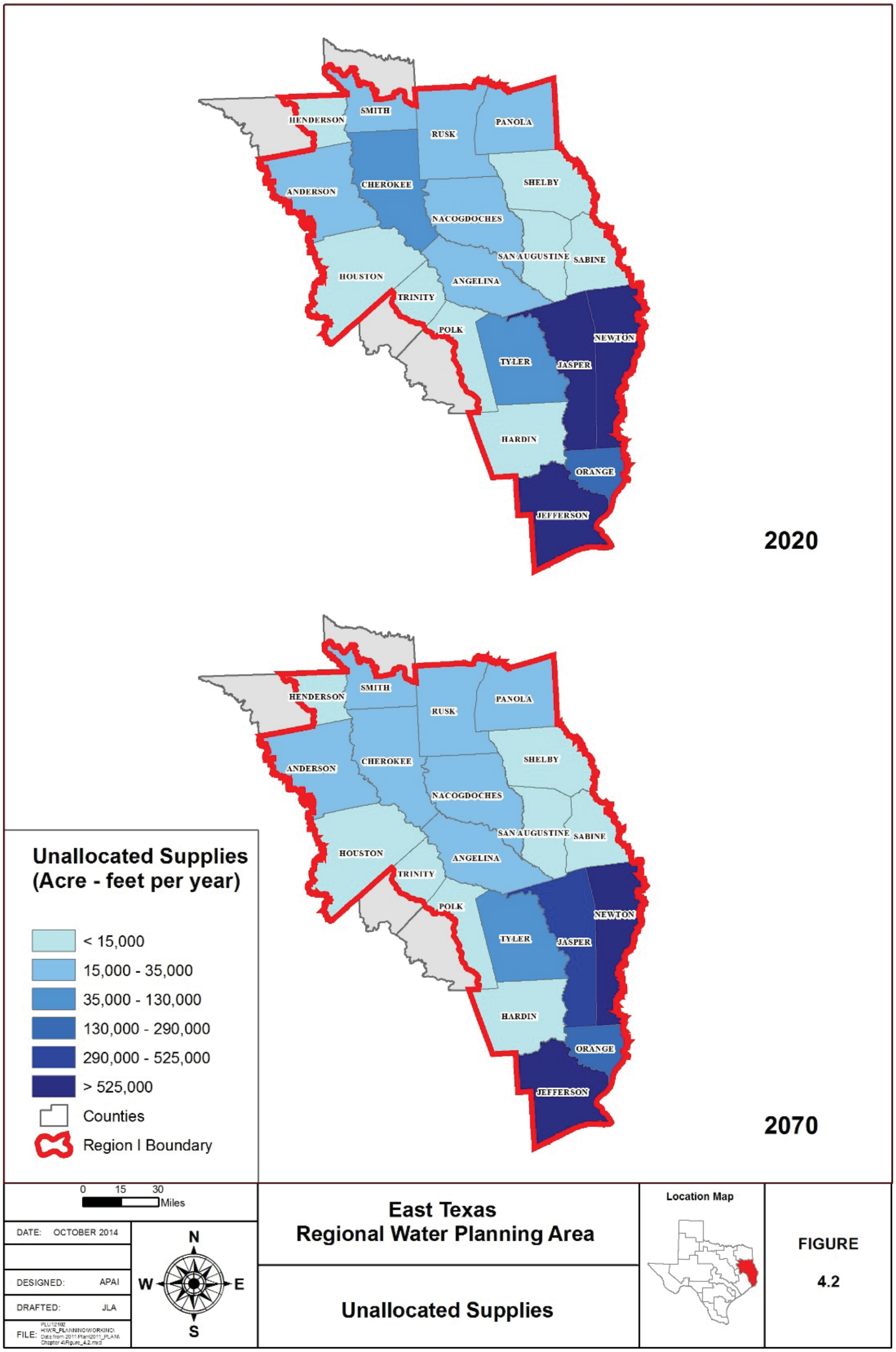
Table 4.2 summarizes regional surpluses and shortages by category of water use. On a regional basis, sufficient supplies exist for municipal and livestock water uses. By far, the greatest shortage is identified for manufacturing. However, lesser shortages are also identified for steam electric power, mining, and irrigation categories. Most of the manufacturing shortages are the result of considerable growth in demands and supplies that are limited to existing contract amounts. The steam electric power shortages are for projected growth that currently does not have an identified source or infrastructure. Mining shortages are largely associated with new mining demands associated with natural gas development and mining demands that have not been realized to date and do not have a current water supply. Even though the municipal water use shows a net surplus in every decade of the planning period, there are individual WUGs that are projected to have shortages during the planning period.

Table 4.2 Summary of Projected Surpluses or Shortages by Water use Type (ac-ft/yr)

Water Use Type	2020	2030	2040	2050	2060	2070
Municipal	48,557	46,690	43,979	38,230	31,501	24,460
Manufacturing	-185,300	-277,259	-299,401	-319,987	-339,240	-359,553
Mining	-5,194	-2,312	3,515	5,663	7,693	8,760
Steam Electric Power	10,863	-3,217	-20,201	-40,797	-65,792	-94,212
Irrigation	46,769	37,036	30,260	27,647	29,669	32,847
Livestock	1,640	257	-1,378	-3,348	-6,011	-6,772

4.2 Comparison of Supply and Demand by County

Table 4.3 shows the projected surpluses and shortages by county for each decade of the planning period both in acre-feet per year and as a percentage of demand. . In general, some shortages exist throughout the region. Ten counties are identified with shortages over the planning horizon, with Anderson, Jefferson, Orange, and Rusk Counties having the largest projected shortages by 2070. As previously discussed and shown in Figure 4.1, these shortages are based on the allocation of supplies with existing constraints. The region has sufficient supplies to meet these shortages. Figure 4.2 shows the amount of unallocated supplies by county in the region. The "Source-Balance" data table in Appendix 4-C lists each water source and the amount of water that is available for future use.


HENDERSON
SMITH
RUSK
PANOLA
ANDERSON
CHEROKEE
SHELBY
NACOGDOCHES
SAN AUGUSTINE
SABINE
HOUSTON
ANGELINA
TRINITY
POLK
NEWTON
TYLER
JASPER
HARDIN
ORANGE
JEFFERSON
2020
2070
Unallocated Supplies
(Acre - feet per year)
< 15,000
15,000 - 35,000
35,000 - 130,000
130,000 - 290,000
290,000 - 525,000
> 525,000
Counties
Region I Boundary
0 15 30
Miles
DATE: OCTOBER 2014
DESIGNED: APAI
DRAFTED: JLA
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N
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S
East Texas
Regional Water Planning Area
Unallocated Supplies
Location Map
FIGURE
4.2

Table 4.3 Summary of Projected Surpluses or Shortages by County (ac-ft/yr)

County	2020	2030	2040	2050	2060	2070
Anderson	-8,401	-10,332	-12,647	-15,451	-18,895	-23,000
Angelina	11,268	9,752	8,464	7,182	5,810	4,360
Cherokee	5,191	4,655	4,072	3,348	2,481	1,829
Hardin	7,709	7,495	7,337	7,204	7,068	6,960
Henderson*	3,314	3,012	2,792	2,514	1,882	1,407
Houston	2,791	2,562	2,302	1,975	1,571	1,022
Jasper	5,238	1,890	-975	-3,143	-3,217	-3,302
Jefferson	-146,885	-239,339	-260,586	-280,756	-297,625	-314,971
Nacogdoches	5,323	6,498	7,361	5,307	2,781	-319
Newton	18	-2,265	-5,040	-8,509	-12,772	-17,880
Orange	-2,582	-9,616	-16,776	-23,396	-30,825	-38,220
Panola	4,587	4,862	5,468	5,740	6,926	6,687
Polk*	757	767	780	790	804	804
Rusk	22,892	16,782	10,457	2,729	-6,656	-17,755
Sabine	2,789	2,815	2,852	2,874	2,891	2,942
San Augustine	-1,549	-515	1,033	1,342	1,641	1,862
Shelby	18	-963	-2,067	-3,072	-5,411	-5,058
Smith*	-641	-1,401	-2,182	-2,981	-3,882	-4,794
Trinity*	689	684	685	694	680	671
Tyler	6,000	5,998	6,083	6,151	6,202	6,228
TOTAL	**-81,474**	**-196,659**	**-240,587**	**-289,458**	**-338,546**	**-390,527**

*The counties marked with an asterisk are split between two water planning regions. The data presented in this table represents only the portion of those counties that are within the boundaries of Region I.

4.3 Comparison of Supply and Demand by Water User Group

The comparison of supply versus projected demands by user group for entities with shortages is presented in Table 4.4. There are 36 WUGs in 18 counties in the ETRWPA with identified shortages that cannot be met by existing infrastructure and supply. These projected shortages total over 513,000 acre-feet per year by 2070. This is more than double the projected shortages identified in the 2011 Plan.

Of the entities with shortages greater than 5,000 ac-ft per year, six are steam electric power uses (Anderson, Jefferson, Nacogdoches, Newton, Orange, and Rusk), one municipal user (Beaumont), manufacturing in Angelina, Jefferson, Jasper, and Orange County, mining in Nacogdoches County.

Table 4.4 Water User Groups with Projected Shortage (ac-ft/yr)

Water User Group	County	2020	2030	2040	2050	2060	2070
Steam Electric Power		-11,306	-13,218	-15,549	-18,390	-21,853	-25,968
Anderson County Total	**Anderson**	**-11,306**	**-13,218**	**-15,549**	**-18,390**	**-21,853**	**-25,968**
Manufacturing	Angelina	-10,722	-12,009	-13,313	-14,470	-15,705	-17,037
Mining	Angelina	-473	-572	-397	-299	-224	-167
Angelina County Total	**Angelina**	**-11,195**	**-12,581**	**-13,710**	**-14,769**	**-15,929**	**-17,204**
Alto Rural WSC	Cherokee	0	0	2	-66	-137	-215
Mining	Cherokee	-238	-247	-210	-147	-84	-40
Cherokee County Total	**Cherokee**	**-238**	**-247**	**-208**	**-213**	**-221**	**-255**
Chandler	Henderson	0	0	0	-77	-196	-312
Athens	Henderson	-2	-3	-2	-1	-17	-33
R-P-M WSC	Henderson	-4	-23	-36	-54	-71	-86
Manufacturing	Henderson	-48	-56	-64	-72	-79	-88
Henderson County Total	**Henderson**	**-54**	**-82**	**-102**	**-204**	**-363**	**-519**
Irrigation	Hardin	-750	-996	-1,264	-1,562	-1,891	-2,339
Houston County Total	**Hardin**	**-750**	**-996**	**-1,264**	**-1,562**	**-1,891**	**-2,339**
Manufacturing	Jasper	0	-3,049	-6,021	-8,250	-8,335	-8,420
Jasper County Total	**Jasper**	**0**	**-3,049**	**-6,021**	**-8,250**	**-8,335**	**-8,420**
Beaumont	Jefferson	0	0	-500	-2,245	-4,403	-6,896
County Other	Jefferson	0	0	0	-680	-1,924	-3,296
Steam Electric Power	Jefferson	-13,426	-15,696	-18,464	-21,838	-25,951	-30,839
Manufacturing	Jefferson	-180,461	-261,473	-273,106	-284,779	-296,461	-308,603
Jefferson County Total	**Jefferson**	**-193,887**	**-277,169**	**-292,070**	**-309,542**	**-328,738**	**-349,634**
D&M WSC	Nacogdoches	0	0	0	0	-112	-234
Mining	Nacogdoches	-5,475	-2,975	-118	0	0	0
Steam Electric Power	Nacogdoches	0	-1,521	-3,238	-5,268	-7,677	-10,472
Livestock	Nacogdoches	-1,644	-1,837	-2,061	-2,320	-2,617	-3,059
Nacogdoches County Total	**Nacogdoches**	**-7,119**	**-6,333**	**-5,417**	**-7,588**	**-10,407**	**-13,765**
Mining	Newton	-115	-59	0	0	0	0
Steam Electric	Newton	-690	-3,080	-5,994	-9,545	-13,875	-19,021
Newton County Total	**Newton**	**-805**	**-3,139**	**-5,994**	**-9,545**	**-13,875**	**-19,021**

Table 4.4 Water User Groups with Projected shortage (ac-ft/yr) (Cont.)

Water User Group	County	2020	2030	2040	2050	2060	2070
Irrigation	Orange	-2,432	-2,685	-2,858	-2,920	-2,855	-2,758
Manufacturing	Orange	-3,621	-9,599	15,559	-20,850	-26,801	-33,186
Steam Electric Power	Orange	0	-14	-1,038	-2,286	-3,807	-4,846
Orange County Total	**Orange**	**-6,053**	**-12,298**	**-19,455**	**-26,056**	**-33,463**	**-40,790**
Manufacturing	Panola	-134	-156	-176	-194	-230	-309
Panola County Total	**Panola**	**-134**	**-156**	**-176**	**-194**	**-230**	**-309**
Overton	Rusk	0	0	-12	-65	-123	-184
Mining	Rusk	-1,075	-2,092	-1,955	-1,809	-1,686	-1,677
Steam Electric Power	Rusk	0	0	0	-462	-8,873	-18,868
Rusk County Total	**Rusk**	**-1,075**	**-2,092**	**-1,967**	**-2,336**	**-10,682**	**-20,729**
Mining	San Augustine	-2,102	-1,102	0	0	0	0
San Augustine Total	**San Augustine**	**-2,102**	**-1,102**	**0**	**0**	**0**	**0**
Livestock	Shelby	-1,367	-2,375	-3,602	-5,099	-6,924	-6,924
Shelby County Total	**Shelby**	**-1,367**	**-2,375**	**-3,602**	**-5,099**	**-6,924**	**-6,924**
Bullard	Smith	-51	-223	-397	-587	-783	-985
Crystal System Inc.	Smith	-12	-105	-219	-356	-510	-642
Lindale	Smith	-52	-180	-310	-451	-596	-746
Manufacturing	Smith	-1,464	-1,655	-1,838	-1,993	-2,206	-2,437
Mining	Smith	-108	-113	-114	-83	-54	-32
Smith County Total	**Smith**	**-1,687**	**-2,276**	**-2,878**	**-3,470**	**-4,149**	**-4,842**
Irrigation	Trinity	-330	-330	-330	-330	-330	-330
Trinity County Other	**Trinity**	**-330**	**-330**	**-330**	**-330**	**-330**	**-330**
TOTAL Regional Shortage		**-237,013**	**-319,365**	**-338,745**	**-366,968**	**-456,268**	**-509,974**

Note: The Total Regional Shortage is the sum of all shortages in the Region.

The steam electric power shortages are due to increases in demand above generation capacities of current facilities. Some of this demand is predicated on power facilities that are not going forward at this time, but have the potential for development in the future. The manufacturing shortages in Angelina and Orange Counties are due to increased demands above current facilities' supplies. The large manufacturing shortages in Jefferson County are due to increased demands associated with potential future LNG facilities. The City of Beaumont's shortage is due to current surface water treatment capacity. In addition to these shortages, there are several near-term mining shortages associated with renewed interest in natural gas exploration in the Haynesville/ Bossier Shale in East Texas.

4.4 Comparison of Supply and Demand by Wholesale Water Provider

The comparison of supply versus demands for each WWP is presented in Appendix 4-D. Seven WWPs were identified with projected shortages in the ETRWPA over the planning cycle. The SRA does not have a projected shortage within the ETRWPA, but will need to implement strategies to meet demands outside the region. The WWPs with shortages within the region are shown in Table 4.5 and discussed below. WWPs with surpluses within the region are shown in Table 4.6.

In addition to these providers, several WWPs are planning WMSs to increase the reliability of their supplies and to meet the needs of potential future customers. These providers and the recommended strategies are discussed in Chapter 5B.

Table 4.5 Wholesale Water Providers with Projected Regional Shortages for current Customers (ac-ft/yr)

Water Provider	2020	2030	2040	2050	2060	2070
ANRA	-45,254	-45,249	-45,249	-45,249	-45,249	-101,299
A N WCID#1	0	0	-2,866	-3,692	-4,519	-5,305
Athens MWA	0	0	0	0	-2,652	-5,986
Beaumont	0	0	-578	-2,570	-4,994	-7,754
Center	0	0	0	0	-196	-450
Houston County WCID 1	-291	-321	-350	-375	-407	-441
UNRMWA	-4,831	-6,849	-8,869	-10,892	-12,919	-14,940
Total	**-50,375**	**-52,419**	**-57,911**	**-62,778**	**-70,936**	**-136,175**

Note: The shortages shown above are for current customers only. Potential future customers may place additional demands on these providers.

Table 4.6 Wholesale Water Providers with Projected Regional Surpluses for current Customers (ac-ft/yr)

Water Provider	2020	2030	2040	2050	2060	2070
Angelina Nacogdoches WCID #1	7,077	6,250	0	0	0	0
Center	756	511	278	55	0	0
Carthage	2,839	2,799	2,767	2,730	2,653	2,570
Jacksonville	2,915	2,635	2,344	1,947	1,475	955
LNVA	642,968	514,337	498,421	482,660	466,462	449,560
Lufkin	0	8,307	7,757	7,213	6,627	6,035
Nacogdoches	13,415	12,163	10,898	9,562	8,066	6,510
Panola Co.FWSD 1	4,201	3,648	3,546	3,425	3,226	2,464
SRA	642,875	624,319	346,838	124,727	86,754	9,196
Tyler	14,397	12,797	11,122	9,206	7,019	4,716
Total	**1,324,367**	**1,181,516**	**883,971**	**641,525**	**582,282**	**482,007**

Note: The surpluses shown above are for current customers only. Potential future customers may place additional demands on these providers. Port Arthur is not included in Table 4.5 and 4.6 because there is no shortage or surplus.

4.4.1 Angelina and Neches River Authority. ANRA is projected to have a shortage of 105,103 ac-ft per year. ANRA has contractual demands for water from Lake Columbia that are estimated to begin by 2020 (assuming that Lake Columbia is completed by 2020). ANRA has no currently available water supply to meet these contractual demands. The potential management strategy to meet this shortage is the construction of Lake Columbia.

4.4.2 Angelina and Nacogdoches Counties Water Control and Improvement District No. 1. The maximum projected shortage for A-N WCID No. 1 is 5,305 ac-ft per year for Year 2070. Most of this shortage is associated with a contract with the City of Henderson for future use.

4.4.3 Athens Municipal Water Authority. The maximum projected shortage for Athens MWA is 5,986 ac-ft per year. Most of this shortage is associated with operational constraints of Lake Athens for the Athens Fish Hatchery. Several water management strategies are being considered for Athens MWA to meet this need, including reuse from return flows from the Athens Fish Hatchery and developing groundwater supplies from the Carrizo-Wilcox aquifer.

4.4.4 City of Beaumont. The City of Beaumont is projected to have a water shortage under drought-of-record conditions of 578 ac-ft per year beginning in Year 2040, growing to 7,754 ac-ft per year for Year 2070. Much of the projected shortages are associated with increased demands for manufacturing needs and local growth.

4.4.5 City of Center. The projected water shortage for City of Center is 196 ac-ft per year beginning in 2060 and 450 ac-ft per year beginning in 2070. Much of the projected shortages are associated with increased demands for manufacturing needs and local growth.

4.4.6 Houston County Water Control and Improvement District No. 1. Houston County WCID No. 1 has contractual demands that exceed its permitted supply from Houston County Lake. Houston County WCID No. 1 is currently seeking a permit amendment to increase the permitted diversions from this source.

4.4.7 Upper Neches River Municipal Water Authority. The UNRMWA has contractual demands that exceed the reliable supply from its Lake Palestine system. The long-term strategy to meet these demands and other potential future demands is to develop additional supplies in the Neches River basin.

4.5 Socioeconomic Impacts of Not Meeting Needs

Administrative Rules in 31 TAC §357.10 require regional water planning groups to evaluate socioeconomic impacts of not meeting water needs as part of the regional water planning process.

The socioeconomic analysis was conducted by the TWDB after submission of the IPP to the TWDB. The findings were summarized and presented in appendix 4-E to this chapter.

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Chapter 5A

Identification of Potentially Feasible Water Management Strategies

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This Chapter provides a review of the types of water management strategies (WMS) considered for the ETRWPA. Included is a discussion on the approach for identifying potentially feasible water management strategies for WUGs and WWPs with a water need, as identified in Chapter 4, as well as a discussion on the evaluation criteria considered and the viability of each WMS type. Once a list of potentially feasible strategies has been identified, the most feasible strategies are recommended for implementation. Alternative strategies may also be identified, in case the recommended strategies become unfeasible. The recommended and alternative water management strategies identified for individual WUGs and WWPs, including a detailed discussion of the evaluation of the strategies, is presented in Chapter 5B. Chapter 5C discusses the conservation strategies and the application of the strategy to meet ETRWPA needs. WMSs to meet potential future demands that are not presently approved by the TWDB are not included in this chapter.

Identification of a supply source as a potentially feasible strategy depends on the availability of the source, the accessibility of the source to the WUG or WWP developing the WMS, and the feasibility of developing a strategy from the source of supply. It should be noted that there can be potentially feasible strategies that are not identified as recommended or alternative WMS for an entity.

The types of WMSs considered in this chapter include water conservation, water reuse, expanded use of existing supplies, new supply development and interbasin transfers. A comprehensive list of the potential strategy types identified is included below.

- Water conservation
    - Water Loss Control
- Water reuse
- Expanded use of existing supplies
    - Improved system operation
    - Conjunctive use of groundwater and surface water
    - Reallocation of reservoir storage
    - Voluntary redistribution of water resources
    - Voluntary subordination of water rights
    - Yield enhancement
    - Water quality improvements
- New supply development
    - Surface water resources
    - Groundwater resources
    - Brush control
    - Precipitation enhancement
    - Desalination
    - Water right cancellation
    - Aquifer storage and recovery
- Interbasin transfers
- Drought Management
    - Demand management

Drought management measures were considered as water management strategies for regional water planning, but such measures would leave little to no flexibility for WUGs to address a drought that exceeds previous drought-of-record conditions. The ability to adopt measures more stringent than planned could be limited in times of emergency. In addition, drought management and emergency response measures are not a reliable source of additional supplies to meet growing demands. For these reasons, the ETRWPG does not recommend the use of drought management measures as water management strategies for regional water planning. Chapter 7 includes an analysis of the drought response information, activities, and drought management recommendations in the ETRWPA.

While several strategy types were considered by the ETRWPA, not all were determined as viable options for addressing water needs in the region. The few subcategories within each strategy type that were determined as potentially feasible strategies for entities within the ETRWPA include: 1) water conservation 2) water reuse 3) expanded use of existing supplies (groundwater supplies, local supplies, and voluntary redistribution) and 4) new supply development (surface water resources: new reservoirs).

The sections below include a detailed discussion of each one of these four strategy types and the specific application of these strategies to WUGs and WWPs in the ETRWPA. Each strategy type is evaluated using screening criteria identified in 31 TAC Chapter 357.34. These criteria include quantity, reliability, cost, environmental factors, impacts on water resources, impacts on agricultural resources, impacts on other natural resources, and impacts on key water quality parameters. The screening criteria also consider issues associated with interbasin transfers and socio-economic impacts associated with voluntary redistribution of supplies, where applicable. A detailed list of the screening criteria used for selecting these strategies is included in Appendix 5A-A.

5A.1 Water Conservation

Water conservation is defined as methods and practices that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses. A detailed evaluation of conservation water management practices, trends, plans, and strategies in the ETRWPA is included in Chapter 5C in section 5C.3; this section also includes discussions on WUGs with needs that do not have recommended WMSs.

Water Conservation Environmental Issues. No substantial environmental impacts are anticipated, as water conservation is typically a non-capital intensive alternative that is not associated with direct physical impacts to the natural environment. A summary of the few environmental issues that might arise for this strategy type are presented in Table 5A.1.

Table 5A.1 Potential Environmental Issues Associated with Water Conservation

Environmental Issue	Evaluation Result
Implementation Measures	Water Conservation implementation requires voluntary participation from the public. This implementation issue can be minimized by enhanced public and school education. Other implementation measures include water conservation pricing, and enhanced water loss control programs.
Environmental Water Needs/Instream Flows	No substantial impact identified, assuming relatively low reduction in diversions and return flows; substantial reductions in municipal and industrial diversions from water conservation would result in possibly low to moderate positive impacts as more stream flow would be available for environmental water needs and instream flows.
Bays and Estuaries	No substantial impact identified, assuming relatively low reduction in diversions and return flows.
Fish and Wildlife Habitat	No substantial impact identified, assuming relatively low reductions in diversions and return flows; possible low to moderate positive impact to aquatic and riparian habitats with substantial reductions as more stream flow would be available to these habitats.
Cultural Resources	No substantial impact anticipated.
Threatened and Endangered Species	No substantial impact identified, assuming relatively low reduction in diversions and return flows; possible low to moderate positive impact to aquatic and riparian threatened and endangered species (where they occur) with substantial diversion reductions.
Comments	Assumes no substantial change in infrastructure.

Water Conservation Cost Considerations. Typical unit costs were used to develop opinions of probable cost for each recommended water conservation strategy. Other costs, such as the cost of hiring a water conservation coordinator, were not considered. The school and public education and enhanced water control program strategies create direct costs for the water user groups for which these strategies are recommended.

Water Conservation Implementation Issues. Water conservation as a water supply option has been compared to the plan development criteria, as shown in Table 5A.2. Based on the table, it is evident that water conservation meets the evaluation criteria.

Table 5A.2 Comparison of Water Conservation to Plan Development Criteria

Impact Category	Comment(s)
A. Water Supply: 1. Quantity 2. Reliability 3. Cost	 1. Limited 2. Variable, dependent on public acceptance 3. Reasonable
B. Environmental Factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries	 1. None or low impact 2. No apparent negative impact 3. None 4. None or low impact
C. Impact on Other State Water Resources	No apparent negative impacts on state water resources; no effect on navigation
D. Threats to Agriculture and Natural Resources	None
E. Equitable Comparison of Strategies Deemed Feasible	Option is considered to meet municipal and industrial water needs
F. Requirements for Interbasin Transfers	Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	Not applicable

5A.2 Water Reuse

Water reuse utilizes treated wastewater effluent as either a replacement for a potable water supply (direct reuse) or utilizes treated wastewater that has been returned to a water supply resource for non-potable reuse or additional treatment at a later time for potable or non-potable purposes (indirect reuse).

Currently, there is one recommended reuse strategy defined for the ETRWPA in the 2016 Plan, a transmission system transferring City of Center's return flows from the WWTP to Lake Center. Water reuse is most feasible for larger municipal water users or industrial users that have access to a source of municipal effluent. In the ETRWPA, small quantities of wastewater are currently being reused where it is economically viable. The ETRWPG identified only a few additional reuse opportunities within the region because the generators of the wastewater effluent were not generally interested in developing this type of project due to the lack of need or to excessive cost compared to other alternatives.

Water reuse is considered as a potentially feasible strategy for Athens MWA. Athens MWA has received a reuse permit that allows the City of Athens to discharge its wastewater effluent to Lake Athens, the City and the MWA have decided not to pursue this strategy at this time due to the cost. However, Athens MWA is pursuing entering into a contract with the Athens Fish Hatchery to return water that is passed through its facility back to Lake Athens. Currently, the hatchery does return this water as part of its operations, but it is under no contractual obligation to do so. Therefore, the volume of water from the hatchery is not considered a water supply for the purposes of regional water planning.

5A.3 Expanded Use of Existing Supplies

Expanded use of existing supplies includes additional use from existing groundwater and local sources and voluntary redistribution of water resources. Most of the potentially feasible strategies for the ETRWPA are associated with the expanded use of existing supplies. The introduction to this chapter includes a comprehensive list of sub-categories identified within the expanded use of existing supplies strategy type. However, not all subcategories were deemed viable as potentially feasible strategy types for ETRWPA. The few subcategories within this strategy type that were determined as potentially feasible strategies for entities within the ETRWPA are: 1) expanded use of groundwater supplies, 2) expanded use of local supplies, and 3) voluntary redistribution). Subsections 5A.3.1 – 5A.3.3 include a detailed discussion on each one of the subcategories.

As mentioned above, ETRWPA is a water rich region. Almost all of the water needs experienced by WUGs and WWPs within the region can be addressed by expanding the usage from the existing sources of supplies (both groundwater and surface water), adding or updating infrastructure to access an existing source of supply, and voluntary redistribution of the existing supplies. Table 5A.3 below includes a region-wide summary of undeveloped supplies that can be utilized for potential WMSs. It should be noted that the undeveloped supplies shown in the table below do not include brackish run-of-river rights granted to users in ETRWPA. It is understood that the demands associated (primarily manufacturing users) with the use of brackish run-of-river rights are not included in the manufacturing demands approved by TWDB for the ETRWPA. Therefore, it is assumed that the brackish run-of-river rights are not available for identifying potential strategies for meeting needs in ETRWPA.

Table 5A.3 Summary of Unallocated Supplies in ETRWPA

Source of Supply	2020	2070
Groundwater Supplies		
Carrizo Wilcox Aquifer	53,017	42,633
Gulf Coast Aquifer	114,325	114,476
Queen City Aquifer	84,527	84,098
Yegua-Jackson Aquifer	22,133	21,713
Sparta Aquifer	2,695	2,695
Surface Water Supplies		
Lakes/Reservoirs	1,525,158	1,347,913
Fresh Run-of-River	81,682	72,598
Total Supplies	**1,883,537**	**1,683,126**

5A.3.1 Expanded Use of Groundwater. Groundwater is a viable and cost-effective supply source for the ETRWPA. Approximately 60 percent of WUGs with an identified need during the planning period are expected to continue using groundwater as a source of new supplies. The supplies established in Chapter 3, Section 3.1 were used to evaluate the ability to meet demands for the ETRWPA. Where needs are shown for aggregated water users such as irrigation and livestock, the expansion of groundwater use was evaluated on the same percentage usage of existing supplies. Counties that are near capacity in utilizing the available groundwater resources, according to the TWDB's Modeled Available Groundwater projections, are Angelina, Cherokee, Nacogdoches, Orange, Shelby, and Smith. An evaluation of the expanded use of groundwater is presented by aquifer and county in Table 5A.4.

Table 5A.4 WUGs with Water Management Strategies Utilizing Groundwater Supplies

<table>
<tr><th></th><th colspan="4">Entities With Projected Additional Groundwater Demand</th></tr>
<tr><th></th><th>Carrizo Wilcox Aquifer</th><th>Gulf Coast Aquifer</th><th>Queen City Aquifer</th><th>Yegua-Jackson Aquifer</th></tr>
<tr><td rowspan="2">Cherokee</td><td>Alto Rural WSC</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Mining</td></tr>
<tr><td rowspan="2">Hardin</td><td rowspan="2"></td><td>Lumberton</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Lumberton MUD</td></tr>
<tr><td rowspan="2">Henderson</td><td>Athens MWA</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Chandler</td></tr>
<tr><td>Houston</td><td>Irrigation</td><td></td><td></td><td></td></tr>
<tr><td>Jefferson</td><td></td><td>County Other</td><td></td><td></td></tr>
<tr><td rowspan="2">Nacogdoches</td><td>D&M WSC</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Livestock</td></tr>
<tr><td>Newton</td><td></td><td>Mining</td><td></td><td></td></tr>
<tr><td>Orange</td><td></td><td>Irrigation</td><td></td><td></td></tr>
<tr><td>Rusk</td><td>Mining</td><td></td><td></td><td></td></tr>
<tr><td>Shelby</td><td>Livestock</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Smith</td><td>Bullard</td><td rowspan="4"></td><td rowspan="4">Mining</td><td rowspan="4"></td></tr>
<tr><td>Crystal Systems Inc.</td></tr>
<tr><td>Lindale</td></tr>
<tr><td>Manufacturing</td></tr>
<tr><td>Trinity</td><td></td><td></td><td></td><td>Irrigation</td></tr>
</table>

Expanded Use of Groundwater Environmental Issues. Under the Joint Planning effort for groundwater, the GCDs determine the appropriate protective level through the adoption of the Desired Future Conditions (DFC). The DFCs are incorporated into regional planning through the Modeled Available Groundwater (MAG) values. There are no recommended strategies that exceed the MAG value, thus providing the necessary environmental and water supply protections desired by the GCDs. Other environmental considerations with expanded groundwater use are associated with increased transmission capacities. It is assumed that new pipelines can be routed to minimize impacts to the environment.

Table 5A.5 Potential Environmental issues Associated with Increased Use of Groundwater

Environmental Issue	Evaluation Result
Implementation Measures	Local impact resulting from development of well fields, storage facilities, pump stations and pipelines.
Environmental Water Needs/Instream Flows	Potential increase in return flows to streams from increased water use. Potential decrease in groundwater-surface water nexus, which could reduce base flows.
Bays and Estuaries	No substantial impact identified.
Fish and Wildlife Habitat	No substantial impact identified.
Cultural Resources	No substantial impact anticipated.
Threatened and Endangered Species	No substantial impact identified.

Expanded Use of Groundwater Cost Considerations. Cost considerations are affected by the distance from development of wells to the need for the water. Facilities requiring capital investment include wells, pipelines, pump stations, and storage. Some water from wells may require minor treatment.

Expanded Use of Groundwater Implementation Issues. This water supply option has been compared to the plan development criteria, and Table 5A.6 shows how this option meets each criterion.

Table 5A. 6 Comparison of Expanded Use of Groundwater to Plan Development Criteria

Impact Category	Comment(s)
A. Water Supply: 1. Quantity 2. Reliability 3. Cost	1. Sufficient to meet needs (except Smith County) 2. High reliability 3. Moderate
B. Environmental Factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries	1. Low impact 2. Low impact 3. Low impact 4. Negligible impact
C. Impact on Other State Water Resources	No apparent negative impacts; no effect on navigation
D. Threats to Agriculture and Natural Resources	None
E. Equitable Comparison of Strategies Deemed Feasible	Option considered to meet demands of all user groups except Steam-Electric
F. Requirements for Interbasin Transfers	None
G. Third Party Social and Economic Impacts from Voluntary Redistribution	It is assumed that expanded groundwater development is between a willing buyer and seller, therefore, there are no apparent impacts

5A.3.2 Expanded Local Supplies. Expansion of existing local supplies involves the development of supplies currently being used near the source of demand, usually Other Aquifer groundwater or local supplies (supply ponds). Currently, no strategies are developed for this supply type.

Expanded Local Supplies Environmental Issues. The expansion of local supplies is very limited in volume and geographic area. Impacts of this WMS on the environment are expected to be negligible.

Expanded Local Supplies Cost Consideration. Costs will vary with each project. This strategy involves development of additional stock ponds for livestock and costs are generally low.

Expanded Local Supplies Implementation Issues. Implementation issues associated with expansion of local supplies are not anticipated.

5A.3.3 Voluntary Redistribution. For purposes of this Plan, "voluntary redistribution" is defined as an entity in possession of water rights or water purchase contracts freely selling, leasing, giving, or otherwise providing water to another entity. Typically, the entity providing the water has determined that it does not need the water for meeting its own demand for the duration of the transfer. The transfer of water could be for a set period of years or a permanent transfer. Voluntary redistribution is essentially a water purchase.

Voluntary redistribution has many benefits over other supply options because it can be much easier than implementing a new reservoir project, it typically costs less than large capital projects, and it avoids implementation issues of new reservoir projects such as environmental and local impacts. Most importantly, redistribution of water makes use of existing resources and provides a more immediate source of water.

Entities that have the potential to meet demands through voluntary redistribution, either by having available supplies or currently providing needs through voluntary redistribution and having the ability to obtain new supplies were identified. It should be noted that the ETRWPA region is a water rich region. The water needs for the WUGs and WWPs in the region primarily exist due to infrastructure limitations or due to lack of water supply availability for the WUG with the need. There are other WWPs and WUGs in the region with excess supplies that can be used to address the water needs in the region. Due to this, voluntary redistribution is an important strategy type used for identifying WMSs for the ETRWPA. It is important to remember that redistribution of water is voluntary. No group or individual is required to participate. Therefore, other strategies should be identified for groups relying on redistribution where the supply would place a burden on the distributor. A discussion of entities considered as potential suppliers of voluntary redistribution is provided in Table 5A.7 below. The amounts shown in this table represent the minimum amount of supply available, during the planning period, for voluntary redistribution after all other obligations based on current contracts are met.

Table 5A.7 List of Needs Met by Voluntary Redistribution

Water Provider	Supply Available for Voluntary Redistribution* (ac-ft/yr)	Entity with Need
City of Palestine (Lake Palestine)	21,769	Steam-Electric (Anderson)
City of Lufkin (Lake Kurth, Sam Rayburn)	6,035	Manufacturing (Angelina)
		Mining (Angelina)
LNVA	460,760	Manufacturing (Jefferson)
		Steam-Electric (Jefferson)
		Manufacturing (Jasper)
		Mining (Nacogdoches)
Athens MWA	1,793	City of Athens (Neches)
		Irrigation (Henderson)
SRA	793,102	Steam-Electric (Newton)
		Mining (Newton)
		Manufacturing (Orange)
		Steam-Electric (Orange)
		Steam-Electric (Rusk)
		Livestock (Shelby)
City of Carthage	2,570	Manufacturing (Panola)
City of Tyler	4,569	Manufacturing (Smith)
Houston County WCID	3,500	Steam-Electric Power (Nacogdoches)
Hudson WSC	750	Hudson

*Value equal to minimum supply available over the planning period beginning in 2020 and ending in 2070.

Voluntary Redistribution Environmental Issues. No significant environmental impacts are anticipated, as available water resources identified for this option are supplied through existing reservoirs or groundwater sources. A summary of the few environmental issues that might arise for this alternative are presented in Table 5A.8.

Table 5A.8 Potential Environmental Impacts Associated with Voluntary Redistribution

Environmental Issues	Evaluation Result
Implementation Measures	Terms of contract addressed on a case by case basis. Potential construction of treatment and distribution infrastructure.
Environmental Water Needs/Instream Flows	No substantial impact identified. Increased use of a surface water source can potentially reduce instream flows, but this was considered during the permitting of the existing source.
Bays and Estuaries	Large quantities of additional water diverted from ETRWPA reservoirs could reduce current flows to bays and estuaries. No substantial impact identified since this strategy assumes use of currently permitted water.
Fish and Wildlife Habitat	Impact dependent on location and size of project. Impacts associated with infrastructure to transport the water could be avoided.
Cultural Resources	Impacts would be associated with infrastructure to transport the water. Impacts could be avoided.
Threatened and Endangered Species	Impacts would be associated with infrastructure to transport the water. Impacts could be avoided.

Voluntary Redistribution Cost Considerations. Potential costs of purchasing and using water available from voluntary redistribution are listed below:

- Cost of raw water;
- Treatment costs;
- Conveyance costs; and/or
- Additional costs required by water supplier.

Voluntary Redistribution Implementation Issues. This water supply option has been compared to the plan development criteria, as shown in Table 5A.9. An issue facing redistribution is proper compensation for the entity or individual that owns the water right or contract for water. If an entity has arranged through contracts to have more water than they currently need or may need in the study period, they should be compensated for the expense and upkeep of any facilities already in place.

Table 5A.9 Comparison of Voluntary Redistribution to Plan Development Criteria

Impact Category	Comment(s)
A. Water Supply: 1. Quantity 2. Reliability 3. Cost	 1. Significant quantity available in parts of the Region 2. High Reliability 3. Low to moderate
B. Environmental Factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries	 1. Minimal impact identified 2. Low impact in areas of construction 3. Possible low impact 4. Possible low impact
C. Impact on Other State Water Resources	No apparent negative impacts, no effect on navigation
D. Threats to Agriculture and Natural Resources	No impact identified
E. Equitable Comparison of Strategies Deemed Feasible	Considered to meet the needs of all user groups
F. Requirements for Interbasin Transfers	Considered on a case-by case basis. Only required for surface water sales to users outside of the basin of the source
G. Third Party Social and Economic Impacts from Voluntary Redistribution	Beneficial because it provides water for economic growth

The following issues should be considered when negotiating a voluntary redistribution agreement:

- Quantity of water to be redistributed;
- Location of excess water supply;
- Location of buyer with water need;
- Necessary water treatment and distribution facilities;
- Determination of fair market value;

- Consideration of how existing contracts will affect the sale or lease;
- Length of agreement;
- Expiration dates of agreement;
- Drought contingencies;
- Protections needed by entity providing water;
- Protections needed by entity needing water;
- Enforcement of protections, and
- Other conditions specific to buyer and seller.

5A.4 New Supply Development

New reservoirs are a type of surface water resource strategy and are the only new supply development strategies evaluated for the ETRWPA.

5A.4.1 New Reservoirs. Major water providers in the ETRWPA have performed numerous studies on locations of reservoir sites. The ETRWPA possesses many features attractive to reservoir construction. The process of implementing a new reservoir is a multi-decade task of identifying, evaluating, and resolving environmental impacts associated with the reservoir as well as evaluating the economic feasibility of the project. These studies are beyond the scope of regional water planning. The process of implementation can go beyond the 50-year planning cycle in the current water planning process. The consideration of reservoir projects in the ETRWPA is based on information provided by major water providers located in the ETRWPA that demonstrates their ability and willingness to serve needs in the 50-year planning cycle. For proposed reservoirs, justification and environmental impacts analyses are the responsibility of the sponsoring water provider. Information available through other studies was used to evaluate these projects for the region.

The ETRWPA has a long history of water supply planning by means of reservoir development. Numerous sites have been identified as being hydrologically and topographically ideal for reservoir development. For a site to be considered for reservoir development, it needs to be recommended by the planning group as a unique reservoir site. Two sites in the ETRWPA are currently designated as unique reservoir sites: Lake Columbia and Lake Fastrill. Lake Fastrill was designated by the 79th Legislature through SB 3. Lake Columbia received its unique designation by the State Legislature, SB1362. Lake Columbia is currently being pursued for development. The ETRWPG has recommended that both Lake Columbia and Lake Fastrill retain their status of unique reservoir sites. Chapter 8 provides additional discussion of unique reservoir sites.

Several reservoir sites in the ETRWPA have long been discussed as potential sources of water. The ETRWPG recognizes that reservoirs can have major impacts on the environment and that protection of the environment is already afforded through a process that is more thorough than the regional water planning effort. Other sites have been considered for water supply development in the past and may be considered again for future supplies. The potential reservoirs initially considered for water supply are presented below in Table 5A.10. Chapter 8 features a brief description of each of the potential reservoir sites.

Table 5A.10 Potential Reservoirs for Designation as Unique Reservoir Sites

Major Water Provider	Reservoir Site
Angelina Neches River Authority	Lake Columbia (Unique Site)
Lower Neches Valley Authority	Rockland Reservoir
Sabine River Authority	Big Cow Creek
	Bon Weir
	Carthage Reservoir
	Kilgore Reservoir
	Rabbit Creek
	State Hwy. 322, Stage I
	State Hwy. 322, Stage II
	Stateline
	Socagee
Upper Neches River Municipal Water Authority	Neches Off-Channel Reservoir (Fastrill Replacement Project)

In the ETRWPA, there are two sponsors of these reservoir projects that are shown to have needs: ANRA and UNRMWA. The LNVA and SRA, the other reservoir sponsors, are shown to have surplus water that is available for voluntary redistribution. Each of these water providers may choose to develop a new reservoir in the future if water demands on the provider change or if the reliability of its current supplies is impacted by drought. For this plan, the two most feasible new reservoirs are Lake Columbia and the Neches Off-Channel Reservoir (Fastrill Replacement Project).

Lake Columbia is located predominantly in Cherokee County but extends into the southern portion of Smith County. The reservoir would be formed by construction of a dam on Mud Creek approximately 2.5 miles downstream of U.S. Highway 79 crossing. The dam is expected to impound water approximately 14 miles upstream with an estimated surface of 10,133 acres. The firm yield for the reservoir site is 75,700 ac-ft with a total storage volume at normal pool elevation of 315 feet, msl or 195,500 ac-ft. This project is sponsored by ANRA.

Neches Off-Channel Reservoir Project is located in the Neches River Basin and is sponsored by the UNRMWA and the City of Dallas. This strategy would include the construction of an off-channel storage reservoir, which would be located on a tributary of the Neches River in Anderson County downstream of Lake Palestine and upstream of the Weches Dam Site. The evaluation of this strategy is discussed in more detail in the 2016 Region C Water Plan.

Needs that would potentially be met by the development of Lake Columbia are provided in Table 5A.11. In addition, Lake Columbia is a recommended strategy for all participants in the project. Some participants intend to replace existing groundwater supplies with water from Lake Columbia. These users may or may not show a need in the 2016 Plan.

Table 5A.11 List of Participants for the Lake Columbia Project

Entities Participating in Lake Columbia Project	Contracted Amount (ac-ft/yr)
Currently Contracted Participants	
Mining (Angelina)	474
New Summerfield	2,565
North Cherokee WSC	4,275
Rusk	4,275
Rusk Rural WSC	855
Mining (Cherokee)	238
Mining (Nacogdoches)	5,475
Jackson WSC	855
Jacksonville	4,275
Mining (San Augustine)	2,102
Alto	428
County Other (Cherokee, Nacogdoches & Smith)	5,131
Nacogdoches	8,551
Arp	428
Troup	4,275
New London	855
Whitehouse	8,551
Potential Participants	
City of Dallas	
Manufacturing (Angelina)	
Steam Electric Power (Nacogdoches)	
Steam Electric Power (Rusk)	
TOTAL	53,607

Water demands that would be satisfied by the development of the Neches Off-Channel Reservoir Project are indicated in Table 5A.12.

Table 5A.12 Demands Supplied by Lake Fastrill Replacement Project

Entity	Projected Demand (ac-ft per year)
UNRMWA	**134,500**
City of Dallas	112,100
Steam-Electric Power (Anderson County)*	21,853
TOTAL	**134,500**

* Alternative Strategy

New Reservoirs Environmental Issues. Environmental impacts associated with the development of a new reservoir can be significant. Evaluation of such impacts is generally beyond the scope of water planning. Table 5A.13 provides a basic evaluation of issues. Environmental impacts for off-channel reservoirs may be less than on-channel reservoirs due to the flexibility in locating these facilities.

Table 5A.13 Environmental Issues Associated with Development of New Reservoirs

Environmental Issues	Evaluation Result
Implementation Measures	Dam and reservoir impact large area (10,000 acres). Requires land acquisition for reservoir and mitigation.
Environmental Water Needs/Instream Flows	Probable moderate to high impact. These impacts will be mitigated through the permitting process
Bays and Estuaries	Possible cumulative impact to limited areas of coastal marsh.
Fish and Wildlife Habitat	Possible high to moderate impact to riverine species and moderate impacts to terrestrial species. Possible moderate impact on State-listed species. Beneficial impacts to aquatic generalist and lentic species
Cultural Resources	Probable moderate impact.
Threatened and Endangered Species	Possible moderate to low impact pending identification of such species in the project area.

New Reservoirs Cost Consideration. As with any major reservoir project, the project costs are large. The annualized estimate of cost will include the construction of the dam, land acquisition, resolution of conflicts, environmental permitting and mitigation, and technical services.

New Reservoirs Implementation Issues. This water supply option has been compared to the plan development criteria, as shown in Table 5A.14. While the construction of new reservoirs is shown to have moderate to high impacts for some categories, these impacts will be adequately mitigated for during the permitting process.

Table 5A.14 Comparison of Development of New Reservoirs to Plan Development Criteria

Impact Category	Comment(s)
A. Water Supply: 1. Quantity 2. Reliability 3. Cost	 1. Sufficient to meet needs 2. High reliability (Moderate reliability for river diversion) 3. Reasonable to High
B. Environmental Factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries	 1. Moderate impact 2. High impact 3. High impact 4. Low to moderate impact
C. Impact on Other State Water Resources	Moderate impacts on state water resources (available water); low to moderate effect on navigation
D. Threats to Agriculture and Natural Resources	Moderate to high impact on bottomland hardwoods and habitat in reservoir area
E. Equitable Comparison of Strategies Deemed Feasible	Option is considered to meet water needs
F. Requirements for Interbasin Transfers	Potential interbasin transfer to Trinity Basin
G. Third Party Social and Economic Impacts from New Reservoirs	Varies: Potential for positive economic impacts

Appendix 5A-B includes a table of WMSs required to be considered and evaluated by statute for every WUG with an identified need and a summary of the potentially feasible and non-feasible strategies.

Chapter 5B

Evaluation of Potentially Feasible, Recommended, and Alternative Water Management Strategies

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The strategies are outlined for each WUG, by county, that has a need identified in Chapter 4. For each WUG with a need, a summary table is provided to review the projected need and the supply delivered by the water management strategy (or strategies). A second summary table provides an evaluation of the cost (capital, annual, and unit) to deliver treated water to the user for the various strategies that were considered. Appendix 5B-A includes technical memorandum for each strategy with a summary of the unit prices, general description of the project scope, and cost for each strategy. Appendix 5B-B includes a memorandum summarizing the quantification of environmental impacts of WMSs and also includes the WMS strategy evaluation matrix.

Four major categories of WMS are recommended: water conservation and drought management, wastewater reuse, expanded use of existing supplies (voluntary redistribution, groundwater, local supplies), and new development. Further discussion of how the strategies will be implemented in the ETRWPA is provided in Chapter 5A.

5B.1 Water Management Strategy Evaluation

WMSs identified to meet water needs during the planning period were evaluated based on the following criteria:

(1) Evaluation of the quantity, reliability, and cost of water delivered and treated for the end user's requirements, incorporating factors to be used in the calculation of costs as required by regional water planning;

(2) Environmental factors including the effects of the proposed water management strategy on environmental water needs, wildlife habitat, cultural resources, water quality and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico;

(3) Impacts on other water resources of the state including other WMSs and groundwater surface water interrelationships;

(4) Impacts of WMSs on threats to agricultural and natural resources of the regional water planning area;

(5) Impacts of the strategy on key water quality parameters;

(6) Any other factors as deemed relevant by the regional water planning group including political feasibility, implementation issues, and potential recreational impacts;

(7) Equitable comparison and consistent application of all WMSs the regional water planning groups determines to be potentially feasible for each water supply need;

(8) Consideration of the provisions in Texas Water Code § 11.085(k)(1) for interbasin transfers; and

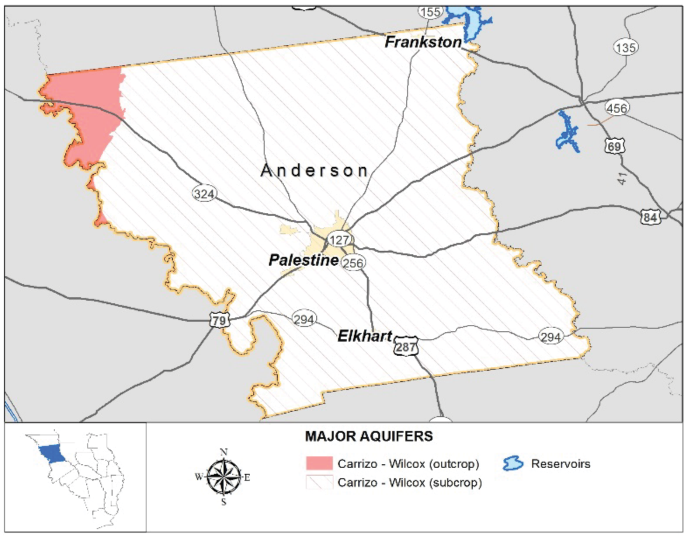
(9) Consideration of third party social and economic impacts resulting from voluntary redistribution of water.

(10) Water losses associated with transmission were assumed to be negligible for regional planning purposes.

The evaluation was undertaken through the development of a matrix to rate the above consideration from most desirable (1) to least desirable (5). Rating of the Environmental Factors (item 2 above) was evaluated using a separate matrix with consideration of nine factors; total acres impacted, wetland acres, environmental water needs, habitat, threatened and endangered species, cultural resources, bays and estuaries, environmental water quality, and other noted factors. The evaluation matrices are included in Appendix 5B-A.

5B.2 Water User Groups with Water Management Strategies

WMSs were identified for WUGs in all 20 counties of the ETRWPA. Following is a county by county review of the WMSs evaluated for the 2016 Plan.



5B.2.1 Anderson County. Anderson County is located between the Trinity and Neches rivers in the northern end of the ETRWPA. The County covers an area of approximately 1,000 square miles. Average rainfall in the County is approximately 41 inches. Palestine is the county seat of Anderson County.

The largest cities in Anderson County are Palestine, Elkhart, and Frankston. Oil and gas production is a significant component of the local economy. Most of the WUG demands in Anderson County are supplied from the Carrizo-Wilcox aquifer. Minor amounts of supplies are taken from the other aquifers. City of Palestine demands are supplied from Lake Palestine and the Carrizo-Wilcox.

All WUGs in Anderson County have surplus supplies except for Steam Electric Power. The Carrizo-Wilcox aquifer does not have enough water supply available to meet the Steam Electric Power needs. The Queen City aquifer does have enough supply available to meet this demand, but water from the Queen City has significant water quality issues. The recommended WMS for future steam-electric facilities is the development of surface water supply from Lake Palestine through a contract with the City of Palestine. There will shortage for Steam Electric Power users in 2070, even with the implementation of the recommended strategy. However, no additional strategy was proposed to address this shortage as the ETRWPG believes that the demands for this decade are over estimated.

Steam-Electric. Previous plans by Louisville Gas & Electric to construct a steam-electric power plant and contract with the City of Palestine for water were abandoned due to lack of funding. The current demand projections are based on a similar project being developed in the future, with plant operation beginning in 2020 and expected to require an annual average amount of 25,968 ac-ft per year by 2070. It is assumed that the future facility could contract with City of Palestine for water from Lake Palestine. After addressing the current commitments, City of Palestine has sufficient supplies to meet the needs for decades 2020-2060. It does not have sufficient supplies to meet all the future steam-electric power demand in 2070. However, no additional strategy was proposed to address this shortage as the ETRWPG believes that the demands for this decade are over estimated. The following table displays the projected future needs for the steam-electric power use in Anderson County. The recommended strategy is to obtain water from Lake Palestine by means of a contract with City of Palestine.

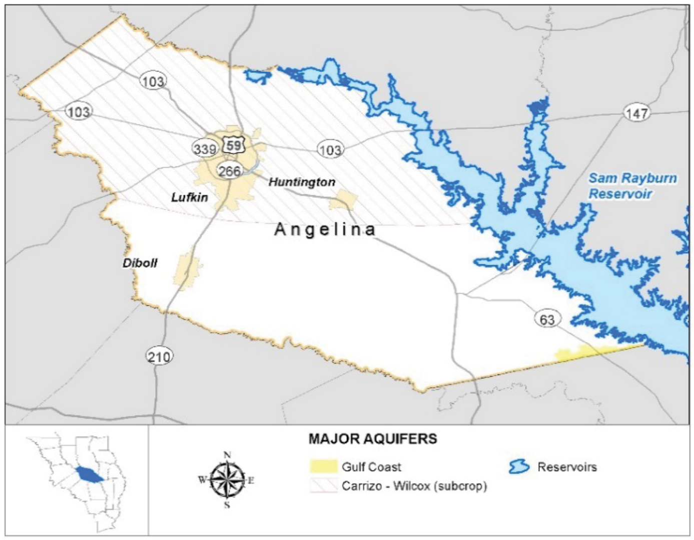
Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Anderson County Steam-Electric	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	11,306	13,218	15,549	18,390	21,853	25,968
Recommended Strategy AND-SEP1: Water from Lake Palestine (ac-ft per year)	11,306	13,218	15,549	18,390	21,853	23,669
Unmet need	0	0	0	0	0	(2,299)

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy AND-SEP1: Water from Lake Palestine (City of Palestine)	23,669	$44,576,000	$12,367,000	$522	$1.60

County Summary. Below is a summary of WUGs in Anderson County showing current supplies, maximum shortages, and recommended WMSs.

Water User Group Anderson County	Current Supplies	Shortage (ac-ft/yr)	Recommended Water Management Strategies
Brushy Creek WSC	Carrizo-Wilcox	0	None
The Consolidated WSC	Carrizo-Wilcox, Houston County Lake	0	None
Elkhart	Carrizo-Wilcox	0	None
Four Pines WSC	Carrizo-Wilcox	0	None
Frankston	Carrizo-Wilcox	0	None
Palestine	Carrizo-Wilcox, Lake Palestine	0	None
Walston Springs WSC	Carrizo-Wilcox	0	None
County Other	Carrizo-Wilcox, Other Aquifers	0	None
Manufacturing	Carrizo-Wilcox, Lake Palestine	0	None
Irrigation	Carrizo-Wilcox, Other Aquifers, Run-of-River Supplies	0	None
Livestock	Carrizo-Wilcox, Other Aquifers, Local Supplies	0	None
Mining	Carrizo-Wilcox, Other Aquifers	0	None
Steam Electric Power	----	23,669	Lake Palestine



5B.2.2 Angelina County. Angelina County is bounded by the Angelina River on the North and the Neches River on the South, in the central portion of the ETRWPA. The largest water body in the County is Sam Rayburn Reservoir, which extends into neighboring counties. Lufkin is the largest city and the County seat. Other major communities include Diboll, Burke, Hudson, and Huntington.

Angelina County is currently dependent on groundwater supplies for water supply; every WUG in Angelina County gets a portion, if not all, of their water from groundwater supplies. However, both the Yegua and Carrizo-Wilcox aquifers have limited capacity for expanded development. Although several rural communities and non-municipal water users will continue to rely on groundwater to meet their demands, the proposed construction of transmission lines and a surface water treatment plant at Lake Kurth by Lufkin will create a reliable surface water supply in the county. Manufacturing and Mining are the two WUGs with needs in Angelina County. Below is a discussion of WMSs identified for these WUGs.

Manufacturing. Current supplies for manufacturing water users include Lufkin and groundwater from the Yegua-Jackson and Other-Undifferentiated aquifers. Lufkin currently meets approximately 20 percent of the manufacturing demand while another 10 percent is self-supplied. This leaves approximately 70 percent of the projected manufacturing demands unmet. It is anticipated that growth in manufacturing will be supplied by Lufkin. Raw surface water is currently available from Lake Kurth for manufacturing use, but there is limited infrastructure.

The recommended strategy to meet the projected needs of Manufacturing in Angelina County is to contract for purchase of water from Lufkin. Lufkin's current supplies in Lake Kurth can only meet part of the demands. However, once Lufkin develops the supply from Sam Rayburn Reservoir to Lake Kurth, there would be enough supplies to meet the manufacturing demand in Angelina County. The strategy development and planning level cost estimate associated with development of the supply from Sam Rayburn Reservoir to Lufkin is discussed in the strategies for wholesale water provider Lufkin. It should be noted that the Sam Rayburn supplies are available by 2030. The proposed strategies leave an unmet need in 2020 because the ETRWPG believes the manufacturing demands for this decade are overestimated. While manufacturing growth is expected in Angelina County, this water demand will not fully develop until 2030.

Angelina Manufacturing	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	10,722	12,009	13,313	14,470	15,705	17,037
Recommended Strategy ANGL-MFG-1: Purchase from Lufkin (Lake Kurth) (ac-ft per year)	6,000	6,000	6,000	6,000	6,000	6,000
Recommended Strategy ANGL-MFG-1: Purchase from Lufkin (Sam Rayburn) (ac-ft per year)	0	6,167	7,471	8,628	9,863	11,195
Unmet Need	(4,722)	0	0	0	0	0

Because Lufkin provides supplies to the manufacturing users in Angelina County, it is assumed that the infrastructure to supply additional manufacturing demand is already in place. Therefore, the cost estimates for this strategy only represent raw water purchase costs for Angelina County manufacturing users. Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy ANGL-MFG-1: Purchase from Lufkin (Lake Kurth)	6,000	0	$1,955,000	$326	$1.00
Rec. Strategy ANGL-MFG-1: Purchase from Lufkin (Sam Rayburn)	11,195	0	$3,648,000	$326	$1.00

Mining. Current supplies are from Other-Undifferentiated aquifers. Several private industries are under contract to purchase enough water from Angelina Neches River Authority to meet their projected demand. Therefore, the recommended strategy for meeting the mining need projected in 2020 is to purchase raw water from Angelina Neches River Authority.

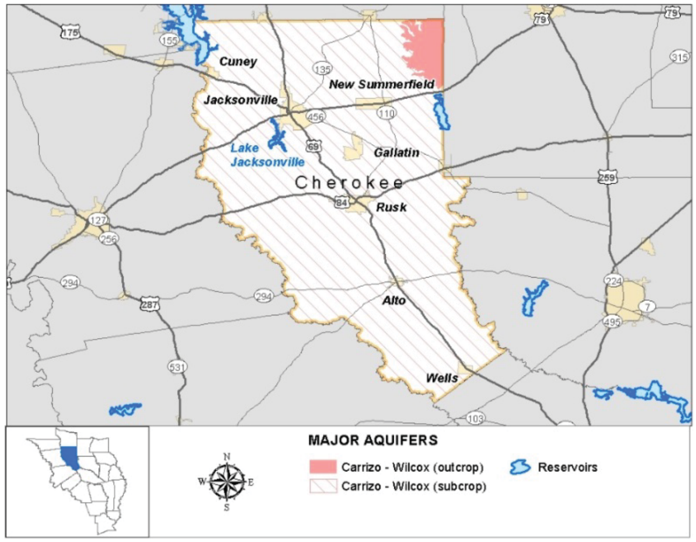
Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. Supplies are assumed to be delivered by a 10-mile pipeline.

Angelina Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	474	573	398	300	225	168
Recommended Strategy ANGL-MIN: Purchase from ANRA (Angelina ROR) (ac-ft per year)	474	573	398	300	225	168

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy ANGL-MIN: Purchase from ANRA (Angelina ROR)	573	$4,005,000	$942,000	$1,644	$5.05

County Summary. Below is a summary of WUGs in Angelina County, their current supplies, maximum shortages, and WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Angelina WSC	Other Undifferentiated	0	None
Burke	Carrizo-Wilcox, Lake Kurth, Sam Rayburn	0	None
Central WCID of Angelina County	Carrizo-Wilcox	0	None
County Other	All Aquifers, Lake Kurth, Sam Rayburn	0	None
Diboll	Yegua-Jackson, Carrizo-Wilcox, Lake Kurth, Sam Rayburn	0	None
Four Way SUD	Yegua-Jackson	0	None
Hudson	Carrizo-Wilcox	0	None
Hudson WSC	Carrizo-Wilcox	0	None
Huntington	Carrizo-Wilcox, Yegua-Jackson	0	None
Lufkin	Carrizo-Wilcox, Lake Kurth, Sam Rayburn	0	None
Redland WSC	Carrizo-Wilcox, Lake Kurth, Sam Rayburn	0	None
Zavalla	Yegua-Jackson	0	None
Manufacturing	All Aquifers, Lake Kurth, Lake Striker,	17,195	Purchase from Lufkin (Sam Rayburn and Kurth)
Mining	Other Undifferentiated	573	Purchase from ANRA
Irrigation	Yegua-Jackson, Lake Kurth	0	None
Livestock	All Aquifers, Local Supply	0	None
Steam Electric Power	Lake Kurth, Carrizo Wilcox	0	None



5B.2.3 Cherokee County. Cherokee County is located in northern portion of the ETRWPA. The county seat is Rusk. The county encompasses an area of approximately 1,049 square miles. Lake Jacksonville, Lake Palestine, and Lake Striker are located wholly or partially in the County.

