June 2007
Priority Groundwater Management Area File Report

Updated Evaluation for the North-Central Texas – Trinity and Woodbine Aquifers – Priority Groundwater Management Study Area

Water Supply Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

UPDATED EVALUATION FOR THE NORTH-CENTRAL TEXAS – TRINITY AND WOODBINE AQUIFERS – PRIORITY GROUNDWATER MANAGEMENT STUDY AREA

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Water Rights Permitting and Availability Section
Water Supply Division

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EXECUTIVE SUMMARY

This report presents the updated priority groundwater management area (PGMA) study for the North-Central Texas – Trinity and Woodbine aquifer area, including Collin, Cooke, Dallas, Delta, Denton, Ellis, Fannin, Grayson, Hood, Hunt, Johnson, Kaufman, Lamar, Montague, Navarro, Parker, Red River, Rockwall, Tarrant, and Wise counties. The purpose of the study is to determine if all, part, or any of this area is experiencing or is expected to experience within the next 25-year period critical groundwater problems, and to recommend feasible and practicable groundwater management solutions if shortages of surface water or groundwater are occurring or are expected to occur.

In 1990, the Texas Water Commission [Texas Commission on Environmental Quality (TCEQ) predecessor agency] determined the North-Central Texas study area was not a PGMA, but requested the issue be studied and reconsidered again in the future. TCEQ efforts to reevaluate the study area were started again in 1998 and Texas Water Development Board (TWDB) and Texas Parks and Wildlife Department (TPWD) reports were completed in 1999. Shortly thereafter, the TCEQ chose to postpone the update effort until the 2001-2002 regional and state water planning cycle was completed. State law was then amended in 2003 to require TCEQ to complete this and several other similar update PGMA studies.

This study evaluates regional water resource issues and summarizes and evaluates data and information that has been developed in the North-Central Texas study area over the past 15 years. For this study, TCEQ staff have considered data and information provided by the TWDB and the 2002 State Water Plan; stakeholders in the study area; the 2001 and 2006 Region B, Region C, Brazos G, and North East Texas Regional Water Plans; the TPWD; and, from independent research.

Notice of the study was mailed to approximately 1,200 water stakeholders in the study area in July 2005 to solicit comments and water supply and management data. These stakeholders included municipal, county, and state officials; entities that supply public drinking water; river authorities; planning entities; nearby groundwater conservation districts; and, other environmental and occupational interest groups. The overdraft of groundwater supplies, wise use of groundwater resources, surface water quality, and potential groundwater quantity and quality impacts from booming natural gas exploration and production activities were the concerns most often voiced by the respondents. A few respondents commented that some type of groundwater management or oversight in some parts of the study area may be warranted.

From 2000 to 2030, the population of this 20-county study area is projected to increase from just over 5.5 million people to almost 9.5 million residents. An estimated 1.36 million acre-feet (acft) of water was used in the study area in 2000, and the demand for water is projected to increase to almost 1.85 million acft/yr by 2010 and to almost 2.46 million acft/yr by 2030. Municipal use presently accounts for and will continue to account for about 87 percent of the total water use over the next 25 years in the area.

About 62 percent of the study area's total water supply is from in-area surface water reservoirs and another 26 percent is from out-of-area reservoirs. The principal regional water planning group strategies to address water shortages in the study area involve existing and new in- and out-of-area surface water supplies. The development of new reservoirs and the inundation of valuable land and limited habitat are the primary water-related natural resource concerns in the study area. The new Muenster Reservoir and the proposed Lake Ralph Hall (by 2020) will inundate some riparian habitat but otherwise have little environmental impact. The proposed Lower Bois d'Arc Creek Reservoir (by 2020) would inundate moderate value wetlands and moderate quality bottomland hardwoods, and the proposed Marvin Nichols Reservoir (by 2030) would inundate high value wetlands and excellent quality bottomland hardwoods. The Marvin Nichols Reservoir would also inundate lignite deposits and oil and gas wells in the proposed pool area, and negatively impact farming, ranching, and timber interests. If constructed, these proposed reservoirs are likely to disrupt instream flows and destroy terrestrial habitat, possibly including threatened or endangered species habitat. Mitigation allowances will be necessary to set aside other land as habitat. Reservoir operations will also be modified to reduce instream flow impacts.

The Trinity and Woodbine aquifers are the primary groundwater resources in the study area, and the Blossom and Nacatoch sands provide minor amounts of water in the northeastern part of the study area. Together, these aquifers supply about five percent of the total water supply in the study area. Water-level declines including the associated reduction of artesian pressure caused by the continued removal of water from aquifer storage is a regional groundwater problem. This problem was reported in 1990 and remains the significant groundwater problem today. At present, water user groups in Ellis, Johnson, and Tarrant counties are collectively using the Trinity aquifer at quantities over regional water planning group estimates for the safe supply for each county, and water user groups in Collin, Cooke, Dallas, Denton, Fannin, Grayson, Hood, Parker, and Wise counties are using the Trinity aquifer at quantities near each county's estimated safe supply. Water user groups in Fannin and Johnson counties are also collectively using the Woodbine aquifer at quantities over the estimated safe supply for each county.

Over 200 water user groups in the study area anticipate the continued use of Trinity and Woodbine aquifer supplies at present levels and most are planning to drill supplemental or replacement wells to maintain their supply. Strategies to increase reliance on the Trinity and Woodbine aquifers have also been recommended for many water user groups in the study area. Overdrafting the Trinity aquifer through at least 2010, and adding new wells or increasing existing well production are regional water plan strategies for 41 water user groups in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Johnson, Montague, Parker, Tarrant and Wise counties. Likewise, overdrafting the Woodbine aquifer through 2010, adding new Woodbine aquifer wells, and increasing existing Woodbine aquifer well production are regional water plan strategies for 23 water user groups in Collin, Denton, Ellis, Fannin, Grayson and Hunt counties. Regional water plan strategies to reduce reliance on the Trinity and Woodbine aquifers are recommended for 33 water user groups in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson and Wise counties. Even with these recommended reductions in pumpage or supply, the strategies to increase reliance on the Trinity and Woodbine aquifers result in collectively higher groundwater demand projections through 2010 for both aquifers and through 2030 for the Woodbine. By 2020, the reduced Trinity aquifer use strategies are projected to offset the new aquifer use strategies.

The water demands for the development of the Barnett Shale are not addressed or included in the regional water plans. Barnett Shale water use and demand projections developed in January 2007, when coupled with present groundwater use estimates, may collectively push Trinity aquifer use above the regional water plan estimates of reliable supply for Cooke, Denton, Parker, and Wise counties and add to ongoing aquifer overdraft in Ellis, Johnson, and Tarrant counties. Shortages are projected in the 2006 Region B, Region C, and Brazos G Water Plans for other mining user groups in Cooke, Denton, Hood, Johnson, Montague, Tarrant, and Wise counties. Recommended strategies to address the projected shortages include conservation, purchasing water from various suppliers, reuse of water, supplemental wells in the Trinity aquifer, overdrafting of the Trinity aquifer, and new wells in the Trinity and Woodbine aquifers.

The past and continued overdevelopment of aquifers from the continued urbanization of the area threatens water supplies for rural domestic, municipal, and small water providers who depend on groundwater resources. Some groundwater users on the fringes of the Dallas-Fort Worth urban core, including many municipalities, are or will be converting to surface water sources over the next 10 to 20 years. However, increased groundwater pumpage to keep pace with the growth around the metroplex and the growing suburban cities is anticipated to continue. Historically, regional groundwater pumpage has not lessened when local providers convert to surface water sources.

Preserving the ability to rely on the limited groundwater resource is and will remain a primary objective for remote rural water suppliers; individual businesses, industries, or landowners; and, small municipalities. Protecting existing groundwater supplies is a critical issue for these groundwater users because the delivery of alternative surface water supplies will not always be economically feasible. For these reasons, it is recommended that following counties be designated as the Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area: Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant and Wise. Critical groundwater problems are not presently occurring or projected to occur in Delta, Hunt, Kaufman, Lamar, Navarro, Red River or Rockwall counties within the next 25-year period and these counties should not be designated as part of the recommended Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area.

One or more groundwater conservation districts (GCDs) created within Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant and Wise counties would have the necessary authority to address the groundwater problems identified in the area, and financing groundwater management activities through well production fees is concluded to be the most viable alternative. A regional groundwater conservation district for these counties would include the greatest areal extent of the Trinity and Woodbine aquifers experiencing supply problems and would be the most cost effective. From a resource protection perspective, this option would be the most efficient by allowing for a single groundwater management program that would assure consistency across the area, providing a central groundwater management entity for decision-making purposes, and simplifying groundwater management planning responsibilities related to Groundwater Management Area #8.

The remote rural water suppliers; individual businesses, industries, or landowners; and, small municipalities of these counties would benefit from groundwater management programs for the Trinity and Woodbine aquifers. GCD programs with goals: to quantify groundwater availability and quality and understand aquifer characteristics; to identify groundwater problems that should be addressed through aquifer- and area-specific research, monitoring, data collection, assessment, and education programs; to quantify aquifer impacts from pumpage and establish an overall understanding of groundwater use through a comprehensive water well inventory, registration, and permitting program; and, to evaluate and understand aquifers sufficiently to establish spacing regulations to minimize drawdown of water levels and to prevent interference among neighboring wells would benefit groundwater users in these counties.

It is recommended that a regional, fee-funded groundwater conservation district for the conservation and management of the Trinity and Woodbine aquifers in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, and Wise counties represents the most feasible, economic, and practicable option for protection and management of the groundwater resources. Alternatively, it is recommended that three multi-county, fee-funded GCDs could be created based on (1) local initiative to establish economically viable and functional districts, (2) aquifer hydrology and present and projected use, and (3) other political or location considerations.

The use and application of the permissive authority granted to municipal and county platting authorities to require groundwater availability certification under the Local Government Code can also be an effective tool to help ensure that residents of new subdivisions with homes that will rely on individual wells will have adequate groundwater resources. It is recommended that local governments consider using this groundwater management tool to address water supply concerns in rapidly developing areas.

Over thirty stakeholders, many representing counties, cities, and water suppliers, provided written comments on a December 2006 draft of this report and the Executive Director updated the report where new data and information was provided. The recommendation for the designation of the 13-county area was not changed because a dedicated aquifer monitoring and management program is needed to protect Trinity and Woodbine aquifer users. The recommendation for a multi-county, fee-funded GCD was refined because the Northern Trinity GCD was created in Tarrant County. The alternative recommendation for the creation of three multi-county, fee-funded GCD was added based on stakeholder comments and other local actions taken independently to create, subject to a confirmation election, the Upper Trinity GCD in Hood, Montague, Parker, and Wise counties.

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INTRODUCTION

To enable effective management of the state's groundwater resources in areas where critical groundwater problems exist or may exist in the future, the Legislature has authorized the Texas Commission on Environmental Quality (TCEQ), with assistance from other agencies, to study, identify, and delineate priority groundwater management areas (PGMAs), and to initiate the creation of groundwater conservation districts (GCDs) within those areas, if necessary.

In 1990 and 1991, the Texas Water Commission (TCEQ predecessor agency) determined that five such study areas did not meet the criteria to be designated as having critical groundwater problems. However, the Commission requested that these five areas be reinvestigated at a later date when more data became available. The North-Central Texas area overlying the Trinity and Woodbine aquifers was one of these five study areas.

Purpose and Scope

This report presents the updated priority groundwater management area study for the North- Central Texas – Trinity and Woodbine aquifer area, including all or part of Collin, Cooke, Dallas, Delta, Denton, Ellis, Fannin, Grayson, Hood, Hunt, Johnson, Kaufman, Lamar, Montague, Navarro, Parker, Red River, Rockwall, Tarrant, and Wise counties. The purpose of the study is to determine if this area is experiencing or will experience critical groundwater problems within the next 25 years. Figure 1 shows the location of the study area and the extent of the urbanized parts of the area.

This report evaluates regional water resource issues. The report summarizes and evaluates data and information that has been developed in the North-Central Texas area over the past fifteen years to determine if the area is experiencing or is expected to experience, within the next 25-year period, critical groundwater problems. By statutory definition, these critical groundwater problems can include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies.

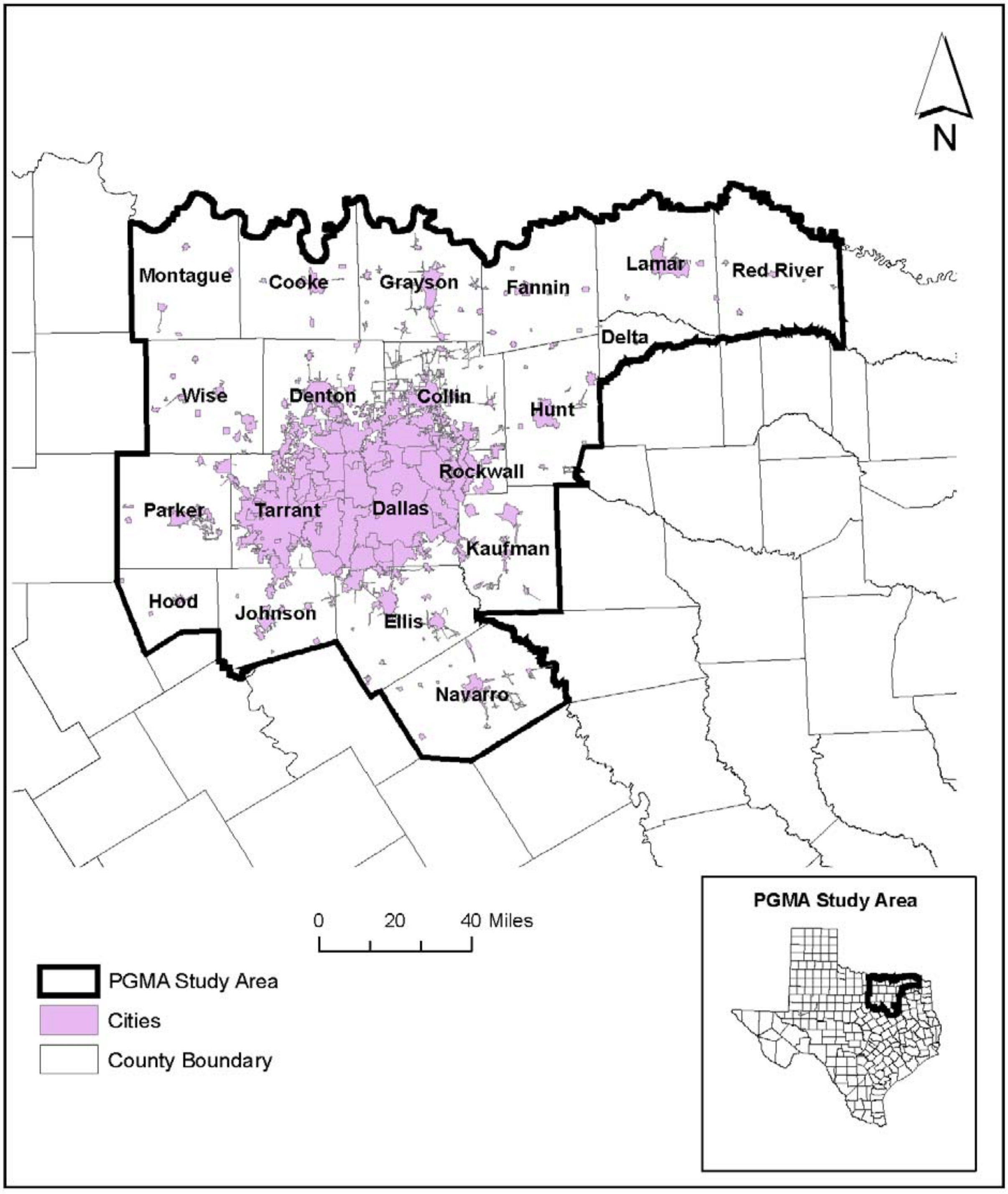
Further, since the end-purpose of PGMA designation is to ensure that groundwater management is undertaken in areas of the state with critical groundwater problems, the evaluation considers the necessity for and different options for the creation of groundwater conservation districts. Such districts are authorized to adopt policies, plans, and rules that can address critical groundwater problems.

Methodology and Acknowledgments

This report evaluates the reasons and supporting information for or against designating all or part of the North-Central Texas study area as a PGMA. Based on this evaluation, the report provides conclusions and recommendations regarding PGMA designation, conservation of natural resources, and creation of GCDs and management of groundwater resources in the area.

This report relies primarily on the data and supporting information that was used to develop conclusions and recommendations in the State Water Plan *Water For Texas – 2002* (TWDB, 2002), the *Region B Regional Water Plan* (Biggs and Mathews, Inc., et al., 2001), the *Region C Water Plan* (Freese and Nichols, Inc., et al., 2001), the *North East Texas Regional Water Plan* (Burcher Willis and Ratliff Corp., et al., 2001), and the *Brazos G Regional Water Plan* (HDR Engineering, Inc., et al., 2001). The report also relies upon information within the 2006 updates for the four regional water plans encompassing the study area. These plans were approved by the regional water planning groups in November 2005 (Brazos G – Brazos G Regional Water Planning Group et al., 2006), December 2005 (Region B – Biggs and Mathews, Inc., et al., 2006; and Region C – Freese and Nichols, Inc., et al., 2006), and January 2006

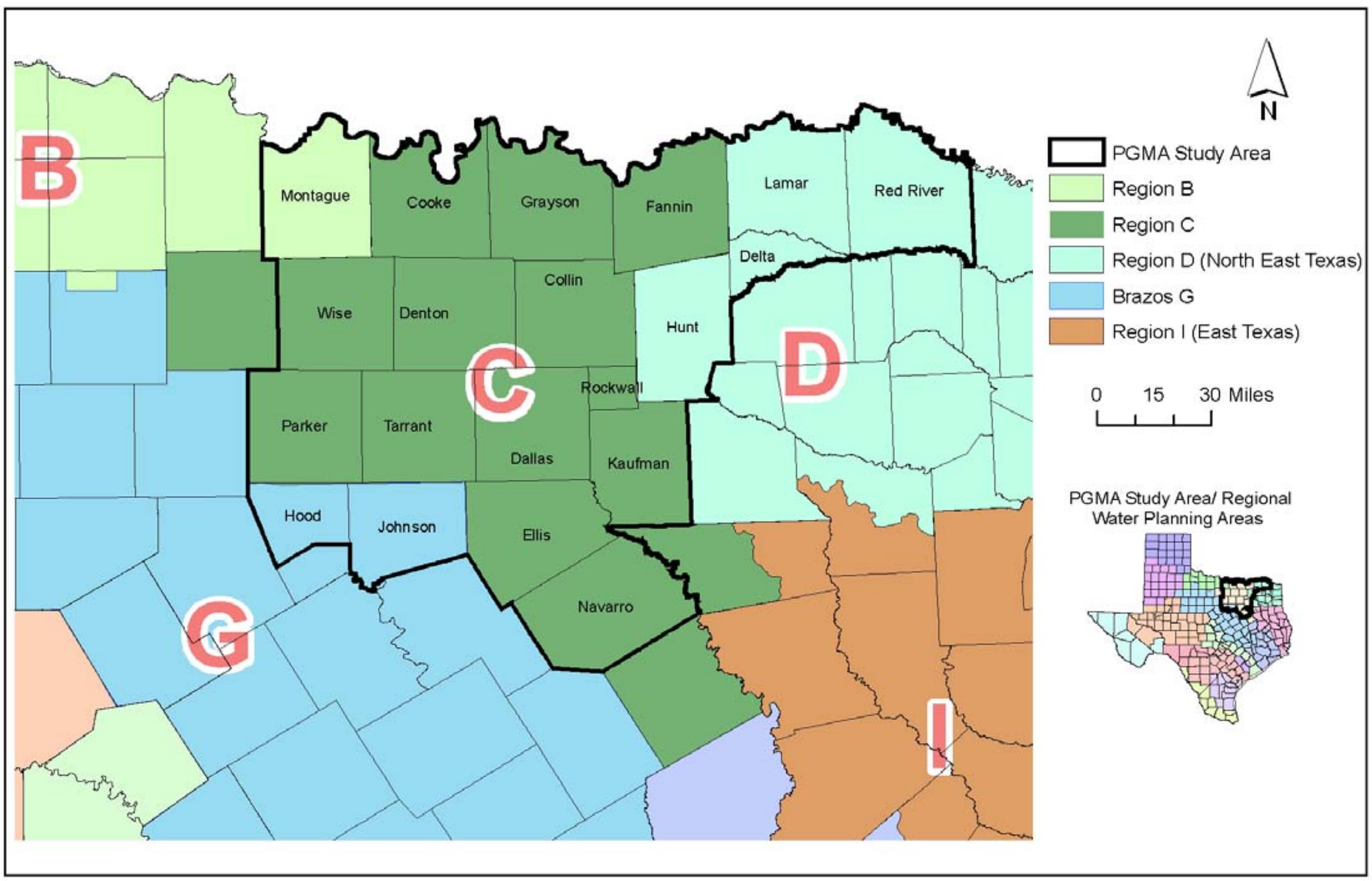
Figure 1. Location of Study Area



(North East Texas – Burcher Willis and Ratliff Corp., et al., 2006). The locations of the regional water planning areas in relation to the study area are shown in Figure 2. The report also considers information from two additional reports that were concurrently under development and released in January 2007: *Water For Texas – 2007* (TWDB, 2007) and *Assessment of Groundwater Use in the Northern Trinity Aquifer Due to Urban Growth and Barnett Shale Development* (Bené, Hardin, Griffin, and Nitcot, 2007).

Much of the data used to support the regional and state water plans, and this report, is the result of other significant Texas Water Development Board efforts (Klempt, Perkins and Alvarez, 1975; Baker, Duffin, Flores and Lynch, 1990; Ashworth and Hopkins, 1995; Langley, 1999; TWDB, 1997; TWDB, 2002; and the *Northern Trinity/Woodbine Aquifer Groundwater Availability Model* by R.W. Harden and Associates, et al., 2004). Furthermore, this report considers natural resource issues identified in the four regional water plans and by the Texas Parks and Wildlife Department (El-Hage, Moulton and Sorensen, 2005). Special thanks are given to TWDB staff members Robert Bradley, Craig Caldwell, Ali Chowdhury, Sanjeev Kalaswad, and Rima Petrossian for their assistance in various aspects of data compilation and interpretation (TWDB, 2005); to the study area stakeholders who provided written and verbal information and comments; and to fellow TCEQ staff members Abiy Berehe, Clifford L. Byrd, Peggy Hunka, and Marcia Workman for assistance with research and graphics, and Steve Musick for consultation and critical review.

Figure 2. Regional Water Planning Areas



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WATER AND NATURAL RESOURCES

For background purposes, this chapter briefly describes the water and natural resources that are used and enjoyed in the study area. This description relies primarily upon work of the Region B, Region C, Brazos G, and North East Texas Water Planing Groups, and other information by the TWDB, TCEQ, and TPWD. The works of these entities provide significantly more detail than can be covered in the context of this report.

In 2000, the population of the 20-county study area was just above 5.5 million people and approximately 1.36 million acre-feet (acft) of water was used to meet study area supply needs. The study area includes four of the ten most populous counties in the state (Dallas, Tarrant, Collin, and Denton), and five of the ten most populous cities (Dallas, Fort Worth, Arlington, Plano, and Garland). From 2000 to 2030, the population of the study area is projected to increase by 73 percent – to almost 9.5 million residents. Likewise, the demand for water is projected to increase 36 percent – from a projected demand of over 1.85 million acft by 2010 to a projected demand of almost 2.46 million acft by 2030. Most of the supply needs throughout the study area are met, and will continue to be met, using in- and out-of-area surface water sources. Table 1 shows the planning data for the study area's overall water availability. Study area planning data for projected population, water supply, and water demand are provided in Appendixes 1 through 3, respectively.

Table 1. Overall Water Availability for the North-Central Texas Study Area

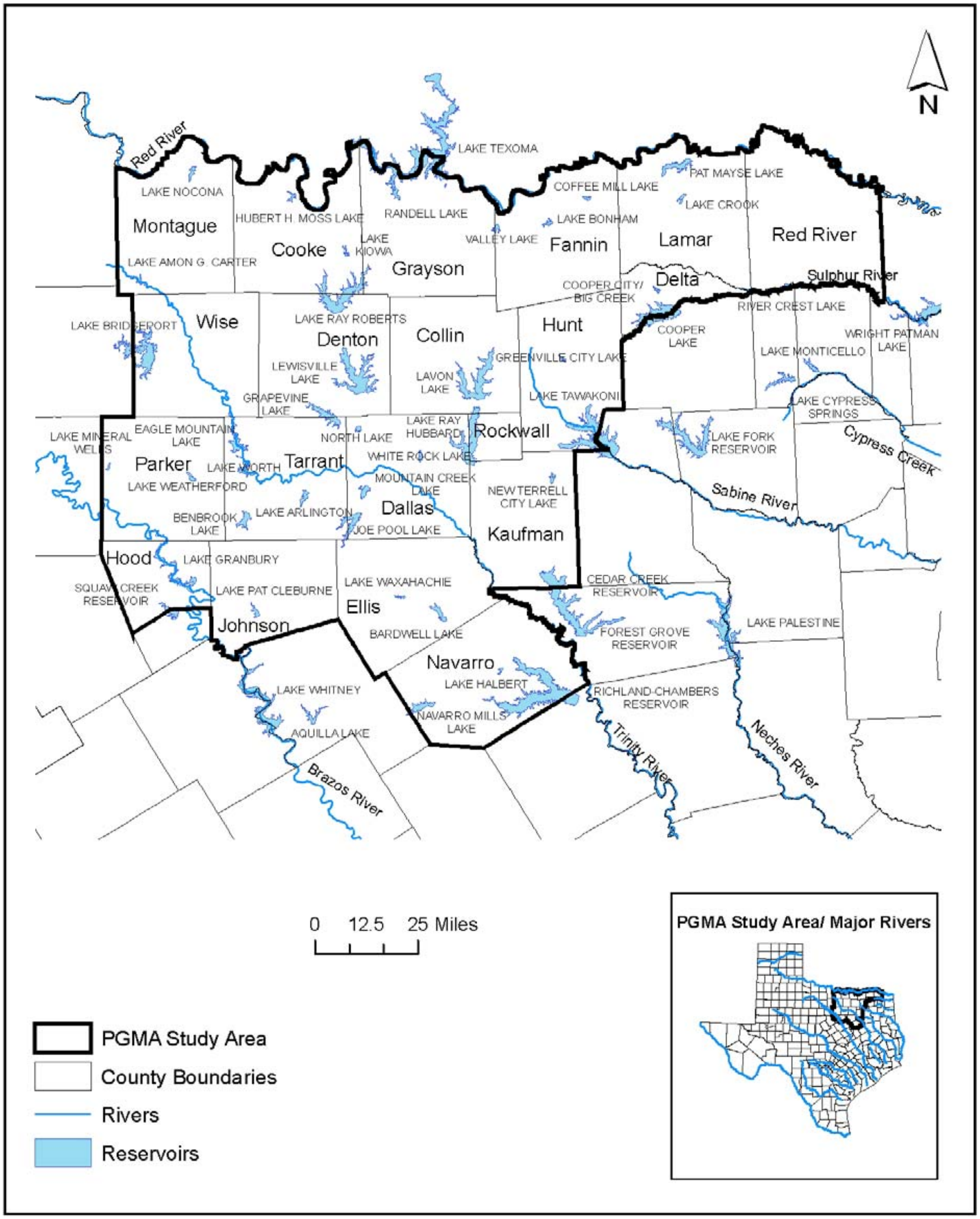
Source Summary	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Surface water Imports	556,559	563,169	558,989	554,806	550,635	546,474
Reservoirs Firm Yield	1,321,679	1,309,963	1,298,736	1,288,518	1,278,191	1,263,515
Other Local Supply	25,445	25,445	25,445	25,445	25,445	25,445
Local Irrigation	20,252	20,252	20,252	20,252	20,252	20,252
Groundwater	117,396	117,396	117,396	117,396	117,396	117,396
Reuse	106,587	106,587	106,587	106,587	106,587	106,587
Total	**2,148,098**	**2,142,992**	**2,127,585**	**2,113,184**	**2,098,686**	**2,079,849**
Note: Tabulated values in acre-feet.						

Municipal use accounted for about 87 percent of the total water use in 2000, and the other use types compared to total use were as follows: manufacturing–4.4 percent, irrigation–4 percent, steam electric–1.3 percent, livestock–2.5 percent, and mining–0.8 percent. The percentages of projected use-type demand compared to total projected demand are not anticipated to change drastically by 2030. The 2030 projected total use percentages are: municipal–86.3 percent, steam electric–4.7 percent, manufacturing–4.1 percent, irrigation–2.3 percent, mining–1.5 percent, and livestock–1.1 percent.

Surface Water Resources

The study area includes parts of five major river basins: the Red, Trinity, Brazos, Sulphur, and Sabine River basins. Three major rivers run through or border the study area and the other two major rivers have headwater tributaries in the study area. The Red River runs along the northern border of the study area, the Trinity River runs through the center of the study area, and the Brazos River runs through the southwestern corner of the study area. The headwaters of the Sulphur and Sabine Rivers are in the northeast and east parts of the study area. The rivers, river basins and major surface water resources in the study area are shown on Figure 3.

Figure 3. Major Surface Water Resources



Within the study area, there are 41 surface water reservoirs that contribute all or part of their respective yields to meet in- and out-of-area water needs. In addition, seven reservoirs located outside of the study area contribute water supplies – or will contribute water supplies – for in-area use. Historic surface water use data (1985—2003) is shown in Table 2 and Figure 4. In total, these reservoirs have a combined capacity of 8,771,149 acre-feet of water and a combined firm yield of approximately 1,878,238 acre-feet of water for 2010 study area uses (Freese and Nichols, Inc., et al., 2006; Burcher Willis and Ratliff Corp., et al., 2006; Brazos G Regional Water Planning Group et al., 2006; and, Biggs and Mathews, Inc., et al., 2006). Surface water resources presently provide over 88 percent of the water used in the study area – 62 percent from in-area reservoirs and 26 percent from surface water imports.

Groundwater Resources

The Trinity and Woodbine aquifers are the primary groundwater resources in the study area. The Trinity aquifer, composed of Cretaceous-aged Trinity Group formations, is characterized as a major aquifer by the TWDB, and the Cretaceous-aged Woodbine Formation aquifer is characterized as a minor aquifer. The Cretaceous-aged Blossom and Nacatoch sands, also characterized as minor aquifers, provide small amounts of water in the northeastern part of the study area. Although it represents only five percent of the total water supply used in the study area, groundwater is an especially important source of supply for the rural areas. The TWDB-delineated aquifers within and adjacent to the study area are shown on Figures 5 and 6. Historic groundwater use, by county, is listed in Table 3, and total historic groundwater use is shown on Figure 7.

Within the state, the Trinity aquifer (Figure 5) stretches from the Red River in north-central Texas to the Hill Country north and west of San Antonio. In the study area, the Antlers, Paluxy, and Twin Mountains Formations are the major water-producing Trinity Group units. North of a line which runs through Decatur in Wise County to Bonham in Fannin County, the Glen Rose Formation thins or is missing, and the Paluxy and Twin Mountains Formations merge and are termed the Antlers Formations.

The Antlers Formation crops out primarily in Montague, Wise, and Cooke counties. The Antlers Formation is about 400 feet in thickness near the outcrop and increases to about 900 feet in southeast Grayson County. The outcrop of the Twin Mountains Formation occurs in Hood, Parker, and Wise counties. The formation thickens from less than 200 feet near the outcrop to approximately 1,000 feet at the downdip limit of fresh to slightly saline water. The Paluxy Formation outcrops in Hood, Parker, Tarrant, and Wise counties. The Paluxy Formation varies in thickness from about 400 feet in the northern part of the study area to less than 100 feet in the southern part (Nordstrom, 1982; Langley, 1999). Slightly more than 73 percent of the groundwater used in the study area in 2000 was produced from the Trinity aquifer.

Minor aquifers in the study area (Figure 6) consist of the Cretaceous-aged Woodbine Formation, the Blossom Sand and the Nacatoch Sand. The Woodbine Formation outcrops in Johnson, Tarrant, Denton, Cooke, and Grayson counties, and in lesser amounts along the Red River in Fannin, Lamar, and Red River counties. The Woodbine Formation trends in a north-south direction extending from the Red River to the north and to northern McClennan County to the south. The thickness of the Woodbine Formation ranges from about 230 feet near the southern extent of the outcrop to approximately 700 feet near the downdip limit of fresh to slightly saline water. Pumpage from the Woodbine aquifer accounted for slightly more than 20 percent of the groundwater used in 2000 in the study area. The Blossom Sand outcrops in central Fannin, Lamar, and Red River counties. The Nacatoch Sand is exposed in Delta, Hunt, Kaufman, Lamar, Navarro, and Red River counties. Less than three percent of the groundwater used during 2002 in the study area was produced from these minor aquifers.

Table 2. Historic Surface Water Use By County

County	1985	1990	1995	2000	2003
Collin	41,938	58,734	79,654	129,818	130,346
Cooke	1,110	1,063	1,527	1,118	1,101
Dallas	464,419	474,466	487,453	541,180	533,123
Delta	4,041	3,136	863	11,984	977
Denton	29,117	39,762	47,917	80,573	78,714
Ellis	9,738	10,050	12,196	19,378	20,752
Fannin	11,760	10,377	9,181	14,732	10,074
Grayson	8,138	6,249	11,974	15,044	14,891
Hood	6,440	11,498	10,120	8,500	6,258
Hunt	11,128	12,735	10,952	13,498	12,836
Johnson	7,319	7,794	9,285	15,918	17,441
Kaufman	9,328	9,730	10,442	15,128	13,639
Lamar	14,777	19,040	18,784	19,839	19,112
Montague	3025	2,988	3,308	3,181	3,110
Navarro	8,427	8,843	8,232	10,953	11,262
Parker	6,437	5,678	5,410	4,890	6,043
Red River	3,343	2,912	5,148	6,391	7,878
Rockwall	4,543	5,216	6,069	10,204	10,849
Tarrant	229,881	268,008	259,260	310,118	316,323
Wise	8,792	11,186	19,856	8,684	11,637
Total	883,701	969,465	1,017,631	1,241,131	1,226,366
Note: Tabulated values in acre-feet					

Figure 4. Total Historic Surface Water Use in Study Area

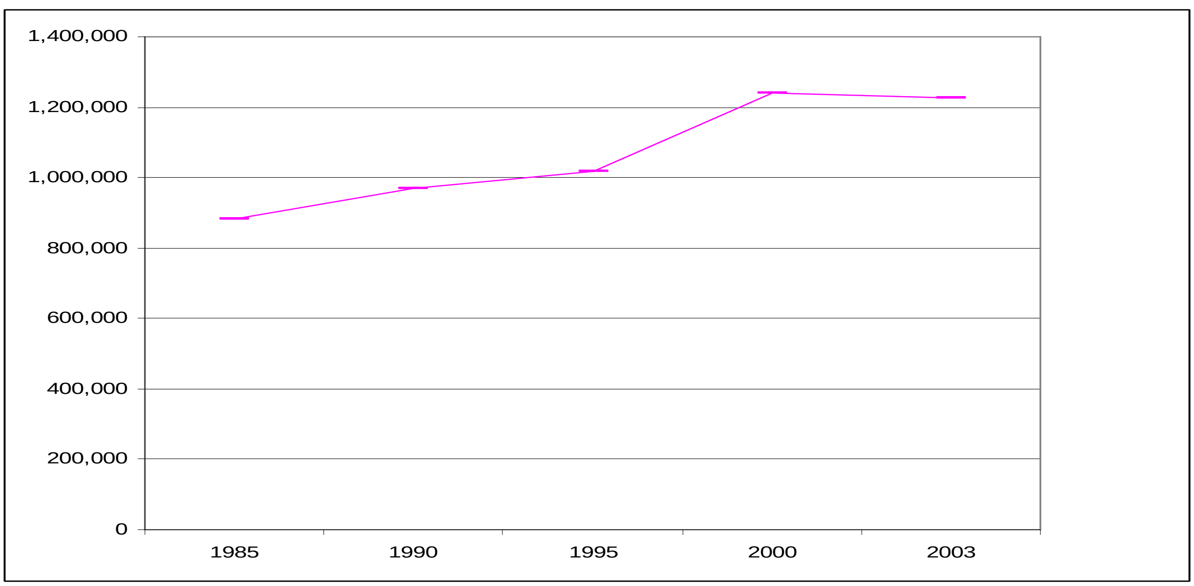


Figure 5. Major Aquifers

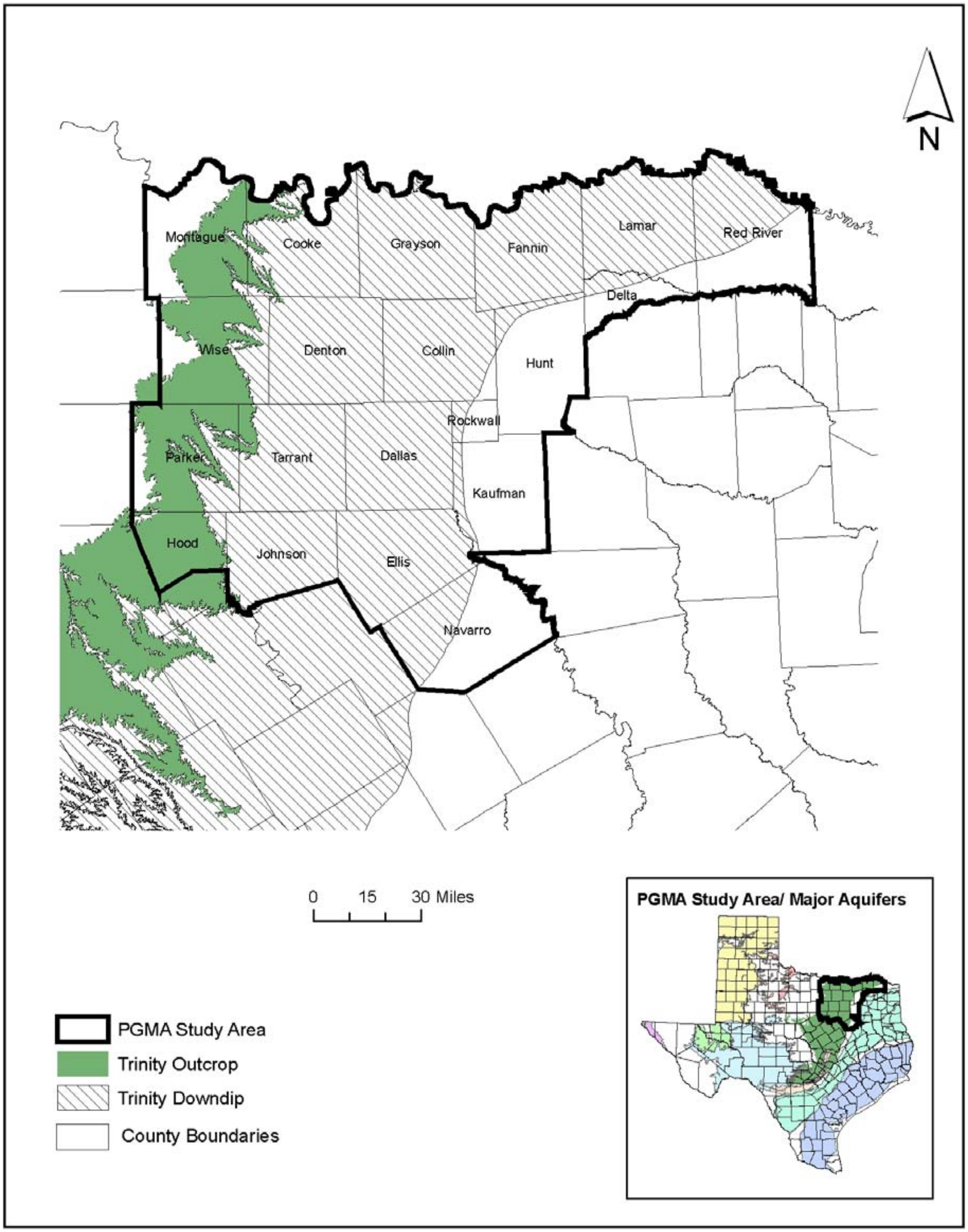


Figure 6. Minor Aquifers

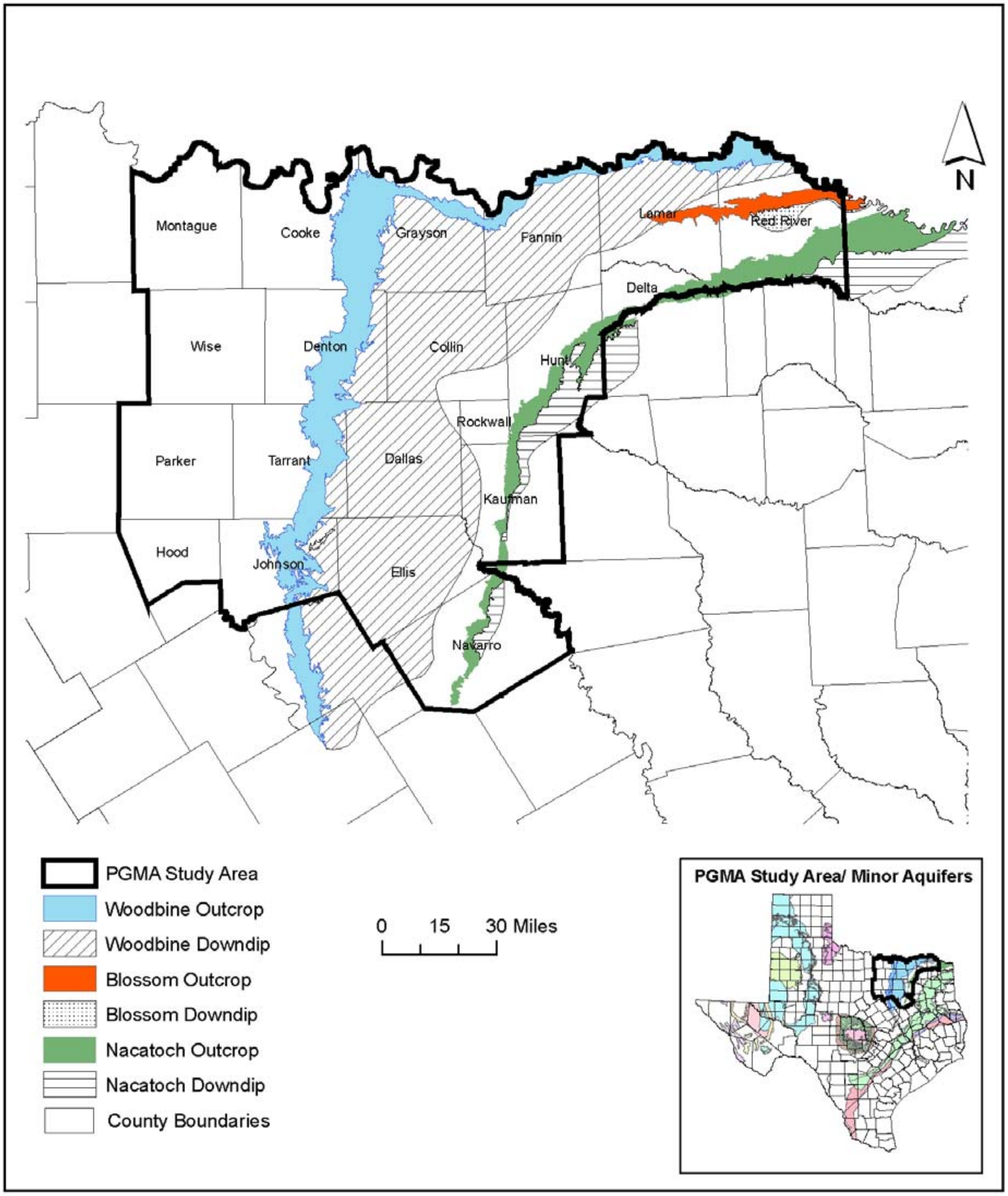
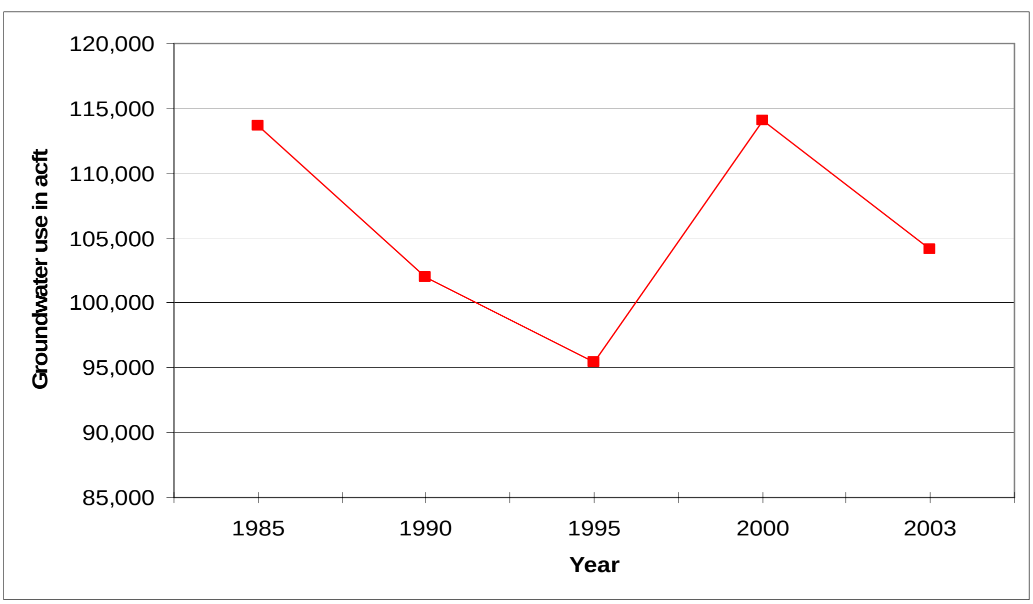


Table 3. Historic Groundwater Use By County

County	1985	1990	1995	2000	2003
Collin	2,476	3,301	2,715	4,886	4,735
Cooke	6,388	6,223	6,656	6,441	5,367
Dallas	20,281	10,258	5,321	6,777	4,840
Delta	212	226	119	1,305	789
Denton	9,038	10,235	10,807	15,800	18,300
Ellis	8,610	8,852	5,839	7,240	7,540
Fannin	3,029	2,891	5,954	4,286	4,011
Grayson	18,180	17,199	15,385	17,992	13,108
Hood	3,729	4,089	3,747	4,364	4,953
Hunt	2,263	1,918	1,628	1,804	1,181
Johnson	8,035	7,950	9,010	10,107	7,799
Kaufman	309	259	308	373	295
Lamar	977	921	622	497	1,285
Montague	1,579	1,376	1,523	1,526	964
Navarro	502	475	322	438	364
Parker	4,385	5,155	5,827	6,716	5,663
Red River	2,041	1,825	1,849	2,011	1,060
Rockwall	58	57	143	135	228
Tarrant	17,822	14,952	13,328	16,529	17,949
Wise	3,701	3,788	4,300	4,856	3,660
Total	**113,615**	**101,950**	**95,403**	**114,083**	**104,091**

Note: Values in acre-feet

Figure 7. Total Historic Groundwater Use in Study Area



Minor amounts of water are also pumped from locally undifferentiated sediments that are referred to as “Other aquifers” in the regional and state water plans. In Montague County, about 80 percent of 2000 groundwater use was attributed to this category. The most likely sources for these Montague County groundwater supplies are the Permian-aged Wichita-Albany Group, the Pennsylvanian-aged Cisco Group, and the Red River and other stream alluvium (Bayha, 1967). All of the 2000 groundwater use for Rockwall County and over 40 percent of the 2000 groundwater use for Navarro County was attributed to “Other aquifers.” The Cretaceous-aged Taylor Group is the probable source of groundwater for shallow wells in these two counties (Thompson, 1972). The alluvium associated with the Red, Sabine, Sulphur, and Trinity Rivers and their tributaries likely contribute “Other aquifer” groundwater in Delta, Fannin, Navarro, Red River, and Rockwall counties. These groundwater sources supplied less than four percent of the total groundwater used in the study area in 2000.