The larger municipal WUGs in the County are New Summerfield, Rusk, Rusk Rural WSC, Alto, Alto Rural WSC, and North Cherokee WSC. The Carrizo-Wilcox aquifer is the primary source of supply for the needs in Cherokee County. Some WUGs in the County also receive supplies from Lake Jacksonville and Lake Acker. There are two WUGs with shortages in Cherokee County; Alto Rural WSC and Mining. The WMSs for these WUGs are discussed below.

There are approximately 5,000 ac-ft per year of supplies in Carrizo Wilcox in 2020 that are available for WMSs. Water is also available from the Queen City aquifer and a small amount available from the Sparta aquifer, but these aquifers do not cover the entire county. Water obtained from the Queen City aquifer may be acidic and may have levels of iron and manganese greater than TCEQ secondary drinking water standards. Water obtained from the Sparta aquifer may have levels of sulfates greater than the TCEQ secondary drinking water standards, especially in far southern Cherokee County. Water quality in the Sparta aquifer is best on the outcrop. However, for planning purposes, water from the Queen City and Sparta aquifers will be allocated primarily for livestock and irrigation uses because of the unreliable supply and quantity. No proposed strategies for municipal water shortages involve the Queen City and Sparta aquifers.

Alto Rural WSC. The WUG currently obtains water supply from the Carrizo-Wilcox aquifer. The recommended strategy is to increase its supply from the Carrizo-Wilcox aquifer. Municipal conservation is the other recommended strategy for Alto Rural WSC.

Alto Rural WSC	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	66	137	215
Recommended Strategy: Conservation (ac-ft per year)	0	0	5	7	9	11
Recommended Strategy CHER-ALT: Increase supply from Carrizo-Wilcox (ac-ft per year)	0	0	0	61	130	250

Strategy	Supply Amount (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy CHE-ALT: Increase supply from Carrizo-Wilcox (ac-ft per year)	250	$2,682,000	$303,000	$1,212	$3.72
Rec. Strategy Conservation (ac-ft per year)	11	0	$4,648	$423	$1.30

Mining. Current mining water needs in Cherokee County are met through groundwater from the Carrizo-Wilcox aquifer and mining local supply. With the increased interest in natural gas exploration in East Texas, including Cherokee County, there are expected water shortages for mining in the near-term in the county. To meet these demands, water from Lake Columbia and/or run-of-the-river diversions from the Angelina River are recommended. It is assumed that Angelina Neches River Authority would be the sponsor for this water.

Cherokee County Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	238	247	210	147	84	40
Recommended Strategy CHER-MIN: Purchase water from ANRA (Run-of-River Angelina River) (ac-ft per year)	238	247	210	147	84	40

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy CHER-MIN: Purchase water from ANRA (Angelina River)	250	$4,214,000	$640,000	$2,560	$7.86

Steam Electric Power. Current steam electric power water needs in Cherokee County are met through surface water supply from Lake Striker. There are currently no shortages for steam electric power users in Cherokee County but there is interest by a potential user for securing water supply. To meet these demands for the potential customer, run-of-the-river diversions from the Angelina River are recommended. It is assumed that Angelina Neches River Authority would be the sponsor for this water.

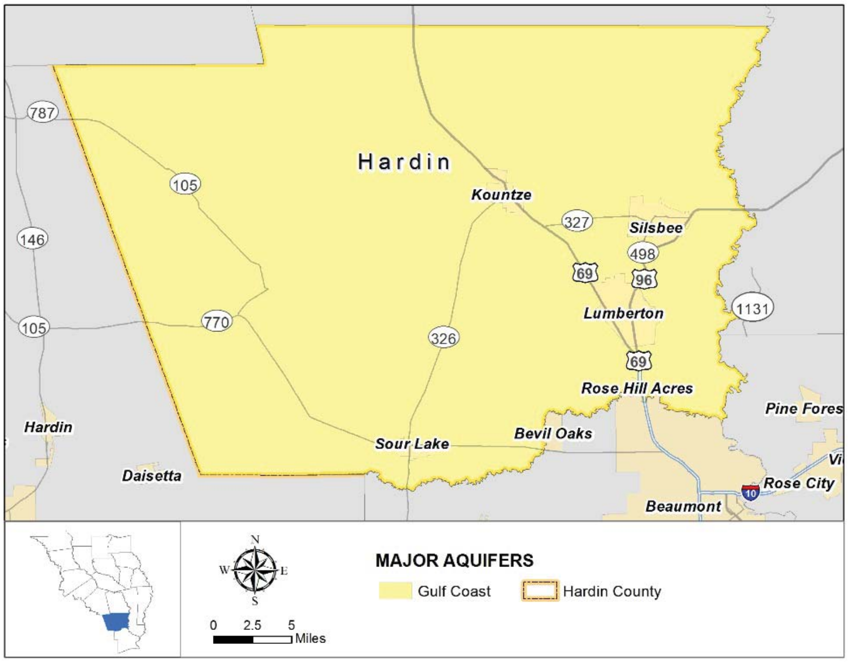
Cherokee County Steam Electric Power	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	0	0	0
Recommended Strategy CHER-SEP: Purchase water from ANRA (Run-of-River Angelina River) (ac-ft per year)	8,000	15,000	20,000	20,000	20,000	20,000

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy CHER-SEP: Purchase water from ANRA (Angelina River)	20,000	$16,735,000	$21,514,000	$1,076	$3.30

County Summary. Below is a summary of WUGs in Cherokee County, their current supplies, maximum shortages, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Alto	Carrizo-Wilcox	0	None
Alto Rural WSC	Carrizo-Wilcox	215	Additional Wells in Carrizo Aquifer, Municipal Conservation
Bullard	Carrizo-Wilcox	0	None
County Other	Carrizo-Wilcox	0	None
Craft-Turney WSC	Carrizo-Wilcox, Lake Jacksonville	0	None
Jacksonville	Carrizo-Wilcox, Lake Jacksonville	0	Pipeline from Lake Columbia to City of Jacksonville (Included in the WWP Summary for Jacksonville)
New Summerfield	Carrizo-Wilcox	0	None
North Cherokee WSC	Carrizo-Wilcox, Lake Jacksonville	0	None
Rusk	Carrizo-Wilcox, Rusk City Lake	0	None
Rusk Rural WSC	Carrizo-Wilcox	0	None
Southern Utility Company	Carrizo-Wilcox	0	None
Troup	Carrizo-Wilcox	0	None
Wells	Carrizo-Wilcox	0	None
Wright City WSC	Carrizo-Wilcox	0	None
Manufacturing	Carrizo-Wilcox, Lake Jacksonville	0	None
Mining	Other Aquifers	250	Purchase from ANRA
Irrigation	All Aquifers, Lake Palestine	0	None
Livestock	Carrizo-Wilcox, Other Aquifers, Local Supply	0	None
Steam Electric Power	Lake Striker	0	Purchase from ANRA

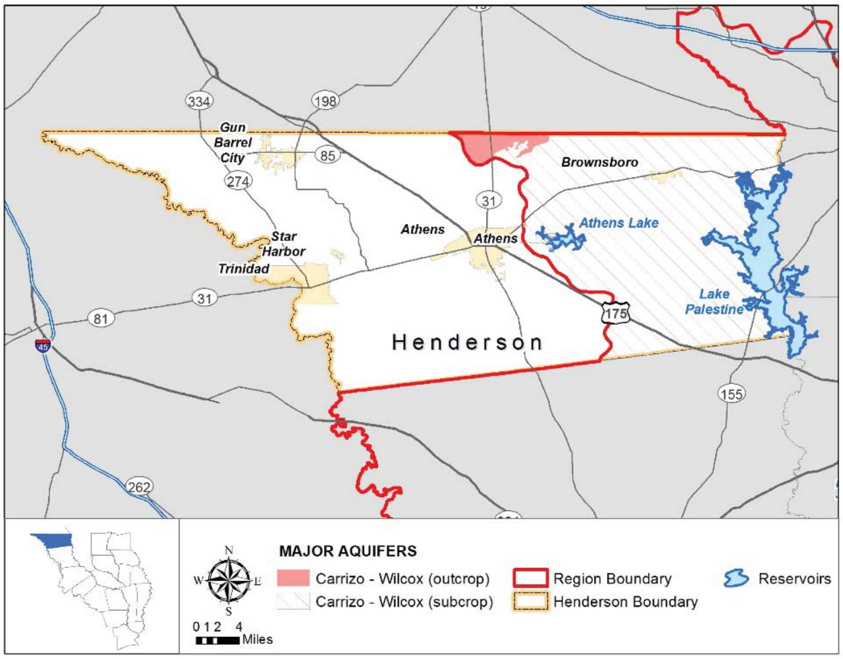


5B.2.4 Hardin County. Hardin County is located in the southern portion of the ETRWPA and is part of the timberlands region in East Texas. The County covers an area of approximately 900 square miles. The average rainfall in the County is about 53 inches.

The County seat is Kountze and other major towns are Lumberton, Sour Lake and Silsbee. Every WUG in Hardin County gets a portion, if not all, of their water from groundwater supplies, and all of the groundwater supply is from the Gulf Coast or Other-Undifferentiated aquifers. Based on the Modeled Available Groundwater used in this round of planning, the Gulf Coast aquifer supplies in Hardin County are limited to approximately 35,000 ac-ft per year. Other sources of supply in this county include Sam Rayburn Reservoir, Neches River run-of-river supplies, and local supplies.

The total demand in Hardin County, including both municipal and non-municipal, is 11,572 ac-ft per year. There is no projected need for any WUG located within Hardin County during the projected planning period. Below is a summary of WUGs in Hardin County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	Gulf Coast	0	None
Kountze	Gulf Coast	0	None
Lake Livingston Water Supply and Sewer Service Company	Gulf Coast	0	None
Lumberton	Gulf Coast	0	None
Lumberton MUD	Gulf Coast	0	None
North Hardin WSC	Gulf Coast	0	None
Silsbee	Gulf Coast	0	None
Sour Lake	Gulf Coast	0	None
West Hardin WSC	Gulf Coast	0	None
Manufacturing	Gulf Coast	0	None
Mining	Gulf Coast, Sam Rayburn	0	None
Irrigation	Gulf Coast, Run-of-River	0	None
Livestock	Gulf Coast, Local Supply	0	None
Steam Electric Power	----	0	None



5B.2.5 Henderson County. Henderson County is located between the Neches and Trinity Rivers in the northern end of the region. Henderson County is located in both Region C and the ETRWPA. The portion of the county in the Neches River Basin is in the ETRWPA. Lake Palestine is located partially within the county. Athens Lake is also located within Henderson County.

Athens is the largest city and also the county seat for Henderson County. The county encompasses approximately 950 square miles. Athens, Bethel Ash WSC, Brownsboro, Chandler, and Berryville are the largest WUGs in the County. Much of the water supplied to users in the ETRWPA is obtained from groundwater, with water also supplied from Lake Athens and Lake Palestine.

Athens	2020	2030	2040	2050	2060	2070
Need in the ETRWPA (ac-ft per year)	2	3	2	1	17	33
Alternative Strategy HDSN-ATN: Purchase from Athens MWA (ac-ft per year)	2	3	2	1	17	18
Unmet Need	0	0	0	0	0	(15)

Athens. The City of Athens receives treated surface water from the Athens MWA and groundwater from local wells. Most of the City is located in Region C with a small portion extending into the ETRWPA. The strategy to meet water shortages for Athens is to purchase water from the Athens MWA through the strategies identified for this wholesale water provider. Conservation was considered as a feasible strategy but most of the conservation savings were associated with the portion of the City in Region C. The conservation savings for portion of City of Athens extending into the ETRWPA was 1 ac-ft per year in 2070. Therefore, a conservation strategy was not proposed for City of Athens in ETRWPA for such a small amount of savings.

The costs of the strategies are presented in the following table.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Alt. Strategy HDSN-ATN: Purchase from Athens MWA (ac-ft per year) [1]	35	NA	NA	NA	NA

[1] See Section 4C.21, Wholesale Water Providers, Athens MWA, for costs for strategies for Athens MWA.

The strategy by Athens MWA to add new wells in Carrizo-Wilcox aquifer in Henderson County is listed as an alternative strategy because the Henderson County MAG is over-allocated both in Region C and the ETRWPA. When the DFCs for Henderson County are revised to update the MAG values, the strategy will be converted to a recommended strategy. However, Athens MWA already has secured the necessary permits to implement this strategy and is proceeding with the project. The strategy for City of Athens relies on the Athens MWA strategy, and it is therefore listed as an alternative strategy as well. Currently there is an unmet need of 33 ac-ft per year in 2070 for City of Athens. Since this is the primary strategy for Athens MWA and the construction is already underway, the 2016 Regional Plans will show shortages in 2060 and 2070 for City of Athens, which in reality will be addressed by the well field development. City of Athens would have to extend their contract with Athens MWA to access the additional supplies.

County Other. There are no identified needs for County Other WUG located in ETRWPA but there are some needs identified in the Region C portion of the Henderson County. A discussion of the WMSs developed to meet this need in is included in the Region C regional water plan in Chapter 5D.

Chandler. City of Chandler has needs starting decade 2050. This demand is met with purchase of water from City of Tyler. Conservation is the other recommended strategy for City of Chandler.

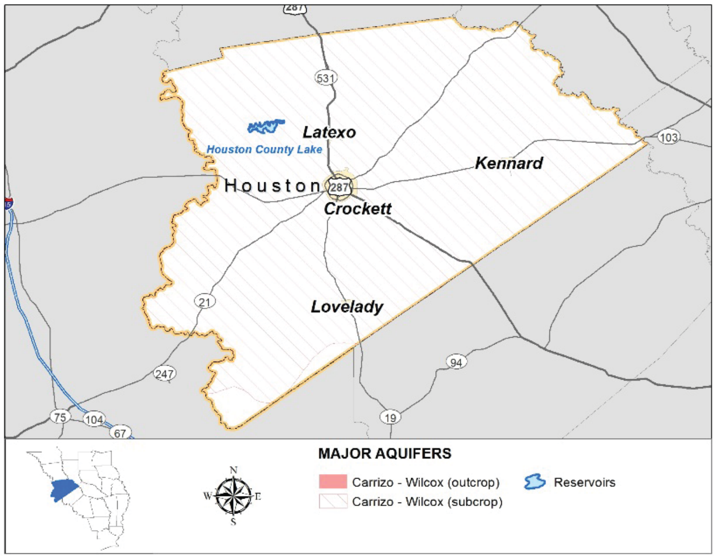
Another potentially feasible strategy for Chandler is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Henderson County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, City of Chandler can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Chandler	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	77	196	312
Recommended Strategy: Conservation (ac-ft per year)	0	0	0	16	30	36
Recommended Strategy HEND-CHN (ac-ft/year): Purchase water from City of Tyler (ac-ft per year)	0	0	0	350	350	350

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy Conservation	36	0	$5,812	$489	$1.50
Rec. Strategy HEND-CHN: Purchase water from City of Tyler	350	$1,886,000	$302,000	$863	$2.65

County Summary. Below is a summary of WUGs in the ETRWPA in Henderson County, current sources of supply, and recommended WMSs.

Water User Group Henderson County	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Athens	Carrizo-Wilcox, Lake Athens	33	Purchase from Athens MWA
Berryville	Carrizo-Wilcox	0	None
Bethel-Ash WSC	Carrizo-Wilcox	0	None
Brownsboro	Carrizo-Wilcox	0	None
Brushy Creek WSC	Carrizo-Wilcox	0	None
Chandler	Carrizo-Wilcox	312	Purchase from City of Tyler
County Other	Carrizo-Wilcox, Other Undifferentiated Aquifer	0	None
Frankston	Carrizo-Wilcox	0	None
Murchison	Carrizo-Wilcox	0	None
R-P-M WSC	Carrizo-Wilcox	0	None
Virginia Hill WSC	Carrizo-Wilcox	0	None
Manufacturing	Carrizo-Wilcox	0	None
Mining	Carrizo-Wilcox, Other Undifferentiated Aquifer	0	None
Livestock	Carrizo-Wilcox, Local Supply, Lake Athens	0	None
Irrigation	Carrizo-Wilcox, Lake Athens, Lake Palestine, Run-of-River	0	None
Steam Electric Power	None	0	None



5B.2.6 Houston County. Water supplies in Houston County include surface water from Houston County Lake (through Houston County WCID #1), run-of-river supplies for irrigation, and groundwater from the Carrizo-Wilcox, Yegua-Jackson, Sparta, Queen City and Other-Undifferentiated aquifers. There are projected water shortages in Houston County for irrigation use. The Carrizo-Wilcox and Yegua-Jackson aquifers have adequate capacity for expanded development in this county.

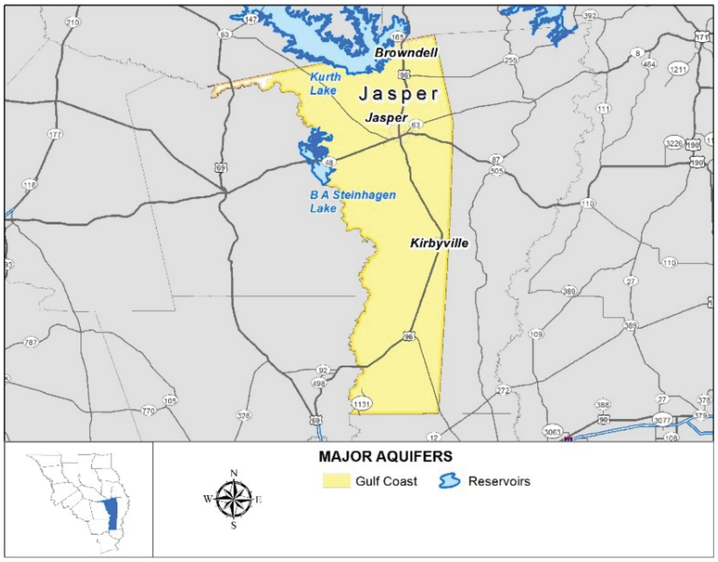
Irrigation. Irrigation needs in Houston County are primarily supplied by run-of-river diversions from the Neches and Trinity Rivers. Based on available data from TWDB, there are currently groundwater wells in Houston County used to meet irrigation demands. Therefore, it is recommended that the projected irrigation shortage beginning in 2020 be met with groundwater. The recommended strategy is to expand existing groundwater supplies from the Yegua-Jackson aquifer.

Houston Irrigation	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	750	996	1,264	1,562	1,891	2,339
Recommended Strategy HOUS-IRR: New Wells (Yegua-Jackson) (ac-ft per year)	751	997	1,265	1,563	1,892	2,340

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy HOUS-IRR: New Wells (Yegua-Jackson)	2,340	$12,926,000	$1,647,000	$704	$2.16

County Summary. Below is a summary of WUGs in Houston County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	All Aquifers	0	None
Crockett	Carrizo-Wilcox, Houston County Lake	0	None
Grapeland	Carrizo-Wilcox, Houston County Lake	0	None
Lovelady	Yegua-Jackson, Houston County Lake	0	None
The Consolidated WSC	Carrizo-Wilcox, Houston County Lake	0	None
Manufacturing	Carrizo-Wilcox, Houston County Lake	0	None
Mining	Other Undifferentiated	0	None
Irrigation	All Aquifers, Run-of-River	2,340	Additional GW Wells in Yegua-Jackson aquifer
Livestock	All Aquifers, Local Supply	0	None
Steam Electric Power	None	0	None



5B.2.7 Jasper County. WUGs in Jasper County utilize surface water from, local supplies, Sam Rayburn Reservoir, and/or the Neches River. Water demands are also met with groundwater from the Gulf Coast and Other-Undifferentiated aquifers. The Gulf Coast aquifer has adequate capacity for expanded development in this county. The only WUG with a projected need during the planning period is manufacturing.

Manufacturing. Current supply is from Sam Rayburn, the Neches River, and the Gulf Coast Aquifer. LNVA has indicated an interest in meeting the entire projected manufacturing needs in Jasper County beginning in 2030. Hence, there is only one recommended strategy that was developed for Jasper Manufacturing, to purchase water from LNVA.

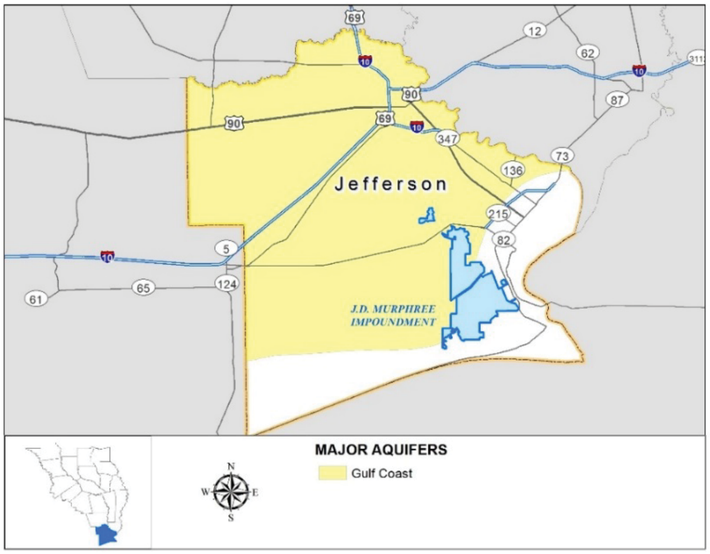
Jasper Manufacturing	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	3,049	6,021	8,250	8,335	8,420
Recommended Strategy JASP-MFG: Purchase from LNVA (Sam Rayburn) (ac-ft per year)	0	3,049	6,021	8,250	8,335	8,420

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy JASP-MFG: Purchase from LNVA (Sam Rayburn)	8,420	$33,497,000	$6,059,000	$720	$2.21

County Summary. Below is a summary of WUGs in Jasper County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	Gulf Coast, Houston County Lake	0	None
Jasper	Gulf Coast	0	None
Jasper County WCID #1	Gulf Coast	0	None
Kirbyville	Gulf Coast	0	None
Mauriceville SUD	Gulf Coast	0	None
Irrigation	Local Supply	0	None
Livestock	Gulf Coast, Local Supply	0	None
Manufacturing	Gulf Coast, Run-of-River, Sam Rayburn	8,420	Purchase from LNVA
Mining	Gulf Coast Aquifer	0	None
Steam Electric Power	None	0	None



5B.2.8 Jefferson County. Water supply is largely provided by LNVA with surface water from Sam Rayburn/BA Steinhagen system and the Neches River. The exception to this is Beaumont, which has a supply from their own water rights on the Neches River in Jefferson County and Gulf Coast aquifer in Hardin County. There are four WUGs with a projected need during the planning period. Beaumont should be able to meet its shortages with conservation, and LNVA has adequate supply to provide water to the remaining WUGs.

Beaumont. The current supply sources for this WUG are the Neches River, Gulf Coast Aquifer, and Sam Rayburn/BA Steinhagen system (LNVA). Beaumont's supply is limited by their water treatment plant capacity of 64 MGD, and the City is projected to have a water shortage beginning in 2040. The City had an average per capita consumption of 219 gpcd in 2011. This value is well over the statewide goal of 140 gpcd. The City has begun a meter replacement program, which may help reduce the per capita use rate somewhat. In addition, after performing a conservation cost analysis, the ETRWPG believes a water conservation strategy for the City is economically achievable and is therefore recommended. This strategy includes cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program. The proposed municipal conservation strategy would reduce Beaumont's demand by more than their projected need; therefore, municipal conservation is the only recommended WMS for the City.

Beaumont	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	500	2,245	4,403	6,896
Recommended Strategy BEAUMONT: Municipal Conservation (ac-ft per year)	0	3,238	5,341	7,047	8,579	9,966

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy BEAUMONT: Municipal Conservation	9,966	$52,623,000	$2,271,000	$317	$0.97

County-Other. Current supply is the Gulf Coast aquifer, Neches River (Beaumont), and Sam Rayburn/BA Steinhagen system (LNVA and Port Arthur). Approximately 80 percent of County-Other demand is met by LNVA. In addition, LNVA has the water available to meet the County-Other water shortage and has expressed interest in providing more water Jefferson County-Other. Purchasing water from Sam Rayburn Reservoir (LNVA) is the only recommended WMS for County-Other.

County Other	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	680	1,924	3,296
Recommended Strategy JEFF-CTR: Purchase from LNVA (Sam Rayburn Reservoir) (ac-ft per year)	0	0	0	797	2,041	3,413

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy JEFF-CTR: Purchase from LNVA (Sam Rayburn Reservoir)	3,413	$14,236,000	$2,521,000	$739	$2.27

Manufacturing. Current supply includes the Gulf Coast aquifer, Neches River (Beaumont and LNVA), Sabine River (SRA), and Sam Rayburn/BA Steinhagen system (Beaumont, LNVA, and Port Arthur). Manufacturing in Jefferson County is projected to have a water supply shortage beginning in 2020. Much of the Manufacturing demand is currently met by LNVA. In addition, LNVA has the water available to meet the water shortage and has expressed interest in providing more water for Jefferson County Manufacturing. Therefore, purchasing water from Sam Rayburn/BA Steinhagen system (LNVA) is the only recommended WMS for manufacturing.

Jefferson Manufacturing	2020	2030	2040	2050	2060	2070
Need(ac-ft per year)	180,461	261,473	273,106	284,779	296,461	308,603
Recommended Strategy JEFF-MFG: Purchase from LNVA (Sam Rayburn) (ac-ft per year)	181,181	262,193	273,826	285,499	297,181	309,322

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy JEFF-MFG: Purchase from LNVA (Sam Rayburn)	309,322	$312,255,000	$139,694,000	$452	$1.39

Steam Electric Power. This WUG is a proposed facility and does not currently have a supply. The projected demands are based on several proposed facilities in Jefferson County that have been delayed or cancelled since the development of water projections. It is anticipated that as the need for electric power increases, these facilities will be constructed. Presently, there is no infrastructure to supply water for steam-electric power. The proposed strategy to meet this need is to purchase water from LNVA. Sam Rayburn Reservoir (LNVA) has sufficient supplies to meet the projected steam-electric power needs. The actual source of water will be negotiated once the facilities are constructed.

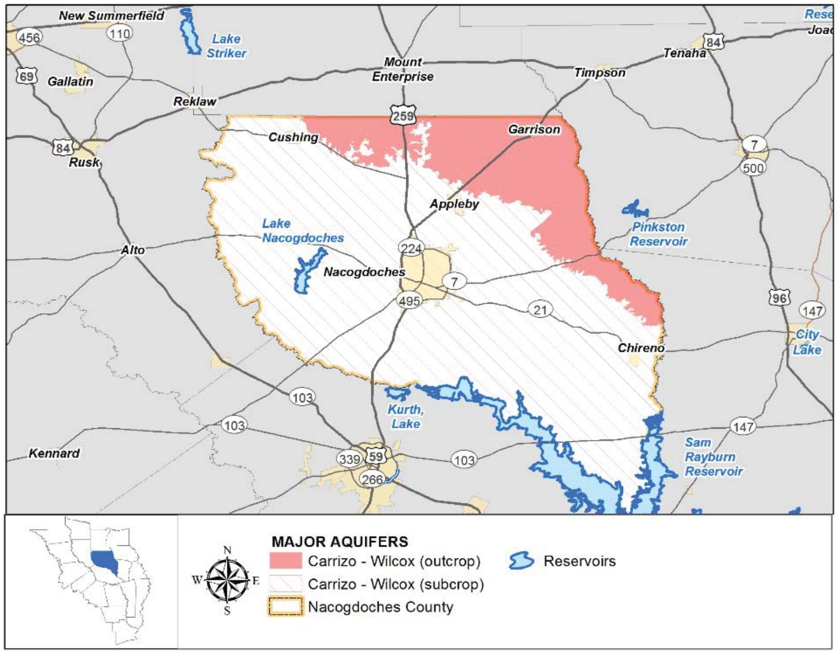
Jefferson Steam Electric Power	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	13,426	15,696	18,464	21,838	25,951	30,839
Recommended Strategy JEFF-SEP: Purchase from LNVA (Sam Rayburn) (ac-ft per year)	13,426	15,696	18,464	21,838	25,951	30,839

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy JEFF-SEP: Purchase from LNVA (Sam Rayburn Reservoir)	30,839	$54,518,000	$15,645,000	$507	$1.56

County Summary. Below is a summary of WUGs in Jefferson County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Beaumont	Gulf Coast, Run-of-River, Sam Rayburn	6,896	Municipal Conservation
Bevil Oaks	Gulf Coast	0	None
China	Gulf Coast	0	None
County Other	Gulf Coast, Run-of-River, Sam Rayburn	3,413	Purchase from LNVA (Sam Rayburn Reservoir)
Groves	Sam Rayburn	0	None
Jefferson County WCID #10	Carrizo-Wilcox, Houston County Lake	0	None
Meeker MUD	Run-of-River, Gulf Coast	0	None
Nederland	Sam Rayburn	0	None
Nome	Sam Rayburn	0	None
Port Arthur	Sam Rayburn	0	Municipal Conservation
Port Neches	Sam Rayburn	0	None
West Jefferson County MWD	Sam Rayburn, Run-of-River	0	None
Irrigation	Gulf Coast, Run-of-River, Sam Rayburn	0	None
Livestock	Gulf Coast, Local Supply	0	None
Manufacturing	Sam Rayburn, Gulf Coast, Run-of-River, Toledo Bend	309,322	Purchase from LNVA (Sam Rayburn Reservoir)
Mining	Gulf Coast, Local Supply, Run-of-River	0	None
Steam Electric Power	None	30,839	Purchase from LNVA (Sam Rayburn Reservoir)



5B.2.9 Nacogdoches County. Surface water, groundwater and local livestock supplies provide water to users in Nacogdoches County. Lake Nacogdoches and Striker Lake provide the majority of surface water, while groundwater is the primary source for rural water supplies. Lake Naconiche has recently been completed. This lake was built by NRCS for flood storage and recreation, but there are plans to develop water supply from the lake for rural communities. A 1992 study evaluated a potential regional water system using water from Lake Naconiche. This regional system is a recommended strategy to provide water to Nacogdoches County-Other users and several rural WSCs. A brief description of the proposed strategy is presented below.

Lake Naconiche Regional Water Supply System. Lake Naconiche is located in northeast Nacogdoches County on Naconiche Creek. It is permitted to store 9,072 ac-ft of water. To use water from Lake Naconiche for water supply, the County must seek a permit amendment to allow diversions for municipal use. According to the Neches WAM, the firm yield of the lake would be approximately 3,239 ac-ft per year. It is assumed that the regional water system would serve Appleby WSC, Lily Grove WSC, Swift WSC, and County-Other entities in Nacogdoches County (including Caro WSC, Lilbert-Looneyville WSC, Libby WSC, and others),. Nacogdoches County is the current sponsor of this water management strategy.

The project is initially sized for 3.0 MGD. This includes a lake intake, new water treatment plant located near Lake Naconiche, pump station and a distribution system of pipelines in the northeast part of the county. Costs are summarized below. The costs for each participant are based on the unit cost of water for the strategy and capital costs are proportioned by strategy amounts. Actual costs would be negotiated as the project is developed.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
NAC-LK: Develop Lake Naconiche	1,700	$34,492,000	$5,273,000	$3,102	$9.52

D&M WSC. D&M WSC currently relies on groundwater from the Carrizo-Wilcox aquifer. The recommended strategy is to expand development of supplies from Carrizo-Wilcox. Municipal conservation was considered for this WUG but not recommended as D&M WSC's average per capita consumption of is below the statewide goal of 140 gpcd.

D & M WSC	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	0	112	234
Recommended Strategy NACW-DMW: Increase Supply from Carrizo-Wilcox (ac-ft per year)	0	0	0	0	112	250

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy DM-1: Increase Supply from Carrizo-Wilcox	250	$3,484,000	$384,000	$1,536	$4.71

Livestock. Local supply provides over half of current livestock needs for Nacogdoches County, with the remainder supplied from groundwater sources. Local supplies may not be adequate to cover the projected shortages and further expansion of groundwater from Carrizo Wilcox aquifer is proposed as the recommended strategy.

Nacogdoches County Livestock	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	1,644	1,837	2,061	2,320	2,617	3,059
Recommended Strategy NACW-LTK: Install New GW Wells in Carrizo Wilcox aquifer (ac-ft per year)	1,644	1,837	2,061	2,320	2,617	3,059

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualize d Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy NACW-LTK: Install New GW Wells in Carrizo Wilcox aquifer	3,059	$23,770,000	$2,766,000	$904	$2.77

Mining. Current mining water needs in Nacogdoches County are met through local surface water supplies. As a result of increased interest in natural gas exploration in East Texas, there are projected water shortages for mining in Nacogdoches County. Nacogdoches has recently negotiated a contract with Angelina Neches River Authority to provide water for the County's mining needs. The recommended water management strategy to meet these needs is run-of-the-river diversions from the Angelina River. It is assumed that Angelina Neches River Authority would be the sponsor for this strategy.

Nacogdoches County Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	5,475	2,975	118	0	0	0
Recommended Strategy NACW-MIN: Purchase water from ANRA (Angelina River) (ac-ft per year)	5,475	2,975	118	0	0	0

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
NACW-MIN: Purchase water from ANRA (Angelina River)	5,500	$12,465,000	$6,650,000	$1,209	$3.71

Steam-Electric. Steam-Electric demands in Nacogdoches County are currently met by the purchase of supplies from Lake Striker from the Angelina Nacogdoches WCID #1. In addition to the existing power plant in Nacogdoches County, another plant is planned for the future. This will be a much larger facility with greater demands for cooling water. For planning purposes it is recommended that the projected need for steam-electric power be met with water from Lake Columbia transmission system by means of a purchase contract with Angelina Neches River Authority. Additional supplies will also be obtained from groundwater wells in Carrizo-Wilcox aquifer and purchase of supplies from Houston County WCID#1. It should be noted that the strategies developed allocated surplus supplies to Nacogdoches Steam Electric Power users.

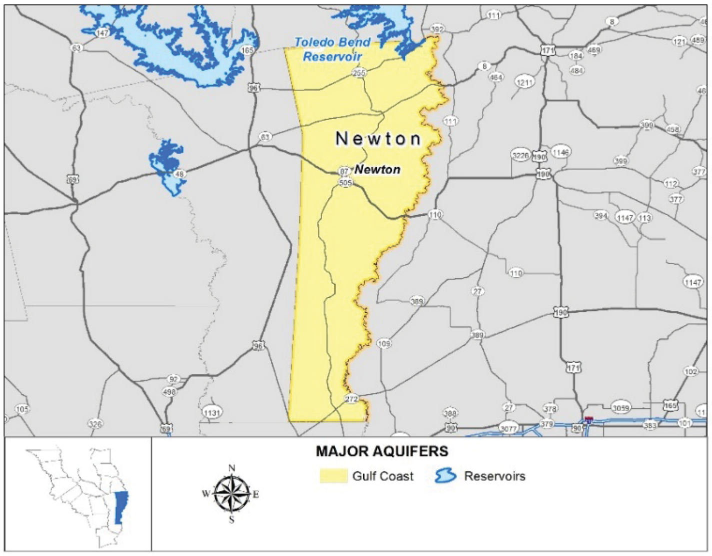
Nacogdoches County Steam-Electric	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	799	2,224	3,961	6,078	8,594
Recommended Strategy 1 NACW-SEP1: Obtain raw water from ANRA (Lake Columbia) (ac-ft per year)	8,500	8,500	7,742	6,741	5,645	4,521
Recommended Strategy 2 NACW-SEP2: New wells in Carrizo-Wilcox and transfer from Houston County WCID #1 (ac-ft per year)	3,000	3,000	3,000	3,000	3,000	4,989

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Contract Amount (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy 1 NACW-SEP1: Obtain raw water from ANRA (Lake Columbia) (ac-ft per year)	8,500	$25,805,000	$5,264,000	$619	$1.90
Rec. Strategy 2 NACW-SEP2: New wells in Carrizo-Wilcox (ac-ft per year) and purchase from Houston County WCID#1	4,989	$16,021,000	$1,875,000	$938	$2.88

County Summary. Below is a summary of WUGs in Nacogdoches County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Appleby WSC	Carrizo-Wilcox, Lake Nacogdoches	0	None
County Other	All aquifers, Lake Nacogdoches	0	Lake Naconiche Regional Treated Water System
Cushing	Carrizo-Wilcox	0	None
D&M WSC	Carrizo-Wilcox, Lake Nacogdoches	234	Additional GW Wells in Carrizo Wilcox aquifer
Garrison	Carrizo-Wilcox	0	None
Lily Grove SUD	Carrizo-Wilcox	0	None
Melrose WSC	Carrizo-Wilcox	0	None
Nacogdoches	Carrizo-Wilcox, Lake Nacogdoches	0	Lake Columbia Transmission System (Discussion Included in the WWP Summary for Nacogdoches)
Swift WSC	Carrizo-Wilcox	0	None
Woden WSC	Carrizo-Wilcox	0	None
Irrigation	Carrizo-Wilcox, Run-of-River	0	None
Manufacturing	Carrizo-Wilcox, Lake Nacogdoches	0	None
Livestock	All aquifers, Local Supply	3,059	Additional GW Wells in Carrizo Wilcox aquifer
Mining	Other Undifferentiated, Local Supply	5,475	Purchase from ANRA
Steam Electric Power	Lake Striker	10,472	Purchase from ANRA, Additional GW Wells in Carrizo Wilcox aquifer, Transfer from Houston County WCID#1



5B.2.10 Newton County. Most of the WUGs in Newton County use groundwater from the Gulf Coast aquifer. According to the Groundwater Availability Model estimates for 2020, there are approximately 34,000 ac-ft per year of groundwater available from the Gulf Coast aquifer in Newton County. As a part of this round of planning, less than 4,000 ac-ft per year has been allocated to WUGs in Newton County. There is also a significant amount of surface water available from the SRA system. Some of this water is contracted for steam-electric power. Based on the available groundwater and proximity of surface water to users in Newton County, there is substantial water available for development to meet projected demands for mining and steam electric power.

Mining. Current supplies are from local surface water supplies and the Gulf Coast aquifer. The Mining demand in Newton County is very low compared to the other demands in this county, but mining is projected to have a water shortage for 2020 and 2030. The recommended strategy to meet this demand is to purchase surface water from SRA. SRA currently provides water for existing mining demands in Newton County.

Newton Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	115	59	0	0	0	0
Recommended Strategy NEWT-MIN: Purchase water from SRA (Toledo Bend Reservoir) (ac-ft per year)	115	59	0	0	0	0

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy NEWT-MIN: Purchase water from SRA (Toledo Bend) (ac-ft per year)	115	0	$111,000	$965	$2.96

Steam-Electric Power. Current supplies are from the Sabine River (SRA canals). The SRA supplies surface water to two facilities in Newton County. Contract volumes limit the supply to these two facilities; consequently, Steam-Electric Power is projected to have a water shortage beginning in 2020. SRA has sufficient available supplies to meet the needs for power generation through 2070, but this will require additional contracts between the power facilities and SRA. The recommended strategy to meet this need is to purchase additional surface water from SRA from Toledo Bend Reservoir.

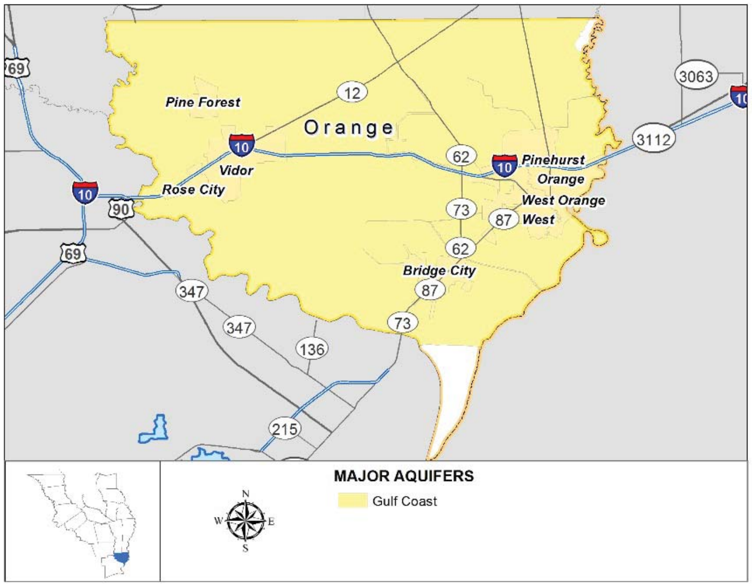
Newton Steam-Electric Power	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	690	3,080	5,994	9,545	13,875	19,021
NEWT-SEP: Purchase water from SRA (Toledo Bend Reservoir) (ac-ft per year)	690	3,080	5,994	9,545	13,875	19,021

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac -ft)	Unit Cost ($/1000 gal)
NEWT-SEP: Purchase water from SRA (Toledo Bend Reservoir)	19,021	$38,170,000	$10,091,000	$531	$1.63

County Summary. Below is a summary of WUGs in Newton County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	All Aquifers	0	None
Mauriceville SUD	Carrizo-Wilcox, Houston County Lake	0	None
Newton	Carrizo-Wilcox, Houston County Lake	0	None
South Newton WSC	Yegua-Jackson, Houston County Lake	0	None
Irrigation	Carrizo-Wilcox, Houston County Lake	0	None
Livestock	Carrizo-Wilcox, Houston County Lake	0	None
Manufacturing	Other Undifferentiated	0	None
Mining	All Aquifers, Run-of-River	115	Purchase from SRA
Steam Electric Power	----	19,021	Purchase from SRA



5B.2.11 Orange County. The majority of the water used in Orange County comes from the Gulf Coast Aquifer and the Sabine River, with a very small portion coming from the Neches River. The total long-term sustainable groundwater availability for Orange is estimated at 20,000 ac-ft per year. Current groundwater use in Orange County is nearly 18,000 ac-ft per year. Because the long-term sustainable availability of the aquifer has nearly been reached, it is recommended that any new large-scale water needs be met with surface water. It is recommended that those entities currently on groundwater be allowed to remain on groundwater to meet their future growth until such a time that a salt water intrusion or subsidence problem is encountered.

There is a significant amount of surface water available in the Sabine River in Orange County. The SRA canal system, which is located in Orange County, has a conveyance capacity of 346,000 ac-ft per year. SRA has water rights of 147,100 ac-ft per year associated with the canal system (100,400 ac-ft per year for municipal and industrial use and 46,700 ac-ft per year for irrigation). Currently, SRA has demands of approximately 76,000 ac-ft per year from the canal system. This leaves approximately 70,000 ac-ft per year available to be contracted. SRA also has a large amount of uncontracted water in Toledo Bend Reservoir that could potentially be released through the dam and carried by the Sabine River for downstream use from the canal.

Irrigation. This WUG has a shortage starting 2020. The current supply comes from SRA's Run-of-river canal system supplies. It is recommended that the irrigation users contract with SRA for additional supplies.

Orange County Irrigation (Neches Basin)	2010	2020	2030	2040	2050	2060
Need (ac-ft per year)	2,432	2,685	2,858	2,920	2,855	2,758
Recommended Strategy ORAN-IRR: Purchase from SRA (ac-ft per year)	2,432	2,685	2,858	2,920	2,855	2,758

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy ORAN-IRR: Purchase from SRA	3,000	$13,281,000	$2,293,000	$764	$2.35

Steam Electric Power. The current supply for steam electric power is from the SRA canal system and wells in the Gulf Coast aquifer. Since groundwater is essentially fully allocated in Orange County, it is proposed that the steam electric power generators contract with SRA to meet the projected shortages.

Steam Electric Power	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	14	1,038	2,286	3,807	4,846
Recommended Strategy ORAN-SEP: Purchase from SRA (ac-ft per year)	0	14	1,038	2,286	3,807	4,486

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy ORAN-SEP: Purchase from SRA	4,486	$15,847,000	$3,077,000	$686	$2.10

Manufacturing. The current supply is from the Gulf Coast aquifer, the Sabine River (SRA canal system), and the Neches River. Additional water is needed from 2020-2070. There is a shortage in the Sabine Basin portion of the county and a surplus in the Neches Basin portion of the county. The surplus in the Neches Basin cannot fully meet the projected needs in the county. By year 2020, new supplies must be made available. The net shortage for both basins is 31,850 ac-ft per year.

Additional supplies from SRA's canal system and Toledo Bend Reservoir are the recommended strategies to meet these shortages. It is assumed that the new manufacturing facilities will be located along the SRA canal and will require minimal transmission facilities. Water from Toledo Bend Reservoir could be released downstream for diversion at the facilities. The only cost presented here is the cost of raw water purchase. It is assumed that no treatment of the water will be necessary.

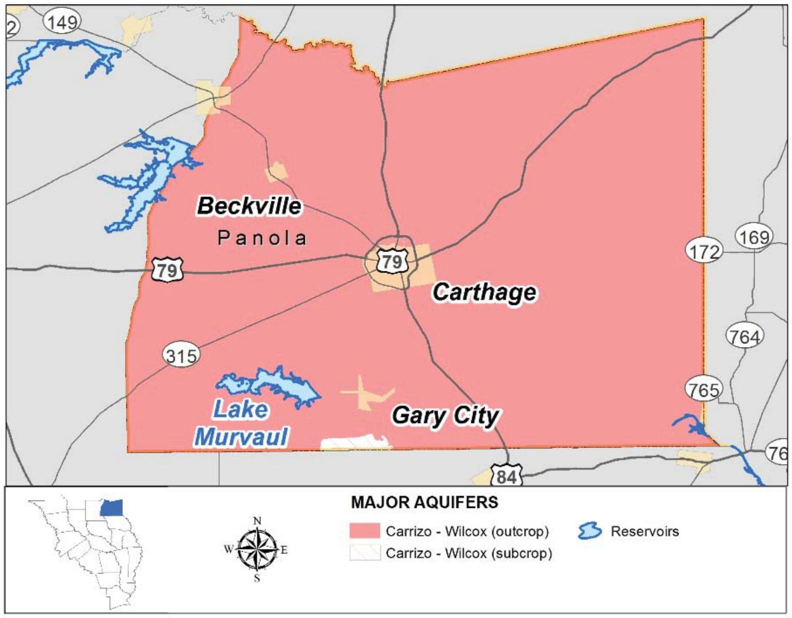
Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Orange County Manufacturing	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	2,532	8,479	14,439	19,730	25,680	32,111
Recommended Strategy ORAN-MFG: Purchase from SRA Canal. (ac-ft per year)	3,943	9,890	15,850	21,141	27,092	33,477

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy ORAN-MFG (ac-ft/year): Purchase from SRA Canal.	33,477	$42,621,000	$14,949,000	$467	$1.43

County Summary. Below is a summary of WUGs in Orange County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Bridge City	Gulf Coast	0	None
County Other	Gulf Coast	0	None
Mauriceville SUD	Gulf Coast	0	None
Orange	Gulf Coast	0	None
Orangefield WSC	Gulf Coast	0	None
Pinehurst	Gulf Coast	0	None
Port Arthur	Gulf Coast	0	None
Rose City	Run-of-River Sabine	0	None
South Newton WSC	Gulf Coast	0	None
Vidor	Gulf Coast	0	None
West Orange	Gulf Coast	0	None
Irrigation	Run-of-River, SRA Canal	2,920	Purchase from SRA
Livestock	Local Supply, Gulf Coast	0	None
Manufacturing	Run-of-River, Gulf Coast	31,850	Purchase from SRA
Mining	Local Supply, Gulf Coast	0	None
Steam Electric Power	SRA Canal, Gulf Coast	4,846	Purchase from SRA



5B.2.12 Panola County. Panola County has only one entity with projected water shortages. Generally, demands in Panola County are expected to increase slightly and can be met through existing supplies. Both groundwater from the Carrizo-Wilcox aquifer and surface water supplies, mostly from Lake Murvaul, are used in Panola County. The Carrizo-Wilcox aquifer has a long-term availability of approximately 3,000 ac-ft per year in Panola County. Based on historical use information and well capacities from entities in the county, the groundwater supply is fully developed. Because the long-term sustainable availability of the aquifer has been reached, it is recommended that any new (not currently identified) large-scale water needs be met with surface water. It is recommended that those entities currently on groundwater remain on groundwater to meet their future growth until such time as groundwater is no longer a reliable supply. Any entities that are willing to convert to surface water should be encouraged to do so.

Manufacturing. The City of Carthage currently provides approximately 75 percent of the manufacturing water needs in Panola County. It was assumed that Carthage will continue to provide this level of supply though the planning period. Based on the projected demands, shortages for manufacturing in Panola County are expected beginning in 2020. It is recommended that this shortage be met by purchasing additional water from the City of Carthage.

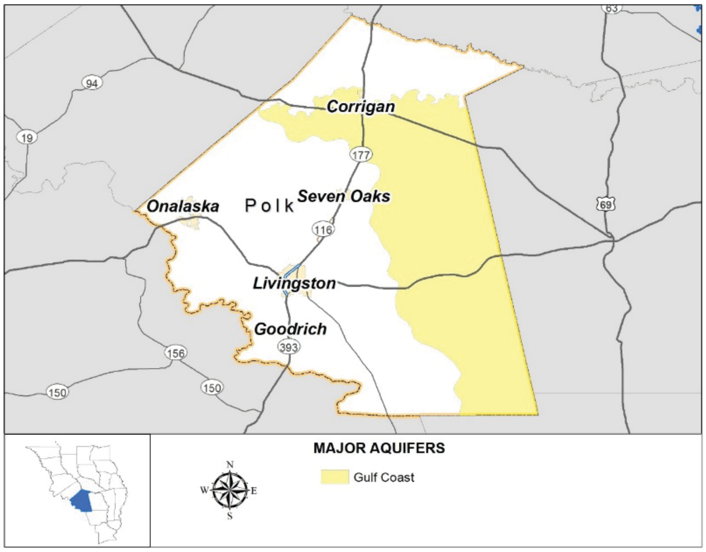
Panola County Manufacturing	2020	2030	2040	2050	2060	2070
Needs (ac-ft per year)	134	156	176	194	230	309
Recommended Strategy: Purchase water from Carthage (ac-ft per year)	134	156	176	194	230	309

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy : Purchase Water from Carthage	309	0	$101,000	$327	$1.00

County Summary. Below is a summary of WUGs in Panola County, current sources of supply, and recommended WMSs.

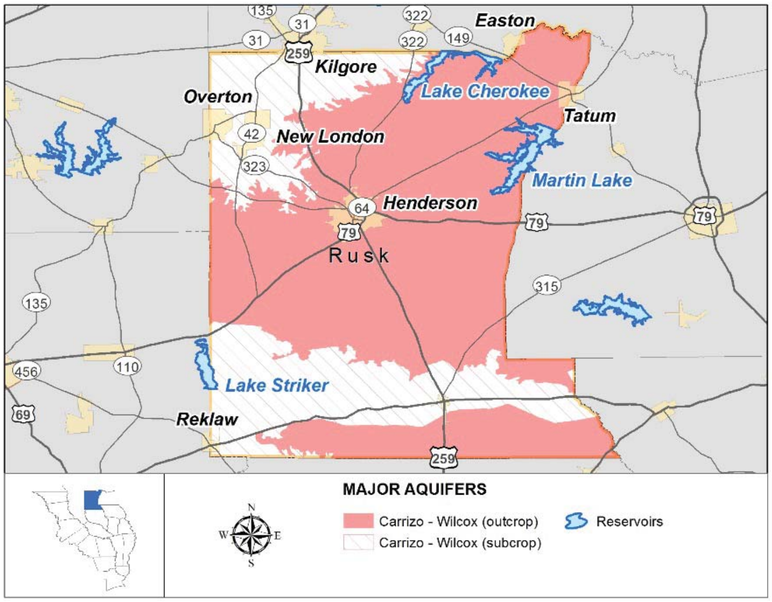
Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Beckville	Carrizo-Wilcox	0	None
Carthage	Carrizo-Wilcox, Lake Murvaul	0	None
County Other	Carrizo-Wilcox, Lake Murvaul	0	None
Gill WSC	Carrizo-Wilcox, Marshall	0	None
Tatum	Carrizo-Wilcox	0	None
Irrigation	Carrizo-Wilcox, Run-of-River	0	None
Livestock	Local Supply, Carrizo-Wilcox	0	None
Manufacturing	Run-of-River, Lake Murvaul, Carrizo-Wilcox	309	Purchase from City of Carthage
Mining	Run-of-River, Lake Murvaul, Carrizo-Wilcox, Toledo Bend	0	None
Steam Electric Power	None	0	None



5B.2.13 Polk County. Polk County is partially located in the ETRWPA and partially in Region H. Every WUG in the county uses water from groundwater supplies. The groundwater supplies are from the Gulf Coast, Yegua-Jackson, and Other-Undifferentiated aquifers. Local surface water supplies are also used to meet demands in Polk County. There is no projected need for any WUG located within Polk County during the planning period. Based on the groundwater availability estimates included in this plan, the Gulf Coast aquifer is sufficient to provide water to future demands that are expected to develop in Polk County.

Below is a summary of WUGs in Polk County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Corrigan	Other Undifferentiated	0	None
County Other	All Aquifers	0	None
Irrigation	Gulf Coast, Local Supply	0	None
Livestock	All Aquifers, Local Supply	0	None
Manufacturing	Gulf Coast, Other Undifferentiated	0	None
Mining	Local Supply, Gulf Coast, Other Undifferentiated	0	None
Steam Electric Power	None	0	None



5B.2.14 Rusk County. Surface water and groundwater are used for water supply in Rusk County. The water sources used include the Neches and Sabine Rivers, the Carrizo-Wilcox, Queen City, and Other-Undifferentiated aquifers, and local supplies. There are projected water shortages for the City of Overton, Mining, and Steam-Electric Power, but there are sufficient supplies available to meet these identified needs. Rusk County Refinery is a potential manufacturing water user that has approached Angelina Neches River Authority for a water supply contract. The contract amount for this entity is approximately 5,600 ac-ft per year. It should be noted that the overall projections for manufacturing demand in Rusk County are at a maximum amount of 489 ac-ft per year. It is believed that the Rusk County Refinery demands were not accounted for the regional water planning demand projections. WMSs for Rusk County Refinery are not discussed in this section because the demand is not included in the regional water planning demand projections. However, Angelina Neches River Authority is identified as the seller to this entity and a WMS is discussed in the WMS discussion for wholesale water providers.

Overton. The current supply for this WUG is the Carrizo-Wilcox aquifer. The City's supply is limited by well capacities and water shortages are projected beginning in 2050. The City had an average per capita consumption of 200 gpcd in 2011. This value is well over the statewide goal of 140 gpcd. After performing a conservation cost analysis, the

ETRWPG believes a water conservation strategy for the City is economically achievable and is therefore recommended. This strategy includes cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program. The proposed municipal conservation strategy would reduce Overton's demand by more than their projected need; therefore, municipal conservation is the only recommended WMS for the City. It should be noted that this WMS will address the shortage for City of Overton WUG both in ETRWPA and North East Texas Region (Region D).

Another potentially feasible strategy for Overton is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Rusk County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, Overton can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Overton	2020	2030	2040	2050	2060	2070
Need (Both Region I & D) (ac-ft per year)	17	18	33	88	150	215
Recommended Strategy OVERTON: Municipal Conservation (ac-ft per year)	17	18	106	181	241	289

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy OVERTON (Region I & D): Municipal Conservation	289	2,105,000	$111,298	$914	$ 2.81

Mining. Rusk County Mining is supplied by groundwater from the Carrizo-Wilcox and Other-Undifferentiated aquifers and surface water from local supplies. Several private industries have undergone negotiations with Angelina Neches River Authority and are currently under contract to purchase water from Angelina Neches River Authority to meet their projected demands. Therefore, the recommended strategy for meeting the mining needs for Rusk County 2020 is to purchase raw water from Angelina Neches River Authority.

Rusk Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	1,075	2,092	1,955	1,809	1,686	1,677
Recommended Strategy RUSK-MIN: Purchase from ANRA (Angelina ROR) (ac-ft per year)	1,075	2,092	1,955	1,809	1,774	1,765

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the mining customers will construct a raw water transmission system to transfer supplies from the Run-of-River diversion location. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy RUSK-MIN: Purchase from ANRA (Angelina ROR)	1,765	$14,158,000	$3,420,000	$1,635	$5.02

Steam-Electric Power. The current supply is the Carrizo-Wilcox aquifer, Martin Lake, and Toledo Bend Reservoir (SRA). The demands for steam-electric power are based on projected demands for two existing power plants that have existing supplies: Luminant's Martin Lake plant and the Tenaska Gateway facilities. Martin Lake has a firm yield of 25,000 ac-ft per year. The Tenaska Gateway facility uses water from Toledo Bend

Reservoir and has a contract for 17,922 ac-ft per year. Based on the projected demands for steam-electric power in Rusk County, there is a projected shortage beginning in 2050. For planning purposes, it is assumed that 1,500 ac-ft per year of this demand will be at the Tenaska facility and can be met through additional supplies from SRA with little to no infrastructure improvements. Therefore, it is also assumed that any additional demand over 1,500 ac-ft per year will occur through a new facility, which does not yet have a specified location. Because SRA has water supplies available to meet the projected water shortage from this WUG, it is recommended that a contract be implemented to secure water from Toledo Bend Reservoir (SRA).

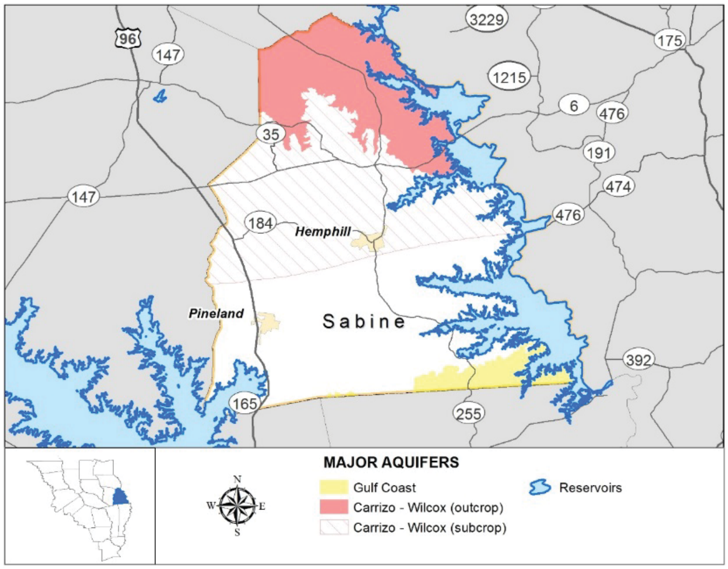
Rusk Steam-Electric Power	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	0	0	0	462	8,873	18,868
Recommended Strategy RUSK-SEP: Purchase from SRA (Toledo Bend Reservoir) (ac-ft per year)	0	0	0	462	8,873	18,868

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy RUSK-SEP: Purchase from SRA (Toledo Bend Reservoir)	18,868	$57,718,000	$11,855,000	$628	$1.93

County Summary. Below is a summary of WUGs in Rusk County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Chalk Hill SUD	Carrizo-Wilcox	0	None
County Other	Carrizo-Wilcox, Other Undifferentiated	0	None
Cross Roads SUD	Carrizo-Wilcox, Lake Fork (Kilgore)	0	None
Easton	Lake Cherokee	0	None
Elderville WSC	Lake Cherokee, Lake Fork	0	None
Henderson	Lake Fork, Carrizo-Wilcox	0	None
Kilgore	Lake Fork, Carrizo-Wilcox	0	None
New London	Carrizo-Wilcox	0	None
Overton	Carrizo-Wilcox	215	Municipal Conservation
Tatum	Carrizo-Wilcox	0	None
West Gregg SUD	Carrizo-Wilcox	0	None
Wright City WSC	Carrizo-Wilcox	0	None
Irrigation	Carrizo-Wilcox, Run-of-River, Other Undifferentiated	0	None
Manufacturing	Carrizo-Wilcox, Run-of-River	0	None
Livestock	Carrizo-Wilcox, Queen City, Local Supply	0	None
Mining	Carrizo-Wilcox, Run-of-River, Other Undifferentiated	2,092	Purchase from ANRA (Angelina ROR)
Steam Electric Power	Carrizo-Wilcox, Martin Lake, Toledo Bend Reservoir	18,868	Purchase from SRA (Toledo Bend Reservoir)



5B.2.15 Sabine County. Water supply sources currently used in Sabine County include the Carrizo-Wilcox, Sparta, Yegua-Jackson and other minor aquifers, Toledo Bend Reservoir, and local surface supplies. The total available supply from groundwater in Sabine County is 11,690 ac-ft per year. Of this amount, about 1,500 ac-ft per year is currently being used. This leaves considerable groundwater for future supplies. In addition, Toledo Bend Reservoir, which is located along the eastern border of Sabine County, has available supply (through contracts with SRA). Currently, there are no shortages for WUGs in Sabine County.

G-M WSC. G-M WSC is a WUG in Sabine County. Currently G-M WSC has sufficient supplies to meet the projected needs over the planning period. However, G-M WSC wanted the WMSs from their five-year water plan discussed in the 2016 regional plan. Below is a discussion on the supplies and WMSs based on the information provided by G-M WSC.