Groundwater flow in the Trinity and Woodbine aquifers is generally to the east and southeast and is controlled by regional geology, water levels, precipitation as it relates to recharge, and water quality. The environments under which the aquifer sediments were deposited controls the orientation of thicker, more permeable units which, in turn, affects the direction of groundwater flow (Ambrose, 1990). The chemical makeup of the lithologic units is dictated by its environment of deposition and directly influences the chemical quality and composition of the aquifer water. Control on accumulated thickness of aquifer sediments was exerted by the paleotopography which existed prior to the deposition of the Cretaceous sands, resulting in thicker accumulation of sand occurring in the paleovalleys and thinner, less permeable, accumulations occurring on the paleoridges (Klemt et al., 1975). In the southern part of the study area, the northernmost expression of the Mexia-Talco Fault Zone may completely block or severely restrict the movement of water into the structural East Texas Basin, and may allow undesirable saline water to enter the aquifer along fault planes.

Natural Resources

A flowing spring indicates the connection between groundwater and surface water. Flowing springs represent locations where groundwater is discharging to the surface. Groundwater level declines have an immediate impact upon spring discharge rates. Brune (1981) reported that many of the springs that were present in the area have disappeared and there has been a noticeable decline in spring-associated riparian habitats in the region. For 19 of the 20 counties in the study area (information was not available for Navarro County), Brune reported there were 8 medium sized springs with a discharge rate of 2.8 to 28 cubic feet per second (CFS), 48 small springs with a discharge rate of 0.28 – 2.8 CFS, 65 very small springs with a discharge rate of 0.028 – 0.28 CFS, and 30 seeps (<0.028 CFS). Brune recorded 34 former spring locations in the 19 counties. El-Hage, Moulton, and Sorensen (2005) note that few species are directly dependent upon the groundwater resources of the study area. However, the study area springs contribute to surface water hydrology and have helped shape the ecosystems that exist in the study area.

The rivers and streams in the study area support a variety of native and introduced fishes and other aquatic species. Freshwater mussels are sensitive biological indicators of environmental quality and are often the first organisms to decline when aquatic ecosystems degrade. There are 52 mussel species recognized in the state and 16 are listed by Texas Parks and Wildlife Department (TPWD) as species of special concern in the study area. The Ouachita rock-pocketbook mussel is federally and state listed as an endangered species. Over 50 fish species are present in the study area. Eleven fish species of special concern are listed by TPWD for the study area and five species including the blue sucker, creek chubsucker, blackside darter, paddlefish, and shovelnose sturgeon are state listed as threatened (El-Hage, Moulton, and Sorensen, 2005).

The TPWD list of species of special concern in the study area includes 15 birds, some of which are riparian or wetland dependent. Many species of wintering songbirds, waterfowl, and neotropical songbirds are migrants that stopover in the study area to feed and rest along river banks, creek bottoms, and other wetlands. In the study area, the golden-cheeked warbler, northern aplomado falcon, whooping crane, eskimo curlew, interior least tern, and black-capped vireo are federally and state listed as endangered. The TPWD also lists 64 species of mammals, amphibians, and reptiles that are either aquatic, semi-aquatic, or in some other way wetland dependent. None of the riparian or water-dependent mammals in the study area are on the list of species of special concern. Two reptiles, the Brazos water snake and the Texas garter snake are included on the list of species of special concern (El-Hage, Moulton, and Sorensen, 2005).

Extensive recreational facilities and holdings contribute substantially to the area's economy. The area reservoirs provide numerous opportunities for fishing, boating, and other water sports. Schorr et al. (1995) estimated that anglers contributed an estimated $25.6 million in fishing expenditures at the nationally recognized Lake Texoma striped bass fishery in 1990, with nonregional anglers visiting the reservoir accounting for 77 percent of the total expenditures. In addition to the reservoirs, El-Hage, Mouton, and Sorensen (2005) describe the following significant stream segments in the study area.

- Red River Basin: the Red River upstream 225 miles from Lake Texoma is a striped bass spawning and migration segment with unique saltwater springs; the Red River from Lake Texoma Dam downstream to the Louisiana border harbors paddlefish and blue suckers; Shawnee Creek, from the Lake Texoma spillway to Red River (overflow basin), harbors paddlefish; Rock Creek, headwaters to Red River (eight miles), North Fish Creek, and South Fish Creek, upstream eight miles from Lake Moss; and Bois d'Arc Creek where the Caddo National Grasslands Wildlife Management Area, a unique state holding, is located.

- Trinity River Basin: Elm Fork Trinity River (headwaters to Ray Roberts Lake), West Fork Trinity River (Lake Bridgeport tailrace to Eagle Mountain), Big Sandy Creek (Amon G. Carter Reservoir tailrace to West Fork of the Trinity River), Spring Creek (Dallas County near Garland), and Tenmile Creek have high water quality, exceptional aquatic life, and high aesthetic value.

- Brazos River Basin: the Brazos River from Possum Kingdom Dam downstream 90 miles to Lake Granbury is a smallmouth bass fishery and a striped bass spawning run, and a prime recreational spot, and Sanchez Creek from the headwaters to the confluence with the Brazos River is a pristine and historic area.

The 2006 Region C Water Plan (Freese and Nichols, Inc., et al., 2006) does not recommend any stream segments to be considered unique.

The TPWD operates eight State Parks (SP) in the study area: Bonham SP on 261 acres of rolling prairies, woodlands, and a 65 acre lake in Fannin County; Cedar Hill SP on 1,826 acres on the east shore of Joe Pool Reservoir in Dallas County; Cleburne SP on 529 acres, including a spring-fed lake, in Johnson County; Cooper Lake SP–Doctors Creek Unit on 715 acres on the north shore of Chapman Lake in Delta County; Eisenhower SP on 423 acres on the south shore of Lake Texoma in Grayson County; Lake Mineral Wells SP on 3,282 acres along Rock Creek, including Lake Mineral Wells in Parker County; Lake Ray Roberts SP composed of two separate units, Isle du Bois (2,263 acres) located on the south side of the lake in Denton County and Johnson Branch (1,514 acres) located on the north side of the lake in Cooke County; and, Lake Tawakoni SP on 376 acres on the south shore of the reservoir in Hunt County. These parks provide swimming, fishing, boating, camping, picnicking, hiking, mountain biking, birdwatching, wildlife observation, nature study and many other outdoor opportunities (El-Hage, Mouton, and Sorensen, 2005).

The TPWD also operates two Wildlife Management Areas (WMA): Pat Mayse WMA, and Lake Ray Roberts WMA, and one State Historic Park (SHP), Eisenhower Birthplace SHP. Pat Mayse WMA is located in northwestern Lamar County and includes 8,925 acres of land and water. It is adjacent to and includes part of the upper end of Pat Mayse Reservoir and contains upland habitat of post oak woods, oil fields, and some creek bottom habitat. Public hunting and fishing is permitted in the area.

Ray Roberts WMA is located on 41,220 acres adjacent to Lake Ray Roberts within Cooke, Denton, and Grayson counties. This WMA provides public hunting opportunities for dove, quail, woodcock, snipe, waterfowl, rabbits, hare, feral hogs, squirrels, and frogs. Other activities include hiking, fishing, and wildlife viewing. These state holdings require water to operate and provide recreational opportunities to the public, as well as to maintain a healthy fauna and flora. Water-based recreation in these public lands draws many visitors.

The Eisenhower SHP is located in Denison, Grayson County, and tours to view the birthplace of President Eisenhower are the main attraction of the park. Weddings, receptions, and meetings are also held at the park (El-Hage, Mouton, and Sorensen, 2005).

In addition to the state holdings, the U.S. Fish and Wildlife Service manages one wildlife refuge and two grasslands in the study area. The Hagerman National Wildlife Refuge lies on the Big Mineral Arm of Lake Texoma, on the Red River between Oklahoma and Texas. The refuge includes 3,000 acres of marsh and water and 8,000 acres of upland and farmland. During fall, winter, and spring, the marshes and waters are in constant use by migrating and wintering waterfowl (http://www.fws.gov/southwest/refuges/texas/hagerman/index.html, accessed Jan. 26, 2006).

The Caddo National Grasslands is comprised of 17,785 acres in Fannin County and contains three lakes: Lake Coffee Mill (651 acres), Lake Davy Crockett (388 acres), and West Lake Davy Crockett. The Lyndon B. Johnson National Grassland is comprised of more than 20,250 acres in Wise County and contains Cottonwood Lake (~30 acres). These grasslands provide grazing for cattle, habitat for wildlife, and a variety of recreational opportunities such as hiking, camping, fishing, hunting, horseback riding, mountain biking, wildlife viewing, and photography (http://www.fs.fed.us/r8/texas/recreation/caddo_lbj/caddo-lbj_gen_info.shtml, accessed Jan. 26, 2006).

Other natural resources are also used for anthropogenic purposes. In the study area and in two additional counties (Somervell and Van Zandt) there are approximately 2.8 million acres of rangeland, 3.0 million acres of pastureland, and 2.1 million acres of cropland. There are also around 300,000 acres of forestland, 18,000 acres of irrigated land, and some 1.7 million acres of land identified as public or miscellaneous (Texas State Soil and Water Conservation Board, 2006). Paleozoic rocks with bituminous coal deposits underlie most of Jack County (immediately west of the study area) and small parts of Wise and Parker counties. Near surface lignite deposits in the Tertiary Wilcox Group underlie large portions of Navarro County. Other rock units present in the study area that are exposed at the surface are quarried or mined for building stone, aggregate, and other purposes.

Oil and natural gas are significant resources in parts of the study area. Data available on the Railroad Commission of Texas internet homepage (RCT, 2006) indicates that as of September 2005, over 10,000 oil wells and 7,000 gas wells have been drilled in the 20-county area (numbers do not included plugged or abandoned wells). Oil well counts are highest in Cooke (3,054), Montague (2,874), Navarro (2,096), Grayson (999), and Wise (951) counties, and gas well counts are highest in Wise (3,797), Denton (1,883), Parker (1,367), Tarrant (624), and Hood (336) counties. The data also indicates that for the 12-month period from December 2004 to November 2005, crude oil production was almost 5.4 million barrels and gas well gas production topped 486 trillion cubic feet.

1990 STUDY CONCLUSIONS AND RECOMMENDATIONS

The previous "critical area" study for the North-Central Texas area resulted in two 1990 reports. The Texas Water Development Board completed *Evaluation of Water Resources in Part of North-Central Texas* (Baker et al., 1990) to describe the geohydologic conditions of the Trinity Group and other aquifers, and to identify problems related to pumpage overdrafts and contamination of groundwater supplies.

The Texas Water Commission report *Ground-water Protection and Management Strategies for North-Central Texas* (Ambrose, 1990) primarily considered two issues. First was an evaluation of the existing water use and planning data to determine if the area was experiencing or was expected to experience by 2010 critical water supply, availability, or quality problems. The second was to identify the best methods to address groundwater problems either through the creation of a groundwater conservation district or through other means available to water suppliers and local governments.

In preparing the report, the Texas Water Commission used and considered the opinions provided by an advisory committee of knowledgeable members of local government, industry and concerned citizens. Appendix 4 includes a reproduction of the technical summary for the North-Central Texas 1990 study and recommendations. The most relevant conclusions and recommendations for the study area were as follows.

- Groundwater pumpage has historically exceeded recharge and resulted in declining water levels and possible deterioration of chemical quality in the Trinity Group and Woodbine aquifers. Overdrafts are occurring in the Trinity Group aquifer in Cooke, Dallas, Denton, Grayson, Hood, Johnson, and Tarrant counties and in the Woodbine aquifer in Ellis, Fannin, and Grayson counties.

- Water-level declines and associated reduction of artesian pressure caused by the continued deficit-removal of water from storage is a regional groundwater problem. Regional management practices are needed to stabilize groundwater levels and to help preserve the aquifers for future use.

- The area is not facing a "critical" water supply problem because of adequate surface water reserves. Surface water supplies are adequate to meet current and projected needs beyond 2010. Many large-volume groundwater users concentrated in the Dallas-Fort Worth (DFW) area have converted to surface water sources in recent years. However, the reduction in pumpage by these users has been offset by continued sharp increases by numerous small municipal users, utility districts, and water supply corporations outside the DFW area.

- Large-quantity groundwater user conversions to surface water may be the best regional management method for the area. New treatment and conveyance systems will have to be built for such conversions. Cities are implementing plans to alleviate groundwater-level declines and other water supply problems and the groundwater supply in these areas will not be critical as future surface water supply plans are implemented.

- Residents of the area most likely would not support the creation of a GCD because (1) the sole funding mechanism to finance GCD operations would be ad valorem taxes and, (2) the punitive measures that would deny state financial assistance for conversions from groundwater to surface water sources should the creation of a GCD be rejected by the voters. Local entities should lead efforts to have special law-created single- or multi-county GCDs with a regional coordinating board and technical staff that would be empowered to monetarily encourage conversion to available surface water in order to preserve groundwater supplies for more isolated and rural areas.

- The area should not be designated. The Commission should monitor the conversion from groundwater to surface water usage, and if conservation plans are not being implemented or if GCDs are not being formed, designation of the area should be reconsidered in the event that state law is modified to furnish other means to finance a GCD besides ad valorem taxes.

As this report will describe, many of these same study area concerns still hold true more than 15 years later. Also during this time, many changes to state law have been made to provide alternative funding sources for GCDs, to remove penalties for failure to establish GCDs, and to provide more flexibility for managing groundwater resources by GCDs. In December 1990, there were 31 GCDs that had been established in all or part of 61 of the state's 254 counties (TWC, 1991). As of May 12, 2007, there were 88 GCDs that cover all or part of 130 counties. None of these GCDs are in the study area.

PUBLIC PARTICIPATION

Public input for this process and report was requested on the front end of the study in July 2005 and after a draft of this report was released in December 2006. This chapter attempts to summarize the comments and information provided by the study area respondents. The writer acknowledges and greatly appreciates the time and diligence of these stakeholders.

Initial Stakeholder Notice and Response

On July 26, 2005, TCEQ mailed a study notice to solicit comments and to request data on water supply; groundwater quality, availability, and water level trends; and, actions to address identified water management strategies. The notice was sent to over 1,200 stakeholders in the study area. The majority of the stakeholders were county officials, municipalities, water supply corporations, river authorities, planning entities, groundwater conservation districts, and other entities that supply public drinking water. Other notified stakeholders included state legislators, selected federal and state agencies, and other environmental and occupational interest groups.

In response to the July 26, 2005 notice, 13 written and 9 verbal comments were received. Respondents included officials from Fannin, Hood, and Parker counties; representative from the cities of The Colony, Denton, Forrest Hill, Fort Worth, Glenn Heights, Mesquite, Richardson, and Watauga; and public water supply interests including Acton Municipal Utility District (Hood County), Azle Independent School District (Parker and Tarrant counties), Bartonville Water Supply Corporation (Denton County), BarVK Water Utility (Denton County), Johnson County Fresh Water Supply District No. 1, Johnson County Special Utility District, Monticello Spring Water (Tarrant County), and Samantha Springs (Tarrant County). Others providing meaningful comments included Ms. Virginia Sabia, TWDB Liaison to the Region C Regional Water Planning Group and Texas Water Development Board member Mr. William W. Meadows from Fort Worth.

<u>Use Surface Water Only</u> – Respondents for the cities of Denton, Forrest Hill, Fort Worth, Mesquite, Richardson, and Watauga noted the cities rely solely on surface water supplies. The respondents for the cities of Mesquite and Richardson noted their water supply was provided by the North Texas Municipal Water District. The respondent for the City of Forrest Hill noted the city had ceased using three Trinity aquifer wells, one of which had been closed. The respondent noted the other two City of Forrest Hill wells were being maintained by the state for aquifer monitoring purposes. The respondent for the City of Fort Worth noted the city also presently provides surface water to 28 communities in the Tarrant County area. The respondent from Fannin County noted that two reservoirs planned by the Region C Regional Water Planning Group – Lake Ralph Hall and Lower Bois D Arc – are located in the study area in Fannin County.

<u>No Present Problems or Immediate Concerns</u> – Seven respondents with public water supply wells, including two cities, did not identify any water supply or water quality concerns but replied to describe present water supply sources and the number of water supply wells and connections served. The Acton Municipal Utility District provided two groundwater availability studies for TCEQ to consider, and the City of The Colony provided well pump test summary data and select water quality analyses. The respondent for the City of Glenn Heights noted the city relies on the Woodbine aquifer.

<u>Use Groundwater or Anticipate Increased Groundwater Usage</u> – Five respondents described present groundwater use or anticipated increases in groundwater use. The respondent for the City of Fort Worth noted many smaller communities in Tarrant, Denton, Parker, Wise, and Johnson counties presently rely – and many new residential housing projects outside of the city's jurisdiction are planned to rely – on groundwater sources. Based on recent groundwater availability modeling, he noted that it appears that

groundwater use in some parts of the study area exceeds the long-term reliable supply and the city anticipates it will be asked to provide surface water to some communities that presently rely on groundwater. He also noted that overdraft of groundwater does not appear to be occurring in all parts of the study area. The respondent noted that conversions from groundwater to surface water supply have occurred in the past as Trinity aquifer water levels have declined or water quality had deteriorated.

The respondent from the Parker County Health Department noted that few public water supply companies serve the unincorporated areas of the county. He noted concerns that the large number of approved and proposed subdivisions that will rely on groundwater will significantly affect water availability and make this a critical issue. Mr. Meadows noted that Parker County has not adopted groundwater availability certification for platting requirements authorized by state law. He also noted the concerns that present trends in development and groundwater production in Parker and western Tarrant counties could result in critical groundwater problems within the next 25-year period.

The respondent for the Bartonville Water Supply Corporation (BWSC) described their conjunctive use of surface water and groundwater. He noted that BWSC presently serves about 2,000 connections using ten wells (seven producing from the Trinity aquifer) and is contracted as a member of the Upper Trinity Regional Water District for 2.5 million gallons per day (mgd) of treated surface water. He also noted that total available water supply for BWSC is presently around 4.0 mgd and BWSC will need about double the amount when the service area is fully developed. When fully developed, BWSC is projected to serve about 4,000 connections. The respondent noted that because of costs associated with treated surface water supplies, BWSC will most likely develop additional Trinity aquifer wells with greater production capacities than those currently being used.

The respondent for the Acton Municipal Utility District reported the District presently operates 18 public water supply wells using the Trinity aquifer. These wells augment surface water supplies and represent about 34 percent of the District’s total water production capacity. He noted that the District is presently planning to construct and develop five additional public water supply wells in area, and will continue to construct additional wells as needed.

The representative from Fannin County noted that groundwater use (in the county) has been heavy in the past and will be heavier in the future. He commented that the need to control usage and protection of the aquifer will become more important in the years to come.

<u>Wise Use of Groundwater</u> – Two respondents had concerns about the use of groundwater for urban irrigation. The respondent for the City of Denton noted the city’s permitting program for drilling new wells within the city’s corporate limits, and noted the city has not denied a new well permit to date. The respondent provided a table listing water well permits issued by the City of Denton. New wells have generally been used for irrigation purposes and have been chosen by users over available treated surface water and type 1 effluent. City water impact fees may discourage use of treated surface water for irrigation purposes, but such fees are not applicable to use of type 1 effluent. The respondent questioned whether this is the best use of region’s groundwater resources when other sources of water were available. A respondent for Samantha Springs in Tarrant County noted concerns about reduced spring flow from the impact of new domestic wells near the City of Keller and the new wells’ primary use for lawn irrigation.

The City of Denton respondent also noted that numerous developments have or are constructing amenity ponds in the Lake Lewisville watershed and the cities of Dallas and Denton (water right holders) are requiring the developments to “make up” for the evaporative losses that result from the ponds. The respondent noted the water to maintain pond levels can be significant and is often supplied by groundwater.

Water Quality Concerns – Two of the Hood County respondents had concerns about Lake Granbury and surface water quality issues. The respondent for Acton Municipal Utility District noted desalination of surface water from Lake Granbury is cost prohibitive for the District and the District must use groundwater supplies to mitigate this cost. The other Hood County respondent noted on-site septic system concerns and concerns about the lack of central sewerage infrastructure near parts of Lake Granbury. This respondent noted the recently funded and pending Lake Granbury Watershed Protection Plan to identify sources of pollution and protect water quality from those sources.

The respondent from the Parker County Health Department noted that most citizens in the unincorporated parts of the county rely on private water wells. He noted that most wells in eastern Parker County generally have good water quality. The respondent noted that, during 2004, 21 percent of the 242 private wells analyzed for coliform organisms and E. coli tested positive. He noted that most of the positive hits were from newly drilled and completed wells, and after chlorination, subsequent analyses was negative on all well samples. In addition, the respondent noted that a large part of western Parker County has no groundwater available because of a salt dome in the Millsap area and that private water wells in the southern part of the county have elevated hydrogen sulfide content.

The respondent for Samantha Springs described a prevalent use of on-site septic systems on one-acre lots. The respondent noted that the City of Keller was presently installing a sewage collection and treatment system in the area.

Concern About Adverse Impacts from Gas Wells – Respondents representing Monticello Spring Water and Johnson County Special Utility District noted concerns about potential groundwater quantity and quality impacts from increased natural gas exploration and production activities in the area. The Monticello Spring Water respondent also noted concerns about the apparent lack of regulation to protect groundwater resources from such activities.

Support Study and May Support Groundwater Management – Four respondents provided comments generally in support of this PGMA study and groundwater conservation districts where needed. The respondent for the Bartonville Water Supply Corporation noted support for the PGMA study and some type of reasonable restrictions being placed on groundwater users. He noted the necessity and requirement for public water systems to provide water service to those who request such within the boundaries of the system's certificated area and noted that this requirement should be considered as a priority use in the management of groundwater resources.

The respondent for the City of Fort Worth noted support for the ongoing study and expressed desire that the study would provide more information on what areas may need some form of groundwater oversight or regulation to maintain the resource. Mr. Meadows suggested that creation of a groundwater conservation district in Parker and western Tarrant counties may be an effective strategy to ensure that area residents have adequate groundwater resources in the future.

The representative from Fannin County noted that citizens will need to be aware of needs and options to create a groundwater conservation district and that creating such a district is the first step to insuring water for future generations.

Summary – In summary, 22 stakeholders provided comments in response to the July 26, 2005 study notice. The overdraft of groundwater supplies, wise use of groundwater resources, surface water quality, and potential groundwater quantity and quality impacts from booming natural gas exploration and production activities were the concerns most often voiced by the respondents. A small number of the respondents provided comments that some type of groundwater management or oversight in some parts of the study area may be warranted.

Draft Report Notice and Stakeholder Response

TCEQ made a draft report available for public comment and provided notice of the draft report's availability to over 1,300 stakeholders on December 14, 2006. Seventeen people contacted TCEQ to request a copy of the draft report or assistance in accessing the draft report on the agency's Internet Homepage. An additional ten people contacted TCEQ staff to ask questions about PGMA study, designation, hearing, and GCD creation processes and timelines; data considerations in the draft report; to request educational material; or to request comments or information provided by other stakeholders.

Twenty-seven respondents requested the comment period set to end on January 31, 2007, be extended. These respondents included the Honorable Bill Freeman, County Judge, Cooke Co.; Honorable Derrell Hall, County Judge, Fannin Co.; Ms. Tammy Rich, County Clerk, Fannin Co.; Honorable Monte Ashcraft, Mayor, City of Honey Grove, Fannin Co.; Honorable Robert Brady, Mayor, City of Denison, Grayson, Co.; Honorable Diana Barker, Mayor, City of Southmayd, Grayson Co.; Honorable David Hamrick, Mayor, City of Trenton, Fannin Co.; Honorable Bob Henderson, Mayor Pro-Tem, City of Callisburg, Cooke Co.; Honorable Leon Hurse, Mayor, City of Ladonia, Fannin Co.; Honorable Michael Jones, Mayor, City of Howe, Grayson Co.; Honorable Glen Loch, Mayor, City of Gainesville, Cooke Co. (verbal request.); Honorable Mike Parker, Mayor, City of Van Alstyne, Grayson Co.; Honorable Clete Stogsdill, Mayor, City of Savoy, Fannin Co.; Honorable Henry Weinzapfel, Mayor, City of Muenster, Cooke Co.; Mr. Ronald L. Ford, President, Fannin County Water Supply Agency; Ms. Polly Kruger, Manager, Boliver WSC, Cooke, Denton & Wise Cos.; Ms. Donna Loiselle, General Manager, Gunter SUD, Grayson Co.; Ms. Kay Lunnon, City Secretary, on behalf of the City of Gainesville; Mr. Jim Mathews, Mathews & Freeland, L.L.P., Austin, on behalf of the City of Gainesville; Mr. John McClellan, Vice President, Monarch Utilities I, L.P., Grayson Co.; Mr. Mark Newhouse, General Manager, Bois D' Arc MUD, Fannin Co.; Mr. William Ray, President, NW Grayson Co. WCID#1, Grayson Co.; Mr. Wayne Ryser, President, Bois D' Arc MUD, Fannin Co.; Mr. Ken Swirczynski, General Manager, Woodbine WSC, Cooke Co.; Mr. L. Scott Wall, City Manager, City of Sherman, Grayson Co.; Mr. John Watson, President, Two Way SUD, Grayson Co.; and, Mr. Warren Williams, General Manager, Luella SUD, Grayson Co. Mayors Barker, Brady, and Jones, Ms. Lunnon, and Mr. Watson also provided resolutions specifically requesting the comment period be extended, an opportunity to meet with TCEQ staff to discuss the draft report, and an opportunity to provide additional data and information.

In response to the above requests, TCEQ extended the comment period for an additional 90 days ending on April 30, 2007. Upon verbal requests and invitation from Mr. Jerry Chapman, General Manager, Greater Texoma Utility Authority (GTUA), TCEQ staff also met with many of the above respondents at an open meeting held in Sherman on April 12, 2007. The meeting was facilitated by the GTUA and hosted by Grayson County.

Additional responses were provided by the Honorable Drue Bynum, County Judge, on behalf of the Grayson County Commissioners Court; the Honorable Bill Freeman, County Judge, on behalf of the Cooke County Commissioners Court and the Cooke County PGMA Steering Committee; the Honorable Derrell Hall, County Judge, on behalf of the Fannin County Commissioners Court; the Honorable Keith Self, County Judge, on behalf of the Collin County Commissioners Court; the Honorable Ted Winn, County Judge, on behalf of the Montague County Commissioner Court, the cities of Bowie, Nocona, Saint Joe, and Sunset, and Amon Carter Lake Water Supply District; the Honorable Kim Brimer, Texas Senate (verbal request); Mr. Samuel Brush, Manager of Environment and Development, North Central Texas Council of Governments, on behalf of the NCTCOG's Water Resources Council (NCTCOG-WRC); Mr. Jerry Chapman, General Manager, Greater Texoma Utility Authority; Ms. Julia Clay of Bells, Grayson Co.; Dr. Hughbert Collier, P.G., Collier Consulting, Inc., Stephenville; Mr. Carl Daniel of

Pottsboro, Grayson Co.; Mr. James Gaddis; Mr. Jack Galloway Sr. of Bells, Grayson Co.; Mr. Thomas C. Gooch, P.E., Vice President, Freese and Nichols, Inc. (FNI); Ms. Debbie Hastings, Vice President for Environmental Affairs, Texas Oil & Gas Association (TXOGA); Mr. Ron Haynes, P.E., Public Works Director, City of Hurst; Mr. Joe Hines, Director of Public Works, City of Willow Park; Ms. Patricia Lambert of Coppell, Dallas Co.; Mr. Jim Leggieri, General Manager, Bartonville WSC (BWSC); Ms. Cindy Loeffler, P.E., Texas Parks and Wildlife Department (TPWD); Mr. Jim Mathews, Mathews & Freeland, L.L.P., Austin, on behalf of the City of Gainesville; Dr. Gordon McAdams and Ms. Leigh McAdams of Parker Co.; Mr. Joe McCombs, Samantha Springs; Mr. Ron McCuller, Public Works Director, City of Grand Prairie; Mr. Larry Standlee, Secretary, Fannin County Water Supply Agency (FCWSA); Mr. and Ms. George and Debra Strandberg of Parker Co.; Ms. Angela M. Stepherson, Crawford & Jordan, LLP, Dallas, on behalf of Denton Co. clients; Mr. Bob Tate, President, WSWS Company; Mr. Charles M. Vokes, Assistant Director of Utilities/Treatment, City of Arlington; Mr. Kevin Ward, Executive Administrator, Texas Water Development Board (TWDB); and, Mr. Larry Wingo of Wise Co.

<u>General Comments</u> – Dr. Collier, FNI, NCTCOG-WRC, Ms. Stepherson, TWDB, TXOGA, and Mr. Wingo commented the draft report, particularly the section related to Barnett Shale natural gas exploration, should be updated based upon new data contained in *Assessment of Groundwater Use in the Northern Trinity Aquifer Due to Urban Growth and Barnett Shale Development* (Bené , Hardin, Griffin, and Nicot, 2007). This TWDB contract report prepared by R.W. Hardin and Associates, Inc., Freese and Nichols, Inc., and the U.T. Bureau of Economic Geology was completed in January 2007.

FNI, Mr. Gaddis, GTUA, Mr. Mathews, TPWD, and TWDB provided comments requesting various clarifications of draft report text. FNI, GTUA, and Mr. Mathews commented that draft report statements about aquifer overdraft should be clarified. FNI and TPWD both commented that environmental impact summaries and discussions regarding proposed reservoirs and unique stream segments be clarified. GTUA commented the draft report made incorrect categorization of Region C Water Plan findings and that draft report conclusions differ from Region C Water Plan and Trinity aquifer GAM report (Hardin and Associates, et al., 2004) conclusions.

NCTCOG-WRC commented that while the vast majority of water supplies for the urban portion of the study area are derived from surface water sources, the drilling of new wells by groundwater-using communities, coupled with private well drilling for supply to developments in unincorporated areas and for irrigation, result in increased demands on Trinity and Woodbine aquifers in the area. NCTCOG-WRC commented that select member governments and water suppliers within the NCTCOG planning area depend on groundwater resources and in several cases are not in a position to convert to more reliable surface water supplies.

Mr. Hines commented that excessive lawn irrigation is a concern in the area. Mr. Hines describes high consumption of water purchased from local suppliers as well as drilling one or more wells for irrigation purposes on relatively small parcels of land. Ms. Lambert commented with similar concerns about groundwater use for irrigation or amenity pond uses and commented that she favored creation of a GCD to manage this type of groundwater use.

BWSC commented that it uses both surface water and groundwater sources to meet its growing service area needs. BWSC noted continuing and projected increases to local surface water rates and BWSC's present consideration to drill additional water supply wells to address present and future customer demands. BWSC also commented that all water purveyors are faced with the challenge of finding the most cost-effective way of providing safe, adequate, and affordable supplies and that availability and affordability are not synonymous. BWSC commented that an ideology that surface water is and will be the "cure all" to meet projected demands would be short-sighted. BWSC commented that even though treated surface water may be available, continuing use of groundwater sources will occur for economic reasons.

Mr. McCuller provided information about the use of the Trinity aquifer by the City of Grand Prairie and noted the City operates 11 Trinity wells in Dallas County and two Trinity wells in Tarrant County. Mr. McCuller noted that for a number of years, the City wells have been utilized only during peak use periods to mitigate other water supply costs. Mr. McCuller noted 2005 groundwater use by the City of Grand Prairie was about 0.57 billion gallons. He described City plans for the development of the area south of Joe Pool Lake and arrangements for a pipeline and wholesale water supplies to the Johnson County SUD that will utilize well water. Mr. McCuller commented that City of Grand Prairie anticipates the contract with Johnson County SUD will increase the use of Trinity aquifer groundwater by at least 2.2 billion gallons per year. Mr. McCuller also noted that by 2025, the City projects total groundwater usage will peak at approximately 4.0 billion gallons per year, which is the City's full well capacity.

NCTCOG-WRC and Mr. and Mrs. Strandberg commented that oil and gas production can have negative impacts on groundwater quality. The Strandbergs also noted concerns about the quantity of groundwater use for oil and gas operations. The Honorable Kim Brimer commented that he had concerns about water use for oil and gas exploration in Palo Pinto County and questioned whether the county could be included in the ongoing evaluation.

Collin County – The Honorable Keith Self provided TWDB information showing 96% surface water and 4% groundwater use in Collin County and indicated future use percentages are expected to remain about the same. Judge Self commented that Collin County is not presently using groundwater at an unsafe level and, with a decrease in reliance, will be able to safely regulate the resource. Judge Self commented that Collin County should be removed from the PGMA and be allowed to independently monitor groundwater conditions. Judge Self commented that the commissioners court will actively look into locally exercising the authorities provided in the Local Government Code relating to groundwater availability certification in the plat application process. Judge Self provided an April 24, 2007 Collin County Commissioners Court resolution that notes the county will seek to form a one-county, non-taxing GCD if the county is included in a PGMA.

Cooke County – The Honorable Bill Freeman et al. provided an April 23, 2007 Cooke County Commissioners Court resolution describing the appointment and purpose of the Cooke County PGMA Steering Committee, noting the committee's recommendation that Cooke County should not be included in a 13-county GCD and should be allowed to form a single-county GCD or possibly partner up with other like-minded entities to create a GCD, and requesting the TCEQ to consider the committee's findings. The Cooke County PGMA Steering Committee findings agreed with (1) the conclusion that groundwater will be a critical issue in Cooke County within the next 25 years, and (2) that a GCD would be beneficial to ensure groundwater management tools are available to address developing water supply concerns.

The Cooke County PGMA Steering Committee considered and evaluated available water-level data for Cooke County water wells and aquifer conditions in the Barnett Shale production area of the county. The committee commented that it anticipates that current and projected water usage and population and water demand projections for Cooke County are underestimated in the 2006 Region C Water Plan. The committee concluded that many positive efforts have been made to manage and protect the water resources in Cooke County, but there were no guarantees that climate change, population surges, or other unseen variables will allow these efforts to continue into the future. The committee recommended that Cooke County should act now to preserve future water supplies.

Mr. Mathews, commenting for the City of Gainesville, stated that the City opposes designating a PGMA or creating a GCD that would include Cooke County. Mr. Mathews commented that the City and Cooke

County are not experiencing or expected to experience in next 25 years critical groundwater problems. Mr. Mathews noted that present groundwater usage in Cooke County is less than the long term reliable supply as indicated in the Region C Water Plan, that groundwater use in the county has declined since 1999, and that available surface water and groundwater supplies will exceed the total anticipated water demand in the county well past the next 25-year planning horizon.

Mr. Mathews commented that the City of Gainesville has proactively invested and planned for the development of surface water supplies from Moss Lake, has preemptively and is presently implementing actions to reduce the City's reliance on groundwater, and is working and in discussions with other groundwater users in Cooke County to make surplus surface water supplies available to other water users groups to reduce their reliance upon groundwater sources. Mr. Mathews noted that the City of Lindsey has already constructed a pipeline that can be used to convey treated surface water supplies to its retail customers in anticipation of executing a wholesale water supply agreement with the City of Gainesville.

Mr. Mathews commented that the 2006 Region C Water Plan underestimates surface water supply available to the City of Gainesville and provided a copy of the City's newly amended certificate of adjudication for an additional diversion from Moss Lake of 3,240 acft/yr. Mr. Mathews commented that the City has developed a business plan that includes capital projects to facilitate the shift to greater reliance on surface water supply. The plan anticipates that the City of Gainesville will double its water treatment capacity to 2.0 million gallons per day (mgd) by 2009 and increase treatment capacity by another 1.0 mgd and provide 2.0 mgd to wholesale customers by 2012.

Mr. Mathews requested the report acknowledge that the water planning process is working in Cooke County and commented that conversions to available surface water sources was the most feasible, economic, and practicable solution for protection and management of groundwater resources in the county. Mr. Mathews commented that a GCD for Cooke County would penalize the City of Gainesville and other water providers who were presently moving to surface water sources and would delay implementation of recommended surface-water conversion strategies.

GTUA commented that it agreed with the City of Gainesville comments regarding Cooke County. GTUA noted a total water supply surplus out to 2060 for the county and recommended strategies and City of Gainesville planning to supply surplus surface water throughout the county. GTUA provided documentation that the Bolivar WSC, the second largest groundwater user in Cooke County, has requested negotiations with the City of Gainesville to purchase surface water in the future. GTUA requested that the efforts of the cities of Gainesville and Muenster to convert to surface water be recognized in the report.

<u>Fannin County</u> – The Honorable Derrell Hall commented that Fannin County believes it should not be included in the PGMA as proposed. GTUA commented that Fannin County will have a total water surplus at 2030 for municipal supply. Judge Hall and GTUA commented that the development of two significant surface water projects in Fannin County will enable a shift to surface water supply for most customers in the future. GTUA commented that all of the water suppliers in Fannin County support the Lower Bois D'Arc Lake project. Judge Hall commented that water levels have risen by 100 feet in parts of Fannin County. Judge Hall commented that if Fannin County is not removed from the PGMA, the commissioners court would favor a local GCD for Fannin County along with Cooke and Grayson counties. FCWSA noted general agreement with the draft report findings and commented that formation of a GCD is probably the surest way to assure conservation of the Trinity and Woodbine aquifers.

<u>Grayson County</u> – The Honorable Drue Bynum, Mr. Tate, and GTUA commented by describing conversions to surface water sources, surpluses of surface water supply, loss of high water-use industrial customers, distribution of surface water, and reduced groundwater use in Grayson County. Mr. Wall described City of Sherman conversions to surface water, reductions in groundwater use, and water

conservation awareness. Judge Bynum, GTUA, and Mr. Tate requested that Grayson County should be excluded from the proposed PGMA designation or any subsequent GCD. Mr. Galloway, Ms. Clay, and Mr. Daniel commented they were very much opposed to the creation of a GCD in Grayson County.

GTUA also commented that Grayson County is projected to have a total water supply surplus out to 2050. GTUA commented that treatment capacity facility changes could increase surface water supplies from 44,743 to over 51,000 acft/yr. GTUA described projects where several cities are already converting to surface water supplies. Most notably, the cities of Howe, Van Alstyne, Anna, and Melissa are scheduled to be on surface water by summer 2007 (Anna and Melissa in Collin Co.); the City of Gunter is presently pursuing a surface water contract with City of Sherman; the City of Denison is making surface water available to the City of Pottsboro, which is no longer dependent on groundwater for municipal supply; and, a project to expand City of Pottsboro capabilities around the southern area of Lake Texoma is scheduled to start in summer 2007. GTUA requested that City of Sherman efforts to convert to surface water supplies should be recognized in the report.

Montague County – The Honorable Ted Winn et al. commented in agreement that groundwater problems are presently occurring in Montague County. Judge Winn et al. commented that they anticipate Montague County population and water demand projections will be substantially greater than projected in the presently approved Region B Water Plan. Judge Winn et al. commented that the county should be included in a GCD to give the county the necessary authority to address groundwater management issues. Judge Winn et al. commented that Montague County may be better served by a smaller-scale GCD than the regional GCD recommended in the draft report.

Parker County – Ms. McAdams and Dr. McAdams of Parker County commented separately. Ms. McAdams commented that increasing minimum lot sizes for new subdivisions that will depend on private water wells would be more protective of the groundwater resource for existing and future residents. She described how a proposed subdivision adjacent to the McAdams' property would use significantly less groundwater if the number of lots were decreased. Dr. McAdams noted that requiring certification of groundwater availability in the plat application process and increasing minimum lot sizes for same-well, same-septic developments, in conjunction with a groundwater conservation district, are good management tools. Ms. McAdams and Dr. McAdams commented that groundwater management tools to increase lot sizes and require drawdown studies could be rapidly implemented at no costs to the taxpayers.

Mr. and Mrs. Strandberg commented in agreement with draft report conclusions that groundwater problems are presently occurring in Parker County. The Strandbergs commented that there are no alternative water supplies for their property other than the Trinity aquifer. They noted concerns about negative impacts to the Trinity aquifer from explosive unplanned home-building. The Strandbergs commented that they support groundwater management for the Trinity aquifer and the creation of a groundwater conservation district.

Other GCD Considerations –None of the respondents commenting on the issue favored the possible creation of a 13-county GCD. FNI and others suggested that several multi-county GCDs grouped on location and situational needs would be a better option. GTUA commented that groundwater users in Cooke, Grayson, and Fannin counties do not agree that a GCD is needed and are opposed to implementation of what they believe to be an unnecessary regulatory agency.

NCTCOG-WRC commented that if a GCD or GCDs is created and funded by well production fees, the fees should be limited to the cost of administering the program in the north-central Texas area only. Mr. Haynes commented that GCD fees should apply to all wells used commercially or for industry. Mr. Vokes and Mr. Haynes commented that any GCD fees proposed in the future should only cover what is needed for administrative costs. Mr. Vokes commented that surface water users should not be required to pay for GCD operations and that ad valorem taxes should not be used to generate GCD revenue. FCWSA commented that Water Code, Chapter 36 does not include provisions to dissolve an unnecessary GCD or to become removed from a GCD should aquifer conditions stabilize, and that costs of maintaining a GCD will be a burden on already thin budgets.

NCTCOG-WRC commented that ample time was needed for the water stakeholders to grasp all the GCD creation options and ramifications and that public participation will be vital in making groundwater management decisions. Mr. Vokes requested a public hearing.

GTUA, Mr. Hines, Mr. Mathews, and NCTCOG-WRC commented that exemptions from GCD permitting and regulatory authority granted to oil and gas drilling industry water supply wells would significantly hamper a GCD's ability to manage groundwater in the area. NCTCOG-WRC also recognized that this issue is difficult to address, but could be an issue that could undermine the ability of a GCD to effectively meet its purpose. Mr. Vokes and Mr. Haynes commented that gas drilling and disposal wells should be subject to GCD regulations and the exemptions from GCD authority should be repealed.

Summary – In response to the December 2006 release of the draft report, 27 respondents requested additional time to consider the draft report and to provide comments back to TCEQ. The comment period was extended and by April 30, 2007, over thirty stakeholders provided written comments related to the draft report's findings, conclusions, and recommendations. These stakeholders represented county and municipal officials and staff; a county commissioners court-appointed steering committee; the regional council of governments for most of the study-area counties; a regional water planning group consultant; regional, local, and rural water suppliers; state agencies and organizations; and, concerned citizens. The majority of the respondents were from the northern study-area counties.

About half of the respondents commented on draft report data considerations and conclusions but were generally neutral to recommendations regarding PGMA designation and GCD creation. County officials from Collin, Fannin, and Grayson counties; the City of Gainesville; Greater Texoma Utility Authority; one Grayson County water supplier; and three residents of Grayson County opposed both the inclusion of their counties in a PGMA and the potential creation of a GCD. County officials from Cooke and Montague counties, five county-appointed steering committee members from Cooke County, four cities and one water supply district from Montague County, four residents of Parker County, and one resident of Dallas County supported draft report recommendations regarding designation of the area as a PGMA and the need to establish groundwater management districts. None of the respondents who commented on the issue favored the possible creation of a 13-county GCD in the area. The regional water planning group consultant and others suggested that several multi-county GCDs grouped on location and situational needs would be a better option than a regional GCD. Several of the respondents commented that single- or multi-county GCD creation options may be explored in the future if the TCEQ includes their specific county in a PGMA.

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WATER SUPPLY CONCERNS

This chapter summarizes data and information to evaluate whether the study area is experiencing or is expected to experience, within the next 25-year period, critical groundwater problems. Discussions in this chapter regard groundwater level declines that may be indicative of aquifer overdrafting, water quality conditions that may limit usability, water supply concerns, and environmental obligations. This discussion relies primarily upon work of the Region B, Region C, Brazos G, and North East Texas Water Planning Groups, and information from the TWDB, TCEQ, and TPWD.

Groundwater Levels

More groundwater is being withdrawn than recharged to aquifers in the North-Central Texas study area. Historically, pumpage has exceeded recharge resulting in declining water levels, removal of water from aquifer storage, and possible deterioration of chemical quality in the Antlers, Twin Mountains, and Paluxy Formations of the Trinity Group aquifer and the Woodbine aquifer. Water-level declines and associated reduction of artesian pressure caused by the continued removal of water from aquifer storage are a regional groundwater problem. In general, regional water levels have not declined greatly in the aquifer outcrop areas but large declines in artesian pressure have occurred in the downdip, confined portions of the aquifers. Large declines in artesian pressure impact well owners economically by causing them to pump their wells for longer periods of time to produce the same volume of water and paying for increased water-lift costs. Artesian pressure declines can also impact well owners by causing them to have well pumps lowered or to have wells deepened.

- The 1984 State Water Plan (Texas Department of Water Resources, 1984) recognized that overdrafts were occurring in the Trinity Group aquifer in Cooke, Dallas, Denton, Grayson, Hood, Johnson, and Tarrant counties and in the Woodbine aquifer in Ellis, Fannin, and Grayson counties.

- Baker, Duffin, Flores, and Lynch (1990) documented water-level declines from 1976–1989 in the following formations:
    - Antlers Formation in Cooke, Denton, and Grayson counties;
    - Twin Mountains Formation in Dallas, Denton, Ellis, Johnson, and Tarrant counties;
    - Paluxy Formation in Denton and Johnson counties; and,
    - Woodbine Group in Collin, Fannin, and Grayson counties.

- Ashworth and Hopkins (1995) noted that: extensive development of the Trinity aquifer in the Dallas-Fort Worth area had historically lowered water levels as much as 550 feet, water levels were rebounding in areas converting to surface water supplies, Trinity aquifer water level declines of as much as 100 feet continued to occur in Denton and Johnson counties, and heavy municipal and industrial pumpage contributed to Woodbine aquifer water-level declines in excess of 100 feet in the Sherman-Denison area of Grayson and surrounding counties.

- Langley (1999) reported that additional water-level declines were observed from 1989–1997 in the Antlers, Twin Mountains, Paluxy, and Woodbine Formations in Cooke, Denton, Grayson, Johnson, Parker, Tarrant, and Wise counties.