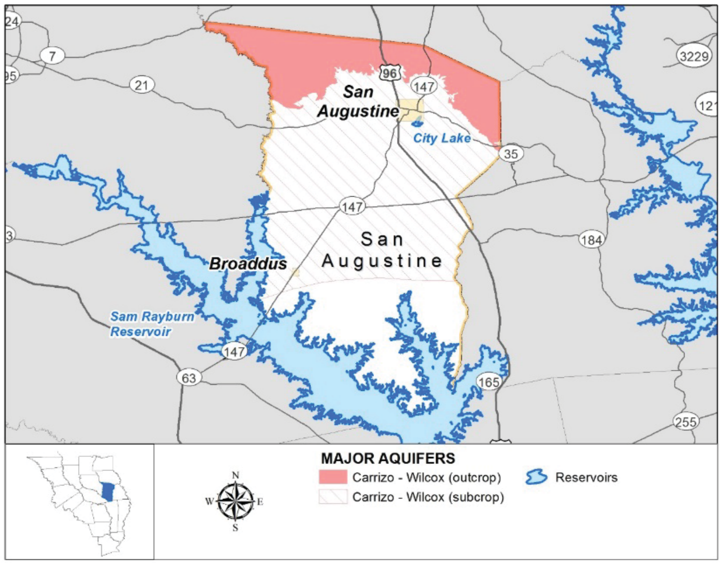
The current and future customers for G-M WSC are 1) G-M WSC, 2) Pendleton Harbor 3) El Camino 4) Dogwood Estates 5) Frontier Park 6) Cypress point. The existing sources of supply for G-M WSC are 1) groundwater wells 2) potable water from City of Hemphill 3) potable water from City of Pineland. G-M WSC would like to be independent of City of Hemphill purchases in five years. The WSC recently completed the construction of a WTP at a capacity of 1 MGD, and a 10-inch waterline from the WTP to FM 3121.

In terms of future projects, G-M WSC is planning some improvements and updates to distribution system infrastructure, expansion of the existing WTP to 2 MGD to potentially sell water to City of Hemphill, replacing water meters and constructing an elevated storage tank. Below is a summary of the list of water supply projects and the cost estimates provided by G-M WSC.

Strategy	Opinion of Probable Costs
Waterline Improvements	
Water Plant to Highway 83 Plant	$ 917,200
FM 3121 to City Limits	$ 535,800
North Bypass Loop around Hemphill	$ 454,200
South Bypass Loop around Hemphill	$ 773,200
TOTAL	$ 2,680,400
Water System Expansion	
Pendleton Harbor and Frontier Park Areas	-
Dogwood Estates and Other Areas of FM 2928	$ 514,750
El Camino, Millionaire Point, and Apache Drive	$ 881,040
Unserved Areas of East FM 2928	$ 594,700
TOTAL	$ 1,990,490
Surface Water Plant Improvements	$ 2,483,000
Highway 83 Plant – Elevated Tank	$ 745,500

County Summary. Below is a summary of WUGs in Sabine County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	All Aquifers, Toledo Bend Reservoir	0	None
G-M WSC	Carrizo-Wilcox, Toledo Bend Reservoir	0	Infrastructure Improvements
Hemphill	Toledo Bend Reservoir	0	None
Pineland	Carrizo-Wilcox	0	None
Irrigation	None	0	None
Livestock	All Aquifers, Local Supply	0	None
Manufacturing	Yegua-Jackson, Reuse, Run-of-River Neches	0	None
Mining	Yegua-Jackson, Toledo Bend Reservoir, Other Undifferentiated	0	None
Steam Electric Power	None	0	None



5B.2.16 San Augustine County. San Augustine County is in the Neches and Sabine River Basins. Current water supplies for the county include groundwater from the Carrizo-Wilcox, Sparta, and Yegua-Jackson aquifers and surface water from San Augustine Lake and local supplies. Available supplies to meet projected shortages include 1,400 ac-ft per year of unallocated groundwater and a small amount of surface water from San Augustine.

Mining. There is a shortage in mining needs for decades 2020 and 2030. San Augustine mining users have negotiated a contract with Angelina Neches River Authority of purchase of water from Angelina Neches River Authority's run-of-river supplies on Angelina River.

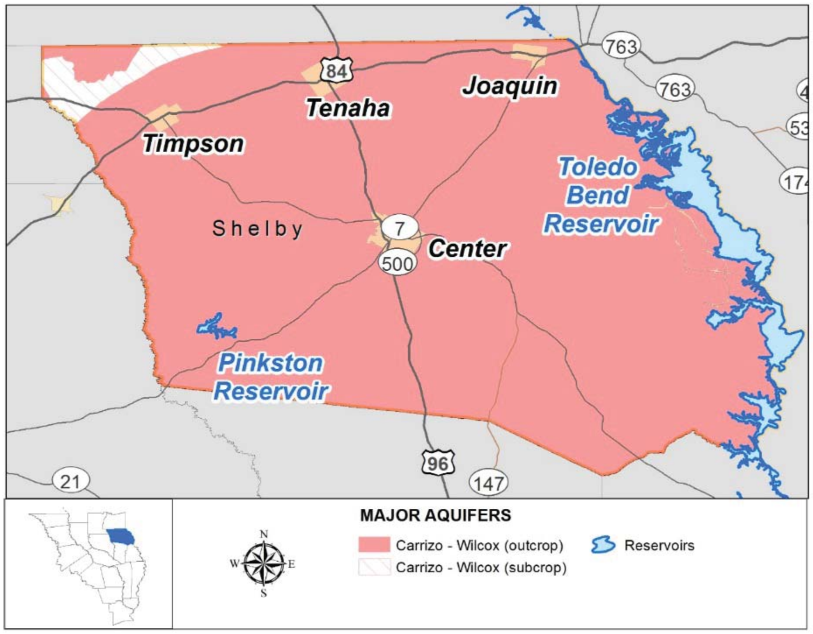
San Augustine Mining	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	2,102	1,102	0	0	0	0
Recommended Strategy SAUG-MIN: Purchase from ANRA (Run-of-River) (ac-ft per year)	2,102	1,102	0	0	0	0

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SAUG-MIN: Purchase from ANRA (Angelina ROR)	2,102	$21,064,000	$4,035,000	$1,920	$5.89

County Summary. Below is a summary of WUGs in San Augustine County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	All Aquifers, San Augustine Lake	0	None
G-M WSC	Carrizo-Wilcox, Toledo Bend Reservoir	0	None
San Augustine	Carrizo-Wilcox, San Augustine Lake	0	None
Irrigation	Carrizo-Wilcox	0	None
Livestock	Carrizo-Wilcox	0	None
Manufacturing	Carrizo-Wilcox	0	None
Mining	All Aquifers, Local Supply	2,102	Purchase from ANRA
Steam Electric Power	None	0	None



5B.2.17 Shelby County. Shelby County, which is located in the northeastern part of the region, uses groundwater from the Carrizo-Wilcox aquifer and surface water from Toledo Bend Reservoir, Lake Pinkston, and Center Lake. The largest water user in the county is livestock, and this demand is expected to nearly triple by 2070. The other major demand center is the City of Center and its customers. The total projected shortage for the county is 8,215 ac-ft per year. The Carrizo-Wilcox aquifer has a long-term availability of 6,000 ac-ft per year, and its estimated current use is approximately 4,500 ac-ft per year. There is some groundwater available for development and considerable supply available from Toledo Bend Reservoir. However, a Toledo Bend Reservoir strategy would require infrastructure development to treat and deliver the water to areas with needs. A long-term shift of water supply to surface water may be needed to address future water needs.

Livestock. Livestock water demands are projected to increase significantly in Shelby County, partially due to the growing poultry industry. Current supply is from Carrizo-Wilcox aquifer and local surface water supplies. It is recommended that any large-scale user should obtain surface water from Toledo Bend Reservoir through a contract with SRA.

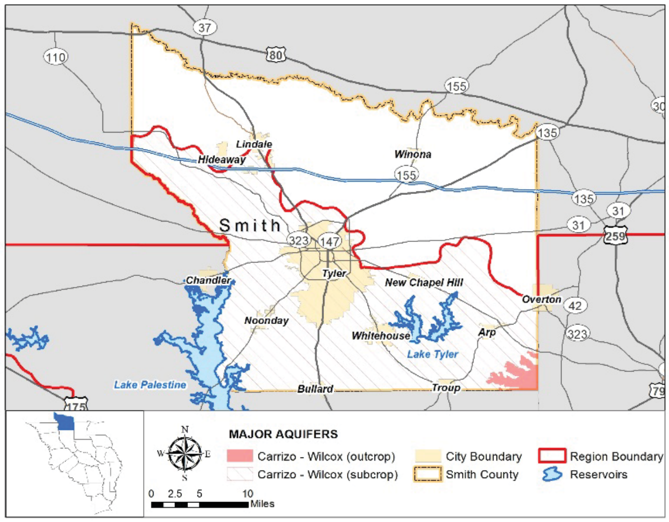
Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers.

Shelby County Livestock	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	1,368	2,376	3,603	5,100	6,925	6,925
Recommended Strategy SHEL-LTK: Purchase Raw Water from SRA (Toledo Bend Reservoir) (ac-ft per year)	1,368	2,376	3,603	5,100	6,925	6,925

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SHEL-LTK: Purchase Raw Water from SRA (Toledo Bend Reservoir) (ac-ft/year)	7,000	$25,238,000	$4,893,000	$699	$2.15

County Summary. Below is a summary of WUGs in Shelby County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Center	Carrizo-Wilcox, Lake Pinkston, Lake Center	0	Reuse Pipeline to Center Lake, Toledo Bend Pipeline to Center Lake (Discussion included in the WWP Summary)
County-Other	Carrizo-Wilcox, Lake Pinkston, Lake Center, Toledo Bend (LA)	0	None
Joaquin	Toledo Bend (LA)	0	None
Tenaha	Carrizo-Wilcox	0	None
Timpson	Carrizo-Wilcox	0	None
Irrigation	Carrizo-Wilcox, Reuse	0	None
Livestock	Carrizo-Wilcox, Local Supply	6,925	Purchase from SRA (Toledo Bend)
Manufacturing	Carrizo-Wilcox, Lake Pinkston, Lake Center	0	None
Mining	Carrizo-Wilcox, Toledo Bend	0	None
Steam Electric Power	None	0	None



5B.2.18 Smith County. Smith County is located partially in the ETRWPA and partially in Region D. Almost all of the supplies in Smith County in the ETRWPA come from City of Tyler sources and groundwater supplies. A small amount of water is supplied from Lake Jacksonville through the Cherokee WSC. The City of Tyler currently utilizes surface water from Lakes Tyler and Tyler East, Bellwood Lake and Lake Palestine. About 10 percent of Tyler's current supply is from the Carrizo-Wilcox aquifer.

The groundwater in Smith County is heavily used for water supply. Current use from the Carrizo-Wilcox aquifer, the county's largest groundwater supply, exceeds the Modeled Available Groundwater. Allocation of the current supplies resulted in an over-allocation of the Modeled Available Groundwater capacity. Therefore, current supplies in Smith County were reduced to cut back uniformly for all water users in Smith County to avoid over-allocation. In the allocation process, it was assumed that there is no additional Carrizo-Wilcox water available at this time. There is water available from the Queen City aquifer, but water quality concerns limit its potential use. The most likely sources for municipal water needs include surface water supplies from the City of Tyler and voluntary transfers from other users. The City of Tyler has indicated that it could provide potable water to most of the municipal WUGs with needs, with limited infrastructure in most cases. Irrigation and mining needs are shown to be supplied by the Queen City aquifer.

Bullard. Bullard's current supply is from the Carrizo-Wilcox aquifer. Due to competition for water from this source, the City is projected to have a shortage of nearly 1,000 ac-ft per year by 2070. It is recommended that Bullard purchase water from City of Tyler. Municipal conservation is another recommended strategy for Bullard. A potentially feasible strategy is to purchase water from North Cherokee WSC, which would be supplied from the WSC's participation in Lake Columbia project.

Another potentially feasible strategy for Bullard is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Smith County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, Bullard can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the Bullard will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Bullard	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	51	223	397	587	783	985
Recommended Strategy SMTH-BLD: Purchase from City of Tyler (ac-ft per year)	49	215	385	570	760	955
Recommended Strategy BULLARD: Water Conservation (ac-ft per year)	11	24	30	38	47	56

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SMTH-BLD: Purchase from City of Tyler (ac-ft/year)	955	$5,260,000	$848,000	$852	$2.62
Recommended Strategy BULLARD: Water Conservation (ac-ft/year)	56	0	$11,789	$489	$1.50

Crystal Systems Inc. Crystal Systems Inc. serves multiple counties in Regions C and D and Smith County in the ETRWPA. Water supplies to Crystal Systems in Smith County are from the Carrizo-Wilcox aquifer. Due to competition for this source, it is recommended that Crystal Systems Inc. purchase water from a local provider. For planning purposes, it is assumed that the City of Tyler would supply Crystal Systems Inc for the ETRWPA portion of the water demand. Water conservation is another recommended strategy for Crystal Systems Inc. in ETRWPA.

Another potentially feasible strategy for Crystal Systems Inc. is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Smith County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, Crystal Systems Inc. can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the Crystal Systems Inc. will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Crystal Systems Inc.	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	12	105	219	356	510	642
Recommended Strategy SMTH-CYS: Purchase water from the City of Tyler (ac-ft per year)	12	105	219	356	490	618
Recommended Strategy CYS: Water Conservation (ac-ft per year)	4	9	12	15	19	22

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Recommended Strategy SMTH-CYS: Purchase water from the City of Tyler (ac-ft/year)	618	$2,021,000	$417,000	$650	$1.99
Recommended Strategy CYS: Water Conservation (ac-ft/year)	22	0	$3,129	$865	$2.66

Lindale. Lindale is located in both Region D and the ETRWPA. The WSC obtains most of its water from the Carrizo-Wilcox aquifer. With the projected growth, Lindale is projected to have shortages starting by 2020. The shortages can likely be met through additional groundwater from the Carrizo-Wilcox aquifer. Pending availability, some water may come from wells located in Region D. For planning purposes, it is assumed that the additional supply will be from City of Tyler supplies in ETRWPA. Water conservation is another recommended strategy for Lindale.

Another potentially feasible strategy for Lindale is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Smith County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, Lindale can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the Lindale will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Lindale	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	310	451	596	746	310	451
Recommended Strategy SMTH-LDL: Purchase Water from City of Tyler (ac-ft per year)	46	169	308	471	638	797
Recommended Strategy LINDALE (ac-ft/year): Municipal Conservation (ac-ft per year)	8	17	22	28	34	41

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SMTH-LDL: Purchase Water from City of Tyler (ac-ft per year)	797	$5,803,000	$862,000	$1,044	$3.20
Rec. Strategy LINDALE: Municipal Conservation (ac-ft per year)	41	0	$7,967	$454	$1.39

R-P-M WSC. R-P-M WSC is located in both Region D and the ETRWPA. The WSC obtains most of its water from the Carrizo-Wilcox aquifer. With the projected growth, R-P-M WSC is projected to have shortages starting by 2020. The shortages can likely be met through additional groundwater from the Carrizo-Wilcox aquifer. Pending availability, some water may come from wells located in Region D. As the needs are small in magnitude, it is assumed that municipal conservation can address most of the needs.

Another potentially feasible strategy for R-P-M WSC is to drill additional wells in the Carrizo Wilcox aquifer. A groundwater strategy was not proposed as a recommended strategy because the Carrizo Wilcox aquifer in Smith County is over-allocated based on the Modeled Available Groundwater (MAG) supplies projected. When the MAG values are updated to address the over-allocation issues, R-P-M WSC can consider a strategy to drill additional wells in the Carrizo Wilcox aquifer.

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the R-P-M WSC will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

R-P-M WSC	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	4	23	36	54	71	86
Recommended Strategy RPM WSC (ac-ft/year): Municipal Conservation (ac-ft per year)	4	23	36	54	71	86

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy RPM WSC: Municipal Conservation (ac-ft per year)	86	0	$1,452	$488	$1.50

Manufacturing. Manufacturing is expected to have shortages beginning in 2020 at 1,764 ac-ft per year and increasing to 2,879 ac-ft per year by 2070. It is recommended that the manufacturing shortage be met through the purchase of additional supplies from the City of Tyler. This strategy will address the shortages for the manufacturing WUG both in ETRWPA and North East Texas Region (Region D) plan.

Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the potential manufacturing customers will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Smith County Manufacturing	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	1,764	1,982	2,192	2,370	2,614	2,879
Recommended Strategy SMTH-MFG (ac-ft/year): Purchase water from City of Tyler (ac-ft per year)	2,039	2,257	2,467	2,645	2,889	3,154

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SMTH-MFG (ac-ft/year): Purchase water from City of Tyler	3,154	$7,272,000	$1,698,000	$590	$1.81

Mining. The mining water demands in Smith County are based on historical water usage that appears to be no longer occurring. The TWDB currently reports only a small amount of groundwater use in Smith County for mining purposes. As a result the projected demands do not accurately reflect the current use. The TWDB has commissioned a study on water use for mining purposes across the State. This study should be completed for the development of the projected water demands for the 2016 water plan. Until such time as new mining demands are developed, it is assumed that the mining shortage be met through the purchase of additional supplies from the City of Tyler.

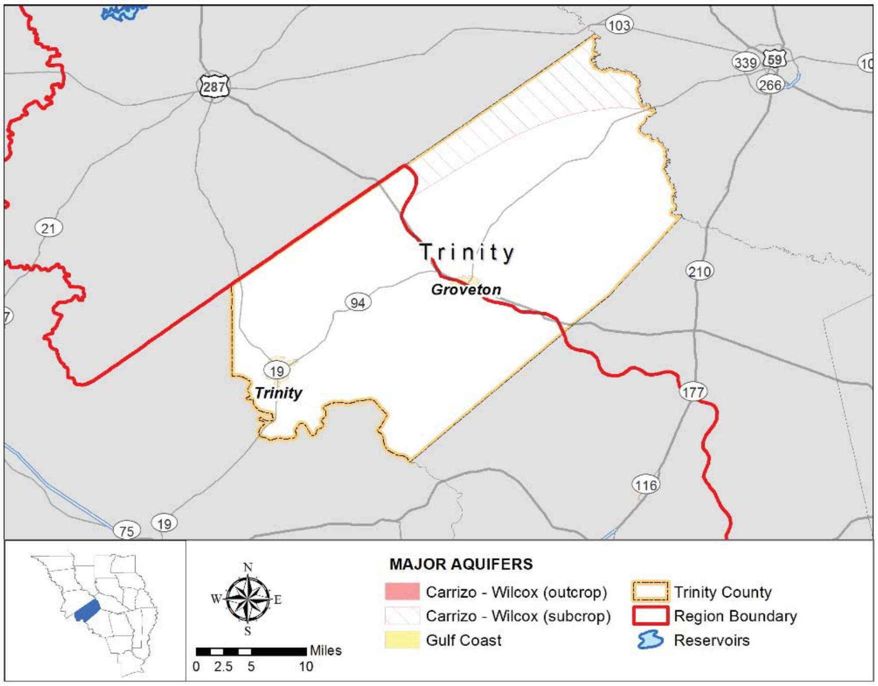
Purchased water costs for this strategy were established at a regional rate chosen for the anticipated category of use within the region. Actual purchased water costs will be determined during contract negotiations between provider and prospective buyers. It is assumed that the potential mining customers will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Smith County Mining	2020	2030	2040	2050	2060	2070
Supply(+)-Demand(-) (ac-ft per year)	108	113	114	83	54	32
Recommended Strategy SMTH-MIN: Purchase from City of Tyler (ac-ft/year)	108	113	114	83	54	32

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy SMTH-MIN: Purchase from City of Tyler	114	$3,103,000	$402,000	$3,526	$10.82

County Summary. Below is a summary of WUGs in Smith County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Arp	Carrizo-Wilcox	0	None
Bullard	Carrizo-Wilcox, Lake Jacksonville	995	City of Tyler, Water Conservation
County Other	Carrizo-Wilcox, Lake Tyler, Lake Palestine	0	None
Crystal Systems Inc	Carrizo-Wilcox	642	City of Tyler, Water Conservation
Dean WSC	Carrizo-Wilcox	0	None
Jackson WSC	Carrizo-Wilcox	0	None
Lindale	Carrizo-Wilcox	826	City of Tyler, Water Conservation
Lindale Rural WSC	Carrizo-Wilcox	0	None
New Chapel Hill	Carrizo-Wilcox	0	None
Noonday	Carrizo-Wilcox	0	None
Overton	Carrizo-Wilcox	0	None
R-P-M WSC	Carrizo-Wilcox	0	Municipal Conservation
Southern Utilities Company	Carrizo-Wilcox, Lake Tyler, Lake Palestine	0	None
Troup	Carrizo-Wilcox	0	None
Tyler	Carrizo-Wilcox, Lake Tyler, Lake Palestine	0	None
Walnut Grove WSC	Lake Palestine	0	None
Whitehouse	Carrizo-Wilcox, Lake Tyler, Lake Palestine	0	None
Wright City WSC	Carrizo-Wilcox	0	None
Irrigation	Carrizo-Wilcox, Lake Tyler, Lake Palestine, Other Aquifers	0	None
Manufacturing	Carrizo-Wilcox, Lake Tyler, Lake Palestine, Other Aquifers	2,879	City of Tyler
Livestock	Carrizo-Wilcox, Queen City, Local Supply	0	None
Mining	Local Supply, Other Undifferentiated	113	City of Tyler
Steam Electric Power	None	0	None



5B.2.19 Trinity County. The county is partially located in the ETRWPA and partially in Region H. Supplies include surface water from local supplies and the Neches River as well as groundwater from the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Other-Undifferentiated aquifers. Municipal demands in Trinity County are less than one percent of the ETRWPA's total municipal demand. While the supplies are limited compared to supplies in other counties in the ETRWPA, there is a small volume of water available for growth not projected in this plan. Irrigation is the only WUG with an identified need.

Irrigation. Current supplies include groundwater from the Yegua-Jackson aquifer and surface water from the Neches River. This is the first round of planning that projects an Irrigation demand in Trinity County (500 ac-ft per year), and the ETRWPA now believes that this demand may have been over estimated. In the event that the demand has not been overestimated, the ETRWPA is including an alternative strategy to meet this need with water purchased from Trinity County-Other. County-Other collectively has unused available supplies to meet the projected irrigation need beginning in 2020. This alternative strategy would require individual irrigation water users to purchase water from entities aggregated into the WUG County-Other. It is assumed that the potential irrigators will construct a raw water transmission system to transfer supplies from the City of Tyler supply sources. Cost estimates include capital cost for a pipeline, pump stations, and storage tanks.

Trinity Irrigation	2020	2030	2040	2050	2060	2070
Need (ac-ft per year)	331	331	331	331	331	331
*TRTY-IRR: Purchase from County-Other (Groundwater)** (ac-ft per year)	*331*	*331*	*331*	*331*	*331*	*331*

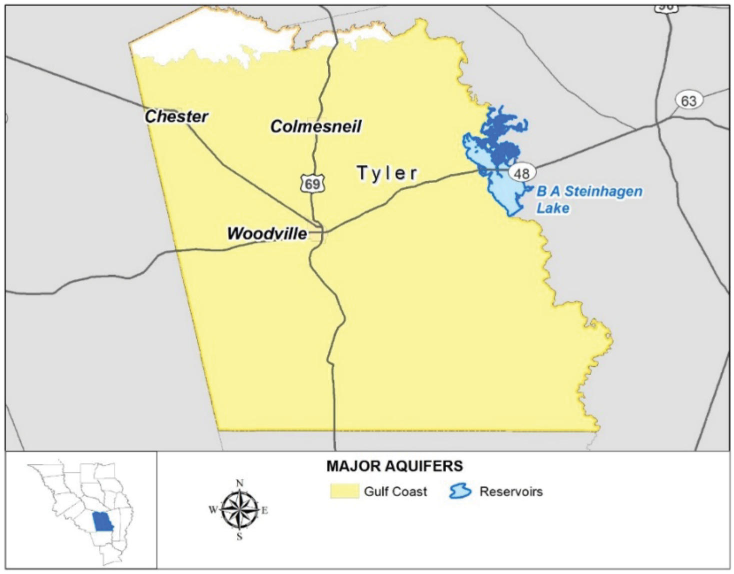
*Alternative Strategy

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
*Alt. Strategy TRTY-IRR: Purchase from County-Other (Groundwater)**	331	$2,174,000	$327,000	$988	$3.03

County Summary. Below is a summary of WUGs in Trinity County, current sources of supply, and recommended WMSs.

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
County Other	Yegua-Jackson, Trinity County Regional WS	-0	None
Groveton	Yegua-Jackson, Trinity County Regional WS	0	None
Irrigation	Yegua-Jackson	331*	----
Livestock	Yegua-Jackson, Local Supply	0	None
Manufacturing	None	0	None
Mining	Yegua-Jackson	0	None
Steam Electric Power	None	0	None

*ETRWPG believes that these demands are overestimated and there is no real shortage.



5B.2.20 Tyler County. Current supplies in Tyler County include groundwater from the Gulf Coast aquifer and surface water from Sam Rayburn Reservoir (LNVA), the Neches River, and local supplies. Tyler County represents less than 2 percent of the total municipal demand in the ETRWPA and has a total county demand of approximately 5,000 ac-ft per year. There is no projected need for any WUG located within Tyler County during the planning period. Based on the water availability estimates included in this plan, there is sufficient water to provide expected future demands in Tyler County. Below is a summary of WUGs in Tyler County, current sources of supply, and recommended WMSs.

Woodville. Woodville is located in Tyler County of the ETRWPA. The City obtains most of its water from the Gulf Coast aquifer and contracts additional supplies from Lower Neches Valley Authority. Currently, there are surplus supplies for Woodville to meet their long term projected demands for the regional planning cycle of 202-2070. The City is proactively planning for a conservation strategy to realize potential savings in the long term water supply that they can in turn provide to the City customers or in the form of sales to the steam electric power users in the Tyler County.

Woodville	2020	2030	2040	2050	2060	2070
Proactive Savings (ac-ft per year)	0	0	0	0	0	0
Recommended Strategy WOOD (ac-ft/year): Municipal Conservation (ac-ft per year)	0	0	10	16	18	19

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy RPM WSC: Municipal Conservation (ac-ft per year)	19	0	$3,992	$489	$1.50

Water User Group	Current Supplies	Maximum Shortage (ac-ft/yr)	Recommended Water Management Strategies
Colmesneil	Gulf Coast	0	None
County Other	Gulf Coast	0	None
Ivanhoe	Gulf Coast	0	None
Ivanhoe North	Gulf Coast	0	None
Lake Livingston Water Supply & Sewer Service Company	Gulf Coast	0	None
Tyler County WSC	Gulf Coast	0	None
Woodville	Gulf Coast, LNVA	0	Municipal Conservation
Irrigation	Gulf Coast, Run-of-River	0	None
Manufacturing	Gulf Coast	0	None
Mining	Gulf Coast, Local Supply	0	None
Livestock	Gulf Coast, Local Supply	0	None
Steam Electric Power	Gulf Coast, LNVA (Woodville)	0	None

5B.3 Wholesale Water Providers

This section provides discussions for wholesale water providers (WWP) located in the ETRWPA that meet one of the following criteria:

Has a projected shortage in supplies based on demands of current customers and current reliable supplies. These WWPs include Angelina Neches River Authority, Angelina Nacogdoches WCID #1, Athens MWA, City of Beaumont, Houston County WCID #1, and Upper Neches River Municipal Water Authority.

Has supply sources in the ETRWPA that are listed as WMSs for WUGs outside the Region. Both the UNRMWA and the SRA are included under this criterion.

Are currently pursuing WMSs to increase the reliability and/or distribution of their supplies. These include the Nacogdoches, Center, Lufkin, Port Arthur, Tyler, Jacksonville, SRA and LNVA.

5B.3.1 Angelina and Neches River Authority. Angelina Neches River Authority is the sponsor for the Lake Columbia project on Mud Creek in Cherokee and Rusk Counties. Lake Columbia is a recommended strategy in the 2011 Plan. Angelina Neches River Authority has been granted a water right permit (Permit No. 4228) by the TCEQ to impound 195,500 ac-ft and to divert 85,507 ac-ft per year (76.3 MGD) for municipal and industrial purposes. Angelina Neches River Authority currently has contracted customers for 53 percent of the 85,507 ac-ft per year permitted supply of the proposed Lake Columbia. In addition, Angelina Neches River Authority has been approached to supply water for mining purposes in Angelina, Cherokee, Nacogdoches, Shelby, San Augustine, Rusk, and Sabine counties. The mining demand will be met with run-of-the-river diversions.

The water suppliers currently under contract with Angelina Neches River Authority for water from Lake Columbia are listed with current participation percentage in the table below. Also included below is a table showing additional contracted customers Angelina Neches River Authority and the corresponding demand. The WMSs for Angelina Neches River Authority were developed to address the total customer demand.

There are four recommended strategies for Angelina Neches River Authority in the 2016 Regional Plan. They are 1) construction of Lake Columbia, 2) Angelina Neches River Authority treatment plant and distribution system, 3) development of 10,000 ac-ft per year of run-of-river supplies (application process is administratively complete) and an additional 20,000 ac-ft per year of run-of-river supplies in Cherokee County, and 4) development of groundwater supplies in Cherokee County.

Construction of Lake Columbia (Recommended). Lake Columbia is currently projected to be online by 2030. In the 2014 October Draft Long Range Water Supply Plan, City of Dallas is has listed Lake Columbia as a recommended strategy for 2070. After considering the local needs in the East Texas Region, Dallas' projected share of the proposed Lake Columbia project is 56,000 ac-ft per year by 2070. Angelina Neches River Authority has a water right for Lake Columbia and is currently seeking a 404 permit for construction. An environmental impact study (EIS) has been prepared for Lake Columbia under the direction of the USACE. The draft EIS was published on January 29, 2010 and public and agency comments on the draft EIS were provided on March 30, 2010. Currently, the Lake Columbia project is subject to completion of the EIS and issuance of the 404 permit from the U.S Army Corps of Engineers and a completion of Source Water Assessment. According to an April 2011 statement from USACE, a new Draft EIS is necessary before the EIS can be finalized. The consideration of the Draft EIS by USACE will likely involve additional studies and compliance with the USACE Mitigation Manual. Angelina Neches River Authority and participating entities will share in the costs associated with the Lake Columbia water management strategy. For reservoir construction, unit costs are based on the WAM Run 3 yield estimate of 75,700 ac-ft per year.

Angelina Neches River Authority treatment plant and distribution system (Recommended). The cities of Nacogdoches, Jacksonville, and Rusk are assumed to purchase raw water from Lake Columbia and develop their own raw water transmission and treatment facilities. Most of the municipal water users (and current customers of Angelina Neches River Authority) in Cherokee, Rusk, and Smith Counties will be purchasing treated water from Angelina Neches River Authority. Costs for water treatment and transmission system are shared among currently contracted entities that are assumed to buy treated water from Angelina Neches River Authority.

Run-of-River Supplies (Recommended). Another recommended strategy for Angelina Neches River Authority is to develop the run-of-river supplies. There are no construction cost to Angelina Neches River Authority associated with the development of run-of-river supplies. Angelina Neches River Authority will incur lawyer fees and other costs associated with the permitting process and coordination with Texas Commission on Environmental Quality. It is assumed that the mining customers will develop their own transmission systems to deliver run-of-river supplies from Mud Creek to the area of use, and those costs are included in the county summaries in Section 5B.2.

Groundwater Wells (Recommended). Angelina Neches River Authority will be developing groundwater supplies in the Carrizo-Wilcox aquifer in Rusk/Cherokee counties to meet the manufacturing demands for the Rusk County Refinery. Angelina Neches River Authority will be providing treated water to meet this demand. Angelina Neches River Authority is proposing to develop groundwater wells in Carrizo-Wilcox aquifer in Cherokee and Rusk Counties to meet the needs projected for Rusk County Refinery. There are sufficient quantities of groundwater available in the Carrizo-Wilcox aquifer in Cherokee and Rusk Counties. The cost estimates for developing the wells and supplying treated water are included in the summary table below.

A comparison of the water supplies versus the demands and the recommended strategies to be implemented is shown in the table below. A summary of the strategy costs is also provided below. The cost estimate reported in this section is the cost for developing the total yield of Lake Columbia, 75,600 ac-ft per year. It is assumed that Dallas will be responsible for 70 percent of the cost for the dam, relocations, and reservoir land acquisitions and Angelina Neches River Authority will be responsible for the remaining 30 percent. Capital costs for the dam and relocations were extracted from the cost estimates developed for the EIS (based on March, 2012 dollars) and updated to reflect September 2013 dollars. Included in the relocation costs are estimates for relocating the four state highways and one railway that will be impacted by the reservoir. Annual costs for the reservoir were developed assuming a 40-year debt service with 5.5% interest rate. Annual costs for the non-reservoir infrastructure was developed for a 20-year debt service with 5.5% interest rate.

Customers for Lake Columbia

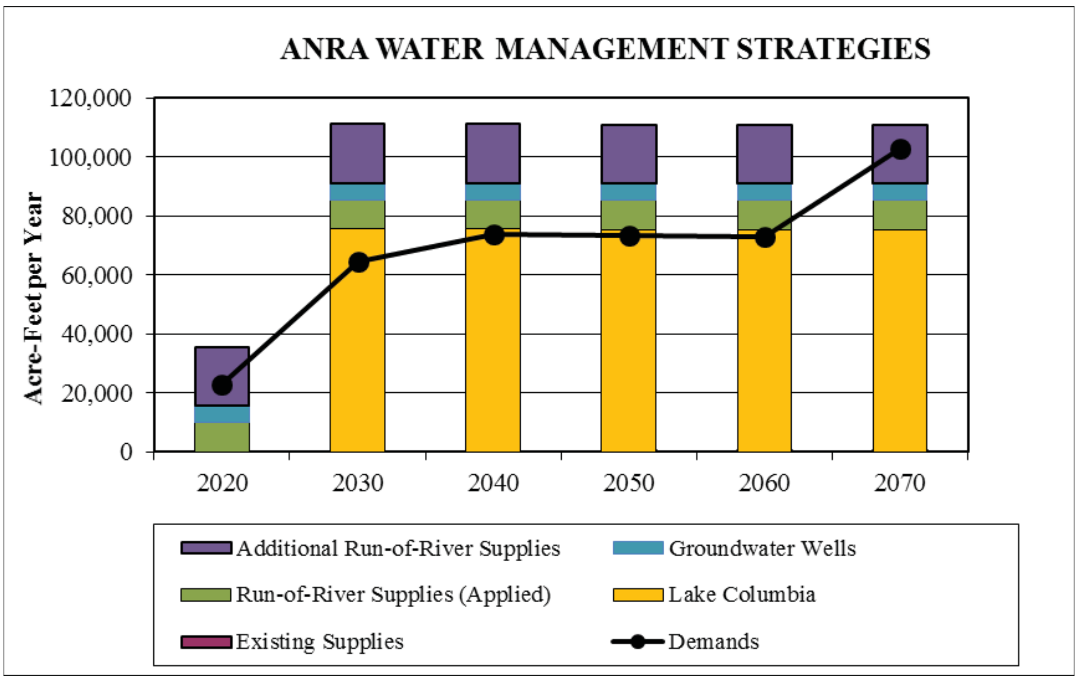
Recipient	County	Basin	Percent Participation in Columbia	Contract Amount (ac-ft per year)
Current Contracted Customers				
Afton Grove WSC, Stryker Lake WSC	Cherokee	Neches	4.5%	3,848
Jacksonville	Cherokee	Neches	5.0%	4,275
New Summerfield	Cherokee	Neches	3.0%	2,565
North Cherokee WSC	Cherokee	Neches	5.0%	4,275
Rusk	Cherokee	Neches	5.0%	4,275
Rusk Rural WSC	Cherokee	Neches	1.0%	855
City of Alto	Cherokee	Neches	0.5%	428
Caro WSC	Nacogdoches	Neches	0.5%	428
Nacogdoches	Nacogdoches	Neches	10.0%	8,551
New London	Rusk	Sabine	1.0%	855
Troup	Smith	Neches	5.0%	4,275
Arp	Smith	Neches	0.5%	428
Blackjack WSC	Smith	Neches	1.0%	855
Jackson WSC	Smith	Neches	1.0%	855
Whitehouse	Smith	Neches	10.0%	8,551
Additional Customers for Lake Columbia				
City of Dallas		Trinity		56,050

Additional Customer Demand for ANRA

Recipient	2020	2030	2040	2050	2060	2070
Holmwood Utility	65	70	70	70	70	70
Steam Electric Demand – Cherokee	8,000	15,000	20,000	20,000	20,000	20,000
Manufacturing – Rusk County Refinery	5,600	5,600	5,600	5,600	5,600	5,600
Mining - Angelina	474	573	398	300	225	168
Mining - Cherokee	238	247	210	147	84	40
Mining - Nacogdoches	5,475	2,975	118	0	0	0
Mining – San Augustine	2,102	1,102	0	0	0	0
Mining – Rusk	1,075	2,092	1,955	1,809	1,686	1,677
Total Future Customer Demand	**23,028**	**27,658**	**28,350**	**27,926**	**27,665**	**27,555**

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Jasper Aquifer	65	70	70	70	70	70
Demands (ac-ft per year)						
Potential Demand (Total)	68,347	72,977	73,669	73,245	72,984	102,905
Surplus or (Shortage)	**(22,963)**	**(64,356)**	**(73,559)**	**(73,175)**	**(72,914)**	**(102,835)**
Water Management Strategies (ac-ft per year)						
Lake Columbia	0	75,550	75,500	75,450	75,400	75,350
ANRA Treatment Plant and Distribution System	22,232	22,232	22,232	22,232	22,232	22,232
Run-of-River Supplies (Application in process)	10,000	10,000	10,000	10,000	10,000	10,000
Run-of-River Supplies (New Application)	20,000	20,000	20,000	20,000	20,000	20,000
Groundwater Wells (Rusk/Cherokee)	5,600	5,600	5,600	5,600	5,600	5,600
Total Supplies from Strategies	**35,600**	**111,150**	**111,100**	**111,050**	**111,000**	**110,950**
Surplus or (Shortage) with WMS	**12,572**	**46,724**	**37,431**	**37,806**	**38,017**	**8,046**

Strategy	Yield (ac-ft per year)	Capital cost	Annual Cost	Unit Cost ($/AF)	Unit Cost ($/1000 gal)
Lake Columbia Reservoir	75,600	$344,498,000	$25,161,000	$333	$1.02
ANRA Treatment Plant and Distribution System	22,232	$117,250,000	$41,859,000	$1,883	$5.78
Groundwater Wells (Cherokee/Rusk)	5,600	$26,023,000	$3,239,000	$578	$1.78
Run-of-River Supplies	30,000	0	0	0	0



5B.3.2 Angelina Nacogdoches WCID#1 (AN WCID#1). Angelina and Nacogdoches WCID#1 is a wholesale water provider to Steam Electric Power demands for Luminant and Nacogdoches Power in Cherokee and Nacogdoches counties respectively. In addition to these customers, Angelina Nacogdoches WCID#1 has a contract with Henderson in Rusk County for future use. The demand for the wholesale customers is supplied from Lake Striker. Angelina Nacogdoches WCID#1 owns a water right for 20,600 ac-ft per year from Lake Striker. The entity's supplies are not sufficient to meet the contracted demands, and Angelina Nacogdoches WCID#1 has shortages beginning in 2020. Table below includes a summary of demands and supplies for Angelina Nacogdoches WCID#1. The following recommended strategies were proposed by Angelina Nacogdoches WCID#1 for inclusion in the 2016 regional plan.

Hydraulic Dredging Operation (Recommended). Angelina Nacogdoches WCID#1 believes that the volumetric survey will result in an additional yield that will address shortages in the first two decades. To address the shortages in the later decades, a second recommended strategy was proposed. The strategy is to conduct hydraulic dredging of Lake Striker to address the Lake sedimentation issues and increase Lake yield. The timing for the dredging operation is expected to be in 2040. Angelina Nacogdoches WCID#1 provided an estimate of the total cost for this strategy. Angelina Nacogdoches WCID#1 also plans to work with TWDB on the adjustment of the normal pool elevation of Lake Striker. The additional yield associated with the normal pool elevation adjustment is not clear at this point but it is assumed to yield an approximate amount of 3,500.

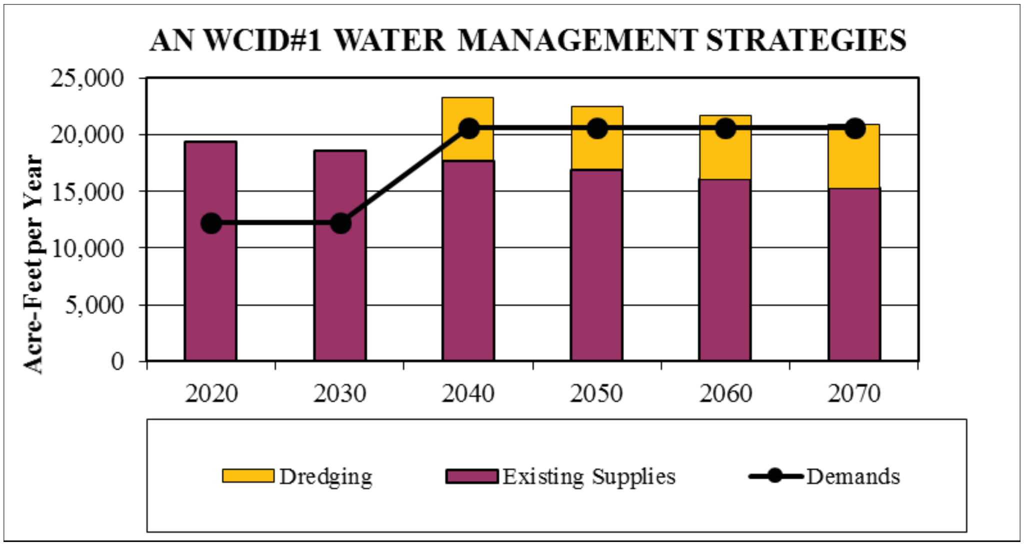
Internal studies conducted by Angelina Nacogdoches WCID#1 resulted in higher yield estimates for Lake Striker than those obtained from the Water Availability Model. Angelina Nacogdoches WCID#1 believes that the additional yield in Lake Striker is sufficient to meet the shortages manifested for this entity in this planning cycle. To address this inconsistency, Angelina Nacogdoches WCID #1 is considering to conduct volumetric survey of Lake Striker to determine the capacity of the lake and the resulting yield. Angelina Nacogdoches WCID#1 will coordinate with TWDB to schedule the volumetric survey. TWDB will charge a fee for conducting volumetric surveys. A cost estimate is not included for this strategy since this cost will be determined by Angelina Nacogdoches WCID#1 during their negotiations with TWDB.

A summary of the cost estimates for the recommended strategy is provided below. The demands for Angelina Nacogdoches WCID#1 also includes a contract with City of

Henderson for 8,280 acre-feet per year. While water management strategies are proposed to meet this demand, it was also noted that the contract for City of Henderson is a future demand and the supply to meet this contract is not required in the early decades of the planning cycles.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Striker	19,357	18,530	17,703	16,877	16,050	15,264
Demands (ac-ft per year)						
Demands	12,280	12,280	20,569	20,569	20,569	20,569
Surplus (Shortage)	**7,077**	**6,250**	**(2,866)**	**(3,692)**	**(4,519)**	**(5,305)**
Water Management Strategies (ac-ft per year)						
Hydraulic Dredging (Includes Volumetric Survey and Normal Pool Elevation Change)	0	0	5,600	5,600	5,600	5,600
Surplus or (Shortage) with WMS	**7,077**	**6,250**	**2,734**	**1,908**	**1,081**	**295**

Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Hydraulic Dredging Operations (Includes Volumetric Survey and Normal Pool Elevation Adjustment)	5,600	$23,716,000	-	$476	$1.46



5B.3.3 Athens MWA. Athens MWA is a wholesale provider for municipal demand in the City of Athens (Region C and ETRWPA), lakeside irrigation around Lake Athens, Livestock demand in Henderson County (ETRWPA - TPWD Fish Hatchery), and Manufacturing demand in Henderson County (Region C). Athens MWA owns and operates Lake Athens. Athens MWA also owns the Athens WTP, which is operated by the City of Athens. Athens MWA has a water right to divert 8,500 ac-ft per year from Lake Athens. Of this amount, approximately 5,780 ac-ft per year can be used to meet projected municipal and manufacturing demands of the City of Athens. Athens MWA also owns a groundwater well on their WTP property. The well produces approximately 966 ac-ft per year. The well is not yet operational but Athens MWA plans to start using the supplies shortly. There is also a projected local demand of 170 ac-ft per year for lawn irrigation around the lake. The Athens Fish Hatchery, located at the lake, has a contract with Athens MWA to divert 3,023 ac-ft per year from Lake Athens to serve the hatchery.

A summary of supplies and demands is included in the table below. The total projected shortages associated with Lake Athens for current customers are 5,986 ac-ft per year by 2070. Based on the shortages associated with current supplies, Athens MWA has proposed the following WMSs.

Conservation (Recommended). Municipal Conservation is a recommended strategy for the City of Athens. Most of the conservation is expected to be in the Region C portion of City of Athens. The savings realized from municipal conservation and the annual cost associated with the strategy are included in the summary table below.

Pump Station Improvements (Recommended). The existing treatment capacity for the City of Athens is 8 MGD, with a 7.5 MGD treated water pipeline to the city of Athens. The total yield from Lake Athens and the groundwater well at the WTP property is approximately 6 MGD. The WTP has sufficient capacity to treat the current supplies. Since the future supply from the groundwater wells will be directly added to the distribution system, there is no need for WTP capacity improvements. However, the Booster pump station at the WTP is limited by its capacity (5 MGD) and age. Athens MWA plans to replace the existing pump station with a new pump station with an average capacity of 6 MGD and peak capacity of 9 MGD. Therefore, the second recommended water management strategy for Athens MWA is to address the booster pump station infrastructure improvements at the WTP.

Reuse of Fish Hatchery Return Flows (Recommended). Another recommended strategy is the indirect reuse of flows returned from fish hatchery to Lake Athens**.** Currently, approximately 95 to 100 percent of the water diverted for the Fish Hatchery is returned to Lake Athens; however, the fish hatchery is under no contractual obligation to continue this practice. To assure adequate supplies for the fish hatchery and other uses, Athens MWA should work with the fish hatchery to assure that the hatchery continues to return diverted water to Lake Athens for subsequent reuse. For purposes of this plan, it is assumed that 95 percent of the contracted water will be returned. This equates to 2,872 ac-ft per year of additional supply.

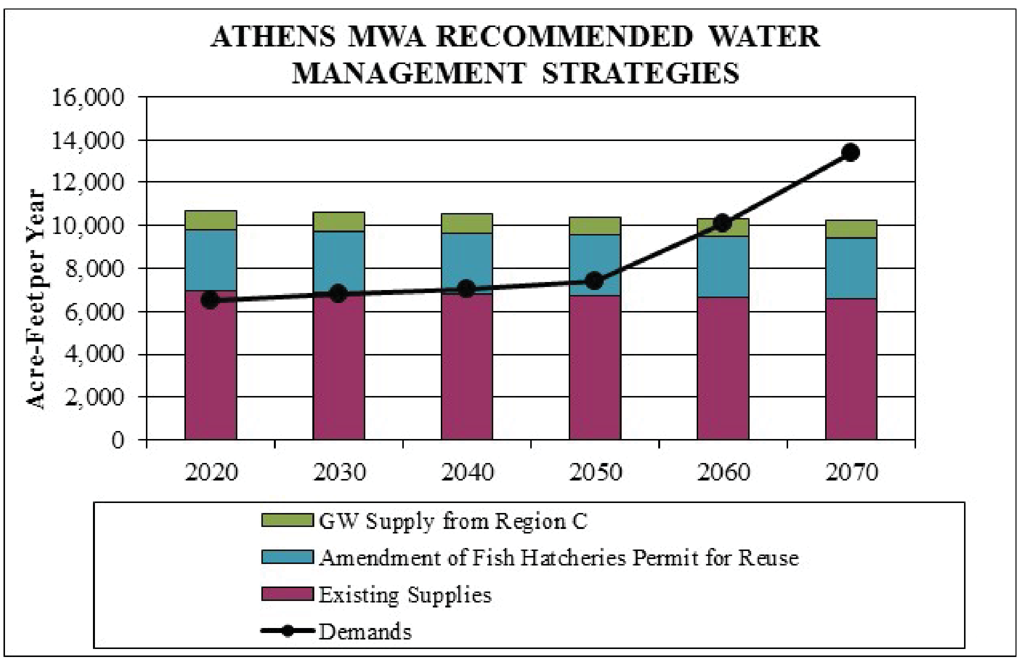
A summary of the amounts and timing of the recommended strategies is presented in the following table and figure.

New Groundwater Wells (Alternative). Athens MWA is currently pursuing developing groundwater from Carrizo-Wilcox aquifer on property near Lake Athens. It is anticipated that eight new wells (with a capacity of 750 gallons per minute each) will be drilled to provide a total of 4 MGD of groundwater supply. The water would be transported directly from the well field to the distribution system. The first well will be online in 2016. It should be noted that although Athens MWA has permits to develop the wells, this strategy cannot be included in the 2016 Regional Plan as a recommended strategy because of the MAG limitations. Current use in the Carrizo-Wilcox aquifer in Henderson County (both in Region C and I) is near the MAG for the county. Therefore, the groundwater wells are included as an alternative strategy for Athens MWA in the 2016 Regional Plan. The strategy will be changed to a recommended strategy when the MAG volumes are updated in the near future. Currently there is an unmet need of 2,657 ac-ft per year in 2070 for Athens MWA. Since this is the primary strategy for Athens MWA and the construction is already under-way, the 2016 Regional Plan will show shortages for Athens MWA, which in reality will be addressed by the well field development.

Another alternative water management strategy for Athens MWA is the reuse of City of Athens wastewater discharges. Recognizing the limitation of its existing supplies, Athens MWA has received a reuse permit that allows the City of Athens to discharge its wastewater effluent to Lake Athens and divert it from the lake for use. The reuse permit is for 2,677 ac-ft per year. However, a recent study by Region C for the 2011 Regional Plan showed that this strategy is less economically feasible than other alternatives. At this time, Athens MWA and the City of Athens are not pursuing reuse of Athens wastewater discharges.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Athens	5,983	5,903	5,822	5,741	5,660	5,580
Groundwater Well	966	966	966	966	966	966
Total Existing Supplies	6,949	6,869	6,788	6,707	6,626	6,546
Demands (ac-ft per year)						
Demands (ac-ft per year)	6,511	6,793	7,034	7,382	10,068	13,378
Surplus (Shortage)	1,283	920	599	170	(2,597)	(5,986)
Water Management Strategies (ac-ft per year)						
Municipal Conservation	59	98	119	144	277	457
Fish Hatchery Reuse	2,872	2,872	2,872	2,872	2,872	2,872
Infrastructure Improvements at WTP	1,121	1,121	1,121	1,121	1,121	1,121
Surplus or (Shortage) with Recommended WMS	**4,214**	**3,890**	**3,590**	**3,186**	**552**	**-2,657**
Alternative WMS – New Groundwater Wells (Carrizo-Wilcox)	*600*	*600*	*2,415*	*2,415*	*2,415*	*4,830*
Surplus or (Shortage) with Recommended And Alternative WMS	**4,814**	**4,490**	**6,005**	**5,601**	**2,967**	**2,173**

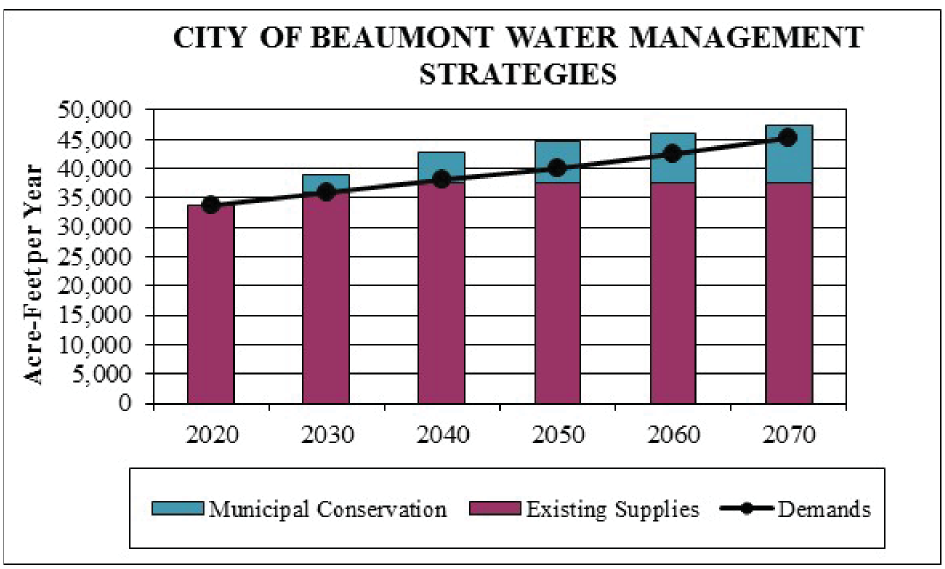
Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Municipal Conservation (Region C, City of Athens)	457	$242,560	$118,330	$258	$0.79
Recommended Strategy: Fish Hatchery Reuse	2,872	$ 0	$ 0	$ 0	$ 0
Recommended Strategy: 6 MGD Booster Pump Station Improvements at WTP	1,121	$2,900,000	$399,000	$59	$0.18
Alternative Strategy: New Groundwater (Carrizo-Wilcox)	*4,830*	*$9,456,000*	*$1,340,000*	*$277*	*$0.85*



5B.3.4 Beaumont. Current supplies include the Neches River, Gulf Coast aquifer, and purchases from Sam Rayburn Reservoir (LNVA); surface water supplies are limited by the City's water treatment plant capacity of 50 mgd. Infrastructure related to groundwater supplies includes three wells with a total capacity of 17 mgd. Beaumont currently supplies water to meet the demands of Jefferson County-Other, Jefferson Manufacturing, and Meeker MUD. Below is the description of the recommended strategy proposed for City of Beaumont in the 2016 Regional Plan.

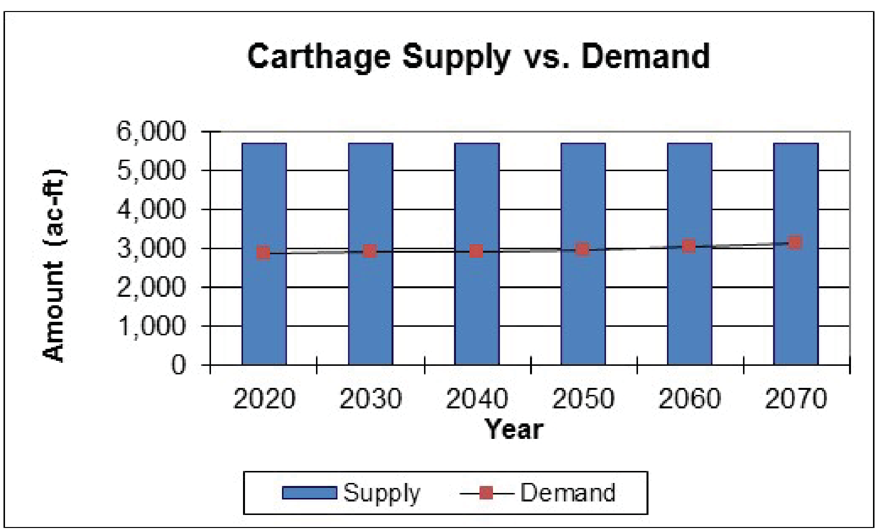
Municipal Conservation (Recommended). The City is projected to have a water shortage beginning in 2040. In 2011, the City had an average per capita consumption of 219 gpcd, well over the statewide goal of 140 gpcd. After performing a conservation cost analysis, the ETRWPG believes that a water conservation strategy for the City is economically achievable. This recommended strategy includes cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program. The proposed municipal conservation strategy would reduce Beaumont's demand by more than their projected need; therefore, municipal conservation is the only recommended WMS for the City. The description of the strategy and cost estimates are included in the discussion on WUG strategies for Jefferson County.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Municipal Run-of-River	15,407	16,180	17,087	18,254	19,637	20,876
Industrial Run-of-River	526	552	583	623	670	712
Gulf Coast Aquifer	9,500	9,500	9,500	9,500	9,500	9,500
Sam Rayburn (Base LNVA)	6,000	6,000	6,000	6,000	6,000	6,000
Sam Rayburn (Supplemental LNVA)	2,411	3,575	4,933	5,718	6,712	7,718
Total Existing Supplies (Limited by WTP Infrastructure)	**33,844**	**35,807**	**37,525**	**37,525**	**37,525**	**37,525**
Demands (ac-ft per year)						
Total Demand	**33,844**	**35,807**	**38,103**	**40,095**	**42,519**	**45,279**
Surplus or (Shortage) with Existing Supplies	**0**	**0**	**-578**	**-2,570**	**-4,994**	**-7,754**
Water Management Strategies (ac-ft per year)						
Municipal Conservation	0	3,238	5,341	7,047	8,579	9,966
Surplus or (Shortage) with WMSs	**0**	**3,238**	**4,763**	**4,477**	**3,585**	**2,212**



5B.3.5 Carthage. City of Carthage is a wholesale water provider in Panola County. The City is the wholesale provider for the Municipal, Manufacturing, and County-Other demands in Panola County. The City owns two groundwater wells that provide approximately 411 ac-ft per year. The City also has a contract with Panola County Fresh Water Supply District for 12 MGD (13,452 ac-ft per year) of water from Lake Murvaul. The City's supplies are limited by treatment capacity to 5,695 ac-ft per year. In this round of planning, City of Carthage has enough supplies to meet the projected demand for the customers in Panola County. Currently, no water management strategies are identified for the City. If the City signs contracts with additional potential customers, the WMSs will be considered in the next round of planning. Table below summarizes the demands, existing supplies, and surplus/deficit values.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Carrizo Wilcox Wells	411	411	411	411	411	411
Lake Murvaul (PC FWSD)	13,452	13,452	13,452	13,452	13,452	13,452
Total Supplies	13,863	13,863	13,863	13,863	13,863	13,863
Total Supplies limited by Treatment Capacity	5,695	5,695	5,695	5,695	5,695	5,695
Demands (ac-ft per year)						
Total Demand	2,855	2,896	2,927	2,965	3,043	3,125
Surplus or (Shortage)	**2,839**	**2,799**	**2,767**	**2,730**	**2,653**	**2,570**



5B.3.6 City of Center. The City of Center provides wholesale water to Shelbyville WSC and Sand Hills WSC in Shelby County. The City also provides water to retail customers in the City of Center and most of the manufacturing demand in Shelby County. City of Center serves Flat Fork WSC, East Lamar WSC, and Five Way WSC, but these WSCs are within the City limits and hence considered as part of the City of Center demands.

City of Center owns water rights for supplies in Lake Center and Lake Pinkston. Currently the City has sufficient supplies to meet the demand in decades 2020 to 2060 with a small shortage in 2070. The City is planning WMSs to proactively prepare for satisfying any additional demand in the decades through 2060 and address the shortage in 2070. Tyson is one of the major manufacturing demand users in Shelby County. Recently Tyson has expanded its plant operations and the current demand for Tyson alone is greater than the projected manufacturing demand for Shelby County. The City noted that the manufacturing demands for Shelby County are under-projected and need to be revised in the next round of planning.

To meet the current demands and higher expected future demands, the City has proposed two WMSs for the planning period, and they are discussed below.

Reuse (Recommended). The City is permitted to use the return flows from the East Bank WWTP. The discharge point for the treated effluent from the WWTP is on a tributary to Mill Creek. The City is planning an indirect reuse project by means of a reuse pipeline from East Bank WWTP to Lake Center. The total capacity for the indirect reuse project will be approximately 1 MGD (1,121 ac-ft per year) and the project will be online in 2020.

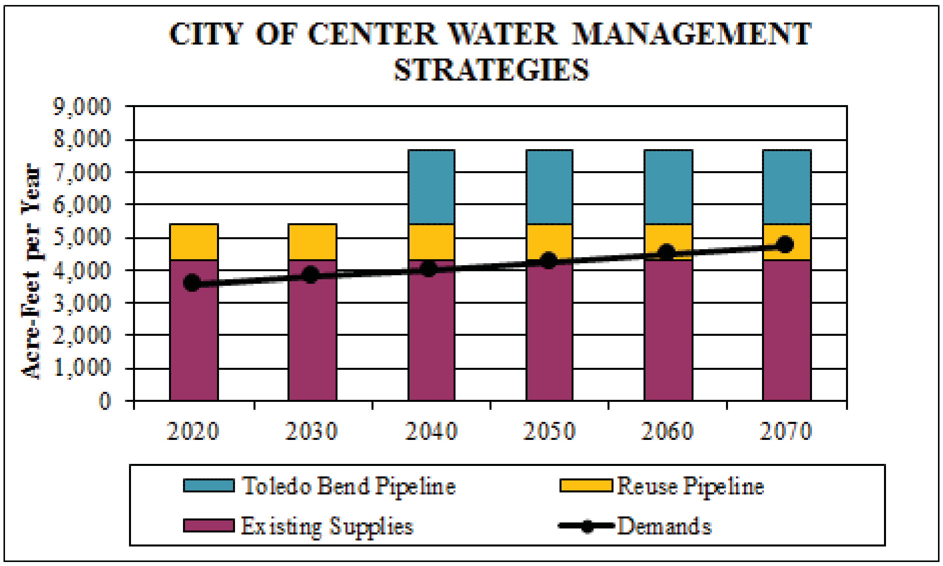
Toledo Bend to Lake Center (Recommended). The City is also planning to purchase water from Sabine River Authority and to transfer water from Toledo Bend Reservoir to Lake Center. The City will construct the raw water transmission pipeline from Toledo Bend Reservoir to Lake Center. At this time, it is not clear how much water Center will purchase from SRA. For planning purposes, it is assumed that the pipeline will be delivering approximately 7.5 MGD at peak capacity and an annual average of 5 MGD (5,605 ac-ft per year).

Volumetric Survey of Lake Center and Pinkston Reservoir. The City of Center is considering a strategy to conduct volumetric surveys of Lake Center and Pinkston Reservoir to develop an accurate estimate of the capacity of the lakes and thus the yields. The City of Center will coordinate with Texas Water Development Board to get on a schedule for the lake volumetric survey. Texas Water Development Board will charge a fee for conducting volumetric surveys, which is a variable depending on the size of the Lake. This is not proposed as a recommended strategy for City of Center in the 2016 ETRWPA but listed as one of the strategies that the City is considering to implement.

A summary of demands, existing supplies, and supplies from WMSs is listed in the table below. A summary of cost estimates is included in the table below. A detailed summary of the WMSs is included in the technical memorandums in Appendix 5B-A.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Center	485	485	485	485	485	485
Lake Pinkston	3,800	3,800	3,800	3,800	3,800	3,800
Demands (ac-ft per year)						
Total Demand	3,529	3,774	4,007	4,230	4,481	4,735
Surplus or (Shortage)	756	511	278	55	(196)	(450)
Water Management Strategies (ac-ft per year)						
Indirect Reuse Pipeline to Lake Center	1,121	1,121	1,121	1,121	1,121	1,121
Toledo Bend to Lake Center	0	0	2,242	2,242	2,242	2,242
Total Supplies from Strategies	1,121	1,121	3,363	3,363	3,363	3,363
Surplus or (Shortage) with WMS	**1,877**	**1,632**	**3,641**	**3,418**	**3,167**	**2,913**

Recommended Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Reuse Pipeline to Lake Center	1,121	$13,579,000	$1,672,000	$1,493	$4.58
Toledo Bend Pipeline	2,242	$27,775,000	$3,462,000	$1,544	$4.74



5B.3.7 Houston County WCID #1. Houston County WCID #1 owns and operates Houston County Lake in the Trinity River Basin in Houston County. This reservoir was originally permitted for 7,000 ac-ft per year; however, the TCEQ reduced the permitted diversion to 3,500 ac-ft per year in 1987. In 2009, Houston County WCID #1 applied to the TCEQ for a permit amendment to return their permitted diversion to the firm yield of the lake and add industrial use to the permit. Houston County WCID #1 upgraded their water treatment plant capacity from 3.1 mgd to 6.2 mgd in 2010.

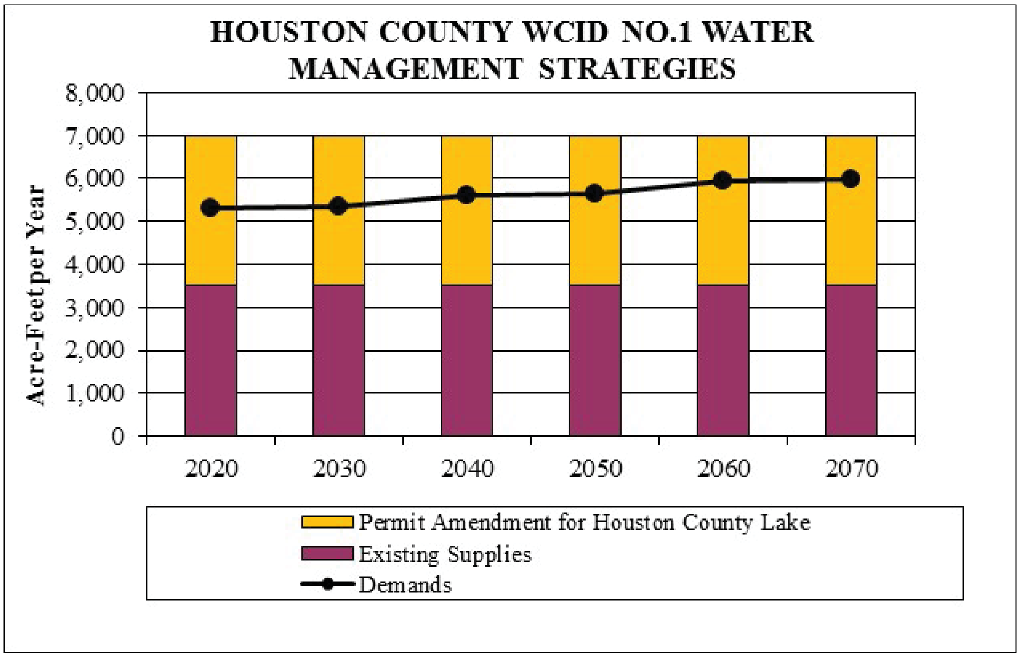
Permit Amendment for Houston County Lake (Recommended). Since 2007, Houston County WCID #1 has received multiple requests for additional water supplies from entities and business including the City of Crockett, the Crockett Economic &

Industrial Development Corporation, The Consolidated WSC, Nacogdoches Power, LLC, and the Houston County Judge, Erin Ford. This permit amendment is essential to meet the projected demands of both existing and future customers including The Consolidated WSC, the Cities of Crockett, Grapeland, and Lovelady, Houston county-Other, Houston Manufacturing, Nacogdoches Mining, and Nacogdoches Steam-Electric Power. Therefore, the permit amendment is proposed as the recommended strategy for Houston County WCID #1. Environmental flow requirements associated with the permit amendment are currently being negotiated with the TCEQ. It is assumed that there are little to no capital costs associated with the amendment (only engineering and legal costs).

Groundwater Supplies (Alternative). In the event Houston County WCID #1 is unable to reacquire all of their original water rights from the TCEQ, an alternative water management strategy is being added for this entity to develop new wells in the Carrizo-Wilcox aquifer.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Houston County Lake	3,500	3,500	3,500	3,500	3,500	3,500
Total Water Demands (ac-ft per year)						
Demands	5,313	5,343	5,622	5,647	5,929	5,963
Surplus or (Shortage) with Existing Supplies and Demands (ac-ft per year)						
Surplus or (Shortage)	(1,813)	(1,843)	(2,122)	(2,147)	(2,429)	(2,463)
Water Management Strategies (ac-ft per year)						
Recommended Strategy: Permit Amendment for Houston County Lake	3,500	3,500	3,500	3,500	3,500	3,500
Recommended Strategy: Transfer Groundwater Supplies to Nacogdoches Steam Electric Power User	1,000	1,000	1,000	1,000	1,000	1,000
Surplus or (Shortage) with WMS	**687**	**657**	**378**	**353**	**72**	**37**
Alternative Strategy (Groundwater Supplies)	*3,500*	*3,500*	*3,500*	*3,500*	*3,500*	*3,500*

Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Recommended Strategy: Permit Amendment of Houston County Lake	3,500	0	0	0	0
Alternative Strategy: Groundwater Wells	*3,000*	$22,793,000	$2,613,000	$747	$2.29



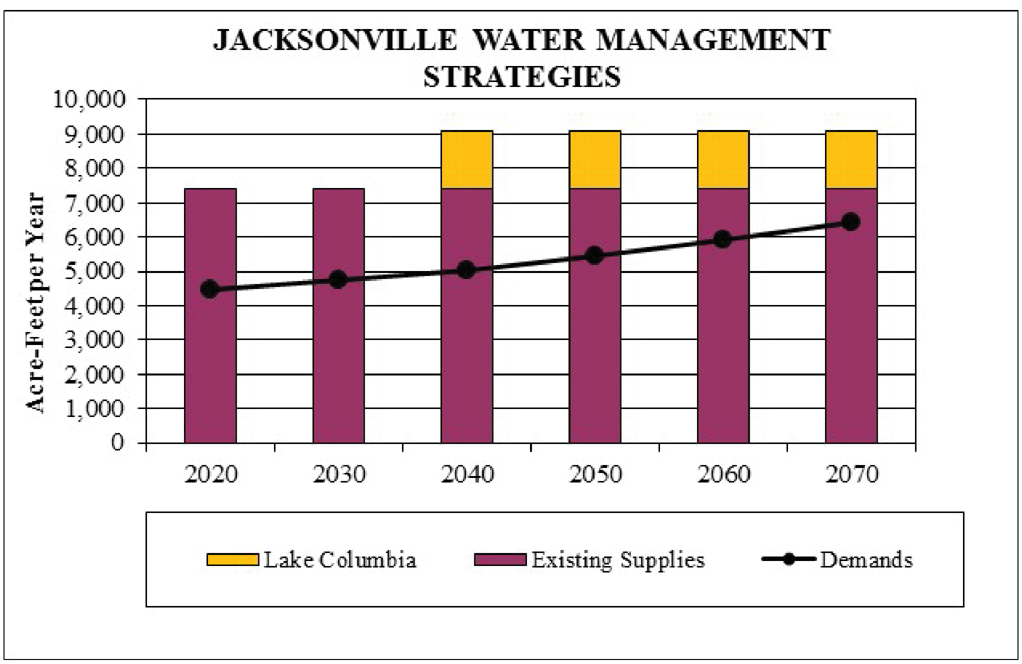
5B.3.8 City of Jacksonville. The City of Jacksonville has sufficient raw water and treatment capacity to meet its projected customer demands for the planning period. Jacksonville has a water right to use 6,200 ac-ft per year from Lake Jacksonville but available supply is limited treatment plant capacity. The City has several constraints to providing treated surface water to all its customers. The City's existing surface water treatment plant is currently underutilized and could provide more surface water with the necessary infrastructure improvements. Currently, the City operates the treatment plant for only part of the day. The City may be able to treat more raw water either by implementing infrastructure improvements to the treatment system or by operating the plant for longer time each day. It is recommended that the City of Jacksonville implement infrastructure improvements to fully utilize its existing water sources. City of Jacksonville has chosen to not implement this strategy at this time.

Raw Water Transmission System from Lake Columbia (Recommended). The recommended strategy for City of Jacksonville is a transmission and treatment system to access City's contracted supplies from Lake Columbia. The City of Jacksonville is a participant in the Lake Columbia project. Jacksonville has a contract with Angelina Neches River Authority for 4,275 ac-ft per year from Lake Columbia. Lake Columbia will provide a source of additional raw water for Jacksonville beyond this planning period or sooner if the City grows faster than projected. This strategy assumes that water would be diverted at Lake Columbia and transported to Jacksonville for treatment and distribution. It is assumed that the first phase of this project would develop 1,700 ac-ft per year (1.6 MGD). Subsequent phases would fully develop the City's contracted amount.

The Columbia to Jacksonville Raw Water Transmission System is the recommended WMSs for City of Jacksonville. Owing to the lack of shortages in supplies to current contracted customers and the low projected growth, the WMS is assumed to be long-term future strategies and not current strategies. A summary of current contracted customer demands, existing supplies, and additional supplies from future WMS is summarized in the table below. A summary of cost estimates for the recommended WMS is listed below. Detailed project summary is included in the technical memorandum in Appendix 5B-A.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Jacksonville	5,173	5,173	5,173	5,173	5,173	5,173
Lake Acker	0	0	0	0	0	0
Carrizo Wilcox Aquifer	2,218	2,218	2,218	2,218	2,218	2,218
Total Existing Supplies	7,391	7,391	7,391	7,391	7,391	7,391
Current Water Demands (ac-ft per year)						
Demands	4,463	4,743	5,034	5,431	5,903	6,423
Surplus or (Shortage) with Existing Supplies and Demands (ac-ft per year)						
Surplus or (Shortage)	2,928	2,648	2,357	1,960	1,488	968
Water Management Strategies (ac-ft per year)						
Lake Columbia to City of Jacksonville Raw Water Transmission System	0	0	1,700	1,700	1,700	1,700
Surplus or (Shortage) with WMS	**2,928**	**2,648**	**4,057**	**3,660**	**3,188**	**2,668**

Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Lake Columbia to Jacksonville Raw Water Transmission System	1,700	$ 20,645,000	$ 2,645,000	$ 1,556	$ 4.77



5B.3.9 Lower Neches Valley Authority. Current supplies for the Lower Neches Valley Authority include the Neches River, the B.A. Steinhagen Lake/Sam Rayburn Reservoir system (Sam Rayburn Reservoir), and a run-of-the-river diversion from the Trinity River in Region H. LNVA provides water to 18 WUGs in the ETRWPA and Region H. The projected water demands supplied by LNVA total over 725,000 ac-ft per year in 2070. In addition to these demands, there are over 400,000 ac-ft per year in potential future demands from existing and future customers by 2070. LNVA is pursuing four recommended WMSs to increase its reliable water supplies and to increase its infrastructure to provide conveyance to future customers. These include:

- Purchase from SRA (Toledo Bend Reservoir)
- Permit Amendment (Sam Rayburn Reservoir)
- Transfer to Region H
- Constructed Levy

In addition to these strategies, the construction of Rockland Reservoir is recommended as an alternative water management strategy. A brief discussion of each strategy is presented below.

Purchase from Sabine River Authority (Toledo Bend Reservoir) (Recommended). The proximity of the Sabine River Basin could make the transfer of water from the Sabine River a feasible strategy. The strategy would require a contract with SRA, approximately 13 miles of pipeline, 17 miles of open canals, and 2 pump stations. The strategy is estimated to provide approximately 200,000 ac-ft per year of supplies for LNVA's customers.

Permit Amendment for Unpermitted Yield in Sam Rayburn Reservoir (Recommended). In 1969 the Corps of Engineers converted 43,000 ac-ft of flood storage in Sam Rayburn Reservoir to water supply by raising the conservation pool from 164.0 ft msl to 164.4 ft msl. The associated firm yield was estimated at 28,000 ac-ft per year. A contract between the Corps and the City of Lufkin for this storage was approved on May 22, 1969; however, a water right for the additional yield was never submitted to the TCEQ. When the City of Lufkin began preliminary design to use this supply the LNVA converted 28,000 ac-ft per year of its Sam Rayburn Reservoir water right to Lufkin, with the intent of submitting a water right application to TCEQ for this amount. This strategy recommends that the LNVA submit a water rights application for the 28,000 ac-ft per year of supply that is associated with the increase of conservation elevation to 164.4 ft msl. The implementation of this strategy would not require construction of additional infrastructure or additional studies.

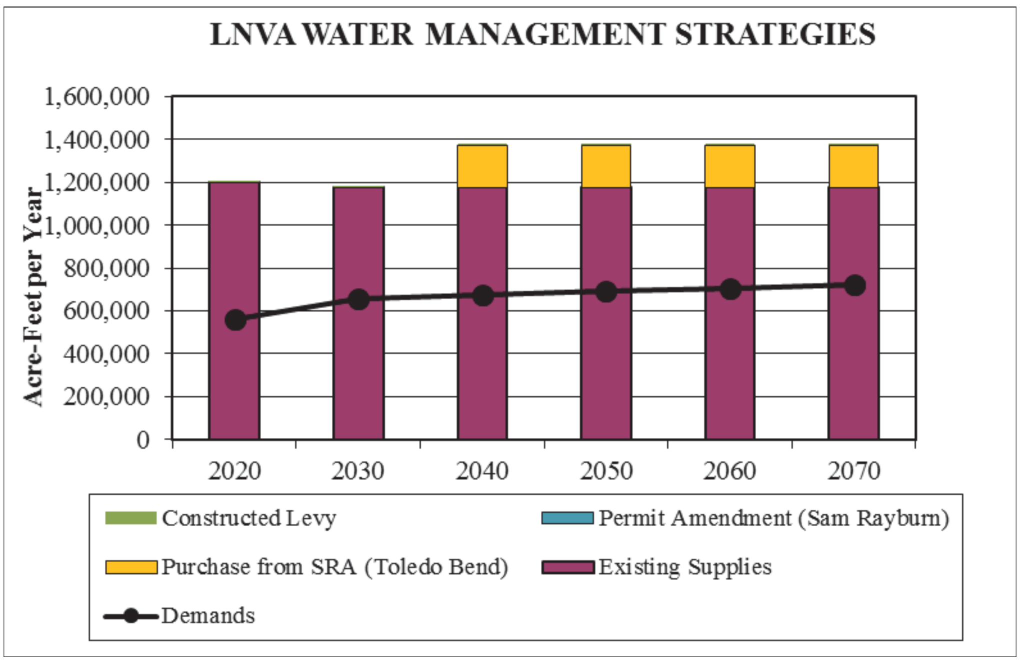
Transfer to Region H (Recommended). LNVA has potential future customers in Liberty County (Region H). To supply water to this county, LNVA is planning a water management strategy to transfer 55,000 ac-ft per year to Region H. A transmission system to transfer these supplies will require 8 miles of pipeline, five miles of open canals, and one pump station with a firm capacity of 100 MGD. The customer for this strategy is Liberty Irrigation, but once a connection is made, this new system could provide water to meet municipal and manufacturing demands in Liberty County.

Constructed Levy (Recommended). This recommended strategy would provide enough storage to provide supply to meet three days of existing municipal and industrial demands. The supply amount for this strategy is approximately 1,600 ac-ft per year. The reservoir would make the supply to these customers more reliable in case of temporary interruptions in water delivery.

Rockland Reservoir (Alternative Strategy). Rockland Reservoir was authorized for construction, as a federal facility, in 1945 along with Sam Rayburn Reservoir, Lake B. A. Steinhagen and Dam A Lake. A 1947 report recommended construction of Sam Rayburn Reservoir and Lake B.A. Steinhagen with deferral of Rockland Reservoir and Dam A until such time the need develops. The Rockland Reservoir site is located on the Neches River at River Mile 160.4. The top of the flood pool would be at elevation 174 ft. msl with the conservation pool at 165 ft. msl. The Reservoir Site Protection Study updated the yield and costs for the Rockland Reservoir using ENR indexing (TWDB, 2007). No recent detailed cost data has been developed for Rockland Reservoir. Based on the TWDB study, the estimated yield of Rockland is 614,400 ac-ft per year and the unit cost of water is $0.43 per 1000 gallons (updated to September, 2013 dollars). More detailed studies are needed to confirm the yield and costs for this project.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Sam Rayburn / B.A. Steinhagen	792,000	792,000	792,000	792,000	792,000	792,000
Pine Island Bayou Run-of-River	381,876	381,876	381,876	381,876	381,876	381,876
Lufkin (Sam Rayburn)	28,000	0	0	0	0	0
Total Existing Supplies	**1,201,876**	**1,173,876**	**1,173,876**	**1,173,876**	**1,173,876**	**1,173,876**
Demands (ac-ft per year)						
Demand	558,908	659,539	675,455	691,216	707,414	724,316
Surplus or (Shortage)	**642,968**	**514,337**	**498,421**	**482,660**	**466,462**	**449,560**
Water Management Strategies (ac-ft per year)						
Purchase from SRA (Toledo Bend)	0	0	200,000	200,000	200,000	200,000
Permit Amendment (Sam Rayburn)	28,000	28,000	28,000	28,000	28,000	28,000
Constructed Levy	1,600	1,600	1,600	1,600	1,600	1,600
Total Increase in Supplies from WMSs	**1,600**	**1,600**	**201,600**	**201,600**	**201,600**	**201,600**
Transfer to Region H	0	0	55,000	55,000	55,000	55,000
Surplus or (Shortage) with WMSs	**644,568**	**515,937**	**645,201**	**629,260**	**613,062**	**596,160**

Strategy	Quantity (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Purchase from SRA (Toledo Bend)	200,000	$399,955,000	$105,144,000	$526	$1.61
Permit Amendment (Sam Rayburn)	28,000	NA	NA	NA	NA
Constructed Levy	1,600	$34,989,000	$3,055,000	$1,909	$5.86
Transfer to Region H	55,000	$48,949,000	$23,905,000	$435	$1.33



5B.3.10 City of Lufkin. The City of Lufkin currently relies on groundwater from the Carrizo-Wilcox aquifer and surface water from Lake Kurth and Sam Rayburn Reservoir. The City's groundwater infrastructure includes 25 wells, including 14 wells acquired from the Abitibi Bowater Corporation. Currently, twelve of the wells provide potable water. Two additional wells have been upgraded to provide potable water, but they are currently permitted for Industrial use and are being re-permitted for Municipal use. The City plans to convert two non-potable wells per year to provide potable water; these upgrades will be complete by 2020. The City provides water to Diboll, Huntington, Redland WSC, Angelina County-Other (Burke, Angelina Freshwater Supply, and Woodlawn WSC) and Manufacturing, Steam-Electric Power, and Irrigation demands in Angelina County. Lufkin has one recommended WMS to expand their developed supplies and provide conveyance from Sam Rayburn Reservoir to Lake Kurth. With additional groundwater and surface water supplies, the City expects to provide up to an additional 16 MGD of water to meet industrial demands in Angelina County.

While the City of Lufkin does not show a water supply shortage within the planning period, Angelina Manufacturing does. Therefore, the ETRWPG is recommending that a portion of the supplies developed by the City of Lufkin be used to meet the projected industrial needs in the county. The City of Lufkin's recommended strategy is described below.

Develop Sam Rayburn Reservoir Water Rights (Recommended). To meet the City of Lufkin's long-term water needs, Lufkin is continuing to plan and develop a water management strategy to utilize its surface water rights in Sam Rayburn Reservoir. In the late 1960's, the City of Lufkin purchased storage and water production rights for surface water from Sam Rayburn Reservoir through contracts with the LNVA and the U.S. Army Corp of Engineers. The City has a water right to divert up to 28,000 ac-ft annually of surface water from the reservoir. This equates to an average withdrawal rate of 25 MGD.

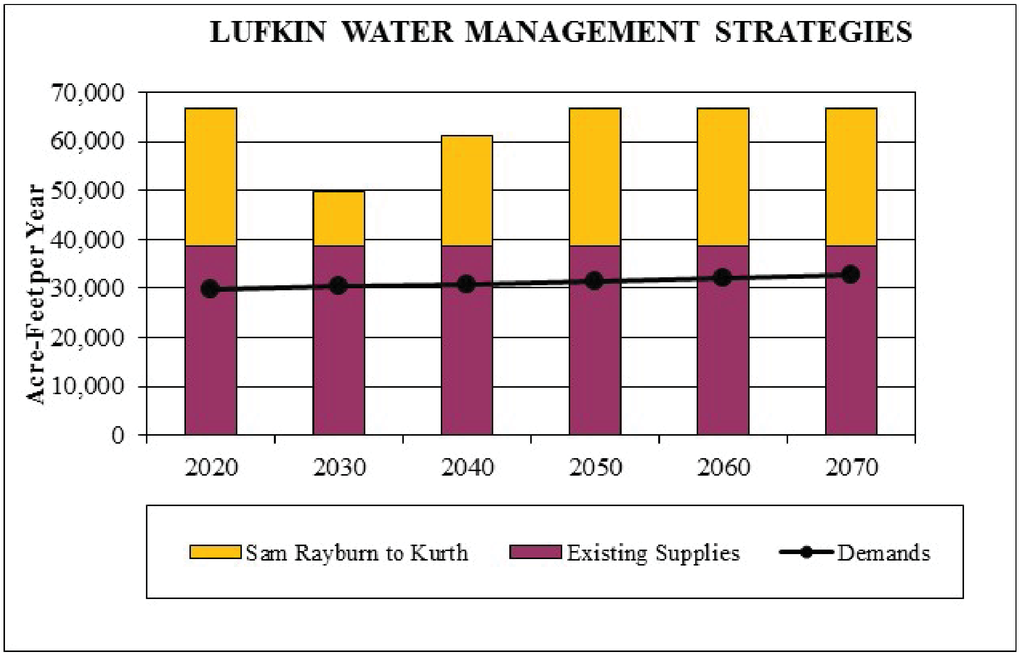
With the acquisition of Lake Kurth, the long-range plan is to expand the surface water treatment plant near Lake Kurth and treat raw water from Sam Rayburn Reservoir at the expanded facility. For planning purposes, it is assumed that water from Sam Rayburn Reservoir will be diverted from the northern end of the Lake and transported through a 36-inch pipeline. The treatment plant proposed at Lake Kurth will be initially expanded from 16 MGD to 25 MGD with the potential for further expansions beyond this planning period. This strategy is expected to be developed in three phases, with the first phase to develop access to 10 MGD of Sam Rayburn supplies by 2020, second phase with an additional 10 MGD capacity expansion by 2030, and the final phase of 5 MGD capacity expansion by 2040. The initial size of the treatment facility will depend on the projected needs at the time.

The supplies and demands associated with the City of Lufkin are shown in the following table and figure.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Carrizo-Wilcox	20,227	20,227	20,227	20,227	20,227	20,227
Lake Kurth	18,417	18,413	18,408	18,404	18,400	18,396
Total Existing Supplies	**38,644**	**38,640**	**38,635**	**38,631**	**38,627**	**38,623**
Demands (ac-ft per year)						
Total Demand	29,749	30,332	30,878	31,418	32,000	32,588
Surplus (Shortage)	**8,894**	**8,307**	**7,757**	**7,213**	**6,627**	**6,035**
Water Management Strategies (ac-ft per year)						
Sam Rayburn Reservoir	0	11,210	22,420	28,000	28,000	28,000
Surplus or (Shortage)	**8,894**	**19,517**	**30,177**	**35,213**	**34,627**	**34,035**

Estimates of capital costs for the Lufkin strategies are included in the table below.

Recommended Strategy (Phased)	Yield (ac-ft per year)	Total Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Sam Rayburn Supply – Phase 1 (2030)	11,210	$49,368,000	$12,503,000	$1,115	$3.42
Sam Rayburn Supply – Phase 2 (2040)	11,210	$37,863,000	$23,373,000	$1,051	$3.23
Sam Rayburn Supply – Phase 3 (2050)	5,760	$2,760,000	$22,797,000	$814	$2.50

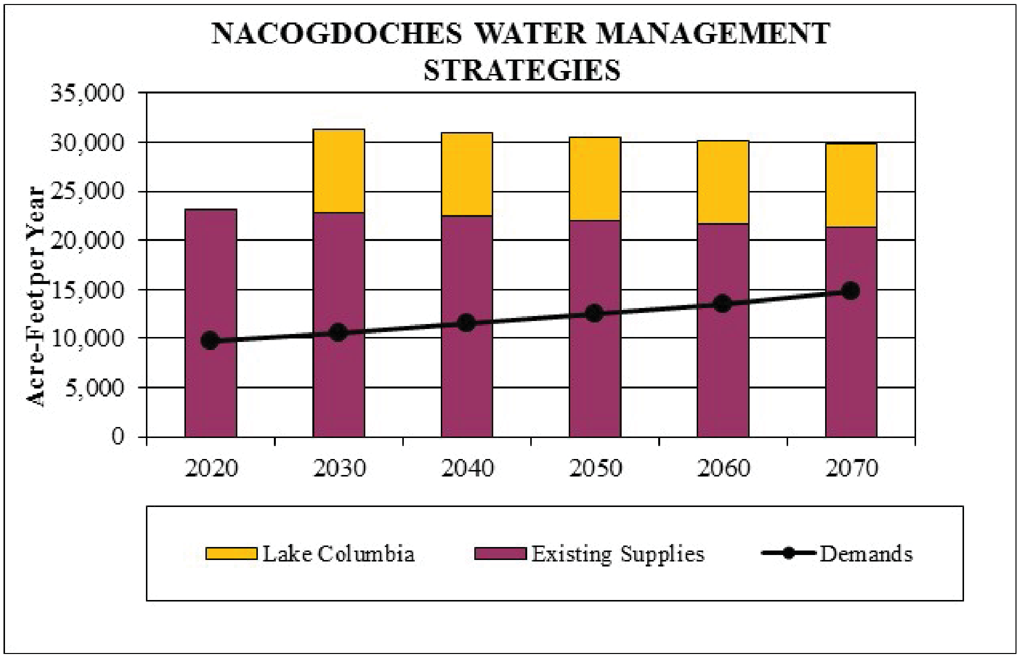


5B.3.11 City of Nacogdoches. The City of Nacogdoches utilizes groundwater from the Carrizo-Wilcox aquifer and surface water from Lake Nacogdoches. In addition to the City of Nacogdoches retail customers, the City is a wholesale water provider to Appleby WSC, D&M WSC, Nacogdoches MUD#1, Lily Grove SUD, and Melrose WSC. Most, if not all, of the manufacturing demands in the county are also supplied by the City. The Neches WAM shows the firm yield of Lake Nacogdoches to be approximately 16,683 ac-ft per year by 2020, reducing to 14,776 ac-ft per year by 2070. Groundwater from the Carrizo-Wilcox aquifer is used to supply much of the southern part of the city, and the City of Nacogdoches has been increasing its groundwater supplies to better serve this section of the city. Since the completion of 2011 Regional Plan, the City has developed two new wells, rehabilitated two existing wells, and is in the process of developing another new well. With the City's existing groundwater supplies, Nacogdoches has a reliable supply of approximately 21,000 ac-ft per year. This supply is sufficient to meet the projected demands in this plan, but the City's current water planning efforts indicate greater population growth and higher demands by the commercial and manufacturing sectors than projected by the TWDB.

Raw Water Transmission System to Lake Columbia (Recommended). The City of Nacogdoches is pursuing one recommended WMS to increase the reliability of its supplies and provide for projected growth using surface water from Lake Columbia. The City of Nacogdoches is also among those contracted for participation in the Lake Columbia project. The City proposes to obtain raw water from Lake Columbia to transmit to Lake Nacogdoches. The existing treatment plant would be expanded to treat the additional water. Currently, there are no alternative strategies proposed for City of Nacogdoches. A summary of demands, existing supplies, and increased supplies from WMSs is provided in the table below. Cost estimates were developed for the raw water transmission system from Lake Columbia to City of Nacogdoches. A summary of cost estimates is included in the table below. A detailed summary of the WMSs is included in the technical memorandums in Appendix 5B-A.

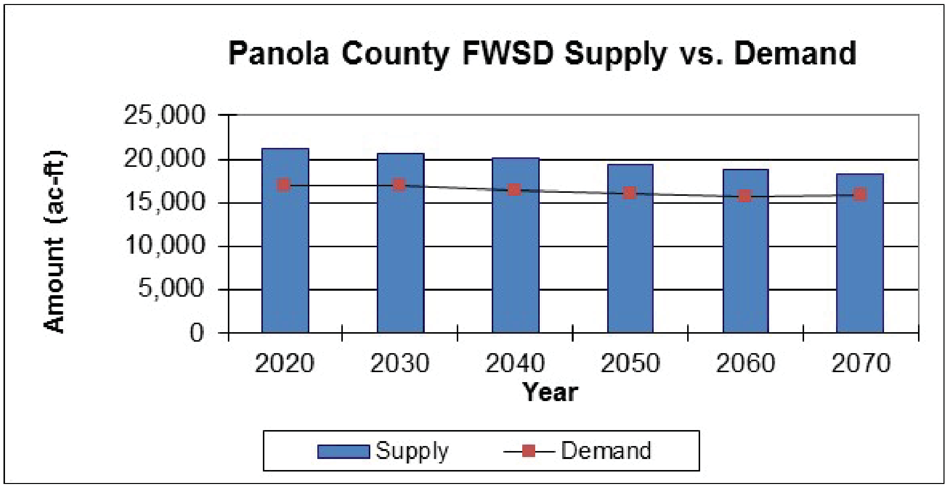
	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Carrizo-Wilcox	6,492	6,492	6,492	6,492	6,492	6,492
Lake Nacogdoches	16,683	16,300	15,917	15,533	15,150	14,776
Demands (ac-ft per year)						
Total Demand	9,761	10,629	11,511	1,464	13,576	14,758
Surplus or (Shortage)	13,415	12,163	10,898	9,562	8,066	6,510
Water Management Strategies (ac-ft per year)						
Lake Columbia to Nacogdoches Raw Water Transmission System	0	8,500	8,500	8,500	8,500	8,500
Surplus or (Shortage) with WMS	**13,415**	**20,714**	**19,449**	**18,113**	**16,617**	**15,061**

Recommended Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Lake Columbia to Nacogdoches Raw Water Transmission System	8,500	$35,829,000	$5,995,000	$705	$2.16



5B.3.12 Panola County Fresh Water Supply District. Panola County Fresh Water Supply District (PC FWSD) is a wholesale water provider in Panola County. PC FWSD is the wholesale provider to City of Carthage and Mining demands in Panola County. PC FWSD owns and operates Lake Murvaul and has a water right for 22,400 ac-ft per year. In this round of planning, PC FWSD has enough supplies to meet the projected customer demand for the planning period 2020-2070. Currently, no WMSs were identified for this entity. Table below summarizes the demands, existing supplies, and surplus/deficit values.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Murvaul	21,203	20,615	20,027	19,438	18,850	18,279
Demands (ac-ft per year)						
Total Demand	17,002	16,967	16,481	16,013	15,624	15,815
Surplus or (Shortage)	**4,201**	**3,648**	**3,546**	**3,425**	**3,226**	**2,464**

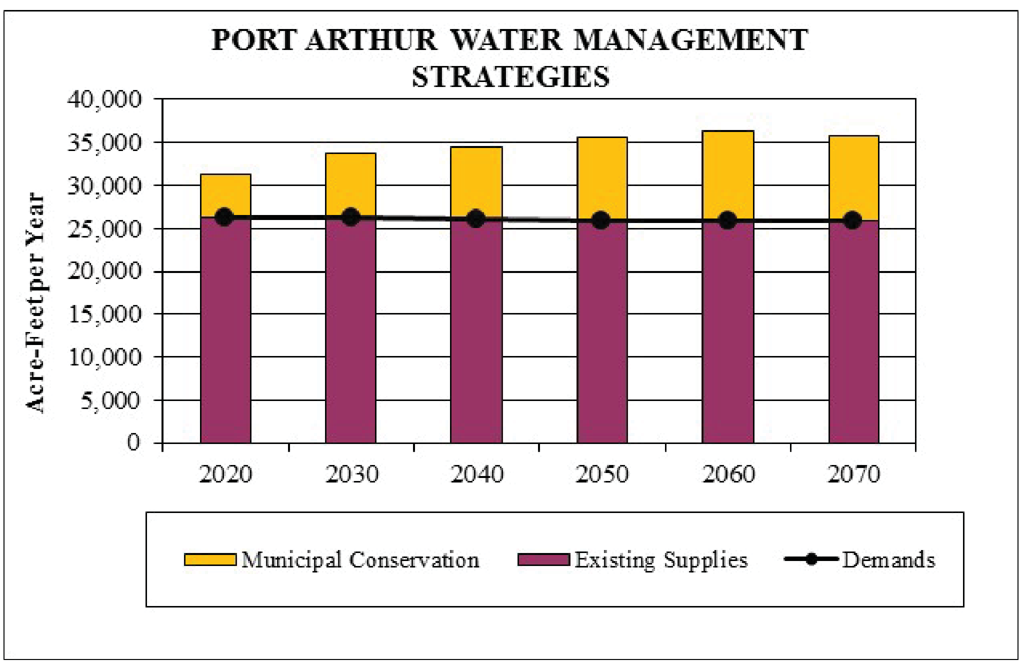


5B.3.13 Port Arthur. Current supplies for the City of Port Arthur include raw surface water from Sam Rayburn Reservoir (LNVA). LNVA provides 100 percent of the City's demands; this supply is limited by Port Arthur's water treatment plant capacity of 20 mgd. Construction to upgrade the treatment plant to 40 mgd began in 2014. The City provides treated water to municipal users both inside and outside the city limits and to industrial users including Cheniere LNG and Motiva Enterprises. Below is a description of the recommended WMS for Port Arthur.

Municipal Conservation (Recommended). Port Arthur is not projected to have a water shortage within the planning period. However, the City had an average per capita consumption of 320 gpcd in 2011. This value is well over the statewide goal of 140 gpcd. In addition, their 2013 Water Loss Report submitted to the TWDB had a total percent loss of over 66%. After performing a conservation analysis, the ETRWPG believes that a water conservation strategy for the City is economically achievable. The recommended water management strategy for Port Arthur is water conservation, which includes cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Sam Rayburn/B.A. Steinhagen (LNVA)	26,253	26,223	25,996	25,949	25,930	25,929
Demands (ac-ft per year)						
Total Demand	26,253	26,223	25,996	25,949	25,930	25,929
Existing Surplus / (Shortage)	**0**	**0**	**0**	**0**	**0**	**0**
Water Management Strategies (ac-ft per year)						
Water Conservation	4,992	7,450	8,516	9,616	10,340	9,767
Surplus /(Shortage) with WMSs	**4,992**	**7,450**	**8,516**	**9,616**	**10,340**	**9,767**

Strategy	Yield (ac-ft per year)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy Conservation	10,340	$50,075,000	$2,150,000	$333	$1.02



5B.3.14 Sabine River Authority (SRA). The SRA is based in the North East Texas planning area (Region D) and the ETRWPA. SRA currently provides water from its Lower Basin system (Toledo Bend Reservoir and the canal system) to water users in the ETRWPA. The SRA provides water from its Upper Basin reservoirs (Lake Tawakoni and Lake Fork) to water users in Region C and the North East Texas planning area (Region D). These sources are fully contracted and SRA has requests for additional water in the Upper Basin. The supply and demand evaluation for the Upper Basin reservoirs is not included in this plan. The upper basin supplies are discussed in Region C and Region D regional plans.

SRA supplies wholesale water to several customers in the East Texas Regional Water Planning Area (ETRWPA) from the Lower Basin supplies (Toledo Bend Reservoir and the canal system). Municipal customers include the Cities of Hemphill, Huxley, and Rose City; Beechwood WSC, El Camino WSC, and Pendleton Harbor WSC, and G-M WSC. In addition to the municipal customers, SRA also supplies Manufacturing demand in Orange and Jefferson Counties and Steam Electric Power demand in Orange, Newton, and Rusk Counties.

SRA has sufficient supplies to meet the current contracted customer demand and surplus supplies for additional potential buyers. In addition to the current customers, several ETRWPA water suppliers have WMSs that use SRA's Toledo Bend Reservoir supplies. The ETRWPA WMSs that use supplies from Toledo Bend Reservoir include: 1) Pipeline from Toledo Bend to City of Center, 2) Transfer from Toledo Bend to Jefferson County, 3) Contract to supply to Manufacturing, Irrigation, and Steam Electric Power demand in Orange County, 4) Contract to supply Mining and Steam Electric Power demand in Newton County, 5) Contract to supply Livestock demand in Shelby County, 6) Contract to supply Steam Electric Power Demand in Rusk County.

It should be noted that the list of strategies were identified as the recommended strategies for these entities by the *regional planning group*. None of these entities have contacted SRA regarding the potential WMSs. For the successful implementation of these strategies, these users will have to contract with SRA for supplies. The additional discussion for these strategies and the detailed cost estimates are included in the write-up for the specific entities and not included here as they are not SRA's strategies. It should be noted that the cost estimates for these potential future customers do not include the cost of purchasing the water since it is subject to negotiation between the seller (SRA) and future buyers. Informal discussions indicate that the pricing of water will be based on "replacement cost" of alternative water supplies.

Toledo Bend Permit Amendment (Recommended). To support the increased use of water from Toledo Bend Reservoir, SRA has submitted a permit amendment to TCEQ to fully utilize Texas' share of the reservoir's firm yield. The application requested an additional 293,300 ac-ft per year of supply based on the TCEQ-approved Sabine River Basin WAM. The application has been declared administratively complete and TCEQ is currently reviewing the permit request. For planning purposes, the supply available from the permit amendment is based on the unpermitted yield for Toledo Bend as determined by the Sabine WAM (2004) that was used for regional water planning. The actual amount will be determined through the permitting process.

Pump station (Recommended). In addition to the permit amendment, SRA is also considering another water management strategy to construct a raw water pump station. SRA intends to construct a raw water pump station along the Sabine River to be able to pump supplies from Toledo Bend Reservoir to the canal system. A water management strategy for developing the pump station infrastructure is included in the list of strategies for SRA. The pump station infrastructure will include an 80 MGD raw water intake pump station, settling basin for the Sabine River supplies, and pipeline connecting the proposed pump station to the existing SRA canal system.

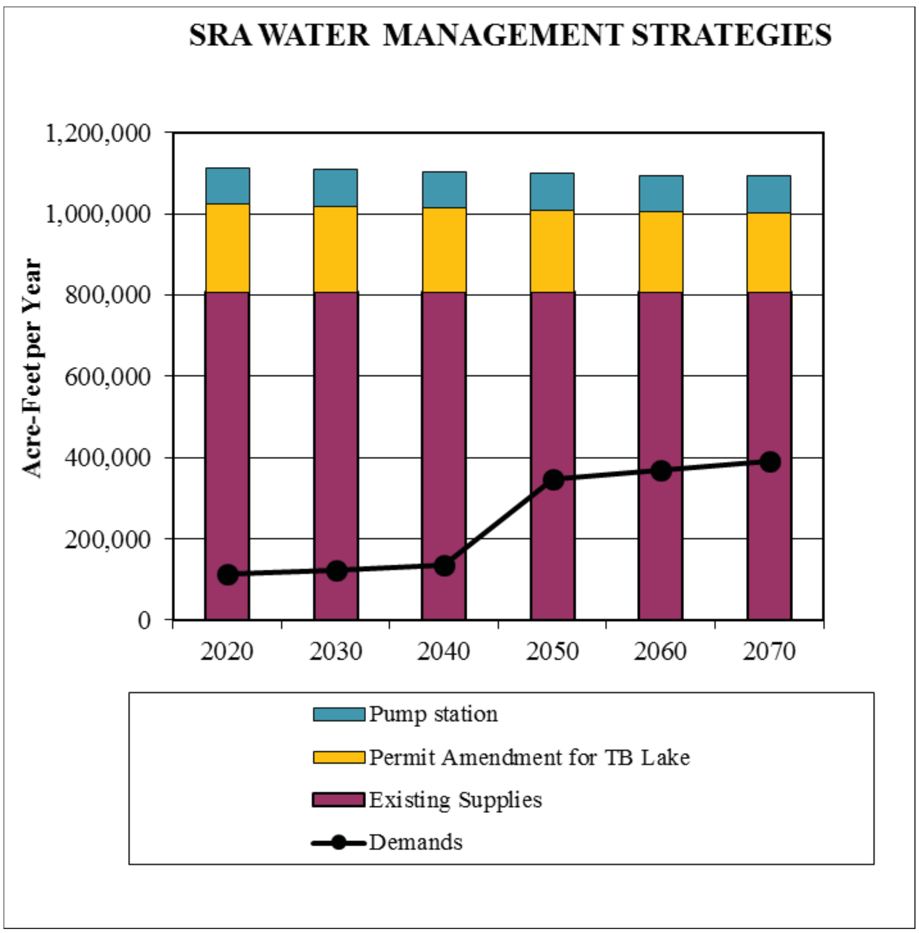
A summary of the total demand for the SRA, existing supplies, supplies from WMSs, and surplus (shortages) is included in the table below. Also included is a summary of the cost estimates for the two strategies identified for SRA. Based on the guidelines used for developing cost estimates for regional planning purposes, the strategy to apply for permit amendment does not have any construction cost associated with it. SRA will incur lawyer fees and other costs associated with the permitting process and coordination with Texas Commission on Environmental Quality.

The cost estimate for the infrastructure improvements was provided by SRA. A detailed cost estimate was provided by SRA based on a detailed preliminary engineering study that was conducted for the Sabine River pump station and pipelines associated with this strategy. The recommended infrastructure configuration assumes construction of a pump station structure capable of future expansion by addition of pumps. The pump station, pipeline, and intake structure will contain enough capacity for potential transfer of Toledo Bend supplies to Jefferson County. An 80 MGD pump station with structure constructed for 285 MGD, a 72-inch pipeline and power supply to accommodate 285 MGD were considered for the cost estimate.

- Pump Station Cost - $27,729,100
- Pipeline Cost - $45,103,575
- Total Construction Cost - $72,832,675

	2020	2030	2040	2050	2060	2070
Existing Supplies in Lower Basin (ac-ft per year)						
Toledo Bend Reservoir	750,000	750,000	750,000	750,000	750,000	750,000
Canal System	147,100	147,100	147,100	147,100	147,100	147,100
Demand (ac-ft per year)						
Canal Customers	76,736	76,736	76,736	76,736	76,736	76,736
Toledo Bend Customers	27,262	27,262	27,262	27,262	27,262	27,262
Potential Future Customers for Toledo Bend Reservoir	8,547	18,103	31,584	243,695	265,668	288,136
Total Demands	112,545	122,101	135,582	147,693	169,666	192,134
Surplus (Shortage)	784,555	774,999	761,518	549,407	527,434	504,966
Water Management Strategies (ac-ft per year)						
Permit Amendment (Toledo Bend)	215,300	210,800	206,200	201,600	197,000	195,000
Pump station	89,680	89,680	89,680	89,680	89,680	89,680
Surplus or (Shortage) with WMSs	**999,855**	**985,799**	**967,718**	**751,007**	**724,434**	**699,966**

Recommended Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy: Permit Amendment for Toledo Bend supplies	293,300	NA	NA	NA	NA
Rec. Strategy: Infrastructure Improvements	89,680	$72,832,675	-	$812.2	$2.5



5B.3.15 City of Tyler. The City of Tyler currently provides wholesale supplies to retail customers, irrigation, and manufacturing demands within the City limits. The City is the wholesale provider for Whitehouse, Southern Utilities Company, Walnut Grove WSC, and Community Water Company. The current supplies for the City include 34 MGD from Lake Tyler, 30 MGD from Lake Palestine, 0.4 MGD from Bellwood Lake, and 12 groundwater wells in Carrizo Wilcox aquifer producing approximately 8 MGD. The City of Tyler is shown to have sufficient supplies through the planning period using the TWDB approved demand projections.

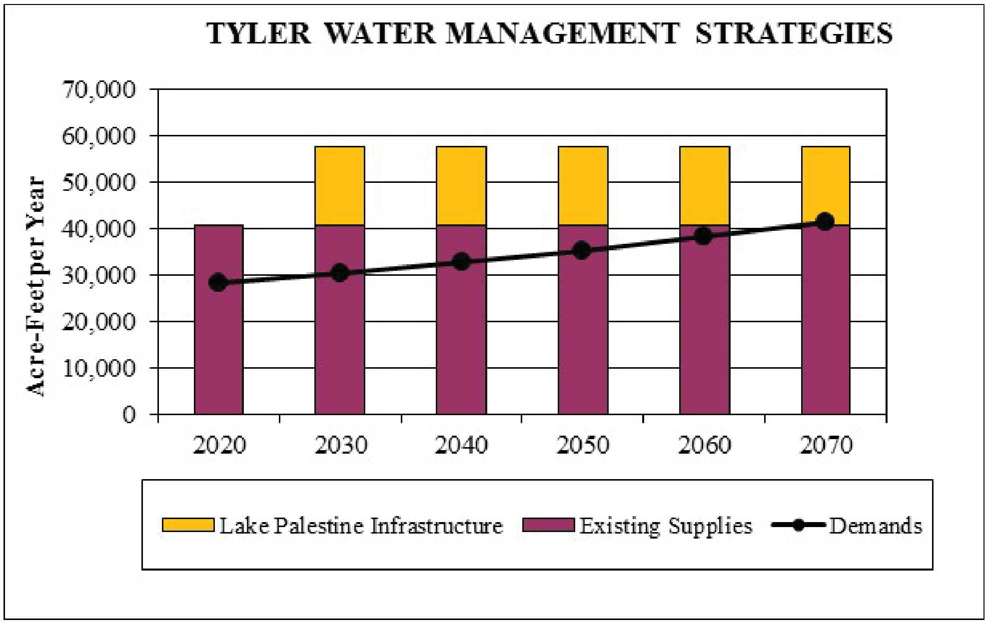
In addition, there is considerable interest from other users in Smith County in contracting with the City of Tyler for water supplies. There are recommended strategies for Tyler to provide additional water to Bullard, Crystal Systems Inc., Lindale, Walnut Grove WSC, Mining, and Manufacturing in Smith County. Until 2060, City of Tyler has sufficient supplies to meet the proposed demands for the potential future customers. City of Tyler has a small shortage in 2070 when current and future customer demands are taken into consideration.

Lake Palestine Infrastructure (Recommended). City of Tyler proposed the following recommended strategy for the 2016 regional plan. The first recommended strategy is that the City of Tyler develop the additional 30 MGD of Lake Palestine water. The City has developed about half of its contracted supply in Lake Palestine and plans to develop the remaining supply by 2030, as part of its long-term water supply plan.

The customer demands, supplies from existing sources and WMSs are summarized in the table below. Summary of the cost estimates for the recommended strategies are included in the table below.

	2020	2030	2040	2050	2060	2070
Existing Supplies (ac-ft per year)						
Lake Tyler	19,057	19,057	19,057	19,057	19,057	19,057
Bellwood Lake	400	400	400	400	400	400
Lake Palestine	16,815	16,815	16,815	16,815	16,815	16,815
Carrizo Wilcox Wells	4,484	4,484	4,484	4,484	4,484	4,484
Demand (ac-ft per year)						
Current Customers	26,359	27,959	29,634	31,550	33,737	36,040
Potential Future Customers	1,993	2,610	3,253	3,961	4,809	5,724
Total Demands	28,352	30,569	32,887	35,511	38,546	41,764
Surplus (Shortage)	12,404	10,187	7,869	5,245	2,210	(1,008)
Water Management Strategies (ac-ft per year)						
Lake Palestine Infrastructure	0	16,815	16,815	16,815	16,815	16,815
Surplus or (Shortage) with WMSs	**12,404**	**27,002**	**24,684**	**22,060**	**19,025**	**15,807**

Strategy	Yield (ac-ft per year)	Capital Cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Lake Palestine Infrastructure	16,815	$93,050,000	$15,135,000	$900	$2.76



5B.3.16 Upper Neches River Municipal Authority. The Upper Neches River Municipal Water Authority (UNRMWA) owns and operates the Lake Palestine system in the Neches River Basin. Upper Neches River Municipal Water Authority has a water right for 238,110 ac-ft per year from Lake Palestine and a downstream run-of-river diversion. City of Palestine, City of Tyler, and City of Dallas have contracts for supplies from Lake Palestine for amounts of 28,000 ac-ft per year, 67,200 ac-ft per year, and 114,337 ac-ft per year respectively. After supplying the contracted amounts to these three contracted customers, Upper Neches River Municipal Water Authority is expected to have 28,573 ac-ft per year available to supply to other entities in ETRWPA. In addition to these three cities, UNRMWA is expected to have small needs from local irrigation and manufacturing users taking supplies from around the lake. The yield for Lake Palestine was estimated using the Water Availability Model for the Neches Basin in the 2011 East Texas Regional Plan. The yield estimates were not revised for the 2016 Regional Plan because there were no changes made to the volumetric information for the lake or the Neches Basin WAM since the last round of planning. Based on the yield analysis from the 2011 East Texas Regional Plan, Lake Palestine is projected to have a yield of 205,417 ac-ft per year in 2020, reducing to 195,229 ac-ft per year by 2070. Based on current contracts and the available supplies from the Neches Basin WAM, the

UNRMWA shows a small shortage during the planning period for Lake Palestine supplies. UNRMWA does not think the shortages to be real as the shortage is primarily associated with the reduced firm yield of Lake Palestine due to projected sediment accumulation in the lake. UNRMWA believes that the storage-area-elevation curves used in the Water Availability Models are severely under-predicting the storage volumes available in various parts of the lake. Therefore, UNRMWA believes that the lake yield is much larger than what is projected by the Water Availability Models. UNRMWA is currently working with Texas Water Development Board to develop revised and refined volumetric information for Lake Palestine, but this information is not available for the 2016 regional planning cycle. The lake yield may be recomputed in the next planning cycle.

To address the shortages for the planning period UNRMWA has evaluated multiple potentially feasible WMSs and have the following recommendation for the 2016 ETRWPA Regional Plan. The UNRMWA was the sponsor the proposed Lake Fastrill project. With the current uncertainties surrounding this project, the UNRMWA in conjunction with the City of Dallas has identified the need for a Lake Fastrill replacement project. The City of Dallas is actively working with the UNRMWA to identify the best replacement project for the loss of the supply that would have been provided by Lake Fastrill. Neches River run-of-river diversion is recommended as the most feasible Lake Fastrill replacement project. Compared to the Lake Fastrill project, all Run-of-river diversion strategies provide lesser firm yield, but avoid environmental impacts and some of the permitting challenges associated with a large, main-stem reservoir on the Neches River.

UNRMWA and City of Dallas are considering development of a water supply project from the run-of-river diversions on Upper Neches River and using Lake Palestine, tributary storage, and/or groundwater as system resources. Using the run-of-river diversions operated as a system with Lake Palestine is the recommended strategy. Run-of-river diversions operated as a system with off-channel tributary storage and as conjunctive use along with groundwater are proposed as alternative strategies. All the potentially feasible WMSs for UNRMWA and City of Dallas are discussed in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study*.

Neches Run-of-River Diversions with Lake Palestine (Recommended). This recommended strategy includes run-of-river diversions near SH 21 on Neches River operated as a system with storage in Lake Palestine. UNRMWA will be the project sponsor for this WMS. . The run-of-river diversions will be taken from the river segment between the existing Rocky Point diversion and the Weches Dam site below the SH21 crossing, between the Neches River National Wildlife Refuge and upstream of the Weches Dam site. The run-of-the-river diversions will be authorized under a new appropriation of surface water, subject to senior water rights and environmental flows. New facilities required for this WMS include a small diversion dam on the Neches River, a river intake and pump station, and a transmission pipeline and booster pump station supporting transmission to Lake Palestine. The run-of-river diversions are an interruptible supply and the firm yield associated with the WMS is the incremental increase in the firm yield of Lake Palestine resulting from the system operation of the new diversions and the transmission facilities with the Lake Palestine.

The feasibility report includes multiple infrastructure alternatives for the recommended strategy, each resulting in a different amount of firm yield at Lake Palestine. Run-of-river diversions with a 108-inch transmission pipeline and a pump station capacity of 317 cfs was selected as the recommended transmission system to yield 68,625 ac-ft per year of firm yield at Lake Palestine. It should be noted that the project configuration for the recommended WMS for UNRMWA in the 2016 ETRWPA Regional Plan is different from the configuration discussed in Dallas' October 2014 *Draft Long Range Water Supply Plan* (Draft LRWSP). The project configuration discussed in the City of Dallas Draft LRWSP resulted in a firm yield of 47,250 ac-ft per year (42 MGD) that is projected to meet Dallas needs starting 2070. A project configuration with a larger firm yield was recommended in ETRWPA Regional Plan so as to meet the projected needs for City of Dallas, shortages for UNRMWA associated with reduced Lake Palestine yield due to sedimentation, and needs for other potential customers in ETRWPA. For regional planning purposes, the WMS is expected to be online in 2020 to address the shortages projected for the current contracted customers for Lake Palestine and potential steam electric power customers in Anderson County. The WMS timing can be changed to a later date if the timing of needs for the current contracted customers and steam-electric power customers changes. City of Dallas is expected to use their share of supplies from this WMS starting in 2060.

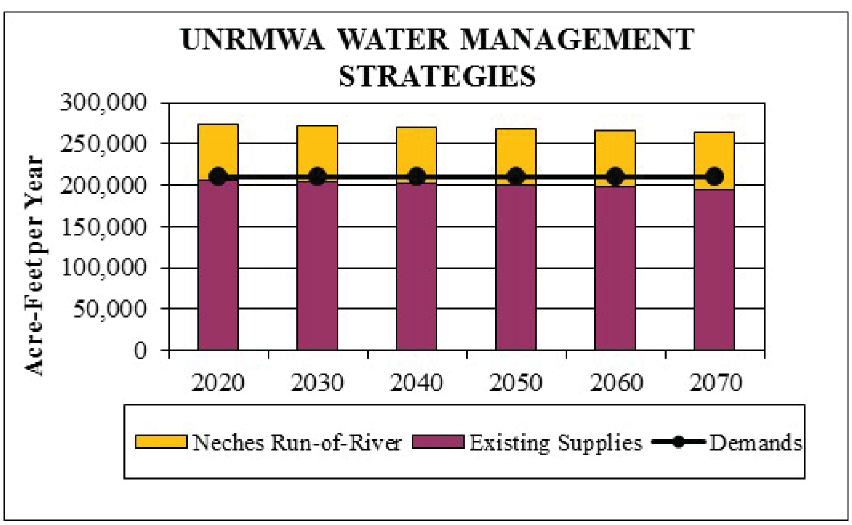
Neches Run-of-River Diversions with Tributary Storage (Alternative). The first alternative strategy for UNRMWA includes new run-of-river diversions from the Neches River segment between the existing Rocky Point diversion dam and the Weches dam site with storage in a new tributary or off-channel reservoir. This alternative strategy includes system operations with Lake Palestine. Facilities for implementation of this WMS include a small diversion dam on the Neches River, a high capacity river intake pump station, a transmission pipeline to the reservoir, and a tributary or off-channel reservoir. The interruptible run-of-river diversions will be backed up using stored water in the tributary or off-channel reservoir. Run-of-river diversions and any impoundment of local runoff in a tributary or off-channel reservoir are subject to inflow passage for senior water rights and environmental protection. The recommended infrastructure combinations for this WMS can provide a firm yield of 75,000 ac-ft per year (67 MGD).

Neches Run-of-River Diversions with Groundwater (Alternative). A conjunctive use WMS is the second proposed alternative strategy for UNRMWA. The WMS includes new run-of-river diversions from the Neches River segment between the existing Rocky Point diversion dam and the Weches dam site with groundwater supplies from new wells in Carrizo, Wilcox, and Queen City aquifers in Anderson and Cherokee Counties. This alternative strategy includes system operations with Lake Palestine. New facilities for the implementation of this WMS include a small diversion dam on the Neches River, a river intake and pump station, wells located on properties controlled by Campbell Timberland Management, LLC and Forestar (USA) Real Estate Group, Inc., and a transmission system for the delivery of the supplies to the potential customers. The interruptible run-of-river supplies will be backed up using groundwater delivered to the run-of-river diversion point using bed and banks of the Neches River and several tributary streams. The run-of-river diversions are subject to inflow passage for senior water rights and environmental protection, but the groundwater supplies are not. The recommended infrastructure combinations for this WMS can provide a firm yield of 84,875 ac-ft per year (76 MGD).

Planning level opinion of probable constructions costs were provided by UNRMWA for inclusion in the table below.

	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Existing Supplies (ac-ft per year)						
Palestine System	205,417	203,375	201,333	199,292	197,250	195,229
Demands (ac-ft per year)						
Demands (With Current Contracted Customers)	210,247	210,224	210,202	210,184	210,169	210,169
Demands (With Current Contracted and Potential Customers)	210,247	210,224	210,202	210,534	257,769	260,068
Surplus (Shortage) with Current Supplies (ac-ft per year)						
Surplus (Shortage) (With Current Contracted Customers)	(4,831)	(6,849)	(8,869)	(10,892)	(12,919)	(14,940)
Surplus (Shortage) (With Current Contracted and Potential Customers)	(4,831)	(6,849)	(8,869)	(11,242)	(60,519)	(64,839)
Water Management Strategies (ac-ft per year)						
Recommended Strategy: Neches Run-of-River Diversions with Lake Palestine	68,625	68,625	68,625	68,625	68,625	68,625
Surplus or (Shortage) with WMSs for Current Contracted Customers	63,794	61,776	59,756	57,733	55,706	53,685
Surplus or (Shortage) with WMSs for Current and Potential Contracted Customers	63,794	61,776	59,756	57,773	8,456	6,435

Strategy	Yield (ac-ft per year)	Capital cost	Annual Cost	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gal)
Rec. Strategy: UNM-ROR Neches Run-of-River Diversions with Lake Palestine (Recommended)	68,625	$444,085,000	$41,285,000	$602	$1.85
Alt. Strategy 1: UNM-TS Neches Run-of-River Diversions with Tributary Storage System Operation (Alternative)	75,000	$363,401,000	$32,551,000	$434	$1.33
Alt. Strategy 2: UNM-CU Neches Run-of-River Diversions with Tributary Storage System Operation (Alternative)	84,875	$289,080,000	$35,143,000	$414	$1.27



5B.4 Unmet Needs

Unmet needs were identified for a few entities in the ETRWPG. It must be pointed that ETRWPA is a water-rich region and therefore should not have any unmet needs as the need can be met by any of the water management strategies discussed in Chapter 5A. The list of the entities with unmet needs and the reasons for the need not being met by a region that is water-plenty are discussed below.

WUG/WWP	Unmet Needs (ac-ft per year)	Decade of Unmet Needs	Reasons
Angelina County - Manufacturing	4,880	2020	Lufkin's current supplies in Lake Kurth can only meet part of the demands. However, once Lufkin develops the supply from Sam Rayburn Reservoir to Lake Kurth, there would be enough supplies to meet the manufacturing demand in Angelina County. It should be noted that the Sam Rayburn supplies are available by 2030. ***The proposed strategies leave an unmet need in 2020 because the ETRWPG believes the manufacturing demands for this decade are overestimated.*** While manufacturing growth is expected in Angelina County, this water demand will not fully develop until 2030.
Anderson County – Steam Electric Power	2,299	2070	Currently a water management strategy is being proposed to meet the needs for this WUG in all decades. The proposed strategy includes a contract between Anderson County Steam Electric Power user and City of Palestine to transfer supplies from Lake Palestine to the project location. The available supplies from Lake Palestine are sufficient to meet the need for this water user group in all decades but 2070. The currently available supplies from Lake Palestine cannot supply to meet the entire need in 2070, thus leaving an unmet need in 2070. ***No additional strategy was developed for this unmet need in 2070 because the ETRWPG believes that the steam electric power demands for this decade are overestimated.***
Trinity County - Irrigation	331	2020-2070	An alternative strategy is proposed to meet the irrigation water use in Trinity County as the ***ETRWPG believes that the irrigation demands for this County are overestimated by 331 ac-ft.***

WUG/WWP	Unmet Needs (ac-ft per year)	Decade of Unmet Needs	Reasons
Henderson County – City of Athens	33	2070	An alternative strategy is proposed to meet City of Athens' needs in 2070. Athens MWA is the WWP for City of Athens and they are currently implementing a strategy to add additional groundwater wells. Athens MWA has permits to drill the wells. ***It cannot be discussed as a recommended strategy for the entity because based on the Henderson County MAG limits, the Carrizo Wilcox aquifer is over-allocated***. Since this is the primary strategy for Athens MWA and the construction is already underway, the 2016 Regional Plans will show shortages in 2060 and 2070 for City of Athens, which in reality will be addressed by the well field development.
Athens MWA (WWP)	2,657	2070	Athens MWA is currently implementing a strategy to add additional groundwater wells. Athens MWA has permits to drill the wells. It cannot be discussed as a recommended strategy for the entity because based on the Henderson County MAG limits, the Carrizo Wilcox aquifer is over-allocated. Since this is the primary strategy for Athens MWA and the construction is already underway, the 2016 Regional Plans will show shortages in 2060 and 2070 for City of Athens, which in reality will be addressed by the well field development.

5B.5 Texas Water Development Board Database

The 2016 Regional Water Planning Data Web Interface (DB17) is an electronic database provided by the Texas Water Development Board which collects, maintains and analyzes water planning data. The Regional Water Planning Groups and their contracted consultants may enter data for their respective regions in order to facilitate development of useful and relevant regional and state water plans. The DB17 Reports required by the TWDB are included as an appendix to Chapter 5B (5B-C through J).

5B.6 Summary of Recommended and Alternative Water Management Strategies

The tables below (Table 5B.1 and Table 5B.2) include a summary of all recommended and alternative strategies considered for the WUGs and all recommended and alternative strategies considered the WWPs in ETRWPA for the 2016 Regional Plan.