- The 2001 Region C Water Plan (Freese and Nichols, Inc., et al., 2001) notes that groundwater use exceeds long-term supply in the Trinity Group aquifer in Cooke, Denton, Grayson, Parker and Tarrant counties and in the Woodbine aquifer in Denton, Ellis, and Grayson counties.

- The 2004 Trinity-Woodbine aquifer groundwater availability model (GAM) report by Harden & Associates, et al. (2004) notes that model runs predict future water-level drawdown and recovery in the study area. Up to 200 feet of drawdown is predicted to occur in the Woodbine aquifer in Fannin and Lamar counties from 2010 to 2050 using either average annual recharge or drought-of-record recharge simulations. The model runs for the Paluxy layer of the Trinity aquifer predict an additional 100 feet of drawdown to occur in Dallas and Ellis counties by 2010 and gradual long-term water-level declines to occur in the eastern part of the study area through 2030. The model runs for the Hensel and Hosston layers of the Trinity aquifer predicts significant water-level recoveries in Tarrant, Dallas and surrounding counties.

  The GAM report concludes that, from a practical standpoint, there has been little reduction in the amount of water in storage in the Northern Trinity/Woodbine system and the decreases in artesian storage or water table storage that have occurred are insignificant compared to the amount of water still present in the aquifer. The report also concludes that the GAM simulation of the aquifer response to the future pumpage projected by the TWDB and regional water planning groups shows a recovery of artesian pressure in the Trinity and Woodbine aquifers of many hundreds of feet because of a predicted reduction in pumpage. The report notes that this simulation is one possible scenario, that it is uncertain that future pumpage will decline by the amounts forecast in the simulation, and that projected growth throughout the IH-35 corridor will likely exert pressure to continue use of the Trinity and Woodbine aquifers at existing or possibly even greater levels (Harden & Associates, et al., 2004).

- The 2006 Region C Water Plan (Freese and Nichols, Inc., et al., 2006) notes the present use of groundwater exceeds or is near the estimate of long-term reliable groundwater supply in many counties in the study area. The plan notes that groundwater pumpage from the Trinity aquifer in Collin, Cooke, Dallas, Ellis, Grayson, Tarrant, and Wise counties above or near the estimated long-term sustainable supply. The plan notes that overdevelopment of aquifers and resulting water-level declines pose a threat to small water suppliers and domestic user in rural areas. The 2006 regional water plan estimates for reliable or safe groundwater supply are tabulated in Appendix 5.

- Figure 7.15 of the 2007 State Water Plan (TWDB, 2007) illustrates the most significant historic water-level declines in the state have occurred in the Trinity aquifer in the study area centered in Dallas, Ellis, Johnson, and Tarrant counties, and in McLennan County (Waco) to the south. Figure 7.18 of the report also illustrates localized water-level declines of over 100 feet between 1994 and 2004 in Collin, Cooke, Denton, Grayson, Johnson, and Tarrant counties, and other localized water-level rises of over 100 feet in Dallas, Fannin, and Grayson counties.

- Bené, Harden, Griffin, and Nicot (2007) ran 2000 – 2025 low- and high-groundwater use simulations on the Trinity/Woodbine GAM based on (1) updated municipal, manufacturing, irrigation, and livestock groundwater demands in Denton, Hood, Johnson, Parker, Tarrant, and Wise counties and, (2) new Barnett Shale development groundwater demands for Dallas, Denton, Ellis, Hood, Johnson, Parker, Tarrant, Wise, and 14 other counties to the south and west. The low-demand estimate simulation shows some recovery of piezometric head in the Hensell and Hosston layers in Dallas and Tarrant counties and additional declines in the rest of the aquifer area. The low-use simulation also suggests additional declines in the Paluxy layer over the next 20 years. In the high-use simulation, the GAM suggests that water level declines will occur throughout the Trinity aquifer in the Paluxy, Hensell, and Hosston layers except for part of eastern Tarrant County in the Hosston. The high-demand simulation also projects locations in Comanche, Erath, Hood, Montague, Parker, and Wise counties where dewatering of the unconfined portion of the aquifer could occur.

Identified Water Supply Needs and Groundwater Strategies to Address Needs

The following information is summarized from the adopted 2001 regional water plans, the 2002 State Water Plan, and the approved 2006 regional water plans. The major water supply strategies that have been recommended by the planning groups to address water shortages in the study area primarily involve in- and out-of-area surface water supplies. The purpose of the following discussion is to identify the regional water planning group strategies for study area water user groups to meet anticipated needs through continued pumpage, aquifer overdraft, or by placing new demands on groundwater sources.

Study Area Counties in the Region C Water Planning Area

Conservation, new surface water supplies, reuse, and supplemental wells (i.e., replacement of existing wells or addition of new wells to maintain the same level of supply) are some of the recommended strategies to meet projected water supply shortages in Kaufman, Navarro and Rockwall counties (Freese and Nichols, Inc., et al., 2006). It is anticipated that groundwater usage will remain fairly constant in these counties through 2030.

- Kaufman County – Supplemental Nacatoch aquifer wells are recommended for the county-other, irrigation, and livestock user groups. New surface water supplies and direct reuse are also recommended to address the projected shortages for these user groups.

- Navarro County – In addition to conservation and new surface water supplies, supplemental Trinity and Woodbine aquifer wells for the county-other user group, and supplemental Woodbine aquifer wells for the City of Frost, are recommended strategies. Supplemental Carrizo-Wilcox, Nacatoch, and other aquifer wells are recommended for the livestock and mining user groups.

- Rockwall County – Conservation, new surface water supplies, and supplemental wells in other aquifers are recommended for the county-other and livestock user groups.

Supplemental wells will be needed and are also Region C Water Plan recommended strategies for continued supply for various water user group needs in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Parker, Tarrant, and Wise counties. These strategies do not indicate new demands on groundwater resources, but they do represent continued demands that are not anticipated to decrease. Supplemental wells are recommended for over 160 water user groups in this 10-county area.

Aquifer overdraft – using groundwater in quantities above the estimated long-term reliable supply – through the year 2010 is a recommended Region C Water Plan strategy for the municipal, rural water supply, county-other, irrigation, and manufacturing user groups listed in Tables 4 and 5 in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Parker, Tarrant, and Wise counties. Overdrafting the Trinity aquifer by an additional 4,473 acre-feet per year (acft/yr), and overdrafting the Woodbine aquifer by an additional 811 acft/yr, from both existing and new wells is considered an interim management strategy through 2010 to meet demands while other alternative water supplies, primarily surface water, are being connected or developed (Freese and Nichols, Inc., et al., 2006).

Table 4. Region C Water Plan Recommended Trinity Aquifer Overdraft Through 2010

Water User Group	**County (s)**	**Recommended 2010 Trinity Aquifer Overdraft (acft/yr)**
City of Anna	Collin	294
Gunter Rural WSC	Collin & Grayson	50
Bolivar WSC	Cooke, Denton & Wise	180
City of Lindsay	Cooke	20
Woodbine WSC	Cooke & Grayson	140
County-other	Cooke	86
Irrigation	Cooke	116
City of Wilmer	Dallas	322
Bartonville WSC	Denton	50
City of Pilot Point	Denton	200
Buena Vista-Bethel SUD	Ellis	56
Sardis-Lone Elm WSC	Ellis & Dallas	50
City of Ladonia	Fannin	254
City of Collinsville	Grayson	90
City of Gunter	Grayson	113
City of Tioga	Grayson	50
Two Way SUD	Grayson & Cooke	159
City of Whitesboro	Grayson	290
City of Aledo	Parker	149
City of Annetta	Parker	57
City of Annetta South	Parker	12
City of Hudson Oaks	Parker	57
City of Kennedale	Tarrant	483
City of Lakeside	Tarrant	161
City of Pantego	Tarrant	149
City of Pelican Bay	Tarrant	72
City of Alvord	Wise	137
County-other	Wise	676
Recommended 2010 Trinity Aquifer Overdraft Total		*4,473*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.		

Table 5. Region C Water Plan Recommended Woodbine Aquifer Overdraft Through 2010

Water User Group	County (s)	Recommended 2010 Woodbine Aquifer Overdraft (acft/yr)
City of Anna	Collin	242
City of Blue Ridge	Collin	189
City of Weston	Collin	121
City of Maypearl	Ellis	19
Manufacturing	Ellis	101
City of Leonard	Fannin	23
City of Savoy	Fannin	4
Southwest Fannin Co. SUD	Fannin & Grayson	83
City of Tom Bean	Grayson	29
Recommended 2010 Woodbine Aquifer Overdraft Total		*811*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.		

New Trinity and Woodbine aquifer water supply wells or using additional volumes of groundwater from existing wells are also recommended strategies for municipal, rural water supply, county-other, irrigation, manufacturing, and mining water user groups in Collin, Cooke, Denton, Ellis, Fannin, and Grayson counties. The water user groups in Cooke, Ellis, Fannin, and Grayson counties listed in Table 6 are projected to use new Trinity aquifer supplies of 2,228 acft/yr by 2010, 3,391 acft/yr by 2020, and 4,333 acft/yr by 2030. This projected supply is over and above projected 2010 Trinity aquifer overdraft, and present use.

Table 6. Region C Water Plan Recommended New Trinity Aquifer Production 2010 – 2030

Water User Group	County (s)	New Trinity Aquifer Production (acft/yr)		
		2010	2020	2030
Bolivar WSC	Cooke, Denton & Wise	510	560	1,200
County-other	Cooke	213	362	367
Irrigation	Cooke	24	140	140
Mining	Cooke	35	48	55
Mountain Peak WSC	Ellis	204	265	300
County-other	Ellis	201	192	170
City of Ector	Fannin	10	10	10
City of Gunter	Grayson	80	122	119
City of Southmayd	Grayson	0	25	30
City of Tioga	Grayson	9	86	119
City of Tom Bean	Grayson	74	58	54

Water User Group	County (s)	New Trinity Aquifer Production (acft/yr)		
City of Van Alystyne	Grayson	229	713	870
Manufacturing	Grayson	639	810	899
New Trinity Aquifer Production Totals		*2,228*	*3,391*	*4,333*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.				

The water user groups listed in Table 7 in Collin, Denton, Ellis, Fannin, and Grayson counties are projected to use new Woodbine aquifer supplies of 3,046 acft/yr by 2010, 3,413 acft/yr by 2020, and 3,410 acft/yr by 2030. Again, this projected supply is over and above projected 2010 Woodbine aquifer overdraft and present use.

Table 7. Region C Water Plan Recommended New Woodbine Aquifer Production 2010 – 2030

Water User Group	County (s)	New Woodbine Aquifer Production (acft/yr)		
Hickory Creek SUD	Collin & Fannin	0	3	6
Mining	Denton	202	202	202
City of Bardwell	Ellis	34	58	84
City of Italy	Ellis	95	140	172
City of Maypearl	Ellis	27	46	49
County-other	Ellis	729	880	919
Irrigation	Ellis	563	563	563
County-other	Fannin	215	190	180
City of Whitewrite	Fannin & Grayson	116	185	211
City of Bells	Grayson	63	8	7
Luella WSC	Grayson	81	28	0
City of Sherman	Grayson	827	742	428
City of Southmayd	Grayson	54	50	52
Manufacturing	Grayson	40	318	537
New Woodbine Aquifer Production Totals		*3,046*	*3,413*	*3,410*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.				

The City of Addison and the City of The Colony are presently considering aquifer storage and recovery (ASR) projects as potentially feasible strategies to reduce peak demands on surface water supplies. Neither project will provide additional water supplies on an annual basis.

A large part of the water supplied in the Region C Water Planning Area is provided by five major water providers: Dallas Water Utilities (DWU), City of Fort Worth, North Texas Municipal Water District (NTMWD), Tarrant Regional Water District (TRWD), and the Trinity River Authority (TRA). These five entities are expected to provide the majority of the water supply for the Region C Water Planning Area through 2060 (Freese and Nichols, Inc., et al., 2006). The NTMWD supplies most of the water used in Collin and Rockwall counties and will continue to do so in the future. Most of Dallas County's current demands are met by DWU, with NTMWD also providing major supplies.

Water suppliers in Denton County are increasing their use of surface water supplies and present groundwater use from the Trinity and Woodbine aquifers exceeds the estimated long-term reliable supply. The Upper Trinity Regional Water District (UTRWD) supplies water to many user groups in the county and is expected to continue to provide this service. DWU, the City of Denton, NTMWD, and TRWD also provide water in Denton County.

The TRWD presently supplies and will continue to supply most of the water used in Tarrant County. The City of Fort Worth and the TRA purchase water from TRWD, treat the water, and sell it to other water user groups in Tarrant and surrounding counties. These user groups will continue to purchase additional water from TRWD, Fort Worth, and TRA to meet future demands. The present use of the Trinity aquifer in the county exceeds the aquifer's long-term reliable supply.

In 2000, groundwater provided the majority of the total water use in Cooke, Grayson, and Parker counties and over 25 percent of total water use in Ellis, Fannin, Hood, Johnson, Montague, and Wise counties. The connection to existing reservoirs or development of new regional surface water supply systems for Cooke, Ellis, Fannin, Grayson, Parker, and Wise counties are recommended 2006 Region C Water Plan strategies to supplement or replace groundwater supplies. The 2006 Region C Water Plan and additional information provided by stakeholders note the following for these counties.

- Cooke County – By 2020, due to limited groundwater availability in the county, the City of Gainesville (City) would develop the Cooke County Water Supply Project. The project would provide treated surface water from Moss Lake to the City, Bolivar WSC, county-other, irrigation, Kiowa Homeowners WSC, City of Lindsay, City of Valley View, and Woodbine WSC. This project would require a new pipeline from Moss Lake, a water transmission system, and a total of seven million gallons per day (mgd) in water treatment plant expansions. This strategy would provide an additional 3,689 acft/yr from Moss Lake, would use all water currently permitted under the City's existing water right in Moss Lake, and would require the City of Gainesville to obtain an additional water right in Moss Lake.

  The City of Gainesville and the Greater Texoma Utility Authority (GTUA) provided comments for this report related to the conversion to surface water supplies in Cooke County. The City provided a copy of the April 2006 amended certificate of adjudication for an additional diversion from Moss Lake of 3,240 acft/yr and noted it has developed a business plan that includes capital projects to facilitate the shift to greater reliance on surface water supply. The plan anticipates that the City of Gainesville will double its water treatment capacity to two mgd by 2009 and increase treatment capacity by another one mgd and provide two mgd to wholesale customers by 2012. The City of Lindsey has already constructed a pipeline that can be used to convey treated surface water supplies to its retail customers in anticipation of executing a wholesale water supply agreement with the City of Gainesville. GTUA provided documentation that the Bolivar WSC, the second largest groundwater user in Cooke County, has requested negotiations with the City of Gainesville to purchase surface water in the future.

- Ellis County – The TRA supplies a large amount of water to the county and by 2010, due to limited groundwater supplies, would develop the Ellis County Water Supply Project. The project would deliver raw water from TRWD pipelines to water suppliers in the county. Raw water would be taken from the TRWD pipelines and treated at regional facilities, probably operated by the cities of Ennis, Waxahachie, and Midlothian. The present plan is for the project to begin by 2010. This project and strategy is projected to provide 26,582 ac/yr to the county by 2060.

- Fannin County – Two Region C Water Plan recommended strategies involve new reservoirs in Fannin County. The NTMWD plans to develop Lower Bois d'Arc Creek Reservoir on Bois d'Arc Creek in the Red River Basin by 2020. This reservoir is projected to provide up to 123,000 acft/yr of supply for NTMWD and the county. NTMWD would also cooperate with county entities to develop the Fannin County Water Supply Stystem in 2020. This system would involve one or more water treatment plants and a treated water distribution system. The UTRWD has applied for a water right permit to develop the proposed Lake Ralph Hall on the North Sulphur River in southeastern Fannin County. The project is projected to yield about 32,940 acft/yr by 2020. About 80 percent of the water from Lake Ralph Hall would be transported to Denton County. The remaining 20 percent would be available for use in southern Fannin County.

- Grayson County – By 2020, the Greater Texoma Utility Authority would develop the Grayson County Water Supply Project to provide treated surface water from Lake Texoma to county customers. Phase 1 would be completed by 2020 and includes a 25 mgd water treatment plant expansion, a new 1.0 mgd water treatment plant in northwestern Grayson County, and a water transmission system. Phase 2, including a 20 mgd water treatment plant expansion, would be constructed by 2040. This strategy would use all water currently permitted under GTUA's existing water right (with interbasin transfer authorization) in Lake Texoma.

  The City of Sherman (City) provided comments for this report noting the City started supplementing groundwater supplies with surface water starting in 1993 and has since reduced groundwater consumption from 10 – 11 mgd to an average of 4.4 mgd in 2006. The City commented that it presently has an available surface water supply of about 25 mgd and is pursuing opportunities to provide surface water to other water user groups in Grayson County largely dependent on groundwater sources. GTUA provided comments noting the cities of Howe, Van Alstyne, Anna, and Melissa are scheduled to be on surface water by summer 2007 (Anna and Melissa in Collin County); the City of Gunter is presently pursuing a surface water contract with City of Sherman; the City of Denison is making surface water available to the City of Pottsboro, which is no longer dependent on groundwater for municipal supply; and a project to expand City of Pottsboro capabilities around the southern area of Lake Texoma is scheduled to start in summer 2007.

- Parker County – The TRWD and the cities of Weatherford and Fort Worth (from TRWD) are the primary wholesale water providers in the county. The East Parker County System is the recommended strategy to deliver treated water to various cities in the county. The project would likely be developed by the Parker County MUD with the City of Weatherford supplying treated water to the participants. The source would be raw water delivered to the City of Weatherford by the TRWD.

- Wise County – The TRWD presently supplies water for use in the county to the Walnut Creek Special Utility District (SUD), West Wise WSC, Wise County Water Supply District (WSD), and directly to seven other water user groups. Additional TRWD water and expanded or new treatment and distribution infrastructure are recommended for the Walnut Creek SUD, West Wise WSC, and Wise County WSD to meet the projected needs of their seven existing customers, and to serve the cities of Alvord, Newark, and New Fairview by 2010.

The 2006 Region C Water Plan recommends strategies for 27 water user groups to reduce Trinity aquifer use by a total of 1,604 acft/yr by 2010, 3,054 acft/yr by 2020, and 4,168 acft/yr by 2030 (Table 8). Reduced groundwater production strategies for the City of Sherman (Grayson County) account for over one-third of these totals. In 2010, water user groups in Grayson and Denton counties account for about 47 percent and 26 percent of the projected reductions, respectively. In 2030, these two counties still account for about 44 percent and 32 percent of the projected reductions, respectively. The 2006 Region C Water Plan projects that Trinity aquifer supply for 130 water user groups that rely totally or in part on the Trinity aquifer remains at constant quantities over the planning period. However, Trinity aquifer supply for seven

Region C water user groups is projected to change over the planning period (Table 9). Almost all of this projected reduction in Trinity aquifer supply is from the City of Gainesville (Cooke County).

Table 8. Region C Water Plan Recommended Strategy to Reduce Trinity Aquifer Production 2010—2030

Water User Group	County (s)	Reduce Trinity Aquifer Production (acft/yr)		
		2010	2020	2030
Gunter Rural WSC	Collin	0	-50	-50
South Grayson WSC	Collin & Grayson	-75	-75	-75
Kiowa Homeowners WSC	Cooke	0	-100	-100
Two Way WSC	Cooke & Grayson	0	-24	-18
Livestock	Cooke	-59	-59	-59
Sardis-Lone Elm WSC	Dallas & Ellis	0	-250	-250
City of Argyle	Denton	-40	-50	-102
Argyle WSC	Denton	-40	-50	-102
City of Aubrey	Denton	-20	-24	-50
City of Bartonville	Denton	-20	-25	-50
Bartonville WSC	Denton	0	-35	-72
Copper Canyon	Denton	-6	-8	-16
Cross Roads	Denton	-9	-11	-22
County-other	Denton	-20	-20	-38
Double Oak	Denton	-11	-13	-27
Highland Village	Denton	-141	-176	-361
City of Justin (redistribution to others)	Denton	-35	-88	-141
Krugerville	Denton	-6	-7	-15
Mustang SUD	Denton	-33	-41	-85
City of Pilot Point	Denton	0	0	-113
City of Ponder	Denton	0	0	-39
City of Sanger (redistribution)	Denton	-54	-136	-217
Manufacturing	Ellis	-175	-210	-225
City of Bells	Grayson	0	-35	-35
County-other	Grayson	-100	-200	-300

		Reduce Trinity Aquifer Production (acft/yr)		
City of Sherman	Grayson	-660	-1,150	-1,350
City of Whitesboro	Grayson	0	-117	-156
Livestock	Wise	-100	-100	-100
Totals – 27 Water User Groups	*Six Counties*	*-1,604*	*-3,054*	*-4,168*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.				

Table 9. Seven Water User Groups With Projected Trinity Aquifer Supply Changes

Water User Group	County (s)	Projected Trinity Aquifer Supply (acft/yr)			20-Year Difference (acft/yr)
		2010	2020	2030	
South Grayson WSC	Collin & Grayson	363	363	362	-1
City of Gainesville	Cooke	2,066	1,555	1,066	-1,000
Two Way SUD	Cooke & Grayson	441	442	442	1
City of Hickory Creek	Denton	33	39	42	9
City of Lake Dallas	Denton	77	70	66	-11
Shady Shores	Denton	19	21	22	3
Johnson County SUD (Region C only)	Johnson	1	0	0	-1
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1. Projected Trinity aquifer supply for other water user groups remains consistent through planning period.					

The Trinity aquifer overdraft and new production strategies for the Region C water user groups exceed the recommended strategies to reduce use by 5,097 acft/yr in 2010. At 2020, 3,391 acft/yr of new Trinity aquifer use is offset by 3,054 acft/yr of reduced use and 510 acft/yr of reduced supply. From 2010 to 2020, projected and recommended Trinity aquifer reductions are greater than new use recommendations by 173 acft/yr. For 2030, 4,333 acft/yr of new Trinity aquifer use is offset by 4,168 acft/yr of reduced use and 1,000 acft/yr of reduced supply. Over the 20-year period from 2010 to 2030, projected and recommended Trinity aquifer reductions are greater than new use recommendations by 835 acft/yr.

Region C Water Plan strategies are recommended for four Grayson County and two Fannin County water user groups to reduce Woodbine aquifer use by a collective 1,563 acft/yr by 2010, 1,486 acft/yr by 2020, and 1,421 acft/yr by 2030 (Table 10). Over 80 percent of this projected reduction would be from the irrigation and county-other user groups in Grayson County. In addition, minor changes in Woodbine aquifer supply are projected and reported for eight Region C water user groups (Table 11). Reported Woodbine aquifer supply for the other 53 Region C water user groups that rely totally or in part on the Woodbine aquifer remains at constant quantities over the planning period. The Region C Water Plan recommended strategies for Woodbine aquifer overdraft in 2010 and new Woodbine aquifer production exceed recommended strategies to curtail aquifer use by 2,294 acft/yr in 2010. Recommended strategies for new Woodbine aquifer production exceed strategies to reduce aquifer use by 1,931 acft/yr in 2020 and 1,998 acft/yr in 2030.

The Region C Water Plan notes that no existing entities can force groundwater users to reduce pumping. It also illustrates that the present use of the Trinity aquifer in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Parker, Tarrant, and Wise counties is greater than or near the long-term reliable supply, and that if the projected reliable supply for the aquifer is correct, users will find it necessary to obtain other supplies. The Region C Water Plan suggests that local water suppliers and government officials should consider the formation of groundwater conservation districts in the areas of heavy groundwater use.

Table 10. Region C Water Plan Recommended Strategy to Reduce Woodbine Aquifer Production 2010—2030

Water User Group	County (s)	Reduce Woodbine Aquifer Production (acft/yr)		
		2010	**2020**	**2030**
South Grayson WSC	Collin & Grayson	-75	-75	-75
Steam Electric Power	Fannin	-120	-100	-100
City of Honey Grove	Fannin	0	-20	-40
Irrigation	Grayson	-698	-550	-388
Livestock	Grayson	0	-31	-55
County-other	Grayson	-670	-710	-763
Totals – Six Water User Groups	*Three Counties*	*-1,563*	*-1,486*	*-1,421*
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1.				

Table 11. Eight Water User Groups With Projected Woodbine Aquifer Supply Changes

Water User Group	County (s)	Projected Woodbine Aquifer Supply (acft/yr)			20-Year Difference (acft/yr)
		2010	**2020**	**2030**	
Hickory Creek SUD	Collin & Fannin	45	45	44	-1
City of Lake Dallas	Denton	166	150	142	-24
City of Hickory Creek	Denton	71	84	90	19
Shady Shores	Denton	41	44	47	6
North Hunt WSC	Fannin	60	65	71	11
City of Whitewright	Fannin & Grayson	437	438	437	0
City of Tom Bean	Grayson	289	288	288	-1
County-other	Grayson	1,659	1,658	1,658	-1
Source: Freese and Nichols, Inc., et al., 2006; Appendix V, Table V-1. Projected Woodbine aquifer supply for other water user groups remains consistent through planning period.					

Study Area Counties in the Brazos G Regional Water Planning Area

In Hood County, four water user groups are projected to have shortages by 2030 – Oak Trail Shores of 114 acft/yr, county-other of 1,195 acft/yr, manufacturing of 8 acft/yr, and mining of 25 acft/yr. Purchasing water from the City of Granbury is the strategy adopted by the Brazos G Regional Water Planning Group for these users to address their shortages. The City of Granbury is projected to have a surplus of 4,888 acft/yr at 2030. The water sources for the City of Granbury are not anticipated to change much over the next 30-year period and consist of about 93 percent surface water from Lake Granbury and 7 percent groundwater from the Trinity aquifer. Also in Hood County, the Acton Municipal Utility District responded that it presently operates 18 public water supply wells using the Trinity aquifer to augment surface water supplies from Lake Granbury. The District reported that it is presently planning to construct five additional public water supply wells in the area and will continue to construct additional wells as needed. The 2006 Brazos G Water Plan indicates that groundwater supply for the Acton Municipal Utility District only increases by four acft/yr between 2000 and 2030. During this time frame, the municipal water supply in Hood County from groundwater sources is anticipated to increase a total of 18 acft/yr (Brazos G Regional Water Planning Group et al., 2006).

Fourteen water user groups in Johnson County are projected to have water supply shortages by 2030 (Brazos G Regional Water Planning Group et al., 2006), and 12 of these water user groups presently rely all or in part on groundwater supplies from the Trinity aquifer. The predominant water management strategy adopted by the Brazos G Regional Water Planning Group is for these user groups to purchase surplus water from nearby regional or local wholesale and municipal water suppliers. These strategies to meet projected 2030 shortages include purchasing water from the:

- City of Fort Worth by the Bethany WSC, Bethesda WSC, and City of Burleson;
- Brazos River Authority by the City of Godley, City of Joshua, and mining user group;
- City of Midlothian by the Mountain Park WSC; and,
- City of Cleburne for the manufacturing and steam electric user groups.

The Parker WSC, City of Rio Vista, and county-other user groups are projected to have 2030 shortages of 400 acft/yr, 69 acft/yr, and 2,516 acft/yr, respectively. The recommended strategy for these user groups is conservation and purchasing water from the Johnson County SUD. The Johnson County SUD obtains is water supply from groundwater from the Trinity aquifer, and through a contract with the BRA for water from Lake Granbury Surface Water and Treatment System (SWATS).

The Johnson County SUD is projected to have a 2030 shortage of 2,456 acft/yr. The adopted strategies to address this shortage are conservation and purchasing water from the Trinity River Authority (TRA). The TRA and Johnson County SUD are presently discussing the development of a project to supply up to 20,000 acft/yr of indirect reuse water through Joe Pool Lake for use in Johnson County. This project is assumed to be developed by 2020 in conjunction with the Dallas County Reuse Project (Freese and Nichols, Inc., et al., 2001) for steam electric power. It is assumed that Johnson County SUD will develop transmission and treatment facilities to use the water from Joe Pool Lake. The alternative strategies suggested to meet the projected Johnson County SUD 2030 shortage are (1) desalination of brackish surface water from Lake Granbury and fresh to brackish groundwater from the Woodbine and Paluxy aquifers in the northeast part of the county, and (2) aquifer storage and recovery with new, dual purpose wells used to inject potable water from the BRA SWATS plant on Lake Granbury into the Trinity aquifer for storage and recovery by public supply wells.

The recommended strategy for the City of Alvarado to meet a projected 2030 shortage of 473 acft/yr is to overdraft the Trinity aquifer from 2010 to 2030, and then to purchase water from the City of Venus. The City of Venus obtains its water supply from groundwater from the Woodbine aquifer (13 percent) and surface water from the City of Midlothian (87 percent). The City of Venus is projected to have a water supply surplus of 1,015 acft/yr out to 2030 and 1,021 acft/yr out to 2060.

Study Area Counties in the North East Texas Regional Water Planning Area

No water shortages are projected through 2030 for Red River County. A 2030 shortage of 33 acft/yr is projected for the Ben Franklin WSC in Delta County, and in Lamar County, a 2030 shortage of 20 acft/yr is projected for the Petty WSC. Contracts to secure surface water supplies from nearby providers are the recommended strategies to address these projected shortages.

Six Hunt County water user groups are projected to have supply shortages by 2030. Two new Nacatoch aquifer wells are the recommended strategy for the Campbell WSC to meet the projected shortage of 101 acft/yr. One new Woodbine aquifer well is the recommended strategy for the Hickory Creek SUD to meet a projected 2030 shortage of 270 acft/yr. One new Woodbine aquifer well is also the recommended strategy for the West Leonard WSC to meet a projected 2030 shortage of 5 acft/yr. Together, these two new Woodbine aquifer wells would provide 350 acft/yr of groundwater.

Purchasing surface water is the recommended strategy for the other three Hunt County user groups with projected shortages. The North East Texas Regional Water Planning Group recommends that Little Creek Acres purchase treated surface water from the Cash WSC to meet its projected 2030 shortage of 37 acft/yr and City of Wolfe City purchase treated surface water from the City of Commerce to meet its projected 2030 shortage of 101 acft/yr. The steam electric user group has a projected 2030 supply shortage of 14,457 acft/yr. The recommended strategy to meet this shortage is to purchase raw water from the Sabine River Authority’s proposed Toledo Bend transfer. Groundwater to meet this demand was not considered feasible because of questionable reliability and the large quantity of water required for a steam electric facility (Burcher Willis and Ratliff Corp., et al., 2006).

Study Area County in the Region B Water Planning Area

The Region B Water Planning Group determined that many water user groups had little or no projected water supplies above their projected demands. To determine which of these entities would potentially be impacted in the future, the Region B Water Planning Group determined the ‘safe supply’ for municipal and manufacturing user groups would be defined as 120 percent of the projected demands. Two water user groups in Montague County are projected to have supply shortages before 2030. A 2010 water supply shortage of 133 acft/yr is projected for the county-other user group and the shortage is projected to increase to 197 acft/yr by 2030. The county-other safe supply shortage for 2010 is projected to be 394 acft/yr increasing to 475 acft/yr at 2030. The mining user group is projected to have a 2010 shortage of 113 acft/yr decreasing to 86 acft/yr at 2030. The mining demand shortage is projected to increase to 111 acft/yr by 2060. Purchasing water from local providers is the recommended strategy for both the county-other and mining user groups. If the county-other user group purchases water from local providers, the Region B Water Planning Group anticipates that approximately 20 percent of the new supply would come from the Trinity aquifer, 40 percent from Lake Nocona, and 40 percent from the City of Bowie. Twenty percent of the projected 2030 county-other water shortage would be almost 40 acft/yr from additional groundwater pumpage by local providers in Montague County.

An alternative Montague County supply shortage recommendation is for the county-other and mining user groups to develop new groundwater supplies. The alternative recommendation contemplates six new wells to meet the county-other shortage and one new well to meet the mining shortage. The alternative recommendation would also include associated storage, pumping and transmission infrastructure (Biggs and Mathews, Inc., et al., 2006).

Barnett Shale Natural Gas Exploration

The Barnett Shale is one of the largest and most active natural gas fields in the United States and may rival the Hugoton Field of southwestern Kansas as the largest onshore natural gas field in the nation. The Mississippian-aged Barnett Shale occurs at depths of 6,500 to 8,500 feet in the Fort Worth Basin of north Texas and is bounded structurally to the east by the Ouachita Thrust-fold Belt and the Muenster Arch, and to the west by the Bend Arch (Figure 8). The shale was deposited in an organic-rich, shallow epicontinental sea, and is now a productive gas reservoir due to the high proportion of total organic carbon (TOC) that averages around 4.5 percent. The Barnett Shale is estimated to cover 5,000 square miles and contain 30 trillion cubic feet of natural gas. The majority of Barnett Shale natural gas production has been from the Newark East Field in portions of Denton, Tarrant, and Wise counties. Present production also occurs in Erath, Hill, Hood, Johnson, Palo Pinto, and Parker counties, and potential production from Bosque, Comanche, Cooke, Ellis, Hamilton, Jack, Montague, and Somervell counties is anticipated (Wikipedia, 2006; Hayden and Pursell, 2005).

The Barnett Shale is a very tight formation and must be hydraulically fractured to improve well productivity enough to produce economic quantities of natural gas. This process generally uses high pressure pumps to inject fluids and propping agents that will overcome the pressure of overlying rock and fracture the low-permeability natural gas reservoir. Hydrofracturing has been performed in the shale since 1997; however, recent technological advances in hydraulic-sand fracturing methods and horizontal drilling have led to increased drilling activity in the formation. Hayden and Pursell (2005) reported that over 3,800 wells had been drilled in the Barnett Shale by October 2005.

In the study area counties of Cooke, Denton, Hood, Johnson, Montague, Parker, Tarrant, and Wise, over 1,500 Barnett Shale drilling applications were filed with the Railroad Commission of Texas (RCT) in 2005. This number has increased annually since 2000 (RCT, 2006). Bené, Harden, Griffin, and Nicot (2007) reported there were over 5,600 producing Barnett Shale wells by November 2006 and projected many thousands more will be constructed within the next couple of decades. All but a few hundred of these wells are located in the North-Central Texas study area (Table 12).

Barnett Shale completions are noted for 75 wells in Jack County and 23 wells in Palo Pinto County just west of the study area. These counties were not included in the study area because the Trinity aquifer crops out only in a very small area in the eastern extreme of each county. Bené et al. (2007) note the active development of the overlying Bend/Atoka Formation in these two counties and in Denton, Erath, Tarrant, and Wise counties and note water use for development of Atoka-Bend wells is small in comparison to Barnett Shale water use.

Millions of gallons of water are used in the drilling of wells and the stimulation of fractures in the Barnett Shale. The amount of water required for each well is highly variable depending on the depth of the well, the type of well, and any problems that may occur during the drilling of the well. One reported estimate for the quantity of water necessary for fracture stimulation was 90,706 barrels–the equivalent of about 3.8 million gallons or 11.69 acre-feet (acft). This was for a well whose true vertical depth was 6,765 feet and reached from 7,595 feet to 10,110 feet horizontally (Texas Drilling Observer, 2006). Another industry source reported typical use as 420,000 gallons during drilling and another four million gallons during fracturing (Teeter, 2005). This estimate would be equivalent to a total use per well of about 105,000 barrels or 13.56 acft. Bené et al., 2007, determined that when well fracture technology is used to improve production, a typical Barnett Shale vertical completion requires about 1.2 million gallons (3.68 acft) and a typical horizontal Barnett Shale completion requires around 3.5 million gallons (10.74 acft).

The water demands for the development of the Barnett Shale are not addressed or included in the regional water plans or the State Water Plan. The 2006 Region B, Region C, and Brazos G Water Plans note that mining water supplies in these counties are derived from local (i.e., privately-owned) surface water supplies; purchases of raw water from surface water suppliers such as BRA, TRWD, and the City of Granbury; groundwater from the Trinity and other aquifers; and, run-of-river and reuse sources. The 2002 State Water Plan notes that the water demand estimates include projections for the extraction of crude oil and natural gas, and for the mining processes necessary to extract nonfuel minerals (TWDB, 2002). Nonfuel 'minerals' that are mined in the study area include sand, gravel, clay, aggregate, and building stone (U.T. Bureau of Economic Geology, 1979; Dallas Morning News, 2001).

Figure 8. Fort Worth Basin showing the Barnett Shale Expansion area and the Structure of the Base of the Barnett Shale (from Givens, N. and Zhao, H., 2005)

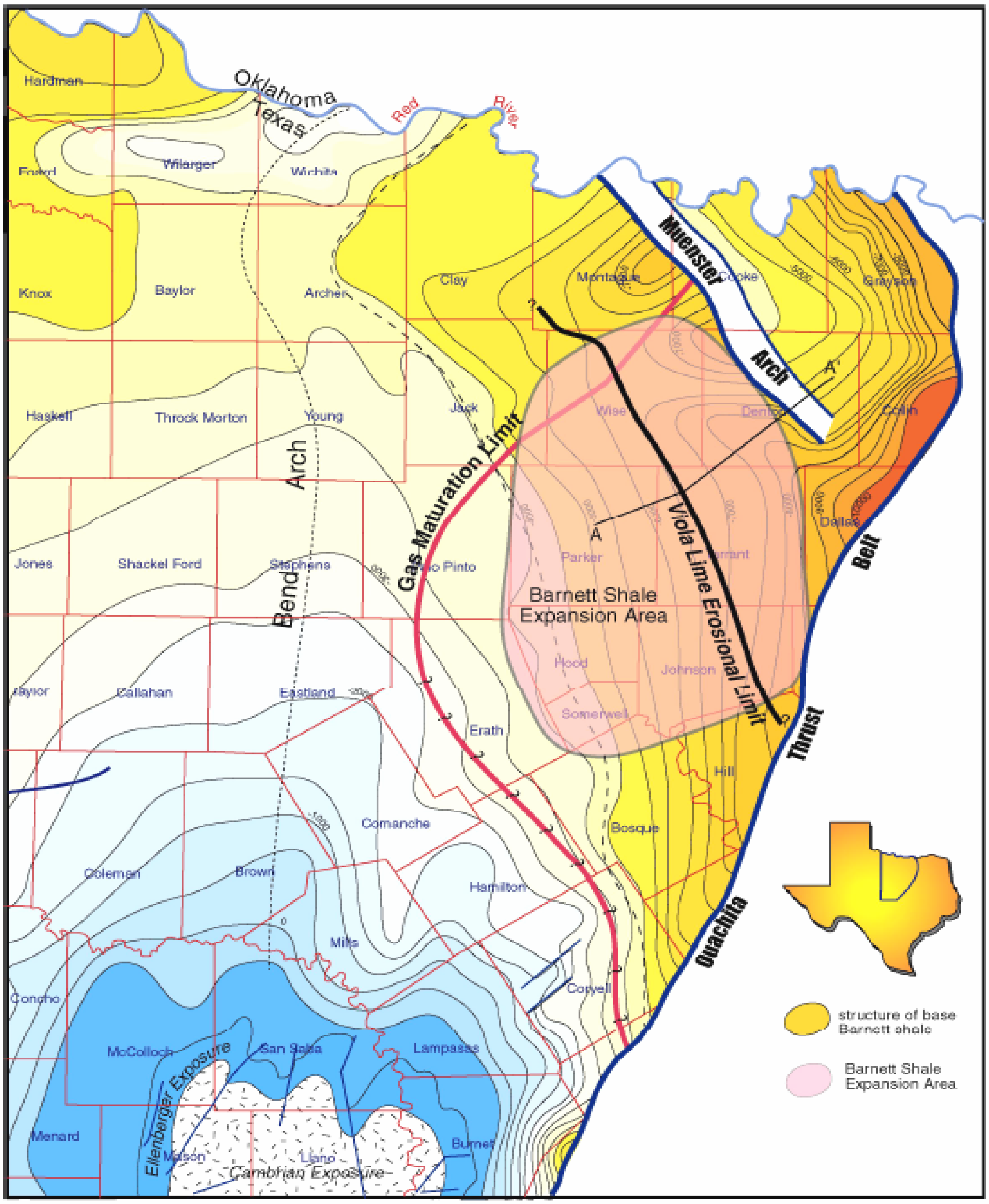


Table 12. Barnett Shale Well Statistics by County

County	<2000	2000	2001	2002	2003	2004	2005	2006[1]	County Total
Cooke			2		4	8	14	11	39
Denton	150	93	269	427	398	267	216	136	1,957
Hood			2	7		1	44	49	103
Johnson	4			6	18	78	217	215	538
Montague	2		7	8	13	4	15	20	69
Parker			5	7	16	87	108	(2)	223(2)
Tarrant	10	1	15	110	153	202	213	108	812
Wise		87	159	248	306	218	162	90	1,664
Year Total	166	181	459	813	908	865	989	629(2)	5,404(2)

Notes:
1. January – November 2006.
2. No well statistics indicated for Parker County, 2006.

Source: Bené, Harden, Griffin, and Nicot, 2007, Page 2-26.

Table 13 summarizes the mining water user group data for the eight counties where Barnett Shale natural gas exploration is ongoing or anticipated in the study area. The mining user group data in the 2006 Region B, Region C, and Brazos G Water Plans estimate the presently available water supply in the eight counties for mining use is about 22,600 acft/yr. Projected 2010, 2020, and 2030 demand for the mining user group for the eight-county area is 25,857 acft/yr, 30,127 acft/yr, and 32,896 ac/yr, respectively. The estimate for the presently available water supply for Wise County accounts for about 85 percent of the mining supply for the eight counties. Likewise, projected demand for Wise County accounts for 92 percent of the projected demand estimates for the eight counties. Shortages are projected in the 2006 Region B, Region C, and Brazos G Water Plans for the mining user group in Cooke, Denton, Hood, Johnson, Montague, Tarrant, and Wise counties. Recommended strategies to address the projected shortages include conservation, purchasing water from various suppliers, reuse of water, supplemental wells in the Trinity aquifer, overdrafting of the Trinity aquifer, and new wells in the Trinity and Woodbine aquifers.

Understanding how much water is and has been used for Barnett Shale well completion is difficult to characterize in water planning terms. To help resolve this issue, the TWDB contracted with R.W. Harden & Associates – teamed with Freese & Nichols, Inc. and the University of Texas Bureau of Economic Geology – to (1) revise demand projections for current and future groundwater pumpage due to urban growth trends in a six-county core area, (2) investigate the effects of recent pumping in the Dallas-Fort Worth area on the Trinity aquifer due to oil and gas production, and (3) simulate how the new estimated pumpage may affect the Trinity and Woodbine aquifers.

In Denton, Hood, Johnson, Parker, Tarrant, and Wise counties, 4,834 new water wells were drilled over a 44-month period ending in August 2006 (Bené et al., 2007). About five percent of the water wells drilled during this span in the six-county area supported drilling and fracturing of Barnett Shale gas wells. In Johnson County, over 60 percent of the new wells drilled in the first eight months of 2006 were for Barnett Shale drilling supply. It is not clear how many of the new water wells represent new demands on the Trinity and Woodbine aquifers or are supplemental wells that have been drilled to replace existing groundwater supplies. However, the 260 new rig supply wells drilled during this period should be considered new demands on the aquifers for planning purposes because the water demands for Barnett Shale gas exploration have not been included in the regional water planning demand projections to date.

Table 13. Mining Water Use Planning Data for Study Area Barnett Shale Counties

County	Planning Data	2010 [1]	2020 [1]	2030 [1]	Water Management Strategies [2]
Cooke	Groundwater (Trinity aquifer)	49	49	49	New wells, overdraft, and supplemental wells in Trinity aquifer
	Surface Water (local supply)	237	237	237	
	Total Water Supply	286	286	286	
	Total Water Demand	321	334	348	
	Surplus (Shortage)	(35)	(48)	(55)	
Denton	Groundwater (Trinity aquifer)	36	36	36	Supplemental wells in Trinity aquifer and new wells in Woodbine aquifer
	Surface Water (local supply)	103	103	103	
	Total Water Supply	139	139	139	
	Total Water Demand	341	341	341	
	Surplus (Shortage)	(202)	(202)	(202)	
Hood	Groundwater (Trinity aquifer)	137	136	135	Conservation and purchasing water from the City of Granbury
	Surface Water	0	0	0	
	Total Water Supply	137	136	135	
	Total Water Demand	162	161	160	
	Surplus (Shortage)	(25)	(25)	(25)	
Johnson	Groundwater (Trinity aquifer)	51	54	56	Conservation and purchasing water from BRA system
	Surface Water (run-of-river rights)	62	62	62	
	Total Water Supply	113	116	118	
	Total Water Demand	370	390	403	
	Surplus (Shortage)	(257)	(274)	(285)	
Montague	Groundwater (Trinity & other aquifer)	328	328	328	Purchasing from local provider
	Surface Water (Amon Carter)	64	61	59	
	Total Water Supply	392	389	387	
	Total Water Demand	505	481	473	
	Surplus (Shortage)	(113)	(92)	(86)	
Parker	Groundwater (Trinity aquifer)	59	59	59	Supplemental wells in Trinity aquifer
	Surface Water (local supply and BRA)	2,020	2,020	2,020	
	Total Water Supply	2,079	2,079	2,079	
	Total Water Demand	98	112	122	
	Surplus (Shortage)	1,981	1,967	1,957	
Tarrant	Groundwater	0	0	0	Purchasing water from TRWD
	Surface Water (local supply)	342	342	342	
	Total Water Supply	342	342	342	
	Total Water Demand	433	484	519	
	Surplus (Shortage)	(91)	(142)	(177)	
Wise	Groundwater (Trinity aquifer)	239	239	239	Purchasing water from TRWD, reuse – recycled water, and supplemental wells in Trinity aquifer
	Surface Water (reuse, r-o-r, TRWD)	18,877	16,650	14,343	
	Total Water Supply	19,116	16,889	14,582	
	Total Water Demand	23,627	27,824	30,530	
	Surplus (Shortage)	(4,511)	(10,936)	(15,948)	

Notes:
1. All tabulated values in acft/yr.
2. Recommended regional water plan strategies to address projected shortages.

Sources: Biggs and Mathews, Inc. et al., 2006, Appendix A; Freese and Nichols, Inc., et al., 2006, Appendix V, Table V-1; and Brazos G Regional Water Planning Group et al., 2006, 4C.16.8, 4C.17.20, and Table C-33.

For the recommended 2005 – 2025 municipal, manufacturing, irrigation, and livestock demand projections for Denton, Hood, Johnson, Parker, Tarrant, and Wise counties (Bené et al., 2007), the 2005 low Trinity aquifer demand projection is about 7,000 acft/yr below 2000 historic groundwater use figures and the 2005 high Trinity aquifer demand projection starts about 6,000 acft/yr higher than the 2000 historic groundwater use values. The recommended low demand projections decrease from 2005 – 2025 and the recommended high demand projections increase over this 25-year period. All of the low and high Trinity aquifer 2005 – 2025 demand projections for the six-county area are above the regional water planning groups estimates for the available safe supply of groundwater. The 2005 low demand projections are about 5,400 acft/yr higher than the regional water planning group estimates of safe groundwater supply, and decrease to about 2,200 acft/yr in 2025. The 2005 high demand projections start about 18,000 acft/yr above the estimates of safe groundwater supply for the six counties and increases to over 45,000 acft/yr by 2025.