Table 5B.1 2016 Needs, Recommended, and Alternative Water Management Strategies for Water User Groups

NEEDS RECOMMENDED STRATEGY *ALTERNATIVE STRATEGY* BALANCE (Does not include Alternative totals)

County	WUG	2020	2030	2040	2050	2060	2070	2016 Strategies	Strategy Source	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
ANDERSON	STEAM ELECTRIC POWER	-11,306	-13,218	-15,549	-18,390	-21,853	-25,968						
		11,306	13,218	15,549	18,390	21,853	21,632	Purchase from Palestine – New Pipeline from Lake Palestine	WUG	$44,576,000	$12,367,000	$522	$365
	BALANCE	0	0	0	0	0	-4,336	Unmet need in 2070					
ANGELINA	MANUFACTURING	-10,722	-12,009	-13,313	-14,470	-15,705	-17,037						
		6,000	6,000	6,000	6,000	6,000	6,000	Purchase from Lufkin (Lake Kurth)	WWP	-	$1,955,000	$326	NA
		0	6,167	7,471	8,628	9,863	11,195	Purchase from Lufkin (Sam Rayburn)	WWP	-	$3,648,000	$326	NA
	MINING	-474	-573	-398	-300	-225	-168						
		474	573	398	300	225	168	Purchase from ANRA (Run of River, Angelina)	WWP	$4,005,000	$942,000	$1,644	$1,059
	BALANCE	-4,722	158	158	158	158	158	Unmet need in 2020					
CHEROKEE	ALTO RURAL WSC	0	0	0	-66	-137	-215						
		0	0	5	7	9	11	Municipal Conservation	Consultant Team	-	$4,648	$489	NA
		0	0	0	61	130	250	New Wells in Carrizo Wilcox	Consultant Team	$2,682,000	$303,000	$1,212	$318
	MINING	-238	-247	-210	-147	-84	-40						
		238	247	210	147	84	40	Purchase from ANRA (Run of River, Angelina)	WUG & WWP	$4,214,000	$640,000	$2,560	$1,148
	BALANCE	0	0	5	2	2	46						
HARDIN								No need Identified					
HENDERSON	ATHENS	-2	-3	-2	-1	-17	-33						
		2	*3*	*2*	*1*	*17*	*18*	*Purchase from Athens MWA (GW Wells)*	*WWP*	$9,456,000	$1,341,000	$277	$114
	CHANDLER	0	0	0	-77	-196	-312						
		0	0	0	16	30	36	Municipal Conservation		-	$5,812	$489	NA
		0	0	0	350	350	350	Purchase from Tyler (Lake Tyler)	Consultant Team	$1,886,000	$302,000	$863	$411
	BALANCE	0	0	0	289	184	74						
HOUSTON	IRRIGATION	-751	-997	-1,265	-1,563	-1,892	-2,340						
		751	997	1,265	1,563	1,892	2,340	New wells (Yegua-Jackson)	Consultant Team	$12,926,000	$1,647,000	$704	$241
	BALANCE	0	0	0	0	0	0						
JASPER	MANUFACTURING	0	-3,049	-6,021	-8,250	-8,335	-8,420						
		0	3,049	6,021	8,250	8,335	8,420	Purchase from LNVA (Sam Rayburn)	WWP	$33,497,000	$6,059,000	$720	$387
	BALANCE	0	0	0	0	0	0						
JEFFERSON	BEAUMONT	0	0	-500	-2,245	-4,403	-6,896						
		0	3,238	5,341	7,047	8,579	9,966	Municipal Conservation	Consultant Team	$52,623,000	$2,271,000	$317	NA

Table 5B.1 2016 Needs, Recommended, and Alternative Water Management Strategies for Water User Groups

NEEDS RECOMMENDED STRATEGY *ALTERNATIVE STRATEGY* BALANCE (Does not include Alternative totals)

County	WUG	2020	2030	2040	2050	2060	2070	2016 Strategies	Strategy Source	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
	COUNTY-OTHER	0	0	0	-680	-1,924	-3,296						
		0	0	0	797	2,041	3,413	Purchase from LNVA (Sam Rayburn)	WWP	$14,236,000	$2,521,000	$739	$390
	MANUFACTURING	-180,461	-261,473	-273,106	-284,779	-296,461	-308,603						
		181,181	262,193	273,826	285,499	297,181	309,322	Purchase from LNVA (Sam Rayburn)	WWP	$312,255,000	$139,694,000	$452	$367
	STEAM ELECTRIC POWER	-13,426	-15,696	-18,464	-21,838	-25,951	-30,839						
		13,426	15,696	18,464	21,838	25,951	30,839	Purchase from LNVA (Sam Rayburn)	WWP	$54,518,000	$15,645,000	$507	$377
	PORT ARTHUR	4,992	7,450	8,516	9,616	10,340	9,767	Municipal Conservation	WUG	$50,075,000	$2,150,000	$333	NA
	BALANCE	5,712	11,408	14,077	15,255	15,353	13,673						
NACOGDOCHES	D&M WSC	0	0	0	0	-112	-234						
		0	0	0	0	112	250	New wells (Carrizo-Wilcox)	Consultant Team	$3,484,000	$384,000	$1,536	$370
	LIVESTOCK	-1,644	-1,837	-2,061	-2,320	-2,617	-3,059						
		1,644	1,837	2,061	2,320	2,617	3,059	New wells (Carrizo-Wilcox)	Consultant Team	$23,770,0000	$2,766,000	$904	$254
	MINING	-5,475	-2,975	-118	0	0	0						
		5,475	2,975	118	0	0	0	Purchase from ANRA (Run of River, Angelina)	WUG & WWP	$12,465,000	$6,650,000	$1,209	$1,019
	STEAM ELECTRIC POWER	0	-799	-2,224	-3,961	-6,078	-8,594						
		8,500	8,500	7,742	6,741	5,645	4,521	Purchase from ANRA (Lake Columbia Pipeline)	Consultant Team	$25,805,000	$5,264,000	$619	$365
		3,000	3,000	3,000	3,000	3,000	4,989	New wells (Carrizo-Wilcox)	Consultant Team	$16,021,000	$1,875,000	$938	$267
	BALANCE	11,500	10,701	8,518	5,780	2,567	932						
NEWTON	MINING	-115	-59	0	0	0	0						
		115	59	0	0	0	0	Purchase from SRA (Toledo Bend)	WWP	-	$111,000	$965	NA
	STEAM ELECTRIC POWER	-690	-3,080	-5,994	-9,545	-13,875	-19,021						
		690	3,080	5,994	9,545	13,875	19,021	Purchase from SRA (Toledo Bend)	WWP	$38,170,000	$10,091,000	$531	$380
	BALANCE	0	0	0	0	0	0						
ORANGE	IRRIGATION	-2,432	-2,685	-2,858	-2,920	-2,855	-2,758						
		2,432	2,685	2,858	2,920	2,855	2,758	Purchase from SRA (Run of River, Sabine)	WWP	$13,281,000	$2,293,000	$764	$419
	MANUFACTURING	-2,532	-8,479	-14,439	-19,730	-25,680	-32,111						
		3,943	9,890	15,850	21,141	27,092	33,477	Purchase from SRA (Run of River, Sabine)	WWP	$42,621,000	$14,949,000	$467	$372
	STEAM ELECTRIC POWER	0	-14	-1,038	-2,286	-3,807	-4,846						
		0	14	1,038	2,286	3,807	4,846	Purchase from SRA (Run of River, Sabine)	WWP	$15,847,000	$3,077,000	$686	$419
	BALANCE	1,411	1,411	1,411	1,411	1,412	1,366						

Table 5B.1 2016 Needs, Recommended, and Alternative Water Management Strategies for Water User Groups

NEEDS RECOMMENDED STRATEGY *ALTERNATIVE STRATEGY* BALANCE (Does not include Alternative totals)

County	WUG	2020	2030	2040	2050	2060	2070	2016 Strategies	Strategy Source	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
PANOLA	MANUFACTURING	-134	-156	-176	-194	-230	-309						
		134	156	176	194	230	309	Purchase from Carthage (Murvaul Lake)	Consultant Team	-	$101,000	$327	NA
	BALANCE	0	0	0	0	0	0						
POLK								No need identified					
RUSK	OVERTON	-17	-18	-33	-88	-150	-215						
		17	18	106	181	241	289	Municipal Conservation	Consultant Team	-	$5,298	$489	NA
	MINING	-1,075	-2,092	-1,955	-1,809	-1,686	-1,677						
		1,075	2,092	1,955	1,809	1,774	1,765	Purchase from ANRA (Run of River, Angelina)	WUG & WWP	$14,158,000	$3,420,000	$1,635	$1,095
	STEAM ELECTRIC POWER	0	0	0	-462	-8,873	-18,868						
		0	0	0	462	8,873	18,868	Purchase from SRA (Toledo Bend)	WWP	$57,718,000	$11,855,000	$628	$392
	BALANCE	0	0	73	93	179	162						
SABINE								No need identified					
	G M WSC	0	0	0	0	0	0	Infrastructure improvements/WTP Expansion	WUG	$8,014,590			
	BALANCE	0	0	0	0	0	0						
SAN AUGUSTINE	MINING	-2,102	-1,102	0	0	0	0						
		2,102	1,102	0	0	0	0	Purchase from ANRA (Run of River, Angelina)	WUG & WWP	$21,064,000	$4,035,000	$1,920	$1,108
	BALANCE	0	0	0	0	0	0						
SHELBY	LIVESTOCK	-1,368	-2,376	-3,603	-5,100	-6,925	-6,925						
		1,368	2,376	3,603	5,100	6,925	6,925	Purchase from SRA (Toledo Bend)	WWP	$25,238,000	$4,893,000	$699	$431
	BALANCE	0	0	0	0	0	0						
SMITH	BULLARD	-51	-223	-397	-587	-783	-985						
		11	24	30	38	47	56	Municipal Conservation	Consultant Team	-	$11,789	$489	NA
		49	215	385	570	760	955	Purchase from City of Tyler	Consultant Team	$5,260,000	$848,000	$852	$444
	CRYSTAL SYSTEMS INC	-12	-105	-219	-356	-510	-642						
		4	9	12	15	19	22	Municipal Conservation	Consultant Team	-	$3,129	$325	NA
		12	105	219	356	510	642	Purchase from City of Tyler	Consultant Team	$2,021,000	$417,000	$650	$405
	LINDALE	-52	-180	-310	-451	-596	-746						
		8	17	22	28	34	41	Municipal Conservation	Consultant Team	-	$7,967	$454	NA
		44	163	308	471	638	797	Purchase from City of Tyler	Consultant Team	$5,803,000	$862,000	$1,044	$511

Table 5B.1 2016 Needs, Recommended, and Alternative Water Management Strategies for Water User Groups

NEEDS **RECOMMENDED STRATEGY** *ALTERNATIVE STRATEGY* BALANCE (Does not include Alternative totals)

County	WUG		2020	2030	2040	2050	2060	2070		2016 Strategies	Strategy Source	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
	R-P-M WSC		-4	-23	-36	-54	-71	-86							
			4	**23**	**36**	**54**	**71**	**86**		Municipal Conservation	Consultant Team	-	$7,967	$454	NA
	MANUFACTURING		-1,764	-1,982	-2,192	-2,370	-2,614	-2,879							
			2,039	**2,257**	**2,467**	**2,645**	**2,889**	**3,154**		Purchase from Tyler (Lake Palestine/Lake Tyler/Carrizo-Wilcox)	WWP	$7,204,000	$1,646,000	$597	$403
	MINING		-108	-113	-114	-83	-54	-32							
			108	**113**	**114**	**83**	**54**	**32**		Purchase from City of Tyler	Consultant Team	$3,103,000	$402,000	$3,526	$1,263
	BALANCE		288	300	325	359	394	415							
TRINITY	IRRIGATION		-331	-331	-331	-331	-331	-331							
			331	*331*	*331*	*331*	*331*	*331*		*Purchase from Trinity County-Other*	Consultant Team	$2,174,000	$327,000	$988	$462
	BALANCE		-331	-331	-331	-331	-331	-331		Unmet need					
TYLER										No need identified					

Table 5B.2 2016 Needs and Water Management Strategies for Wholesale Water Providers (ac-ft per year)

RECOMMENDED STRATEGY *ALTERNATIVE STRATEGY*

WWP	2016 Strategies	2020	2030	2040	2050	2060	2070	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
ANRA	**Lake Columbia**	0	75,550	75,500	75,450	75,400	75,350	$344,498,000	$25,161,000	$333	$13
	ANRA Treatment and Distribution System	0	22,232	22,232	22,232	22,232	22,232	$117,250,000	$41,859,000	$1,883	$1,442
	Run of River, Neches (New Application)	20,000	20,000	20,000	20,000	20,000	20,000	-	-	-	-
	Run of River, Neches (Submitted Application)	10,000	10,000	10,000	10,000	10,000	10,000	-	-	-	-
	New wells (Wilcox Aquifer)	5,600	5,600	5,600	5,600	5,600	5,600	$26,023,000	$3,239,000	$578	$190
AN WCID#1	**Hydraulic Dredging (Includes Volumetric Survey and Normal Pool Elevation Adjustment)**	0	0	5,600	5,600	5,600	5,600	$23,716,000	-	-	-
ATHENS MWA	**Municipal Conservation**	59	98	119	144	277	457	$242,560	$118,330	$258	NA
	Amendment of Fish Hatcheries Permit for Reuse	2,872	2,872	2,872	2,872	2,872	2,872	$0	$0	-	-
	WTP Booster PS Infrastructure Updates	1,121	1,121	1,121	1,121	1,121	1,121	$2,900,000	$399,000	$59	$37
	Additional Carrizo-Wilcox Groundwater	600	600	2,415	2,415	2,415	4,830	$9,456,000	$1,341,000	$277	$114
BEAUMONT	**Municipal Conservation**	0	3,238	5,341	7,047	8,579	9,966	$52,623,000	$2,271,000	$317	NA
CARTHAGE	**No strategies were identified**										
CENTER	**Reuse Pipeline to Lake Center**	1,121	1,121	1,121	1,121	1,121	1,121	$13,579,000	$1,672,000	$1,493	$479
	Pipeline from Toledo Bend	0	0	2,242	2,242	2,242	2,242	$27,775,000	$3,462,000	$1,544	$865
HOUSTON CO WCID #1	**Permit Amendment - Houston County Lake**	3,500	3,500	3,500	3,500	3,500	3,500	-	-	-	-
	New wells(Carrizo-Wilcox)	*3,500*	*3,500*	*3,500*	*3,500*	*3,500*	*3,500*	*$22,793,000*	*$2,613,000*	*$747*	*$202*
JACKSONVILLE	**Supply from Lake Columbia**	0	0	1,700	1,700	1,700	1,700	$20,645,000	$2,645,000	$1,556	$539
LNVA	**Purchase from SRA (Toledo Bend)**	0	0	0	200,000	200,000	200,000	$399,955,000	$105,144,000	$526	$358
	Permit Amendment for Sam Rayburn	28,000	28,000	28,000	28,000	28,000	28,000	-	-	-	-
	Transfer to Region H	0	0	55,000	55,000	55,000	55,000	$48,949,000	$23,905,000	$435	$360
	Constructed Levy	1,600	1,600	1,600	1,600	1,600	1,600	$34,989,000	$3,055,000	$1,909	$86

Table 5B.2 2016 Needs and Water Management Strategies for Wholesale Water Providers (ac-ft per year)

RECOMMENDED STRATEGY *ALTERNATIVE STRATEGY*

WWP	2016 Strategies	2020	2030	2040	2050	2060	2070	Capital Costs ($)	Annual Costs ($)	Unit Costs before Amortization ($ per acre-feet)	Unit Costs after Amortization ($ per acre-feet)
LUFKIN	**Transfer from Rayburn to Lake Kurth – Phase I (2030)**	**0**	**11,210**	**22,420**	**28,000**	**28,000**	**28,000**	**$49,368,000**	**$12,503,000**	**$1,115**	**$747**
	Transfer from Rayburn to Lake Kurth – Phase II (2040)							**$37,863,000**	**$23,373,000**	**$1,051**	**$723**
	Transfer from Rayburn to Lake Kurth – Phase III (2050)							**$2,760,000**	**$22,797,000**	**$814**	**$693**
NACOGDOCHES	**Supply from Lake Columbia**	**0**	**8,500**	**8,500**	**8,500**	**8,500**	**8,500**	**$35,829,000**	**$5,995,000**	**$705**	**$353**
PANOLA COUNTY FWSD	**No strategies were identified**										
PORT ARTHUR	**Municipal Conservation**	**4,992**	**7,450**	**8,516**	**9,616**	**10,340**	**9,767**	**$50,075,000**	**$2,150,000**	**$333**	**NA**
SRA	**Permit Amendment for Toledo Bend**	**293,300**	**293,300**	**293,300**	**293,300**	**293,300**	**293,300**	-	-	-	-
	Pump station	**89,680**	**89,680**	**89,680**	**89,680**	**89,680**	**89,680**	**$72,832,675**	-	**$812.2**	**$812.2**
TYLER	**Lake Palestine Infrastructure Improvements**	**0**	**16,815**	**16,815**	**16,815**	**16,815**	**16,815**	**$93,050,000**	**$15,135,000**	**$900**	**$780**
UNRMWA	**Run of River, Neches with Lake Palestine Storage**	**68,625**	**68,625**	**68,625**	**68,625**	**68,625**	**68,625**	**$444,085,000**	**$41,285,000**	**$602**	**$156**
	Run of River, Neches with Terminal Storage	*75,000*	*75,000*	*75,000*	*75,000*	*75,000*	*75,000*	*$363,401,000*	*$32,551,000*	*$434*	*$101*
	Run of River, Neches with Groundwater	*84,875*	*84,875*	*84,875*	*84,875*	*84,875*	*84,875*	*$289,080,000*	*$35,143,000*	*$414*	*$180*

Chapter 5C

Water Conservation Recommendations

Water conservation is defined by Texas Water Code §11.002(8) as "the development of water resources; and those practices, techniques and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses." Water conservation measures are long-term, permanent strategies to reduce water use.

Title 31 Texas Administrative Code (31 TAC) §357.34(g) requires the 2016 Plan to consolidate and present recommendations that may include Best Management Practices (BMPs) appropriate for the region. Further, for WUGs with identified water needs, conservation WMSs must be included as part of the WUGs list of strategies to meet shortages; or a summary of reasons must be provided in the plan for not including conservation WMSs must be provided.

Following Section 5C.1 is a discussion of water conservation practices and trends in the ETRWPA. This will be followed by a discussion in Section 5C.2 of water conservation plans in use by WUGs in the region, and BMPs in use currently or which could be implemented by WUGs.

Conservation WMSs identified for WUGs with needs are addressed in Chapter 5B within the discussions of WMSs for these WUGs. For WUGs with identified needs where conservation WMSs were not recommended, Section 5C.3 of this chapter includes a discussion of reasons for not making such recommendations.

5C.1 Water Conservation Practices and Trends in the East Texas Regional Water Planning Area

The ETRWPA water demand projections incorporate an expected level of conservation to be implemented over the planning period. For municipal use, the assumed reductions in per capita water use are the result of the implementation of three regulatory initiatives:

- The Water Saving Performance Standards for Plumbing Act, implemented by Texas in 1992. This act prohibits the sale, distribution, or importation of plumbing fixtures that do not meet certain low flow performance standards. House Bill 2667, implemented September 1, 2009, updated the water savings performance standards. For new fixtures, the average toilet flush volume is limited to 1.28 gallons, and the maximum showerhead flow is limited to 2.5 gallons per minute.
- A federal requirement that residential clothes washers manufactured on or after January 1, 2007, must achieve a water factor[1] of 9.5 gallons per cubic foot of capacity. For front-loading machines, the maximum integrated water factor[2] decreases to 4.5 gallons per cubic foot on March 7, 2015. For top-loading machines, the maximum integrated water factor decreases to 8.4 gallons per cubic foot on March 7, 2015, and 6.5 gallons per cubic foot on January 1, 2018.
- A federal requirement that residential dishwashers manufactured on or after May 30, 2013, must achieve water consumption of 5.0 gallons per cycle or less.

The "low flow plumbing fixture rules" measure assumes that all new construction will be built with water saving plumbing fixtures and that existing plumbing fixtures will

[1] Total weighted per-cycle water consumption for the cold wash/cold rinse cycle divided by the clothes container capacity.
[2] Total weighted per-cycle water consumption for all wash cycles divided by the clothes container capacity.

be replaced over time with low flow fixtures. The "efficient new residential clothes washer standards" and "efficient new residential dishwasher standards" measures assume that all new construction will be built with efficient clothes washers and dishwashers and that existing clothes washers and dishwashers will be replaced over time with efficient appliances. On a regional basis, these regulatory initiatives are projected to reduce municipal water use by 11.3 percent (over 30,000 ac-ft per year) by year 2070. See Appendix 5C-D for volumetric water savings by county.

The ETRWPA is a water-rich region, and water conservation in the region is driven by economics and not by lack of water supply. The ETRWPG believes that water users in the ETRWPA will implement advanced water conservation measures (i.e., savings associated with active conservation measures) as economic conditions dictate to each individual user. Given the general abundance of accessible water supply to the water users in the ETRWPA, the ETRWPG believes the water conservation strategies included in this planning period represent an economically achievable level of conservation.

5C.1.1 Water Use in the ETRWPA. The State of Texas Water Conservation Implementation Task Force (WCITF) has set a statewide goal of an average per capita consumption of 140 gpcd. The WCITF also set a recommended goal for municipal water suppliers to have a minimum annual reduction of one percent in total gpcd until the entity achieves a total gpcd of 140 or less. Currently, over 25 percent of the municipal water users in the ETRWPA use less than 100 gallons per capita per day (gpcd) and 62 percent use less than the WCITF recommended 140 gpcd. Municipal use represents 14 to 17 percent of the total regional water demands, so the potential savings from advanced municipal conservation could be considered relatively small.

During the 2011 planning process, water production and sales surveys were sent to 65 WUGs in the ETRWPA with approximately 1,000 connections or more. Residential and total water production and water use were calculated from the survey responses. Median residential water use and median total water production for all but two of the responding 27 WUGs demonstrated water use below 140 gpcd. Median residential water use for the region was calculated to be 68 gpcd. Based on total water production, median water use was 86 gpcd.

It must be recognized that long-term changes to water supplies can be brought on by impacts on water quality or quantity, or by changing economic conditions. Such changes could require additional emphasis on water conservation in the future. The need for additional water conservation will continue to be evaluated in future plans.

The base gpcds used to calculate demand projections in Chapter 2 are presented in Table 5C.1 for every WUG in the ETRWPA. The base gpcd was calculated by the TWDB using 2011 water use surveys, setting a minimum gpcd value of 60, and subtracting anticipated water efficiency savings.

Table 5C.1 TWDB Base Per Capita Water Use in the East Texas Regional Water Planning Area by Water User Group

Water User Group	Base GPCD	Water User Group	Base GPCD
ALTO	175	KIRBYVILLE	171
ALTO RURAL WSC	185	KOUNTZE	116
ANGELINA WSC	85	LILLY GROVE SUD	133
APPLEBY WSC	170	LINDALE	211
ARP	153	LINDALE RURAL WSC	78
ATHENS	192	LOVELADY	181
BEAUMONT	221	LUFKIN	158
BECKVILLE	132	LUMBERTON	112
BERRYVILLE	106	LUMBERTON MUD	90
BETHEL-ASH WSC	100	MEEKER MUD	124
BEVIL OAKS	99	MELROSE WSC	139
BRIDGE CITY	89	MURCHISON	148
BROWNSBORO	151	NACOGDOCHES	173
BURKE	182	NEDERLAND	125
CARTHAGE	222	NEW CHAPEL HILL	348
CENTER	304	NEW LONDON	322
CENTRAL WCID OF ANGELINA COUNTY	72	NEW SUMMERFIELD	122
CHALK HILL SUD	87	NEWTON	168
CHANDLER	161	NOME	115
CHINA	113	NOONDAY	185
COLMESNEIL	225	NORTH CHEROKEE WSC	118

Table 5C.1 TWDB Base Per Capita Water Use in the East Texas Regional Water Planning Area by Water User Group (Cont.)

Water User Group	Base GPCD	Water User Group	Base GPCD
CORRIGAN	121	NORTH HARDIN WSC	71
CRAFT-TURNEY WSC	93	ORANGE	129
CROCKETT	171	ORANGEFIELD WSC	89
CROSS ROADS SUD	83	PALESTINE	240
CRYSTAL SYSTEMS INC	291	PINEHURST	124
CUSHING	171	PINELAND	93
D&M WSC	137	PORT NECHES	102
DEAN WSC	153	REDLAND WSC	80
DIBOLL	127	ROSE CITY	154
EASTON	69	RUSK	159
ELDERVILLE WSC	60	RUSK RURAL WSC	100
ELKHART	164	SAN AUGUSTINE	228
FOUR PINES WSC	91	SILSBEE	127
FOUR WAY SUD	84	SOUR LAKE	139
GARRISON	210	SWIFT WSC	147
GILL WSC	113	TENAHA	171
GRAPELAND	133	TIMPSON	137
GROVES	133	TYLER	180
GROVETON	105	TYLER COUNTY WSC	113
HEMPHILL	220	VIDOR	190
HENDERSON	233	VIRGINIA HILL WSC	96
HUDSON	76	WALNUT GROVE WSC	120
HUDSON WSC	68	WALSTON SPRINGS WSC	100
HUNTINGTON	100	WELLS	153
IVANHOE	97	WEST GREGG SUD	86
IVANHOE NORTH	107	WEST HARDIN WSC	68
JACKSON WSC	91	WEST JEFFERSON COUNTY MWD	86
JACKSONVILLE	160	WEST ORANGE	146
JASPER	203	WHITEHOUSE	122
JASPER COUNTY WCID #1	77	WODEN WSC	119
JEFFERSON COUNTY WCID #10	87	WOODVILLE	315
JOAQUIN	147	ZAVALLA	101
KILGORE	202		

5C.1.2 Water Loss in the ETRWPA. Since 2003, retail public water utilities have been required to complete and submit a water loss audit form to the TWDB every five years. The second round of water loss audit reports was submitted to the TWDB by May 1, 2011. The TWDB compiled the data from these reports. The water audit reporting requirements follow the International Water Association (IWA) and American Water Works Association (AWWA) Water Loss Control Committee methodology.

The primary purposes of a water loss audit are to account for all of the water being used and to identify potential areas where water can be saved. Water audits track multiple sources of water loss that are commonly described as apparent loss and real loss. Apparent loss is water that was used but for which the utility did not receive compensation. Apparent losses are associated with customer meters under-registering, billing adjustment and waivers, and unauthorized consumption. Real loss is water that was physically lost from the system before it could be used, including main breaks and leaks, customer service line breaks and leaks, and storage overflows. The sum of the apparent loss and the real loss make up the total water loss for a utility.

In the ETRWPA, 142 public water suppliers submitted a water loss audit to TWDB. These water suppliers represent a retail service population of approximately 589,000 people, or about 55 percent of the regional population. Table 5C.2 shows a summary of reported 2010 water loss accounting for the ETRWPA.

Table 5C.2 Reported 2010 Water Loss Accounting in the ETRWPA

System Input Volume 49,264,397,900 100.0%	Authorized Consumption 40,762,451,765 82.7%	Billed Consumption 39,715,161,393 80.6%	Billed Metered 39,658,411,074 80.5%	Revenue Water 39,715,161,393 80.6%
			Billed Unmetered 56,750,319 0.1%	
		Unbilled Consumption 1,047,290,372 2.1%	Unbilled Metered 528,937,654 1.1%	Non-Revenue Water 9,550,301,736 19.4%
			Unbilled Unmetered 518,352,718 1.1%	
	Water Loss 8,503,222,510 17.3%	Apparent Loss 1,299,717,405 2.6%	Unauthorized Consumption 186,016,040 0.4%	
			Customer Meter Accuracy Loss 1,075,937,970 2.2%	
			Systematic Data Handling Discrepancy 37,763,395 0.1%	
		Real Loss 7,211,368,309 14.6%	Reported Breaks and Leaks 856,923,200 1.7%	
			Unreported Loss 6,375,337,625 12.9%	

Two problems with the reported water loss accounting data include:

- Misreported units. Several utilities appear to have misreported the units for their water loss data. In particular, two utilities reported water volumes in units of thousand gallons, when the volumes appear to be in units of gallons. These two discrepancies alone would reduce the reported overall 2010 system input volume in the ETRWPA from 49.3 billion gallons (229 gpcd) to 32.4 billion gallons (151 gpcd), which is much more in line with other historical water use data.

- Negative real water losses. Fourteen utilities reported negative real losses. The physical meaning of a negative water loss is that water is infiltrating into the distribution system, which is not realistic.

On a regional basis, the reported percentage of total water loss for the ETRWPA was 17.3 percent, with reported percentages for WUGs ranging from -1.3 percent to 57.6 percent. Based on these figures, it appears that enhanced water loss control programs may be a potentially feasible water conservation strategy for some WUGs in the East Texas Region.

5C.2 Water Conservation Plans

The TCEQ requires water conservation plans for all municipal, industrial, and other non-irrigation water users with surface water rights of 1,000 ac-ft per year or more, all irrigation water users with surface water rights of 10,000 ac-ft per year or more, and all retail public water suppliers providing water service to 3,300 connections or more.[1] Water conservation plans are also required for all water users applying for a new or amended State water right and for entities seeking more than $500,000 in State funding for water supply projects.

All conservation plans must specify quantifiable 5-year and 10-year conservation goals and targets. While these goals are not enforceable, they must be identified. Updated water conservation plans for WUGs in the region were to be submitted to the Executive

Director of the TCEQ and to the ETRWPG by May 1, 2014. Failure to submit a water conservation plan is a violation of the Texas Water Code, Section 11.1272 and the Texas Administrative Code, Section 288.30, and is subject to enforcement by the TCEQ.

In the ETRWPA, 30 entities hold municipal, industrial, or other non-irrigation surface water rights in excess of 1,000 ac-ft per year, four entities have irrigation water rights greater than 10,000 ac-ft per year, and 23 entities serve 3,300 connections or more. A list of the users in the ETRWPG required to submit water conservation plans is shown in Table 5C.3.

Other entities have contracts with regional and wholesale water providers for greater than 1,000 ac-ft per year. Presently, these water users are not required to develop water conservation plans unless the user is seeking State funding; however, a wholesale water provider may request that its customers prepare a conservation plan to assist in meeting the goals and targets of the wholesale water provider's plan.

To assist entities in the ETRWPA with developing water conservation plans, model plans for municipal water users (wholesale or retail public water suppliers), industrial users and irrigation districts may be found in Appendices 5C-A through 5C-C. Additionally, model conservation plans are available on the TCEQ website at http://www.tceq.state.tx.us/permitting/water_rights/conserve.html. Each of these model plans addresses the latest TCEQ requirements and is intended to be modified by each user to best reflect the activities appropriate to the entity.

Table 5C.3 Water Users and Types of Use that are Required to Develop, Implement, and Submit Water Conservation Plans

Entity	WUG	3,300 Connections or More	Non-Irrigation Water Right of 1,000 ac-ft/yr or More				Irrigation Water Right of 10,000 ac-ft/yr or More
			Municipal / Domestic	Industrial	Mining	Other	
Athens	Yes	•					
Beaumont	Yes	•	•				
Bridge City	Yes	•					
Carthage	Yes	•					
Center	Yes		•				
GM WSC	Yes	•					
Groves	Yes	•					
Henderson	Yes	•					
Jacksonville	Yes	•	•				
Jasper	Yes	•					
Kilgore	Yes	•					
Lake Livingston Water Supply & Sewer Service Company	Yes	•					
Lindale Rural WSC	Yes	•					
Lufkin	Yes	•	•	•			
Lumberton MUD	Yes	•					
Nacogdoches	Yes	•	•				
Nederland	Yes	•					
Orange	Yes	•					
Palestine	Yes	•					
Port Arthur	Yes	•					
Port Neches	Yes	•					
San Augustine	Yes		•				
Southern Utilities Company	Yes	•					
The Consolidated WSC	Yes	•					
Tyler	Yes	•	•	•			
Angelina & Neches River Authority	No		•	•			
Angelina-Nacogdoches WCID 1	No			•			
Athens Municipal Water Authority	No		•	•			
E I Dupont De Nemours & Co	No			•			
Entergy Texas Inc.	No			•			
Exxon Mobil Oil Co	No			•			
Houston Co WCID 1	No		•				
Independent Refining Corp	No			•			
Jefferson County Drainage District No 6	No					•	
Joe Broussard II et al	No						•
Lower Neches Valley Authority	No		•	•	•	•	•
Luminant Generation Co LLC	No			•			

Table 5C.3 Water Users and Types of Use That are Required to Develop, Implement, and Submit Water Conservation Plans (Cont.)

Entity	WUG	3,300 Connections or More	Non-Irrigation Water Right of 1,000 ac-ft/yr or More				Irrigation Water Right of 10,000 ac-ft/yr or More
			Municipal/ Domestic	Industrial	Mining	Other	
Luminant Mining Co LLC	No				•		
M Half Circle Ranch Company	No						•
Motiva Enterprises LLC	No			•			
Panola Co FWSD 1	No		•	•			
Premcor Refining Group Inc.	No			•			
Rowan Companies Inc.	No			•			
Sabine River Authority	No		•	•	•	•	•
Temple-Inland Forest Prod Corp/Georgia-Pacific LLC	No			•			
Texas Parks & Wildlife Dept.	No					•	
TPC Group LLC	No			•			
Union Oil Of California	No			•			
United States Department Of Energy	No				•		
Upper Neches River MWD	No		•				

NOTE: May not include applicants for new water rights or TWDB funding.

Implemented water conservation strategies vary by water user and are shown in Table 5C.4. This table lists water conservation strategies for individuals who have submitted water conservation plans as of February 20, 2015, or who have published water conservation plans on their web sites. The focus of the conservation activities for municipal water users in the ETRWPA are:

- Education and public awareness programs.
- Reduction of unaccounted for water through universal metering, water audits, maintenance and repair of water systems, and meter testing and repair.
- Water rate structures that discourage water waste.

Table 5C.5 summarizes water conservation measures implemented by the utilities for which water conservation plans were available.

Table 5C.4 Primary Water Conservation Strategies Documented in Water Conservation Plans

Entity	Plan Date	Primary Water Conservation Strategies								
		Plumbing Fixture Requirements	Reduce Water Loss/Leak Detection	Public Education/Awareness Programs	Pressure Control	Universal Metering or Meter Calibration or Replacement	Rate Structure Not Promoting Excessive use	Active Fixture Retrofit Program	Require/request wholesale customers to have conservation plan/conservation strategies	Other
		Passive Strategies	Active Conservation Strategies							
Angelina & Neches River Authority	2014		•	•		•	•		•	
Angelina-Nacogdoches WCID No.1	2009		•							
City of Beaumont	2014	•	•	•		•	•			
City of Bridge City	2010		•	•		•	•			•
City of Carthage	2005		•	•		•	•		•	•
City of Center	2014	•	•	•		•	•		•	•
City of Crockett	2014		•	•		•	•			•
City of Groves	2014		•	•			•			
City of Henderson	2010	•	•	•		•	•			•
City of Jacksonville	2014	•	•	•	•	•	•		•	•
City of Jasper	2009	•	•	•	•	•	•		•	
City of Kilgore	2009	•	•	•		•	•		•	•
City of Lindale	2009[a]	•	•	•		•	•		•	•
City of Lufkin	2014	•	•	•		•	•		•	•
City of Nacogdoches	2012		•	•		•	•			
City of Nederland	2009	•	•	•	•	•	•		•	•
City of Orange	2009	•	•	•		•	•		•	•
City of Palestine	2014	•	•	•		•	•		•	•
City of Pineland	2014			•			•			•
City of Port Arthur	2014	•	•	•		•	•			•
City of Port Neches	2009	•	•	•	•	•	•			•

Table 5C.4 Primary Water Conservation Strategies Documented in Water Conservation Plans (Cont.)

Entity	Plan Date	Primary Water Conservation Strategies								
		Plumbing Fixture Requirements	Reduce Water Loss/Leak Detection	Public Education/Awareness Programs	Pressure Control	Universal Metering or Meter Calibration or Replacement	Rate Structure Not Promoting Excessive use	Active Fixture Retrofit Program	Require/request wholesale customers to have conservation plan/conservation strategies	Other
		Passive Strategies	Active Conservation Strategies							
City of Tyler	2014	•	•	•	•	•			•	•
Entergy Texas, Inc.	2014		•		•					
Houston Co WCID No.1	2014		•	•	•	•			•	
Lower Neches Valley Authority	2014		•	•		•	•		•	•
Sabine River Authority	2014		•	•		•			•	•
Southern Utilities Company	2014		•	•	•	•	•		•	•
Temple-Inland Forest Prod Corp/Georgia-Pacific LLC	2014		•							•
Upper Neches River MWD	2014	•	•	•		•			•	•

[a] Dated 1999 but updated with water use statistics through 2008.

Table 5C.5 Summary of Measures in Water Conservation Plans

Number of Plans That Include Measure	Measure
26	Public education (distribute materials, web site, school programs, news articles, conservation tips, etc.)
22	Routine observation for leaks/illegal connections by utility personnel and public
21	Meter testing and repair program or replacement program
20	Repair leaks as soon as practical
19	Universal metering
17	Require wholesale water customers to develop water conservation plans or adopt city programs
16	Conduct annual water audits
14	Consistency check on meter readings
13	Calibrate master meters annually or semiannually
13	Flat rate structure
12	Encourage retrofit of inefficient plumbing fixtures
10	Minimize real water losses by replacement of deteriorating water mains and appurtenances on an on-going basis
10	Track monthly production and sales records and unaccounted-for water
10	State fixture water use standards
9	Increasing block rate structure
8	Monitor and/or control system pressures
8	Adopt International Building/Plumbing Codes
8	Encourage water-efficient landscaping
7	Active leak detection program
7	Conduct water audits less frequently than annually
7	Recycling/reuse
5	Convert to AMR/AMI meter infrastructure
4	Water waste prohibition
3	Calibrate master meters less frequently than annually
3	Other ordinances (recirculate swimming pool water, insulation of hot-water piping for new construction, etc.)
2	Meters at all city facilities
2	Subbasin metering to identify areas with water losses
2	Canal inspection and maintenance
2	Technical assistance for conservation planning
2	Federal clothes washer standards
1	Track street cleaner water use
1	Measure night flows
1	Conservation grant program
1	Encourage smart irrigation controllers
1	State irrigation system rules
1	Golf course conservation
1	ICI conservation
1	Saltwater barrier
1	Restricted pumping hours
1	Computerized controls to improve water and production efficiency

5C.3 Recommended Water Conservation Strategies in the East Texas Regional Water Planning Area

Water conservation actions implemented as strategies would result in savings above that assumed for the TWDB water demand projections. The Texas Water Development Board Report 362,[2] published by the Water Conservation Implementation Task Force in November 2004, provides a review of best management practices (BMPs) for water conservation for municipal, industrial and agricultural water users. Since that time, the Water Conservation Advisory Council has worked with the TWDB and the TCEQ to develop new water conservation BMPs and to review and update the existing BMPs. Recommended water conservation strategies are presented by WUG type in the following sections.

5C.3.1 Municipal Water Conservation Strategies. Water conservation BMPs were evaluated for municipal WUGs that have a projected per capita water use greater than 140 gpcd and have either demonstrated needs in the planning period or recommended water management strategies that involve interbasin transfer. Evaluated water conservation practices included enhanced public and school education, water conservation pricing, and an enhanced water loss control program.

Enhanced Public and School Education. Enhanced public and school education would involve providing formal and indirect means of information on how to conserve water beyond current efforts. Education costs were applied to all of the entities meeting the above criteria. Assumptions made in evaluating the efficiency of this measure included restrictions that the annual budget spent on education would be limited to approximately $1.50 per capita or per 1,000 gallons water conserved, whichever was most restrictive. The total budget available will be an indication as to the effectiveness of the program. Table 5C.6 indicated efficiencies assigned to various ranges of available budget.

Table 5C.6 Water Conservation Efficiencies for Enhanced Public and School Education

Budget		Efficiency of Conservation
Low	High	
$1,500 (minimum)	$14,999	1.5%
$15,000	$29,999	2.0%
$30,000	$44,999	2.5%
$45,000	$60,000 (maximum)	3.0%

Water Conservation Pricing. Water conservation pricing requires an increasing rate structure with increasing use. The minimum price increase between rate blocks should be 25 percent. For maximum effectiveness, the price increase between rate blocks should be at least 50 percent.[2] The effectiveness of this measure is, in part, determined by whether water conservation pricing is currently implemented.

Water conservation pricing will be most effective in areas where groundwater resources are becoming less available and require high expenditures in capital projects to supply water. Only those entities meeting the previous criteria and located in counties that are reaching the limits of groundwater were considered for this strategy. Where other recommended strategies were projected to cost less than $1.50 per 1,000 gallons, the efficiency achieved is assumed to be 1.0 percent. A 2.0 percent efficiency is assumed where the recommended strategy cost exceeds $1.50 per 1,000 gallons.

Enhanced Water Loss Control Program. An enhanced water loss control program involves committing more resources towards identifying and repairing leaks, replacing inaccurate water meters, minimizing billing errors, and replacing mains with chronic leakage. Utilities would strive to achieve target water loss percentages that depend on water system characteristics. For more rural utilities with fewer than 32 connections per mile of main, the target water loss is 18 percent of water entering the system (Table 5C.7). For more urban or suburban utilities with 32 or more connections per mile of main, the target water loss is 12 percent of water entering the system. For WUGs with severe water loss, achieving the water loss target may involve replacing a substantial portion of the potable water transmission and distribution system.

Table 5C.7 Enhanced Water Loss Control Program Targets

Service Connections per Mile of Main	Water Loss Target (% of System Input)
Less than 32	18% or less
32 or more	12% or less

The projected total water savings is provided in Table 5C.8 for WUGs that have a projected per capita water use greater than 140 gpcd and have either demonstrated needs in the planning period or recommended water management strategies that involve interbasin transfer. Since Athens is primarily located in Region C, the recommended water conservation strategy for Athens is included in the *Region C Water Plan*.

Table 5C.8 Water Conservation Savings for Selected WUGs

Entity (County)	Amount Conserved (ac-ft per year)					
	2020	2030	2040	2050	2060	2070
Alto Rural WSC (Cherokee)	0	0	0	5	7	10
Beaumont (Jefferson)	0	3,238	5,341	7,047	8,579	9,966
Bullard (Smith/Cherokee))	11	24	30	38	47	56
Chandler (Henderson)	0	0	0	16	30	36
Crystal Systems Inc. (Smith)	4	9	12	15	19	22
Lindale (Smith)	8	17	22	28	34	41
Overton (Rusk/Smith)	0	0	97	167	223	269
Port Arthur (Jefferson/Orange)	4,992	7,450	8,516	9,616	10,340	9,767
Woodville (Tyler)	0	0	10	16	18	19
TOTAL	**5,015**	**10,738**	**14,029**	**16,949**	**19,297**	**20,186**

The following WUGs have water needs but use less than 140 gpcd:

- County-Other (Jasper)
- County-Other (Jefferson)
- D&M WSC (Nacogdoches)
- R-P-M WSC (Henderson/Smith)

In addition, seven WUGs are customers of the Lower Neches Valley Authority, a WWP with a recommended water management strategy involving an interbasin transfer. These WUGs are also projected to use less than 140 gpcd:

- County-Other (Jefferson)
- Groves (Jefferson)
- Jefferson County WCID #10 (Jefferson)
- Nederland (Jefferson)
- Nome (Jefferson)
- Port Neches (Jefferson)
- West Jefferson County MWD (Jefferson)

The WUGs listed above already use water in an efficient manner. It should be noted that, the water demand projections for these entities already include projected water savings from natural replacement of inefficient fixtures and appliances with high-efficiency toilets and showerheads, residential clothes washers, and residential dishwashers. For these WUGs, the “built-in” water savings from these measures is 7.8 percent of pre-savings water demand in 2020, increasing to 14.6 percent in 2070. For these reasons, no additional water conservation strategies are recommended for WUGs that use less than 140 gpcd.

5C.3.2 Other Water User Groups. Water conservation measures for other water user groups are described in the following sections.

Manufacturing. Industrial water users include large petrochemical industries as well as smaller local manufacturers. The current state of water conservation at existing manufacturing facilities is unknown. Conservation measures associated with industries are highly industry- and site-specific. For example, some industries can utilize brackish water supplies or wastewater effluent while others require only potable water. In addition, the future mix of industries is also unknown.

It is important in evaluating conservation strategies for industries to balance the water savings from conservation to economic benefits to the industry and the region. In the ETRWPA, where water is readily available, requiring costly changes to processes and equipment may not be practical and beneficial to the region. Finally, although it is expected that manufacturers will implement water conservation measures during the planning period, the ETRWPG does not have the industry- and site-specific information necessary to identify the current status of manufacturing water conservation or to say what measures should be implemented. In light of these considerations, the ETRWPG has not recommended water conservation strategies for manufacturing WUGs.

Irrigation. Most irrigation occurs in the lower parts of the Neches and Sabine Basins. Much of the irrigation water is delivered by canals and is used for rice farming along the coast. The Lower Neches Valley Authority is the largest provider of agricultural irrigation water in the ETRPWA. LNVA has implemented significant irrigation water conservation measures, including:

- Information and education program.
- Meter repair and replacement program
- Water billing based on water usage: In 2005, LNVA began billing rice farmers based on metered water use rather than farmed acreage. After implementation of this measure, average water consumption was reduced from 3.79 acre-feet per acre farmed in 2004 to 2.84 acre-feet per acre farmed in 2005, a reduction of about 25 percent.
- Canal water loss reduction: From 2009 to 2013, LNVA reduced its canal water loss from 25 percent to 14 percent through aggressive leak detection and repair along with vegetation control. This represents a reduction in canal water loss of more than 23,000 acre-feet per year.
- Neches River saltwater barrier: This measure is estimated to conserve an average of 200,000 acre-feet per year of stored, fresh water that does not have to be released to prevent saltwater intrusion into the river.

Individual farmers also apply measures such as minimization of water loss from on-farm water distribution, irrigation scheduling, land leveling, and tailwater recovery. As described above, significant increases in efficiency have already been achieved. In addition, the appropriate water conservation strategies for individual farms are site-specific. Although the ETRWPG encourages implementation of irrigation water conservation measures, it does not have the farm-specific information necessary to identify the current status of on-farm water conservation or to recommend what measures should be implemented. In light of these considerations, the ETRWPG has not recommended further water conservation strategies for irrigation WUGs.

Other. Steam-electric power, livestock, and mining WUGs account for about 11 to 14 percent of the total water demand in the ETRWPA during the planning period. The demand for steam-electric use is projected to grow from 7.2 to 11.5 percent of the demand during the 50-year period. The projections for steam-electric use were provided by the TWDB. Most of the demand will be consumed by new projects, which may include conservation in the projected water use. Livestock and mining comprise a total of 3 to 5 percent of the demand. The cost of water in these industries comprises a small percentage of the overall business cost, and it is not expected that these industries will see an economic benefit to water conservation. Based on these considerations, water conservation strategies have not been recommended for steam-electric, livestock and mining WUGs.

Chapter 6

Impacts of the Regional Water Plan and Consistency with Protection of Resources

The development of viable strategies to meet the demand for water is the primary focus of regional water planning. However, another important goal of water planning is the long-term protection of resources that contribute to water availability, and to the quality of life in the State. The purpose of this chapter is to describe how the 2016 Plan is consistent with the long-term protection of the State's water resources, agricultural resources, and natural resources. The requirement to evaluate the impact of the regional water plan and its consistency with protection of resources is found in 31 TAC Chapter 357.40 & 41, which require the following:

- A description of the socioeconomic impacts of not meeting identified water needs in the region. (§357.40(a))
- A description of potential impacts of the regional water plan regarding agricultural resources; other water resources; threats to agricultural and natural resources; third-party social and economic impacts resulting from voluntary redistributions of water; major impacts of recommended water management strategies on key water quality parameters; and, effects on navigation. (§357.40(b))
- A summary of identified water needs that remain unmet by the plan. (§357.40(c))
- A description of how the 2016 Plan is consistent with the long-term protection of the state's water resources, agricultural resources, and natural resources. (§357.41)

The socioeconomic impacts of not meeting identified water needs in the ETRWPA have been previously addressed in Chapter 4. Other elements of §357.40 & 41 are addressed in Chapter 6. These requirements are addressed by providing general descriptions of how the plan is consistent with protection of water resources, agricultural resources, and natural resources.

Additionally, the chapter will specifically address consistency of the 2016 Plan with the State's water planning requirements. To demonstrate compliance with the State's requirements, a matrix has been developed and is addressed in Section 6.4.

6.1 Consistency with Protection of Water Resources

The water resources in the ETRWPA include portions of three river basins providing surface water, and portions of four aquifers providing groundwater. The three major river basins within the ETRWPA boundaries are the Sabine River Basin (Basin 5), the Neches River Basin (Basin 6), and the Trinity River Basin (Basin 8). The respective boundaries of these basins are depicted in Figure 1.10, in Chapter 1.

The region's groundwater resources include, primarily, the Gulf Coast and Carrizo-Wilcox aquifers. Lesser amounts of water are also drawn from the Sparta aquifer, Queen City aquifer, and localized aquifers, such as the Yegua-Jackson. The extents of these aquifers within the region are depicted on Figures 1.7 and 1.8, in Chapter 1.

Surface water accounts for approximately 75% of the total water use in the region. Sources within the region include 11 reservoirs in the Neches River Basin, three in the Sabine River Basin, and one in the Trinity River Basin. If constructed, Lake Columbia would be located in the Neches River Basin. Currently, the majority of the available surface water supply used in the ETRWPA comes from the Neches River Basin.

The Carrizo-Wilcox aquifer and Gulf Coast aquifers are, by far, the most important groundwater resources in the ETRWPA, accounting for approximately 75% of the available groundwater. Significant water level declines have been observed in the Carrizo-Wilcox aquifer around the cities of Tyler, Lufkin, and Nacogdoches over the past two decades. Lufkin and Nacogdoches are both considering development of new surface water sources to meet projected shortages. The City of Tyler already relies largely on surface water supplies.

Protection of surface water resources and groundwater resources necessarily involves understanding potential impacts to the interrelationship between groundwater and surface water. This is particularly important in aquifer recharge (i.e., outcrop) areas and contributing zones to recharge areas. The Carrizo-Wilcox Aquifer outcrops in the northeastern area of the region, predominantly in Panola, Shelby, and Rusk counties. In addition the Queen City Aquifer outcrop is found in the northwestern area of the region, mostly in Henderson, Smith, Cherokee, and Anderson counties. All of these counties support surface water supplies that are likely located on a portion of an aquifer outcrop.

Hence, water management impacts on surface water sources could affect supplies in these important groundwater supplies. Strategies to manage impacts in the ETRWPA need to consider protection of the groundwater-surface water interfaces, where it is may be possible to do so.

To be consistent with the long-term protection of water resources, the 2016 Plan must recommend strategies that minimize threats to the region’s sources of water over the planning period. The water management strategies identified in Chapter 5B were evaluated for threats to water resources. The recommended strategies represent a comprehensive plan for meeting the needs of the region while effectively minimizing threats to water resources. Threats to water resources are minimized in the 2016 Plan in the following ways:

- **Water conservation**. Strategies for water conservation have been recommended that will help reduce the demand for water, thereby reducing the impact on the region’s groundwater and surface water sources. Water conservation practices are expected to save over 20,000 ac–ft of water annually by 2070, reducing impacts on both groundwater and surface water resources. The plan also assumes significant savings in municipal demands due to the implementation of plumbing codes. Water conservation benefits the State's water resources by reducing the volumes of water withdrawals necessary to support human activity. This can benefit surface water, groundwater, and groundwater-surface water relationships.

- **Development of Lake Columbia**. This strategy will increase surface water supplies available for cities, industry, and agriculture in the ETRWPA.
- **Optimized use of existing surface water resources**. Water management strategies that involve existing surface water resources work to optimize the utilization of these resources. The WAM, a part of the regional planning process, assesses how the increased use of surface water resources will impact the Region's water resources. The WAMs developed for the ETRWPA indicate adequate availability of surface water in the region. As with conservation, optimized use of existing surface water resources can help protect groundwater-surface water relationships where surface waters extend across an aquifer outcrop.
- **Optimized use of groundwater**. This strategy has generally been recommended for entities with sufficient groundwater supply available to meet needs, but currently without adequate infrastructure (i.e., well capacity). Groundwater availability reported in the plan is based on the long-term sustainability of the aquifer. No strategies are recommended to use water above currently identified sustainable levels.

6.2 Consistency with Protection of Agricultural Resources

Agriculture is an important economic cornerstone of the ETRWPA. Even with adequate rainfall, irrigation is a critical aspect of some agriculture in the region. Rice irrigation in the coastal counties is supplied by LNVA, primarily, with water from the Rayburn/Steinhagen system. The WAMs indicate adequate availability of surface water to meet the projected irrigation demands for the planning period.

6.3 Consistency with Protection of Natural Resources

The ETRWPA contains many natural resources including threatened or endangered species; local, state, and federal parks and public land; and energy/mineral reserves. Following is a brief discussion of how the 2016 Plan is consistent with the long-term protection of these resources.

6.3.1 Threatened/Endangered Species. A list of species of special concern, including threatened or endangered species, located within the ETRWPA is contained in Appendix 1-A. Included are 22 species of birds, eight insects, six mammals, 11 reptiles, one amphibian, nine fish, six mollusks, 27 plants, and two crustaceans. In general, most WMSs planned for the ETRWPA will not affect threatened or endangered species. Development of new reservoirs in the region could affect threatened or endangered species and their habitats. However, the development of any reservoir requires extensive environmental impact studies that address potential effects on threatened or endangered species. Any such impacts indicated by these studies would need to be mitigated in accordance with federal and state environmental regulations in order for the reservoir project to be allowed.

6.3.2 Parks and Public Lands. The ETRWPA contains national forests, wildlife refuges, and a preserve; as well as state parks, forests, and wildlife management areas. In addition, there are numerous local (e.g., city or county parks), recreational facilities, and other local public lands located throughout the region. None of the water management strategies currently proposed for the ETRWPA is expected to adversely impact state or local parks or public land.

In general, federal lands (i.e., national forests, wildlife refuges, or preserves) cannot be subjugated by state or local projects. Therefore, a proposed WMS for the ETRWPA would not be permitted to adversely impact such properties unless adequate mitigation measures were planned, and the plans approved by the appropriate federal agencies.

6.3.3 Timber Resources. Timber is an important economic resource for the ETRWPA. Although the development of Lake Columbia would inundate some forested areas, this loss in timber resources would be partially offset by gains in wetland areas, aquatic habitat and water recreation areas. A full environmental assessment is part of the planning process for development of reservoirs. The results of such environmental assessments identify any significant effects on timber resources and propose mitigation, as necessary.

6.3.4 Energy Reserves. Numerous oil and gas wells are located within the ETRWPA, including the East Texas Oil Field, and four of the top 10 producing gas fields in the state. Producing oil wells and top producing oil fields are depicted in Chapter 1 Figures 1.16 and 1.17, respectively. In addition, significant lignite coal resources can be found in the ETRWPA under portions of 12 counties. Lignite coal resources are depicted in Figure 1.19. These resources represent an important economic base for the region. None of the water management strategies is expected to significantly impact oil, gas, or coal production in the region.

6.4 Consistency with State Water Planning Guidelines

To be considered consistent with long-term protection of the State's water, agricultural, and natural resources, the ETRWPA Water Plan must also be determined to be in compliance with provisions of 31 TAC Chapter 357. The information, data, evaluation, and recommendations included in Chapters 1 through 5C, Chapters 7 through 11 of the 2016 Plan collectively demonstrate compliance with these regulations. To more clearly demonstrate compliance, the ETRWPA has developed a matrix addressing the specific recommendations contained in the referenced regulations. Appendix 6-1 contains a completed matrix or checklist highlighting each pertinent paragraph of the regulations. The content of the 2016 Plan have been evaluated against this matrix.

Chapter 7

Drought Response Information, Activities, and Recommendations

Drought response and management have long been important aspects of regional water planning. The extensive drought experienced in Texas during the 2010-2012 time-frame, however, served to re-focus attention on the need for comprehensive consideration of drought management measures. Requirements for improved drought planning in the State through the regional water planning process are found in Title 31 of the Texas Administrative Code, Part 10, Chapter 357, Subchapter D. Specifically §357.42 of Subchapter D includes requirements related to drought response information, activities, and recommendations. This chapter addresses the requirements found in §357.42.

While the ETRWPA is generally less prone to extreme drought, there have been significant historical droughts identified throughout the region. These have tended to be sub-regional in nature, meaning a significant or extreme drought is more likely to be localized than in other, drier regions of the State. This limited geographic extent affects how the region prepares for and responds to drought when it does occur.

7.1 Droughts of Record

A central principal of regional water planning is that the availability of water sources is determined for drought-of-record conditions. State-wide, the drought of the 1950's is often considered the drought of record, but on regional or sub-regional bases, droughts during other periods of time may actually be demonstrated to have been more severe. Chapter 7 includes a detailed examination of preparations for and responses to drought conditions in the region, as required by §357.42. Such examination begins with identification of significant recent droughts within the region.

7.1.1 Historical Droughts of Record. As described in Chapter 3, the surface water supplies for the regional water plans were determined using the TCEQ-approved Water Availability Models (WAMs).[1] The WAMs can be used to simulate the response of existing and proposed water supply reservoirs to historical hydrologic conditions. The firm yield of a reservoir is the greatest amount of water the reservoir can supply on an annual basis without shortage during a repeat of historical drought of record conditions. The WAMs incorporate historical hydrologic conditions that occurred between 1940 and 1996. The historical droughts of record that were used to evaluate currently available water supplies occurred during this time period. Table 7.1 shows the historical drought of record for each major reservoir in the ETRWPA.

Table 7.1 Historical Droughts of Record for Major Water Supply Reservoirs

<table>
<tr><th rowspan="2">Reservoir Name</th><th rowspan="2">Counties</th><th colspan="2">Drought of Record[a]</th></tr>
<tr><th>Start Date</th><th>End Date</th></tr>
<tr><td colspan="4">Trinity River Basin</td></tr>
<tr><td>Houston County</td><td>Houston</td><td>Jul 1950</td><td>Apr 1957</td></tr>
<tr><td colspan="4">Neches River Basin</td></tr>
<tr><td>Lake Athens</td><td>Henderson</td><td>Jun 1947</td><td>Mar 1957</td></tr>
<tr><td>Lake Jacksonville</td><td>Cherokee</td><td>Jul 1950</td><td>Mar 1957</td></tr>
<tr><td>Lake Palestine</td><td>Anderson, Cherokee, Henderson, Smith</td><td>Jul 1950</td><td>Feb 1957</td></tr>
<tr><td>Sam Rayburn</td><td>Angelina, Jasper, Nacogdoches, Sabine, San Augustine</td><td rowspan="2">Jun 1954</td><td rowspan="2">Feb 1957</td></tr>
<tr><td>B. A. Steinhagen</td><td>Jasper, Tyler</td></tr>
<tr><td>Lake Columbia[b]</td><td>Cherokee, Smith</td><td>Jul 1962</td><td>Mar 1966</td></tr>
<tr><td>Lake Naconiche</td><td>Nacogdoches</td><td>Jan 1962</td><td>Oct 1973</td></tr>
<tr><td>Striker Creek Reservoir</td><td>Cherokee, Rusk</td><td>May 1963</td><td>Mar 1965</td></tr>
<tr><td>Lake Nacogdoches</td><td>Nacogdoches</td><td>Jun 1969</td><td>Oct 1972</td></tr>
<tr><td>Lake Pinkston</td><td>Shelby</td><td>Jun 1969</td><td>Oct 1972</td></tr>
<tr><td>Lake Tyler/Tyler East</td><td>Smith</td><td>Jun 1980</td><td>Oct 1985</td></tr>
<tr><td colspan="4">Sabine River Basin</td></tr>
<tr><td>Lake Cherokee</td><td>Gregg, Rusk</td><td>Jun 1962</td><td>Dec 1964</td></tr>
<tr><td>Lake Murvaul</td><td>Panola</td><td>Jun 1962</td><td>Jan 1965</td></tr>
<tr><td>Toledo Bend Reservoir</td><td>Newton, Panola, Sabine, Shelby</td><td>Jun 1962</td><td>Jan 1968</td></tr>
</table>

a For each location, the drought of record refers to a set of hydrologic conditions that is used to evaluate the firm yield of an existing or proposed reservoir.

b Lake Columbia is permitted but not yet constructed, and is in the process of U.S. Army Corps of Engineers permitting.

The drought of record can be different for different geographic locations. There have been four primary droughts of record in the East Texas Region:

- The drought of the 1950s in the western and central portions of the region.
- With exceptions described below, the drought beginning in about 1962 and spanning the mid-1960s for the north central and eastern portions of the region.
- The June 1969-October 1972 drought in the north central portion of the region.
- The June 1980-October 1985 drought for the northern portion of the region.

7.1.2 Recent Droughts in the Region. There are a number of ways to measure drought, including the U.S. Drought Monitor index, the Palmer Hydrological Drought Index, and reservoir water levels. These indicators were used in an attempt to identify significant new droughts in the ETRWPA since the mid-1990's.

The Drought Monitor is a composite index that is calculated weekly based on measurements of climatic, hydrologic, and soil conditions, as well as reported impacts and observations from more than 350 contributors around the country.[2] The Drought Monitor was initiated in 2000, and data can be obtained for each county in the United States. Figure 7.1 shows a composite Drought Monitor index calculated for the 20 counties in the ETRWPA over the period of record. This composite index shows the percentage of the land area in the affected counties that experienced different levels of drought. Approximately 15 to 30 percent of the region experienced extreme drought in 2006, 2007, and for a brief period in 2013. The Drought Monitor index indicates that the region experienced extreme/exceptional drought conditions from late 2010 through early 2012. In October 2011, the entire region experienced exceptional drought conditions.

Compared to climatic effects of drought, the hydrological effects, such as lower reservoir and groundwater levels, may take longer to develop and take longer to recover from. The Palmer Hydrological Drought Index (PHDI) was developed as an indicator of the long-term cumulative moisture supply. The PHDI is available on a monthly basis for each year since 1900 for ten climatic zones in each state.[3] The East Texas climatic zone includes most of the ETRWPA, as well as parts of Regions C, G, and H and the North East Texas RWPA. Figure 7.2 shows the PHDI for the East Texas climatic zone. The PHDI reflects extreme droughts in this area during the 1950s, as well as in 1981, 2005-06, and 2010-12.[1] According to the PHDI, the 2010-2012 drought was more severe than any of the individual droughts in the 1950s.

Since construction of the Sam Rayburn and Toledo Bend Reservoirs in the late 1960s, reservoirs in the ETRWPA reached minimum conservation storage during the droughts of 1995-1996 and 2010-2012, with several smaller droughts occurring during the period (Figure 7.3).[4]

Each of the three drought indicators suggests that the 2010-2012 period was one of significant drought for the ETRWPA. However, each of these indicators applies to the ETRWPA as a whole, and more localized hydrologic information is necessary to evaluate whether accounting for recent droughts would change the estimates of available surface water supplies. For a full evaluation of the impact of a potential new drought of record on surface water supply availability, the WAMs should be updated to incorporate the hydrologic conditions that have occurred since 1996.

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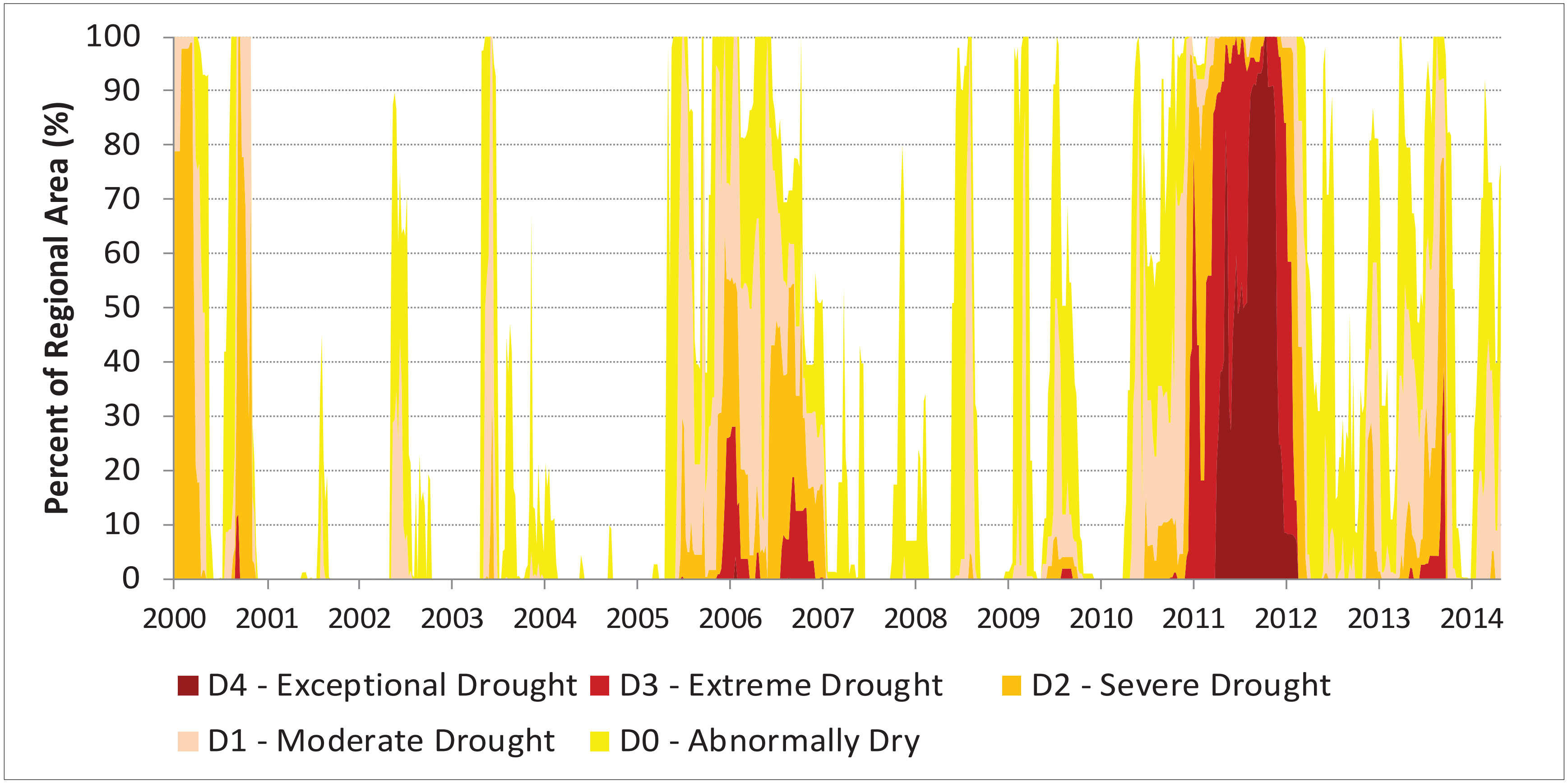
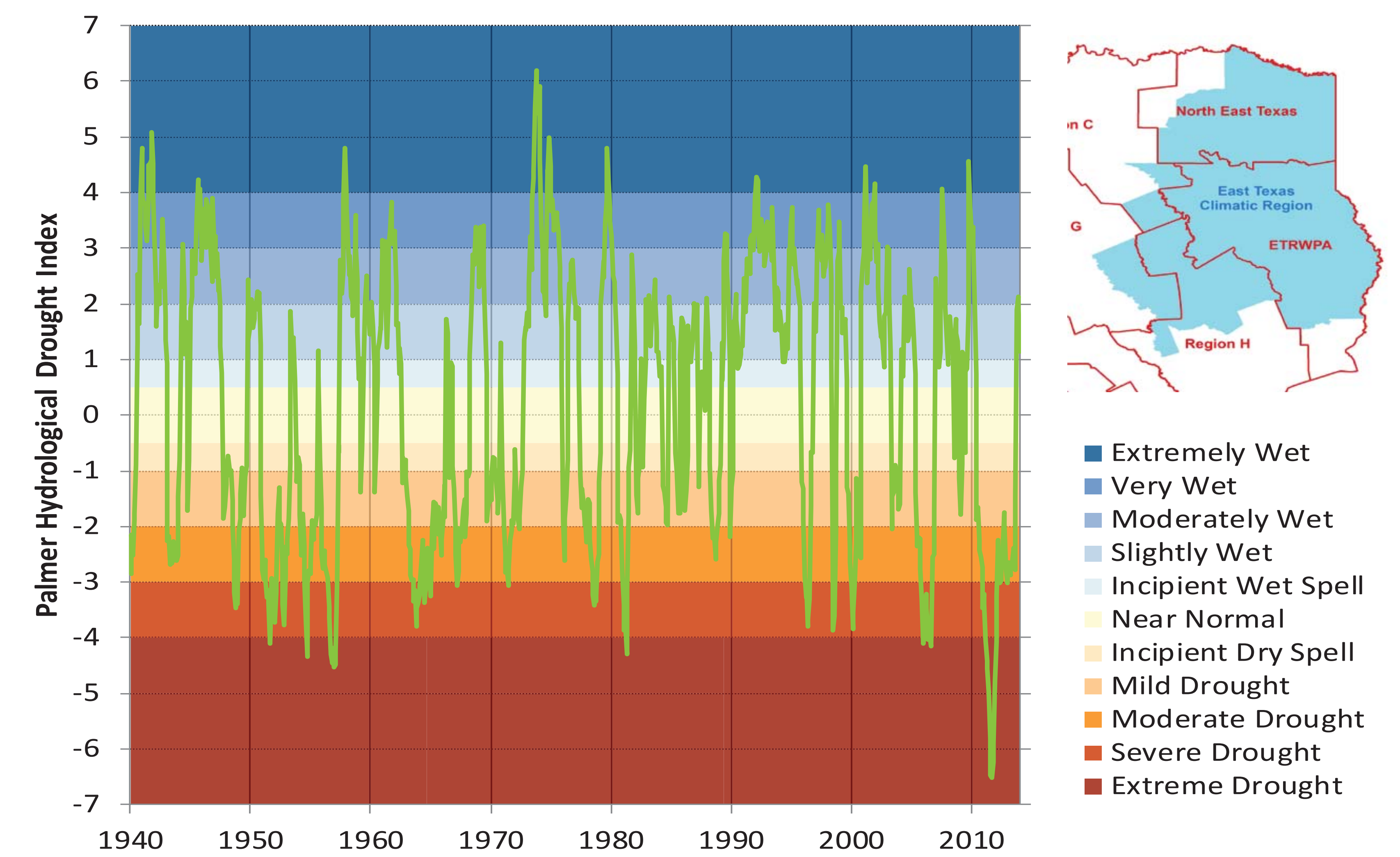
[1] Note that, while “extreme drought” is the second most severe category of drought for the Drought Monitor index, it is the most severe category of drought for the PHDI.

Figure 7.1 Composite Drought Monitor Index for Counties in the ETRWPA



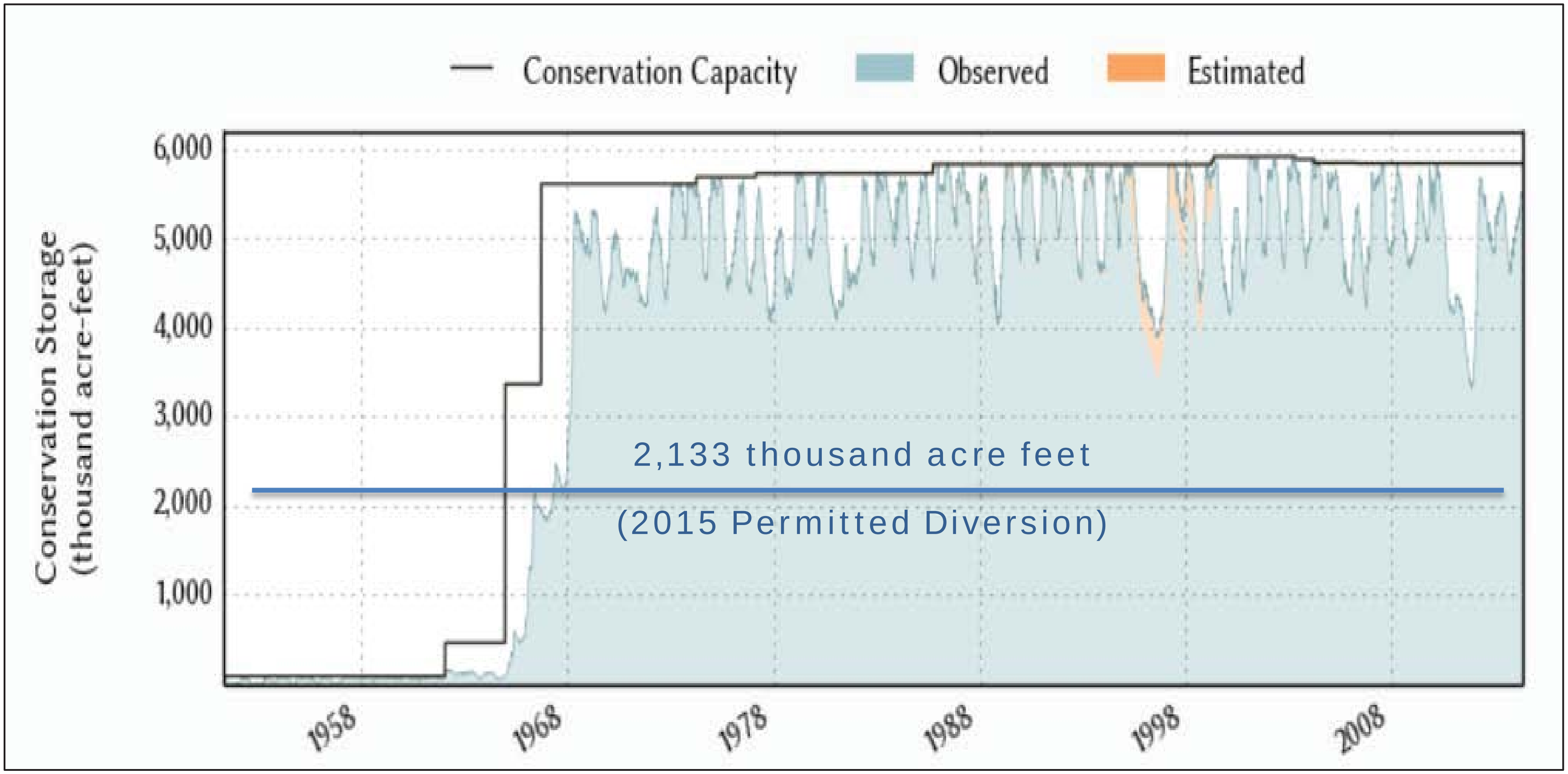
Source: Data provided by the National Drought Mitigation Center, May 2014.

Figure 7.2 Palmer Hydrological Drought Index for the East Texas Climatic Zone



Source: National Climatic Data Center: PHDI Divisional Data, URL: http://www1.ncdc.noaa.gov/pub/data/cirs/drd/drd964x.phdi.txt, accessed May 2014.

Figure 7.3 Composite Reservoir Storage in the ETRWPA



Source: Texas Water Development Board: East Texas Planning Region Reservoirs, URL: http://waterdatafortexas.org/reservoirs/region/east-texas, accessed May 2014.

7.2 Current Drought Preparations and Responses in Drought Contingency Plans

The Texas Commission on Environmental Quality (TCEQ) requires the following types of water providers to submit drought contingency plans to the agency:

- Retail public water suppliers serving 3,300 connections or more
- Wholesale public water suppliers
- Irrigation districts
- Applicants for new or amended water rights

In addition, the TCEQ requires retail public water suppliers serving fewer than 3,300 connections to prepare and adopt a drought contingency plan and make the plan available upon request. A list of water users that are required by Texas Water Code Section 11.1272 to submit a drought contingency plan is included in Table 7.2. For retail public water suppliers, the current number of connections was obtained from the TCEQ Water Utility Database. Drought contingency plans were to be updated and submitted to the TCEQ and ETRWPG by May 1, 2014. Failure to submit a drought contingency plan is a violation of the Texas Water Code, Section 11.272 and the Texas Administrative Code, Section 288.30, and is subject to enforcement by the TCEQ.

7.2.1 Summary of Current Drought Triggers, Goals, and Response Measures. The majority of the drought contingency plans (DCPs) in the ETRWPA use trigger conditions based on a combination of water supply and demands placed on the water distribution system.

Utilities use water supply-based triggers to identify the onset of drought and to reduce water usage accordingly. Typical supply based triggers depend on water levels in wells, water levels in reservoirs, and/or water system storage capacity.

Demand-based triggers are based on limitations in a utility's ability to treat and/or convey water to its customers. Demand-based triggers are typically expressed as a percentage of water production capacity.

Drought contingency plans typically identify different stages of drought and specific triggers and responses for each stage. In addition, the plan must specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement. Table 7.3 summarizes 36 DCPs for entities who submitted their plans to the ETRWPG by February 20, 2015 or who have published drought contingency plans on their web sites. The plans include 3 to 6 stages, typically with voluntary measures beginning in Stage 1 and mandatory measures beginning in Stage 2. Some DCPs include an emergency stage not directly related to drought but based on system rupture or failure. Other DCPs have a water rationing section, apparently for situations that are more severe than the final drought contingency stage. In these instances, water rationing is listed in Table 7.3 as the final stage.

Many plans that list water savings goals in terms of percentages of total water use. For these plans, Figure 7.4 shows the following by drought response stage:

- Range of water savings goals and
- Number of plans that include percentage water savings goals.

Table 7.2 ETRWPA Water Suppliers Required to Submit Drought Contingency Plans

Angelina & Neches River Authority	City of Palestine
Angelina-Nacogdoches WCID	City of Pineland
Athens Municipal Water Authority	City of Port Arthur
City of Athens	City of Port Neches
City of Beaumont	City of Rusk
City of Bridge City	City of San Augustine
City of Carthage	City of Tyler
City of Center	G M WSC
City of Crockett	Houston County WCID No. 1
City of Grapeland	Lake Livingston Water Supply & Sewer Service Company
City of Groves	Lindale Rural WSC
City of Hemphill	Lower Neches Valley Authority
City of Henderson	Lumberton MUD
City of Jacksonville	North Cherokee WSC
City of Jasper	Orange County WCID 1
City of Joaquin	Panola County Fresh Water Supply District No. 1
City of Kilgore	Rusk Rural WSC
City of Lindale	Sabine River Authority
City of Lufkin	Southern Utilities Company
City of Nacogdoches	South Sabine WSC
City of Nederland	The Consolidated WSC
City of Orange	Upper Neches River Municipal Water Authority

Table 7.3 Drought Trigger Conditions and Strategies Documented in Drought Contingency Plans

Entity	Plan Date	Trigger Based On:		No. of Stages	First Stage with Manda-tory Measures	Retail Water Sales	Wholesale Water Sales	Water Use Reduction Goals by Stage: (Reduction in Total Use Unless Otherwise Specified)					
		Supply	Demand					1	2	3	4	5	6
Angelina and Neches River Authority	2014	•	•	5	2	•	•	5%	10%	10%	10%	10%	
Angelina-Nacogdoches WCID 1	2009	•		4	2		•	n/a 290'[b]	10% 288'[b]	25% 286'[b]	50% 284'[b]		
Athens Municipal Water Authority	2011	•	•	6	2		•	10%	4 MGD[c]	4 MGD[c]	4 MGD[c]	4 MGD[c]	n/a
City of Athens	2011	•	•	6	2	•		10%	4 MGD[c]	4 MGD[c]	4 MGD[c]	4 MGD[c]	n/a
City of Beaumont	2008	•	•	5	2	•	•	8%	10%	12.5%	15%	30%	
City of Bridge City	2010	•		6	2	•	•	5%	10%	15%	25%	40%	n/a
City of Carthage	2014	•	•	5	2	•	•	5%	10%	15%	20%	25%	
City of Center	2014	•	•	3	1	•	•	5%	10%	15%			
City of Crockett	2014	•	•	4	2	•	•	10%	20%	30%	n/a		
City of Grapeland	2014	•	•	4	2	•	•	10%	20%	30%	n/a		
City of Groves	2014	•	•	5	2	•	•	5%	10%	12.5%	15%	15%	
City of Henderson	2014	•	•	3	2	•		10%	10%	10%[d]			
City of Jacksonville	2014	•	•	3	2	•	•	n/a	n/a	n/a			
City of Jasper	2014	•	•	3	2	•		10%	20%	30%			
City of Kilgore	2009	•		6	2	•	•	5%	10%	15%	20%	30%	n/a
City of Lindale	2009[a]	•	•	3	2	•	•	n/a	n/a	n/a			
City of Lufkin	2000	•	•	3	2	•	•	n/a	n/a	n/a			
City of Nacogdoches	2011	•	•	5	2	•	•	10%[e]	30%[e]	50%[e]	90%[e]	75%	
City of Orange	2014	•		4	2	•	•	10%	15%	25%	n/a		
City of Palestine	2014	•	•	4	2	•	•	n/a	n/a	n/a	n/a		
City of Pineland	2014	•	•	4	2	•	•	5%	10%	20%	n/a		

Table 7.3 Drought Trigger Conditions and Strategies Documented in Drought Contingency Plans (Cont.)

Entity	Plan Date	Trigger Based On:		No. of Stages	First Stage with Manda-tory Measures	Retail Water Sales	Wholesale Water Sales	Water Use Reduction Goals by Stage: (Reduction in Total Use Unless Otherwise Specified)					
		Supply	Demand					1	2	3	4	5	6
City of Port Arthur	2014	•	•	3	2	•	•	n/a	n/a	n/a			
City of Rusk	2014	•	•	4	2	•	•	10%	15%	20%	n/a		
City of Tyler	2014	•	•	3	2	•	•	5%	10%	25%			
Four Pines WSC	2014	•	•	3	1	•	•	20%	30%	40%			
G M WSC	2009	•	•	5	2	•	•	5%	10%	20%	30%	40%	
Houston County WCID No. 1	2014	•	•	4	2	•		10%	20%	30%	n/a		
Lake Livingston Water Supply & Sewer Service Company	2011	•	•	3	2	•		n/a	n/a	n/a			
Lower Neches Valley Authority	2012	•		6	2		•	30%[f]	10%	20%	30%	n/a	n/a
Lumberton MUD	2014	•	•	6	2	•	•	25%	30%	50%	60%	70%	n/a
North Cherokee WSC	2000	•		6	2	•	•	n/a	n/a	n/a	n/a	n/a	n/a
Orange County WCID 1	2014	•	•	6	2	•		10%	15%	20%	25%	30%	n/a
Sabine River Authority	2014	•		5	2		•	n/a	10%	20%	n/a	n/a	
South Sabine WSC	2000	•		6	2	•	•	10%	15%	20%	30%	35%	n/a
Southern Utilities Company	2014	•	•	3	2	•		5%	10%	25%			
Upper Neches River Municipal Water Authority	2014	•		4	2		•	5%	10%	15%	n/a		

[a] Dated 1999 but updated with water use statistics through 2008.
[b] Water surface elevation in Lake Striker.
[c] Total usage.
[d] Cushion between demand and capacity.
[e] Reduction in landscape irrigation usage.
[f] Reduction in non-essential water use.

Figure 7.4 Range of Percentage Water Savings Goals ETRWPA Drought Contingency Plans

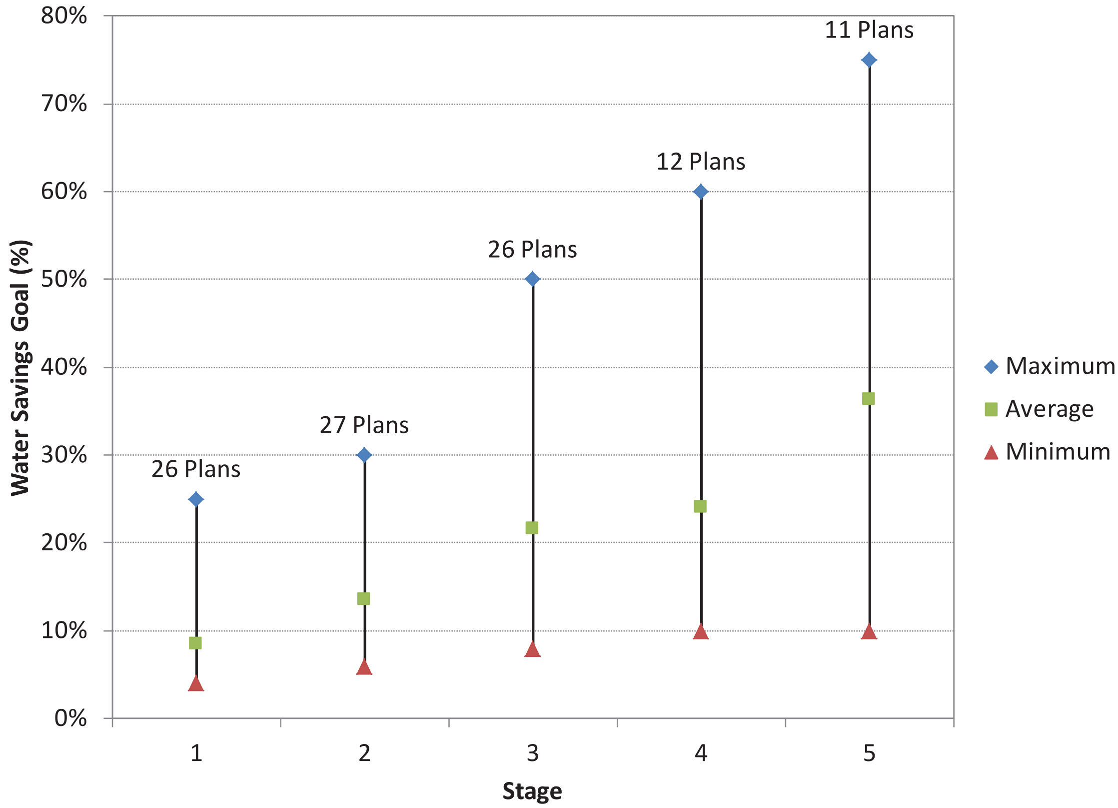


Table 7.4 summarizes drought response measures in the DCPs, showing measures that are present in at least 10 percent of the plans reviewed. In general, retail water suppliers have a wider range of drought response measures available to them compared to wholesale water suppliers.

Table 7.4 Summary of Drought Response Measures

Strategy Type 1	Strategy Type 2	Percentage of Plans Specifying Strategy	Stage Index (0-1)	Strategy
General		80%	0.24	Voluntary usage reductions
Waste	Ban	72%	0.49	Prohibit non-essential water uses (washdown, dust control, uncontrolled leaks)
Irrigation	Ban	72%	0.89	No irrigation
Rationing		64%	0.88	Water rationing
Education		63%	0.30	Public awareness/ customer awareness measures
Irrigation	Ban	63%	0.45	No irrigation during certain hours
Irrigation	Timing	54%	0.21	Voluntary irrigation hours
Waste	Ban	51%	0.70	No adding water to pools, spas
Waste	Ban	49%	0.41	No operation of ornamental fountains, ponds
Irrigation	Timing	47%	0.41	Mandatory twice-weekly irrigation limits
Irrigation	Ban	46%	0.61	No irrigation with hose-end sprinklers
Waste	Reduce	43%	0.37	Add water to pools, spas only during certain days/hours
Comm/Ind		43%	0.39	Restaurants serve water only on request
Vehicle		43%	0.46	Residential vehicle watering, window washing, pavement washing limited to hose with positive shutoff and/or bucket
Irrigation	Timing	42%	0.21	Voluntary twice-weekly irrigation limits
Comm/Ind		40%	0.75	Mandatory (or additional mandatory) reductions by wholesale, industrial, and commercial customers
Vehicle		37%	0.42	Vehicle washing only during certain days/hours (outside of commercial facilities)
Vehicle		37%	0.62	No vehicle washing outside commercial facilities
Vehicle		37%	0.62	Commercial vehicle washing only during certain hours
Irrigation	Ban	37%	0.64	No irrigation of golf course tees
Irrigation	Ban	37%	0.71	No irrigation with automatic sprinkler systems
Utility	Hydrant	34%	0.38	Limit use of water from hydrants to firefighting, activities necessary to maintain public health, safety, and welfare, and specially permitted uses.
Vehicle		34%	0.93	No vehicle washing
Rationing		33%	0.65	Initiate pro rata curtailment for wholesale customers (focus on temporary & short-term contracts first)
Utility	Similar	31%	0.30	Discuss conservation/ rationing with wholesale customers; request voluntary measures
Utility	Rates	31%	0.75	Implement rate surcharges
Utility	Admin	31%	0.80	If appropriate, notify city, county, and/or state emergency response officials for assistance
Utility	Hydrant	29%	0.25	Reduce flushing of water mains
Utility	Similar	29%	0.47	Request wholesale customers implement mandatory conservation/ rationing measures
Utility	Hydrant	29%	0.64	No construction water use from hydrants

Table 7.4 Summary of Drought Response Measures (Cont.)

Strategy Type 1	Strategy Type 2	Percentage of Plans Specifying Strategy	Stage Index (0-1)	Strategy
Utility	Admin	29%	0.65	Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate, to alleviate problems
Utility	Admin	29%	0.65	Undertake necessary actions, including repairs and/or clean-up as needed
Utility	Admin	29%	0.88	Assess the severity of the problem and identify the actions needed and time required to solve the problem
Utility	System	26%	0.72	No new or increased connections
Alternative		26%	0.74	Use alternative supply sources, including interconnects
Utility	Admin	26%	0.87	Prepare a post-event assessment report on the incident and critique of emergency response procedures and actions
Utility	Similar	23%	0.19	Utility water use follows Stage 2
Irrigation	Timing	23%	0.43	Mandatory odd-even irrigation limits
Waste	Ban	23%	0.80	No outdoor water use
Waste	Ban	23%	0.97	All water usage except to protect public health, safety, and welfare is prohibited
Utility	System	20%	0.32	Inspect infrastructure, equipment; system oversight
Rationing		20%	0.46	Prepare monthly water usage allocations for wholesale customers in advance of pro rata curtailment
Utility	Hydrant	20%	0.53	No hydrant flushing/ no flushing of water mains
Irrigation		20%	0.54	Reduce or discontinue irrigation of public areas
Waste	Enforce	19%	0.67	Increased enforcement; add personnel
Alternative		17%	0.57	Investigate alternative water sources, including interconnects
Waste	Ban	17%	0.78	Discontinue non-essential water use by utility personnel
Irrigation	Timing	14%	0.25	Voluntary odd-even irrigation limits
Comm/Ind		14%	0.29	Discuss conservation with industrial and commercial customers
Utility	System	14%	0.35	Take steps toward increasing system capacity (e.g., repair wells, etc.)
Irrigation	Ban	14%	0.53	Discontinue irrigation of public areas
Irrigation	Ban	14%	0.64	No irrigation of golf course fairways
Rationing		11%	0.33	Eliminate reservoir releases to supply interruptible supplies
Utility	Leaks	11%	0.42	Aggressively locate and repair major water main leaks and breaks; move personnel to leak repair
Waste	Reduce	11%	0.42	Request customers insulate pipes to prevent freezing
Irrigation	Timing	11%	0.60	Mandatory irrigation schedule (unspecified)
Irrigation	Timing	11%	0.63	Mandatory every fourth day irrigation limits
Irrigation	Ban	11%	0.65	No irrigation of athletic fields
Rationing		11%	0.68	Establish water allocations for residential customers

Stage index is the average over all plans of the stage in which a strategy is specified divided by the number of stages. It indicates of how far into the drought response stages a strategy is specified: The higher the value, the later the stage.

One of the primary drought response measures for retail water suppliers is restricting irrigation. Many plans include the following progression of irrigation limits:

- Stage 1: Voluntary limits on irrigation days (maximum of twice per week, odd/even schedule, etc.) and hours (no irrigation in the middle of the day).
- Stage 2: Mandatory limits on irrigation days and hours.
- Stage 3: No use of hose-end sprinklers.
- Stage 4: No use of automatic irrigation systems.
- Stage 5: No irrigation.

7.2.2 Drought Contingency Plan Recommendations. During the review of submitted DCPs, eight common water sources were identified. In the following sections, DCPs are compared for entities that sell or receive water from these common water sources. The comparison focuses on the number of response stages, the triggers that initiate the stages, the water savings goals, and the response measures.

Lake Athens

The Athens Municipal Water Authority (AMWA) supplies treated water from Lake Athens to the City of Athens. The DCPs for AMWA and Athens are identical.

Houston County Lake

The Houston County Water Control and Improvement District No. 1 (HCWCID #1) supplies treated water from Houston County Lake to the Cities of Crockett and Grapeland. In the DCPs for HCWCID #1 and Crockett, the triggers, stages, and goals are aligned, and the response measures are complementary. In the DCPs for HCWCID #1 and Grapeland, the triggers, stages, and goals are aligned, and the response measures are the same. However, response measures for the HCWCID #1 are general in nature and not necessarily appropriate for a retail water provider. Grapeland should consider adding detail about the specific response measures that will be used to achieve its goals for each response stage.

Lake Jacksonville

The City of Jacksonville supplies treated water from Lake Jacksonville to the North Cherokee WSC. Jacksonville’s DCP has three stages, while the North Cherokee WSC DCP has six stages. Neither plan specifies water savings goals for any of the stages. Response measures are not well-aligned, probably due to the different numbers of stages. For example, the third stage in each plan is labeled "Severe Conditions," but Jacksonville's plan bans all outdoor water use, while North Cherokee WSC's plan appears to allow twice-weekly irrigation by hand or drip irrigation system.

Both Jacksonville and North Cherokee WSC should specify water savings goals by response stage. In addition, North Cherokee WSC and Jacksonville should consider revising their plans to have the same number of response stages and commensurate response measures.

Sam Rayburn Reservoir-Steinhagen Lake System

The Lower Neches Valley Authority (LNVA) supplies raw water from the Sam Rayburn Reservoir-Steinhagen Lake System to Beaumont, Bolivar Peninsula SUD, Groves, Jefferson County WCID #10, Nederland, Nome, Port Arthur, Port Neches, West Jefferson County MWD, and Woodville. The triggers in the LNVA and Groves DCPs are aligned, but the Groves water savings goals for Stages 3 through 5 are significantly lower than LNVA's goals (12.5% vs. 20% for Stage 3, 15% vs. 30% for Stage 4, and 15% vs. "maximum" for Stage 5). Groves should consider revising response measures for Stages 3 through 5 to achieve water savings goals similar to LNVA's goals.

The Port Arthur DCP has three stages, while the LNVA DCP has five stages. Some of the Port Arthur triggers depend on LNVA declarations of "mild", "moderate", or "severe" conditions, but LNVA's stages are labeled "moderate", "severe", "extreme", "exceptional", and "emergency". Port Arthur does not specify water savings goals for any of the response stages. Due to the different stage names, different numbers of stages, and uncertain savings goals, it is not clear whether response measures are well-aligned between the two plans. Port Arthur and LNVA should consider revising plans to have the same number of response stages and commensurate response measures, and Port Arthur should specify water savings goals by response stage.

Lake Fork Reservoir

The Sabine River Authority (SRA) Iron Bridge/Lake Fork Division supplies raw water from Lake Fork Reservoir to the Cities of Henderson and Kilgore. The Henderson DCP has three stages, while the SRA Iron Bridge/Lake Fork DCP has five stages (not counting the emergency stage). Henderson's water savings goals appear to be commensurate with or more stringent than SRA's, so the response measures appear to be complementary. Henderson's triggers are based on its treatment/distribution capacity and not on raw water supply conditions. Henderson and SRA should consider revising the plans to have the same number of response stages, and Henderson should consider adding triggers based on raw water supply conditions.

The Kilgore DCP has six stages, while the SRA Iron Bridge/Lake Fork DCP has five stages (not counting the emergency stage). Kilgore's triggers take into account the SRA response stages. However, there is no mention of SRA Stage 5 or SRA "Emergency Water Shortage Conditions", partly due to different numbers of stages between the plans. Kilgore's water savings goals appear to be commensurate with or more stringent than SRA's, so the response measures appear to be complementary. Kilgore and SRA should consider revising the plans to have the same number of response stages, and Kilgore should consider amending triggers to acknowledge SRA Stage 5 and SRA "Emergency Water Shortage Conditions".

Toledo Bend Reservoir

The Sabine River Authority (SRA) Toledo Bend/Gulf Coast Division supplies raw water from Toledo Bend Reservoir to the City of Hemphill, which in turn provides treated water to the G M WSC. No drought contingency plan was available for the City of Hemphill.

The G M WSC DCP has five stages, while the SRA Toledo Bend/Gulf Coast DCP has three stages (not counting the emergency stage). G M WSC's water savings goals are commensurate with or more stringent than SRA's, so the response measures appear to be complementary. For each response stage, the SRA DCP contains triggers that are based on the water surface elevation in Toledo Bend Reservoir (165.1 feet in Stage 1, 162.2 feet in Stage 2, and 156 feet in Stage 3). The G M WSC DCP only contains trigger based on the Toledo Bend Reservoir elevation in Stage 1 (168 feet). The other stages are triggered based only on demands.

In coordination with the City of Hemphill, G M WSC and SRA should consider revising the plans to have the same number of response stages. In addition, G M WSC should consider adding Stage 2 and Stage 3 triggers based on raw water supply conditions (similar or complementary to SRA's and/or Hemphill's triggers).

Lake Palestine

The Upper Neches River Municipal Water Authority (UNRMWA) supplies raw water from Lake Palestine to the City of Tyler, which in turn provides treated water to the Southern Utilities Company. Tyler's triggers are based on its treatment/distribution/ storage capacity and other factors but not on raw water supply conditions. Tyler's water savings goals are commensurate with or more stringent than UNRMWA's, so the response measures appear to be complementary. Tyler should consider adding triggers based on raw water supply conditions (similar or complementary to UNRMWA's triggers).

The Tyler and Southern Utilities Company DCPs have the same number of response stages, with the complementary triggers, identical water savings goals, and substantially similar response measures. Like Tyler, Southern Utilities Company should consider adding triggers based on raw water supply conditions (similar or complementary to UNRMWA's and/or Tyler’s triggers).

The UNRMWA also supplies raw water from Lake Palestine to the City of Palestine via the Neches River. The UNRMWA and Palestine DCPs have the same number of response stages. Palestine’s triggers are based on demand volume, water levels in storage tanks, and UNRMWA drought stage. Although Palestine has not listed water savings goals for its drought stages, the response measures for each stage appear to be commensurate with UNRMWA's goals. Therefore, the triggers, stages, and goals in the UNRMWA and Palestine DCPs are aligned.

Yegua-Jackson Aquifer

The City of Pineland supplies treated water from the Yegua-Jackson Aquifer to the G M WSC. The G M WSC triggers are based on its Toledo Bend Reservoir and Carrizo-Wilcox Aquifer supplies but not on Pineland water supply conditions. The G M WSC DCP has five stages, while the Pineland DCP has four stages. G M WSC's water savings goals in the latter stages (30-40%) are also greater than Pineland's (unspecified). In addition, the response measures are not particularly well-aligned. Examples include:

- In Stage 2, Pineland allows even/odd irrigation days, while G M WSC allows twice-weekly watering.
- In Stage 3, Pineland prohibits outdoor water use, while G M WSC bans hose-end sprinklers but allow twice-weekly irrigation by other methods.

However, the water purchased from Pineland comprises only a small amount of the G M WSC water supply (5.5% in 2012). For this reason, major changes to the GM-WSC plan do not appear to be necessary.

7.2.3 Drought Preparedness Council. Title 31 of the Texas Administrative Code, §357.42(h), requires each regional water planning group to consider recommendations from the Drought Preparedness Council. On November 10, 2014, the Drought Preparedness Council provided the ETRWPG with a letter with the following two recommendations:

- Follow the outline template for Chapter 7 provided to the regions by Texas Water Development Board staff in February of 2013, making an effort to fully address the assessment of current drought preparations and planned responses, as well as planned responses to local drought conditions or loss of municipal supply.

- Evaluate the drought preparedness impacts of unanticipated population growth or industrial growth within the region over the planning horizon.

These recommendations were considered in the development of this chapter. The sections of this chapter were developed to correspond to the sections of the Chapter 7 outline provided by the TWDB. In addition, Safety factors were used in the development of recommended WMSs, where possible, and extensive coordination with local water providers account for unanticipated population growth or industrial growth within the ETRWPA.

7.3 Existing and Potential Emergency Interconnects

Regional water planning requirements include collection of information on existing major water infrastructure facilities that could be used for interconnections with WUGs in the event of an emergency shortage of water (§357.42(d)). However, Texas Water Code §16.053(c) requires such information to be confidential and may not be released to the public. Texas Water Development Board (TWDB) guidance on the subject states that the regional water planning group will collect such information confidentially and separately from the 2016 Plan. However, a general description in the plan that does not divulge details such as interconnect locations is acceptable. This section of Chapter 7 provides the required general information regarding the use of interconnections in the region and how they are or may be used as potential drought management measures.

For example, there are a number of existing and proposed emergency interconnects between WUGs in the ETRWPA. In a region where drought may be more geographically limited, emergency interconnects become an effective tool to mitigate its effects. As emergency interconnects become more common in the region, it may be necessary to encourage the connected communities to coordinate closely on their individual drought planning processes to that when emergency interconnections are utilized, all affected communities are aware of the need and can help facilitate water transfers with a minimum of adverse impact on all parties.

Interconnecting with another water system is a potential drought response measure. The drought contingency plans reviewed in Section 7.2 establish the following interconnection drought response measures.

- Evaluate the potential for interconnecting with other neighboring systems (Stage 1, one utility)
- Implement protocols to establish interconnections with other neighboring systems, if appropriate (Stage 2, one utility)
- Interconnect with other neighboring systems/implement agreements with adjacent water providers (Stage 3, three utilities)

Many WUGs have existing emergency interconnects with other utilities. Existing interconnects have not been listed in this plan for security reasons.

7.4 Emergency Responses to Local Drought Conditions or Loss of Municipal Supply

For all County-Other WUGs and for municipal WUGs with 2010 population less than 7,500 that rely on a sole water source, regional water planning rules require an evaluation of potential emergency response to local drought conditions or temporary loss of existing water supplies.

Of the 142 municipal WUGs, 82 had a 2010 Census population of less than 7,500 people and rely on a single water source. Of these municipal WUGs:

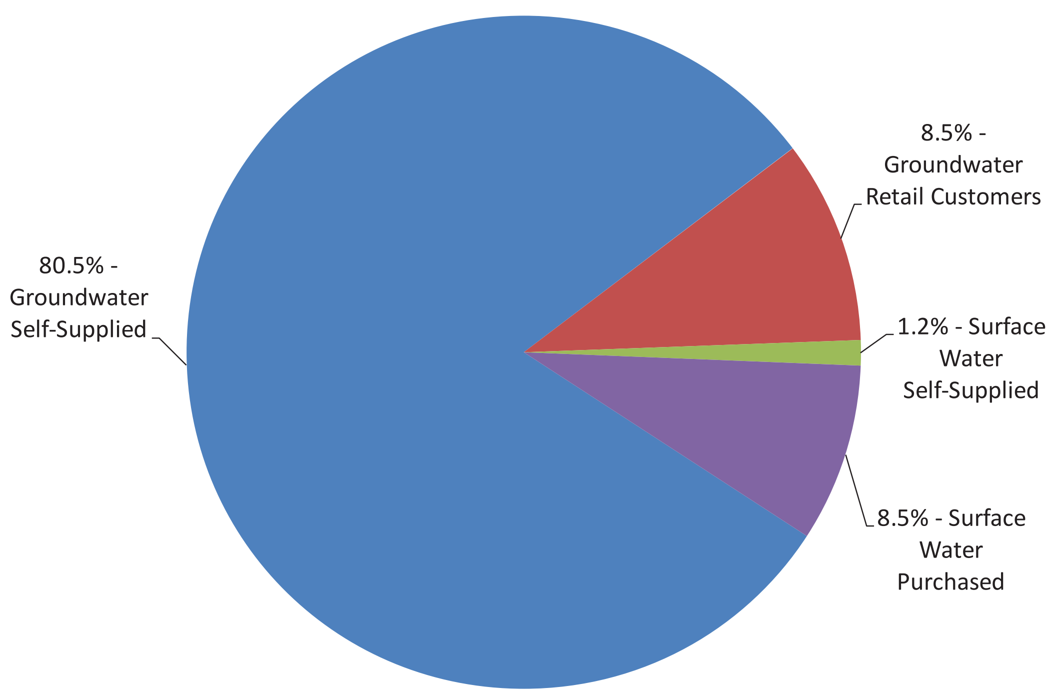
- Most (66) rely on their own groundwater wells;
- Eight also rely on groundwater but the water users are retail customers of other entities;
- Seven purchase surface water from other entities; and

- One relies on its own surface water source.

Figure 7.5 shows the relative distribution of sole water supplies for these municipal WUGs.

The ETRWPG conducted a limited, screening-level review of emergency response options available to the WUGs described in the previous section. The results are to serve as a general indicator of the potential options that might be considered in the event of a local emergency and should be investigated in greater detail by the subject WUG(s) before implementation. For the purposes of this analysis, it is assumed that the emergency response option must provide additional water within 180 days.

Figure 7.5 Summary of Sole-Source Water Supplies for Municipal WUGs with Population Less Than 7,500



Emergency response options considered include:

- Additional local groundwater well(s),

- Use of brackish groundwater,
- Voluntary Redistribution,
- Emergency interconnect(s), and
- Trucked-in water.

7.4.1 Additional Local Groundwater Wells. Depending on the emergency, drilling one or more wells may be a potential option for obtaining an emergency water supply. Since virtually the entire region is underlain by water supply aquifers, this is a potential option that each of the subject WUGs should evaluate in more detail.

Required infrastructure would include a new well and additional conveyance facilities. If the subject WUG is located within a Groundwater Conservation District, additional rules may apply.

7.4.2 Brackish Groundwater. Brackish water has total dissolved solids (TDS) concentrations between 1,000 and 10,000 milligrams per liter (mg/L). Brackish groundwater can be obtained from two locations in the ETRWPA: (1) relatively narrow bands of the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers that cross the middle of the ETRWPA in an east-west orientation and (2) a narrow band of the Gulf Coast aquifer that crosses Jefferson and Orange Counties near the coast in an east-west orientation.[5] Subject WUGs that are located in these bands should evaluate the emergency use of brackish groundwater in more detail (Table 7.5).

Required infrastructure would include a new well into the brackish part of the formation and additional conveyance facilities. Treatment to remove dissolved salts might also be included. However, such treatment is very expensive and disposal of treatment residuals is often difficult. Therefore, treatment is considered to be a viable component of using brackish groundwater only in extraordinary circumstances.

For brackish groundwater that is at the lower end of elevated TDS concentrations, the brackish water could be blended with existing non-brackish supplies to create an emergency potable supply. As the TDS of a brackish source increases or as fresh water supplies diminish, blending may become less practical. For reasons noted above, brackish groundwater at the higher end of TDS concentrations would likely not be a viable alternative, even for emergency situations.

Table 7.5 Potential Brackish Groundwater Sources for Subject WUGs

Subject WUG	Aquifer			
	Carrizo-Wilcox	Gulf Coast	Queen City/ Sparta	Yegua-Jackson
Angelina WSC	x		x	
Burke	x		x	
Colmesneil				x
Diboll	x		x	
Four Way SUD	x		x	
Groveton	x			
Hemphill	x		x	
Hudson	x		x	
Hudson WSC	x		x	
Pineland	x		x	
Tyler County WSC				x
Woodville				x
Angelina County-Other	x		x	
Houston County-Other	x		x	
Jasper County-Other				x
Jefferson County-Other		x		
Nacogdoches County-Other	x		x	
Newton County-Other				x
Orange County-Other		x		
Polk County-Other				x
Sabine County-Other	x		x	
San Augustine County-Other	x		x	
Trinity County-Other	x		x	x
Tyler County-Other				x

Brackish groundwater availability, productivity, and production costs are summarized for each aquifer in Table 7.6. In the counties where brackish groundwater is located, availability is moderate to high. The major aquifers (Carrizo-Wilcox and Gulf Coast) have greater productivity than the minor aquifers. The production cost for the Carrizo-Wilcox aquifer is moderate to high, since the depth to the brackish groundwater may be 3,000 to 6,000 feet.

Table 7.6 Summary of ETRWPA Potential Emergency Water Supplies from Brackish Groundwater

Aquifer	Availability	Productivity	Source Water Production Cost	Primary Counties
Carrizo-Wilcox	High	Moderate	Moderate to High	Houston, Trinity, Angelina, Nacogdoches, San Augustine, Sabine
Queen City/ Sparta	High	Low	Moderate	
Gulf Coast	High	High	Low to Moderate	Jefferson, Orange
Yegua-Jackson	Moderate	Low	Moderate	Trinity, Polk, Tyler, Jasper, Newton

Source: LBG-Guyton Associates in association with NRS Consulting Engineers: Brackish Groundwater Manual for Texas Regional Water Planning Groups, prepared for Texas Water Development Board, Austin, February 2003.

7.4.3 Voluntary Redistribution. Another emergency response option for WUGs that already treat surface water is a voluntary redistribution of water from upstream water right holders. This option requires a contract with an upstream entity for water to release from an upstream reservoir for diversion by the subject WUG downstream. For purposes of this evaluation, if a watercourse downstream of a major reservoir flows through or within close proximity to the CCN of a subject WUG that treats surface water and has an existing surface water intake, then a release from an upstream reservoir is considered a potential emergency response alternative (Table 7.7). The TCEQ's Water Utilities Map Viewer was used to identify subject WUGs and potential emergency releases from upstream reservoirs.[6]

Required infrastructure may include upgrades to existing intake and conveyance facilities. It has been assumed that WUGs that would use this emergency response option already treat surface water, but improvements to treatment processes may also be necessary. This option would require an agreement with one or more water right holders or their contractees in the upstream reservoir and would require approval of the treatment facilities by the TCEQ. This option would also require a new or amended water right permit from the TCEQ that authorizes the use of stream bed and banks for conveyance of the water and a new diversion point.

Table 7.7 Potential Supplies from Releases from an Upstream Reservoir for Subject WUGs

Subject WUG	Upstream Reservoir	Water Right Holders
Jefferson County WCID #10	Sam Rayburn Reservoir; B.A. Steinhagen Reservoir	LNVA, Lufkin; LNVA
Nome	Sam Rayburn Reservoir; B.A. Steinhagen Reservoir	LNVA, Lufkin; LNVA
Cherokee County-Other	Lake Palestine; Lake Jacksonville; Striker Lake; Lake Tyler; Lake Tyler East	Upper Neches River Municipal Water Authority; Jacksonville; Angelina-Nacogdoches WCID 1; Tyler; Tyler
Houston County-Other	Lake Palestine; Lake Jacksonville; Various Region C Reservoirs	Upper Neches River Municipal Water Authority; Jacksonville; Various
Nacogdoches County-Other	Striker Lake; Lake Tyler; Lake Tyler East; Lake Naconiche	Angelina-Nacogdoches WCID 1; Tyler; Tyler; County of Nacogdoches
Panola County-Other	Lake Cherokee; Martin Lake; Lake Tawakoni/Lake Fork	Cherokee Water Company; Luminant Generation Company LLC; SRA, North Texas Municipal Water District
San Augustine County-Other	Lake Pinkston; Lake Naconiche; San Augustine City Lake	Center; County of Nacogdoches; San Augustine
Shelby County-Other	Lake Murvaul; Lake Cherokee; Martin Lake; Lake Tawakoni/Lake Fork	Panola County FWSD 1; Cherokee Water Company; Luminant Generation Company LLC; SRA, North Texas Municipal Water District
Trinity County-Other	Lake Palestine; Lake Jacksonville	Upper Neches River Municipal Water Authority; Jacksonville

7.4.4 Emergency Interconnect. An emergency interconnect is an alternative for subject WUGs that are located in close proximity to another water provider. For purposes of this evaluation, it is assumed that an emergency interconnect is a potential emergency response option if there is another Certificate of Convenience and Necessity (CCN) located contiguous to or within close proximity to the subject WUG's CCN. Potential emergency interconnects are summarized in Table 7.8. Some of these potential emergency interconnects may already be in place. Subject WUGs should investigate further the potential for obtaining potable water through emergency interconnects with neighboring water systems.

Table 7.8 Potential Emergency Interconnect Sources for Subject WUGs

Subject WUG	Potential Emergency Interconnects
Alto	Alto Rural WSC
Alto Rural WSC	Alto, Rusk Rural WSC, Rusk, Iron Hill WSC, Lilbert-Looneyville WSC, D&M WSC, Forest WSC
Angelina WSC	Lufkin, Beulah WSC, M&M WSC, Four Way SUD
Appleby WSC	Nacogdoches, Caro WSC, Swift WSC, Libby WSC, Garrison
Arp	Jackson WSC, Wright City WSC,
Beckville	Fairplay WSC, Rock Hill WSC, Hollands Quarter, Riderville WSC
Berryville	Frankston Rural WSC, Monarch Utilities I LP
Bethel-Ash WSC	Eustace, Quality Water of East Texas, Monarch Utilities I LP, Leagueville WSC, Virginia Hill WSC, Athens, Payne Springs WSC
Bevil Oaks	Water Necessities Inc., Hardin County WCID 1, Lumberton MUD, Meeker MWD
Brownsboro	Leagueville WSC, Edom WSC, Union Hill WSC, Moore Station WSC
Brushy Creek WSC	BBS WSC, Virginia Hill WSC, Poynor Community WSC, Dogwood Springs WSC, Frankston Rural WSC, Norwood WSC, Montalba WSC
Bullard	Southern Utilities Company, Walnut Grove WSC, North Cherokee WSC
Burke	Hudson WSC, Diboll,
Central WCID Of Angelina County	Woodlawn WSC, Hudson WSC, Pollok Redtown WSC, D&M WSC, Redland WSC, Angelina County FWSD 1, Lufkin
Chalk Hill SUD	New Prospect WSC, Crims Chapel WSC, Elderville WSC, Crystal Farms WSC, Tatum
Chandler	R-P-M WSC, Chandler Water Company, Three Community WSC, Dean WSC
China	Nome, Meeker MUD
Colmesneil	Tyler County WSC, Lakeside Water Supply
Corrigan	Damascus Stryker Water Supply, Moscow WSC
Cross Roads SUD	Kilgore, Elderville WSC, Kennedy Road WSC, Leveretts Chapel WSC, Jacobs WSC
Crystal Systems Inc.	Texas Water Systems Inc., Carroll WSC, Lindale Rural WSC, Lindale, Tyler, Southern Utilities Company
Cushing	Lilbert-Looneyville WSC, Sacul WSC, Caro WSC, South Rusk County WSC
Dean WSC	Southern Utilities Company, Tyler, R-P-M WSC, Chandler Water Company, Chandler
Diboll	Prairie Grove WSC, Lufkin
Easton	Elderville WSC, Chalk Hill SUD
Elkhart	Slocum WSC, Walston Springs WSC
Four Pines WSC	Palestine, BCY WSC, Tucker WSC, Pleasant Springs WSC, Lone Pine WSC
Four Way SUD	Zavalla, Angelina WSC, Huntington, M&M WSC

Table 7.8 Potential Emergency Interconnect Sources for Subject WUGs (Cont.)

Subject WUG	Potential Emergency Interconnects
Frankston	Frankston Rural WSC,
Garrison	Appleby WSC, Timpson Rural WSC, Arlam Concord WSC
Gill WSC	Marshall, Deadwood WSC, Dewberry WSC, Elysian Fields WSC, Blocker-Crossroads WSC
Groveton	Pennington WSC, Centerville WSC, Woodlake-Josserand WSC, Trinity Rural WSC, Glendale WSC
Hemphill	G M WSC
Hudson	Lufkin, Woodlawn WSC, Central WCID of Angelina County
Hudson WSC	Lufkin, Woodlawn WSC, Central WCID of Angelina County
Ivanhoe	Seneca WSC, Tyler County WSC, Warren WSC
Ivanhoe North	Seneca WSC, Tyler County WSC, Warren WSC
Jackson WSC	Wright City WSC, Lakeshore Utility Co. Inc., Southern Utilities Company, Tyler, Star Mountain WSC, Starrville WSC, West Gregg WSC
Jasper County WCID #1	South Jasper County WSC, Cougar Country Water System
Jefferson County WCID #10	Beaumont, Nederland,
Joaquin	Deadwood WSC, Paxton WSC,
Kirbyville	Upper Jasper County Water Authority, South Kirbyville Rural WSC
Kountze	West Hardin WSC, Johnson Water Service, Ranchland POA Inc.
Lilly Grove SUD	Nacogdoches, D&M WSC, Lilbert-Looneyville WSC, Caro WSC
Lindale	Tyler, Lindale Rural WSC, Crystal Systems Inc.
Meeker MUD	Beaumont, West Jefferson County MWD, China, Bevil Oaks, Lumberton MUD
Melrose WSC	Nacogdoches, Woden WSC, Swift WSC, New WSC, Denning WSC
Murchison	Bethel-Ash WSC, Leagueville WSC
New Chapel Hill	Southern Utilities Company, Jackson WSC, Lakeshore Utility Co. Inc., Wright City WSC, Walnut Grove WSC, Tyler
New London	Overton, Wright City WSC, Gaston WSC, Pleasant Hill WSC, Jacobs WSC
New Summerfield	Blackjack WSC, Stryker Lake WSC, Afton Grove WSC
Newton	East Newton WSC, Bon Wier WSC, Holly Huff WSC, Jamestown WSC
Nome	China
Noonday	Southern Utilities Company, Algonquin Water Resources, Tyler, Dean WSC
North Hardin WSC	Water Necessities Inc., Tyler County WSC, Johnson Water Service, Silsbee
Orangefield WSC	Orange County WCID 1, Orange, Bridge City
Overton	New London, Wright City WSC, Jackson WSC, Southern Utilities Company, Jacobs WSC, Leveretts Chapel WSC

Table 7.8 Potential Emergency Interconnect Sources for Subject WUGs (Cont.)

Subject WUG	Potential Emergency Interconnects
Pinehurst	Orange
Pineland	G M WSC
Rose City	Beaumont, Orange County WCID 1
R-P-M WSC	Chandler, Edom WSC, Ben Wheeler WSC, Southern Utilities Company
Rusk	Rusk Rural WSC, Alto Rural WSC, Iron Hill WSC,
San Augustine	San Augustine Rural WSC, New WSC, Bland Lake Rural WSC, Denning WSC, G M WSC
Silsbee	North Hardin WSC, Johnson Water Service, Lumberton MUD
Sour Lake	Hardin County WCID 1, Water Necessities Inc.
South Newton WSC	Orange, Mauriceville SUD
Swift WSC	Melrose WSC, Nacogdoches, Woden WSC, Appleby WSC, Libby WSC, Sand Hills WSC
Tatum	Crystal Farms WSC, Chalk Hill SUD, Rock Hill WSC
Tenaha	Tennessee WSC, Paxton WSC, Flat Fork WSC, Buena Vista WSC
Timpson	Timpson Rural WSC, Tennessee WSC, Buena Vista WSC,
Troup	Blackjack WSC, Wright City WSC,
Tyler County WSC	North Hardin WSC, Colmesneil, Ivanhoe, Ivanhoe North, Warren WSC, Monarch Utilities I LP, Seneca WSC, Woodville, Chester WSC, Upper Jasper County Water Authority
Virginia Hill WSC	Aqua Texas Inc., Brushy Creek WSC, Athens, Double Diamond Utilities Co, Leagueville WSC, Bethel-Ash WSC, Moore Station WSC, Poynor Community WSC
Walston Springs WSC	Slocum WSC, Anderson County Cedar Creek WSC, Pleasant Springs WSC, Neches WSC, Palestine
Wells	Pollok Redtown WSC, Forest WSC
West Gregg SUD	Kilgore, Jackson WSC, Starrville WSC, Liberty City WSC, Southern Utilities Company
West Hardin WSC	Hardin WSC, Lake Livingston Water Supply and Sewer Service Company, Johnson Water Service
West Orange	Orange
Woden WSC	Nacogdoches, Melrose, WSC, Swift WSC, D&M WSC
Woodville	Cypress Creek WSC, Doucette Water System, Tyler County WSC,
Wright City WSC	Southern Utilities Company, Jackson WSC, Price WSC, New Concord WSC, Blackjack WSC, Troup
Zavalla	Four Way SUD, Raylake WSC

Potential emergency interconnects were not identified for County-Other WUGs. In a given county, the County-Other WUG may represent many small utilities, and an emergency interconnect that may be a feasible emergency source for one of these utilities may not be a feasible source for another. Therefore, an extensive list of potential emergency interconnects in each county will not be sufficiently "local" to assist an individual utility that is a component of the County-Other WUG. Utilities that are not named in Table 7.8, should consult local maps/data to identify nearby utilities that may be potential emergency interconnect supplies.

Required infrastructure would include piping and valving necessary to connect the systems. If the relative system pressures are not appropriate for the proposed connection, additional pressurization and/or conveyance facilities may be needed. This option would require an agreement with one or more neighboring utilities. Construction would require authorization from the TCEQ.

7.4.5 Trucked-In Water. Trucked-in water is considered to be an emergency response option for every subject WUG. Although this would likely require little infrastructure, it would require agreements with a treated water provider and a water transporter.

Findings for the subject WUGs and the County-Other WUGs are briefly summarized in Table 7.9.

Table 7.9 Summary of Potential Emergency Supplies for Subject WUGs

Entity		Potential Emergency Water Supply Source(s)					
Water User Group Name	County	Local groundwater well	Brackish groundwater	Other named local supply	Release from upstream reservoir	Emergency interconnect	Trucked-in water
Alto	Cherokee	x				x	x
Alto Rural WSC	Cherokee	x		x	x	x	x
Angelina WSC	Angelina	x	x	x		x	x
Appleby WSC	Nacogdoches	x		x		x	x
Arp	Smith	x		x		x	x
Beckville	Panola	x				x	x
Berryville	Henderson	x		x		x	x
Bethel-Ash WSC	Henderson, Van Zandt	x		x		x	x
Bevil Oaks	Jefferson	x		x		x	x
Brownsboro	Henderson	x				x	x
Brushy Creek WSC	Anderson, Henderson	x		x		x	x
Bullard	Smith, Cherokee	x				x	x
Burke	Angelina	x	x			x	x
Central WCID Of Angelina County	Angelina	x		x		x	x
Chalk Hill SUD	Rusk	x		x		x	x
Chandler	Henderson	x		x		x	x
China	Jefferson	x		x	x	x	x
Colmesneil	Tyler	x	x	x		x	x
Corrigan	Polk	x				x	x
Cross Roads SUD	Rusk, Gregg	x		x		x	x
Crystal Systems Inc.	Smith	x		x		x	x
Cushing	Nacogdoches	x		x		x	x
Dean WSC	Smith	x		x		x	x
Diboll	Angelina	x	x	x	x	x	x
Easton	Gregg, Rusk	x		x	x	x	x
Elkhart	Anderson	x		x		x	x
Four Pines WSC	Anderson	x		x		x	x
Four Way SUD	Angelina	x	x	x		x	x
Frankston	Anderson, Henderson	x		x		x	x
Garrison	Nacogdoches	x		x		x	x
Gill WSC	Harrison, Panola	x		x	x	x	x
Groveton	Trinity	x	x	x		x	x
Hemphill	Sabine	x	x	x		x	x
Hudson	Angelina	x	x	x	x	x	x
Hudson WSC	Angelina	x	x	x	x	x	x
Ivanhoe	Tyler	x		x	x	x	x
Ivanhoe North	Tyler	x		x	x	x	x

Table 7.9 Summary of Potential Emergency Supplies for Subject WUGs (Cont.)