Bené et al. (2007) also developed 2000 – 2005 estimates for historic water use to support the completion and development of Barnett Shale gas wells. About 60 percent of total water use for this purpose was established to be from the Trinity and Woodbine aquifers. In 2000, an estimated 702 acft/yr of water was used for this purpose in the study area counties of Denton, Tarrant, and Wise, with about 410 acft/yr from the Trinity aquifer. By 2005, an estimated 7,130 acft/yr of water was used in these three counties and in Cooke, Ellis, Hood, Johnson, Montague, and Parker counties. Trinity aquifer Barnett Shale gas well development use for the nine study-area counties was estimated to be about 4,720 acft/yr in 2005.

Bené et al. (2007) then developed projections of Trinity aquifer use by the oil and gas industry for 2005 – 2025. The amount of groundwater used by the oil and gas industry is largely dependent upon the fluctuating market price of these commodities and is hard to predict. Bené et al. developed low, medium, and high scenarios for groundwater use based largely on this economic fact. They also considered other important variables such as geologic risk factors in the Barnett Shale and other technological, operational, and regulatory factors. Their low use projections correlate with most of the low-end water use for these factors while the high end use projections represent the other end of the spectrum. The projection data developed by Bené et al. for Cooke, Denton, Ellis, Hood, Johnson, Montague, Parker, Tarrant, and Wise counties is included in Appendix 6 and is summarized as follows.

- The low use scenario projects that 25,193 acft of groundwater could be used for Barnett Shale well development to 2025. The low scenario for these nine counties averages about 1,326 acft/yr of groundwater use, represents a retreat from present annual use estimates, and corresponds to a large drop in the price of natural gas.
- From 2007 – 2025, the medium use scenario projects total groundwater usage of about 111,895 acft and averages about 5,942 acft/yr. The medium case could be considered the most likely under the condition that natural gas prices remain at current levels.
- The high use scenario projections predict 2007 – 2025 groundwater use of 186,132 acft and average around 9,796 acft/yr. This projection scenario relates to sustained high gas prices that would allow the industry to expand to all economically viable areas. The high scenario assumes there are no external factors that would limit water use.

Bené et al. tabulated percent of total groundwater use by five use categories for low and high groundwater demand estimates (2007; Tables 5a and 5b). The use categories were assigned as Barnett Shale, Point Source, Rural Domestic, Livestock, and Irrigation. Barnett Shale percentages for the low demand estimates were at or above 10 percent of total use between 2006 – 2010 in Denton (10 percent), Johnson (29 percent), and Wise (23 percent) counties. From 2011 – 2015, Barnett Shale groundwater use is projected to account for 15 percent of total use in Hood County and 21 percent of total use in Parker County, and from 2016 – 2020 an estimated 20 percent of total groundwater use in Montague County. Under the high use estimates, Barnett Shale percentages were at or above 10 percent of total use between 2006 – 2010 in Denton (10 percent), Johnson (20 percent), Parker (26 percent), and Wise (25 percent) counties. Barnett Shale groundwater use was estimated to account for 18 percent of total groundwater use in Hood County from 2011 – 2015 and 35 percent of total groundwater use in Montague County from 2021 – 2025.

Historic artesian pressure declines of up to 1,000 feet have occurred in the Dallas, Fort Worth and Waco areas, and declines greater than 500 feet have occurred along the I-35 corridor over the past century. The GAM simulations performed by Bené et al. (2007) generally predict additional artesian pressure declines to be widespread in the Trinity and Woodbine aquifers under both low and high demand projections except for the lower two zones of the Trinity aquifer in the eastern Tarrant – western Dallas county area where recovery of artesian pressure is projected in the low demand simulation. Additional reductions in artesian pressure can result in declining production ability for existing wells and may lower the piezometric head below pumping levels for many existing wells. The net effect for both situations is increased operating cost for existing well owners, either because of prolonged pumping-time requirements or addition of new wells to produce the same volume of supply, lowering of well pumps and addition lift costs for the same volume of supply, or deepening of existing shallow wells to remain in contact with the aquifer to access the same volume of water. In the high demand GAM scenario that predicts ‘dewatering’ in some of the western portions of the Trinity aquifer, the ability by landowners to pump and use groundwater would be forfeited.

A few water conservation initiatives are being investigated by various companies and government entities. In February 2005, the RCT approved a pilot study for the recycling of water used during drilling and water fracturing activities (RCT News Release, 2005). The study is ongoing and the results of the study are not yet available. Most of the hydrofracture fluid that cannot be reused is hauled to one of the 46 Class II underground injection control disposal wells in the area (7 in Cooke County, 3 in Denton County, 13 in Jack County, 2 in Tarrant County, and 21 in Wise County). Fountain Quail Water Management LLC was the first oil field service company in the area to use mobile evaporator technology to distill on-site return water for reuse at other wells. The wastewater service company Aqua-Pure Ventures, Inc. purchased the remaining shares of Fountain Quail in April 2006, and is presently refining the mobile evaporator technology. This process shows the potential to treat up to 85 percent of the wastewater stream for reuse, and the remaining concentrate (brine) will require disposal. Aqua-Pure Ventures, Inc. is also presently working on a plan to use the heavy concentrate as kill fluid to hold gas pressures down when working on a well. In addition to three mobile purification units operated by Devon Energy in Tarrant County, Aqua-Pure Ventures, Inc. plans to add six more mobile purification units to operate in north Texas in 2006. These companies anticipate that the nine units in the area will be able to produce about 18,000 barrels (756,000 gallons or ~2.3 acft) of distilled water per day. The purification units are fueled by on-site natural gas. This new process should turn at least some wastewater liabilities into fresh water assets (Scott, 2006).

Knowledgeable RCT staff is of the opinion that there could be over 50,000 wells in the Barnett Shale before the field is fully developed. Well spacing in the Barnett Shale can be very tight (i.e., 500 feet apart for horizontal wells or every 30 acres) and no significant decline in the annual number of wells that can be placed is expected. At present, the number of active drilling rigs appears to be the primary limiting factor to the number of wells that can be drilled each year (RCT personal communication, January 2006).

Surface Water Quality

The TCEQ regularly monitors the condition of the state’s surface waters, and assesses the status of water quality every two years. This assessment is submitted to the U.S. Environmental Protection Agency (USEPA) and published on the TCEQ web site as the *Texas Water Quality Inventory and 303(d) List* (Inventory and List). Requirements for the Inventory and List are codified in the federal Clean Water Act, Sections 305(b) and 303(d). Further requirements are set out in state law and in rules and guidance established by the TCEQ.

The Inventory describes the status of all surface water bodies of the state that were evaluated for the given assessment period. The TCEQ uses data collected during the most recent five-year period in making its assessment. The data are gathered by many different organizations that all operate according to approved quality control guidelines and sample collection procedures. The quality of waters described in the Inventory represents a snapshot of conditions during the assessed time period.

The 303(d) List identifies waters for which preventive measures–such as permits that limit discharges of wastewater and the technology used by the dischargers–are not sufficient to achieve water quality standards. The 303(d) List is subject to review and approval by the USEPA. The Inventory assigns each assessed water body to one of five categories to indicate the status of the water body and how the state will approach identified water quality problems. Higher category numbers correspond to higher levels of effort required to manage water quality. Water bodies in Category 5 constitute the 303(d) List, and require remedial action by the state to restore water quality. For water bodies assigned to Category 5a, the state must develop a scientific model called a total maximum daily load (TMDL) and a plan to implement it.

In the study area, there are 20 water bodies identified on the 2004 Texas 303(d) List. TMDLs have been developed for legacy pollutants for nine of the study area water bodies. Legacy pollutants are chemicals whose use has been banned or severely restricted, but which still remain in the environment. Chlordane, DDT, DDD, DDE, dieldrin, heptachlor epoxide, and PCBs, most of which were once used as insecticides, were detected in fish tissues in portions of the Upper Trinity River (Segment No. 0805), the Lower West Fork Trinity River (Segment No. 0841), and Mountain Creek Lake (Segment No. 0841A), all in the Dallas area. The report, *Nine Total Maximum Daily Loads for Legacy Pollutants in Streams and a Reservoir in Dallas and Tarrant Counties*, was approved by the Commission on December 20, 2000, and adopted as an update to the Texas Water Quality Management Plan. The USEPA approved the TMDLs on June 26, 2001.

Chlordane, DDT, DDE, dieldrin, and PCBs have been detected in fish tissues in portions of Clear Fork Trinity River below Benbrook Lake (Segment No. 0829) and West Fork Trinity River below Lake Worth (Segment No. 0806), and in Lake Como (Segment No. 0829A), Fosdic Lake (Segment No. 0806A), and Echo Lake (Segment No. 0806B), all in the Fort Worth area. The report, *Eleven Total Maximum Daily Loads for Legacy Pollutants in Streams and Reservoirs in Fort Worth*, was approved by the Commission on November 17, 2000, and adopted as an update to the Texas Water Quality Management Plan. The USEPA approved the TMDLs on May 24, 2001.

The *Implementation Plan for Dallas and Tarrant County Legacy Pollutant TMDLs* was approved by the Commission on August 10, 2001. The objective of the implementation plan is to establish historical trends, identify any remaining pollutant sources, and, if applicable, evaluate and implement mitigation or remediation strategies which will result in the restoration of the fish consumption use for these water bodies. In February 2005, TCEQ contracted with the Texas Department of State Health Services (DSHS) to collect and analyze fish tissue samples from numerous sites on Lake Como, Fosdic Lake and Echo Lake. DSHS will use the data to reassess the risk associated with consuming fish from these areas. The study should be completed by Fall 2007.

Lake Worth (Segment No. 0807) is a 3,558-acre impoundment of the West Fork Trinity River located in northwest Tarrant County. The lake has a conservation capacity of approximately 37,000 acre-feet, and drains a 2,064 square-mile watershed. Water quality testing found that fish in Lake Worth (Segment 0807) are contaminated with PCBs, resulting in an advisory to the public in 2002 to limit their consumption of fish caught in the lake. The report *One Total Maximum Daily Load for Polychlorinated Biphenol (PCBs) in Fish Tissue in Lake Worth, Tarrant County* was adopted by the Commission on August 10, 2005, and approved by the USEPA on October 13, 2005. The goal of this project is to reduce PCBs to levels that will make it safe to eat fish from the lake. The implementation plan for this TMDL is presently under development.

Concentrations of bacteria are elevated in three segments of the Trinity River that flow through the densely populated Dallas–Fort Worth metropolitan area and rural areas to the southeast. The goal of the West Fork/Upper Trinity River TMDL project is to reduce bacteria concentrations to within acceptable risk levels for contact recreation in the Upper Trinity River (Segment No. 0805), the Lower West Fork Trinity River (Segment No. 0841), and the West Fork Trinity River Below Lake Worth (Segment No.

0806). The three segments flow 160 miles through Dallas, Ellis, Henderson, Kaufman, Navarro, and Tarrant counties and their watersheds cover approximately 1,450 square miles. To varying degrees, the segments in the entire project area are affected by municipal and industrial wastewater discharges, and by stormwater runoff from agricultural, industrial, and urban areas. This TMDL project was initiated by the TCEQ in October 2004 and is projected to be completed by August 2008.

Ten other study area water bodies are on the 2004 Texas 303(d) List because bacteria sometimes exceeds contact recreation use levels. These include Pine Creek (Segment No. 0202D) in Lamar County and Post Oak Creek (Segment No. 0202E) and Big Mineral Creek (Segment No. 0203A) in Grayson County in the Red River Basin; Cowleech Fork Sabine River (Segment No. 0507A) in Hunt County in the Sabine River Basin; West Fork Trinity River Below Bridgeport Reservoir (Segment No. 0810) in Wise County, Muddy Creek (Segment No. 0820C) in Collin and Dallas counties, Little Elm Creek (Segment No. 0823A) in Grayson County, Elm Fork Trinity River Above Ray Roberts Lake (Segment No. 0824) in Cooke and Montague counties, and Clear Fork Trinity River Below Lake Weatherford (Segment No. 0831) in Parker and Tarrant counties in the Trinity River Basin; and the Nolan River (Segment No. 1227) in Hill and Johnson counties in the Brazos River Basin. Additional data and information will be collected before TMDLs are scheduled for these water bodies for this parameter.

Concentrations of dissolved oxygen in the Clear Fork Trinity River Above Lake Weatherford (Segment No. 0833) and Clear Fork Trinity River Below Lake Weatherford (Segment No. 0831) are not optimal for supporting aquatic life. Both watersheds are predominantly rural, but rapidly increasing urban populations are changing the landscape. Data and information about the Clear Fork Trinity River suggested that the water quality standards for the segments might not be appropriate. Consequently, TCEQ initiated a project to examine the causes of low dissolved oxygen in the stream and to evaluate whether the agency should develop a TMDL or a use attainability analysis (UAA) to determine whether the existing standards are appropriate for the river. Depending on the results, the aquatic life use standard and criteria may be modified. This ongoing project is a collaborative effort involving the TCEQ, the Texas Institute for Applied Environmental Research, the Trinity River Authority, and the Tarrant Regional Water District. TCEQ staff is presently reviewing the April 2003 report *Technical Use Attainability Analysis, Clear Fork Trinity River (Stream Segments 0831 and 0833)* to determine if a use attainability analysis is warranted.

Depressed dissolved oxygen concentrations are also occasionally lower than the aquatic life standard in four other water bodies on the 2004 303(d) List. These include the Upper South Sulphur River (Segment No. 0306) and Cooper Lake (Segment No. 0307) in the Sulphur River Basin; Cowleech Fork Sabine River (Segment No. 0507A) in the Sabine River Basin; and Chambers Creek Above Richland-Chambers Reservoir, (Segment No. 0814) in the Trinity River Basin. In addition, three study area water bodies are on the 2004 303(d) List for high pH including the Upper South Sulphur River (Segment No. 0306) and Cooper Lake (Segment No. 0307) in the Sulphur River Basin and Richland-Chambers Reservoir (Segment No. 0836) in the Trinity River Basin, and the Nolan River (Segment No. 1227) of the Brazos River Basin is on the list for high average sulphate. These parameters exceed general quality standards but not secondary drinking water standards. Standards reviews or additional data and information will be collected before TMDLs are scheduled for these water bodies and parameters.

Public water supply concerns were noted for two study area water bodies in the 2004 305(b) Inventory – Lake Texoma and Lake Granbury. Nutrient enrichment and algal growth are the other water quality concerns noted in the 2004 305(b) Inventory for study area water bodies. Concerns about chloride, sulfate, and total dissolved solids (TDS), and increased costs due to demineralization were noted for Lake Texoma (Segment No. 0203). Dissolved solids in the Red River and Lake Texoma are generally high, and the use of Lake Texoma water for public water supply requires desalination or blending with higher-quality water. The high TDS has historically limited the use of this water for public supply purposes.

Concerns about chloride, total dissolved solids, and increased costs due to mineralization were noted for Lake Granbury (Segment No. 1205). Most of the inhabited areas around Lake Granbury are near coves, and are served by an estimated 9,000 septic tanks located close to the lake. Between 2002 and 2004, the BRA monitored multiple Lake Granbury locations for E. coli and identified several areas where on-site septic systems were most likely failing or improperly maintained. The TCEQ, through a $1.4 million USEPA grant, is presently funding the Lake Granbury Watershed Protection Plan. The funding will be used to: (1) identify the sources and causes of E. coli contamination; (2) continue the BRA water quality monitoring program; (3) develop citizen involvement and education by forming an advisory group and developing a web page to share information; (4) acknowledge local water quality management initiatives and provide funding to implement Best Management Practices identified during the project; (5) develop a Watershed Protection Plan; and (6) develop a water quality effectiveness monitoring strategy to measure environmental benefits.

In 2004, the TCEQ did a focused review of mining activities that may have the potential to impact surface water quality. This effort was in response to numerous inquires and requests for investigations into complaints concerning potential surface water quality impacts from mining activities in the Brazos River Basin. Field investigations were conducted at 316 mining facilities in 62 counties. The selection of the facilities for the investigation included 163 sites with current TCEQ Multi-Sector General Permits for rock mining operations, 103 sites operating without the required permit, and 50 sites where no permit was required. The review was designed to identify the extent of noncompliance, identify necessary corrective actions, apply appropriate deterrent penalties, and join the effort of other state agencies to protect natural resources. A report detailing the results of the investigation was completed in September 2004 (TCEQ, 2004).

The most common operational violation documented was inadequate or no Best Management Practices (BMPs). Other common operational violations documented included unauthorized discharges and failure to perform required monitoring directed by permit. After the investigations, the TCEQ issued 128 Notices of Violation, 38 Notices of Enforcement, and 6 referrals to the Office of the Attorney General (OAG). The overall findings from the investigations were that the waterways in the state are not significantly impacted by mining activities. Inspectors noted and followed up a number of quarry activities that were directly discharging sediment into adjacent waterways, but this number was not significant and the problems noted were not rampant.

In July 2004, a TCEQ inter-disciplinary team met with the Brazos River Conservation Coalition (BRCC) and area residents along the Brazos River, in Palo Pinto County. The team sought input and participated in discussion about water quality, discharges from area mining and quarrying operations, and other wastewater discharges to the river. They also toured and inspected the Brazos River via airboats. This team was used to develop, review, and comment on proposed regulatory controls for mining and quarrying operations in the state.

Senate Bill (SB) 1354 was passed by the 79th Legislature in 2005. The Act defines the John Graves Scenic Riverway as a unique portion of the Brazos River watershed between Morris Shepard Dam on Possum Kingdom Reservoir in Palo Pinto County and the county line between Parker and Hood counties. The statute addresses permitting, financial responsibility, inspections, water quality sampling, enforcement, cost recovery, and interagency cooperation with regards to quarry operations in the riverway. The statute requires quarries located within one mile of a water body or within the 100-year flood plain of any water body in this watershed to acquire individual permits. General permits would be issued to quarries located outside the one-mile distance in this watershed. The statute also provides a prohibition on new quarries or expansion of existing quarries located within 1,500 feet of a water body, however, if certain requirements apply, a permit may be allowed. The Act requires a biennial report to the legislative leadership evaluating the success of the water quality protection permitting and enforcement programs developed for the waterway.

The TCEQ adopted rules to implement SB 1374 on July 12, 2006. The TCEQ rules establish the permitting and financial assurance requirements for the John Graves Scenic Riverway 20-year pilot program. At this time there are 16 permitted quarries operating within the riverway.

Groundwater Quality

Recharge, infiltration, lithology or rock type, environment of deposition, and geologic structure exert natural controls on groundwater quality in the study area. Water quality in the Trinity aquifer is acceptable for most municipal and industrial uses. However, in some areas, natural concentrations of arsenic, fluoride, nitrate, chloride, iron, manganese, sulfate, and TDS in excess of either primary or secondary drinking water standards can be found. Water on the outcrop tends to be harder with relatively high iron concentration. Downdip, water tends to be softer, with concentrations of TDS, chlorides, and sulfates higher than on the outcrop. Groundwater contamination from man-made sources is found in localized areas.

Water quality in the layers of the Woodbine aquifer used for public water supply is good along the outcrop. Water quality decreases downdip, with increasing concentrations of sodium, chloride, TDS, and bicarbonate. High sulfate and boron concentrations may be found in Tarrant, Dallas, Ellis, and Navarro counties. Excessive iron concentrations also occur in parts of the Woodbine formation.

Continuous removal of water from aquifer storage and the resulting water-level declines pose a threat to small water suppliers and to domestic water users in rural areas. As groundwater levels decline, it becomes more expensive to pump the water out of the aquifer, and water quality generally suffers. Excessive groundwater pumpage from the lower part of the Trinity aquifer may allow significant amounts of more sulfate-rich water, from the Glen Rose or deeper, more basinal water, to be drawn into the production zone resulting in poorer quality water (TWC, 1989). Localized water-level declines have been reported in each of the major and minor aquifers in the study area.

The Texas Groundwater Protection Committee's *Joint Groundwater Monitoring and Contamination Report – 2004* (TGPC, 2005) lists 1,440 groundwater contamination cases in the twenty-county study area. These cases are generally from surface or near-surface releases of product or waste confined to a specific property and have not significantly impacted groundwater resources being used for drinking water purposes. The cases have predominantly been documented through regulatory requirements for compliance monitoring or through investigation in response to groundwater contamination complaints. Of these, 1,428 cases are related to activities under the jurisdiction of the TCEQ. The majority of the TCEQ-documented sites are contaminated by gasoline, diesel, or other petroleum products. Most (1,020) of the TCEQ-documented cases of contamination are in Dallas and Tarrant counties and are related to releases from petroleum storage tank facilities. Other documented contaminants under other TCEQ regulatory programs include, but are not limited to organic compounds, solvents, heavy metals, and pesticides. Six counties – Cooke, Delta, Fannin, Hood, Red River, and Rockwall – have fewer than 10 contamination cases each, and six additional counties – Hunt, Kaufman, Lamar, Montague, Navarro, and Wise – have fewer than 20 contamination cases each listed in the report.

Twelve cases listed in the *Joint Groundwater Monitoring and Contamination Report – 2004* are related to oilfield activities under the jurisdiction of the Railroad Commission of Texas. These cases document groundwater contamination in Cooke County by sodium chloride (NaCl) and natural gas; in Montague County by NaCl, hydrocarbons, and crude oil; in Parker County by NaCl and hydrocarbons; and, in Wise County by natural gas and condensate.

In the study-area counties, an additional 138 groundwater contamination cases are reported as completed in the *Joint Groundwater Monitoring and Contamination Report – 2004.* Action on theses cases was considered complete when the desired remedy was achieved or when no further regulatory action was required. Most of the closed-case sites are in Dallas (78) and Tarrant (25) counties.

Natural Resource and Habitat Loss Concerns

Water concerns to the natural resources in the study area are primarily related to water purveyors fully utilizing existing reservoirs or developing new reservoirs to meet future needs. These strategies raise concerns about changes to historic reservoir levels, changes to natural flow conditions and water quality, and inundation of valuable land and limited habitat.

Adopted regional water plan strategies to increase utilization of some reservoirs may lower lake levels during severe drought. This strategy will affect the parks and public lands surrounding these reservoirs. The regional water plans note that strategies to fully utilize existing reservoirs will not have any additional adverse impact on the water resources or on parks and public lands beyond that which has already been allowed in their existing water rights permits.

Long term decreases in flow can exacerbate water quality problems and impact the species that are directly and indirectly dependent upon freshwater resources. The TCEQ has documented concerns over water quality impacts to aquatic life or fish consumption in a number of surface water reaches in the study area. In general, these concerns are due to low dissolved oxygen levels or levels of pesticides or other pollutants that can harm aquatic life or present a threat to humans eating fish in which these compounds tend to accumulate.

Reservoir development, groundwater drawdown, and return flows of treated wastewater have greatly altered natural flow patterns in the study area. Since the late 1880's, spring flows in the study area have diminished and many springs have dried up because of groundwater development. The resulting water-level declines have reduce groundwater discharge (baseflow) to many tributary streams. While few species depend directly on the groundwater resources of the study area, the springs from groundwater discharge contribute to the surface water hydrology and have helped shape study-area ecosystems.

Reservoir development changes the natural hydrology by diminishing flood flows and capturing low flows. Some reservoirs provide steady downstream flows due to releases to empty flood control storage or to meet permit requirements. When new reservoirs are developed, they will likely be required to release some inflow to maintain downstream flow conditions. Maintaining downstream flow conditions was often not required in the past. It is unlikely that future changes to flow conditions in the study area will be as dramatic as those that have occurred over the past century.

The 2006 Region C Water Plan notes that base flows on the Trinity River downstream from the Dallas-Fort Worth metroplex have been greatly increased due to return flows of treated wastewater. It is likely that return flows from the Dallas-Fort Worth area will continue to increase, thus increasing flows in the Trinity River. The Region C Water Plan stipulates that on balance, these return flows may enhance habitat in this reach of the Trinity River (Freese and Nichols, Inc., et al., 2006).

El-Hage, Moulton, and Sorensen (2005) note the construction of reservoirs has negative impacts upon some important natural resources. Forested wetlands and other habitats are inundated and native stream and river fishes are deprived of their natural habitat. Reduced base flows below dams alter downstream aquatic, wetland, and upland habitats, and ultimately impact the estuarine habitats of the coastal bays. In addition, human users can be affected due to diminished recreational opportunities, increased levels of required water treatment, and decreased quantities of usable water. The 2006 Region C Water Plan notes that water management strategies that are likely to disturb threatened or endangered species habitat include specific mitigation allowances that will set aside additional land for that habitat.

Recommendations for the development of Muenster Reservoir, Lower Bois d'Arc Creek Reservoir, and Marvin Nichols I Reservoir were included in the 2002 State Water Plan (TWDB, 2002). These reservoirs are shown on Figure 9. The legislature did not designate additional unique reservoir sites based on the 2002 State Water Plan. The 2006 Region C Water Plan also includes the recommendation for an additional reservoir, Lake Ralph Hall, in the study area. New reservoir impacts to natural resources include the inundation of habitat, often including wetlands and bottomland hardwoods, and changes to downstream flow patterns. A new reservoir may also inundate prime farmland. Specific new reservoir project impacts will depend on the location, the mitigation required, and the operation of the project (Freese and Nichols, Inc., et al., 2006).

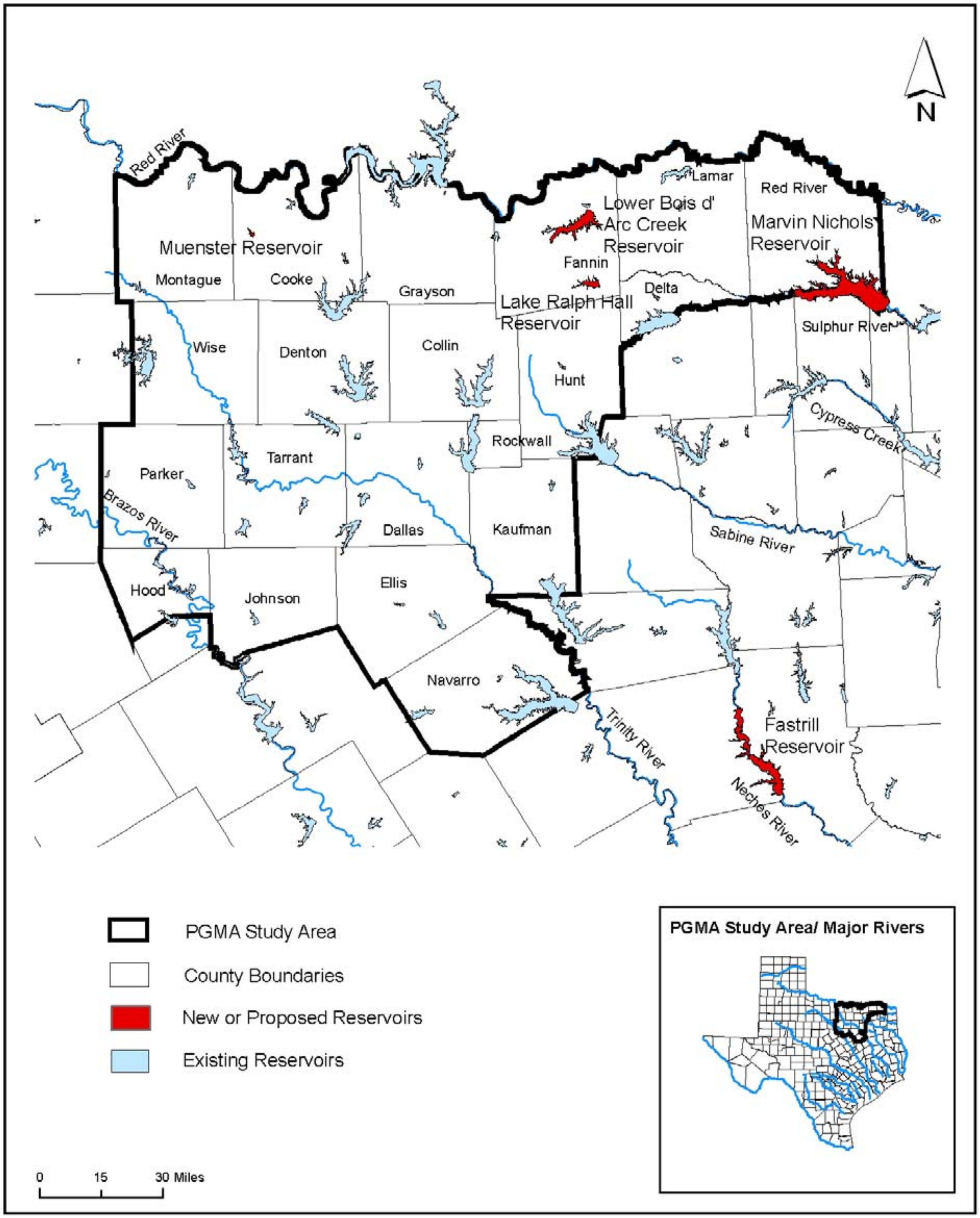
The Muenster Water District and the U.S. Natural Resource Conservation Service are presently completing the construction of Muenster Reservoir. Located on Brushy Elm Creek in Cooke County, the reservoir has been permitted by the TCEQ and approved by the local voters for municipal water supply, flood control, and recreational purposes. It has been permitted for impoundment of 4,700 acft and diversion of 500 acft/yr for municipal use. The reservoir will flood 418 acres at the top of conservation storage. Because of its small size, the reservoir will have little environmental impact.

The Lower Bois d'Arc Creek Reservoir would be located on Bois d'Arc Creek in Fannin County, immediately upstream from the Caddo National Grassland. With the top of conservation storage at an elevation of 534.0 feet above mean sea level (MSL), the proposed reservoir would have a yield of 123,000 acft/yr and would flood 16,400 acres. The most significant environmental impacts of Lower Bois d'Arc Creek Reservoir would be inundation of habitat, including wetlands and bottomland hardwoods. The lake would inundate the Bois d'Arc Creek bottomland hardwoods area, which is designated as a Priority 4 area by the U.S. Fish and Wildlife Service. A Priority 4 area is described as a moderate quality bottomland with minor waterfowl benefits. The lake would have no direct impacts on the Caddo National Grasslands, but changes in flow patterns on Bois d'Arc Creek could have an indirect impact on the grasslands. TPWD included Bois d'Arc Creek from the confluence with the Red River in Fannin County upstream to its headwaters in east Grayson County in its list of ecologically significant streams in the Region C Water Planning Area. This segment met several qualifying criteria including biological function due to priority bottomland hardwood habitat displaying significant overall habitat value, hydrologic function relating to water quality and flood attenuation, and as a riparian conservation area since it borders Caddo National Grasslands. Downstream impacts of Lower Bois d'Arc Creek Reservoir would be reduced if consensus criteria release requirements are met.

The Marvin Nichols I Reservoir would be located on the Sulphur River upstream from its confluence with White Oak Creek. The dam would be in Titus and Red River counties, and the reservoir would also impound water in Franklin County. The proposed reservoir would have an assumed yield of 612,300 acft/yr and would flood 67,400 acres. The most significant environmental impact of the Marvin Nichols I Reservoir project would be the inundation of habitat, including wetlands and bottomland hardwoods. The lake would inundate a portion of the Sulphur River Bottom West/Cuckoo Pond bottomland hardwoods area, which is designated as a Priority 1 area by the U.S. Fish and Wildlife Service. A Priority 1 area is described as an excellent quality bottomland of high value to key waterfowl species. There are also lignite deposits and some oil and gas wells in the pool area of the proposed lake.

Lake Ralph Hall would be located on the North Sulphur River in southeast Fannin County, north of Ladonia. The reservoir would have a conservation pool elevation of 550.0 feet above MSL, resulting in a yield of 32,100 acft/yr and would flood 7,236 acres. The most significant environmental impacts of Lake Ralph Hall would be the inundation of habitat.

Figure 9. New and Proposed Reservoirs



The expected beneficiaries of Muenster Reservoir include the City of Muenster and the manufacturing and county-other user groups in Cooke County. The reservoir will indirectly benefit other water user groups in the county by reducing use from the Trinity aquifer.

The anticipated beneficiaries of the Lower Bois d'Arc Creek and Lake Ralph Hall projects would be the NTMWD and the UTRWD and their current and potential customers, along with residents in the southern area of Fannin County. The 2006 Region C Water Plan notes that the NTMWD needs a major new supply by 2020, approximately ten years earlier than most of the other wholesale water providers in the area. Because Lower Bois d'Arc Creek Reservoir is smaller, costs less, and has less environmental impact than the proposed Marvin Nichols I Reservoir, it could be developed by the NTMWD alone and be developed more quickly than the larger reservoir.

The expected beneficiaries of the Marvin Nichols I project in the Region C Water Planning Area include the NTMWD, the TRWD, the UTRWD, and their customers. If these three wholesale water providers participate in the project, 56 percent of the water user groups in Region C would benefit. If DWU also participates in the project, 88 percent of the Region C water user groups would benefit. Phase 1 of the proposed Marvin Nichols I project would include the reservoir, pipelines, and pump stations by 2030, and Phase 2 would include additional pipelines and pump stations by 2050.

As noted, the proposed Marvin Nichols I project was included in the 2002 State Water Plan as a 2030 source of water supply for the Region C and North East Texas Water Planning Areas. Since then, further Region C Water Planning Group studies have suggested that an upstream location called Marvin Nichols 1A, would provide the same yield as previously proposed with less environmental impact. The project would provide a substantial portion of the projected water needs of Region C Water Planning Area and is included in the 2006 Region C Water Plan as a recommended water management strategy for the NTMWD, the TRWD, and the UTRWD, and their customers. The 2006 Region C Water Plan notes that the project provides more water at a lower cost with less environmental impact than developing a number of smaller reservoirs in the Sulphur River Basin.

The Marvin Nichols I Reservoir project would be located entirely in the North East Texas Regional Water Planning Area. Because of the anticipated impacts on agricultural resources; the timber industry; the farming, ranching, and other related industries; and on impacts to the natural resources in the area, the North East Texas Regional Water Planning Group's 2006 Plan recommends that the Marvin Nichols I Reservoir should not be included in any 2006 regional water plan as a water management strategy nor should it be included in the 2007 State Water Plan as a water management strategy. The North East Texas Regional Water Plan was approved by the TWDB on May 16, 2006.

On April 18, 2006, the TWDB approved the Region C Water Plan. The TWDB found no interregional conflicts in the plan since it does not rely upon the same source of water as any other regional water plan so that there would, at any point in the 50-year planning period, be insufficient water available to fully implement all plans (TWDB, 2006). The Marvin Nichols Reservoir project is included in the 2007 State Water Plan as a recommended strategy for the Region C Water Planning Area (TWDB, 2007).

The 2006 Region C Water Plan also recommends a new reservoir on the Neches River in Anderson and Cherokee counties even though this specific area included a portion of a potential wildlife refuge under study by the U.S. Fish and Wildlife Service The proposed Lake Fastrill (Figure 9) would provide a 2050 water supply source of 121,000 acft/yr for DWU and would inundate 24,950 acres – including parts of the Neches River designated as a Priority 1 area by the U.S. Fish and Wildlife Services with excellent quality bottomland of high value to key waterfowl species.

In June 2006, the U.S. Fish and Wildlife Service approved the establishment of the Neches River National Wildlife Refuge. The new refuge will conserve up to 25,281 acres along 38 miles of the Neches River pending the availability of land acquisition funds. All acquisitions or easements will come from willing sellers and neighboring landowners will retain full rights to access their properties (USFW, 2006). The approval and establishment of the Neches River National Wildlife Refuge will likely prevent the proposed Lake Fastrill project from being developed.

WATER PLANNING AND REGULATION

This report is required to consider the need for groundwater management in the study area by a groundwater conservation district (GCD). Part of this consideration is to understand the groundwater planning and regulatory functions of existing entities, and the roles, responsibilities, relationships, and abilities of existing entities and GCDs to effectively manage groundwater resources. Entities that may be involved with activities that impact groundwater resources include local municipalities; counties; state and federal government; regional planning authorities and commissions; regional surface water and groundwater management authorities; regional, municipal, and private water suppliers; and major agricultural, industrial and commercial water users. Water planning and regulatory functions of existing entities and GCDs are described in this chapter.

State and Regional Water Planning

Water planning efforts at the state level are the responsibility of the Texas Water Development Board (TWDB) which prepares a statewide water plan using information provided by regional stakeholders and other state water agencies. State law directs the TWDB to coordinate a regional water planning process and to develop a State Water Plan that incorporates regional water plans, resolves interregional conflicts, provides additional analysis, and makes policy recommendations to the Texas Legislature. State and regional water planning is a dynamic process with each type of plan updated on a five-year cycle.

There are 16 TWDB-delineated regional water planning areas covering the state, and a regional water planning group (RWPG) for each of these areas. The RWPGs consist of members representing the public, counties, municipalities, industry, agriculture, environmental groups, small business, electric generating utilities, river authorities, water districts, and water utilities. The RWPGs are required to develop a regional water plan, establish policies, make decisions, and consider interest groups in the development of the plans consistent with Texas Water Code requirements. The development of a regional water plan includes studies, decisions, and recommendations on water supply needs. The purpose of the plan is to identify and recommend methods or strategies to conserve water supplies, meet future water supply needs, and respond to future droughts in the region.

The North-Central Texas study area is located within four regional water planning areas (Figure 2). Most of the counties (13) in the study area are in the Region C Water Planning Area. Four study-area counties–Delta, Hunt, Lamar, and Red River–are in the Northeast Texas (Region D) Water Planning Area, two study-area counties–Hood and Johnson–are in the Brazos G Regional Water Planning Area, and one study-area county–Montague–is in the Region B Water Planning Area.

As previously discussed, each of the four study area RWPGs adopted and submitted their initial regional water plans to the TWDB in January 2001. The 2001 regional water plans were approved and incorporated into the 2002 State Water Plan that was adopted by the TWDB on December 12, 2001 (TWDB, 2002). The second round of regional water plans were adopted and submitted to the TWDB in December 2005 and January 2006. As of May 16, 2006, the TWDB has approved the 2006 regional water plans for the four study area RWPGs. The TWDB adopted the 2007 State Water Plan on November 14, 2006 (TWDB, 2007).

The TWDB also collects, interprets, and provides information on the groundwater resources of Texas. The TWDB works with a network of cooperators including groundwater conservation districts, municipal water agencies, the U.S. Geological Survey, and others to measure water levels and monitor groundwater quantity and quality; maintains the state's water well database; and collects and maintains data on historic and present groundwater use and projected groundwater demand. The TWDB develops, maintains, and updates groundwater availability models for the state's major and minor aquifers and runs the models or uses other tools to help assess groundwater availability. The TWDB provides technical expertise and assistance to GCDs, RWPGs, and others on groundwater availability for regional, state, and GCD water planning issues.

In addition to its water planning and technical assistance responsibilities, the TWDB administers water development funds under state and federal programs. Water development funds generally are available as low interest loans and as grants to local and regional governments for water supply and wastewater planning, feasibility studies, and infrastructure development. TWDB financial assistance may be provided only to water supply projects that meet needs in a manner that is consistent with an approved regional water plan.

Groundwater Conservation District Management Planning

Groundwater conservation districts are statutorily charged and authorized to manage groundwater resources by providing for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater resources within their jurisdictions. In addition to groundwater management planning as outlined below, GCDs manage groundwater resources by adopting necessary rules to implement management plans; require permits for drilling, equipping, or completing wells that produce more than 25,000 gallons per day or for alterations to well size or well pumps; and require records to be kept of the drilling, equipping, and completion of water wells, as well as on the production and use of groundwater resources.

Every GCD in Texas is required to develop, in coordination with surface-water management entities, a comprehensive management plan that addresses the groundwater management goals of the district. Texas Water Code, Chapter 36 outlines the general contents of a groundwater management plan and the requirements for its adoption by the GCD's governing board of directors and for approval by the TWDB. These GCD plans must include specific groundwater management goals to address:

- the most efficient use of groundwater,
- the control and prevention of waste of groundwater,
- the control and prevention of subsidence,
- conjunctive surface water management issues,
- natural resource issues that impact the use and availability of groundwater and which are impacted by the use of groundwater,
- drought conditions,
- conservation and specific conservation practices, and
- the desired future conditions of the groundwater resources.

GCD management plans must be developed by the district using the best available data and forwarded to the regional water planning group(s) for use in their planning process. The plans must identify management objectives and performance standards under which the district will operate to achieve management goals. The GCD management plans must also consider the water supply needs and water management strategies included in the adopted State Water Plan. The GCD management plans take effect on approval by the TWDB. The GCDs must readopt management plans with or without changes at least once every five years.

Groundwater conservation districts are also authorized to manage groundwater resources by adopting rules and permit requirements for the spacing of water wells, regulating the production of wells, and for transferring groundwater out of the district. New GCDs may not adopt rules limiting the production of wells until their management plan has been approved by the TWDB. GCDs may also undertake projects to recharge aquifers; survey, monitor, evaluate, and research groundwater quantity and quality; and protect groundwater quality by adopting well construction standards more stringent than state standards and requiring the closure of abandoned water wells. No other such entities are authorized with these broad powers to manage groundwater resources.

Joint GCD Management Planning in Groundwater Management Areas

In 2002, the TWDB delineated 16 Groundwater Management Areas (GMAs) in accordance with state law. A GMA is a formal boundary delineation for an aquifer or a segment of an aquifer that provides a suitable area for management of groundwater resources. State law requires GCDs in a common GMA to conduct joint planning for the common groundwater resources. The study area is included in GMA #8 for the Trinity Aquifer. There were six GCDs in the southern portion of GMA #8 (Figure 10) in May 2007.

Changes to state law that became effective in 2005 require the presiding officer or the presiding officer's designee of each GCD located in whole or in part in a GMA to meet at least annually to conduct joint planning with the other districts in the management area and to review the management plans and accomplishments for the management area. The districts are required to consider the goals and effectiveness of each management plan and each management plan's impact on planning throughout the management area. Before September 1, 2010, and every five years thereafter, the GCDs in the GMA must consider groundwater availability models and other data to establish the desired future conditions for relevant aquifers within the GMA. Different desired future conditions may be established for each aquifer, subdivision of an aquifer, or geologic strata; or each geographic area overlying an aquifer or subdivision of an aquifer.

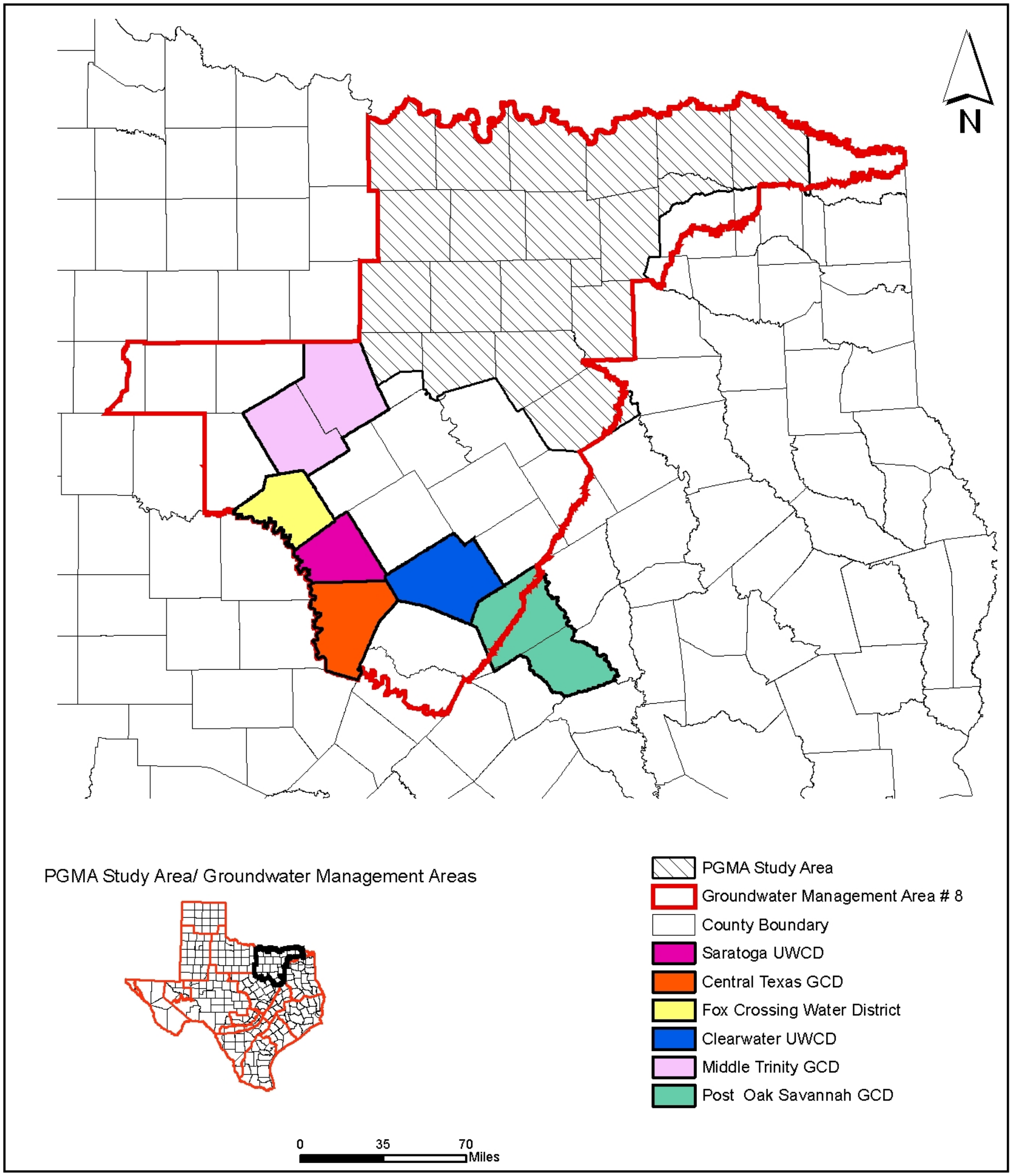
TWDB rules define desired future conditions as a desired, quantified condition for groundwater resources – such as water levels, water quality, spring flows, or volumes – at a specified time or times in the future or in perpetuity. Desired future conditions have to be physically possible, individually and collectively, if different desired future conditions are stated for different geographic areas overlying an aquifer or subdivision of an aquifer.

After they are developed, the GCDs submit the desired future condition statements to the TWDB. The TWDB will then provide each groundwater conservation district and regional water planning group in the GMA with the values of managed available groundwater based on the established desired future conditions for the groundwater resources. GCD management plans adopted after this joint planning process has been completed must use the managed available groundwater values and include quantifiable goals and objectives that are consistent with addressing the desired future conditions of the groundwater resources. Through these cooperative planning efforts, local GCDs can effectively provide coordinated regional management of a shared groundwater resource. The RWPGs will be required to use the managed available groundwater values in the regional water plans.