Entity		Potential Emergency Water Supply Source(s)					
Water User Group Name	County	Local groundwater well	Brackish groundwater	Other named local supply	Release from upstream reservoir	Emergency interconnect	Trucked-in water
Jackson WSC	Smith	x		x		x	x
Jasper County WCID #1	Jasper	x				x	x
Jefferson County WCID #10	Jefferson	x		x	x	x	x
Joaquin	Shelby	x		x	x	x	x
Kirbyville	Jasper	x				x	x
Kountze	Hardin	x				x	x
Lilly Grove SUD	Nacogdoches	x				x	x
Lindale	Smith	x		x		x	x
Meeker MUD	Jefferson	x		x	x	x	x
Melrose WSC	Nacogdoches	x		x	x	x	x
Murchison	Henderson	x		x		x	x
New Chapel Hill	Smith	x		x		x	x
New London	Rusk	x		x		x	x
New Summerfield	Cherokee	x				x	x
Newton	Newton	x				x	x
Nome	Jefferson	x		x	x	x	x
Noonday	Smith	x		x		x	x
North Hardin WSC	Hardin	x		x	x	x	x
Orangefield WSC	Orange	x				x	x
Overton	Rusk, Smith	x		x		x	x
Pinehurst	Orange	x		x		x	x
Pineland	Sabine	x	x	x		x	x
Rose City	Orange	x		x		x	x
R-P-M WSC	Van Zandt, Henderson, Smith	x		x		x	x
Rusk	Cherokee	x		x		x	x
San Augustine	San Augustine	x				x	x
Silsbee	Hardin	x		x	x	x	x
Sour Lake	Hardin	x		x		x	x
South Newton WSC	Newton, Orange	x		x	x	x	x
Swift WSC	Nacogdoches	x		x	x	x	x
Tatum	Rusk, Panola	x		x	x	x	x
Tenaha	Shelby	x		x		x	x
Timpson	Shelby	x		x		x	x
Troup	Smith, Cherokee	x		x	x	x	x
Tyler County WSC	Tyler	x	x	x		x	x
Virginia Hill WSC	Henderson	x		x		x	x

Table 7.9 Summary of Potential Emergency Supplies for Subject WUGs (Cont.)

Entity		Potential Emergency Water Supply Source(s)					
Water User Group Name	**County**	**Local groundwater well**	**Brackish groundwater**	**Other named local supply**	**Release from upstream reservoir**	**Emergency interconnect**	**Trucked-in water**
Walston Springs WSC	Anderson	x		x	x	x	x
Wells	Cherokee	x				x	x
West Gregg SUD	Gregg, Smith, Rusk	x		x		x	x
West Hardin WSC	Hardin, Liberty	x		x		x	x
West Orange	Orange	x		x		x	x
Woden WSC	Nacogdoches	x		x		x	x
Woodville	Tyler	x		x		x	x
Wright City WSC	Smith, Cherokee, Rusk	x		x		x	x
Zavalla	Angelina	x		x		x	x
Anderson County-Other	Anderson	x		n/a[a]	x	n/a	x
Angelina County-Other	Angelina	x	x	n/a	x	n/a	x
Cherokee County-Other	Cherokee	x		n/a	x	n/a	x
Hardin County-Other	Hardin	x		n/a		n/a	x
Henderson County-Other	Henderson	x		n/a	x	n/a	x
Houston County-Other	Houston	x	x	n/a	x	n/a	x
Jasper County-Other	Jasper	x	x	n/a	x	n/a	x
Jefferson County-Other	Jefferson	x	x	n/a		n/a	x
Nacogdoches County-Other	Nacogdoches	x	x	n/a	x	n/a	x
Newton County-Other	Newton	x	x	n/a	x	n/a	x
Orange County-Other	Orange	x	x	n/a	x	n/a	x
Panola County-Other	Panola	x		n/a	x	n/a	x
Polk County-Other	Polk	x	x	n/a		n/a	x
Rusk County-Other	Rusk	x		n/a	x	n/a	x
Sabine County-Other	Sabine	x	x	n/a		n/a	x
San Augustine County-Other	San Augustine	x	x	n/a	x	n/a	x
Shelby County-Other	Shelby	x		n/a	x	n/a	x
Smith County-Other	Smith	x		n/a		n/a	x
Trinity County-Other	Trinity	x	x	n/a	x	n/a	x
Tyler County-Other	Tyler	x	x	n/a	x	n/a	x

[a] "n/a" indicates that this potential emergency water supply was not evaluated for a given WUG. Additional discussion is provided in Section 7.4.

7.5 Region-Specific Drought Response Recommendations and Model Drought Contingency Plans

Region-specific drought response recommendations regarding the management of existing surface water and groundwater sources are presented in the following sections. These recommendations include:

- Factors specific to each source of water supply to be considered in determining whether to initiate a drought response for each water source, including specific recommended drought response triggers;
- Actions to be taken as part of the drought response by the manager of each water source and the entities relying on each source, including the number of drought stages;
- Triggers and actions consider existing triggers and actions associated with existing drought contingency plans.

7.5.1 Drought Trigger Conditions for Reservoirs. The major recommended triggers and potential actions for reservoirs in the ETRWPA are presented in this section. Where possible, the ETRWPG has incorporated triggers and major actions from drought contingency plans that have been developed for these water sources. A summary of triggers and actions for the 16 reservoirs in the ETRWPA is provided in the following tables (Tables 7.10 through 7.21). An additional five reservoirs in the region have not submitted drought contingency plans. Therefore, generic drought triggers and actions have been developed by the consulting team for these reservoirs. (See Table 7.22). These drought contingency plans may require more actions than shown in this section and may contain exceptions to these potential actions. These additional potential actions and exceptions are also endorsed by the ETRWPA.

The potential actions are generally cumulative between stages: actions implemented in Stage 1 remain in effect in Stage 2 and so on.

Lake Athens (Athens Municipal Water Authority)

The Athens Municipal Water Authority adopted its current drought contingency plan in October 2011. The triggers and actions are related to water demand and the elevation of Lake Athens and are summarized below in Table 7.10.

Table 7.10 Lake Athens Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	• Total daily production of potable water exceeds 4.5 million gallons per day (MGD); or, • The water surface elevation of Lake Athens drops to 436.90 feet MSL (75% of net usable volume).	Request voluntary conservation measures, including odd/even watering schedule and limited irrigation hours.
Moderate	• Total daily production of potable water exceeds 4.5 MGD and the storage facilities do not refill to a level above 80% capacity overnight; or, • The water surface elevation of Lake Athens drops to 434.60 feet MSL (60% of net usable volume).	Implement mandatory conservation measures, including odd/even watering schedule and limited irrigation hours. Prohibit non-essential water use. Limit water use for vehicle washing and filling of pools. Limit water use from fire hydrants.
Severe	• Total daily production of potable water exceeds 4.5 MGD and the storage facilities do not refill to a level above 65% capacity overnight; or, • The water surface elevation of Lake Athens drops to 432.00 feet MSL (45% of net usable volume).	Implement mandatory conservation measures, including continued odd/even watering schedule and limited irrigation hours. Prohibit oil/gas/construction water use from fire hydrants. Prohibit irrigation of golf course fairways. Prohibit irrigation with private pumps that draw water from Lake Athens.
Critical	• Total daily production of potable water exceeds 4.5 MGD and the storage facilities do not refill to a level above 50% capacity overnight; or, • The water surface elevation of Lake Athens drops to 429.00 feet MSL (30% of net usable volume).	Implement mandatory conservation measures, including continued odd/even watering schedule and curtailed irrigation hours. Prohibit use of hose end sprinklers and permanently installed automatic sprinkler systems. No new connections.
Emergency	• Major water line breaks or pump or system failures occur, which cause an unprecedented loss of capability to provide water service; or • Natural or man-made contamination of the water supply source(s) occurs; or • Water supply sources are depleted to a level beyond those described above for Stage 4 — Critical Water Shortage Conditions.	Prohibit irrigation of landscaped areas. Prohibit vehicle washing.

Lake Center and Lake Pinkston (Center)

Center adopted its current Drought Contingency Plan in 2014. The triggers are associated with water demands and total storage in the reservoirs. The triggers and actions related to Lake Center and Lake Pinkston are outlined below in Table 7.11.

Table 7.11 Lake Center and Lake Pinkston Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	Water demand reaches ninety percent (90%) of production capacity; or Distribution limitations	Implement mandatory maximum twice-weekly watering schedule. Request that customers discontinue non-essential water uses.
Moderate	Water demand reaches ninety-five percent (95%) of production capacity; Water storage falls to fifty percent (50%) of storage capacity; or Distribution limitations	Implement mandatory maximum once-weekly watering schedule. Require that customers discontinue non-essential water uses. Expand enforcement.
Severe	Water demand reaches one hundred percent (100%) of production capacity; Water storage falls to twenty-five percent (25%) of storage capacity; or Major distribution limitations	Prohibit all landscape, non-essential, and discretionary water uses. Continue enforcement. Examine alternative sources.

Houston County Lake (Houston County WCID No. 1)

The Houston County WCID No. 1 adopted its current Drought Contingency Plan in 2014. The triggers are associated with water demands, weather conditions, and the reservoir’s elevation. The triggers and actions related to Houston County Lake are outlined below in Table 7.12.

The Cities of Crockett and Grapeland purchase water from the Houston County WCID No. 1. Recommendations for aligning their DCPs with the Houston County WCID No. 1 DCP are presented in Section 7.2.2.

Table 7.12 Houston County Lake Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	1. Water demand has reached 90% of the capacity of the system for three consecutive days with the plant operating at 100% of the rated production. 2. Weather conditions that will result in reduced water supply available from the Houston County Lake for an extended period of time. 3. Water level at the Lake drops below 258 feet above mean sea level, which is 2 feet below pool. (260 feet mean sea level).	Request voluntary conservation measures.
Moderate	1. Water demand has reached 100% of the capacity of the system for three consecutive days with the plant operating at 100% of the rated production. 2. Weather conditions that result in Lake levels falling to 256 mean sea level, which is 3 feet below pool. 3. Water supply storage facilities are not maintaining a constant level with the plant operating at 100% of the rated production.	Implement mandatory conservation measures, limiting outdoor watering to hand-held hose use only. Require wholesale customers to initiate Stage 2 of their DCPs. Prepare for curtailment by preparing a monthly usage allocation for each wholesale customer.
Severe	1. The treatment plant is non-operational due to a malfunction at the site. 2. Water levels drop at the reservoir to a point where pumping equipment will not function properly.	Implement additional mandatory conservation measures, including prohibition of outdoor watering except for livestock. Initiate pro-rata curtailment of water sales to each wholesale customer.
Emergency	1. A major water line breaks which causes considerable water loss. 2. Pumps or system failures occur which causes the inability to obtain the water from the Lake, treat the water adequately, or supply the water to our customers. 3. Natural or man-made contamination of the water supply source.	Assess the severity of the problem, and identify actions needed and time required to solve the problem. If necessary, notify city, county, and/or state emergency response officials for assistance. Undertake necessary actions as needed.

Lake Jacksonville (Jacksonville)

The City of Jacksonville adopted its current Drought Contingency Plan in 2014. The triggers are associated with water demands and the status of water supply facilities such as storage tanks and pumps. The triggers and actions related to Lake Jacksonville are outlined below in Table 7.13.

The North Cherokee WSC purchases water from Jacksonville. Recommendations for aligning the DCPs for these entities are presented in Section 7.2.2.

Table 7.13 Lake Jacksonville Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	a. Water demand is approaching the safe capacity of the system on a sustained basis. Sustained water usage over 85% of safe capacity, or 7.04 MGD (five consecutive days) should be taken as a trigger condition for mild conditions. b. Mild contamination is noted in the water supply, but water can still be treated by existing facilities by means such as increasing chlorine dosage; or contamination is reported in updip portions of aquifer. c. Additional well drilling in the vicinity threatens interference with water wells. d. Water levels in tanks are consistently below% full (five days uninterrupted). e. Local power failures are imminent as a result of power station failures, storms, transmission problems, or excessive power demand in the area. f. Performance of well water pumps, high service pumps, or other equipment indicates imminent failure. g. Transmission line from surface water plant to Dorothy St. tank is in danger of failure.	Warn customers to reduce water use. Recommend a voluntary lawn watering schedule. Explore possibility of interconnection with other systems. Take steps toward increasing system capacity, including repair of wells not currently in use.

Table 7.13 Lake Jacksonville Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Moderate	a. Water demand occasionally reaches safe limit of system (two days within a 30 day period), and failure of any pump or chlorine feeder could reduce the level of service to the system. Safe limit is 8.38 MGD as discussed above. b. Contamination of supply water is approaching limit of treatability with existing facilities; or brackish water is very near the well. c. Additional wells in vicinity are drawing water at a rate which interferes with production rate of City's wells. d. Over 20% of storage tank capacity is out of service due to structural failure, leakage, maintenance, or contamination. e. Water level in tanks is consistently below half full (three days uninterrupted). f. Water emergencies in adjacent communities require diversion of so much water that the level of service to any part of the Jacksonville system is threatened. g. Severe freezing conditions have resulted in widespread damage to home plumbing or distribution lines.	Implement mandatory lawn watering schedule. Prohibit wasteful water uses. Seek reduced usage from commercial users and industries. Take steps toward interconnection with other systems. Impose system surcharge. Take steps toward increasing system capacity, including repair of wells not currently in use.
Severe	a. Water demand is exceeding safe capacity (8.38 MGD) on a regular basis (more than five consecutive days). b. Supply water is so contaminated that it cannot be treated with existing facilities or such contamination is imminent because of nearby aquifer pollution. c. Rupture of transmission lines from the raw water pumps or from the water treatment plant. d. An immediate health or safety hazard could result from actual or imminent failure of system components. e. Water levels in elevated tanks are too low to provide adequate fire protection (generally less than 1/4 full). f. Over half of storage tank capacity is out of service. h. All service pumps are out of service. i. Water emergencies in adjacent communities require so much water diversion that service to portions of the Jacksonville system is severely disrupted.	Prohibit all outdoor use and all wasteful use. Impose system surcharge. Impose rationing. Require commercial users and industries to stop using City water for processes, cooling, or recreation. Implement interconnection with other systems. Implement increased system capacity.

Lake Murvaul (Panola County FWSD No. 1)

The Panola County FWSD No. 1 did not submit a drought contingency plan. Therefore, recommendations are based on the drought contingency plan for the City of Carthage, which purchases water from the Panola County FWSD No. 1. Carthage adopted its most recent drought contingency plan in 2014. The triggers and actions are based on water demands, weather conditions, and reservoir storage. These are outlined in Table 7.14 below.

Table 7.14 Lake Murvaul Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	a. Average daily water consumption reaches 90% of the water treatment plant's production capacity for three consecutive days. b. Water level in Lake Murvaul is declining at a rate that could disrupt water supply in the future. c. Weather conditions are considered in drought classification determination. Predicted long, cold, or dry periods are to be considered in impact analysis.	Encourage voluntary reduction of water use.
Moderate	a. Average daily water consumption reaches 100% of the water treatment plant's production capacity for three consecutive days. b. Water levels in Lake Murvaul continue to decline or are declining at a rate that makes supply problems imminent. c. Weather conditions indicate mild drought will exist for five or more consecutive days.	Implement mandatory conservation measures, including odd/even watering schedule and limited watering hours. Discontinue irrigation of parks and public areas. Limit water use for vehicle washing. Prohibit water use from fire hydrants except for firefighting.
Severe	a. Average daily water consumption reaches 110% of the water treatment plant's production capacity for three consecutive days. b. Water storage levels are drained daily and recover only during overnight periods of low demand. c. Lake Murvaul water levels have declined to the point where any additional loss of water will expose an intake point to the atmosphere. d. Lake Murvaul water levels have declined to the point where water withdrawal is impeded. e. A clear well at the water treatment plant is taken out of service during a mild or moderate water shortage period.	Prohibit use of hose-end sprinklers. Prohibit use of water for street washing, filling pools, water athletic fields and courses, and dust control. Initiate development of alternative supply sources.

Table 7.14 Lake Murvaul Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Critical	a. Average daily water consumption reaches 115% of the water treatment plant's production capacity for any one day. b. Water storage levels do not fully recover even during overnight periods of low demand. c. Lake Murvaul water levels have declined to the point where water withdrawal is impeded due to exposed water inlets on the intake structure. d. System demand exceeds available high service pump capacity.	Prohibit vehicle washing.
Emergency	a. Average daily water consumption reaches 120% of the water treatment plant's production capacity for any one day. b. Lake Murvaul water levels have declined to the point where water withdrawal is impeded or equipment could be damaged by normal operation of water supply system facilities and equipment due to water supply deficiency. c. Water system is contaminated, either accidentally or intentionally. Severe condition is reached immediately upon detection. d. Water system fails-- from acts of God (tornados, hurricanes) or man. Severe condition is reached immediately upon detection.	Prohibit all non-essential water uses, including landscape watering and vehicle washing. Implement alternative supply sources. Implement pro-rate water allocation.

Lake Nacogdoches (Nacogdoches)

Nacogdoches adopted its most recent drought contingency plan in 2011. The triggers and actions are based on water demands and production capacity. These are outlined in Table 7.15 below.

Table 7.15 Lake Nacogdoches Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	When total daily water demand equals or exceeds 90% of the daily water production capacity for 4 consecutive days or 92% of water capacity production on a single day.	Request voluntary conservation measures, including maximum twice-weekly watering schedule and limited irrigation hours.
Moderate	When total daily water demand equals or exceeds 92% of the daily water production capacity for 4 consecutive days or 94% of the daily production capacity on a single day.	Implement mandatory conservation measures, including maximum twice-weekly watering schedule and limited watering hours. Prohibit non-essential water use. Limit water use for vehicle washing and filling of pools. Limit water use from fire hydrants.
Severe	When total daily water production capacity equals or exceeds 94% of the daily production capacity for 4 consecutive days or 96% of the daily water production capacity on a single day.	Prohibit use of hose-end sprinklers. Prohibit watering golf course tees. Discontinue irrigation of public landscaped areas, including parks and ball fields. Prohibit use of water from fire hydrants for construction purposes.
Critical	When total daily water production capacity equals or exceeds 96% of the daily water production capacity for 4 consecutive days or 98% of the daily water production capacity on a single day.	Prohibit use of permanently installed automatic sprinklers. Prohibit filling of pools. Prohibit vehicle washing outside of commercial facilities. No new connections.
Emergency	When the City Manager, or designee, determines a water supply emergency exists based on: (1) Major water line breaks, or pump or system failures occur which cause unprecedented loss of capability to provide water service; or (2) Natural or man-made contamination of water supply source(s).	Implement alternative supply sources. Prohibit all non-essential water uses, including landscape watering and vehicle washing.

Lake Palestine (Upper Neches River Municipal Water Authority)

The UNRMWA adopted its most recent drought contingency plan in 2014. The triggers and actions are based on water elevations in the reservoir. These are outlined in Table 7.16 below.

In the ETRWPA, the Cities of Tyler and Palestine purchase water from the UNRMWA. In addition, Southern Utilities Company purchases water from Tyler. Recommendations for aligning these DCPs are presented in Section 7.2.2.

Table 7.16 Lake Palestine Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	When the stage elevation of Lake Palestine reaches or drops below 339.5 feet for three consecutive days.	Minimize unnecessary releases from Lake Palestine. Encourage wholesale customers to use alternative water sources. Request that wholesale customers implement voluntary conservation measures and Stage 1 of DCP.
Moderate	When the stage elevation of Lake Palestine reaches or drops below 336 feet for three consecutive days.	Request that wholesale customers implement mandatory conservation measures and Stage 2 of DCP. Prepare monthly water usage allocation in preparation for pro-rata curtailment.
Severe	When the stage elevation of Lake Palestine reaches or drops below 333 feet for three consecutive days.	Coordinate with authorities to reduce or eliminate releases downstream. Request that wholesale customers implement additional mandatory conservation measures and Stage 3 of DCP. Initiate pro-rata curtailment of water diversions/deliveries.
Emergency	When any of the following occur: 1. A dam, spillway, or outlet works and associated appurtenances failure occurs, which cause unprecedented loss of capability to provide water service; or 2. Natural or man-made contamination of the water supply source occurs.	Assess the severity of the problem, and identify actions needed and time required to solve the problem. If necessary, notify city, county, and/or state emergency response officials for assistance. Undertake necessary actions as needed.

Rusk City Lake (Rusk)

Rusk adopted its most recent drought contingency plan in 2014. The triggers and actions are based on water demands. These are outlined in Table 7.17 below.

Table 7.17 Rusk City Lake Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	When total daily water demand equals or exceeds 800,000 gallons for five consecutive days or 1,600,000 gallons on a single day.	Request that wholesale customers implement voluntary conservation measures and Stage 1 of DCP.
Moderate	When total daily water demand equals or exceeds 1,600,000 gallons for five consecutive days or 1,900,000 gallons on a single day.	Request that wholesale customers implement mandatory conservation measures and Stage 2 of DCP. Prepare monthly water usage allocation in preparation for pro-rata curtailment.
Severe	When total daily water demand equals or exceeds 1,900,000 gallons for five consecutive days or 2,200,000 gallons on a single day.	Request that wholesale customers implement additional mandatory conservation measures and Stage 3 of DCP. Initiate pro-rata curtailment of water diversions/deliveries.
Emergency	When there exist major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; or natural or man-made contamination of the water supply source(s).	Assess the severity of the problem, and identify actions needed and time required to solve the problem. If necessary, notify city, county, and/or state emergency response officials for assistance. Undertake necessary actions as needed.

Sam Rayburn/B.A. Steinhagen System (Lower Neches Valley Authority)

The LNVA adopted its most recent drought contingency plan in 2012. The triggers and actions are based on water elevations in the Sam Rayburn Reservoir. These are outlined in Table 7.18 below.

The Cities of Port Arthur and Groves purchase water from the LNVA. Recommendations for aligning these DCPs are presented in Section 7.2.2.

Table 7.18 Sam Rayburn/B. A. Steinhagen System Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Moderate	When Sam Rayburn Reservoir has remained below the following critical water supply level for a continuous 30-day period. Seasonal critical lake level shall be defined as follows: Lake Level: Time Period 158.0 MSL: January 1 - March 31 160.0 MSL: April 1 - July 31 158.0 MSL: August 1 - August 31 156.0 MSL: September 1 - December 31	Request municipal customers implement voluntary conservation, including restriction of lawn irrigation. Request municipal customers prohibit other non-essential uses. Request industrial customers evaluate measures to minimize process water use and encourage basic water conservation practices. Request irrigation customers monitor use to prevent water waste.
Severe	When the water surface elevation in Sam Rayburn Reservoir falls below 153.0 MSL for a continuous period of 20 days. With Sam Rayburn water surface at elevation 153.0 MSL the remaining water in the conservation pool is sufficient to sustain LNVA's water use demands for approximately one year without significant rainfall in the basin.	Initiate pro-rata curtailment of deliveries if necessary. Request municipal customers evaluate mandatory conservation measures, both outdoors and indoors. Request industrial customers minimize process water use and encourage basic water conservation practices. LNVA personnel will monitor irrigation use to prevent water waste.
Extreme	When the water surface elevation in Sam Rayburn Reservoir falls below 151.5 MSL for a continuous period of 10 days. At a water surface at elevation of 151.5 MSL sufficient water remains in the Sam Rayburn Reservoir water conservation pool to sustain LNVA's water use demands for approximately six months without significant rainfall in the basin.	Severe level measures plus curtailment of irrigation deliveries as appropriate.
Exceptional	When the water surface elevation in Sam Rayburn Reservoir falls below 149.00 MSL for a continuous period of 3 days. Once the water surface elevation in Sam Rayburn Reservoir falls to 149.00 MSL, the water remaining in the conservation pool at Lake BA Steinhagen will only be sufficient to sustain LNVA's water use demands for approximately three months without significant rainfall in the basin. An emergency water supply may be made available from the inactive pool of Sam Rayburn Reservoir upon approval of the US Army Corps of Engineers.	Initiate pro-rata curtailment of deliveries if the situation dictates. Direct municipal customers to initiate mandatory conservation measures, including prohibition of outdoor water use and practices to minimize indoor water use. Direct industrial customers to minimize process water use to the extent feasible and encourage basic water conservation practices among employees. Cease releases from Rayburn/Steinhagen for interruptible water supplies.
Emergency	Upon the failure of a major component of the water supply, the pumps or canals in the LNVA's distribution system or the contamination of the canals or source water supply which substantially curtails LNVA's ability to supply water to its customers.	Assess the severity of the problem, and identify actions needed and time required to solve the problem. If necessary, notify city, county, and/or state emergency response officials for assistance. Undertake necessary actions as needed.

Lake Striker (Angelina-Nacogdoches WCID)

The Angelina-Nacogdoches WCID adopted its most recent drought contingency plan in 2009. The triggers and actions are based on water elevations in the lake. These are outlined in Table 7.19 below.

Table 7.19 Lake Striker Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	When the water level in Lake Striker Reservoir drops to 290.00 amsl.	Request that customers implement voluntary conservation measures and Stage 1 of their DCPs
Moderate	When the water level in Lake Striker Reservoir drops to 288.00 amsl.	Initiate pro-rata curtailment of diversions/deliveries and implement a surcharge if the situation dictates. Request that customers initiate mandatory conservation measures and Stage 2 of their DCPs.
Severe	When the water level in Lake Striker Reservoir drops to 286.00 amsl.	Initiate additional pro-rata curtailment of diversions/deliveries. Request that customers initiate additional mandatory conservation measures and Stage 3 of their DCPs.
Emergency	When the water level in Lake Striker Reservoir is at 284.00 amsl.	Initiate additional pro-rata curtailment of diversions/deliveries. Request that customers initiate additional mandatory conservation measures and additional stages of their DCPs.

Toledo Bend Reservoir (Sabine River Authority)

The SRA adopted its most recent drought contingency plan in 2014. The triggers and actions are based on water elevations in the reservoir and downstream flows in the Sabine River. These are outlined in Table 7.20 below.

The GM WSC purchases water from the SRA. Recommendations for aligning these DCPs are presented in Section 7.2.2.

Table 7.20 Toledo Bend Reservoir Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	• The water surface elevation in Toledo Bend falls to and remains at or below 165.1 feet for fourteen consecutive days, or • The flow measured by the U.S. Geological Survey (USGS) gage on the Sabine River near Ruliff, Texas falls to and remains at or below the mild conditions flow in Table 10 of the SRA DCP for fourteen consecutive days.	Request that customers implement Stage 1 of their DCPs.
Moderate	• The water surface elevation in Toledo Bend falls to and remains at or below 162.2 feet for fourteen consecutive days, or • The flow measured by the USGS gage on the Sabine River near Ruliff, Texas, falls to and remains at or below the moderate conditions flow in Table 10 of the SRA DCP	Initiate pro-rata curtailment of diversions/deliveries if the situation dictates. If appropriate, request that customers prohibit non-essential outdoor uses, such as lawn irrigation, vehicle washing, filling of swimming pools, or routine maintenance of facilities.
Severe	• The water surface elevation in Toledo Bend falls to and remains at or below 156 feet for fourteen consecutive days, or • The flow measured by the USGS gage on the Sabine River near Ruliff, Texas, falls to the severe conditions flow in Table 10 of the SRA DCP for fourteen consecutive days.	Initiate pro-rata curtailment of diversions/deliveries if the situation dictates. If appropriate, request that customers prohibit all outdoor water use (except for livestock watering) and initiate measures to reduce indoor water use.
Emergency	• There is a major contamination or a major required drawdown of Toledo Bend for emergency repairs of major infrastructure, or • The failure of a major component of the pumps or canals in the John W. Simmons Gulf Coast Canal System significantly impacts the supply of water to its customers.	Initiate pro-rata curtailment of diversions/deliveries if the situation dictates. Request that customers prohibit all outdoor water use (except for livestock watering) and initiate measures to reduce indoor water use.

Lake Tyler/Lake Tyler East/Lake Bellwood (Tyler)

Tyler adopted its most recent drought contingency plan in August 2014. The triggers and actions are based on water demands, production and storage capacity, and weather conditions. These are outlined in Table 7.21 below.

The Southern Utilities Company purchases water from Tyler. Recommendations for aligning these DCPs are presented in Section 7.2.2.

Table 7.21 Lake Tyler/Lake Tyler East/Lake Bellwood Triggers and Potential Actions

Drought Stage	Trigger	Potential Action
Mild	a. Average daily water consumption reaches 85% of production capacity. Production capacity is defined as on line capacity in case of failure of a water source. b. Consumption (85%) has existed for a period of three days. c. Weather conditions are considered in drought classification determination. Predicted long, hot or dry periods are to be considered in the impact analysis.	Encourage implementation of voluntary water conservation measures.
Moderate	a. Average daily water consumption reaches 90% of rated production capacity for a three day period. Production capacity is defined as on line capacity in case of failure or shut down of one or both water treatment plants. b. Weather conditions indicate mild drought will exist five (5) days or more. c. One or more ground storage tank is taken out of service during mild drought period. d. Storage capacity (water level) is not being maintained during period of 100% rated production period. e. Existence of any one listed condition for a duration of 3-6 hours.	Implement mandatory water conservation measures, including every-fourth-day outdoor water use schedule and limited outdoor water use hours.
Severe	a. Average daily water consumption reaches 100% of production capacity. Production capacity is defined as on line capacity in case of failure or shut down of one or both water treatment facilities. b. Average daily water consumption will not enable storage levels to be maintained. c. System demand exceeds available high service pump capacity. d. Any two (2) conditions listed in moderate drought classification occurs at the same time for a 24 hour period. e. Water system is contaminated either accidentally or intentionally. Severe condition is reached immediately upon detection. f. Water system fails - from acts of God, (tornadoes, hurricanes) or man. Severe condition is reached immediately upon detection.	Curtail use of water for vehicle washing, window washing, outdoor watering, and non-essential water uses. Limit water use by other commercial users and industries.
Emergency	• There is a major contamination or a major required drawdown of Toledo Bend for emergency repairs of major infrastructure, or • The failure of a major component of the pumps or canals in the John W. Simmons Gulf Coast Canal System significantly impacts the supply of water to its customers.	Initiate pro-rata curtailment of diversions/deliveries if the situation dictates. Request that customers prohibit all outdoor water use (except for livestock watering) and initiate measures to reduce indoor water use.

Surface Water Supplies without Site-Specific Drought Contingency Plans

The ETRWPG did not receive drought contingency plans from suppliers that use water from these lakes. Therefore, the ETRWPG recommends drought triggers and response actions based primarily on the water volume stored in the reservoir (Table 7.22). These recommendations are generic in nature, and no site-specific studies have been performed to develop them. They are meant to provide guidance until site-specific drought contingency plans are developed and submitted. Drought response actions in addition to those recommended in Table 7.22 may also be appropriate. Site-specific plans may include other types of triggers, including those related to local water demands and operation of water supply systems.

Table 7.22 Recommended Triggers and Potential Actions for Lakes Without Site-Specific Drought Contingency Plans

Drought Stage	Trigger	Potential Action
Mild	Water volume stored in the lake drops to 80 percent of the conservation storage capacity	• Increase public education efforts on ways to reduce water use. • Encourage reduction of non-essential water use and auditing of irrigation systems. • Implement maximum twice per week watering for hose-end sprinklers and automatic irrigation systems. • Limit hours of irrigation to reduce evaporative losses. • Prohibit water waste, such as operating an irrigation system with broken spray heads or excessive runoff.
Moderate	Water volume stored in the lake drops to 60 percent of the conservation storage capacity	• Continue actions implemented in the previous stage. • Initiate engineering studies to evaluate water supply alternatives. • Accelerate public education efforts on ways to reduce water use. • Eliminate non-essential water use. • Implement maximum once per week watering for hose-end sprinklers and automatic irrigation systems.
Severe	Water volume stored in the lake drops to 40 percent of the conservation storage capacity	• Continue actions implemented in the previous stage. • Implement water supply alternatives. • Increase frequency of media releases explaining water supply conditions. • Prohibit outdoor watering with hose-end sprinklers and automatic irrigation systems. • Prohibit washing of paved areas or hosing of buildings (exceptions for public health and safety). • Limit vehicle washing to commercial car washes. • Prohibit permitting of new swimming pools. • Prohibit operation of ornamental fountains or ponds that use potable water except where necessary to support aquatic life. • Initiate measure to reduce indoor water use. • Initiate surcharge on excessive water use • Establish water allocations for each customer to be used if conditions worsen.
Emergency	• Water volume stored in the lake drops to 30 percent of the conservation storage capacity; or • Major water line breaks or pump or system failures occur; or • Natural or man-made contamination of the water supply source(s) occurs; • Water levels have declined to the point where water withdrawal is impeded or equipment could be damaged by normal operation; or • Other emergency conditions exist	• Implement water supply alternatives. • Increase frequency of media releases explaining water supply conditions. • Increase surcharge on excessive water use. • Initiate water allocation by customer.

7.5.2 Drought Trigger Conditions for Run-of-River and Ground Water Supplies. Run-of-river and ground water supplies typically serve many water users over a broad geographical area. Some water providers may have drought contingency plans, while other water users, particularly agricultural or industrial users, may not have drought contingency plans. For these water supplies, the ETRWPG proposes to use the U.S. Drought Monitor for Texas as a trigger for drought response actions.[2] This information is easily accessible through the U.S. Drought Monitor web site and is updated regularly. It does not require monitoring of well water levels or stream gages, and drought triggers can identified on a local basis. Table 7.23 shows the drought severity classifications adopted by the U.S. Drought Monitor and the associated Palmer Drought Index.

Table 7.23 Drought Severity Classification

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less

U.S. Drought Monitor: http://droughtmonitor.unl.edu/AboutUs/ClassificationScheme.aspx

[2] http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?TX

The ETRWPG recommends the following actions based on each of the drought classifications listed above:

- Abnormally Dry – Entities should review the status of supplies and demands to determine if implementation of a DCP stage is necessary.
- Moderate Drought – Entities should review the status of supplies and demands to determine if implementation of a DCP stage is necessary. Other potential actions include voluntary water conservation measures, such as restrictions on lawn watering days and hours, vehicle washing, pool filling, and non-essential water uses.
- Severe Drought – Entities should review the status of supplies and demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. Entities should begin considering alternative supplies. Other potential actions include mandatory water conservation measures, such as restrictions on lawn watering days and hours, vehicle washing, pool filling, and non-essential water uses.
- Extreme Drought – Entities should review the status of supplies and demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. Entities should begin to plan implementation of alternative supplies and prepare monthly water usage allocations in preparation for water rationing. Other potential actions include additional mandatory water conservation measures, such as more stringent restrictions on lawn watering days and hours, vehicle washing, pool filling, and non-essential water uses.
- Exceptional Drought – Entities should review the status of supplies and demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. Entities should implement alternative supplies. Other potential actions include additional mandatory water conservation measures, such as prohibition of outdoor watering and non-essential water uses. If necessary, entities should implement water rationing.

7.5.3 Region-Specific Model Drought Contingency Plans. Model DCPs for use by WUGs in the ETRWPA are provided in Appendix 7A. Model DCPs were developed for a public water supplier and for an irrigation water user.

7.6 Drought Management Water Management Strategies

Drought management and emergency response measures are important planning tools for all water suppliers. They are temporary measures that are implemented when certain criteria are met and are terminated when these criteria are no longer met. They are intended to preserve water resources for the most essential uses when water supplies are threatened by extraordinary conditions, such as:

- A multi-year drought,
- An unexpected increase in demand,
- The inability to use a water supply due to a chemical spill or due to invasive species,
- A water supply system component failure, or
- A water management strategy is not fully implemented when it is needed.

The ETRWPG supports implementation of DCPs under appropriate conditions by water providers in order to prolong the availability of existing water supplies and reduce impacts to water users and local economies. However, drought management and emergency response measures are not a reliable source of additional supplies to meet growing demands. Therefore, drought management measures are not recommended as a water management strategy to provide additional supplies for the ETRWPA.

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Chapter 8

Unique Stream Segments, Unique Reservoir Sites, and Legislative and Regulatory Recommendations

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This chapter of the 2016 Plan addresses unique stream segment designation, unique reservoir site designation, and water planning recommendations to the Texas Legislature. Information relevant to these issues was considered by the ETRWPG and the group voted on each issue.

8.1 Unique Stream Segments

According to §357.43(1) of the Texas Administrative Code, the ETRWPG is obligated to consider potential river or stream segments as being of unique ecological value based upon the following criteria set forth in §358.2(6):

(1) **Biological function** – stream segments that display significant overall habitat value including both quantity and quality considering the degree of biodiversity, age, and uniqueness observed and including terrestrial, wetland, aquatic, or estuarine habitats;

(2) **Hydrologic function** – stream segments that are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge;

(3) **Riparian conservation areas** – stream segments that are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes, or stream segments which are fringed by other areas managed for

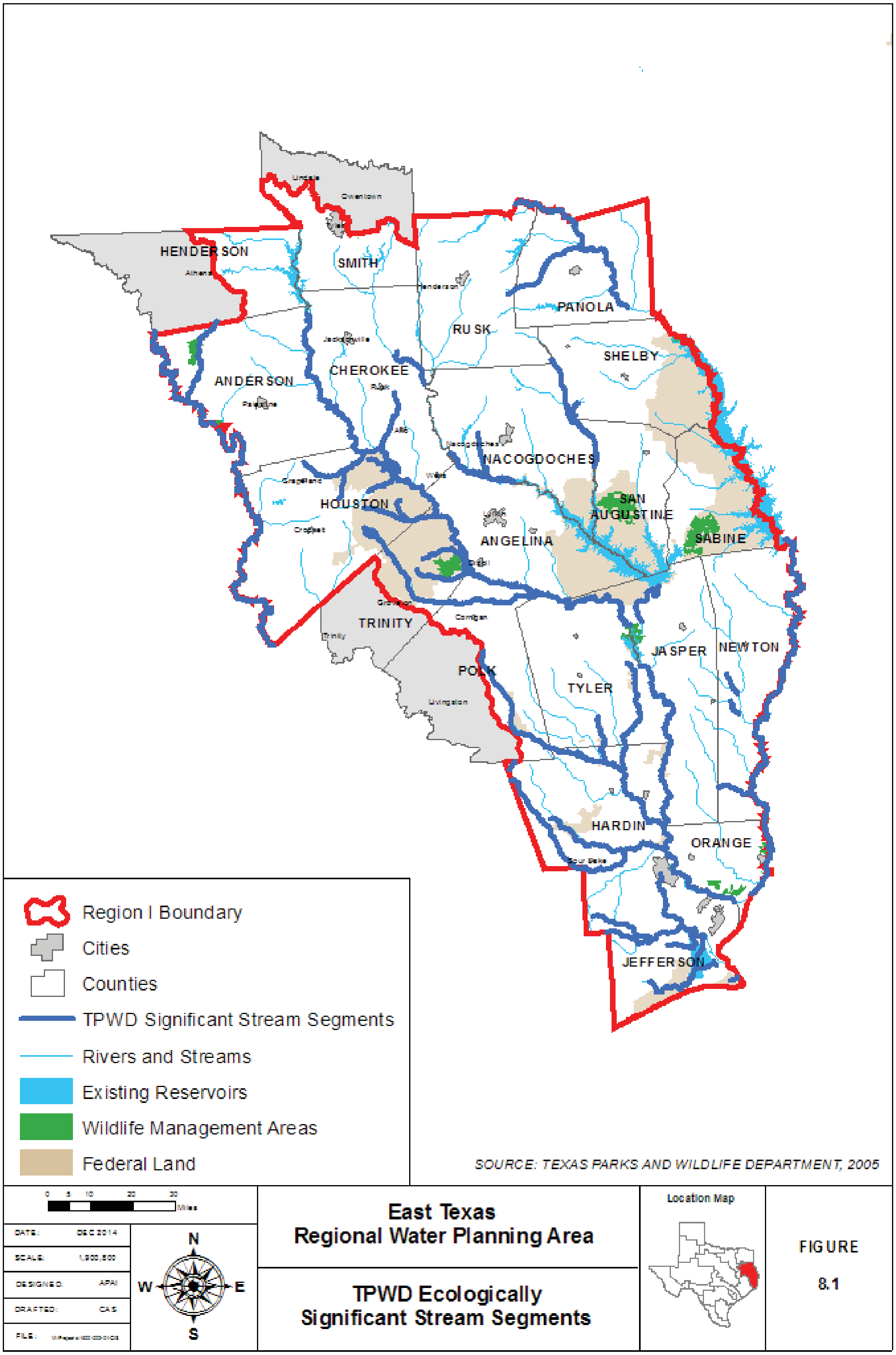
conservation purposes under a governmentally approved conservation plan;

(4) **High water quality/exceptional aquatic life/high aesthetic value –** stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; or

(5) **Threatened or endangered species/unique communities –** sites along streams where water development projects would have significant detrimental effects on state or federally listed threatened and endangered species; and sites along streams significant due to the presence of unique, exemplary, or unusually extensive natural communities.

To assist the ETRWPG with identifying potential stream segments for designation, the TPWD developed a report[1] in 2005 of ecologically significant river and stream segments in the ETRWPA. The TPWD draft report identified 41 river and stream segments in the ETRWPA as possibly ecologically significant. A map prepared by TPWD showing the locations of the 41 river and stream segments is presented on Figure 8.1. The draft report has not been finalized and no action has been taken as of yet.

The planning rules do not provide guidance on how many of the criteria need to be met as a prerequisite for consideration for designation as a unique stream segment. As an initial screening tool, the ETRWPG determined that those segments that meet three or more of the criteria would be further evaluated.


HENDERSON
SMITH
PANOLA
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SHELBY
ANDERSON
CHEROKEE
NACOGDOCHES
SAN AUGUSTINE
HOUSTON
ANGELINA
SABINE
TRINITY
JASPER
NEWTON
POLK
TYLER
HARDIN
ORANGE
JEFFERSON
Region I Boundary
Cities
Counties
TPWD Significant Stream Segments
Rivers and Streams
Existing Reservoirs
Wildlife Management Areas
Federal Land
SOURCE: TEXAS PARKS AND WILDLIFE DEPARTMENT, 2005
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East Texas
Regional Water Planning Area
TPWD Ecologically
Significant Stream Segments
Location Map
FIGURE
8.1

Only 11 of the 41 segments have three or more applicable criteria. Table 8.1 presents a summary of the 41 segments identified by TPWD and indicates which of the five criteria are identified by TPWD for each segment. Some of the segments are categorized as having threatened or endangered species or unique communities. The specific threatened or endangered species or unique community that is the basis for this categorization is presented in Table 8.2.

The intent of the Texas Legislature regarding the purpose of the unique stream segment designation is stated in Section 16.051(f) of the Texas Water Code:

> *This designation solely means that a state agency or political subdivision of the state may not finance the actual construction of a reservoir in a specific river or stream designated by the legislature under this subsection.*

Based on this section of the law, it would be irrelevant to consider recommending a segment for designation if it does not have potential to be a reservoir site.

There continues to be concern among many regional water planning groups (including the ETRWPG) that designation of a stream segment might lead to unwarranted restrictions on the use of the segment, including water diversions and discharges of treated effluent. During the current round of regional water planning, representatives of Region C met with TCEQ, TWDB, and TPWD to discuss potential issues related to restrictions associated with unique stream segment designation. As a result of this meeting, the TWDB has determined that a stakeholder committee should be formed to address the potential concerns. The committee has not yet been formed. However, it is understood that recommendations of the committee should be developed before the next round of water planning is complete.

Table 8.1 TPWD Ecologically Significant River and Stream Segments

River or Stream Segment	Biological Function	Hydrologic Function	Riparian Conservation Area	High Water Quality/Aesthetic Value	Endangered Species/Unique Communities	Total # 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			•			1
Texas Bayou			•			1
Trinity River	•		•		•	3
Trout Creek			•			1
Turkey Creek			•			1
Village Creek	•		•	•	•	4
White Oak Creek				•		1

Table 8.2 TPWD Threatened and Endangered Species/Unique Communities

Threatened / Endangered Species	Angelina River	Big Sandy Creek	Catfish Creek	Upper Neches River	Lower Neches River	Piney Creek	Sabine River	Trinity River	Village Creek
Paddlefish	•			•	•		•		
Creek chubsucker				•		•			
Sandbank pocketbook freshwater mussel					•				
Texas heelsplitter freshwater mussel					•			•	
Neches River rose-mallow				•					
Rough-stem aster			•						
Unique community		•							•

Seven of the 11 stream segments identified for further evaluation are not currently considered as potentially suitable for reservoir construction. Therefore, these segments have been eliminated from further consideration at this time. These segments are as follows:

- Alazan Bayou
- Upper and Lower Angelina River (Segment 0611; Nacogdoches County)
- Big Sandy Creek (Segment 0608B)
- Catfish Creek (Segment 0804G)
- Trinity River (Segment 0803/0804)
- Village Creek (Segment 0608)

Four segments include reaches that have been identified as potentially suitable for a reservoir site.

- Upper and Lower Neches River (Segment 0601/0602/0604) – Rockland Reservoir
- Piney Creek (Segment 0604D) – Rockland Reservoir
- Upper Sabine River (Segment 0505; Panola County) – Lake Stateline and Lake Carthage

Very little information currently exists on the relative value of using these sites for a reservoir compared to maintaining a riverine environment. Prior to proceeding with the construction of a reservoir at any of these sites, extensive environmental studies must be conducted to determine the extent and nature of potential environmental impacts and whether these impacts can be effectively mitigated. The information obtained through such environmental studies is the type of data needed to provide a basis for decisions regarding the relative merits of constructing a reservoir or preserving a riverine environment.

No regulatory purpose has been identified that would be served by a unique stream segment designation, other than precluding reservoir construction. Indeed, there are currently extensive regulations and programs to protect the environment in the ETRWPA.

The ETRWPA has a high proportion of land that has been assigned a special protective status; this land is summarized in Table 8.3 below. In addition to the land shown below, there are a number of state parks, state historic sites, and the Alabama and Coushatta Indian Reservation.

Areas of the ETRWPA that are not part of a state or federal preserve are also protected by various regulatory programs that require environmental assessments for activities that could adversely affect the environment.

Table 8.3 Land with a Special Protective Status

Name	Acreage
Alabama Creek Wildlife Management Area	14,600
Alazan Bayou Wildlife Management Area	2,100
Angelina National Forest	153,200
Big Lake Bottom Wildlife Management Area	4,100
Big Thicket National Preserve	106,300
Davy Crockett National Forest	160,600
E.O. Siecke State Forest	1,700
Engeling Wildlife Management Area	11,000
J.D. Murphree Wildlife Management Area	24,300
Lower Neches Wildlife Management Area	8,000
McFaddin and Texas Point National Wildlife Refuges	67,800
Neches National Wildlife Refuge	25,000*
Sabine National Forest	160,900
Tony Houseman Wildlife Management Area	3,300

*The current size of the Neches National Wildlife Refuge is 35 acres; ongoing land acquisitions will potentially expand the refuge to 25,000 acres.

At its regularly scheduled meeting in January 2015, the ETRWPG considered the above information and voted not to recommend any stream segments in the region for unique status. The ETRWPG concluded that sufficient programs are already in place to protect the regions streams from inappropriate reservoir construction. In addition, the ETRWPG prefers to allow the TWDB to study issues associated with unique stream segment designation before further considering potential designations in the ETRWPA.

8.2 Unique Reservoir Sites

Regional water planning guidelines allow regional water planning groups to recommend sites of unique value for construction where:

(1) Site-specific reservoir development is recommended as a specific water management strategy; or

(2) The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors make the site uniquely suited for reservoir development to provide water supply.

The ETRWPA has a long history of water supply planning and reservoir development. Numerous sites have been identified as being hydrologically and topographically ideal for reservoir development. Two sites in the ETRWPA are currently designated as unique reservoir sites: Lake Columbia and Fastrill Reservoir. Fastrill Reservoir was designated by the 79th Legislature through SB 3. Lake Columbia received its unique designation by the State Legislature, SB 1362. Lake Columbia is currently being pursued for development. The ETRWPG fully supports the designation of these two reservoir sites as unique.

The ETRWPG considered other potential reservoir sites for possible designation as unique but did not recommend any additional sites. The considered sites are described in Sections 8.2.2 through 8.2.12 below. The ETRWPG agrees with past evaluations of these sites as being hydrologically and topographically unique for reservoir construction. The ETRWPG recognizes that reservoirs can have major impacts on the environment and that protection of the environment is already afforded through a process that is more thorough than the regional water planning effort. The ETRWPG is not recommending these additional sites (i.e., the proposed reservoirs other than Lake Columbia and Lake Fastrill) be designated as unique reservoir sites. The ETRWPG is recommending that these sites be recognized as potential long-term water management strategies for the time period more than fifty years in the future. The ETRWPG believes that the lengthy and thorough economic and environmental review process will determine if any of these reservoirs are constructed as opposed to any decision by the ETRWPG.

At its regularly scheduled meeting in January 2015, the ETRWPG voted not to recommend any proposed reservoir sites as unique during this planning cycle. Proposed sites, including the two sites already designated as unique, are included in Table 8.4, following.

Table 8.4 Potential Reservoirs for Designation as Unique Reservoir Sites

Major Water Provider	Reservoir Site
Angelina Neches River Authority	Lake Columbia (Already Unique Site)
	Ponta
Lower Neches Valley Authority	Rockland Reservoir (Alternative WMS)
Sabine River Authority	Big Cow Creek
	Bon Weir
	Carthage Reservoir
	Kilgore Reservoir
	Rabbit Creek
	State Hwy. 322, Stage I
	State Hwy. 322, Stage II
	Stateline
	Socagee
Upper Neches River Municipal Water Authority	Fastrill Reservoir (Already Unique Site)

A brief description of each of the above reservoir sites follows. Appendix 8-A contains maps showing the proposed locations for each reservoir.

8.2.1 Lake Columbia. The reservoir is a project of ANRA located predominantly in Cherokee County but extends into the southern portion of Smith County. Figure 8-A.4 indicates the location for Lake Columbia. The reservoir would be formed by construction of a dam on Mud Creek approximately 2.5 miles downstream of the U. S. Highway 79 crossing. The dam is expected to impound water approximately 14 miles upstream with an estimated surface area of 10,133 acres. The reservoir is permitted for 85,507 ac-ft per year of water. It has a total storage volume at normal pool elevation, 315 feet msl, of

195,500 acre-feet. State of Texas Senate Bill 1362 designated the site for Lake Columbia as a site of unique value for the construction of a dam and reservoir.

In January 2010, ANRA released a draft Environmental Impact Study (EIS) for Lake Columbia. The EIS underwent public comment in 2010 and was submitted to the U.S. Army Corp of Engineers and other federal resource agencies for review and comment. ANRA is currently responding to comments of state and federal review agencies, including the TCEQ, TPWD, and EPA.

8.2.2 Ponta Reservoir. The Ponta Reservoir would be located on Mud Creek in Cherokee County east of Jacksonville, Texas. The dam site is located approximately one mile upstream from the Southern Pacific Railroad crossing over Mud Creek. Figure 8-A.4 indicates the proposed location. The normal pool elevation would be about elevation

302 ft msl and would have an area of 11,000 acres. Storage capacity at normal pool elevation would be 200,000 acre-feet. Previous studies have indicated that the reservoir could provide a dependable yield of 105,000 ac-ft per year. However, with the construction of Lake Columbia the yield would be substantially less.

8.2.3 Rockland Reservoir. The Rockland Reservoir site is located on the Neches River at River Mile 160.4. The top of the flood pool would be at elevation 174 feet, msl with top of conservation pool of 165 feet, msl. It is estimated the reservoir site would affect 99,524 acres of wildlife habitat (Frye, 1990).

Rockland Reservoir was authorized for construction as a federal facility in 1945, along with Sam Rayburn, B. A. Steinhagen and Dam A lakes. A report in 1947 recommended construction of Sam Rayburn and B. A. Steinhagen with deferral of Rockland Reservoir and Dam A until such time the need develops. Rockland and Dam A were classified as inactive in 1954. A re-evaluation study performed in 1987 identified the potential for significant benefits in the areas of flood control, water supply, hydropower, and recreation.

8.2.4 Big Cow Reservoir. The Big Cow Reservoir is a proposed local water supply project on Big Cow Creek in Newton County. The Big Cow Creek dam site is located about one-half mile upstream from U.S. Hwy 190, west-northwest of the Town of Newton. It is in the Lower Sabine Basin. Figure 8-A.2 indicates the location of the proposed reservoir. The expected yield of the reservoir is 61,700 ac-ft per year with a storage capacity of 79,852 ac-ft and an area of 4,618 acres. The conservation level would be 212 feet msl.

The perennial streams that feed Big Cow Creek and abundant rainfall should provide sufficient inflow for considerable yield for a reservoir of this size.

8.2.5 Bon Weir Reservoir. The Bon Weir dam site is located on the state line reach of the Sabine River in Newton County, Texas and Beauregard Parish, Louisiana. The reservoir would extend from about 5 miles upstream of U.S. Hwy 190 to approximately Highway 63. Figure 8-A.2 indicates the location of the proposed reservoir. It was originally proposed for re-regulation of the hydropower discharges from Toledo Bend Reservoir and for the generation of hydropower. The reservoir, if constructed, would yield 440,000 ac-ft per year at a normal operating elevation of 90 feet above msl. The area and capacity would be 34,540 acres and 353,960 acre-feet, respectively.

It is estimated that the Bon Weir Reservoir would affect 35,000 acres of wildlife habitat (Frye, 1990). This includes several acid bogs/baygalls, which are unique and sensitive areas of the region. Several threatened and endangered species are known to occur in this area. No cultural resource survey has been conducted, but the site is expected to affect numerous archeological and historical sites in both Texas and Louisiana. The Clean Rivers Program Water Quality data reported possible concerns for elevated TDS and low dissolved oxygen during the summer months. The site also requires congressional approval for construction of a dam, because it is on interstate navigable waters of the U.S.

8.2.6 Carthage Reservoir. The Carthage Reservoir is a proposed main stem project on the Sabine River in Panola, Harrison, Rusk and Gregg counties. It is located immediately upstream of the U.S. Highway 59 crossing and downstream of the City of Longview. Figure 8-A.3 indicates the proposed location. The yield of this reservoir, if constructed, would be approximately 537,000 ac-ft per year at a conservation pool elevation of 244 feet msl. The area and capacity would be 41,200 acres and 651,914 acre-feet, respectively.

Developmental concerns for Carthage Reservoir include bottomland hardwoods, aquatic life, lignite deposits, and cultural resources. The downstream half of the site encompasses a USFWS Priority 1 bottomland hardwood area. This portion of the Sabine River is designated a significant stream segment and is home to several protected aquatic species (Bauer, 1991). Other potential conflicts with this site include oil and gas wells. Permitting for this reservoir will require an act of Congress since the dam is located on navigable interstate waters of the U.S. There is one active lignite mine, South Hallisville Mine No. 1, near the reservoir boundary.

The water quality assessment of the Sabine River (SRA, 1996) indicates this segment of the river has possible concerns for nutrients, but the water quality is improving. The advantage of this reservoir is its large yield. The estimated yield of 537,000 ac-ft per year would provide for all projected needs well beyond the year 2060.

8.2.7 Kilgore Reservoir. The Kilgore Reservoir is a proposed local water supply project located on the Upper Wilds Creek in Rusk, Gregg, and Smith counties. Figure 8-A.5 indicates the proposed location of the reservoir. It was originally proposed to supplement the City of Kilgore's water supply. The project would provide a yield of 5,500 ac-ft per year at the normal operating elevation of 398 feet msl. At that level, the area and capacity would be 817 acres and 16,270 acre-feet, respectively.

Construction of this reservoir has never been initiated, and the City of Kilgore is using diversions from the Sabine (purchased from SRA and released from Lake Fork) and ground water for its water supply. However, this project still has the potential as a local water supply source in the Kilgore area should other proposed projects not be developed. Only preliminary studies have been performed for the Kilgore Reservoir and no environmental impacts have been assessed. Based on preliminary screening data, the site is not located within a priority bottomland hardwood area; there are no known water quality issues and no active mines within the reservoir site.

8.2.8 Rabbit Creek Reservoir. Several reservoir projects have been proposed on Rabbit Creek for local water supply. The latest proposal for the City of Overton and surrounding communities was completed in 1998 (Burton, 1998). The proposed reservoir project is located on Rabbit Creek in Smith and Rusk counties, and would have a firm yield of 3,500 ac-ft per year. Figure 8-A.5 indicates the proposed location of the reservoir. This is considerably less yield than the previous studies, which is due in part to the smaller storage capacity and conservative inflows that were assumed for the study. In the latest study, the area would be 520 acres and the capacity would be 8,000 acre-feet at a conservation level of 406 ft msl. However, this yield is considered satisfactory to meet the regional demands of the area. Environmental review of the site reports no significant concerns that would preclude development. There are also no significant cultural resources in the area, no known water quality issues, and no active mining within the reservoir area.

The advantages of this reservoir site are the few developmental concerns. However, it was rejected as a water supply alternative in the 1998 study due to costs. A large percentage of the total costs were associated with a water treatment and distribution system. Due to the relatively low yield of Rabbit Reservoir, this project could only be considered for local water supply.

8.2.9 State Highway 322 Stage I. The Highway 322 Reservoir is a proposed local water supply project in Rusk County, upstream of Lake Cherokee. Figure 8-A.3 indicates the proposed location. The project, as originally proposed, was to be developed in two stages: 1) a dam and reservoir on Tiawichi Creek (Stage I), and 2) a separate dam and reservoir on Mill Creek (Stage II). The reservoirs were to be joined by a connecting channel that would allow one spillway to serve both dams.

The proposed Stage I dam is located on Tiawichi Creek, approximately one mile upstream of its confluence with the upper end of Lake Cherokee. The reservoir, at its normal operating elevation of 330 feet msl, would provide a net yield of 22,000 ac-ft per year. Its area and capacity would be 4,450 acres and 82,450 acre-feet, respectively. If Stage I is operated independently from Lake Cherokee, the firm yield of the reservoir would be reduced due to Lake Cherokee's superior water rights.

The primary developmental concern for the Stage I reservoir is active lignite mining. In 1995, the Oak Hill Mine expanded its current permit area to include approximately one third of the proposed Stage I reservoir area. There have been no environmental studies conducted for this site. Based on preliminary screening, the site is located outside priority bottomland hardwood areas, and there are no known water quality issues.

8.2.10 State Highway 322 Stage II. The State Highway 322 - Stage II reservoir is the second phase of the State Highway 322 water supply project in Rusk County. The Stage II dam would be located on Mill Creek, approximately one mile upstream of the existing Lake Cherokee. Figure 8-A.3 indicates the proposed location. Operated at the same level as Stage I (330 feet msl), this project would provide an increased yield to the Cherokee Lake system of 13,000 ac-ft per year with added storage capacity of 112,000 acre-feet. Stage II surface area would be 2,060 acres. The State Highway 322 project (Stages I and II) and Lake Cherokee could be operated as a system to provide a total yield of 53,000 ac-ft per year and maintain the recreational and aesthetic benefits currently provided by Lake Cherokee. If State Highway 322 project were operated independently from Lake Cherokee, the firm yield would be reduced due to Lake Cherokee's superior water rights.

The primary developmental concern for Stage II is the active lignite mining. Surface mining records indicate that the Oak Hill Mine permit encompasses much of the Stage II reservoir. Preliminary screening indicates no priority bottomland hardwoods in the reservoir area, and there are no known water quality issues. The advantages to this reservoir site is its location near the areas with projected water needs and the possibility that when mining is completed, the site will already be cleared and ready for reservoir development.

8.2.11 Stateline Reservoir. The Stateline Reservoir is a proposed main stem project on the Sabine River, approximately eight miles upstream of Logansport, Louisiana and about four miles upstream from the headwaters of Toledo Bend Reservoir. Figure 8-A.3 indicates the proposed location. The project site is located in the southeastern section of Panola County and would have an estimated yield of 280,000 ac-ft per year. At the conservation level of 187 feet msl, the area and capacity would be 24,100 acres and 268,330 acre-feet, respectively.

Developmental concerns for this site include bottomland hardwoods, oil and gas wells, water quality, and permitting issues. The northern half of the site lies in a USFWS designated Priority 1 hardwood area. The southern half is a high quality wetland area and currently being considered for a wetland mitigation bank by the SRA. The mineral rights associated with the Carthage Oilfield significantly affect land acquisition for the reservoir. The Clean Rivers Program Water Quality data indicated possible concerns for elevated nutrient levels, metals, low dissolved oxygen, and fecal coliform. This segment of the stream is also a known habitat for several protected aquatic species. Permitting for this reservoir will require an act of Congress since the dam is located on navigable interstate waters of the U.S. (Rivers and Harbors Act, 1899). Construction of the dam and reservoir may also require consent of Louisiana for the part that will affect the state of Louisiana (Sabine River Compact). As currently proposed, the dam site is located immediately upstream of the Stateline reach and there is minimal impact to Louisiana lands. However, due to the close proximity of Toledo Bend Reservoir, it is unlikely that Stateline Reservoir would be more economical than Toledo Bend in meeting the needs of the Upper Basin.

8.2.12 Socagee Reservoir. The Socagee Reservoir site is located in the eastern portion of Panola County on Socagee Creek, approximately six miles upstream of its mouth. Figure 8-A.3 indicates the proposed location. The reservoir, at normal pool elevation, would have a yield of 39,131 ac-ft per year. The reservoir area would be approximately 9,100 acres and the capacity would be about 160,000 acres.

Approximately 40 percent of the site overlies existing lignite deposits. As of 1986, there was no known exploitation of the lignite deposits, and there currently are no active mines within the area. One cultural resource site is reported in the reservoir boundary. There are no known water quality issues or priority bottomland hardwoods that affect this reservoir site. Socagee Reservoir could be used to meet the local needs of Panola County; however, Lake Murvaul, which has been designated for Panola County use only, has adequate yield to meet the future needs of Panola County.

8.2.13 Fastrill Reservoir. Fastrill Reservoir has long been a project of the City of Dallas and UNRMWA and the site was designated as unique by the Texas Legislature in 2007. Subsequently, actions at the federal level to designate a wildlife refuge within the footprint of the proposed lake have called into question the lake's ultimate viability. However, because of the site's designation by the Texas Legislature, the ETRWPG has decided not to eliminate it from the list of proposed reservoirs in the ETRWPA at this time. The reservoir would be located on the Neches River in Anderson and Cherokee Counties downstream of Lake Palestine and upstream of the Weches Dam site. The dam would be located at River Mile 288. Figure 8-A.4 indicates the proposed location. Normal pool elevation would be at an elevation of 274 ft msl and would have an area of 24,950 acres based on digital topographic information. Recent analyses using the Neches River Basin Water Availability Model (WAM) indicate that the firm yield of Fastrill Reservoir may range from approximately 140,000 ac-ft per year (stand-alone operations) to about 155,000 ac-ft per year (system operations with Lake Palestine) subject to senior water rights and Consensus Criteria for Environmental Flow Needs.

8.3 Legislative and Regulatory Recommendations

Rules in 31 TAC 357.43(d – f) state that regional water planning groups are to consider and make recommendations to the legislature regarding regulatory, administrative, or legislative issues that the group believes are needed and desirable to achieve the stated goals of state and regional water planning, including to:

(1) Facilitate the orderly development, management, and conservation of water resources;

(2) Prepare for and respond to drought conditions; or

(3) Facilitate more voluntary water transfers in the region.