State law includes provisions for mediation and court appeal processes for cases of regional water plan - GCD management plan conflict and TWDB management plan approval - GCD disagreement. Regarding joint GCD management planning, a GCD or a person with a legally defined interest in groundwater in the GMA may petition the TCEQ for a review panel inquiry if a GCD does not join in the planning process or if the process failed to result in adequate planning, including the establishment of the desired future conditions of the aquifers.

The 16 GMAs cover the entire state. At present, representation for areas in a GMA that lie outside of a GCD is not addressed by the statute; therefore, areas outside of a GCD do not have formal representation in GMA matters. The GCDs in some GMAs are inviting nonvoting representation from areas without GCDs. The TWDB estimates that desired future condition statements will need to be submitted in 2007 or early 2008 for the managed available groundwater numbers to be used in the next round of regional water planning (Mace et al., 2006).

Figure 10. Groundwater Management Area #8 and Groundwater Conservation Districts



Federal Regulatory Agencies

The U.S. Environmental Protection Agency (USEPA) and the U.S. Nuclear Regulatory Commission are federal agencies responsible for enforcing numerous federal laws for protecting groundwater resources. Generally, these agencies have delegated the administration of federal regulatory programs to individual states, or occasionally to local authorities. For example, the USEPA which has authority over the federal Resource Conservation and Recovery Act; the Comprehensive Environmental Response, Compensation and Liability Act; the Clean Water Act; the Safe Drinking Water Act; and the Federal Insecticide, Fungicide and Rodenticide Act has delegated administration of these programs in Texas to the TCEQ.

The U.S. Fish and Wildlife Service (USFWS) is a bureau within the Department of the Interior that works with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people. Among its key functions, the USFWS enforces federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, and conserves and restores wildlife habitat.

The U.S. Army Corps of Engineers (USACOE) mission is to provide quality, responsive engineering services to the nation including: planning, designing, building and operating water resources and other civil works projects (navigation, flood control, environmental protection, disaster response, etc.); designing and managing the construction of military facilities for the Army and Air Force. (Military Construction); and, providing design and construction management support for other Department of Defense and federal agencies. The study area is located in the USACOE's Southwestern Division in the Fort Worth and Tulsa Districts. The USACOE oversees 11 reservoirs in the study area including Bardwell, Benbrook, Chapman (Cooper), Grapevine, Joe Pool, Lavon, Lewisville, Navarro Mills, Pat Mayse, Ray Roberts, and Texoma.

The U.S. Department of Agriculture (USDA) administers numerous programs at the local level to protect and conserve water resources. The USDA Farm Service Agency's Conservation Reserve Program (CRP) undertakes to reduce soil erosion and sedimentation in streams and lakes, improve water quality, establish wildlife habitats, and enhance wetland resources. The CRP encourages farmers to convert highly erodible cropland or other environmentally sensitive areas to vegetative cover such as native grasses. The USDA Natural Resource Conservation Service (NRCS) provides technical assistance to landowners, communities, and local governments in planning and implementing conservation programs. The USDA/NRCS's national Farm*A*Syst and Home*A*Syst programs promote voluntary assessments to prevent pollution. Step-by-step worksheets allow individuals to apply site-specific management practices to their property.

North Texas is included in two interstate compacts to resolve and prevent disputes over waters that are shared between neighboring states. The Red River Compact includes the states of Oklahoma, Arkansas, Louisiana, and Texas, and the Red River Compact Commission ensures that each state receives its share of water from the Red River and its tributaries as apportioned by the Compact. The Sabine River Compact includes the states of Texas and Louisiana and the Sabine River Compact Commission serves the same functions for appropriating water from the Sabine River and its tributaries.

State Regulatory Agencies

State agencies do not have authority to manage or regulate groundwater resources. The roles of state agencies in addressing the problems and concerns identified in the study area are limited to water quality protection through the regulation of waste management or implementation of best management practices (BMPs), water resource planning and project funding, and facilitation of groundwater management activities through the creation of GCDs. State law does not provide any state agency the authority to control groundwater pumpage and use.

The TCEQ is the state's primary environmental regulatory agency and implements state and federally delegated programs. TCEQ administers the supervision program for public drinking water systems and has primary responsibility for public water system aspects of the federal Safe Drinking Water Act. Other regulatory authorities are surface water rights permitting; creation and supervision of water districts; industrial, municipal and hazardous waste management; and water quality protection. In relation to water planning, the TCEQ cannot issue a surface water right for municipal purposes unless it is consistent with an approved regional water plan.

Other state agencies such as the Texas Parks and Wildlife Department (TPWD), Railroad Commission of Texas, Department of State Health Services, Texas Department of Agriculture, Texas Department of Licensing and Regulation (TDLR), and the Texas State Soil and Water Conservation Board (TSSWCB) have management or regulatory responsibilities for some activities related to environmental protection. The TPWD is the state agency with primary responsibility for protecting the state's fish and wildlife resources. The TDLR licenses water well drillers and pump installers and enforces water well construction, water-quality protection, set-back, and well plugging rules (TGPC, 2005).

Most of the study area counties are included within the jurisdictional boundaries of one of five legislatively-created river authorities. These include the Red River Authority of Texas, the Trinity River Authority of Texas, the Brazos River Authority, the Sabine River Authority of Texas, and the Sulphur River Basin Authority of Texas. The primary purpose of the river authorities is to manage, distribute, and conserve the surface water resources within their defined boundaries. River authorities control rights to surface water and sell water directly or indirectly to consumers. River authorities may monitor and enforce surface water quality, finance and construct water projects, and manage waste water systems. Some river authorities administer on-site wastewater or septic tank regulatory programs designed to prevent both surface and groundwater pollution. Two of the study area river authorities provide the administrative staff and support for a regional water planning group – the Red River Authority of Texas for the Region B Water Planning Group and the Brazos River Authority for the Brazos G Water Planning Group.

Soil and Water Conservation Districts

The TSSWCB administers the Texas Soil Conservation Law and offers a technical assistance program to the state's 216 soil and water conservation districts (SWCDs). The TSSWCB is the lead agency for the planning, management and abatement of agricultural and silvicultural (forestry) nonpoint source pollution (TGPC, 2005). The local SWCDs in the study area include:

- Brazos Valley SWCD #557 (Hood and Somervell counties)
- Collin County SWCD #535
- Dalworth SWCD #515 (Dallas, Tarrant, and part of Johnson counties)
- Delta SWCD #443 (Delta County)
- Denton County SWCD #547
- Ellis-Praire SWCD #504 (Ellis County)
- Fannin County SWCD #520
- Johnson County SWCD #541
- Kaufman-Van Zandt SWCD #505 (Kaufman, Rockwall, and Van Zandt counties)
- Lamar SWCD #415 (Lamar County)
- Navarro SWCD #514 (Navarro County)
- Parker County SWCD #558
- Red River County SWCD #423
- Upper Elm-Red SWCD #524 (Montague, Cooke, and Grayson counties)

- Upper Sabine SWCD #530 (Hunt County)
- Wise SWCD #548 (Wise County)

SWCD programs and plans identify and inventory the land and water resources, describe physical and socio economic conditions bearing on the land and its use, and identify conservation problems. Each local SWCD develops a long range program and plan of work and an annual plan of operation which guide the district in solving its conservation problems. These district programs and plans of work are updated regularly to recognize and evaluate changes in agriculture, economy and natural resources. With appropriate education, landowners recognize the desirability of implementing suitable management practices to conserve natural resources. Farmers and ranchers desiring to use a conservation program on their land may receive assistance from their local district. The landowner's interest and the district's commitment of assistance are formalized by both parties signing a cooperative agreement to implement conservation best management practices. A conservation plan, which may include or be classified as a water quality management plan for each individual farm or ranch, is then developed.

The 16 SWCDs covering the study area plus Somervell and Van Zandt counties include over 60,000 landowners or operators and have assisted over 24,000 cooperators. There are over 4.7 million acres with approved conservation plans in the study area SWCDs and over 400 water quality management plans covering about 77,000 acres (Texas State Soil and Water Conservation Board, 2006). Conservation plans generally address practices to improve grade stabilization, terraces, and contour farming; ponds, waterways and grassed waterways, and livestock watering; grass planting, cover crops, and conservation cropping, tillage, and buffers strips; pasture, range, and hayland seeding and management; wildlife, habitat, and brush management; brush and tree planting; and nutrient, pesticide, crop residue, and forage harvest management. These conservation practices are implemented by cooperator landowners and operators and the benefits are enjoyed by these same people.

Local Governments and Regional Councils

Cities and counties, the primary units of local government in Texas, typically carry out public health programs such as disposal of municipal solid waste; production, distribution, and protection of public drinking water supplies; and treatment and discharge of municipal wastewater. Cities and counties can also accomplish other water protection activities such as implementing wellhead and source water protection programs and, after delegation from the TCEQ, implementing the on-site wastewater or septic tank regulatory program.

Texas Water Code, Section 26.177 describes some of the duties of cities in the area of water pollution control and authorizes cities to adopt and implement water pollution abatement plans. Through their ordinance authority to protect the public welfare, cities may initiate water resource protection programs such as data collection or land use regulation to protect water quality. Many study-area cities have adopted ordinances that require private water wells within city limits be registered with the city. City ordinances specifying set-back distances for water wells, and more recently in the study area, set back distances from natural gas wells, are not uncommon.

State law that became effective in 2003 authorizes the TCEQ to receive, process and certify Municipal Setting Designation (MSD) applications for properties with contaminated groundwater that are located in cities or their extraterritorial jurisdiction with a population of at least 20,000. TCEQ can certify an application only if it is supported by a resolution adopted by the city and retail pubic utilities. An MSD is an official state designation given to property within a municipality or its extraterritorial jurisdiction that certifies that groundwater at the property is not used as potable water, and is prohibited from future use as potable water because that groundwater is contaminated in excess of the applicable potable-water protective concentration level. The prohibition must be in the form of a city ordinance, or a restrictive covenant that is enforceable by the city and filed in the property records. MSD property can be a single property, multi-property, or a portion of property (TCEQ, 2005). At the end of April 2006, four properties in Dallas County totaling about 20 acres, and one 46-acre property in Tarrant County had received MSD certification. Eight other MSD applications, six in the City of Dallas and one each in the cities of Euless and Garland, were pending certification (http://www.tceq.state.tx.us/assets/public/remediation/msd/MSDAppChart.pdf, accessed May 11, 2006).

The Local Government Code, Sections 212.0101 and 232.0032 provide groundwater availability certification authority to all municipal and county platting authorities in the state. Under this statute, a municipal platting authority or county commissioners court may require a person submitting a plat for the subdivision of a tract of land for which the intended source of water supply is groundwater under that land to demonstrate adequate groundwater is available for the proposed subdivision. If groundwater availability certification is required by the local platting authority under the Local Government Code, the plat applicant must evaluate groundwater resources and prepare the availability certification pursuant to TCEQ rules. The rules in Title 30, Texas Administrative Code, Chapter 230 establish the appropriate form and content of a groundwater availability certification. Exercising this authority under the Local Government Code can be an effective groundwater management tool in areas undergoing significant growth and development. This tool, however, is limited because it can only be used to address site-specific cases of land subdivision and does not allow for aquifer-wide or regional considerations. Daniel B. Stephens & Associates, Inc. (2006) report that Dallas, Denton, Collin, Ellis, Johnson, Parker, Rockwall, and Tarrant counties do not exercise this authority in their plat application processes. TCEQ staff is aware of only two units of local government in the 20-county study area presently exercising this authority, the City of Annetta in Parker County (TCEQ personal communication, Sept. 14, 2006) and, effective March 1, 2007, Parker County (Scott, 2007).

The Local Government Code was amended in 2005 to add new Sections 240.041 through 240.048. This new law provides that a commissioners court of a county with a population of 1.4 million or more may, in unincorporated areas of the county, regulate by order and by rule the placement of water wells to prevent: (1) the contamination of a well from an existing on-site sewage disposal system, (2) the rendering of an existing on-site sewage disposal system out of compliance because of the placement of the well, or (3) the drilling of a domestic well into a contaminated groundwater plume. Based on 2004 estimated census data, this law could be applied in Harris, Dallas, Tarrant, and Bexar counties. Exceptions to this new authority were listed as: private water wells drilled on a parcel of land that is 10 acres or more in size or on a parcel of land that is qualified open-space as defined by Section 23.51, Tax Code; private water wells within the boundaries of a GCD (would exclude Bexar County); private water wells within the boundaries of a subsidence district other than the Harris-Galveston Subsidence District (would not exclude Harris County); private water wells incident to the exploration, development, or production of oil, gas, or other minerals; or, a public water systems that has been permitted under rules adopted by the TCEQ. TCEQ staff is unaware of either Dallas County or Tarrant County exercising this new authority.

Regional councils, or councils of governments (COGs) are voluntary associations of local governments formed under Texas law. These associations deal with the problems and planning needs that cross the boundaries of individual local governments or that require regional attention. They are predominantly planning, facilitating, and funding distribution agencies with no independent regulatory authority. The regional councils provide services undertaken in cooperation with member governments, the private sector, and state and federal partners to plan and implement regional homeland security strategies, operate law enforcement training academies, provide cooperative purchasing options for governments, manage region-wide services to the elderly, maintain and improve regional 9-1-1 systems, promote regional economic development, operate specialized transit systems, and provide management services for member governments. In addition, Texas' regional councils of government are responsible for regional planning activities that may differ from region to region, but typically include planning for economic growth, water supply and water quality, air quality, transportation, emergency preparedness, and the coordinated delivery of various social services (Texas Association of Regional Councils, 2006). State law mandates that COGs have primary responsibility for the development of regional municipal solid waste plans. Regional solid waste plans must conform with the state plans and are adopted by TCEQ rule.

Most of the counties in the study area are served by the North Central Texas Council of Governments (NCTCOG). The NCTCOG assists its members in planning for common needs, cooperating for mutual benefit, and recognizing regional opportunities for improving the quality of life in North Central Texas. The NCTCOG promotes a spirit of cooperation among the local governments of the North Central Texas Region; assists in resolving problems affecting the region in a manner that is mutually satisfactory to the rights and prerogatives of the local governments; advises and assists the local governments of the region; and serves, upon the request of local governments, as the representatives of such governments in matters that they may determine affect the region as a whole (Texas Association of Regional Councils, 2006).

The Texoma Council of Governments is a partnership of governments and public representatives that works to continually improve the economic, social and educational opportunities for the citizens of Cooke, Grayson, and Fannin counties by developing resources, quality programs, and services. For the study-area counties of Delta, Lamar, Red River, and five other counties, the mission of the Ark-Tex Council of Governments (ATCOG) is to improve the social, economic, political, physical and natural environments for the citizens in the area on behalf of its member governmental organizations. The ATCOG achieves its mission by providing a regional perspective on service, information, and problem-solving, and by coordinating funding, resources and programs. The Nortex Regional Planning Commission (NRPC) serves Montague and ten other counties as an association of local governments committed to regional planning and development programs for the improvement of the health, safety, and general welfare of their citizens. NRPC develops studies and plans to guide the development of the area, to eliminate duplication, and to promote economy and efficiency in the coordinated development of the region (Texas Association of Regional Councils, 2006).

Water Purveyors

Wholesale and retail public water suppliers are the most important water management entities because of their responsibilities to provide safe, reliable water to their customers. These water purveyors can include municipalities, water supply corporations, river authorities, water supply districts, investor-owned utilities, and water conservation and irrigation districts. In accordance with TCEQ rules (Title 30, Texas Administrative Code, Chapter 288), all public water suppliers are required to develop and implement water conservation plans. Wholesale and retail public water suppliers serving more than 3,300 connections and irrigation districts are required to develop drought contingency plans and to submit the plans to the TCEQ. Retail public water suppliers serving less than 3,300 connections are also required to develop drought contingency plans but are only required to submit them to the TCEQ upon request.

A water conservation plan is basically a strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency of the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. Quantified five- and ten-year targets for water savings must be included in all water conservation plans. Water conservation plans help suppliers determine how much water they and their customers can save, what actions they can take to save water, and what educational efforts are needed to encourage water conservation.

The next required revision of the water conservation plans must be submitted to the TCEQ no later than May 1, 2009 to coincide with the next round of the regional water planning process. In addition to the revised water conservation plans, water conservation implementation reports must be submitted to the TCEQ no later than May 1, 2009. The implementation reports will describe measures that have been taken, whether targets have been met, and provide data about actual quantities of water saved.

A drought contingency plan is defined as a strategy or combination of strategies for temporary supply management and demand management responses to temporary, and potentially recurring, water supply shortages and other water supply emergencies. Unlike water conservation, which focuses on the ongoing maintenance and efficiency of the water supply system and customers' water-use habits, drought contingency is triggered by cases of extreme drought, periods of abnormally high usage, supply contamination, or extended reduction in ability to supply water due to equipment failure.

Also, any entity applying for a new water right or an amendment to an existing water right must prepare and implement a water conservation plan and submit the plan with the application. The TCEQ is required to determine whether requested appropriations of state water are reasonable and necessary for the proposed use(s), and that the water rights applicant will conserve and avoid wasting water.

The 2006 Region C Water Plan identifies 12 regional wholesale water providers and 23 local wholesale water provides. The regional wholesale water providers supply large amounts of water to several customers and include:

City of Corsicana
City of Fort Worth
Dallas Water Utilities
Dallas Co. Park Cities Municipal Utility District
Greater Texoma Utility Authority
North Texas Municipal Water District
Sabine River Authority
Sulphur River Water District
Tarrant Regional Water District
Trinity River Authority
Upper Neches River Municipal Water Authority
Upper Trinity Regional Water District

The local wholesale water providers identified in the Region C Water Plan include the cities of Cedar Hill, Denton, Ennis, Forney, Gainesville, Garland, Mansfield, Midlothian, North Richland Hills, Rockwall, Seagoville, Terrell, Waxahachie, Weatherford, and the Athens Municipal Water Authority, East Cedar Creek Fresh Water Supply District (WSD), Lake Cities Municipal Utility Authority, Mustang Special Utility District (SUD), Parker County Utility District No. 1, Rockett SUD, Walnut Creek SUD, West Cedar Creek Municipal Utility District (MUD), and Wise County WSD.

Other regional wholesale water providers in or serving the study area are the Brazos River Authority and the Red River Authority. Additional local wholesale water providers include the cities of Burleson, Cleburne, Granbury, Greenville, Keene, Paris, and Venus, and Acton MUD, Cash Water Supply Corporation (WSC), Johnson County Fresh Water Supply District No. 1, Johnson County SUD, and Lamar County WSD. Smaller water provides in the study area include:

410 WSC
Able Springs WSC
Acton MUD
Argyle WSC
Aquasource Co.
Aquilla WSD
Bartonville WSC
Benbrook WSA
Ben Franklin WSC
Bethany WSC
Bethesda WSC
BHP WSC
Blackland WSC
Brandon-Irene WSC
Bolliver WSC
Buena Vista-Bethel SUD
Danville WSC
Delta County MUD
Denton County FWSD No. 1
East Fork SUD
Ellis County WCID No. 1
Enloe-Lake Creek WSC
Files Valley WSC
Forney Lake WSC
Gunter Rural WSC
Hickory Creek SUD
High Point WSC
Jacobia WSC
Johnson Co. FWCD No. 1
Kiowa Homeowners WSC
Lavon WSC
Lone Star WSC
Nocona Hills WSC
North Collin WSC
North Hunt WSC
Oak Trail Shores Subdivision
Parker WSC
Pattonville WSC
Petty WSC
Poetry WSC
R-C-H WSC
Red River County WSC
Rice WSC
Ringgold WSC
Sardis-Lone Elm WSC
Shady Grove WSC
South Grayson WSC
Southwest Fannin Co. SUD

Caddo Basin SUD
Campbell WSC
Charleston WSC
Chatfield WSC
College Mound WSC
Combine WSC
Combined Customers WSC
Community Water Co.
Culleoka WSC
Dallas County WCID No. 6
Luella WSC
Mac Bee WSC
MEN WSC
MJC WSC
Miller Grove WSC
Milligan WSC
Montague WSC
Mountain Peak WSC
Mt. Zion WSC
Navarro Mills WSC
Sunset WSC
Trophy Club MUD No. 1
Two Way WSC
West Delta WSC
West Leonard WSC
West Oaks Pheonix WS
West Wise Rural WSC
Whisper Oaks Water Coop.
Woodbine WSC

The Texas Water Conservation Implementation Task Force – an interim multi-agency, multi-constituency study group established by the 78th Texas Legislature in 2003 – identified 22 best management practices (BMPs) to conserve water resources that can be effectively administered by public water suppliers, and an additional 33 BMPs that can be exercised by industrial and agricultural water users. The Task Force used a working definition of conservation as those practices, techniques, programs, and technologies that will protect water resources, 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. The BMPs and cost effectiveness considerations were identified for the state's regional water planning groups, water providers, and water users as tools for planning and designing effective conservation programs. Each BMP is organized to be of assistance in conservation planning, program development, implementation, and evaluation (TWDB, 2004).

As of July 1, 2006, 41 public water systems in the study area were suggesting that customers voluntarily limit water use to avoid shortages; 34 systems were restricting use for outdoor purposes such as watering lawns and gardens or washing cars; 1 system was prohibiting outdoor water use except by hand-held hoses; and, 4 systems were prohibiting outdoor water usage or limiting consumption. On April 1, 2007, 31 public water supply systems in the study area were suggesting voluntary rationing, 54 were under stage one rationing restrictions, 6 were under moderate rationing restriction, and 3 were under severe water rationing restrictions (http://www.tceq.state.tx.us/permitting/water_supply/pdw/trot/droughtw.html, accessed July 12, 2006 and May 15, 2007). Figure 11 shows water systems that are under water use restrictions as of April 1, 2007.

A TCEQ issued certificate of convenience and necessity (CCN) defines a water purveyor's service area. The purveyor's water delivery system might not extend to the limits of its defined service area, but other utility service providers generally may not encroach upon the service area. If anyone in this area applies for service, the supplier generally must serve them. Water purveyors may use one or more systems to serve their area. Any county within 50 miles of Mexico, an investor-owned utility, or a water supply corporation must obtain a CCN. However, other counties, cities, or districts are not required to obtain a CCN. TCEQ rules regarding CCNs are in Title 30 Texas Administrative Code, Chapter 291.

A May 2006 query of the TCEQ water utilities database indicates that 544 of the 817 active public water supply systems in the 20-county study area are presently using groundwater sources. There are almost 1,650 active public water supply wells and over 800 inactive public water supply wells, a small percentage of which are used for standby or emergency water-supply purposes, in the study area. Denton, Johnson, Parker, and Tarrant counties each have over 200 active public water supply wells, and Grayson and Hood counties each have over 175 active wells. Around 550 study-area water suppliers have service areas that have been certificated by the TCEQ. Pubic water supply well locations are shown on Figure 12.

Figure 11. Water Systems Under Water Use Restriction

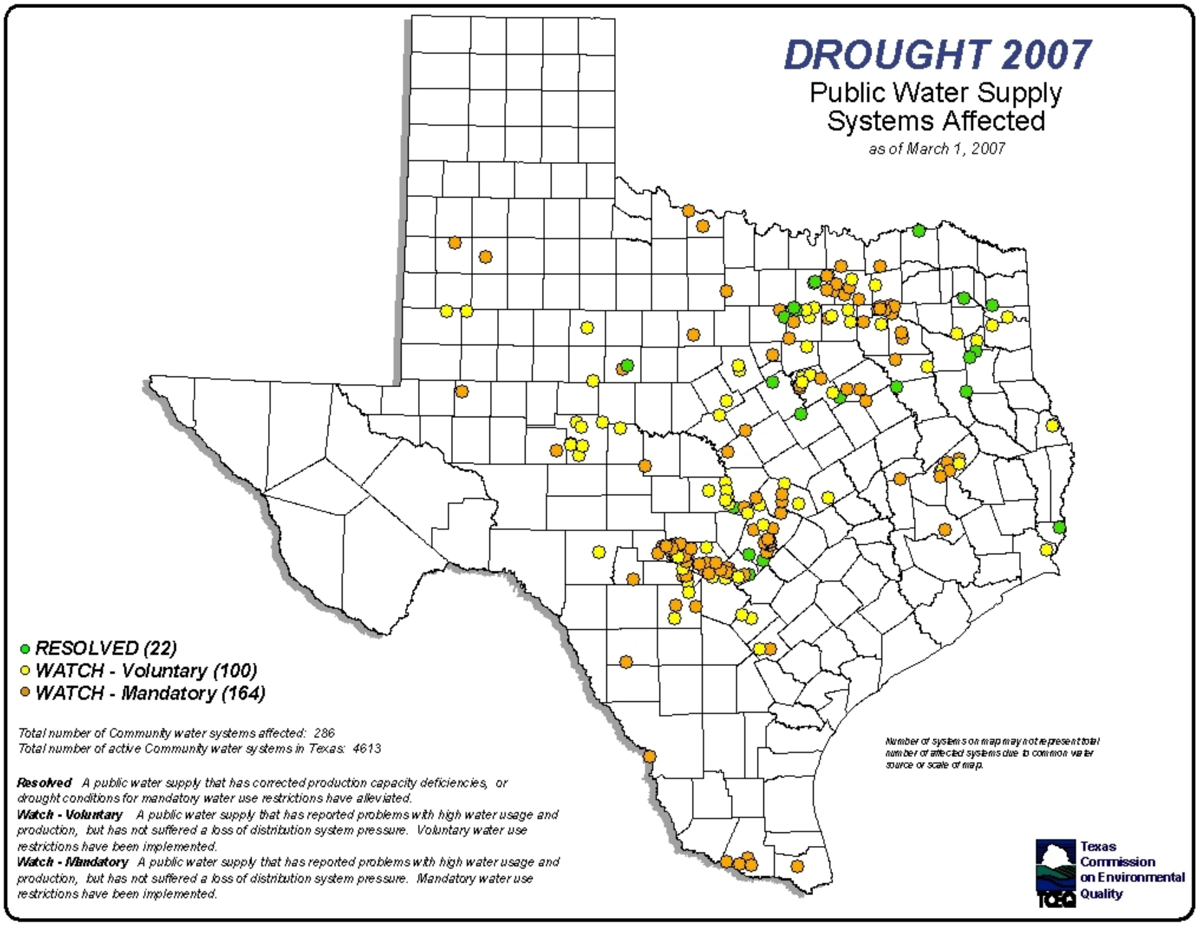
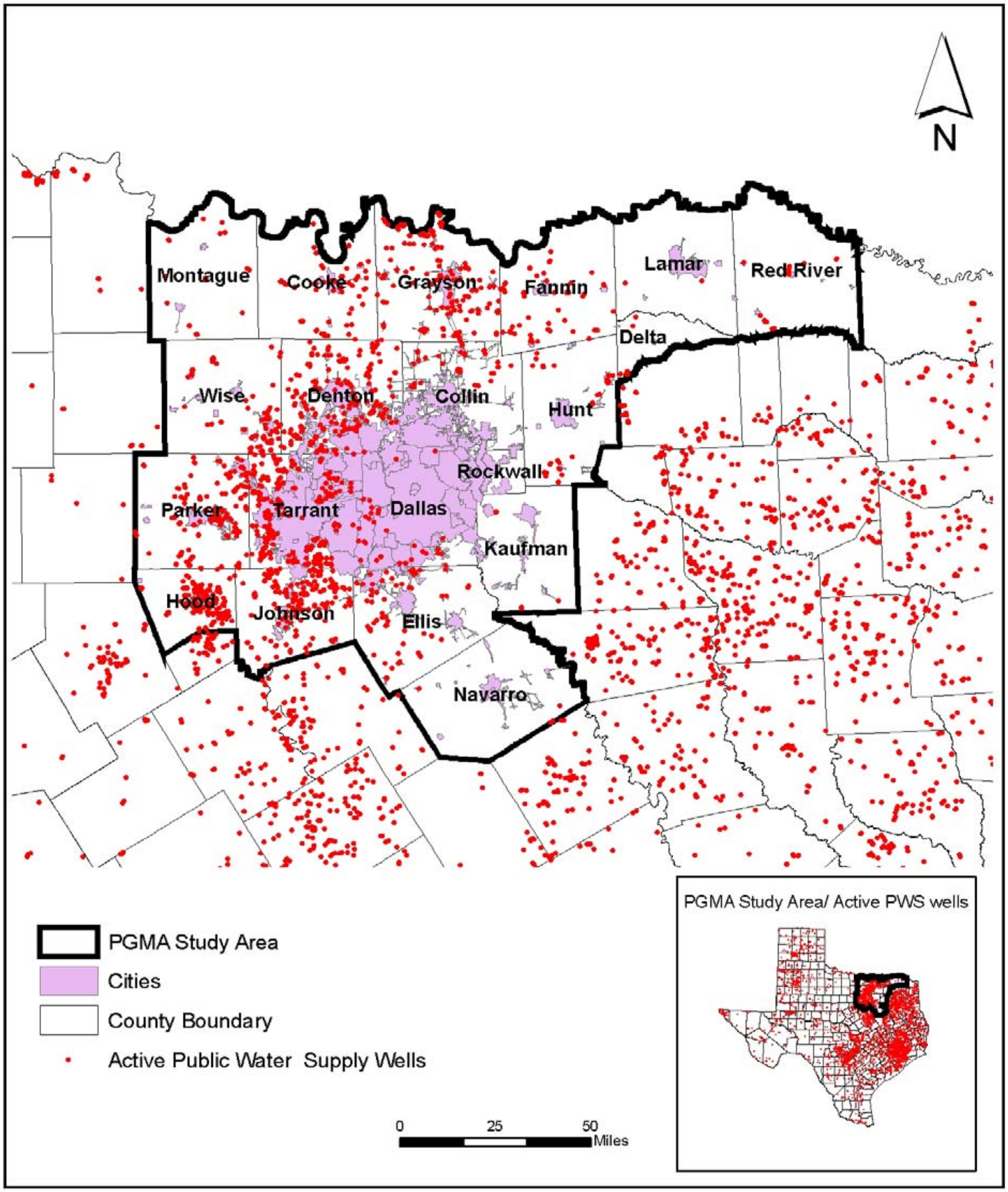


Figure 12. Public Water Supply Well Locations



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GROUNDWATER CONSERVATION DISTRICT CONSIDERATIONS FOR AREA

The feasibility of managing groundwater resources within the study area is presented within this section. Groundwater management approaches that can be used by groundwater conservation districts are evaluated. Area-specific groundwater management strategies, economic and financial considerations, available district-creation options, and recent district-creation actions are discussed below.

Groundwater Management Functions

Various mechanisms are available for protecting groundwater resources in an area. They range from imposing restrictions on groundwater withdrawals to developing alternate supplies, to conjunctively using both surface water and groundwater. Regulating groundwater withdrawal can prolong the life of an aquifer and increase land value by assuring a reliable supply of water for future use and economic development.

Local or regional groundwater conservation districts (GCDs) are the state's preferred method of managing groundwater resources, and are the only entities in Texas explicitly granted the power to regulate groundwater withdrawals. Under state law, GCDs are governed by a locally elected board of directors who serve staggered four-year terms. The board of directors is responsible for managing the district including the adoption of district policies, plans, rules, and procedures.

State law requires GCDs to manage groundwater by conserving, preserving, protecting, recharging, and preventing wastage of the groundwater resources within their jurisdiction, and provides permissive authorities to empower local decision-making for resource protection programs. Some GCD approaches or techniques for managing groundwater include:

- water resource planning and educational outreach;
- groundwater resource assessment and research;
- monitoring of water levels, water quality, and land subsidence;
- well inventory, registration, permitting and closure;
- limiting well interference or withdrawals through well spacing or setback requirements;
- well pumpage or use limitations; and
- use of engineered structures or injection wells to enhance natural recharge or artificially recharge groundwater aquifers.

Through groundwater monitoring (both quantity and quality) and assessment functions, a GCD can quantify groundwater resources, study and investigate aquifer characteristics, and identify groundwater problems that need to be addressed. Planning functions outline appropriate management objectives and goals for the district to preserve and protect groundwater resources and GCD rules are adopted to achieve the management planning objectives and goals.

Groundwater conservation districts are required to establish water well permitting and registration programs and through these programs, can quantify aquifer impacts from pumpage. An efficient water well inventory, permitting, and registration program allows a GCD to establish an overall understanding of groundwater use and production within the district. This water well and water use data provides the scientific bases for a GCD to develop aquifer-specific requirements to protect well owners dependent upon the resource.

Permits must be obtained from a GCD to drill, equip or complete nonexempt water wells, or to substantially alter the size of wells or well pumps. Certain types of water wells are exempted from GCD permitting by state law, and each district is also authorized to provide exemption for other wells through their rulemaking procedures. Wells exempted from regulation by statute or by district rule must be registered with the district before being installed and be completed and maintained in accordance with the district's rules regarding prevention of waste and pollution of the groundwater. The wells that are exempt from GCD permitting by state law generally include (1) domestic or livestock wells incapable of producing 25,000 gallons per day located on tracts of land larger than 10 acres, and (2) wells supplying water for exploration, production, and other activities permitted by the Railroad Commission of Texas (RCT). If the use of an exempted well changes from its original purpose, it must then obtain a permit consistent with all other like-use wells in the GCD. Also, an entity holding a surface-mining permit issued by the RCT that authorizes the drilling of a water well can be required to make monthly reports to a GCD about the total amount of water withdrawn during the month, the quantity of water necessary for mining activities, and the quantity of water withdrawn for other purposes. With the passage of Senate Bill 714 (80th Legislature, Regular Session) by Senator Troy Fraser, GCDs are authorized effective September 1, 2007, to adopt rules that require the owners or operators of water supply wells for oil and gas drilling or exploration to report groundwater usage to the district.

Groundwater conservation districts may also adopt rules to regulate the spacing and production of water wells. Spacing regulations are generally adopted by a district to minimize drawdown of water levels (both water table and artesian pressure), control subsidence, prevent waste, and prevent interference from other nearby wells. Spacing and production regulations are commonly based on minimum distances from other wells or property lines, a maximum number of wells in a specified area of land (e.g., ¼-section, ½-section, or full-section), or a maximum allowable production per a given unit of land (e.g., 5 gallons per minute per acre or 1 acre-foot of production per year per acre of land).

Groundwater conservation district management activities can include protecting water quality by regulating water well construction and ensuring proper well closure and actively identifying and closing abandoned wells. Districts may also implement activities such as recharge enhancement projects or use-efficiency services to enhance natural recharge, decrease groundwater usage, and increase groundwater supplies. Other important GCD management programs include water conservation and public education efforts and providing conservation assistance through loan and grant programs.

Other types of regional, county, or local governments do not have the statutory authority to regulate groundwater production. Municipal platting authorities and county commissioners courts have permissive authority to require plat applicants to demonstrate that sufficient supplies are available to support groundwater-dependent subdivisions when fully developed. Municipalities and water purveyors can indirectly limit groundwater withdrawals by implementing and enforcing water conservation measures. Municipalities, water supply districts, and river authorities play key roles in the development of alternative supplies such as surface water reservoirs or reuse systems that can reduce dependence on groundwater. Public water suppliers are required to prepare drought contingency plans and to implement the plans during times of water shortages and drought. These drought contingency plans generally call for mandatory water conservation and address options for alternate supplies during times of shortage.

The Region C Water Plan notes that groundwater conservation districts may be an appropriate way to manage limited resources in areas where groundwater use exceeds or approaches the long-term reliable supply, and notes that Trinity aquifer groundwater use is above or near the long-term availability in Collin, Cooke, Dallas, Ellis, Grayson, Tarrant, and Wise counties (Freese and Nichols, Inc., et al., 2006). The Brazos G Regional Water Plan notes that GCDs are created in part to manage competing interests in groundwater supplies (Brazos G Regional Water Planning Group et al., 2006).

The Region C Water Plan recommends that the formation of groundwater conservation districts is a local decision and should be considered by water suppliers and government officials in areas of heavy groundwater use (Freese and Nichols, Inc., et al., 2006).

Needed Groundwater Management Programs and Goals

More groundwater is being withdrawn than recharged to aquifers in most parts of the North-Central Texas study area. The overdevelopment of aquifers threatens water supplies for rural domestic and small water providers who depend on groundwater resources. The water demands due to the continued urbanization of the area, and more recently, the growing natural gas exploration activity show no discernable trends to level out or to lessen over the next 25-year period.

Some groundwater users on the fringes of the Dallas-Fort Worth urban core, including many municipalities, will be converting to surface water sources over the next 10 to 20 years. However, increased groundwater pumpage to keep pace with the growth around the metroplex and the growing suburban cities is anticipated to continue. Historically, regional groundwater pumpage has not lessened when local providers convert to surface water sources because those who develop next, just outside of the area that has recently converted to surface water, will look first and foremost to use the groundwater resources.

Preserving the ability to rely on the limited groundwater resource is and will remain a primary objective for remote rural water suppliers; individual businesses, industries, or homeowners; and, small municipalities. Protecting existing groundwater supplies is a critical issue for these groundwater users because the delivery of alternative surface water supplies is not projected to be economically feasible.

The primary problems identified in the study area include the historic overdevelopment of the Trinity and Woodbine aquifers, recommended and projected mining of groundwater from aquifer storage (i.e., ‘overdraft’ and new production) to meet future demands, and the potential for competing interest between historic rural groundwater users and urbanizing interests intent on using the common resource. Opportunities for the study area include facilitating groundwater research, planning, and management, and cooperating with regional and local water suppliers to implement conservation and educational programs. The following groundwater management programs and goals would benefit the residents of the North-Central Texas study area to help address identified problems and issues:

- quantify groundwater availability and quality, understand aquifer characteristics, and identify groundwater problems that should be addressed (both quantity and quality) through aquifer- and area-specific research, monitoring, data collection, and assessment programs;

- quantify aquifer impacts from pumpage and establish an overall understanding of groundwater use through a comprehensive water well inventory, registration, and permitting program;

- evaluate and understand aquifers sufficiently to establish spacing regulations to minimize drawdown of water levels and to prevent interference from neighboring wells;

- cooperate and work with the TCEQ, RCT, and other state agencies to inventory sites, wells, boreholes, or other man-made structures that could potentially impact groundwater supplies;

- establish programs that encourage conservation of fresh groundwater and the use of poorer-quality groundwater when feasible and practicable and facilitate such transitions;

- quantify aquifer and other contributing characteristics sufficiently to evaluate the feasibility and practicability for weather enhancement and aquifer recharge projects in the outcrop areas;

- establish school and public educational programs to increase awareness of the finite water resources and actions that can be taken to conserve the resources;

- protect water quality by encouraging water well construction to be protective of fresh-water zones and by administering a program to locate and plug abandoned water wells; and,

- participate in the Groundwater Management Area #8 and regional water planning processes, groundwater availability model refinements, and regional groundwater management and protection programs with other entities.

Economic Considerations and Impacts

Obtaining alternative sources of water for an area is often cost prohibitive because either new or additional surface water rights must be acquired or infrastructure constructed to deliver surface water or groundwater from outside sources. The economic impacts of managing groundwater resources through a groundwater conservation district are both positive and negative. For example, managing an area's groundwater resources can increase the value of land in the area by extending the economic life of the aquifer(s), limiting the possible encroachment of salt-water, and reducing other water quality impacts. Indeed, one of the greatest benefits of a GCD is the district's proactive approach through its assessment and monitoring, planning, permitting, and other conservation programs to equitably extend groundwater supplies for future use and economic development. GCDs also benefit the area by developing and implementing regulations for adequate well spacing, water well construction, pollution prevention through the plugging of abandoned wells, and also by providing public education outreach programs.

While a district may provide many benefits to those living within its boundaries, there is a cost for the groundwater management programs and activities that are provided. To finance its operations, a GCD must generate revenue which is generally done either through property taxes collected from all residents within the district or from well production fees collected from major water users. Collection of taxes to operate a district places an additional financial burden on all property owners within the district, and the collection of well production fees adds a financial burden to the users of water with permitted wells. The scale of cost for residents is dependent upon many factors including the size and total tax base of the district or the quantity of water that is subject to production fees, and the scale and scope of the programs undertaken by the district. Additionally, because a GCD is a political subdivision, it is an additional layer of local government that may not be welcomed by all residents.

Financing Groundwater Management Activities

Groundwater conservation districts are required to operate from an annual budget with spending limited to budgeted items. Present budgets for existing, operational GCDs range from under $100,000 for some single-county districts with limited permitting and monitoring programs to over several million dollars for special-law type, multi-county districts with specific statutory groundwater management responsibilities such as restricting production to protect spring-flow or to mitigate subsidence caused by groundwater withdrawal. Present budgets for GCDs that include three- to four-counties range from about $150,000 to about $485,000.

Under Texas Water Code, Chapter 36, a GCD may levy an ad valorem tax at a rate not to exceed 50 cents per $100 assessed valuation to pay for maintenance and operating expenses. In fact, most GCDs have lower ad valorem tax caps established either by their enabling legislation or by voters. Most existing groundwater conservation districts currently have tax rates ranging from $0.004 to $0.0775 per $100 assessed valuation (or, $4.00 to $77.50 annual tax paid on property valued at $100,000) (TAGD, 2004). Single-county districts generally tend to have higher tax rates than multi-county districts which typically have tax rates averaging around $0.01 per $100 assessed valuation. Before any GCD can levy and collect an ad valorem tax, the proposition must first be offered to and approved by the voters.

Table 14 shows the total appraised value for county taxation in each of the twenty counties in the study area and the potential revenue that could be generated in each county based on an ad valorem tax rate of $0.01 (one cent) per $100 assessed valuation. Table 14 also shows an estimated tax rate that would be needed for a GCD to generate $250,000 in revenue. For the purposes of this report, this estimate will be considered the lowest amount of revenue needed to finance a functional GCD. This estimate is based on review of GCD financial audits records that have been filed with the TCEQ, review and consideration of Texas Alliance of Groundwater District (2004) and State Auditor's Office (2000 and 2001) report information, personal communication with existing GCD managers and board members, and other considerations of best professional judgment.

Table 14. Appraised Tax Valuation for Study Area Counties

County	Total 2003 Appraised Value for County Taxation[1]	Revenue ($) Generated at Tax Rate of $0.01 (one cent) per $100 Assessed Valuation	Tax Rate ($ per $100 Assessed Valuation) to Generate $250,000 in Revenue
Collin	48,938,000,000	4,893,800	0.00051
Cooke	1,638,000,000	163,800	0.01526
Dallas	127,728,000,000	12,772,800	0.00020
Delta	119,000,000	11,900	0.21008
Denton	33,046,000,000	3,304,600	0.00076
Ellis	6,850,000,000	685,000	0.00365
Fannin	948,000,000	94,800	0.02637
Grayson	4,476,000,000	447,600	0.00559
Hood	2,443,000,000	244,300	0.01023
Hunt	2,484,000,000	248,400	0.01006
Johnson	4,908,000,000	490,800	0.00509
Kaufman	3,642,000,000	364,200	0.00686
Lamar	1,715,000,000	171,500	0.01458
Montague	696,000,000	69,600	0.03592
Navarro	1,554,000,000	155,400	0.01609
Parker	4,478,000,000	447,800	0.00558
Red River	351,000,000	35,100	0.07123
Rockwall	3,949,000,000	394,900	0.00633
Tarrant	84,887,000,000	8,488,700	0.00029
Wise	3,049,000,000	304,900	0.00820

Note 1: Rounded to the nearest million dollars.
Source: Texas Association of Counties, 2003, http://www.txcip.org/tac/census/CountyProfiles.php

Most of the counties (11) in the study area could fund a single-county GCD through an ad valorem tax at a rate of less than $0.01 per $100. Two study area counties – Hood and Hunt – would be able to fund a GCD at a tax rate close to $0.01 per $100, and three other counties – Cooke, Lamar, and Navarro – would be able to do the same at a tax rate around $0.015 per $100. Four study-area counties – Delta, Fannin, Montague, and Red River – would require higher rates to sufficiently fund a GCD. If a single-county GCD required about $250,000 per year to finance groundwater management and protection programs, Delta County would need to levy a tax around $0.21 per $100, Fannin County would need to levy a tax around $0.026 per $100, Montague County would need to levy a tax around $0.035 per $100, and Red River County would need to levy a tax around $0.07 per $100 to adequately finance a district.

Groundwater conservation districts may also generate revenue through the assessment and collection of well production fees on permitted wells. Unless otherwise addressed by a district's enabling legislation, the production fees are capped by state law at $1 per acre-foot/year for agricultural use, and $10 per acre-foot/year for other uses. Based on year 2003 groundwater use data (TWDB, 2005), and assuming that county-other, livestock, and mining uses would be exempt from potential regulation and fees, about 93,972 acre-feet of groundwater was produced for non-agricultural purposes (municipal, manufacturing, steam electric) and about 3,623 acre-feet of water was produced for irrigation in the North-Central Texas study area. Table 15 lists, by county, the amount of 2003 Trinity and Woodbine aquifer use and the estimated amount of revenue that could be generated in each county at the maximum well production fee rates for GCDs authorized by state law. Potential production fee revenue does not appear to be sufficient for any of the study area counties to adequately fund a single-county GCD.

Table 15. Potential Revenue From Well Production Fees

County	**Trinity Aquifer**				**Woodbine Aquifer**				**Total Fee Revenue ($)**
	Non-Agriculture Use		Agriculture Use		Non-Agriculture Use		Agriculture Use		
	Subject to GCD Fees[1]	Potential Fee Revenue[2]	Subject to GCD Fees[1]	Potential Fee Revenue[3]	Subject to GCD Fees[1]	Potential Fee Revenue[2]	Subject to GCD Fees[1]	Potential Fee Revenue[3]	
Collin	1,537	15,370	0	0	1,540	15,400	0	0	30,770
Cooke	5,067	50,670	0	0	NA	0	NA	0	50,670
Dallas	2,802	28,020	0	0	83	830	0	0	28,850
Delta	74	740	0	0	NA	0	NA	0	740
Denton	12,379	123,970	0	0	2,316	23,160	1,500	1,500	148,630
Ellis	3,572	35,720	61	61	2,200	22,000	0	0	57,781
Fannin	1,086	10,860	0	0	3,532	35,320	0	0	46,180
Grayson	9,091	90,910	0	0	4,084	40,840	1,933	1,933	133,683
Hood	2,358	23,580	7	7	NA	0	NA	0	23,587
Hunt	NA	0	NA	0	462	4,620	0	0	4,620
Johnson	9,212	92,120	0	0	558	5,580	0	0	97,700
Kaufman	NA	0	NA	0	NA	0	0	0	0
Lamar	150	1,500	0	0	204	2,040	0	0	3,540
Montague	99	990	0	0	NA	0	NA	0	990
Navarro	NA	0	0	0	85	850	0	0	850
Parker	9,388	93,880	36	36	NA	0	NA	0	93,916
Red River	261	2,610	0	0	NA	0	NA	0	2,610
Rockwall	NA	0	NA	0	NA	0	NA	0	0
Tarrant	18,995	189,950	0	0	NA	0	NA	0	189,950
Wise	2,819	28,190	86	86	NA	0	NA	0	28,276
Totals	78,908	$789,080	190	$190	15,064	$150,640	3,433	$3,433	$943,343

Notes:
1. Volumes in acre-feet per year.
2. Potential revenue generated at maximum fee rate of $10 per acre-foot per year.
3. Potential revenue generated at maximum fee rate of $1 per acre-foot per year.

To a lesser extent, GCDs may also recover costs by assessing fees for administrative services such as processing permit or groundwater transport applications, performing water quality analysis, providing services outside of the district, and capping or plugging abandoned wells. These fees must not unreasonably exceed the cost of providing these services. GCDs can also impose export fees (see below) and apply for and receive grants, loans and donations from governmental agencies, individuals, companies or corporations for specific conservation projects or research.

In addition, GCDs can issue and sell tax bonds for capital improvements such as building dams, draining lakes and depressions, installing pumps and equipment, and providing facilities for the recharge of aquifers. Such tax bonds are subject to voter authorization, TCEQ review, and the State Attorney General's approval. The taxing rate is not capped for the repayment of bond indebtedness.
GCDs may impose an export fee on water transferred out of the district. Unless specified in the legislation creating the district, the export fee is based on the district's existing tax or production fee rates or is negotiated with the transporter. GCDs are allowed to charge a 50 percent export surcharge in addition to the production fee charged for in-district use.

A few groundwater conservation districts have been created without the authority to impose ad valorem taxes or water use fees. These districts have generally been funded by county government and are limited, by the amount of funding received, in the scope of programs they can implement.

Groundwater Management Considerations and Options

Water management and management planning can be carried out at various scales of oversight and authority. On a state-wide scale, no federal or state entity has authority to regulate groundwater withdrawal or use. However, state-level water planning responsibilities and groundwater conservation district management plan oversight responsibilities are well defined, as previously discussed. Assessment and planning by the regional water planning groups can identify groundwater problem areas and appropriate management options for use by regional and local entities, but these planning entities are not authorized to manage and regulate groundwater resources or implement water conservation programs. County and municipal authorities can require plat applicants to evaluate and demonstrate that site-specific groundwater resources are available and sufficient for new subdivisions. Cities, utilities, and water suppliers can implement programs to encourage conservation, discourage groundwater waste, and develop alternative supplies. However, none of these local entities are directly authorized to manage groundwater pumpage.

Several groundwater management options are available for the study area. In one scenario, local leadership, landowners, and citizens can opt not to take any action. If an area does not have any demonstrated or anticipated groundwater problems or issues, this may be an appropriate choice. If this is not the case, however, this choice would not offer any resource protection to landowners and would allow existing or anticipated groundwater problems to persist or worsen.

A groundwater conservation district created within the study area would have the necessary authority to address groundwater issues and accomplish groundwater management objectives identified in the preceding text. Such a district would have the best available regulatory authority to manage and protect groundwater resources in the area and could benefit the study area by implementing groundwater management strategies as authorized under Texas Water Code, Chapter 36. The study area could benefit from monitoring, assessment, planning, and permitting programs as well as water well spacing, and water-quality protection rules for the Trinity and Woodbine aquifers.

Several issues must be considered if groundwater management through the creation of a groundwater conservation district is desired. First, the methods for the creation of a groundwater conservation district must be considered. Most GCDs are created by special Acts of the Texas Legislature. In other general law procedures, statute allows landowners to petition the TCEQ for the creation of a GCD, or allows landowners to petition another district to have property or territory added into that district. Lastly, if an area is designated as a PGMA, landowners are provided a two-year period to accomplish one of the above district creation actions. If they do not, TCEQ is required to create a GCD or recommend the area be added to an existing GCD. (Methods of, and procedures for GCD creation are discussed in significant detail in TCE, 2002a and 2002b, and TCE, 2006.)

The next three considerations go hand-in-hand: district size, representation on the district's board of directors, and funding for district operations. Regarding district size, eight of the first ten GCDs created in the state included multiple counties, and additional territory and counties have been added to five of these eight districts over the ensuing years. Starting in the mid 1980s and with few exceptions prior to 2001, single-county groundwater conservation districts became the predominant choice of Texas citizens. Multi-county GCDs covering larger portions of aquifers have increased in popularity this decade and represent about 30 percent of the new districts created since 2001.

As discussed in the preceding chapter, state law was amended in 2005 to require coordinated groundwater management planning by GCDs in a common groundwater management areas. Groundwater management areas such as GMA #1 for the northern part of the Ogallala aquifer and GMA # 10 for the San Antonio and Barton Spring segments of the Edwards aquifer are predominantly covered by larger, multi-county GCDs that exercise consistent regulation and effective conservation and management planning on a large or even aquifer-wide scale. Greater coordination and effort is required to achieve GMA planning objectives when multiple single-county GCDs or a few multi-county GCDs are created within the same groundwater management area and each district operates under its own rules and regulations to manage the groundwater resource. Because these GCDs share common groundwater resources, state law requires coordination of their efforts to manage the resource.

The board of directors for most GCDs ranges from five to 11 members, and under general law, they are elected to serve staggered four-year terms. Most single-county GCDs have five directors although some have as many as nine. At this size, board members are normally chosen from either five single-member precincts within the county or, from four county commissioners precincts with one elected from the county at-large. The largest GCD in the state, the High Plains Underground Water Conservation District No. 1, covers all or part of 15 counties and is governed by five directors. The High Plains district and a few others use County Committees to review water well permit applications, to make recommendations to the board for approval or denial of these permits, to make recommendations to the board concerning programs and activities that the committee believes will be beneficial for the county they serve, and to advise the board and district staff on water-related issues in their county that require district attention. GCD directors are not entitled to receive a salary; however, they may receive fees of office of not more than $150 a day for each day the director spends performing district duties. These fees of office are limited by state law not to exceed $9,000 a year. GCD directors are also entitled to receive reimbursement of actual expenses incurred while engaging in activities on behalf of the district.

Last of all, considerations must be made to determine the most feasible way to finance GCD operations – through taxes paid by all residents or through fees paid by large groundwater users. Local leadership and interested citizens must make realistic estimates for the amount of revenue that will be needed to fund meaningful groundwater management activities and determine which finance method would be most acceptable to the area residents.

Regional Groundwater Conservation District

A regional groundwater conservation district for the twenty-county area would include the greatest areal extent of the Trinity and Woodbine aquifers. From a resource protection perspective, this option would be the most efficient. Under this scenario, a single groundwater management program would assure consistency across the region, provide a central groundwater management entity for decision-making purposes, and simplify groundwater management planning responsibilities related to Groundwater Management Area #8. Because of economy-of-scale issues, a regional GCD would also be the most economic choice. Such a district could be adequately financed through either an ad valorem tax levied at a very low rate, or through groundwater production fees.

Conversely, generating citizen support to create a 20-county GCD may be difficult and the creation of a groundwater management entity of this magnitude has not been attempted within the state to date. Besides building the necessary support to confirm creation of such a large district, board representation may also be an issue to area residents. Overcoming these issues would require much consensus building between state and local leadership and the large groundwater users in the region.

Multi- and Single-County Groundwater Conservation Districts

A combination of district configurations ranging from single-county GCDs to two or more multi-county GCDs could also be considered. The generation of revenue to finance meaningful groundwater management programs would be the limiting factor for the consideration of these GCD creation options. If sufficient revenue – estimated here at a minimum of about $250,000 – cannot be generated through either the levy of taxes or the assessment of well production fees, then the GCD being considered may not be able to practicably address groundwater management.

None of the study area counties individually would be able to generate the needed revenue estimated here to finance and operate a GCD through the assessment of well production fees. For example, at the maximum rate authorized by state law, only about $51,000 could be generated annually in Cooke County. However, if Cooke, Montague, Wise, Parker, Tarrant, and Hood counties chose to form a multi-county, fee-funded GCD for the Trinity aquifer outcrop area, over $387,000 could be generated for groundwater management programs and activities (Table 15). A limited number of two-county, fee-funded GCD creation options, such as Denton and Grayson counties or Parker and Tarrant counties, would also be able to generate enough revenue to implement groundwater management programs.

Any individual-county GCD or combination-of-counties GCD could be funded by ad valorem taxes – that is if the voters choose to grant such authority. The local consensus in 1990 was that GCDs funded by ad valorem taxes would not be supported in the study area primarily because the majority of the citizens are served by surface water sources (Ambrose, 1990; Appendix 4). Since groundwater sources represent only five percent of the total water supply for the study area, the ability to achieve voter-approved taxing authority for a GCD may be remote in many of the study area counties. The ability to pass a tax authorization proposition for a GCD may be somewhat higher in counties such as Cooke, Grayson, and Parker where groundwater use represents the majority of the total water use, and potentially in Ellis, Fannin, Hood, Johnson, Montague, and Wise counties where groundwater use is over 25 percent of the total water use.

Also, as the total tax base becomes smaller, the tax rate needed to generate sufficient revenue for GCD operation increases. As noted previously, only four study-area counties – Delta, Fannin, Montague, and Red River – would not be able to sufficiently fund a viable single-county GCD through an ad valorem tax at a rate of less than $0.015 per $100. These counties could generate $250,000 per year to fund a GCD, but would need to levy taxes at rates ranging for $0.026 (2.6 cents) to $0.21 (21 cents) per $100 assessed valuation. However, even though these tax rates would represent a larger economic impact on property owners, they are comparable to tax rates presently levied by existing GCDs.

Having two, three, four, or even more GCDs would require a like number of individual groundwater management programs. These GCD-creation options may provide for the most local control because each director would likely represent a smaller area. However, these options would also require that largely duplicative administrative and management programs be implemented. For example, each GCD would be required to:

- establish and maintain an office;
- establish procedures to address open meetings and open records and records retention;
- annually address financial budgeting and auditing requirements;
- develop and adopt a management plan;
- participate in Groundwater Management Area #8 planning and decision-making;
- develop and adopt administrative, well permitting and other regulatory rules; and,
- meet and uphold other statutory requirement relating to policies and district operation.

The creation of multi- and single-county districts in the study area is feasible. Nevertheless, better economic and administrative options exist to protect the groundwater resources.

Actions of the 80th Legislature, Regular Session, 2007

Two groundwater conservation districts were created by special law during the 80th Legislature, Regular Session, 2007, and authorized with the powers and duties provided by Texas Water Code, Chapter 36 for GCDs (Figure 13). Senate Bill (SB) 1983 by Senator Craig Estes creates, subject to a confirmation election, the Upper Trinity Groundwater Conservation District (District) and provides for the powers, duties, administration, operations and financing of the District. The District's initial boundaries would be coextensive with the boundaries of Hood, Montague, Parker, and Wise counties. Creation of the District will take effect immediately if the Act is signed by the Governor or allowed to become law without the Governor's signature.

Unlike general law GCDs with directors elected by the precinct method, the Upper Trinity Groundwater Conservation District's directors will be appointed by the Commissioners Courts of Hood, Montague, Parker, and Wise counties. The District's temporary directors are responsible for scheduling and holding an election to confirm creation of the District and may hold a subsequent election if the initial election to confirm the District's creation is defeated by a majority of the voters. If director appointments are not made within set time frames, or if vacancies occur on the board, the District directors are responsible for filling the vacancies on the District board. Also unlike general law GCDs, the District's directors are not entitled to receive fees of office for performance of duties. The District would be dissolved on September 1, 2009, if it is not confirmed by the voters and the enabling legislation would expire on September 1, 2012.

SB 1983 also includes prohibitions from exercising certain Texas Water Code, Chapter 36 powers and provides additional authorities not included in Chapter 36 for the Upper Trinity Groundwater Conservation District. The District may not exercise the power of eminent domain or impose a tax for any purpose. The District may require any new well or class of wells exempt from permitting to register the wells and comply with District spacing requirements. By rule, the District may require the owner or operator or a well or class of wells exempt from permitting to report groundwater usage and pay District production fees on the amount of water actually withdrawn from the wells. This District authority specifically does not apply to private domestic water wells on tracts of land larger than 10 acres that produce less than 25,000 gallons per day. Existing water wells are exempt from District well spacing requirements. The District's well production fees for non-agricultural use are capped at $0.30 per 1,000 gallons and the District is provided enhanced fee remedies for enforcement purposes. The District is authorized to establish, adopt, and enforce the collection of fees and establish and enforce metering and reporting requirements before the adoption of the District's management plan.

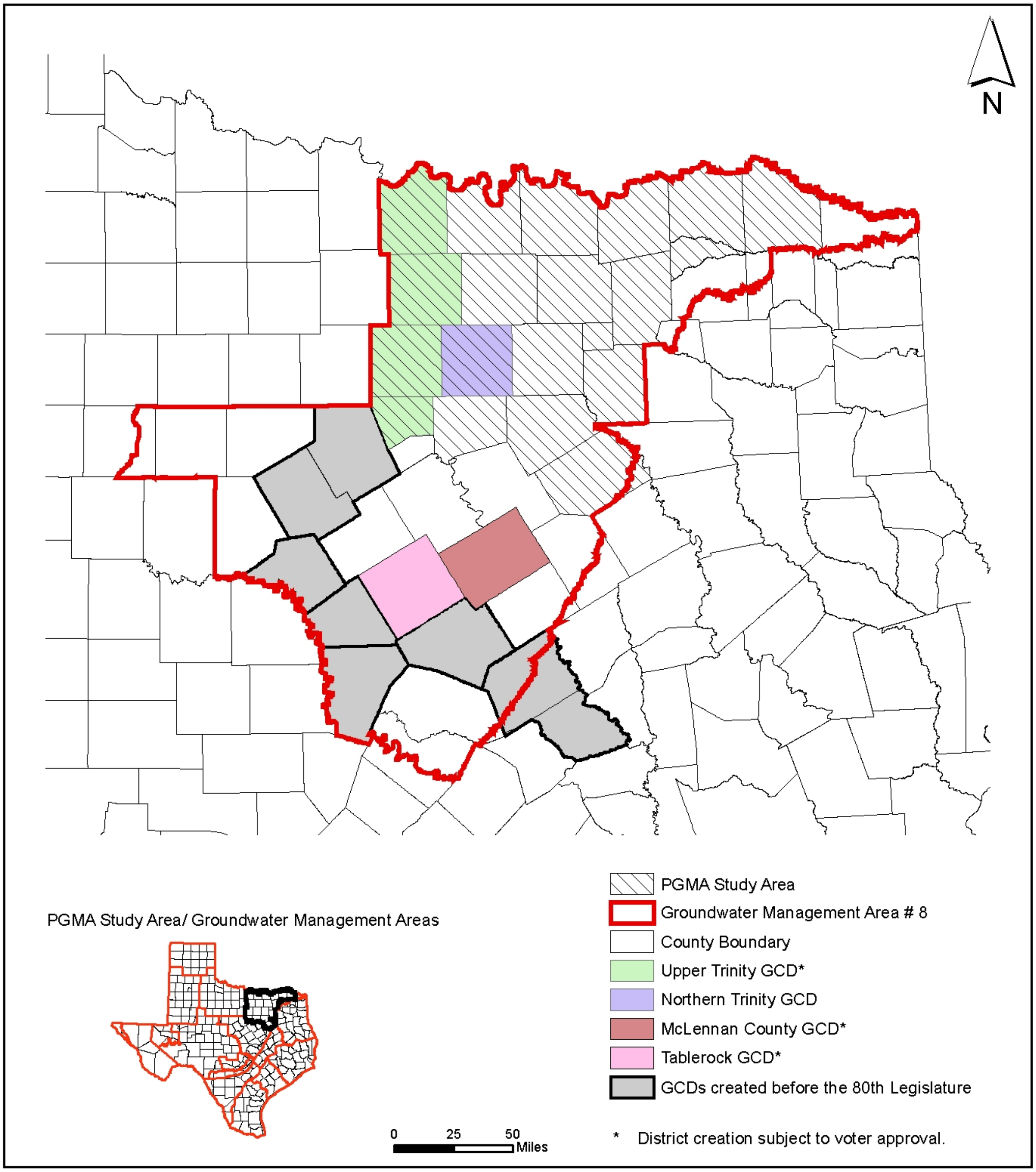
House Bill (HB) 4028, by Representative Charlie Geren, creates the Northern Trinity Groundwater Conservation District (District) and provides for the powers, duties, administration, operations and financing of the District. The District's boundaries are coextensive with the boundaries of Tarrant County. Unlike general law GCDs with directors elected by the precinct method, HB 4028 provides that four District directors are appointed by the Tarrant County Commissioners and one District director is appointed by the Tarrant County Judge. The District directors are not required to hold an election to confirm the District's creation. The District may not exercise the power of eminent domain and may not impose a tax or issue bonds. Creation of the Northern Trinity GCD will take effect immediately if HB 4028 is signed by the Governor or allowed to become law without the Governor's signature.

Addition to Existing Groundwater Conservation District

Alternatively, all or part of the study area could opt to join an existing groundwater conservation district through the petition procedures outlined in Texas Water Code, Chapter 36, Subchapter J. Under such circumstances, and assuming that a petition to add territory is accepted by the receiving district, landowners and groundwater users in the study area would agree to assume the financial obligations of the district they would join and be provided equitable representation on the receiving district's board of directors. The advantage of joining an existing district include accessibility to the district's established regulations, programs, and infrastructure, and an increased revenue stream which may be less burdensome on the residents and groundwater users in the study area.

Landowners in the study area could attempt to join any of the existing GCDs located in Groundwater Management Area #8 (Figures 10 and 13). Within the study area are the two new GCDs, the Northern Trinity Groundwater Conservation District that is created in Tarrant County, and the Upper Trinity Groundwater Conservation District that will be created if confirmed by the voters of Hood, Montague, Parker, and Wise counties. The Middle Trinity Groundwater Conservation District in Erath and Comanche counties is the only established district in GMA #8 that is adjacent to the North-Central Texas study area (Hood County). Two new GCDs in the central part of GMA #8, the McLennan County Groundwater Conservation District and the Tablerock Groundwater Conservation District in Coryell County, were also created during the 80th Legislature and are subject to confirmation by the voters. The other five established districts are located in the southernmost part of GMA #8 and are distant from the study area. In addition, this creation option may become more useable in the future if additional GCDs are established for the Trinity aquifer.

Figure 13. New GCDs Created by the 80th Legislature



SUMMARY

Chapter 35 of the Texas Water Code requires that a TCEQ Priority Groundwater Management Area (PGMA) report: 1) examine the reasons and supporting information for or against designating the study area as a PGMA; 2) recommend the delineation of boundaries if PGMA designation is proposed; 3) provide recommendations regarding groundwater conservation district creation in the study area; 4) recommend actions necessary to conserve natural resources within the study area; and 5) evaluate information or studies submitted by the study area stakeholders.

The Texas Water Code requires the report to identify present critical groundwater problems, or those expected to occur within a 25-year planning horizon. Critical groundwater problems which warrant PGMA designation include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies. This report evaluates the authorities and management practices of existing water management entities within the study area and makes recommendations on appropriate strategies necessary to conserve and protect groundwater resources in the area.

An estimated 1.36 million acre-feet (acft) of water was used in the North-Central Texas study area in 2000. From 2000 to 2030, the population of the 20-county area is projected to increase by 73 percent – from just over 5.5 million people to almost 9.5 million residents. Likewise, the demand for water is projected to increase 36 percent – from a projected demand of almost 1.85 million acft/yr by 2010 to a projected demand of almost 2.46 million acft/yr by 2030. Municipal use presently accounts for and will continue to account for about 87 percent of the total water use over the next 25 years in the area.

At present, about 62 percent of the study area’s total water supply is from in-area reservoirs and another 26 percent is from out-of-area reservoirs. The Trinity and Woodbine aquifers are the primary groundwater resources in the study area, and the Blossom and Nacatoch sands provide minor amounts of water in the northeastern part of the study area. Together, these aquifers supply about five percent of the total water supply in the study area. In the Trinity aquifer, the Antlers, Paluxy, and Twin Mountains Formations are the major water-producing units. In 2000, groundwater provided the majority of the total water use in Cooke, Grayson, and Parker counties and over 25 percent of total water use in Ellis, Fannin, Hood, Johnson, Montague, and Wise counties. Of the remaining seven percent of the study area’s total water supply, reuse accounts for almost five percent and local irrigation and privately owned surface water make up the other two percent.

Because of surface water reserves and ongoing conversions from groundwater to surface water sources, the 1990 Texas Water Commission report recommended that this study area should not be designated as a PGMA. This recommendation was made even though water-level declines and associated reduction of artesian pressure caused by the continued deficit-removal of groundwater from aquifer storage was a noted regional problem. The most significant historic water-level declines in the state have occurred in the Trinity aquifer in the study area centered in Dallas, Ellis, Johnson, and Tarrant counties. Between 1989 and 1997, continued water-level declines were observed in parts of Cooke, Denton, Grayson, Johnson, Parker, Tarrant and Wise counties. From 1994 to 2004, records indicated over 100 feet of additional decline for some wells in Collin, Cooke, Denton, Grayson, Johnson, and Tarrant counties, and over 100 feet of water-level recovery for some wells in Dallas, Fannin, and Grayson counties. The recently adopted 2006 Region C Water Plan notes that overdevelopment of aquifers and resulting water-level declines poses a threat to small water suppliers and domestic users in rural areas.

At the beginning of this evaluation, 22 study-area stakeholders provided comments in response to a July 2005 study notice. The overdraft of groundwater supplies, wise use of groundwater resources, surface water quality, and potential groundwater quantity and quality impacts from booming natural gas exploration and production activities were the noted concerns voiced by the respondents.

Water Supply Strategies and Concerns

Aquifer overdraft – using groundwater in quantities above the estimated long-term reliable supply – through the year 2010 is a recommended 2006 Region C Water Plan strategy for 37 municipal, rural water supply, county-other, irrigation, and manufacturing user groups in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Parker, Tarrant, and Wise counties. Overdrafting the Trinity aquifer by an additional 4,473 acre-feet per year (acft/yr), and overdrafting the Woodbine aquifer by an additional 811 acft/yr, from both existing and new wells is considered an interim management strategy through 2010 to meet demands while other alternative water supplies, primarily surface water, are being developed.

New Trinity and Woodbine aquifer water supply wells or using additional volumes of groundwater from existing wells are also recommended strategies for 27 municipal, rural water supply, county-other, irrigation, manufacturing, and mining water user groups in Collin, Cooke, Denton, Ellis, Fannin, and Grayson counties. Thirteen water user groups in Cooke, Ellis, Fannin, and Grayson counties are projected to use new Trinity aquifer supplies of 2,228 acft/yr by 2010, 3,391 acft/yr by 2030, and 4,333 acft/yr by 2030, and 14 water user groups in Collin, Denton, Ellis, Fannin, and Grayson counties are projected to use new Woodbine aquifer supplies of 3,046 acft/yr by 2010, 3,413 acft/yr by 2020, and 3,410 acft/yr by 2030. This recommended new supply is over and above recommended 2010 Trinity and Woodbine aquifer overdraft and present groundwater use.

The 2006 Region C Water Plan recommends strategies for 27 water user groups to reduce Trinity aquifer use by a total of 1,604 acft/yr by 2010, 3,054 acft/yr by 2020, and 4,168 acft/yr by 2030. Reduced groundwater production strategies for the City of Sherman (Grayson County) account for over one-third of these totals. In addition, the Region C Water Plan projects that the City of Gainesville's (Cooke County) Trinity aquifer supply will decrease by 1,000 acft/yr from 2010 to 2030. The recommended Trinity aquifer overdraft and new production strategies for the Region C water user groups exceed the recommended strategies to reduce use by 5,097 acft/yr in 2010. At 2020, recommended strategies for 3,391 acft/yr of new Trinity aquifer use is countered by recommended strategies to reduce use by 3,564 acft/yr. From 2010 to 2020, projected and recommended Trinity aquifer reduction strategies are greater than new use recommendation strategies by 173 acft/yr. For 2030, recommended strategies for 4,333 acft/yr of new Trinity aquifer use is countered by recommended strategies for 5,168 acft/yr of reduced use. Over the 20-year period from 2010 to 2030, projected and recommended Trinity aquifer reductions are greater than new use recommendations by 835 acft/yr.

Region C Water Plan strategies are also recommended for four Grayson County and two Fannin County water user groups to reduce Woodbine aquifer use by a collective 1,563 acft/yr by 2010, 1,486 acft/yr by 2020, and 1,421 acft/yr by 2030. Over 80 percent of this projected reduction would be from the irrigation and county-other user groups in Grayson County. The Region C Water Plan recommended strategies for Woodbine aquifer overdraft to 2010 and new Woodbine aquifer production exceed recommended strategies to curtail aquifer use by 2,294 acft/yr in 2010. Recommended strategies for new Woodbine aquifer production exceed strategies to reduce aquifer use by 1,931 acft/yr in 2020 and 1,998 acft/yr in 2030.

Increased reliance on the Woodbine aquifer to meet demands through 2030 is projected for two water user groups in Hunt County in the North East Texas Regional Planning Area. Producing an additional 350 acft/yr of Woodbine water is the recommended strategy for the Hickory Creek SUD and West Leonard WSC. In the two counties in the Brazos G Regional Water Planning Area, the Acton MUD and county-other user groups in Hood County anticipate increased use of groundwater sources through 2030, and the City of Alvarado in Johnson County anticipates it will overdraft the Trinity aquifer from 2010 to 2030. In Montague County in the Region B Water Planning Area, the recommended strategy for the county-other and mining user groups to meet projected shortages is to purchase water from local suppliers with alternative strategies to develop additional groundwater supplies.

Over 180 water user groups in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Parker, Tarrant, and Wise counties do not anticipate new demands on groundwater sources, but they do anticipate the continued use of Trinity and Woodbine aquifer supplies at present levels. Supplemental or replacement wells are recommended for over 160 water user groups in this 10-county area. New groundwater users or new demands on groundwater resources are not anticipated by the regional water planning groups over the next 25-year period in Delta, Kaufman, Lamar, Navarro, Red River or Rockwall counties.

The development of new regional surface water supply systems for Cooke, Ellis, Fannin, Grayson, Johnson, Parker, and Wise counties are recommended regional water plan strategies that will supplement groundwater supplies. The Ellis County system is projected to be in place by 2010 and most of the other recommended systems are anticipated to come on line by 2020.

In the North-Central Texas study area, the Barnett Shale is one of the largest and most active natural gas fields in the United States. The majority of Barnett Shale natural gas production has been from the Newark East Field in portions of Denton, Tarrant, and Wise counties. Present production in the study area also occurs in Hood, Johnson, and Parker counties, and potential production from Cooke, Ellis, and Montague counties is anticipated. At present, the number of active drilling rigs appears to be the primary limiting factor to the number of Barnett Shale gas wells that can be drilled each year. In the study area counties of Cooke, Denton, Ellis, Hood, Johnson, Montague, Parker, Tarrant, and Wise, almost 1,000 Barnett Shale wells were completed in 2005.

The amount of present and past use of water for Barnett Shale well completion is difficult to characterize in water planning terms. This use and demand are not addressed or included in the regional water plans or the State Water Plan. Recent research concludes that the well fracture technology used for a typical Barnett Shale vertical completion requires about 1.2 million gallons (3.68 acft) and a typical horizontal Barnett Shale completion requires around 3.5 million gallons (10.74 acft). About 60 percent of total water use for this purpose was established to be from the Trinity and Woodbine aquifers. In Denton, Hood, Johnson, Parker, Tarrant, and Wise counties, 4,834 new water wells were drilled over a 44-month period ending in August 2006. About five percent of the water wells drilled during this span in the six-county area supported drilling and fracturing of Barnett Shale gas wells. In Johnson County, over 60 percent of the new wells drilled in the first eight months of 2006 were for Barnett Shale drilling supply. In 2005, the researchers estimated that the Trinity aquifer supplied 4,720 acft of water for Barnett Shale gas well development in Cooke, Denton, Ellis, Hood, Johnson, Montague, Parker, Tarrant, and Wise counties.

The 2007 research also considered economic, geologic, technical, operational, and regulatory factors to develop low, medium, and high 2005 to 2025 projections of Trinity aquifer use by the oil and gas industry. For the nine study area counties, the low use scenario projects that 25,193 acft (average of 1,326 acft/yr) of groundwater could be used for Barnett Shale well development to 2025. The low scenario represents a retreat from present annual use estimates and corresponds to a large drop in the price of natural gas. From 2007 – 2025, the medium use scenario projects total groundwater usage of about 111,895 acft and averages about 5,942 acft/yr. The medium case could be considered the most likely under the condition that natural gas prices remain at current levels. The high use scenario projections predict 2007 – 2025 groundwater use of 186,132 acft and average around 9,796 acft/yr. This projection scenario relates to sustained high gas prices that would allow the industry to expand to all economically viable areas. The high scenario assumes there are no external factors that would limit water use.

The 2006 regional water plans note that other mining water supplies in the study-area counties are derived from privately-owned surface water supplies; purchases of raw or treated water from surface water management entities and water purveyors; groundwater from the Trinity and Woodbine aquifers; and, run-of-river and reuse sources. The mining user group data in the regional water plans estimate the presently available water supply in these eight counties for mining use is about 22,600 acft/yr. Projected

2010, 2020, and 2030 demand for the mining user group for the eight-county area is 25,857 acft/yr, 30,127 acft/yr, and 32,896 acft/yr, respectively. Shortages are projected in the 2006 Region B, Region C, and Brazos G Water Plans for the mining user group in Cooke, Denton, Hood, Johnson, Montague, Tarrant, and Wise counties. Recommended strategies to address the projected shortages include conservation, purchasing water from various suppliers, reuse of water, supplemental wells in the Trinity aquifer, overdrafting of the Trinity aquifer, and new wells in the Trinity and Woodbine aquifers.

Water Quality Concerns

There are 20 study area surface water bodies identified on the 2004 Texas 303(d) List. Total maximum daily loads (TMDLs) have been developed for legacy pollutants for nine water bodies in Dallas and Tarrant counties. Concentrations of bacteria are elevated in three segments of the Trinity River that flow through Dallas and Fort Worth, and Ellis, Henderson, Kaufman, and Navarro counties to the southeast. The TMDL for these three segments to reduce bacteria concentrations to within acceptable risk levels for contact recreation is projected to be completed by August 2008. Ten other study area water bodies are on the 303(d) List because bacteria sometimes exceeds contact recreation use levels. These include three segments of the Red River in Grayson County; one segment of the Sabine River in Hunt County; five segments of the Trinity River in Collin, Dallas, Grayson, Parker and Wise counties; and one segment of the Brazos River in Hill and Johnson counties. Additional data and information will be collected before TMDLs are scheduled for these water bodies for this parameter.

Concentrations of dissolved oxygen in two segments of the Trinity River in Parker and Tarrant counties are not optimal for supporting aquatic life. TCEQ has initiated a project to examine the causes of low dissolved oxygen and to evaluate whether the agency should develop a TMDL or a use attainability analysis (UAA) to determine whether the existing standards are appropriate for the river. Depressed dissolved oxygen concentrations are also occasionally lower than the aquatic life standard in two segments of the Sulphur River in Delta and Fannin counties, one segment of the Sabine River in Hunt County, and one segment of the Trinity River in Navarro County. In addition, three study area water bodies are listed for high pH including two segments of the Sulphur River in Delta and Fannin counties and one segment of the Trinity River in Navarro County, and one segment of the Brazos River is listed for high average sulphate in Johnson County. These parameters exceed general quality standards but not secondary drinking water standards. Standards reviews or additional data and information will be collected before TMDLs are scheduled for these water bodies and parameters.

Public water supply concerns were noted for two study area water bodies in the 2004 305(b) Inventory – Lake Texoma and Lake Granbury. Concerns about chloride, sulfate, and total dissolved solids (TDS), and increased treatment costs due to demineralization were noted for Lake Texoma. Dissolved solids in the Red River and Lake Texoma are generally high, and the use of Lake Texoma water for public water supply requires desalination or blending with higher-quality water. Concerns about chloride, TDS, and increased costs due to mineralization were noted for Lake Granbury. In addition, the Brazos River Authority (BRA) monitored multiple Lake Granbury locations between 2002 and 2004 for E. coli and identified several areas where on-site septic systems were potentially failing or improperly maintained. The TCEQ, through a $1.4 million USEPA grant, is presently funding a Lake Granbury Watershed Protection Plan to delineate and address this issue.

Water quality in the Trinity aquifer is acceptable for most municipal and industrial uses. However, in some areas, natural concentrations of arsenic, fluoride, nitrate, chloride, iron, manganese, sulfate, and TDS in excess of either primary or secondary drinking water standards occur. Groundwater in the western outcrop area tends to be harder with relatively high iron concentration. Downdip and to the east, groundwater tends to be softer, with concentrations of TDS, chlorides, and sulfates higher than on the outcrop. Water quality in the Woodbine aquifer used for public water supply is good along the outcrop. Water quality decreases downdip, with increasing concentrations of sodium, chloride, TDS, and bicarbonate. High sulfate and boron concentrations may be found in Tarrant, Dallas, Ellis, and Navarro counties. Excessive iron concentrations also occur in parts of the Woodbine formation.

In the 20-county study area, 1,440 site-specific groundwater contamination cases have been documented through regulatory requirements for compliance monitoring or through state-agency investigation in response to groundwater contamination complaints. These cases are generally from surface or near-surface releases of product or waste confined to a specific property and have not significantly impacted groundwater resources being used for drinking water purposes. Of these, 1,428 cases are related to activities under the jurisdiction of the TCEQ. The majority of the TCEQ-documented sites are contaminated by gasoline, diesel, or other petroleum products. Most (1,020) of the TCEQ-documented cases of contamination are in Dallas and Tarrant counties and are related to releases from petroleum storage tank facilities. Other documented contaminants under other TCEQ regulatory programs include, but are not limited to organic compounds, solvents, heavy metals, and pesticides. The other 12 contamination cases are related to oilfield activities under the jurisdiction of the Railroad Commission of Texas. These cases document groundwater contamination in Cooke County by sodium chloride (NaCl) and natural gas; in Montague County by NaCl, hydrocarbons, and crude oil; in Parker County by NaCl and hydrocarbons; and, in Wise County by natural gas and condensate. An additional 138 groundwater contamination cases, mostly in Dallas and Tarrant counties, are reported as completed because either the desired regulatory remedy was achieved or no further regulatory action was required.

Natural Resource Concerns

The rivers and streams in the study area support a variety of native and introduced fishes and other aquatic species. Many species of wintering songbirds, waterfowl, and neotropical songbirds are migrants that stopover in the study area to feed and rest along river banks, creek bottoms, and other wetlands. Some 64 species of mammals, amphibians, and reptiles in the study area are either aquatic, semi-aquatic, or in some other way wetland dependent. In the study area, the Ouachita rock-pocketbook mussel, golden-cheeked warbler, northern aplomado falcon, whooping crane, eskimo curlew, interior least tern, and black-capped vireo are federally and state listed as endangered.

The Texas Parks and Wildlife Department operates eight State Parks, two Wildlife Management Areas, and one State Historic Park in the study area. Federal holdings in the area include the Hagerman National Wildlife Refuge and the Caddo and Lyndon B. Johnson National Grasslands. Other resources include rangeland, pastureland, cropland, forestland, and oil and natural gas fields. Water concerns to the natural resources in the study area are primarily related to water purveyors fully utilizing existing reservoirs or developing new reservoirs to meet future needs. These strategies raise concerns about changes to historic reservoir levels, changes to natural flow conditions and water quality, and inundation of valuable land and limited habitat. Regarding new or proposed reservoirs, the 2006 Region C Water Plan suggests that Muenster Reservoir and Lake Ralph Hall will inundate some riparian habitat but otherwise will have little environmental impact; Lower Bois d'Arc Creek Reservoir would inundate moderate value wetlands and bottomland hardwoods, but would otherwise only have indirect impacts on the Caddo National Grasslands because of changes in flow patterns on Bois d'Arc Creek; and, the Marvin Nichols Reservoir I project would inundate high value wetlands and bottomland hardwoods, and inundate lignite deposits and oil and gas wells in the proposed pool area. The 2006 Region C Water Plan notes that water management strategies that are likely to disturb threatened or endangered species habitat include specific mitigation allowances that will set aside additional land for that habitat.

At present, the 2006 Region C and North East Texas Water Plans are at odds regarding the necessity and environmental impact for the proposed Marvin Nichols Reservoir I project. The Region C Water Plan recommends the reservoir be constructed and impacts to the environment be mitigated. The North East Texas Regional Water Plan recommends that because of the anticipated impacts on agricultural resources; the timber industry; the farming, ranching, and other related industries; and on the impacts to the natural resources in the area, the Marvin Nichols Reservoir project should not be included in any regional or state water plan at this time. The TWDB has approved both plans and noted there was no interregional conflict because the two plans do not rely upon the same source of water to meet future demands. The 2007 State Water Plan includes Marvin Nichols Reservoir as a recommended strategy for the Region C Water Planning Area.

Water Planning, Management and Regulation

Water planning and other management activities that impact groundwater resources are conducted by all levels of users. State agencies carry out programs to protect water quality through the regulation of waste management or implementation of best management practices, and provide water resource planning, project funding, and technical assistance functions. Water plans on the regional level include developing consensus on the availability of groundwater for use and developing strategies for water user groups to meet the long-term projected demands of the growing population. Assessment and planning by the regional water planning groups can identify groundwater problem areas and appropriate management options for use by regional and local entities.

Wholesale, retail, and community water suppliers develop and implement conservation and drought contingency plans to address supply system efficiency and maintenance, and to identify actions they will take during times of potential water supply deficit. Water supply districts, cities, utilities, and rural water suppliers implement programs to encourage conservation, discourage groundwater waste, and develop alternative supplies. At the most local level, individual landowners and operators implement strategies or best management practices to conserve natural resources and water supplies on private acreage.

Local governments have permissive groundwater management authority relating to the subdivision of tracts of land. If a new subdivision is going to rely on the groundwater resources under the land, municipal and county authorities can require plat applicants to demonstrate that sufficient groundwater is available to support the project when it is fully developed. Only Parker County and the City of Annetta in Parker County are presently exercising this permissive authority. Counties with a population of 1.4 million or more can, in certain unincorporated areas, regulate water well spacing to protect water quality from contaminated groundwater or on-site sewage disposal system impacts.

Municipalities also have authority over the protection of public health and land use regulation, and ordinances requiring registration of water wells or establishing set-back distances for water wells are not uncommon. Wholesale and retail public water suppliers, including municipalities, river authorities, water supply corporations, water supply districts, investor-owned utilities, and water conservation and irrigation districts are important as water management entities because of their responsibility to provide safe, reliable water to their customers. Municipalities and other water suppliers can indirectly limit groundwater withdrawals by implementing water conservation programs and securing and developing alternative supplies.

None of the existing entities – state agencies, regional planning groups or councils, counties, municipalities, or water suppliers – are directly authorized to collectively manage or regulate groundwater withdrawals or use. The directive and authority to conserve, preserve, protect, recharge, and prevent waste of groundwater resources is provided only to groundwater conservation districts.

Groundwater Conservation Districts

Groundwater conservation districts are the state's preferred method of managing groundwater resources, and are the only entities in Texas explicitly granted the authority to regulate the spacing of water wells and groundwater withdrawals. Under state law, GCDs are governed by a locally elected board of directors who serve staggered four-year terms. The board is responsible for managing the district including the adoption of district policies, plans, rules, and procedures. The development of GCD management plans must be coordinated with surface water management entities on a regional basis, and with other GCDs that manage the same aquifer. The GCD management plans are provided to the regional water planning groups for consideration in their five-year regional water planning process. GCDs finance their operations through either taxes paid by all residents or through well production fees paid by large groundwater users. District directors are not entitled to receive a salary and spending GCD revenue is limited to budgeted items. Present GCDs range in size from as large as all or part of 15 counties to as small as a part of a single county.

The Region C Water Plan notes that GCDs may be an appropriate way to manage limited resources in areas where groundwater use exceeds or approaches the long-term reliable supply. The Brazos G Regional Water Plan notes that GCDs are created in part to manage competing interests in groundwater supplies. The Region C Water Plan recommends the formation of groundwater conservation districts as a local decision that should be considered by water suppliers and government officials in areas of heavy groundwater use. In addition, a small number of the stakeholders who responded to the July 2005 study notice commented that some type of groundwater management or oversight in some parts of the study area may be warranted to protect existing users.

There are four methods for the creation of a groundwater conservation district: three through local initiative and one through state directive if necessary. Most GCDs are created by special Acts of the Texas Legislature. In two other processes, state law allows landowners to petition the TCEQ for the creation of a GCD, or allows landowners to petition another district to have property or territory added into that district. Lastly, if an area is designated as a PGMA, landowners are provided a two-year period to accomplish one of the above district creation actions. If they do not, TCEQ is required to create a GCD or recommend the area be added to an existing GCD.

Two GCDs, the Upper Trinity Groundwater Conservation District and Northern Trinity Groundwater Conservation District, were created by special law during the 80th Legislature, Regular Session, 2007. Senate Bill 1983 creates, subject to a confirmation election, the Upper Trinity Groundwater Conservation District in Hood, Montague, Parker and Wise counties and provides for the powers, duties, administration, operations and financing of the District. SB 1983 provides for the appointment and terms of office for the directors, prohibits directors from receiving a fee of office, prohibits the District from levying taxes or exercising the power of eminent domain, and provides authority for the District to require owners or operators of otherwise exempt rig supply wells to comply with District well spacing requirements, to submit water production reports, and to pay District well production fees. Existing wells will be exempt from District well spacing requirements. The District's well production fees for non-agricultural use is capped at $0.30 per 1,000 gallons. The temporary directors of the Upper Trinity GCD must hold an election to confirm creation of the District before any of its authorities are vested.

House Bill 4028 created the Northern Trinity Groundwater Conservation District in Tarrant County and provides for the powers, duties, administration, operations and financing of the District. HB 4028 provides for the appointment and terms of office for directors and prohibits the District from levying taxes, issuing bonds, or exercising the power of eminent domain. A confirmation election is not required for the creation of the Northern Trinity GCD.

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CONCLUSIONS AND RECOMMENDATIONS

TCEQ staff have considered data and information provided by the TWDB and the 2002 State Water Plan; stakeholders in the study area; the 2001 and 2006 Region B, Region C, Brazos G, and North East Texas Regional Water Plans; the TPWD; and, from independent research to support the following conclusions and recommendations regarding the North-Central Texas PGMA study area.

Study Area Designation Considerations

Surface water quality has been impacted by anthropogenic activities and the long-term urbanization of the region. Public water supply concerns with chloride, sulfate, total dissolved solids, E. coli, sedimentation, and increased treatment costs due to mineralization exist in the study area. Some surface water sources must be desalinated or blended with higher quality water before use as a public supply. Sufficient federal, state, regional, and local programs to monitor, assess, and address these impacts are established and ongoing at present. Groundwater quality in the Trinity and Woodbine aquifers is acceptable for most municipal and industrial uses in the study area. Water quality in both aquifers is generally better in the outcrop areas and tends to decrease in quality from west to east in the artesian areas.

More groundwater is being withdrawn than recharged to aquifers in the North-Central Texas study area. Historically, pumpage has exceeded recharge resulting in declining water levels, removal of water from aquifer storage, and possible deterioration of water quality in the Antlers, Twin Mountains, and Paluxy Formations of the Trinity aquifer and the Woodbine aquifer.

Water-level declines including the associated reduction of artesian pressure caused by the continued removal of water from aquifer storage is a regional groundwater problem. The most significant historic water-level declines in the state have occurred in the Trinity aquifer in the study area centered in Dallas, Ellis, Johnson, and Tarrant counties. This problem was reported in 1990 and remains the significant groundwater problem today. The 2006 Region C Water Plan notes that overdevelopment of aquifers and resulting water-level declines poses a threat to small water suppliers and domestic users in rural area. In general, regional water levels have not declined greatly in the aquifer outcrop areas but large declines in artesian pressure have occurred in the downdip, confined portions of the aquifers. Large declines in artesian pressure impact well owners economically by causing them to pump their wells for longer periods of time to produce the same volume of water and paying for increased water-lift costs. Artesian pressure declines can also impact well owners by causing them to have well pumps lowered or to have wells deepened.

At present, water user groups in Ellis, Johnson, and Tarrant counties are collectively using the Trinity aquifer at quantities over regional water planning group estimates for the safe supply for each county, and water user groups in Collin, Cooke, Dallas, Denton, Fannin, Grayson, Hood, Parker, and Wise counties are using the Trinity aquifer at quantities near each county's estimated safe supply. Water user groups in Fannin and Johnson counties are also collectively using the Woodbine aquifer at quantities over the estimated safe supply for each county. The 2006 Region C Water Plan generally defines the 'estimated safe supply of groundwater' as the amount of groundwater available for use with acceptable long-term impacts to water levels.

Over 200 water user groups in the study area anticipate the continued use of Trinity and Woodbine aquifer supplies at present levels and most are planning to drill supplemental or replacement wells to maintain their supply. Strategies to increase reliance on the Trinity and Woodbine aquifers have also been recommended for many water user groups in the study area. Overdrafting the Trinity aquifer through at least 2010, and adding new wells or increasing existing well production are regional water plan strategies for 41 water user groups in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Johnson, Montague, Parker, Tarrant and Wise counties. Likewise, overdrafting the Woodbine aquifer through at least 2010, and adding new wells or increasing existing well production are regional water plan strategies for 23 water user groups in Collin, Denton, Ellis, Fannin, Grayson and Hunt counties.

Regional water plan strategies to reduce reliance on the Trinity and Woodbine aquifers have also been recommended. Reduced reliance on the Trinity aquifer is recommended for 27 water user groups in Collin, Cooke, Dallas, Denton, Ellis, Grayson and Wise counties; and, reduced reliance on the Woodbine aquifer is recommended for six water user groups in Grayson and Fannin counties. Even with these recommended reductions in pumpage, the strategies to increase reliance on the Trinity and Woodbine aquifers result in collectively higher groundwater demand projections through 2010 for both aquifers and through 2030 for the Woodbine. By 2020, the reduced Trinity aquifer use strategies are projected to counter the new aquifer use strategies.

The water demands for the development of the Barnett Shale are not addressed or included in the regional water plans or the State Water Plan. This water demand should be considered in the next round of regional water planning. The Barnett Shale water use and demand projections developed in January 2007, when coupled with present groundwater use estimates, may collectively push Trinity aquifer use above the regional water plan estimates of reliable supply for Cooke, Denton, Parker, and Wise counties and add to ongoing aquifer overdraft in Ellis, Johnson, and Tarrant counties. Shortages are projected in the 2006 Region B, Region C, and Brazos G Water Plans for other mining user groups in Cooke, Denton, Hood, Johnson, Montague, Tarrant, and Wise counties. Recommended strategies to address the projected shortages include conservation, purchasing water from various suppliers, reuse of water, supplemental wells in the Trinity aquifer, overdrafting of the Trinity aquifer, and new wells in the Trinity and Woodbine aquifers.