For this update of the regional water plan, the ETRWPG discussed legislative and regulatory recommendations at three meetings, beginning with the January 28, 2015, meeting of the group. The Executive Committee of the ETRWPG also reviewed previous recommendations made pursuant to the planning process and evaluated new potential recommendations. Proposed recommendations were brought to the ETRWPG at the March 11, 2015, meeting for consideration. Following is a list of recommendations adopted by the ETRWPG on April 8, 2015.

8.3.1 Flexibility in Determining Water Plan Consistency. The ETRWPG is concerned that small cities and unincorporated areas that fall under the group of "county-other" may not have specific water needs and water management strategies identified in the regional water plan due to the nature of aggregating these entities. As such, there is concern that these entities may not be eligible for state funding assistance. The ETRWPG is also concerned that there is sufficient flexibility in identifying and implementing water management strategies as it pertains to permitting and funding such projects. Water suppliers need to have a full range of options as they seek to provide new water supplies for Texas' future. It is impossible to foresee all the possibilities for new water supplies in a planning process such as this, and changing circumstances can change the timing, amounts, and preferred options for new supplies very quickly. The inclusion of alternate strategies in regional water planning is the first step in providing this flexibility. In addition, the ETRWPG recommends that the following steps be taken to address these concerns.

- The TWDB should add language to their guidance for funding that allows entities that fall under the planning limits to retain eligibility for state funding of water related projects without having specific needs identified in the regional water plans.

- The TWDB and the TCEQ should interpret existing legislation to give the maximum possible flexibility to water suppliers as they seek to serve the public and provide new supplies. Changes in the timing of supply development, the order in which strategies are implemented, the amount of supply from a management strategy, or the details of a project should not be interpreted as making that project inconsistent with the regional plan.

- Willing buyer/willing seller transactions of water rights and treated water should not be controlled by this regulation. Such transactions may be beneficial to all concerned and may simply not have been foreseen in the planning process.

- The TWDB and TCEQ should make use of their ability to waive consistency requirements if local water suppliers elect strategies that differ from those in the regional plan.

8.3.2 Continued Funding by the State of the Regional Water Planning Process on a Five-Year Cycle. The ETRWPG believes the grassroots planning effort created by Senate Bill 1 is important to the state of Texas and should be continued. In addition, the ETRWPG believes that the most fair and efficient method of financing continuation of this effort for future planning cycles is to continue funding of this effort by the state with administrative expenses for the region being provided from sources within the region. There are important tasks that need to continue. Improvement of data for the next planning cycle is very important. State funding of those efforts needs to be made available.

8.3.3 Unique Reservoir Designation. The 79th Texas Legislature designated 19 sites as having unique value for the construction of a reservoir. Two of these sites, Lake Columbia and Lake Fastrill are located in the ETRWPA. As part of this designation, efforts to develop the site as a water supply reservoir must be taken by September 2015 or the designation becomes null. Loss of this designation for Lake Columbia or Lake Fastrill could unnecessarily limit the ability of sponsors of these proposed reservoirs to develop these sites. The ETRWPG recommends that the designation of unique reservoir site for Lake Columbia and Lake Fastrill be retained beyond September 2015 and extended to the current planning horizon, 2070.

8.3.4 Water Reuse. The ETRWPG recommends that current regulations as they pertain to the reuse of treated wastewater (i.e., water reuse) should be reviewed and amended, as necessary, to encourage the development of these resources.

8.3.5 Funding. In order to take advantage of the variety of funding options available through the TWDB, increased flexibility by the agency is needed. For example, TWDB guidance currently excludes the replacement of aging infrastructure from eligibility for funding through the existing Water Infrastructure Fund (WIF) & SWIFT. The ETRWPG recommends that the TWDB expand existing programs to assist entities with funding replacement and repairs to aging infrastructure and/or allow replacement of water supply infrastructure to be funded through the WIF program. This would include existing well fields, transmission lines, and storage facilities.

In addition, the TWDB does not provide for sufficient flexibility in categorical exclusions for Environmental Information Documents that are required for funding of water projects. Increasing flexibility regarding these exclusions could ease the crisis in funding available for water projects.

The TWDB offers the Economically Distressed Areas Program (EDAP) to certain areas in need of water projects. The EDAP provides grants, loans, or combination grant/loans when requirements are met:

- for water and wastewater services;
- in economically distressed areas; and
- present facilities are inadequate to meet residents' minimal needs.

However, requirements to meet the EDAP are very difficult for local governments and areas to administer, causing otherwise eligible local governmental entities to elect to not pursue the EDAP funding. EDAP requirements should be revised to reduce unnecessary and difficult requirements for eligibility, including requirements for model subdivision planning.

8.3.6 Uncommitted Surface Water. The Texas Water Code currently allows the TCEQ to cancel any water right, in whole or in part, for ten consecutive years of non-use. This rule inhibits long-term water supply planning. Water supplies are often developed for ultimate capacity to meet needs far into the future. Some entities enter into contracts for supply that will be needed long after the first ten years. Many times, only part of the supply is used in the first ten years of operation.

The regional water plans identify water supply projects to meet water needs over a 50-year use period. In some cases, there are water supplies that are not currently fully utilized or new management strategies that are projected to be used beyond the 50-year planning period. To support adequate supply for future needs and encourage reliable water supply planning, the ETRWPG:

- Opposes unilateral cancellation of uncommitted water contracts/rights;
- Supports long term contracts that are required for future projects and drought periods; and

- Supports "interruptible" water supply contracts as a way to meet seasonal and short-term needs before long-term water rights are fully utilized.

8.3.7 Standardized Processes for Regional Water Plan Development. The process of permitting a federal water project, such as a reservoir, is a long, detailed, and resource intensive projects that must follow federal guidelines of the National Environmental Policy Act (NEPA) process. The ETRWPG recommends that the TWDB develop guidelines for regional water planning evaluations of federally permitted water projects that will produce documentation that can be integrated and used in the NEPA process. In addition, the TWDB is encouraged to continue to develop relationships with federal authorities to allow the use of the state and regional water planning population projections in the NEPA process.

8.3.8 Funding for Additional Groundwater Modeling. The ETRWPG recommends that funding for groundwater modeling for development of desired future conditions (DFCs) and modeled available groundwater (MAGs) be provided to the TWDB. This would improve the development of DFCs and MAGs by enabling a consistent, standardized approach across Groundwater Conservation District boundaries to groundwater modeling.

8.3.9 Clarification of Unique Stream Segment Criteria. Consideration of the designation of stream segments of unique ecological value (unique stream segments) is a component of regional water planning throughout the State. For some, however, there is a significant concern about the use of unique stream segments because of a lack of clarity about how the designation might be used in the future. In particular, there are concerns about the possibility of restriction of property rights for landowners adjacent to designated unique stream segments. House Bill 1016 of the 84th Texas Legislature proposes language specific to the Region L Water Planning Area, providing clarification by stating that the designation of a river or stream segment as being of unique ecological value:

1. means only that a state agency or political subdivision of the state may not finance the actual construction of a reservoir in the designated segment;

2. does not affect the ability of a state agency or political subdivision of the state to construct, operate, maintain, or replace a weir, a water diversion, flood control, drainage, or water supply system, a low water crossing, or a recreational facility in the designated segment;

3. does not prohibit the permitting, financing, construction, operation, maintenance, or replacement of any water management strategy to meet projected water supply needs recommended in, or designated as an alternative in, the 2011 or 2016 Regional Water Plan, and

4. does not alter any existing property right of an affected landowner.

The ETRWPA supports the proposed clarifications found in House Bill 1016 and recommends that these clarifications be incorporated into the regional water planning process on a statewide basis.

8.3.10 Recommendations Regarding Water Management Strategy Prioritization. The ETRWPG has previously commented on the prioritization process that was required in 2013 by the 83rd Texas Legislature through House Bill 4.[1] The Region's comments and concerns about the prioritization process are included as Appendix 8-B of the 2016 Plan. Specific recommendations of the ETRWPG associated with the referenced technical memorandum include the following:

- Project Description: Care should be taken in development of the DB17 to provide more clarity, resolve problems, and minimize risk of inappropriate scoring. In addition, a commentary section should be added to the scoring template to enable additional detail to be added by the RWPG as necessary.

[1] The ETRWPG provided the results of the prioritization of water management strategies identified in the 2011 Plan in a letter dated August 29, 2014, to the TWDB. The letter included a number of exhibits including a technical memorandum dated August 29, 2014, entitled Regional Water Planning Group Comments and Concerns.

- Scoring to Minimize Ties: Water planning regions should be allowed to add their own unique scoring criteria to be used specifically for the purpose of breaking scoring ties.

- Uniform Standard 2A: Uniform Standard 2A should be modified to provide for a maximum score for new surface water sources if modeling suggests a sufficient quantity of water would be available.

- Uniform Standard 3C: This standard should be modified to eliminate the advantage in scoring given to project sponsors with only one recommended WMS.

- Uniform Stand 3D: A more detailed scoring breakdown is needed to distinguish between two WUGs served and numbers of WUGs greater than two.

- Projects Shared across Regions: Clarification is needed on how projects serving more than one region will be integrated into one list.

- Evaluation across Water Type and Water Use Categories: The prioritization process should be modified to minimize the comparison of raw water and treated water strategies or water use categories.

- Rolled up Projects: The TWDB should clarify the definition of what constitutes a rolled-up project.

In addition, the ETRWPG recommends that, for purposes of prioritization of water management strategies identified in a regional water plan, the definition of a "project" be clarified to exclude strategies that do not have a capital cost associated with them. This will significantly reduce the effort required to prioritize identified projects by eliminating the requirement to prioritize strategies that will not need to seek funding anyway.

8.3.11 Allow Groundwater Supplies to Exceed the Modeled Available Groundwater. TWDB policy regarding the use of MAGs in regional water planning currently states that the MAG values are a cap for water supply and strategy development. However, the MAG is not necessarily considered a cap for permitting purposes by GCDs according to Chapter 36 of the Water Code. In addition, MAGs are unenforceable in areas with no groundwater regulation (i.e., with no GCDs). Chapter 36 describes the process of managing to DFCs. The MAG is an estimate of the groundwater availability based on the DFC but Chapter 36 provides flexibility for GCDs to permit above or below the MAG based on local knowledge, usage patterns, and other factors. The ETRWPG recommends that the TWDB allow groundwater supplies to exceed the MAG in the regional water plan if the RWPG obtains written agreement from the relevant GCD. This approach assumes that the strategy is consistent with the management plan of the GCD, but allows for minor shortages to be covered without excessive administrative actions, such as alternate strategies that would ultimately require a plan amendment. It also allows a GCD to apply local knowledge to account for variations in permitting approaches and usage patterns, while honoring the DFCs associated with the aquifer. This approach could also be used in areas with no GCDs if the RWPG demonstrates compliance with the DFCs.

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Chapter 9

Infrastructure Financing Report

The purpose of the Infrastructure Financing Report (IFR) is to identify funding needed to implement the WMSs recommended in the 2016 Plan. The primary objectives of the report are:

- To determine the number of political subdivisions with identified needs for additional water supplies that will be unable to pay for their water infrastructure needs without some form of outside financial assistance;
- To determine how much of the infrastructure costs in the regional water plans cannot be paid for solely using local utility revenue sources;
- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and,
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

A survey was designed and distributed to the WUGs with identified infrastructure needs by the TWDB and the consulting engineers. The survey was conducted in July of 2015, after the Initially Prepared Plan was approved by the ETRWPG. Results of the survey are contained in Appendix 9A and 9B.

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Chapter 10

Public Participation and Adoption of Plan

Regional water planning in Texas is a public process, requiring strategy for ensuring that the region's citizens are able to participate in the process. Rules in 31 TAC Chapter 357.21 define the notice and public participation requirements of the process. These rules include the following requirements:

- A public meeting prior to preparation of the next regional water plan or proposing major amendments to the previous regional water plan.
- Ongoing opportunities for public input during preparation of the plan.
- A public hearing following adoption of an initially prepared plan (IPP).

In addition, opportunities for public participation and input have specific requirements regarding public notice and open meetings in the State of Texas. The rules call for the following:

- Public meetings and hearings noticed and held in accordance with the Texas Open Meetings Act.
- Agendas, meeting notices, IPP, and final regional water plan published on the internet.
- Copies of the IPP made available for public viewing.

This chapter addresses the ETRWPG's strategy for public involvement and participation in the development and adoption of the 2016 Plan[1]. The strategy included regular meetings of the ETRWPG, consultation with representatives of the major water user groups, publication of a region newsletter, distribution of regular press releases, and

[1] Chapter 10 may be revised, as necessary, during and subsequent to the public comment period.

maintenance of a website for the ETRWPA. In addition, the regional planning process requires holding a public hearing to introduce the 2016 IPP and accept public comment. Copies of news releases and newspaper articles concerning water planning in the ETRWPA are included in Appendix 10-A. A description of the ETRWPG and the process follows.

10.1 East Texas Regional Water Planning Group Members

Original legislation for SB1 and the TWDB planning guidelines establish regional water planning groups to manage the planning process in their respective regions. The regional water planning groups include representatives of eleven specific community interests. Table 10.1 lists members of the ETRWPG and the interests they represent.

Table 10.1 Voting Members of the East Texas Regional Water Planning Group and Group Representation

Member	Interest
Leah Adams	Groundwater Management Areas
David Alders	Agricultural
Jeff Branick	Counties
David Brock	Municipalities
Josh David	Agricultural
Chris Davis	Counties
Mark Dunn	Small Business
Scott Hall	River Authorities
Michael Harbordt	Industries
William Heugel	Public
Kelley Holcomb	River Authorities
Dr. Joseph Holcomb	Small Business
Bill Kimbrough	Public
John Martin	Groundwater Management Areas
David Montagne	River Authorities
Gregory M. Morgan	Municipalities
Dale Peddy	Electric Power
Monty Shank	River Authorities
Darla Smith	Industries
Worth Whitehead	Water Districts
Dr. J Leon Young	Environmental

The ETRWPG appointed a Technical Committee comprised of individuals within the planning group. The charge to the Technical Committee was to work with the East Texas Region consulting team to develop recommended population and water demand projections, review work product of the consulting team, and provide technical advice to the planning group. Members of the Technical Committee include:

- Dr. Michael Harbordt
- Scott Hall
- Joseph Holcomb
- Monty Shank
- Dr. Leon Young

The ETRWPG also worked closely with water planning staff at the TWDB during the planning process. TWDB water planning staff provided valuable technical and regulatory guidance to the ETRWPG regarding the 2016 Plan.

10.2 Preplanning for the 2016 Plan

Rules in 31 TAC Chapter 357.12 define tasks that must be performed prior to development of the regional water plan. These rules include the following requirements:

- A public meeting to discuss recommendations and suggestions of issues that should be addressed in the regional or state water plan.
- Prepare a scope of work including a detailed description of tasks to be performed.
- Designate a political subdivision as a representative of the regional water planning group.
- Determine a process for identifying potentially feasible water management strategies.

The ETRWPG held a public meeting, in conjunction with the regular RWPG meeting, on June 22, 2011, to discuss issues and provisions important to the ETRWPA that should be included in the regional water plan. As a result of this public meeting, a scope of work was prepared by the consulting team. The scope detailed tasks and activities to be performed during the planning cycle, including expense budgets, schedule, and description of reports to be developed as part of the planning process. The City of Nacogdoches was designated as the political subdivision representative of the ETRWPG, responsible for applying for financial assistance for the scope of work and regional water plan development.

On February 1, 2012, the ETRWPG held a regular public meeting to determine a process for identifying potentially feasible WMSs. The consultant team presented a proposed methodology for identifying strategies. Recommendations from the ETRWPG were incorporated into the methodology; no public comments were received. The ETRWPG approved the draft process to identify and select WMSs at a subsequent public RWPG meeting on May 22, 2013.

10.3 Opportunities for Public Input

The ETRWPG utilized various types of media and outreach to keep the public informed and to receive input throughout the development of the 2016 Plan, including the following:

- Water user group involvement
- Press releases
- Newsletters
- ETRWPA website – www.etexwaterplan.org
- Public meetings
- Public hearings

These means of media and outreach are described below.

10.3.1 Contact with Water User Groups. The ETRWPG made special efforts to contact WUGs in the region and obtain their input in the planning process. Chapters 1 through 5 of the 2016 Plan cite specific instances of contact with WUGs.

10.3.2 East Texas Regional Water Planning Website. The ETRWPA website, www.etexwaterplan.org was regularly updated to inform the public of scheduled meetings and to provide minutes, agenda, press releases, newsletters, presentations, and memoranda.

10.3.3 Regular Meetings of the East Texas Regional Water Planning Group. In execution of its duties as the water planning organization for the region, the ETRWPG held regular meetings during the development of the 2011 Plan, received information from the region's consultants, accepted public comment on issues relevant to water planning, reviewed proposed planning elements, and made decisions on planning efforts. ETRWPG meetings were open to the public, with notice made in accordance with the ETRWPG By-Laws and the Texas Open Meetings Act. Regular meetings were held on the following dates:

- March 16, 2011
- June 22, 2011
- February 1, 2012
- July 26, 2012
- September 12, 2012
- February 13, 2013
- May 22, 2013
- August 8, 2013
- February 26, 2014
- May 21, 2014
- August 27, 2014
- November 19, 2014
- January 28, 2015

- March 11, 2015
- April 8, 2015

On September 12, 2012, the ETRWPG held a regular public meeting where they considered and approved Draft Non-Municipal Water Demand Projections. These projections are summarized in Appendix 2-C.

During the public regular RWPG meeting on November 19, 2014, the RWPG considered and approved the following planning group member changes: Letter of resignation due to retirement from Jerry Clark; Resolution from Sabine River Authority designating David Montagne. No public comments were received.

The IPP was adopted by the ETRWPG at its regularly scheduled meeting on April 8, 2015. The certification letter for this submittal is included in Appendix 10-D.

10.3.4 Public Hearings for the Initially Prepared Plan. The IPP was published for public review and a public hearing to receive comments was held on June 25, 2015 in Nacogdoches, Texas. Appropriate public notice was provided for the hearing (See Appendix 10-A). Transcripts, presentations, and minutes from the public hearings are included are Appendix 10-B.

10.4 Public Comment

As a public planning process, the ETRWPG must accept comments by the public and state agencies regarding the plan. The public are invited to provide comments at each regularly scheduled meeting of the ETRWPG. Likewise, comment in the form of letters, emails, or by telephone may be received.

Comments received through the end of the public comment period will be reviewed and evaluated by the ETRWPG and consulting team. The ETRWPG will modify the IPP as necessary, in response to comments. Copies of written comments are provided in Appendix 10-C. Table 10.2 summarizes the official IPP comments received by the ETRWPG and describes the action taken to address the comments.

Table 10.2 2016 Initially Prepared Plan Comments and ETRWPG Responses

Comment	ETRWPG Response	Changes Made (if applicable)
Comment Received: 6/25/2015 **John W. Stine and Alvin V. Newton (Public, San Augustine County)** **2016 IPP Public Hearing, Public Comment, Appendix 10-C**		
Do not support any future water impoundment projects for Groundwater Managmenet Area 11 as proposed in The East Texas Regional Water Planning Group 2016 Initially Prepared Regional Water Plan. Surface water from Toledo Bend Reservoir is just one of many existing water impoundments in East Texas that precludes future water impoundment projects in East Texas and specifically in Groundwater Management Area 11.	No Action Taken by RWPG	No Change
Comment Received: 8/10/2015 **Jeff Walker (Texas Water Development Board)** **Level 1: Comments and Questions, Appendix 10-C**		
1. Please describe how publicly available plans of major agricultural, municipal, manufacturing and commercial water users were considered in the final, adopted regional water plan. [31 Texas Administrative Code (TAC) §357.22(a)(4)]	RWPG Accepted Recommended Change	Chapter 1 Added Section 1.13.4
2. The plan does not appear to include a listing of the water rights that are the basis for the surface water availability in the plan. Please include such a listing in the final, adopted regional water plan. [Contract Exhibit 'C', Section 3.1]	RWPG Accepted Recommended Change	Chapter 3 Updated Table 3.2
3. Please clarify how the run-of-river availabilities were calculated for municipal water users to ensure that all monthly demands are fully met for the entire simulation of the unmodified Texas Commission on Environmental Quality WAM Run 3 in the final, adopted regional water plan. [Contract Exhibit 'C', Section 3.4]	RWPG Accepted Recommended Change	Chapter 3 Updated Section 3.1.1
4. Pages 3-23 and 3-24, Tables 3.5 and 3.6; Vol. II, Appendix 3A: The availability volumes shown in Table 3.5 for the Carrizo-Wicox in Smith County, Neches Basin do not match the availability from DB17 in all decades. For example, 2020 availability is 12,245 AFY, compared to the 2020 value in the source availability report of 21,004 AFY. Additionally, the aquifer totals presented in Table 3.6 should reflect this correction. Please revise in the final, adopted regional water plan.	RWPG Accepted Recommended Change	Chapter 3 Updated Table 3.5
5. The plan does not appear to consider conservation or drought management as a potentially feasible strategy for all identified water supply needs. Please include documentation whether conservation and drought management were considered to meet identified needs and, if not recommended, please document the reason in the final, adopted regional water plan. [Texas Water Code (TWC) §16.053(e)(5), 31 TAC §357.34(c)(3), §357.34(f)(2)]	RWPG Accepted Recommended Change	Chapters 5A and 5C Updated 5A Introduction and Section 5C.3

Table 10.2 2016 Initially Prepared Plan Comments and ETRWPG Responses (Cont.)

Comment	ETRWPG Response	Changes Made (if applicable)
6. Page 5B-121: The plan does not appear to include a recommended water management strategy summary table including strategy names, total yield for all decades, total capital costs, and estimated unit costs. The table starting on page 5B-121 appears to present strategies but the header of the table is unclear as to exactly what information is being presented (e.g., recommended or alternative strategies) and costs are not included. Please include recommended and alternative strategy summary tables in the final, adopted regional water plan. [Contract Exhibit 'C', Section 12.1.2]	RWPG Accepted Recommended Change	Chapter 5B Updated Table 5B-1
7. Page 6-2: The description of protection of water resources does not appear to include information on potential impacts to groundwater and surface water interrelationships. Please include this information in the final, adopted regional water plan. [31 TAC §357.40(b)(2)]	RWPG Accepted Recommended Change	Chapter 6 Updated Section 6.1
8. Chapter 7: The plan does not appear to include recommended drought triggers and actions for each water source. Please include this information in the final, adopted regional water plan. [TWC §16.053(e)(3)(A-C); 31 TAC §357.42(c)(1-3)]	RWPG Accepted Recommended Change	Chapter 7 Updated Section 7.2
9. Please indicate how the planning group considered relevant recommendations from the Drought Preparedness Council (a letter was provided to planning groups with relevant recommendations in November 2014) in the final, adopted regional water plan. [31 TAC §357.42(h)]	RWPG Accepted Recommended Change	Chapter 7 Added Section 7.2.4
10. The technical evaluations of the water management strategies do not appear to estimate water losses from the associated strategies. Please include an estimate of water losses in the final, adopted regional water plan, for example in a format of an estimated percent loss. [31 TAC §357.34(d)(3)(A); Contract Exhibit 'C', Section 5.1.1]	RWPG Accepted Recommended Change	Chapter 5B Updated Appendix 5B-A Introduction
11. Vol. II, Pages Appendix 5B-129, 5B-132, 5B-136, 5B-146, 5B-156, 5B-181: The plan appears to include water management strategies, including retail distribution system infrastructure, that appear to not increase the volume of supply to water user groups. For example, the Athens MWA Water Treatment Plant Improvements, the Volumetric Surveys of Lake Striker, Lake Center, and Lake Pinkston, the Normal Pool Elevation Adjustment of Lake Striker, Sabine River Authority Infrastructure Improvements, and the City of Jacksonville Distribution System Improvements. Regional water plans must not include any strategies or costs that are associated with simply maintaining existing supplies, improving retail distribution systems, improving water treatment processes, or replacing infrastructure. Plans may include only infrastructure costs that are associated with volumetric increases of treated water supplies delivered to water user groups or that result in more efficient use of existing supplies (e.g., conservation). Please revise as appropriate throughout the final, adopted regional water plan. [31 TAC §357.34(d)(3)(A); Contract Exhibit 'C', Sections 5.1.2.2 and 5.1.2.3]	RWPG Accepted Recommended Change	Chapter 5B Updated Water Management Strategies to Include Increase in Volume of Supply or the Strategy was Removed

Table 10.2 2016 Initially Prepared Plan Comments and ETRWPG Responses (Cont.)

Comment	ETRWPG Response	Changes Made (if applicable)
12. Vol. II, Appendix 5A-B: The plan does not appear to identify potentially feasible water management strategies for all wholesale water provider (WWPs) with identified needs. Please include documentation that potentially feasible water management strategy types, as required by statute and rule, were considered for identified needs in the final, adopted regional water plan. [TWC §16.053(e)(5), 31 TAC §357.34(a)]	RWPG Accepted Recommended Change	Chapter 5A Updated Appendix 5A-B
13. Vol. II, Pages Appendix 5B-15, 5B-24, 5B-42, 5B-45, 5B-150, and 5B-158: The plan in some instances, does not appear to include a quantitative reporting of environmental factors. For example, strategy evaluations for Alto Rural WSC New Wells, Houston Irrigation New Wells, D&M WSC New Wells, Nacogdoches Livestock New Wells, Houston County WCID #1 New Wells, and LNVA Purchase from Sabine River Authority provide qualitative descriptions such as "low" or "moderate" impacts, but the plan does not appear to include quantification of the impacts. Please include quantitative reporting in the final, adopted regional water plan. [31 TAC §357.34 (d)(3)(B)]	RWPG Accepted Recommended Change	Chapter 5B Updated Appendix 5B-A Introduction
14. Vol. II, Pages Appendix 5B-108, 5B-114, and 5B-124: The plan in some instances, does not appear to include a quantitative reporting of impacts to agricultural resources. For example, strategy evaluations for Lake Columbia, ANRA Treatment Plant and Distribution System, and Athens MWA Indirect Reuse do not appear to include quantified impacts to agricultural resources, even in instances where there may be no impact. Please include quantitative reporting of impacts to agricultural resources in the final, adopted regional water plan. [31 TAC §357.34 (d)(3)(C)]	RWPG Accepted Recommended Change	Chapter 5B Updated Appendix 5B-A Introduction
8/10/2015 **Jeff Walker (Texas Water Development Board)** **Level 2: Comments and Suggestions, Appendix 10-C**		
1. Please consider numbering, titling, and referencing all tables in the final, adopted regional water plan. For example, all tables in Section 5B of Volume I.	RWPG Partially Accepted Recommended Change	Chapter 5B Numbered summary tables beginning in Section 5B.4
2. Page 3-13, Table 3.3: Please consider specifying the stream or river source names for the run-of-river supplies listed in this table in the final, adopted regional water plan.	RWPG Accepted Recommended Change	Chapter 3 Updated Table 3.3
3. Page 3-24, Table 3.6: Please consider revising the citation for the source information to "GAM Run 10-038 MAG" and "GAM Run 10-016 MAG (ver. 2)" in the final, adopted regional water plan.	RWPG Accepted Recommended Change	Chapter 3 Updated Table 3.6
4. Page 5B-2: Reference is made to Appendix 5B-B, but there appears to be no associated Appendix or a listing for the appendix in the plan. Please reconcile in the final, adopted regional water plan.	RWPG Accepted Recommended Change	Chapter 5B Added Appendix 5B-B

Table 10.2 2016 Initially Prepared Plan Comments and ETRWPG Responses (Cont.)

Comment	ETRWPG Response	Changes Made (if applicable)
5. Page 5C-12: The plan lists "appropriate conservation activities" for Irrigation, but does not appear to evaluate the BMPs for recommended strategies in chapter 5B. Please consider including additional documentation of potentially feasible irrigation conservation strategies in the final, adopted regional water plan.	RWPG Accepted Recommended Change	Chapter 5C Updated Section 5C.2
6. Page 11-12: Although the plan contains a volumetric summary of the differences in recommended and alternative strategies between the 2011 and 2016 plans, please consider specifically identifying the individual recommended and alternative strategies in the plan.	RWPG Will Not Make Recommended Change	No Change
Comment Received: 8/14/2015 **Ross Melinchuk (Texas Parks and Wildlife Department)** **Re: 2016 Region I Initially Prepared Regional Water Plan, Appendix 10-C**		
The ETRWPA IPP adequately describes the natural resources of the region.	No Action Taken by RWPG	No Change
TPWD would like to see DFCs adopted in the ETRWPA to protect springs or groundwaterr surface water interaction since the TWDB planning rules require that groundwater supplies not exceed the Modeled Available Groundwater values determined to meet DFCs, if applicable.	No Action Taken by RWPG	No Change
TPWD agrees that environmental impacts associated with the development of a new reservoir can be significant. Consruction of off-channel reservoirs can also help to minimze wildlife impacts if reservoirs are located to mimnimize inundation of habitats and diversions are modified to avoid impacts to environmental flows.	No Action Taken by RWPG	No Change
TPWD aggres that the implementation of environmental flow recommendations will result in a need to more carefully consider environmental flow needs during the development of surface water management strategies.	No Action Taken by RWPG	No Change

Table 10.2 2016 Initially Prepared Plan Comments and ETRWPG Responses (Cont.)

Comment	ETRWPG Response	Changes Made (if applicable)
Comment Received: 8/18/2015 **Monty D. Shank (Upper Neches River Municipal Water Authority)** **Re: Comments on the 2016 Initially Prepared Region I Water Plan, Appendix 10-C**		
The UNRMWA does not presently intend to meet future steam-electric water needs in Anderson County.	RWPG Accepted Recommended Change	Updated Chapter 5B and Appendix 5B-A
The UNRMWA does not presently intend to meet the future municipal water needs of the City of Chandler in Henderson County.	RWPG Accepted Recommended Change	Updated Chapter 5B and Appendix 5B-A
Revise text to ensure the Region I 2016 Plan is consistent with both the Region C 2016 Plan and the 2014 Draft Dallas Long Range Water Supply Plan to 2070 and Beyond.*	RWPG Accepted Recommended Change	2016 Plan will be updated as appropriate

* Comment No. 28 is a summary of a series of individual comments which all referred to clarifications designed to ensure that the Neches run of river water management strategy and the 2016 ETRWP were consistent with the 2016 Regional Water Plan for Region C.

10.5 Final Adoption of the 2016 Plan

The ETRWPG reconvened following the public comment period to review comments and proposed modifications to the IPP. The final 2016 Plan was adopted by the ETRWPG on November 5, 2015 and published on the internet for public viewing. The final 2016 Plan will be submitted to the TWDB by December 1, 2015.

Chapter 11

Implementation and Comparison to the Previous Regional Water Plan

Chapter 11 is a new requirement for the 4th round of regional water planning. It includes a summary of the level of implementation of Recommended Water Management Strategies from the 2011 Plan that were created to meet needs, as well as a brief comparison of the 2011 Plan Compared to the 2016 Plan in the following categories:

- Water Demand Projections
- Drought of Record
- Water Availability
- Existing Water Supplies of Water User Groups
- Identified Needs
    - Water User Group Needs
    - Wholesale Water Provider Needs
- Water Management Strategies
    - Recommended Water Management Strategies
    - Alternative Water Management Strategies

11.1 Water Demand Projections

The total demand projections for the ETRWPA increased for every decade from the 2011 Plan to the 2016 Plan, as shown in Figure 11.1 and Table 11.1 below. This increase in demand is largely due to the increase in projected demands for the Water User Groups Jasper Manufacturing and Jefferson Irrigation.

Figure 11.1 Total Projected Demand for the ETRWPA from the 2011 and 2016 Plans

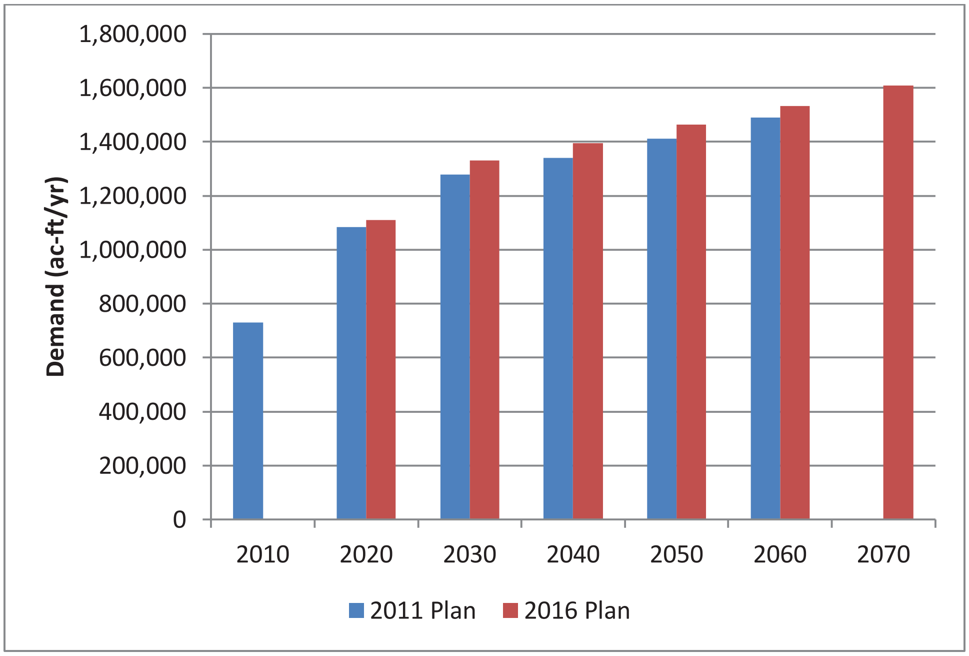


Table 11.1 Summary of Projected Water Demands from the ETRWPA by Use Category and Decade

2011 Plan Projected Demands (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Municipal	189,559	196,828	202,761	208,193	218,705	233,622	NA
Manufacturing	299,992	591,904	784,140	821,841	857,902	893,476	NA
Mining	21,662	37,297	17,331	18,385	19,432	20,314	NA
Steam Electric Power	44,985	80,989	94,515	111,006	131,108	155,611	NA
Livestock	23,613	25,114	26,899	29,020	31,546	34,533	NA
Irrigation	151,100	151,417	151,771	152,153	152,575	153,040	NA
2011 Total for ETRWPA	730,911	1,083,549	1,277,417	1,340,598	1,411,268	1,490,596	NA
2016 Plan Projected Demands (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Municipal	NA	188,646	196,302	204,157	214,540	226,622	239,607
Manufacturing	NA	608,667	800,989	838,639	874,546	909,373	945,886
Mining	NA	27,523	24,547	18,169	15,488	12,986	12,093
Steam Electric Power	NA	82,018	95,544	112,035	132,137	156,640	184,714
Livestock	NA	24,027	25,549	27,361	29,521	32,081	32,764
Irrigation	NA	177,919	187,894	194,851	197,546	195,445	192,186
2016 Total for ETRWPA	NA	1,108,800	1,330,825	1,395,212	1,463,778	1,533,147	1,607,250
Percent Change in Texas Water Development Board Demand Projections from 2011 to 2016							
	2010	2020	2030	2040	2050	2060	2070
Municipal	NA	-4	-3	-2	-2	-3	NA
Manufacturing	NA	3	2	2	2	2	NA
Mining	NA	-26	42	-1	-20	-36	NA
Steam Electric Power	NA	1	1	1	1	1	NA
Livestock	NA	-4	-5	-6	-6	-7	NA
Irrigation	NA	18	24	28	29	28	NA
Total for ETRWPA	NA	2	4	4	4	3	NA

Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.

11.2 Drought of Record

The drought of the 1950's was the drought of record used for regional water planning in the 2011 Plan; this is the same drought of record used in the 2016 Plan. In both plans, surface water supplies were determined using the TCEQ approved Water Availability Models (WAM) that only incorporate historical hydrologic conditions that occurred between 1940 and 1996. Chapter 7 of the 2016 Plan includes a detailed examination of more recent droughts within the region and suggests that the 2010-2012 period was one of significant drought for the ETRWPA. For a full evaluation of the impact of a potential new drought of record on surface water supply availability, the

WAMs should be updated to incorporate the hydrologic conditions that have occurred since 1996

11.3 Water Availability

The total water availability increased in every decade by less than 1% from the 2011 Plan to the 2016 Plan, as shown in Figure 11.2 and Table 11.2 below. This increase in availability is largely due to increased groundwater infrastructure, utilization of other undifferentiated aquifers, and an increased use of local supplies.

Figure 11.2 Total Available Supply for the ETRWPA from the 2011 and 2016 Plans

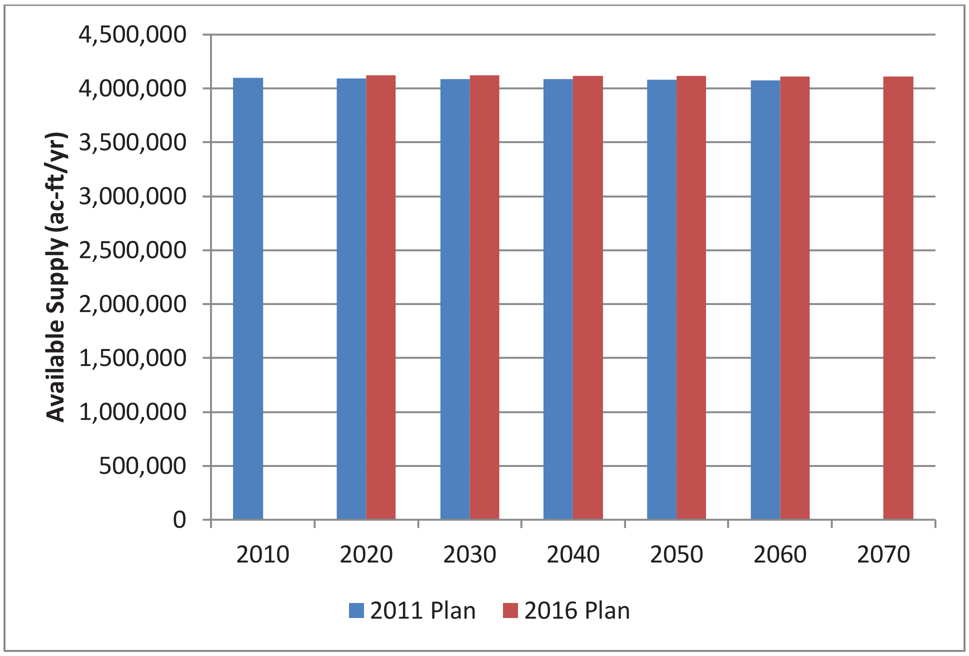


Table 11.2 Summary of Available Supply in the ETRWPA by Decade

2011 Plan Available Supply (ac-ft/yr)							
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Reservoirs (permitted)	1,962,698	1,958,512	1,954,328	1,950,141	1,945,955	1,941,769	NA
Run-of-the-River (freshwater)	623,004	623,004	623,004	623,004	623,004	623,004	NA
Run-of-the-River (brackish)	1,035,982	1,035,982	1,035,982	1,035,982	1,035,982	1,035,982	NA
Groundwater	446,043	446,043	446,043	446,043	446,043	446,043	NA
Local Supplies	13,094	13,094	13,094	13,094	13,094	13,094	NA
Reuse	18,077	15,205	15,205	15,205	15,205	15,205	NA
2011 Total for ETRWPA	4,098,898	4,091,840	4,087,656	4,083,469	4,079,283	4,075,097	NA
2016 Plan Available Supply (ac-ft/yr)							
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Reservoirs (permitted)	NA	1,958,512	1,954,328	1,950,141	1,945,955	1,941,769	1,937,675
Run-of-the-River (freshwater)	NA	606,346	607,145	608,083	609,290	610,720	612,001
Run-of-the-River (brackish)	NA	1,036,462	1,036,462	1,036,462	1,036,462	1,036,462	1,036,462
Groundwater	NA	489,876	490,090	489,478	488,732	487,696	487,696
Local Supplies	NA	19,367	19,367	19,367	19,367	19,367	19,367
Reuse	NA	13,955	13,955	13,955	13,955	13,955	13,955
2016 Total for ETRWPA	NA	4,124,518	4,121,347	4,117,486	4,113,761	4,109,969	4,107,156
Percent Change in Available Supply from 2011 to 2016							
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Reservoirs (permitted)	NA	0	0	0	0	0	NA
Run-of-the-River (freshwater)	NA	-3	-3	-2	-2	-2	NA
Run-of-the-River (brackish)	NA	0	0	0	0	0	NA
Groundwater	NA	10	10	10	10	9	NA
Local Supplies	NA	48	48	48	48	48	NA
Reuse	NA	-8	-8	-8	-8	-8	NA
Total for ETRWPA	NA	0.8	0.8	0.8	0.8	0.9	NA

Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.

11.4 Existing Water Supplies of Water User Groups

The existing water supplies of water user groups decreased between 13% and 18% in every decade from the 2011 Plan to the 2016 Plan. This is largely due to infrastructure limitations and lack of contracts with wholesale water providers. The largest decrease in supplies occurred in water user groups from Jefferson County who collectively had an average decrease in existing supplies of 250,000 acre-feet per year in every decade of the planning period.

Figure 11.3 Total Existing Supplies of Water User Groups in the ETRWPA from the 2011 and 2016 Plans

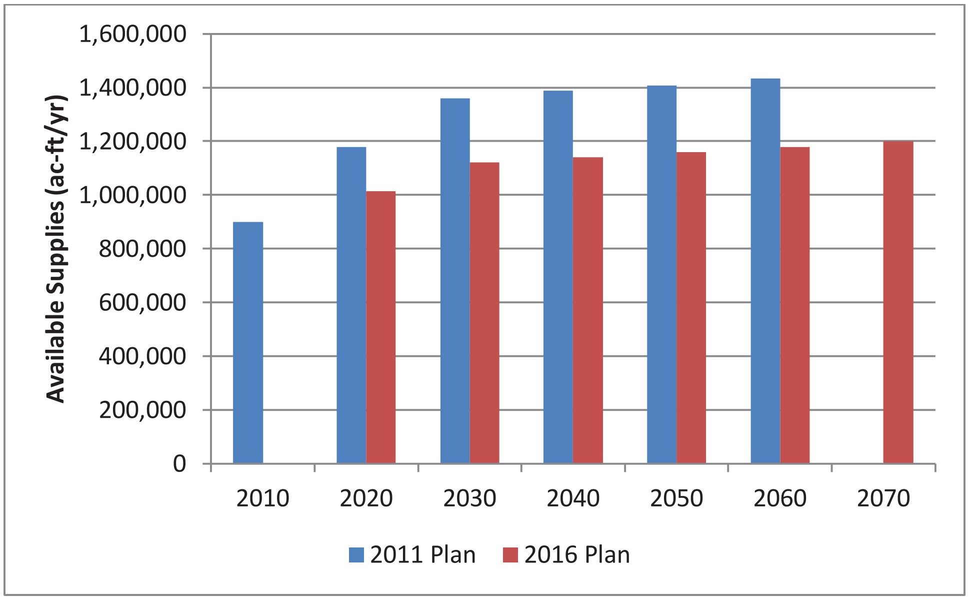


Table 11.3 Summary of Existing Supplies of Water User Groups in the ETRWPA by Decade

2011 WUG Existing Supplies (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Anderson	17,649	17,649	17,649	17,649	17,649	17,649	NA
Angelina	25,957	26,321	26,392	26,458	26,521	26,579	NA
Cherokee	18,684	18,273	18,625	19,046	19,539	20,126	NA
Hardin	14,296	14,296	14,296	14,296	14,296	14,271	NA
Henderson*	9,509	7,890	7,705	7,538	7,365	7,205	NA
Houston	10,248	10,246	10,246	10,247	10,246	10,246	NA
Jasper	72,835	76,218	78,731	80,928	82,575	82,638	NA
Jefferson	414,903	686,525	866,571	892,088	918,150	944,597	NA
Nacogdoches	33,596	37,693	37,289	36,856	29,640	29,129	NA
Newton	19,908	19,908	19,908	19,908	19,908	19,908	NA
Orange	98,484	98,484	98,484	98,484	98,484	98,484	NA
Panola	16,758	17,067	17,256	17,448	17,641	17,826	NA
Polk*	2,626	2,626	2,626	2,626	2,626	2,626	NA
Rusk	60,725	60,732	60,732	60,722	60,719	60,729	NA
Sabine	4,101	4,101	4,101	4,101	4,101	4,101	NA
San Augustine	2,933	2,933	2,933	2,933	2,933	2,933	NA
Shelby	11,430	11,445	11,458	11,471	11,482	11,496	NA
Smith*	59,273	58,953	58,711	58,484	58,186	57,842	NA
Trinity*	1,021	1,028	1,029	1,025	1,020	1,016	NA
Tyler	5,328	5,328	5,328	5,328	5,328	5,328	NA
2011 Total for ETRWPA	900,264	1,177,716	1,360,070	1,387,636	1,408,409	1,434,729	NA

Table 11.3 Summary of Existing Supplies of Water User Groups in the ETRWPA by Decade (Cont.)

2016 WUG Existing Supplies (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Anderson	NA	15,372	15,473	15,411	15,299	15,257	15,239
Angelina	NA	40,719	41,304	41,850	42,393	42,978	43,590
Cherokee	NA	17,454	17,563	17,683	17,922	18,243	18,852
Hardin	NA	17,934	18,232	18,441	18,573	18,581	18,552
Henderson*	NA	7,842	7,705	7,603	7,561	7,154	6,891
Houston	NA	11,448	11,488	11,540	11,604	11,680	11,830
Jasper	NA	102,073	102,015	101,942	101,884	101,847	101,833
Jefferson	NA	512,147	613,229	629,139	643,731	658,509	673,965
Nacogdoches	NA	28,089	28,713	29,436	30,239	31,210	32,363
Newton	NA	17,260	17,333	17,409	17,477	17,544	17,616
Orange	NA	80,249	80,307	80,430	80,557	80,675	80,776
Panola	NA	16,993	17,308	17,160	16,735	17,429	17,666
Polk*	NA	3,217	3,354	3,484	3,606	3,717	3,838
Rusk	NA	64,294	64,652	64,668	64,677	64,693	64,738
Sabine	NA	5,850	5,850	5,850	5,850	5,850	5,850
San Augustine	NA	4,573	4,670	4,781	4,910	5,052	5,052
Shelby	NA	14,667	14,677	14,670	14,972	14,317	14,663
Smith*	NA	40,131	42,343	44,662	47,352	50,396	53,634
Trinity*	NA	1,960	1,960	1,961	1,962	1,960	1,965
Tyler	NA	11,998	11,959	11,922	11,904	11,905	11,910
2016 Total for ETRWPA	NA	1,014,270	1,120,135	1,140,042	1,159,208	1,178,997	1,200,823

Percent Change in WUG Existing Supplies from 2011 to 2016							
	2010	2020	2030	2040	2050	2060	2070
Anderson	NA	-13	-12	-13	-13	-14	NA
Angelina	NA	55	57	58	60	62	NA
Cherokee	NA	-4	-6	-7	-8	-9	NA
Hardin	NA	25	28	29	30	30	NA
Henderson*	NA	-1	0	1	3	-1	NA
Houston	NA	12	12	13	13	14	NA
Jasper	NA	34	30	26	23	23	NA
Jefferson	NA	-25	-29	-29	-30	-30	NA
Nacogdoches	NA	-25	-23	-20	2	7	NA
Newton	NA	-13	-13	-13	-12	-12	NA
Orange	NA	-19	-18	-18	-18	-18	NA
Panola	NA	0	0	-2	-5	-2	NA
Polk*	NA	23	28	33	37	42	NA
Rusk	NA	6	6	6	7	7	NA
Sabine	NA	43	43	43	43	43	NA
San Augustine	NA	56	59	63	67	72	NA
Shelby	NA	28	28	28	30	25	NA
Smith*	NA	-32	-28	-24	-19	-13	NA
Trinity*	NA	91	90	91	92	93	NA
Tyler	NA	125	124	124	123	123	NA
Total for ETRWPA	NA	-13	-17	-17	-17	-17	NA

Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.
* The counties marked with an asterisk are split between two water planning regions. The available supply presented in this table represents only the portion of those counties that are within the boundaries of Region I.

11.5 Water User Group and Wholesale Water Provider Needs

A comparison of WUG and WWP identified needs between the 2011 Plan and the 2016 Plan follows.

11.5.1 Water User Group Needs. In the last round of planning, there were 67 WUGs with identified needs; approximately 70% of these needs were from Municipal WUGs and Steam Electric Power. In the 2016 Plan, there are 40 WUGs with identified needs; approximately 80% of these needs are from Manufacturing. Even though there are fewer WUGs with an identified need in this round of planning compared to the previous round of planning, the total volume of needs for the region has increased by over 150% in every decade of the planning period. In both rounds of planning, the identified needs are largely due to infrastructure limitations and lack of contracts with wholesale water providers.

Figure 11.4 Total Identified WUG Needs for the ETRWPA in the 2011 and 2016 Plans

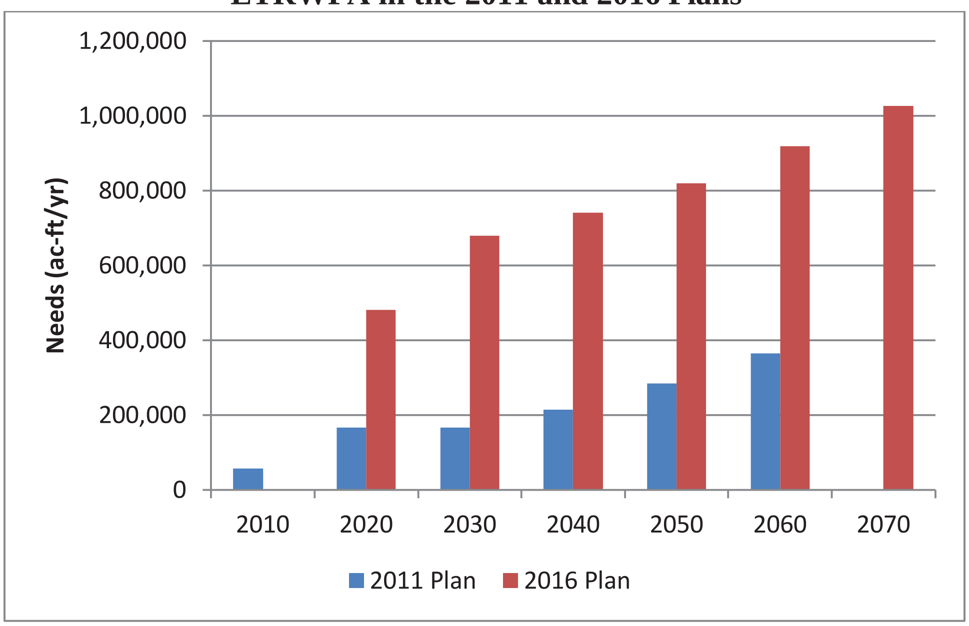


Table 11.4 Summary of Identified Water User Group Needs from the ETRWPA by Use Category and Decade

2011 Plan Identified WUG Needs (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Municipal	20,899	38,900	20,865	24,244	29,072	45,201	NA
Manufacturing	3,392	16,014	24,580	33,256	40,999	49,588	NA
Mining	0	0	0	0	0	0	NA
Steam Electric Power	3,588	25,922	33,615	43,053	62,775	75,212	NA
Livestock	977	2,196	4,093	6,347	9,020	12,144	NA
Irrigation	28,856	83,032	83,153	106,900	141,866	182,145	NA
2011 Total for ETRWPA	57,712	166,064	166,306	213,800	283,732	364,290	NA

2016 Plan Identified WUG Needs (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Municipal	NA	3,945	4,852	6,236	9,821	14,373	19,485
Manufacturing	NA	197,877	289,385	311,457	331,980	351,182	371,436
Mining	NA	10,264	7,678	2,969	2,338	2,048	1,916
Steam Electric Power	NA	25,422	33,529	44,283	57,789	82,036	110,014
Livestock	NA	3,157	4,366	5,826	7,593	9,725	10,167
Irrigation	NA	240,665	339,810	370,771	409,521	459,364	513,018
2016 Total for ETRWPA	NA	481,330	679,620	741,542	819,042	918,728	1,026,036

Percent Change in Identified WUG Needs from 2011 to 2016							
	2010	2020	2030	2040	2050	2060	2070
Municipal	NA	-90	-77	-74	-66	-68	NA
Manufacturing	NA	1,136	1,077	837	710	608	NA
Mining	NA	NA	NA	NA	NA	NA	NA
Steam Electric Power	NA	-2	0	3	-8	9	NA
Livestock	NA	44	7	-8	-16	-20	NA
Irrigation	NA	190	309	247	189	152	NA
Total for ETRWPA	NA	190	309	247	189	152	NA

Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.

11.5.2 Wholesale Water Provider Needs. In the last round of planning, there were five WWPs out of 16 total with identified needs; over 60% of this need is from the Angelina Neches River Authority. In the 2016 Plan, there are seven WWPs with identified needs; approximately 70% of these needs are again, from the Angelina Neches River Authority. Even though there are more WWPs with an identified need in this round of planning compared to the previous round of planning, the total needs for the region has decreased by approximately 30% in every decade of the planning period. In both rounds of planning, the WWPs have identified multiple water management strategies to obtain available water in the region to meet their identified needs.

Figure 11.5 Total Identified WWP Needs for the ETRWPA in the 2011 and 2016 Plans

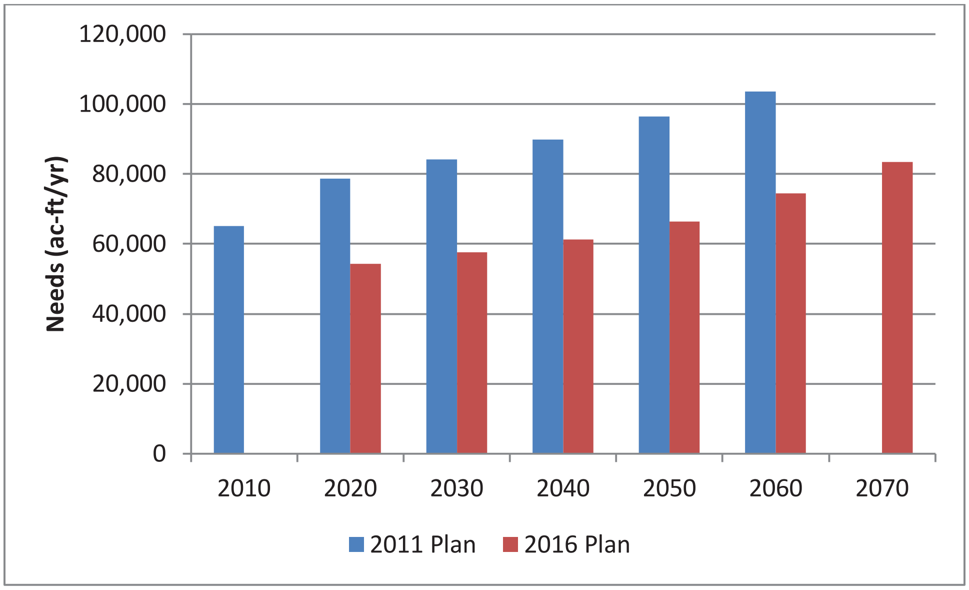


Table 11.5 Summary of Identified Wholesale Water Provider Needs from the ETRWPA by Use Category and Decade

2011 Plan Identified WWP Needs (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
AN WCID #1	0	0	0	0	0	0	NA
ANRA	53,870	53,870	53,870	53,870	53,870	53,870	NA
Athens MWA	0	2,984	3,602	4,303	5,219	6,351	NA
Beaumont	0	0	0	0	0	0	NA
Center	0	0	0	0	0	0	NA
HC WCID #1	194	218	238	257	277	301	NA
Lufkin	8,294	16,918	19,664	22,694	26,189	30,162	NA
UNRMWA	2,677	4,708	6,740	8,773	10,808	12,843	NA
2011 Total for ETRWPA	65,035	78,698	84,114	89,897	96,363	103,527	NA
2016 Plan Identified WWP Needs (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
AN WCID #1	NA	1,212	2,039	2,866	3,692	4,519	5,305
ANRA	NA	45,319	45,319	45,319	45,319	45,319	45,319
Athens MWA	NA	2,766	3,048	3,289	3,637	6,323	9,633
Beaumont	NA	0	0	578	2,570	4,994	7,754
Center	NA	0	0	0	0	0	171
HC WCID #1	NA	244	268	296	321	352	386
Lufkin	NA	0	0	0	0	0	0
UNRMWA	NA	4,831	6,849	8,869	10,892	12,919	14,940
2016 Total for ETRWPA	NA	54,372	57,523	61,217	66,431	74,426	83,508
Percent Change in Identified WWP Needs from 2011 to 2016							
	2010	2020	2030	2040	2050	2060	2070
AN WCID #1	NA	NA	NA	NA	NA	NA	NA
ANRA	NA	-16	-16	-16	-16	-16	NA
Athens MWA	NA	-7	-15	-24	-30	0	NA
Beaumont	NA	NA	NA	NA	NA	NA	NA
Center	NA	NA	NA	NA	NA	NA	NA
HC WCID #1	NA	12	13	15	16	17	NA
Lufkin	NA	-100	-100	-100	-100	-100	NA
UNRMWA	NA	3	2	1	1	1	NA
Total for ETRWPA	NA	-31	-32	-32	-31	-28	NA

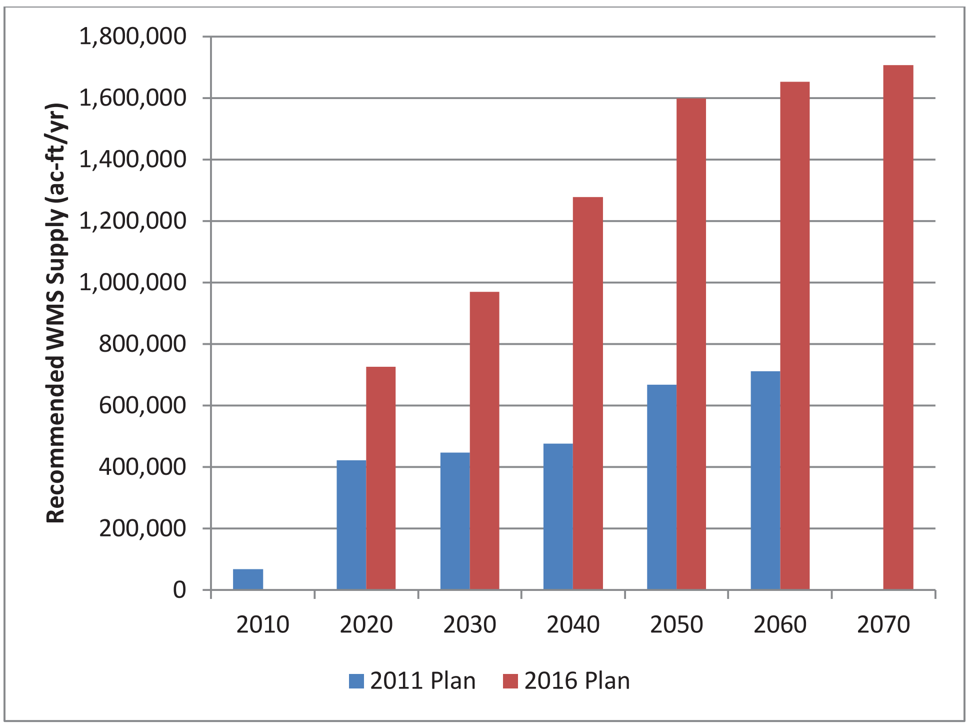
Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.

11.6 Recommended and Alternative Water Management Strategies

The following is a summary of both recommended and alternative water management strategies (WMS) included in the 2011 and 2016 Plans.

11.6.1 Recommended Water Management Strategies. The 2011 Plan included 130 Recommended WMSs with a total supply of 67,848 acre-feet per year beginning in 2010 and increasing to over 700,000 acre-feet per year beginning in 2060. In the 2016 Plan, there are 70 Recommended WMSs with a total supply of over 725,000 acre-feet beginning in 2020 and increasing to over 1,700,000 acre-feet per year beginning in 2070. These shifts in the number and total supply of recommended strategies are due to changes in WUG and WWP long term water planning.

Figure 11.6 Total Supply of Recommended Water Management Strategies for the ETRWPA in the 2011 and 2016 Plans



11.6.2 Alternative Water Management Strategies. The 2011 Plan included five Alternative WMSs with a total supply of 4,500 acre-feet per year beginning in 2010 and increased to over 22,000 acre-feet per year beginning in 2060. The 2016 Plan includes four Alternative WMSs with a total of 33,574 acre-feet per year for every decade in the planning period (2020-2070). This increase in supply from alternative strategies is due to more WUGs and WWPs being proactive about having backup projects ready in the event their recommended WMS cannot be implemented.

Table 11.6 Summary of Water Management Strategies in the ETRWPA by Decade

2011 Plan Water Management Strategies Supply (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Recommended WMSs	67,848	422,443	447,041	476,493	668,575	712,724	NA
Alternative WMSs	4,500	33,541	22,541	22,753	22,753	22,753	NA
2016 Plan Water Management Strategies Supply (ac-ft/yr)							
	2010	2020	2030	2040	2050	2060	2070
Recommended WMSs	NA	726,190	970,814	1,278,989	1,598,554	1,652,293	1,707,025
Alternative WMSs	NA	33,574	33,574	33,574	33,574	33,574	33,574
Percent Change in Water Management Strategy Supply from 2011 to 2016							
	2010	2020	2030	2040	2050	2060	2070
Recommended WMSs	NA	72	117	168	139	132	NA
Alternative WMSs	NA	0	49	48	48	48	NA

Green cells indicate values that are greater in the 2016 Plan compared to the 2011 Plan.

11.6.3 Texas Water Development Board Implementation Survey. Title 31 of the Texas Administrative Code (31 TAC) §357.45(a) requires the 2016 Plan to report the level of implementation of previously recommended Water Management Strategies meeting needs. The status of each of these projects was not directly available to the consulting team and the surveys were completed to the best of the consultants' knowledge using other available information.

The ETRWPG and consultants were responsible for gathering information and completing the surveys. Methods used to gather information will include:

- Contact Recommended Water Management Strategy Project Sponsors.
- Track changes in supplies since completion of the 2011 Plan.
- Evaluate TWDB funding records to identify projects.
- Analyze conservation implementation reports submitted to the TWDB.

The results of this survey are presented in Appendix 11-A of the Final 2016 Plan submitted to the TWDB December 1, 2015.

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