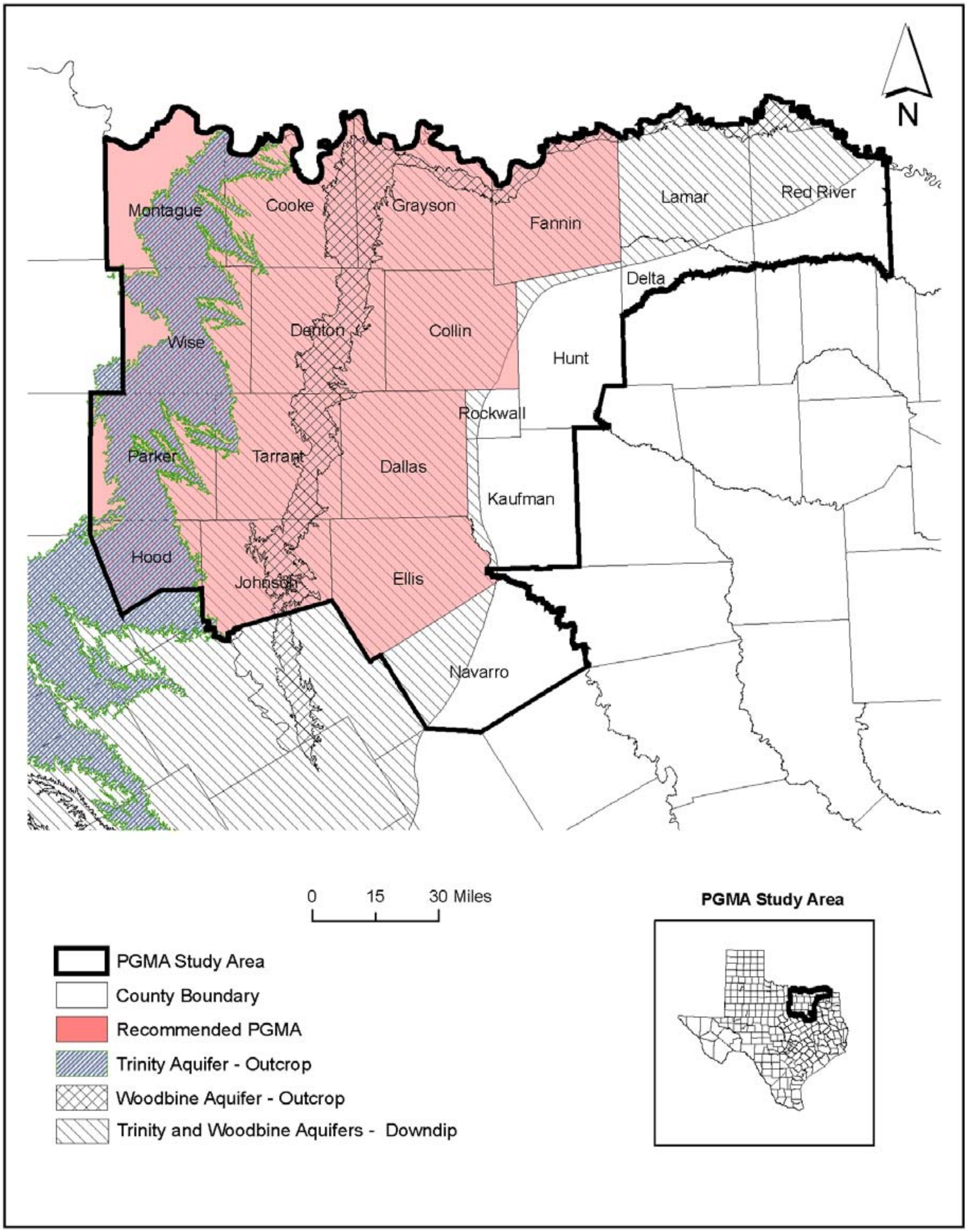
The past and continued overdevelopment of aquifers from the continued urbanization of the area threatens water supplies for rural domestic, municipal, and small water providers who depend on groundwater resources. Some groundwater users on the fringes of the Dallas-Fort Worth urban core, including many municipalities, are or will be converting to surface water sources over the next 10 to 20 years. However, increased groundwater use to keep pace with the growth around the metroplex and the growing suburban cities is anticipated to continue. Historically, regional groundwater use has not lessened when local providers convert to surface water sources because those who develop next, just outside of the area that has recently converted to surface water, will look first and foremost to use the groundwater resources.

Designation Recommendations

Preserving the ability to rely on the limited groundwater resource is and will remain a primary objective for remote rural water suppliers; individual businesses, industries, or landowners; and, small municipalities. Protecting existing groundwater supplies is a critical issue for these groundwater users because the delivery of alternative surface water supplies is not projected to always be economically feasible. <u>For these reasons, it is recommended that the following counties be designated as the Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area: Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant and Wise.</u> A general boundary description for the Northern Trinity and Woodbine Aquifers PGMA is provided in Appendix 7.

New groundwater users or significant new demands on the Trinity or Woodbine aquifers are not anticipated by the regional water planning groups over the next 25-year period in Delta, Kaufman, Lamar, Navarro, Red River or Rockwall counties. Present and projected use of the Trinity and Woodbine aquifers in these counties, and in Hunt County is well under the estimated safe supply for each county. <u>Critical groundwater problems are not presently occurring or projected to occur in Delta, Hunt, Kaufman, Lamar, Navarro, Red River or Rockwall counties within the next 25-year period and these counties should not be designated as part of the recommended Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area.</u> The PGMA designation recommendations are illustrated in Figure 14.

Figure 14. Recommended Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area



Groundwater Conservation District Considerations

One or more groundwater conservation districts created within Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant and Wise counties (i.e., the recommended PGMA counties) would have the necessary authority to address the groundwater problems identified in the area. Such a district(s) would have the best available regulatory authority to manage and protect groundwater resources in the area and would benefit small water suppliers and domestic users in rural areas in these counties by implementing groundwater management programs as authorized under state law. GCD programs with goals: to quantify groundwater availability and quality and understand aquifer characteristics; to identify groundwater problems that should be addressed through aquifer- and area-specific research, monitoring, data collection, assessment, and education programs; to quantify aquifer impacts from pumpage and establish an overall understanding of groundwater use through a comprehensive water well inventory, registration, and permitting program; and, to evaluate and understand aquifers sufficiently to establish spacing regulations to minimize drawdown of water levels and to prevent interference among neighboring wells would benefit groundwater users in these counties. The remote rural water suppliers; individual businesses, industries, or landowners; and, small municipalities of these counties would benefit from these and other types of management programs for the Trinity and Woodbine aquifers.

The 1990 Texas Water Commission report for the study area concluded the residents of the area would not support the creation of GCDs financed by ad valorem taxes. The report recommended that local entities should lead efforts to have special law-created single- or multi-county GCDs with a regional coordinating board and technical staff with sufficient resources to encourage conversion to available surface water in order to preserve groundwater supplies for more isolated and rural areas. This approach contemplates two levels of groundwater management oversight – local groundwater regulation and regional water supply coordination. The 1990 report also recommended the Commission should monitor the conversion from groundwater to surface water usage, and if conversion plans are not being implemented or if GCDs are not being formed, designation of the area should be reconsidered if state law is modified to furnish other means to finance a GCD besides ad valorem taxes.

Conversions from groundwater to surface water have and continue to occur. Continued and new conversions are also prominent regional water plan strategy recommendations for implementation over the next 30 years. However, new groundwater demands in most of the study area counties continue and are anticipated to continue increasing at amounts above already realized and projected groundwater reductions. Prior to the 80th Texas Legislature in 2007, GCDs had not been formed even though state law had been modified to authorize their funding through sources other than ad valorem taxes.

A regional groundwater conservation district for the recommended PGMA counties would include the greatest areal extent of the Trinity and Woodbine aquifers experiencing supply problems. From a resource protection perspective, this option would be the most efficient by allowing for a single groundwater management program that would assure consistency across the area, providing a central groundwater management entity for decision-making purposes, and simplifying groundwater management planning responsibilities related to Groundwater Management Area #8. This type of regional GCD could effectively be governed by a board of directors with one board member elected to represent each county.

Financing groundwater management activities through well production fees is concluded to be the most viable alternative in area, and the limiting factor for GCD creation considerations will be the amount of revenue that can be generated through this means. Because of economy-of-scale issues, a regional GCD would be the most economic choice. A regional GCD could be adequately funded by the water well production fees authorized under state law and would avoid voter negativity associated with any attempt to authorize, pass, or create a new taxing entity.

The creation of multi-county GCDs with boundaries based on aquifer occurrence or on political boundaries or other political-preference considerations would also be considered feasible if sufficient fee revenue can be generated in the area to finance district operation and maintenance. This is the case for the new, 80th Legislature-created, Upper Trinity Groundwater Conservation District in Hood, Montague, Parker, and Wise counties that includes most of the Trinity aquifer outcrop area in the recommended PGMA. The creation of the new Upper Trinity GCD must be confirmed by the voters before it can establish a groundwater management program. Having two, three, or even more GCDs in the recommended PGMA would require a like number of largely duplicative administrative and groundwater management programs be implemented and coordinated.

The new, 80th Legislature-created Northern Trinity Groundwater Conservation District in Tarrant County will be funded by well production fees authorized under state law and could generate up to $190,000 annually to support its operations. The creation of other single-county, production fee-funded GCDs are not considered feasible options because none of the remaining counties, on an individual basis, have enough groundwater production to generate sufficient revenue to operate an efficient and functional GCD. All of the counties in the recommended PGMA on an individual basis could feasibly finance GCD operation and maintenance through the levy of ad valorem taxes, and most could generate sufficient revenue to operate a GCD at a rate below $0.015 (one and a half cents) per $100 assessed valuation. Attempts to authorize a new taxing entity to manage groundwater resources will be difficult in counties where most of the voters rely on surface water sources.

Groundwater Conservation District Recommendations

<u>It is recommended that a regional, fee-funded groundwater conservation district for the conservation and management of the Trinity and Woodbine aquifers in Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, and Wise counties represents the most feasible, economic, and practicable option for protection and management of the groundwater resources</u> (Figure 15). Under this recommendation, each county would be represented by a single member on the district's board of directors, and the users of the resource will be responsible for funding the district. Such a district would be able to generate about $740,000 annually from water well production fees to finance the operation and maintenance of the district and to implement the groundwater assessment, monitoring, registration, permitting, planning, and educational programs that are needed to protect the Trinity and Woodbine aquifers. Such a district could also establish county committees for more localized and formal input for permitting and other decisions of the board of directors. The county committees could be charged to make recommendations and advise the board of directors on water-related issues, well permits, programs, or other activities that affect the individual counties. The purpose, board of directors configuration, and estimate of minimum financing needs for the recommended regional GCD is provided in Appendix 8.

<u>Alternatively, it is recommended that three multi-county, fee-funded GCDs could be created based on (1) local initiative to establish economically viable and functional districts, (2) aquifer hydrology and present and projected use, and (3) other political or location considerations</u> (Figure 16). Under this scenario, two directors could be locally chosen to represent each county on the district's board of directors. Based on comments received and GCD creation bills passed during the 80th Legislature, Regular Session, 2007, it is suggested that one GCD could include the Trinity aquifer outcrop counties of Montague, Wise, Parker, Hood, and Cooke. A second GCD could consist of the northern counties of Grayson, Fannin, Denton, and Collin and a third GCD could include Dallas, Johnson, and Ellis counties to the south.

In regard to the local actions taken in Hood, Montague, Parker and Wise counties to date, it is suggested that the temporary directors of the new Upper Trinity Groundwater Conservation District coordinate educational programming for the creation of the district with the Texas Cooperative Extension and the Texas Alliance of Groundwater Districts. The Upper Trinity Groundwater Conservation District has the necessary local representation, powers, authorities, and fee-funded revenue source to enable the district to adequately manage the Trinity aquifer in this four-county area.

For Delta, Hunt, Kaufman, Lamar, Navarro, Red River and Rockwall counties, it is suggested that the creation of one or more GCDs may be warranted in the future if groundwater usage practices and trends drastically exceed what is projected in the 2006 regional water plans. These counties can monitor and consider the need for groundwater management over a longer term because they do not presently have, or are projected to have critical groundwater problems in the next 25-year period.

The use and application of the permissive authority granted to municipal and county platting authorities to require groundwater availability certification under the Local Government Code can also be an effective tool to help ensure that residents of new subdivisions with homes that will rely on individual wells will have adequate groundwater resources. The exercise of this power by platting authorities can be used to help determine the lot size requirements needed to minimize or prevent well interference between and with the new neighbors. The aquifer testing required under the application of this authority would provide meaningful and valid data for groundwater management decision making, especially if it can be done in conjunction with GCD water well permitting responsibilities. It is recommended that local governments consider using this groundwater management tool to address water supply concerns in rapidly developing areas.

Public Comment and Response

Over thirty stakeholders provided written comments related to the December 2006 draft report findings, conclusions, and recommendations for this study. These stakeholders represented county and municipal officials and staff; a county commissioners court-appointed steering committee; the regional council of governments for most of the study-area counties; a regional water planning group consultant; regional, local, and rural water suppliers; state agencies and organizations; and, concerned citizens. The majority of the respondents were from the northern study-area counties.

About half of the respondents commented on draft report data considerations and conclusions but were generally neutral to recommendations regarding PGMA designation and GCD creation. County officials from Collin, Fannin, and Grayson counties; the City of Gainesville; Greater Texoma Utility Authority; one Grayson County water supplier; and three residents of Grayson County opposed both the inclusion of their counties in a PGMA and the potential creation of a GCD. County officials from Cooke and Montague counties, five county-appointed steering committee members from Cooke County, four cities and one water supply district from Montague County, four residents of Parker County, and one resident of Dallas County supported draft report recommendations regarding designation of the area as a PGMA and the need to establish groundwater management districts. None of the respondents who commented on the issue favored the possible creation of a 13-county GCD in the area. The regional water planning group consultant and others suggested that several multi-county GCDs grouped on location and situational needs would be a better option than a regional GCD. Several of the respondents commented that single- or multi-county GCD creation options may be explored in the future if the TCEQ includes their specific county in a PGMA.

The Executive Director updated the report based on new data and information that was provided by the stakeholders. The recommendation for the designation of the 13-county area was not changed because a dedicated aquifer monitoring and management program is needed to protect Trinity and Woodbine aquifer users. The recommendation for a multi-county, fee-funded GCD was refined because the Northern Trinity Groundwater Conservation District was created in Tarrant County. An alternative recommendation for the creation of three multi-county, fee-funded GCDs was added based on stakeholder comments and other local actions taken independently to create the Upper Trinity Groundwater Conservation District.

Natural Resource Considerations

Few species are directly dependent upon the groundwater resources of the study area. However, the study area springs contribute to surface water hydrology and have helped shape the ecosystems that exist in the study area. Any groundwater management program that would abate and reverse aquifer overdrafting and the resultant decline in water levels would benefit the land and habitat for the remaining species in the area. Groundwater management programs to monitor, evaluate, and understand the aquifers may be used peripherally to develop and establish educational programs to voluntarily protect riparian habitats or to attempt to enhance or rejuvenate spring flows.

The TPWD concluded that protecting the quality and quantity of the ground and surface water of the North-Central Texas study area are important goals and the implementation of protection and management strategies will ultimately safeguard other natural and economic resources in the area that are either directly or indirectly influenced by groundwater. Designation of the 13 counties as a PGMA and the creation of a regional GCD would lead to a more efficient use of the existing water resources.

Figure 15. Regional GCD Recommendation

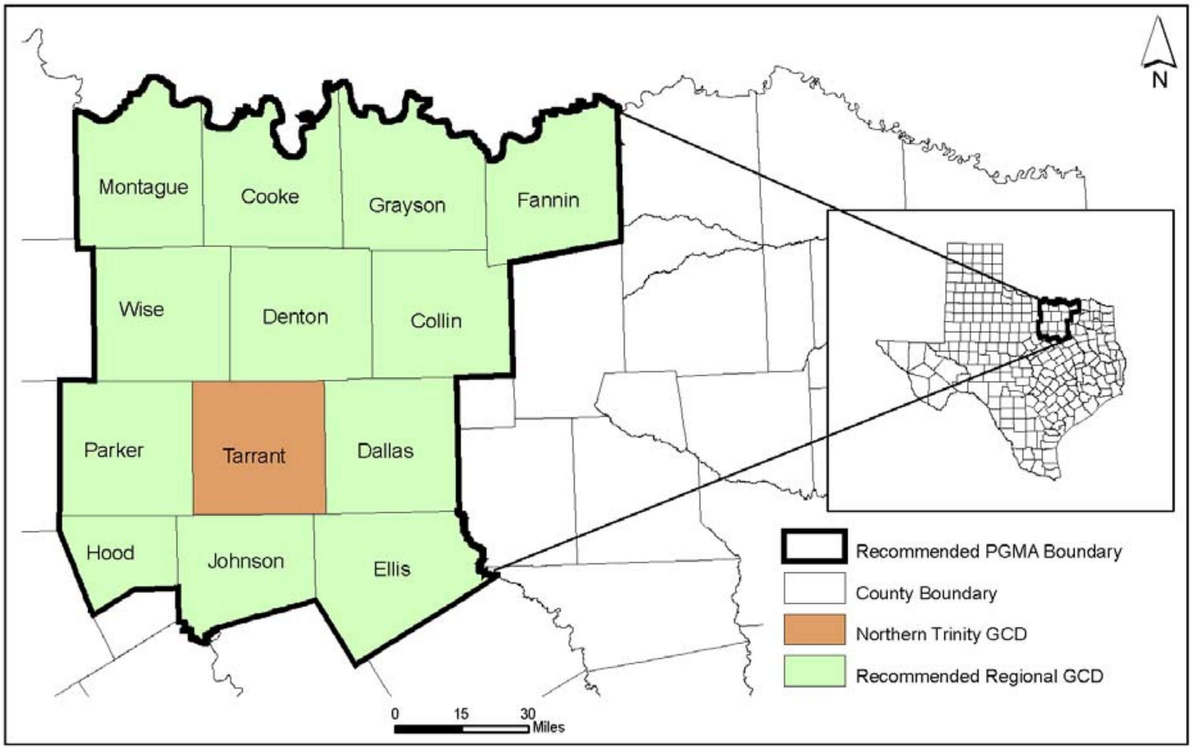
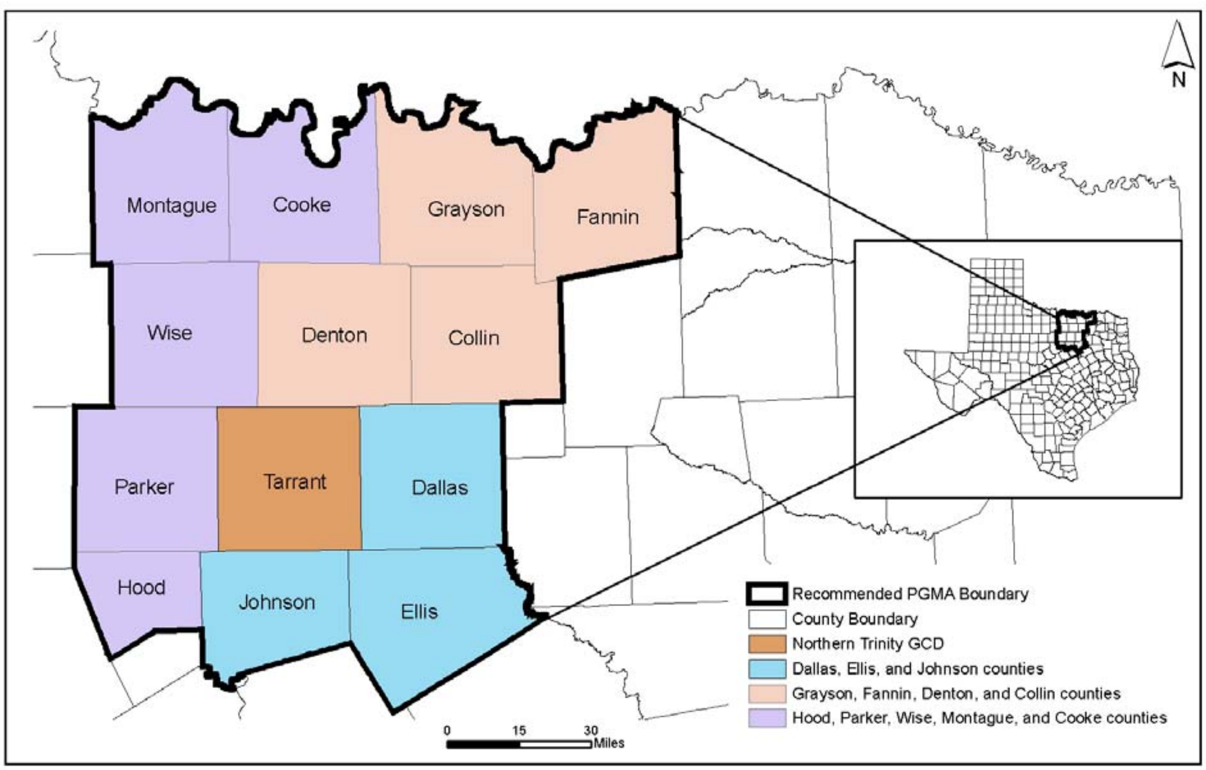


Figure 16. Alternative Recommendation for Three Multi-County GCDs



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Appendix 1. Study Area Population Projections

County	2000	P2010	P2020	P2030	P2040	P2050	P2060
Collin	491,774	756,088	1,033,173	1,249,795	1,512,261	1,762,329	2,033,981
Cooke	36,363	42,675	47,792	53,379	58,273	66,099	72,428
Dallas	2,218,774	2,557,152	2,883,564	3,117,428	3,338,498	3,640,347	4,032,056
Delta	5,327	5,728	6,244	6,744	7,244	7,244	7,244
Denton	432,976	720,064	953,668	1,184,744	1,392,575	1,610,447	1,870,472
Ellis	111,360	149,627	188,280	230,402	277,956	334,794	402,573
Fannin	31,242	36,842	40,539	47,393	57,913	71,389	83,522
Grayson	110,595	133,913	163,711	188,537	208,936	230,413	253,568
Hood	41,100	49,207	58,364	66,888	75,814	87,059	100,045
Hunt	76,596	82,948	94,401	110,672	137,371	196,757	289,645
Johnson	126,811	151,468	180,509	211,020	244,349	285,700	336,431
Kaufman	71,313	112,971	148,580	177,072	205,571	237,625	277,783
Lamar	48,499	52,525	56,536	60,286	64,036	64,036	64,036
Montague	19,117	19,863	20,596	20,892	21,009	21,040	21,119
Navarro	45,124	52,189	58,161	64,637	71,810	80,344	90,940
Parker	88,495	115,529	172,136	216,956	242,904	268,224	291,978
Red River	14,314	14,251	14,251	14,251	14,251	14,251	14,251
Rockwall	43,080	82,547	126,029	148,991	170,493	186,083	196,472
Tarrant	1,446,219	1,705,885	1,956,163	2,189,565	2,454,046	2,779,448	3,146,721
Wise	48,793	66,847	87,624	103,873	119,876	139,509	161,354
Total	**5,507,872**	**6,908,319**	**8,290,321**	**9,463,525**	**10,675,186**	**12,083,138**	**13,746,619**

Source: TWDB, 2005.

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Appendix 2. Water Supply

Collin County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Allen	Trinity	Lake Texoma	4802	4537	4566	4224	3928	3615
Allen	Trinity	Lake Lavon/Reuse	6460	6104	6142	5683	5284	4862
Allen	Trinity	Lake Chapman	3104	2885	2854	2596	2372	2144
Allen	Trinity	Indirect Reuse (Lavon)	2232	2109	2122	1963	1826	1680
Anna	Trinity	Trinity Aquifer	88	88	88	88	88	88
Anna	Trinity	Woodbine Aquifer	124	124	124	124	124	124
Blue Ridge	Trinity	Woodbine Aquifer	119	119	119	119	119	119
Caddo Basin SUD	Sabine	Lake Texoma	84	81	87	93	99	105
Caddo Basin SUD	Sabine	Lake Lavon	114	110	118	124	133	141
Caddo Basin SUD	Sabine	Lake Chapman	54	52	54	57	60	62
Caddo Basin SUD	Sabine	Indirect Reuse (Lavon)	39	38	40	43	46	49
Caddo Basin SUD	Trinity	Lake Texoma	39	38	40	43	46	48
Caddo Basin SUD	Trinity	Lake Lavon	53	51	54	58	61	65
Caddo Basin SUD	Trinity	Lake Chapman	25	24	25	26	28	29
Caddo Basin SUD	Trinity	Indirect Reuse (Lavon)	18	17	19	20	21	23
Celina	Trinity	Lake Ray Roberts	242	1117	1445	1675	2012	1906
Celina	Trinity	Lake Chapman	331	1403	1358	1128	891	897
Celina	Trinity	Trinity Aquifer	317	317	317	317	317	317
Celina	Trinity	Woodbine Aquifer	408	408	408	408	408	408
Culleoka WSC	Trinity	Lake Texoma	184	213	220	225	238	249
Culleoka WSC	Trinity	Lake Lavon	248	286	296	303	320	336
Culleoka WSC	Trinity	Lake Chapman	119	135	137	138	144	148
Culleoka WSC	Trinity	Indirect Reuse (Lavon)	86	99	102	105	111	116
Dallas	Trinity	Lake Ray Roberts	5354	5279	5066	4726	4194	3697
Dallas	Trinity	Lake Ray Hubbard	1996	1993	1937	1830	1645	1470
Dallas	Trinity	Lake Tawakoni	4940	4896	4722	4428	3950	3502
Danville WSC	Trinity	Lake Texoma	172	182	192	202	217	229
Danville WSC	Trinity	Lake Lavon	230	245	257	273	292	309
Danville WSC	Trinity	Lake Chapman	111	115	120	124	131	136
Danville WSC	Trinity	Indirect Reuse (Lavon)	80	84	89	94	101	107
East Fork SUD	Trinity	Lake Texoma	113	111	113	116	121	127
East Fork SUD	Trinity	Lake Lavon	151	149	152	157	165	170

Collin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
East Fork SUD	Trinity	Lake Chapman	73	71	71	71	73	75
East Fork SUD	Trinity	Indirect Reuse (Lavon)	52	52	52	54	56	59
Fairview	Trinity	Lake Texoma	349	361	399	526	799	1276
Fairview	Trinity	Lake Lavon	470	485	536	707	1075	1716
Fairview	Trinity	Lake Chapman	226	229	249	323	482	756
Fairview	Trinity	Indirect Reuse (Lavon)	162	168	185	244	371	593
Farmersville	Trinity	Lake Texoma	115	163	195	257	344	428
Farmersville	Trinity	Lake Lavon	154	219	263	346	462	575
Farmersville	Trinity	Lake Chapman	74	104	122	158	208	254
Farmersville	Trinity	Indirect Reuse (Lavon)	53	76	91	120	160	199
Frisco	Trinity	Lake Texoma	6077	7547	6969	6600	6413	6066
Frisco	Trinity	Lake Lavon	8177	10153	9376	8880	8628	8161
Frisco	Trinity	Lake Chapman	3929	4799	4356	4056	3872	3597
Frisco	Trinity	Trinity Aquifer	61	61	61	61	61	61
Frisco	Trinity	Indirect Reuse (Lavon)	2824	3507	3239	3067	2980	2819
Gunter Rural WSC	Trinity	Trinity Aquifer	424	424	424	424	424	424
Hickory Creek SUD	Trinity	Woodbine Aquifer	13	15	16	17	18	19
Josephine	Trinity	Lake Texoma	21	45	38	33	30	28
Josephine	Trinity	Lake Lavon	27	60	50	45	41	37
Josephine	Trinity	Lake Chapman	14	29	24	20	18	16
Josephine	Trinity	Indirect Reuse (Lavon)	10	21	18	15	14	13
Lavon WSC	Trinity	Lake Texoma	75	92	114	201	288	358
Lavon WSC	Trinity	Lake Lavon	101	124	154	270	386	482
Lavon WSC	Trinity	Lake Chapman	48	58	72	123	174	212
Lavon WSC	Trinity	Indirect Reuse (Lavon)	35	43	53	93	134	166
Lowry Crossing	Trinity	Lake Texoma	64	62	63	64	67	231
Lowry Crossing	Trinity	Lake Lavon	85	83	84	87	91	311
Lowry Crossing	Trinity	Lake Chapman	41	39	39	39	40	137
Lowry Crossing	Trinity	Indirect Reuse (Lavon)	30	29	29	30	31	107
Lucas	Trinity	Lake Texoma	209	241	247	280	363	451
Lucas	Trinity	Lake Lavon	283	325	333	378	487	607
Lucas	Trinity	Lake Chapman	135	154	154	172	219	268
Lucas	Trinity	Indirect Reuse (Lavon)	97	112	115	130	169	210

Collin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
McKinney	Trinity	Lake Texoma	5016	6338	7916	9475	10300	10788
McKinney	Trinity	Lake Lavon	6750	8528	10650	12747	13857	14514
McKinney	Trinity	Lake Chapman	3243	4030	4948	5822	6219	6398
McKinney	Trinity	Indirect Reuse (Lavon)	2331	2946	3679	4403	4787	5014
Melissa	Trinity	Lake Texoma	450	664	741	810	926	1059
Melissa	Trinity	Lake Lavon	604	893	998	1090	1247	1425
Melissa	Trinity	Lake Chapman	291	422	463	498	559	628
Melissa	Trinity	Woodbine Aquifer	108	108	108	108	108	108
Melissa	Trinity	Indirect Reuse (Lavon)	209	309	345	377	430	492
Milligan WSC	Trinity	Lake Texoma	41	31	26	22	20	18
Milligan WSC	Trinity	Lake Lavon	55	41	35	30	27	25
Milligan WSC	Trinity	Lake Chapman	27	20	16	14	12	11
Milligan WSC	Trinity	Indirect Reuse (Lavon)	19	14	12	10	9	8
Murphy	Trinity	Lake Texoma	315	915	781	687	626	572
Murphy	Trinity	Lake Lavon	424	1232	1051	926	844	769
Murphy	Trinity	Lake Chapman	204	582	488	422	378	339
Murphy	Trinity	Indirect Reuse (Lavon)	147	425	363	319	291	266
Nevada	Sabine	Lake Texoma	36	55	57	100	152	347
Nevada	Sabine	Lake Lavon	48	75	77	135	203	466
Nevada	Sabine	Lake Chapman	23	35	36	61	92	206
Nevada	Sabine	Indirect Reuse (Lavon)	17	26	26	46	71	161
Nevada	Trinity	Lake Texoma	14	28	28	50	76	173
Nevada	Trinity	Lake Lavon	19	37	39	67	102	233
Nevada	Trinity	Lake Chapman	9	18	18	31	46	103
Nevada	Trinity	Indirect Reuse (Lavon)	7	13	13	23	35	81
New Hope	Trinity	Lake Texoma	54	60	85	113	154	313
New Hope	Trinity	Lake Lavon	73	82	116	153	208	421
New Hope	Trinity	Lake Chapman	35	38	53	69	93	186
New Hope	Trinity	Indirect Reuse (Lavon)	25	28	40	52	72	146
North Collin WSC	Trinity	Lake Texoma	178	176	179	182	192	199
North Collin WSC	Trinity	Lake Lavon	239	236	239	246	257	269
North Collin WSC	Trinity	Lake Chapman	115	112	112	112	116	118
North Collin WSC	Trinity	Indirect Reuse (Lavon)	83	82	83	85	89	93

Collin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Parker	Trinity	Lake Texoma	389	642	804	1156	1541	1924
Parker	Trinity	Lake Lavon	523	864	1082	1556	2073	2589
Parker	Trinity	Lake Chapman	251	408	503	711	930	1141
Parker	Trinity	Indirect Reuse (Lavon)	181	299	374	537	716	894
Plano	Trinity	Lake Texoma	14389	11486	10160	9286	8733	8246
Plano	Trinity	Lake Lavon	19359	15452	13669	12493	11750	11095
Plano	Trinity	Lake Chapman	9303	7303	6351	5706	5273	4890
Plano	Trinity	Indirect Reuse (Lavon)	6687	5338	4722	4316	4059	3832
Princeton	Trinity	Lake Texoma	135	247	376	551	837	1145
Princeton	Trinity	Lake Lavon	182	332	506	741	1125	1541
Princeton	Trinity	Lake Chapman	87	157	235	338	505	679
Princeton	Trinity	Indirect Reuse (Lavon)	63	115	175	256	389	532
Prosper	Trinity	Lake Texoma	226	845	1079	1087	1062	1034
Prosper	Trinity	Lake Lavon	305	1137	1451	1464	1430	1392
Prosper	Trinity	Lake Chapman	146	537	674	668	641	613
Prosper	Trinity	Woodbine Aquifer	605	605	605	605	605	605
Prosper	Trinity	Indirect Reuse (Lavon)	105	393	501	505	494	481
Richardson	Trinity	Lake Texoma	1406	1668	1426	1248	1129	1031
Richardson	Trinity	Lake Lavon	1891	2244	1918	1680	1520	1387
Richardson	Trinity	Lake Chapman	909	1060	892	767	682	611
Richardson	Trinity	Indirect Reuse (Lavon)	653	775	663	580	525	479
Royse City	Sabine	Lake Texoma	64	166	226	301	365	375
Royse City	Sabine	Lake Lavon	85	223	305	404	491	505
Royse City	Sabine	Lake Chapman	41	106	142	185	221	223
Royse City	Sabine	Indirect Reuse (Lavon)	30	77	105	140	170	174
Sachse	Trinity	Lake Texoma	147	184	182	169	157	146
Sachse	Trinity	Lake Lavon	199	248	245	227	212	196
Sachse	Trinity	Lake Chapman	95	117	114	104	95	87
Sachse	Trinity	Indirect Reuse (Lavon)	68	86	85	78	73	68
Saint Paul	Trinity	Lake Texoma	39	74	126	177	191	184
Saint Paul	Trinity	Lake Lavon	53	99	169	238	258	248
Saint Paul	Trinity	Lake Chapman	25	47	79	109	116	109
Saint Paul	Trinity	Indirect Reuse (Lavon)	18	34	58	82	89	85

Collin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
South Grayson WSC	Trinity	Woodbine Aquifer	199	161	140	120	105	90
South Grayson WSC	Trinity	Trinity Aquifer	202	163	141	122	106	91
Weston	Trinity	Woodbine Aquifer	64	64	64	64	64	64
Wylie	Trinity	Lake Texoma	1343	1630	1736	2138	2042	2036
Wylie	Trinity	Lake Lavon	1806	2193	2334	2876	2747	2740
Wylie	Trinity	Lake Chapman	868	1037	1085	1314	1233	1208
Wylie	Trinity	Indirect Reuse (Lavon)	624	758	807	994	949	946
Irrigation	Trinity	Run-of-River - Trinity	408	408	408	408	408	408
Irrigation	Trinity	Direct reuse	2227	2227	2227	2227	2227	2227
Livestock	Sabine	Livestock Local Supply	31	31	31	31	31	31
Livestock	Sabine	Other Aquifer	4	4	4	4	4	4
Livestock	Trinity	Livestock Local Supply	971	971	971	971	971	971
Livestock	Trinity	Other Aquifer	114	114	114	114	114	114
Manufacturing	Trinity	Lake Texoma	689	618	600	593	591	587
Manufacturing	Trinity	Lake Chapman	445	393	375	364	357	348
Manufacturing	Trinity	Woodbine Aquifer	214	214	214	214	214	214
Manufacturing	Trinity	Indirect Reuse (Lavon)	1247	1119	1087	1073	1069	1063
Mining	Trinity	Other Local Supply	195	195	195	195	195	195
County-Other	Sabine	Lake Texoma	3	3	3	3	2	2
County-Other	Sabine	Lake Lavon	5	5	4	3	4	3
County-Other	Sabine	Lake Chapman	2	2	2	2	1	1
County-Other	Sabine	Woodbine Aquifer	0	0	0	0	0	0
County-Other	Sabine	Trinity Aquifer	0	0	0	0	0	0
County-Other	Sabine	Indirect Reuse (Lavon)	2	1	1	1	1	1
County-Other	Trinity	Lake Texoma	80	55	43	34	28	23
County-Other	Trinity	Lake Lavon	107	75	57	46	37	30
County-Other	Trinity	Lake Chapman	51	35	27	21	17	14
County-Other	Trinity	Trinity Aquifer	655	655	655	655	655	655
County-Other	Trinity	Woodbine Aquifer	505	505	505	505	505	505
County-Other	Trinity	Indirect Reuse (Lavon)	37	26	20	16	13	11
Steam Electric Power	Trinity	Lake Texoma	161	100	100	104	112	122

Collin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Steam Electric Power	Trinity	Lake Lavon	216	134	135	140	151	163
Steam Electric Power	Trinity	Lake Chapman	104	63	62	64	68	72
Steam Electric Power	Trinity	Trinity Aquifer	555	555	555	555	555	555
Steam Electric Power	Trinity	Indirect Reuse (Lavon)	75	46	46	48	52	57

Cooke County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bolivar WSC	Trinity	Trinity Aquifer	173	173	173	173	173	173
Gainesville	Red	Lake Hubert H. Moss	2	2	2	2	2	2
Gainesville	Trinity	Trinity Aquifer	233	207	185	185	185	185
Gainesville	Trinity	Trinity Aquifer	1833	1348	881	874	870	866
Gainesville	Trinity	Lake Hubert H. Moss	1119	1119	1119	1119	1119	1119
Kiowa Homeowners WSC	Trinity	Trinity Aquifer	630	630	630	630	630	630
Lindsay	Trinity	Trinity Aquifer	130	130	130	130	130	130
Muenster	Trinity	Trinity Aquifer	301	301	301	301	301	301
Two Way WSC	Red	Trinity Aquifer	10	11	11	11	11	11
Valley View	Trinity	Trinity Aquifer	78	78	78	78	78	78
Woodbine WSC	Red	Trinity Aquifer	13	13	13	13	13	13
Woodbine WSC	Trinity	Trinity Aquifer	503	503	503	503	503	503
Irrigation	Red	Run-of-River - Irrigation	23	23	23	23	23	23
Irrigation	Red	Trinity Aquifer	176	176	176	176	176	176
Irrigation	Trinity	Run-of-River - Trinity	0	0	0	0	0	0
Irrigation	Trinity	Trinity Aquifer	96	96	96	96	96	96
Irrigation	Trinity	Direct reuse	9	9	9	9	9	9
Livestock	Red	Livestock Local Supply	380	380	380	380	380	380
Livestock	Red	Trinity Aquifer	287	287	287	287	287	287
Livestock	Trinity	Livestock Local Supply	807	807	807	807	807	807
Livestock	Trinity	Trinity Aquifer	611	611	611	611	611	611
Manufacturing	Trinity	Trinity Aquifer	209	209	209	209	209	209

Cooke County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Mining	Red	Trinity Aquifer	42	42	42	42	42	42
Mining	Red	Other Local Supply	77	77	77	77	77	77
Mining	Trinity	Other Local Supply	160	160	160	160	160	160
Mining	Trinity	Trinity Aquifer	7	7	7	7	7	7
County-Other	Red	Trinity Aquifer	171	171	171	171	171	171
County-Other	Trinity	Trinity Aquifer	604	604	604	604	604	604

Dallas County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Addison	Trinity	Lake Ray Roberts	2835	2880	2851	2731	2469	2170
Addison	Trinity	Lake Ray Hubbard	1057	1087	1090	1058	969	863
Addison	Trinity	Lake Tawakoni	2616	2670	2658	2560	2326	2055
Balch Springs	Trinity	Lake Ray Roberts	765	682	624	566	494	423
Balch Springs	Trinity	Lake Ray Hubbard	285	258	238	219	194	169
Balch Springs	Trinity	Lake Tawakoni	705	633	581	531	466	402
Carrollton	Trinity	Lake Ray Roberts	3458	3068	2817	2557	2244	1942
Carrollton	Trinity	Lake Ray Hubbard	1290	1159	1077	990	880	773
Carrollton	Trinity	Lake Tawakoni	3192	2846	2626	2396	2114	1841
Carrollton	Trinity	Trinity Aquifer	10	10	10	10	10	10
Cedar Hill	Trinity	Lake Ray Roberts	2466	2778	2994	3040	2916	2687
Cedar Hill	Trinity	Lake Joe Pool	0	0	0	0	0	0
Cedar Hill	Trinity	Lake Ray Hubbard	920	1049	1145	1177	1144	1068
Cedar Hill	Trinity	Lake Tawakoni	2275	2576	2792	2849	2747	2545
Cedar Hill	Trinity	Trinity Aquifer	275	275	275	275	275	275
Cedar Hill	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Cockrell Hill	Trinity	Lake Ray Roberts	209	197	178	158	139	119
Cockrell Hill	Trinity	Lake Ray Hubbard	78	74	68	62	54	47
Cockrell Hill	Trinity	Lake Tawakoni	193	182	166	149	130	112
Combine	Trinity	Lake Ray Roberts	32	36	35	35	35	33
Combine	Trinity	Lake Ray Hubbard	12	14	14	14	13	13
Combine	Trinity	Lake Tawakoni	30	33	33	33	32	32
Combine WSC	Trinity	Lake Ray Roberts	50	63	65	66	66	66

Dallas County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Combine WSC	Trinity	Lake Ray Hubbard	19	24	25	26	26	26
Combine WSC	Trinity	Lake Tawakoni	46	59	61	62	62	63
Coppell	Trinity	Lake Ray Roberts	3214	2843	2574	2327	2024	1734
Coppell	Trinity	Lake Ray Hubbard	1198	1073	984	902	794	690
Coppell	Trinity	Lake Tawakoni	2966	2637	2400	2181	1906	1643
Dallas	Trinity	Lake Ray Roberts	109163	102505	92312	81613	71046	67890
Dallas	Trinity	Lake Ray Hubbard	32382	33078	32477	32076	32946	34563
Dallas	Trinity	Lake Tawakoni	113383	114140	112270	110655	112776	116705
Dallas County WCID #6	Trinity	Lake Ray Roberts	184	221	231	236	239	240
Dallas County WCID #6	Trinity	Lake Ray Hubbard	69	83	88	91	93	96
Dallas County WCID #6	Trinity	Lake Tawakoni	171	204	215	221	224	228
DeSoto	Trinity	DWU Sources	3410	3676	3826	3881	3785	3342
DeSoto	Trinity	Lake Ray Roberts	1272	1388	1463	1503	1485	1329
DeSoto	Trinity	Lake Ray Hubbard	3147	3410	3567	3637	3567	3166
DeSoto	Trinity	Lake Tawakoni	25	25	25	25	25	25
Duncanville	Trinity	Lake Ray Roberts	2542	2353	2156	1970	1747	1526
Duncanville	Trinity	Lake Joe Pool	0	0	0	0	0	0
Duncanville	Trinity	Lake Ray Hubbard	948	888	824	763	685	607
Duncanville	Trinity	Lake Tawakoni	2345	2181	2009	1846	1646	1446
East Fork SUD	Trinity	Lake Texoma	23	19	16	15	14	13
East Fork SUD	Trinity	Lake Lavon	32	24	22	19	19	18
East Fork SUD	Trinity	Lake Chapman	15	12	10	9	8	8
East Fork SUD	Trinity	Indirect Reuse (Lavon)	11	9	8	7	6	6
Farmers Branch	Trinity	Lake Ray Roberts	3596	3460	3364	3227	2960	2654
Farmers Branch	Trinity	Lake Ray Hubbard	1341	1307	1286	1250	1161	1055
Farmers Branch	Trinity	Lake Tawakoni	3318	3210	3136	3024	2788	2514
Garland	Trinity	Lake Texoma	8710	7198	6508	5998	5679	5182
Garland	Trinity	Lake Lavon	11717	9686	8756	8070	7640	6973
Garland	Trinity	Lake Chapman	5631	4577	4068	3686	3429	3073
Garland	Trinity	Indirect Reuse (Lavon)	4048	3345	3024	2788	2639	2408
Glenn Heights	Trinity	Lake Ray Roberts	235	262	281	290	283	268

Dallas County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Glenn Heights	Trinity	Lake Ray Hubbard	88	99	107	113	111	106
Glenn Heights	Trinity	Lake Tawakoni	217	243	262	273	266	253
Glenn Heights	Trinity	Trinity Aquifer	178	178	178	178	178	178
Glenn Heights	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Grand Prairie	Trinity	Lake Ray Roberts	6813	6919	7406	8033	8332	8357
Grand Prairie	Trinity	Lake Joe Pool	0	0	0	0	0	0
Grand Prairie	Trinity	Lake Ray Hubbard	2540	2613	2832	3111	3269	3323
Grand Prairie	Trinity	Lake Tawakoni	6287	6418	6904	7527	7849	7917
Grand Prairie	Trinity	Trinity Aquifer	1292	1274	1272	1286	1305	1319
Highland Park	Trinity	Lake Grapevine	5960	5694	5452	5223	4986	4757
Hutchins	Trinity	Lake Ray Roberts	388	679	987	1339	1559	1420
Hutchins	Trinity	Lake Ray Hubbard	144	256	378	519	612	565
Hutchins	Trinity	Lake Tawakoni	358	630	921	1255	1469	1345
Hutchins	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Irving	Trinity	Lake Ray Roberts	4706	641	585	532	562	787
Irving	Trinity	Lake Ray Hubbard	1755	242	224	206	220	312
Irving	Trinity	Lake Chapman	44815	43908	43019	42156	41348	40678
Irving	Trinity	Lake Tawakoni	4343	594	546	498	529	744
Irving	Trinity	Trinity Aquifer	0	0	0	0	0	0
Lancaster	Trinity	Lake Ray Roberts	2287	3251	3679	3995	3964	3654
Lancaster	Trinity	Lake Ray Hubbard	853	1228	1407	1548	1556	1452
Lancaster	Trinity	Lake Tawakoni	2111	3016	3429	3744	3735	3460
Lancaster	Trinity	Trinity Aquifer	362	362	362	362	362	362
Lewisville	Trinity	Lake Ray Roberts	1	1	1	1	1	1
Mesquite	Trinity	Lake Texoma	5820	5401	5247	4960	4622	4245
Mesquite	Trinity	Lake Lavon	7830	7268	7058	6674	6218	5710
Mesquite	Trinity	Lake Chapman	3763	3434	3280	3048	2791	2518
Mesquite	Trinity	Indirect Reuse (Lavon)	2705	2510	2439	2305	2148	1973
Ovilla	Trinity	Lake Ray Roberts	25	32	42	56	72	91
Ovilla	Trinity	Lake Ray Hubbard	9	12	16	22	28	36
Ovilla	Trinity	Lake Tawakoni	23	29	39	52	68	86
Richardson	Trinity	Lake Texoma	5167	4022	3440	3010	2724	2486
Richardson	Trinity	Lake Lavon	6952	5412	4627	4049	3664	3344

Dallas County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Richardson	Trinity	Lake Chapman	3341	2557	2150	1850	1645	1474
Richardson	Trinity	Indirect Reuse (Lavon)	2401	1869	1599	1399	1266	1155
Rockett SUD	Trinity	Lake Joe Pool	105	0	0	0	0	0
Rockett SUD	Trinity	Lake Waxahachie	69	0	0	0	0	0
Rowlett	Trinity	Lake Texoma	2173	2151	2096	2037	1987	1918
Rowlett	Trinity	Lake Lavon	2925	2894	2821	2740	2674	2580
Rowlett	Trinity	Lake Chapman	1405	1368	1311	1251	1200	1137
Rowlett	Trinity	Indirect Reuse (Lavon)	1010	1000	974	947	924	891
Sachse	Trinity	Lake Texoma	467	449	447	442	446	441
Sachse	Trinity	Lake Lavon	629	603	602	595	599	594
Sachse	Trinity	Lake Chapman	302	285	280	272	269	262
Sachse	Trinity	Indirect Reuse (Lavon)	217	209	208	206	207	205
Sardis-Lone Elm WSC	Trinity	Trinity Aquifer	8	7	7	7	7	7
Seagoville	Trinity	Lake Ray Roberts	788	784	792	784	737	679
Seagoville	Trinity	Lake Ray Hubbard	294	296	302	304	289	270
Seagoville	Trinity	Lake Tawakoni	727	728	737	735	694	644
Sunnyvale	Trinity	Lake Texoma	359	387	424	457	492	459
Sunnyvale	Trinity	Lake Lavon	484	519	570	615	662	619
Sunnyvale	Trinity	Lake Chapman	232	246	265	281	297	272
Sunnyvale	Trinity	Indirect Reuse (Lavon)	167	180	197	212	229	214
University Park	Trinity	Lake Grapevine	8968	8968	8968	8968	8647	8243
Wilmer	Trinity	Trinity Aquifer	322	322	322	322	322	322
Wylie	Trinity	Lake Texoma	23	28	30	32	33	33
Wylie	Trinity	Lake Lavon	31	38	41	42	45	45
Wylie	Trinity	Lake Chapman	15	18	19	20	20	20
Wylie	Trinity	Indirect Reuse (Lavon)	11	13	14	15	15	16
Dallas County-Irrigation	Trinity	Lake Ray Roberts	320	286	261	237	208	177
Dallas County-Irrigation	Trinity	Lake Joe Pool	100	100	100	100	100	100
Dallas County-Irrigation	Trinity	Lake Ray Hubbard	119	108	100	92	81	71

Dallas County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Dallas County-Irrigation	Trinity	Lake Tawakoni	296	265	243	222	195	168
Dallas County-Irrigation	Trinity	Other Aquifer	593	593	593	593	593	593
Dallas County-Irrigation	Trinity	Indirect Reuse	8000	8000	8000	8000	8000	8000
Dallas County-Irrigation	Trinity	Direct Reuse	561	561	561	561	561	561
Dallas County-Livestock	Trinity	Livestock Local Supply	712	712	712	712	712	712
Dallas County-Livestock	Trinity	Woodbine Aquifer	69	69	69	69	69	69
Dallas County-Manufacturing	Trinity	Lake Texoma	1316	1131	1057	1005	967	888
Dallas County-Manufacturing	Trinity	Lake Lavon	1770	1521	1422	1352	1302	1195
Dallas County-Manufacturing	Trinity	Lake Ray Roberts	8030	7938	7897	7709	7111	6132
Dallas County-Manufacturing	Trinity	Lake Ray Hubbard	2994	2998	3020	2986	2791	2438
Dallas County-Manufacturing	Trinity	Lake Chapman	2353	2480	2589	2672	2700	2590
Dallas County-Manufacturing	Trinity	Lake Chapman	851	719	661	617	584	527
Dallas County-Manufacturing	Trinity	Lake Tawakoni	7410	7363	7362	7224	6700	5809
Dallas County-Manufacturing	Trinity	Trinity Aquifer	250	250	250	250	250	250
Dallas County-Manufacturing	Trinity	Woodbine Aquifer	521	521	521	521	521	521
Dallas County-Manufacturing	Trinity	Direct Reuse	20	20	20	20	20	20
Dallas County-Manufacturing	Trinity	Indirect Reuse (Lavon)	611	526	491	467	450	413
Dallas County-Mining	Trinity	Other Local Supply	1525	1525	1525	1525	1525	1525
Dallas County-Mining	Trinity	Trinity Aquifer	1138	1138	1138	1138	1138	1138
Dallas County-Other	Trinity	Lake Texoma	0	0	0	0	0	0
Dallas County-Other	Trinity	Lake Ray Roberts	6	6	5	5	4	3
Dallas County-Other	Trinity	Lake Ray Hubbard	2	2	2	2	2	1

Dallas County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Dallas County-Other	Trinity	Lake Chapman	0	0	0	0	0	0
Dallas County-Other	Trinity	Lake Tawakoni	6	5	5	4	4	3
Dallas County-Other	Trinity	Other Aquifer	0	0	0	0	0	0
Dallas County-Other	Trinity	Trinity Aquifer	150	150	150	150	150	150
Dallas County-Other	Trinity	Woodbine Aquifer	89	89	89	89	89	89
Dallas County-Other	Trinity	Indirect Reuse	0	0	0	0	0	0
Dallas County-Steam Electric Power	Trinity	Lake Texoma	22	13	13	14	15	16
Dallas County-Steam Electric Power	Trinity	Lake Lavon	28	19	19	19	20	21
Dallas County-Steam Electric Power	Trinity	Lake Ray Roberts	1726	1140	535	794	1020	1216
Dallas County-Steam Electric Power	Trinity	Lake Mountain Creek	6400	6400	6400	6400	6400	6400
Dallas County-Steam Electric Power	Trinity	Lake Ray Hubbard	644	431	205	307	400	483
Dallas County-Steam Electric Power	Trinity	Lake Chapman	14	8	8	9	9	10
Dallas County-Steam Electric Power	Trinity	Lake Tawakoni	1593	1058	500	744	961	1152
Dallas County-Steam Electric Power	Trinity	Trinity Aquifer	0	0	0	0	0	0
Dallas County-Steam Electric Power	Trinity	Run-of-River - Industrial	368	368	368	368	368	368
Dallas County-Steam Electric Power	Trinity	Indirect Reuse (Lavon)	10	6	6	6	7	8

Delta County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
COOPER	Sulphur	Chapman/cooper Lake/reservoir Non-system Portion	710	690	669	647	623	591
Cooper	Sulphur	Big Creek Lake/reservoir	980	980	980	980	980	980
County-other	Sulphur	Big Creek Lake/reservoir	453	460	467	477	477	477
County-other	Sulphur	Tawakoni Lake/reservoir	74	74	74	74	74	74
County-other	Sulphur	Trinity Aquifer	85	85	0	0	0	0
County-other	Sulphur	Woodbine Aquifer	10	10	11	12	12	12
Irrigation	Sulphur	Irrigation Local Supply	416	416	416	416	416	416
Irrigation	Sulphur	Nacatoch Aquifer	5	38	51	61	66	66
Irrigation	Sulphur	Trinity Aquifer	157	118	99	82	71	65
Livestock	Sulphur	Livestock Local Supply	202	202	202	202	202	202
Livestock	Sulphur	Nacatoch Aquifer	20	20	20	20	20	20
Livestock	Sulphur	Trinity Aquifer	122	122	122	122	122	122
North Hunt WSC	Sulphur	Tawakoni Lake/reservoir	28	32	36	40	41	42
North Hunt WSC	Sulphur	Woodbine Aquifer	6	5	4	3	2	1

Denton County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Argyle	Trinity	Lake Ray Roberts	569	648	769	895	1025	1027
Argyle	Trinity	Lake Chapman	776	813	723	604	478	483
Argyle	Trinity	Trinity Aquifer	398	398	398	398	398	398
Argyle WSC	Trinity	Lake Ray Roberts	143	98	97	109	122	117
Argyle WSC	Trinity	Lake Chapman	195	123	93	74	57	55
Argyle WSC	Trinity	Trinity Aquifer	398	398	398	398	398	398
Aubrey	Trinity	Lake Ray Roberts	48	50	58	67	77	76
Aubrey	Trinity	Lake Chapman	64	62	54	45	35	36
Aubrey	Trinity	Trinity Aquifer	195	195	195	195	195	195
Bartonville	Trinity	Lake Ray Roberts	281	442	598	742	907	809

Denton County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bartonville	Trinity	Lake Chapman	382	555	564	502	423	381
Bartonville	Trinity	Trinity Aquifer	196	196	196	196	196	196
Bartonville WSC	Trinity	Lake Ray Roberts	19	30	44	62	89	89
Bartonville WSC	Trinity	Lake Chapman	27	39	43	43	42	42
Bartonville WSC	Trinity	Trinity Aquifer	282	282	282	282	282	282
Bolivar WSC	Trinity	Trinity Aquifer	760	760	760	760	760	760
Carrollton	Trinity	Lake Ray Roberts	4829	4393	4171	3861	3421	2962
Carrollton	Trinity	Lake Ray Hubbard	1800	1658	1595	1495	1343	1178
Carrollton	Trinity	Lake Tawakoni	4455	4073	3889	3618	3224	2806
Carrollton	Trinity	Trinity Aquifer	0	0	0	0	0	0
Coppell	Trinity	Lake Ray Roberts	33	41	45	48	48	44
Coppell	Trinity	Lake Ray Hubbard	12	15	18	19	18	17
Coppell	Trinity	Lake Tawakoni	31	38	43	45	44	42
Copper Canyon	Trinity	Lake Ray Roberts	125	112	164	256	343	320
Copper Canyon	Trinity	Lake Chapman	171	141	153	171	160	151
Copper Canyon	Trinity	Trinity Aquifer	61	61	61	61	61	61
Corinth	Trinity	Lake Ray Roberts	1379	1060	1147	1350	1648	1493
Corinth	Trinity	Lake Chapman	1881	1331	1085	910	769	703
Corinth	Trinity	Trinity Aquifer	13	13	13	13	13	13
Cross Roads	Trinity	Lake Ray Roberts	182	273	427	752	1219	1235
Cross Roads	Trinity	Lake Chapman	249	342	404	507	569	581
Cross Roads	Trinity	Trinity Aquifer	87	87	87	87	87	87
Dallas	Trinity	Lake Ray Roberts	2493	2364	2209	2025	1775	1528
Dallas	Trinity	Lake Ray Hubbard	929	893	845	784	697	608
Dallas	Trinity	Lake Tawakoni	2300	2192	2059	1897	1673	1448
Denton	Trinity	Lake Ray Roberts	20076	19562	19026	18476	17944	17433
Denton	Trinity	Lake Ray Roberts Non-System	841	1054	1038	1118	1054	941
Denton	Trinity	Lake Lewisville	7563	7387	7202	7013	6830	6655
Denton	Trinity	Indirect Reuse	1682	2130	2915	3475	4372	5382
Denton County FWSD	Trinity	Lake Ray Roberts	363	360	457	601	832	851
Denton County FWSD	Trinity	Lake Chapman	497	450	430	405	387	399

Denton County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Denton County-Irrigation	Trinity	Woodbine Aquifer	590	590	590	590	590	590
Denton County-Irrigation	Trinity	Direct Reuse	2099	2195	2276	2348	2428	2509
Denton County-Livestock	Trinity	Livestock Local Supply	935	935	935	935	935	935
Denton County-Livestock	Trinity	Trinity Aquifer	246	246	246	246	246	246
Denton County-Livestock	Trinity	Woodbine Aquifer	531	531	531	531	531	531
Denton County-Manufacturing	Trinity	Lake Ray Roberts	369	320	293	280	249	197
Denton County-Manufacturing	Trinity	Lake Ray Roberts	197	202	217	234	244	227
Denton County-Manufacturing	Trinity	Lake Ray Hubbard	46	55	61	64	63	60
Denton County-Manufacturing	Trinity	Lake Lewisville	139	120	111	106	94	75
Denton County-Manufacturing	Trinity	Lake Chapman	102	67	54	45	39	37
Denton County-Manufacturing	Trinity	Lake Tawakoni	113	136	149	155	151	142
Denton County-Manufacturing	Trinity	Trinity Aquifer	59	59	59	59	59	59
Denton County-Mining	Trinity	Other Local Supply	103	103	103	103	103	103
Denton County-Mining	Trinity	Trinity Aquifer	36	36	36	36	36	36
Denton County-Other	Trinity	Lake Ray Roberts	2119	1638	1839	2196	2827	2732
Denton County-Other	Trinity	TRWD Sources	775	785	793	783	751	715
Denton County-Other	Trinity	Lake Chapman	2892	2052	1730	1477	1319	1285
Denton County-Other	Trinity	Other Aquifer	0	0	0	0	0	0
Denton County-Other	Trinity	Trinity Aquifer	1806	1806	1806	1806	1806	1806
Denton County-Other	Trinity	Woodbine Aquifer	200	200	200	200	200	200
Denton County-Other	Trinity	Direct Reuse	0	0	0	0	0	0
Denton County-Steam Electric Power	Trinity	Direct Reuse	831	1840	2288	2849	3363	3363
Double Oak	Trinity	Lake Ray Roberts	211	146	151	169	208	193

Denton County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Double Oak	Trinity	Lake Chapman	286	186	142	115	97	89
Double Oak	Trinity	Trinity Aquifer	106	106	106	106	106	106
Flower Mound	Trinity	Lake Ray Roberts	5633	5784	6145	6800	7553	6847
Flower Mound	Trinity	Lake Ray Hubbard	1473	1331	1231	1133	1002	871
Flower Mound	Trinity	Lake Chapman	2296	2833	2754	2607	2330	2188
Flower Mound	Trinity	Lake Tawakoni	3644	3269	3002	2741	2407	2074
Fort Worth	Trinity	TRWD Sources	1270	6065	7637	9383	11558	12914
Frisco	Trinity	Lake Texoma	3181	2863	3931	4031	4035	3797
Frisco	Trinity	Lake Lavon	4280	3851	5288	5424	5429	5109
Frisco	Trinity	Lake Chapman	2057	1820	2458	2477	2436	2252
Frisco	Trinity	Trinity Aquifer	0	0	0	0	0	0
Frisco	Trinity	Indirect Reuse (Lavon)	1479	1330	1827	1874	1875	1765
Hackberry	Trinity	Lake Texoma	29	33	37	36	35	32
Hackberry	Trinity	Lake Lavon	39	45	51	50	47	44
Hackberry	Trinity	Lake Chapman	19	21	23	22	21	19
Hackberry	Trinity	Trinity Aquifer	73	73	73	73	73	73
Hackberry	Trinity	Indirect Reuse (Lavon)	13	15	17	17	16	15
Hebron	Trinity	Lake Ray Roberts	72	91	138	255	352	327
Hebron	Trinity	Lake Ray Hubbard	21	29	44	80	106	99
Hebron	Trinity	Lake Chapman	22	19	22	32	39	36
Hebron	Trinity	Lake Tawakoni	52	71	107	193	255	237
Hebron	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Hickory Creek	Trinity	Lake Ray Roberts	159	166	198	257	392	441
Hickory Creek	Trinity	Lake Chapman	218	209	186	172	183	207
Hickory Creek	Trinity	Trinity Aquifer	33	39	42	45	51	57
Hickory Creek	Trinity	Woodbine Aquifer	71	84	90	97	111	124
Highland Village	Trinity	Lake Ray Roberts	780	606	655	746	915	831
Highland Village	Trinity	Lake Chapman	1063	758	616	501	425	390
Highland Village	Trinity	Trinity Aquifer	1411	1411	1411	1411	1411	1411
Justin	Trinity	Lake Ray Roberts	67	136	249	464	574	572
Justin	Trinity	Lake Chapman	92	170	235	314	267	269
Justin	Trinity	Trinity Aquifer	353	353	353	353	353	353
Krugerville	Trinity	Lake Ray Roberts	41	32	36	53	74	89

Denton County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Krugerville	Trinity	Lake Chapman	55	39	34	35	34	41
Krugerville	Trinity	Trinity Aquifer	57	57	57	57	57	57
Krum	Trinity	Lake Ray Roberts	74	99	134	208	305	305
Krum	Trinity	Lake Chapman	100	125	127	139	143	143
Krum	Trinity	Trinity Aquifer	298	298	298	298	298	298
Lake Dallas	Trinity	Lake Ray Roberts	371	298	303	351	422	379
Lake Dallas	Trinity	Lake Chapman	507	374	295	237	197	178
Lake Dallas	Trinity	Trinity Aquifer	77	70	66	61	55	49
Lake Dallas	Trinity	Woodbine Aquifer	166	150	142	133	119	106
Lewisville	Trinity	Lake Ray Roberts	6672	7333	7647	7511	6903	6255
Lewisville	Trinity	Lake Ray Hubbard	2488	2769	2924	2909	2709	2487
Lewisville	Trinity	Lake Tawakoni	6157	6801	7128	7039	6504	5926
Lincoln Park	Trinity	Lake Ray Roberts	32	36	47	61	77	76
Lincoln Park	Trinity	Lake Chapman	44	45	43	42	35	36
Lincoln Park	Trinity	Trinity Aquifer	49	49	49	49	49	49
Little Elm	Trinity	Lake Texoma	963	1196	1229	1087	991	904
Little Elm	Trinity	Lake Lavon	1295	1609	1653	1463	1333	1217
Little Elm	Trinity	Lake Chapman	623	760	768	668	598	536
Little Elm	Trinity	Woodbine Aquifer	696	696	696	696	696	696
Little Elm	Trinity	Indirect Reuse (Lavon)	448	556	571	505	461	420
Mustang SUD	Trinity	Lake Ray Roberts	229	279	377	502	871	1018
Mustang SUD	Trinity	Lake Chapman	312	349	351	337	298	289
Mustang SUD	Trinity	Trinity Aquifer	331	331	331	331	331	331
Northlake	Trinity	TRWD Sources	563	543	885	1125	1146	1048
Northlake	Trinity	Woodbine Aquifer	9	9	9	9	9	9
Oak Point	Trinity	Lake Ray Roberts	140	166	215	286	362	349
Oak Point	Trinity	Lake Chapman	190	207	204	193	169	163
Oak Point	Trinity	Trinity Aquifer	145	145	145	145	145	145
Pilot Point	Trinity	Lake Ray Roberts	0	0	0	0	0	0
Pilot Point	Trinity	Lake Ray Hubbard	0	0	0	0	0	0
Pilot Point	Trinity	Lake Chapman	0	0	0	0	0	0
Pilot Point	Trinity	Lake Tawakoni	0	0	0	0	0	0
Pilot Point	Trinity	Trinity Aquifer	587	587	587	587	587	587
Plano	Trinity	Lake Texoma	314	340	293	260	237	218

Denton County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Plano	Trinity	Lake Lavon	422	458	393	348	320	293
Plano	Trinity	Lake Chapman	203	216	183	160	143	129
Plano	Trinity	Indirect Reuse (Lavon)	146	158	136	121	110	101
Ponder	Trinity	Trinity Aquifer	201	201	201	201	201	201
Prosper	Trinity	Lake Texoma	57	250	387	519	520	517
Prosper	Trinity	Lake Lavon	76	338	520	699	699	696
Prosper	Trinity	Lake Chapman	37	159	242	319	314	307
Prosper	Trinity	Indirect Reuse (Lavon)	26	116	180	241	242	240
Roanoke	Trinity	TRWD Sources	1196	1599	2139	2510	2845	2916
Roanoke	Trinity	Trinity Aquifer	63	63	63	63	63	63
Sanger	Trinity	Lake Ray Roberts	237	249	289	335	382	382
Sanger	Trinity	Lake Chapman	324	312	272	226	179	179
Sanger	Trinity	Trinity Aquifer	543	543	543	543	543	543
Shady Shores	Trinity	Lake Ray Roberts	92	87	103	130	174	174
Shady Shores	Trinity	Lake Chapman	126	111	97	87	81	82
Shady Shores	Trinity	Trinity Aquifer	19	21	22	23	23	23
Shady Shores	Trinity	Woodbine Aquifer	41	44	47	49	49	49
Southlake	Trinity	TRWD Sources	357	578	732	836	1027	903
The Colony	Trinity	Lake Texoma	105	104	98	89	83	76
The Colony	Trinity	Lake Lavon	141	139	133	119	111	103
The Colony	Trinity	Lake Ray Roberts	1492	1694	1709	1586	1412	1222
The Colony	Trinity	Lake Ray Hubbard	557	640	653	614	555	486
The Colony	Trinity	Lake Chapman	68	66	61	55	50	45
The Colony	Trinity	Lake Tawakoni	1377	1571	1592	1486	1332	1158
The Colony	Trinity	Trinity Aquifer	934	934	934	934	934	934
The Colony	Trinity	Indirect Reuse (Lavon)	49	48	46	41	38	35
Trophy Club	Trinity	TRWD Sources	2306	2154	2027	1894	1750	1610
Trophy Club	Trinity	Trinity Aquifer	546	546	546	546	546	546

Ellis County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bardwell	Trinity	Woodbine Aquifer	78	78	78	78	78	78
Brandon-Irene WSC	Trinity	Lake Aquilla	10	11	11	12	13	15
Buena Vista - Bethel SUD	Trinity	Trinity Aquifer	305	305	305	305	305	305
Buena Vista - Bethel SUD	Trinity	TRWD Sources	0	0	0	0	0	0
Cedar Hill	Trinity	Lake Ray Roberts	4	4	4	4	4	4
Cedar Hill	Trinity	Lake Joe Pool	0	0	0	0	0	0
Cedar Hill	Trinity	Lake Ray Hubbard	1	1	1	1	1	1
Cedar Hill	Trinity	Lake Tawakoni	3	3	3	3	3	3
Cedar Hill	Trinity	Trinity Aquifer	0	0	0	0	0	0
Cedar Hill	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Community Water Company	Trinity	Lake Bardwell	129	148	134	118	102	78
Ellis County-Irrigation	Trinity	Run-of-River - Trinity	3	3	3	3	3	3
Ellis County-Irrigation	Trinity	Trinity Aquifer	17	17	17	17	17	17
Ellis County-Livestock	Trinity	Livestock Local Supply	1688	1688	1688	1688	1688	1688
Ellis County-Livestock	Trinity	Woodbine Aquifer	154	154	154	154	154	154
Ellis County-Manufacturing	Trinity	Lake Joe Pool	1009	1335	1332	1143	979	769
Ellis County-Manufacturing	Trinity	Lake Bardwell	386	317	256	204	159	114
Ellis County-Manufacturing	Trinity	Lake Waxahachie	939	941	793	661	540	410
Ellis County-Manufacturing	Trinity	Trinity Aquifer	1007	1007	1007	1007	1007	1007
Ellis County-Manufacturing	Trinity	Woodbine Aquifer	364	364	364	364	364	364
Ellis County-Mining	Trinity	Woodbine Aquifer	113	113	113	113	113	113
Ellis County-Other	Trinity	Lake Joe Pool	0	0	0	0	0	0
Ellis County-Other	Trinity	Lake Bardwell	224	173	132	101	76	57
Ellis County-Other	Trinity	Lake Waxahachie	131	0	0	0	0	0
Ellis County-Other	Trinity	Trinity Aquifer	497	497	497	497	497	497
Ellis County-Other	Trinity	Other Aquifer	0	0	0	0	0	0
Ellis County-Other	Trinity	Woodbine Aquifer	260	260	260	260	260	260
Ellis County-Steam Electric Power	Trinity	Lake Joe Pool	204	175	114	91	74	64

Ellis County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Ellis County-Steam Electric Power	Trinity	Direct Reuse	2098	2615	3302	3363	3363	3363
Ennis	Trinity	TRWD Sources	0	0	0	0	0	0
Ennis	Trinity	Lake Bardwell	3888	3762	3668	3556	3426	3297
Ennis	Trinity	Lake Clark	0	0	0	0	0	0
Ferris	Trinity	Lake Joe Pool	15	0	0	0	0	0
Ferris	Trinity	Lake Waxahachie	39	0	0	0	0	0
Ferris	Trinity	Woodbine Aquifer	327	327	327	327	327	327
Files Valley WSC	Trinity	Brazos River Authority	143	153	163	173	186	201
Glenn Heights	Trinity	Lake Ray Roberts	85	107	124	138	145	149
Glenn Heights	Trinity	Lake Ray Hubbard	32	40	48	54	57	59
Glenn Heights	Trinity	Lake Tawakoni	79	99	116	130	137	141
Glenn Heights	Trinity	Trinity Aquifer	51	51	51	51	51	51
Glenn Heights	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Grand Prairie	Trinity	Lake Ray Roberts	21	83	193	297	389	477
Grand Prairie	Trinity	Lake Ray Hubbard	8	32	74	116	152	189
Grand Prairie	Trinity	Lake Tawakoni	19	78	180	280	366	451
Grand Prairie	Trinity	Trinity Aquifer	4	16	34	49	62	77
Grand Prairie	Trinity	Trinity Aquifer	0	0	0	0	0	0
Italy	Trinity	Trinity Aquifer	111	111	111	111	111	111
Italy	Trinity	Woodbine Aquifer	79	79	79	79	79	79
Johnson County Rural WSC	Trinity	Trinity Aquifer	0	0	0	0	0	0
Johnson County Rural WSC	Trinity	Brazos River Authority	21	21	21	21	21	21
Mansfield	Trinity	TRWD Sources	101	155	209	266	352	495
Maypearl	Trinity	Trinity Aquifer	55	55	55	55	55	55
Maypearl	Trinity	Woodbine Aquifer	49	49	49	49	49	49
Midlothian	Trinity	TRWD Sources	0	0	0	0	0	0
Midlothian	Trinity	Joe Pool Lake	2543	3430	3304	3186	3012	2853
Midlothian	Trinity	Trinity Aquifer	36	36	36	36	36	36
Milford	Trinity	Other Aquifer	0	0	0	0	0	0
Milford	Trinity	Woodbine Aquifer	53	53	53	53	53	53
Milford	Trinity	Brazos River Authority	84	84	81	79	77	77

Ellis County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Mountain Peak WSC	Trinity	Lake Joe Pool	408	436	286	227	185	159
Mountain Peak WSC	Trinity	Trinity Aquifer	751	751	751	751	751	751
Oak Leaf	Trinity	Lake Ray Roberts	108	113	117	119	117	113
Oak Leaf	Trinity	Lake Ray Hubbard	40	42	45	46	46	45
Oak Leaf	Trinity	Lake Tawakoni	100	104	109	112	111	108
Ovilla	Trinity	Lake Ray Roberts	310	368	420	425	371	316
Ovilla	Trinity	Lake Ray Hubbard	115	139	161	165	145	126
Ovilla	Trinity	Lake Tawakoni	286	342	391	398	349	300
Ovilla	Trinity	Woodbine Aquifer	56	56	56	56	56	56
Palmer	Trinity	Woodbine Aquifer	280	280	280	280	280	280
Pecan Hill	Trinity	Lake Waxahachie	29	0	0	0	0	0
Pecan Hill	Trinity	Other Aquifer	111	111	111	111	111	111
Red Oak	Trinity	Lake Joe Pool	100	0	0	0	0	0
Red Oak	Trinity	Woodbine Aquifer	698	698	698	698	698	698
Rice WSC	Trinity	Navarro Mills Reservoir	43	65	108	143	175	199
Rice WSC	Trinity	Lake Bardwell	85	85	67	52	39	29
Rockett SUD	Trinity	Lake Joe Pool	1370	0	0	0	0	0
Rockett SUD	Trinity	Lake Waxahachie	948	0	0	0	0	0
Rockett SUD	Trinity	Trinity Aquifer	71	71	71	71	71	71
Sardis-Lone Elm WSC	Trinity	Lake Joe Pool	0	0	0	0	0	0
Sardis-Lone Elm WSC	Trinity	Trinity Aquifer	1142	1143	1143	1143	1143	1143
Waxahachie	Trinity	Lake Bardwell	3855	3668	3483	3296	3111	2925
Waxahachie	Trinity	Lake Waxahachie	512	1632	1687	1726	1753	1790
Waxahachie	Trinity	Indirect Reuse	1886	2166	2445	2724	3004	3283

Fannin County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bonham	Red	Lake Bonham	3656	3649	3645	3640	3636	3476
Ector	Red	Woodbine Aquifer	113	113	113	113	113	113
Fannin County-Irrigation	Red	Run-of-River - Irrigation	14758	14758	14758	14758	14758	14758
Fannin County-Irrigation	Red	Other Aquifer	2620	2620	2620	2620	2620	2620

Fannin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Fannin County-Livestock	Red	Livestock Local Supply	1139	1139	1139	1139	1139	1139
Fannin County-Livestock	Red	Woodbine Aquifer	94	94	94	94	94	94
Fannin County-Livestock	Red	Trinity Aquifer	0	0	0	0	0	0
Fannin County-Livestock	Sulphur	Livestock Local Supply	364	364	364	364	364	364
Fannin County-Livestock	Sulphur	Woodbine Aquifer	30	30	30	30	30	30
Fannin County-Livestock	Sulphur	Trinity Aquifer	24	24	24	24	24	24
Fannin County-Livestock	Trinity	Livestock Local Supply	80	80	80	80	80	80
Fannin County-Livestock	Trinity	Woodbine Aquifer	7	7	7	6	7	6
Fannin County-Livestock	Trinity	Trinity Aquifer	0	0	0	0	0	0
Fannin County-Manufacturing	Red	Lake Bonham	73	82	90	98	105	114
Fannin County-Manufacturing	Red	Woodbine Aquifer	0	0	0	0	0	0
Fannin County-Mining	Red	Run-of-River - Mining	72	72	72	72	72	72
Fannin County-Other	Red	Lake Bonham	75	73	70	66	63	60
Fannin County-Other	Red	Woodbine Aquifer	742	741	742	742	742	742
Fannin County-Other	Red	Run-of-River - Red River	20	20	20	20	20	20
Fannin County-Other	Sulphur	Lake Bonham	0	0	0	0	0	0
Fannin County-Other	Sulphur	Woodbine Aquifer	53	54	53	53	53	53
Fannin County-Other	Sulphur	Trinity Aquifer	265	265	265	265	265	265
Fannin County-Other	Sulphur	Run-of-river - Sulphur River	49	49	49	49	49	49
Fannin County-Other	Trinity	Woodbine Aquifer	50	50	50	50	50	50
Fannin County-Other	Trinity	Trinity Aquifer	88	88	88	88	88	88
Fannin County-Steam Electric Power	Red	Lake Texoma	10000	10000	10000	10000	10000	10000
Fannin County-Steam Electric Power	Red	Woodbine Aquifer	629	629	629	629	629	629
Hickory Creek SUD	Sulphur	Woodbine Aquifer	18	17	16	15	14	0
Hickory Creek SUD	Trinity	Woodbine Aquifer	14	13	12	12	12	11
Honey Grove	Red	Woodbine Aquifer	107	107	107	107	107	107
Honey Grove	Sulphur	Woodbine Aquifer	334	334	334	334	334	334
Ladonia	Sulphur	Trinity Aquifer	276	276	276	276	276	276
Leonard	Sulphur	Woodbine Aquifer	5	5	5	5	6	6
Leonard	Trinity	Woodbine Aquifer	271	271	271	271	270	270

Fannin County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
North Hunt WSC	Sulphur	Woodbine Aquifer	60	65	71	71	71	71
Savoy	Red	Woodbine Aquifer	123	123	123	123	123	123
Southwest Fannin County SUD	Red	Woodbine Aquifer	394	392	391	390	390	389
Southwest Fannin County SUD	Trinity	Woodbine Aquifer	5	7	8	9	9	10
Trenton	Trinity	Woodbine Aquifer	189	189	189	189	189	189
Whitewright	Red	Woodbine Aquifer	5	6	7	7	8	8

Grayson County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bells	Red	Trinity	161	161	161	161	161	161
Bells	Red	Woodbine Aquifer	31	31	31	31	31	31
Collinsville	Trinity	Trinity Aquifer	283	283	283	283	283	283
Denison	Red	Lake Randell	4720	4720	4720	4720	4720	4720
Denison	Red	Lake Texoma	1100	1100	1100	1100	1100	1100
Denison	Red	Trinity Aquifer	157	157	157	157	157	157
Denison	Red	Woodbine Aquifer	155	155	155	155	155	155
Grayson County-Irrigation	Red	Run-of-River - Irrigation	2394	2394	2394	2394	2394	2394
Grayson County-Irrigation	Red	Lake Texoma	150	150	150	150	150	150
Grayson County-Irrigation	Red	Trinity Aquifer	0	0	0	0	0	0
Grayson County-Irrigation	Red	Woodbine Aquifer	100	100	100	100	100	100
Grayson County-Irrigation	Trinity	Woodbine Aquifer	3839	3839	3839	3839	3839	3839
Grayson County-Irrigation	Trinity	Trinity Aquifer	0	0	0	0	0	0
Grayson County-Livestock	Red	Livestock Local Supply	1077	1077	1077	1077	1077	1077
Grayson County-Livestock	Red	Woodbine Aquifer	107	107	107	107	107	107
Grayson County-Livestock	Trinity	Livestock Local Supply	606	606	606	606	606	606
Grayson County-Livestock	Trinity	Woodbine Aquifer	60	60	60	60	60	60
Grayson County-Manufacturing	Red	Lake Randell	500	500	500	500	500	500

Grayson County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Grayson County-Manufacturing	Red	Lake Texoma	8567	5253	4995	4734	4361	3984
Grayson County-Manufacturing	Red	Woodbine Aquifer	0	0	0	0	0	0
Grayson County-Manufacturing	Red	Run-of-River - Industrial	30	30	30	30	30	30
Grayson County-Manufacturing	Trinity	Lake Texoma	2	2	2	2	2	2
Grayson County-Manufacturing	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Grayson County-Mining	Red	Lake Texoma	100	100	100	100	100	100
Grayson County-Mining	Red	Trinity Aquifer	0	0	0	0	0	0
Grayson County-Mining	Red	Woodbine Aquifer	285	285	285	285	285	285
Grayson County-Mining	Trinity	Woodbine Aquifer	274	274	274	274	274	274
Grayson County-Mining	Trinity	Trinity Aquifer	431	431	431	431	431	431
Grayson County-Other	Red	Lake Randell	60	60	60	60	60	60
Grayson County-Other	Red	Lake Texoma	891	891	891	891	891	891
Grayson County-Other	Red	Trinity Aquifer	986	986	986	986	986	986
Grayson County-Other	Red	Other Aquifer	35	35	35	35	35	35
Grayson County-Other	Trinity	Woodbine Aquifer	1389	1388	1389	1388	1387	1388
Grayson County-Other	Red	Direct Reuse	0	0	0	0	0	0
Grayson County-Other	Red	Woodbine Aquifer	270	270	270	270	270	270
Grayson County-Other	Red	Other Aquifer	0	0	0	0	0	0
Grayson County-Other	Red	Trinity Aquifer	183	183	183	183	183	183
Gunter	Trinity	Trinity Aquifer	214	214	214	214	214	214
Gunter Rural WSC	Trinity	Trinity Aquifer	48	48	48	48	48	48
Howe	Red	Woodbine Aquifer	73	52	41	36	32	30
Howe	Trinity	Woodbine Aquifer	336	357	369	374	377	380
Luella WSC	Trinity	Woodbine Aquifer	408	408	408	408	408	408
Pottsboro	Red	Lake Randell	0	0	0	0	0	0
Pottsboro	Red	Lake Texoma	561	561	561	561	561	561
Pottsboro	Red	Woodbine Aquifer	123	123	123	123	123	123
Sherman	Red	Lake Texoma	2641	5955	6213	6474	6847	7224
Sherman	Red	Trinity Aquifer	4674	4674	4674	4674	4674	4674
Sherman	Red	Woodbine Aquifer	3463	3463	3463	3463	3463	3463
South Grayson WSC	Trinity	Woodbine Aquifer	159	197	218	238	254	268
South Grayson WSC	Trinity	Trinity Aquifer	161	200	221	240	256	271

Grayson Count (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Southmayd	Red	Woodbine Aquifer	49	49	49	49	49	49
Southmayd	Red	Trinity Aquifer	99	99	99	99	99	99
Southwest Fannin County SUD	Red	Woodbine Aquifer	54	54	54	54	54	54
Tioga	Trinity	Trinity Aquifer	130	130	130	130	130	130
Tom Bean	Red	Woodbine Aquifer	44	43	43	43	43	43
Tom Bean	Trinity	Woodbine Aquifer	245	245	245	245	245	245
Two Way WSC	Red	Trinity Aquifer	276	275	276	276	276	276
Two Way WSC	Trinity	Trinity Aquifer	155	156	155	154	154	154
Van Alstyne	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Van Alstyne	Trinity	Trinity Aquifer	468	468	468	468	468	468
Whitesboro	Red	Trinity Aquifer	434	486	510	526	536	537
Whitesboro	Trinity	Trinity Aquifer	327	275	251	235	225	223
Whitewright	Red	Woodbine Aquifer	432	432	430	431	430	429
Woodbine WSC	Trinity	Trinity Aquifer	13	13	13	13	13	13

Hood County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Acton Mud	Brazos	Groundwater	1311	1312	1313	1314	1315	1316
Acton Mud	Brazos	Surface Water	4366	4366	4366	4,366	4366	4366
Granbury	Brazos	Groundwater	540	541	541	542	542	543
Granbury	Brazos	Surface Water	7560	7560	7560	7560	7560	7560
Irrigation	Brazos	Groundwater	246	242	238	234	229	225
Irrigation	Brazos	Surface Water	13085	13127	13170	13212	13254	13296
Livestock	Brazos	Groundwater	0	0	0	0	0	0
Livestock	Brazos	Surface Water	623	623	623	623	623	623
Manufacturing	Brazos	Groundwater	22	22	22	22	22	22
Manufacturing	Brazos	Surface Water	0	0	0	0	0	0
Mining	Brazos	Groundwater	137	136	135	134	134	133
Mining	Brazos	Surface Water	0	0	0	0	0	0
Oak Trail Shores Subdivision	Brazos	Groundwater	378	378	378	379	379	379

Hood County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Oak Trail Shores Subdivision	Brazos	Surface Water	-	-	-	-	-	-
Steam-Electric	Brazos	Groundwater	0	0	0	0	0	0
Steam-Electric	Brazos	Surface water	43447	43447	43447	43447	43447	43447
Tolar	Brazos	Groundwater	151	151	151	151	151	152
Tolar	Brazos	Surface Water	-	-	-	-	-	-
County-Other	Brazos	Groundwater	3115	3118	3121	3123	3126	3129
County-Other	Brazos	Surface Water	600	600	600	600	600	600

Hunt County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Caddo Mills	Sabine	Tawakoni Lake/reservoir	174	178	186	201	242	309
Campbell	Sabine	Nacatoch Aquifer	109	109	111	123	149	189
Celeste	Sabine	Woodbine Aquifer	161	161	161	161	161	161
Greenville	Sabine	Tawakoni Lake/reservoir	18890	18572	18243	17890	17523	17179
Greenville	Sabine	Greenville City Lake/reservoir	3486	3486	3486	3486	3486	3486
Lone Oak	Sabine	Tawakoni Lake/reservoir	164	164	164	164	164	164
Quinlan	Sabine	Tawakoni Lake/reservoir	605	605	605	605	605	605
West Tawakoni	Sabine	Tawakoni Lake/reservoir	1080	1072	1064	1056	1047	1039
County-other	Sabine	Lavon Lake/reservoir North Texas Mwd System	261	321	409	556	883	1397
County-other	Sabine	Terrell Lake/reservoir	28	29	32	39	57	80
County-other	Sabine	Big Creek Lake/reservoir	4	4	6	8	12	19
County-other	Sabine	Tawakoni Lake/reservoir	1102	1103	1107	1116	1139	1169
County-other	Sabine	Nacatoch Aquifer	248	248	248	248	248	248
County-other	Sabine	Woodbine Aquifer	29	29	29	29	29	29
Manufacturing	Sabine	Tawakoni Lake/reservoir	532	694	862	1043	1216	1335
Manufacturing	Sabine	Trinity Aquifer	200	200	200	200	200	200
Mining	Sabine	Tawakoni Lake/reservoir	20	19	20	23	24	29

Hunt County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Mining	Sabine	Trinity Aquifer	37	36	34	30	28	22
Irrigation	Sabine	Irrigation Local Supply	1386	1386	1386	1386	1386	1386
Irrigation	Sabine	Trinity Aquifer	106	106	106	106	106	106
Livestock	Sabine	Livestock Local Supply	812	812	812	812	812	812
Josephine	Sabine	Lavon Lake/reservoir North Texas Mwd System	3	3	4	4	6	8
Able Springs WSC	Sabine	Tawakoni Lake/reservoir	119	119	119	119	119	119
Blackland WSC	Sabine	Lavon Lake/reservoir North Texas Mwd System	4	5	7	9	14	23
Caddo Basin SUD	Sabine	Lavon Lake/reservoir North Texas Mwd System	597	738	942	1279	2033	3214
Cash SUD	Sabine	Lavon Lake/reservoir North Texas Mwd System	1222	943	808	667	594	530
Cash SUD	Sabine	Fork Lake/reservoir	2240	2240	2240	2240	2240	2240
Cash SUD	Sabine	Tawakoni Lake/reservoir	2409	2386	2371	2366	2371	2377
Combined Consumers WSC	Sabine	Tawakoni Lake/reservoir	1419	1390	1348	1312	1271	1226
Community Water Company	Sabine	Tawakoni Lake/reservoir	189	189	189	189	189	189
Hickory Creek SUD	Sabine	Woodbine Aquifer	75	75	75	75	75	75
Mac Bee WSC	Sabine	Tawakoni Lake/reservoir	109	109	109	112	178	281
Campbell WSC	Sabine	Nacatoch Aquifer	28	28	26	14	0	0
Commerce	Sulphur	Chapman/cooper Lake/reservoir Non-system Portion	0	0	0	0	0	0
Commerce	Sulphur	Tawakoni Lake/reservoir	7676	7541	7383	7173	6731	6074
Commerce	Sulphur	Nacatoch Aquifer	196	196	196	196	196	196
Commerce	Sulphur	Nacatoch Aquifer	175	175	175	175	175	175
Wolfe City	Sulphur	Other Local Supply	140	140	120	120	120	120
County-other	Sulphur	Tawakoni Lake/reservoir	69	143	241	390	771	1369
County-other	Sulphur	Woodbine Aquifer	116	150	196	265	442	717
County-other	Sulphur	Nacatoch Aquifer	290	290	290	290	290	290
Manufacturing	Sulphur	Tawakoni Lake/reservoir	277	338	401	470	535	580

Hunt Count (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Livestock	Sulphur	Livestock Local Supply	300	300	300	300	300	300
Hickory Creek SUD	Sulphur	Woodbine Aquifer	176	178	180	183	187	189
North Hunt WSC	Sulphur	Tawakoni Lake/reservoir	119	115	111	107	106	105
North Hunt WSC	Sulphur	Woodbine Aquifer	0	0	0	0	0	0
North Hunt WSC	Sulphur	Trinity Aquifer	18	18	18	18	18	0
North Hunt WSC	Sulphur	Woodbine Aquifer	56	57	58	59	60	61
Campbell WSC	Sulphur	Nacatoch Aquifer	41	41	41	41	29	0
Irrigation	Sulphur	Sulphur River Combined Run-of-river	446	446	446	446	446	446
County-other	Trinity	Woodbine Aquifer	5	5	5	5	5	5
County-other	Trinity	Woodbine Aquifer	19	24	30	39	60	95
Livestock	Trinity	Livestock Local Supply	5	5	5	5	5	6
Livestock	Trinity	Trinity Aquifer	4	4	4	4	4	3
Caddo Basin SUD	Trinity	Lavon Lake/reservoir North Texas Mwd System	6	7	9	12	20	32
Hickory Creek SUD	Trinity	Woodbine Aquifer	74	72	73	76	82	86

Johnson County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Acton Mud	Brazos	Groundwater	10	10	10	10	10	10
Acton Mud	Brazos	Surface water	534	534	534	534	534	534
Alvarado	Brazos	Groundwater	76	75	75	75	75	75
Alvarado	Brazos	Surface water	11	11	11	11	11	11
Bethany WSC	Brazos	Groundwater	87	87	87	87	87	87
Bethany WSC	Brazos	Surface water	-	-	-	-	-	-
Bethesda WSC	Brazos	Groundwater	393	393	393	393	393	393
Bethesda WSC	Brazos	Surface water	-	-	-	-	-	-
Burleson	Brazos	Groundwater	-	-	-	-	-	-
Burleson	Brazos	Surface water	2330	2330	2330	2330	2330	2330
Cleburne	Brazos	Groundwater	-	-	-	-	-	-
Cleburne	Brazos	Surface water	10562	9383	8794	8205	7615	7026

Johnson County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Godley	Brazos	Groundwater	26	26	26	26	26	26
Godley	Brazos	Surface water	-	-	-	-	-	-
Grand View	Brazos	Groundwater	284	284	284	284	284	284
Grand View	Brazos	Surface water	-	-	-	-	-	-
Irrigation	Brazos	Groundwater	0	0	0	0	0	0
Irrigation	Brazos	Surface water	811	811	811	811	811	811
Johnson County Fwsd #1	Brazos	Groundwater	33	33	33	33	33	33
Johnson County Fwsd #1	Brazos	Surface water	1166	1166	1166	1166	1166	1166
Johnson County Rural WSC	Brazos	Groundwater	260	260	260	260	259	259
Johnson County Rural WSC	Brazos	Surface water	9181	9181	9181	9181	9181	9181
Joshua	Brazos	Groundwater	118	117	117	117	117	116
Joshua	Brazos	Surface water	-	-	-	-	-	-
Keene	Brazos	Groundwater	96	96	96	96	96	96
Keene	Brazos	Surface water	2040	2040	2040	2040	2040	2040
Livestock	Brazos	Groundwater	0	0	0	0	0	0
Livestock	Brazos	Surface water	2117	2117	2117	2117	2117	2117
Mansfield	Brazos	Groundwater	-	-	-	-	-	-
Mansfield	Brazos	Surface water	165	172	172	173	175	178
Mining	Brazos	Groundwater	51	54	56	57	58	59
Mining	Brazos	Surface water	62	62	62	62	62	62
Mountain Peak WSC	Brazos	Groundwater	113	113	113	113	113	113
Mountain Peak WSC	Brazos	Surface water	-	-	-	-	-	-
Manufacturing	Brazos	Groundwater	359	358	357	356	355	355
Manufacturing	Brazos	Surface water	0	0	0	0	0	0
Parker WSC	Brazos	Groundwater	48	48	48	48	47	47
Parker WSC	Brazos	Surface water	-	-	-	-	-	-
Rio Vista	Brazos	Groundwater	17	16	16	16	16	16
Rio Vista	Brazos	Surface water	-	-	-	-	-	-

Johnson County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Steam-Electric	Brazos	Groundwater	0	0	0	0	0	0
Steam-Electric	Brazos	Surface water	0	0	0	0	0	0

Kaufman County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Able Springs WSC	Trinity	Lake Fork	965	965	959	946	918	887
Able Springs WSC	Trinity	Lake Tawakoni	0	0	0	0	0	0
College Mound WSC	Trinity	Lake Texoma	99	149	194	209	232	262
College Mound WSC	Trinity	Lake Lavon	133	199	261	282	314	353
College Mound WSC	Trinity	Lake Terrell	161	140	127	119	111	101
College Mound WSC	Trinity	Lake Chapman	64	95	121	128	140	155
College Mound WSC	Trinity	Lake Tawakoni	213	187	168	158	148	134
College Mound WSC	Trinity	Indirect Reuse (Lavon)	46	69	90	97	108	122
Combine	Trinity	Lake Ray Roberts	58	66	70	75	77	79
Combine	Trinity	Lake Ray Hubbard	22	25	27	29	30	32
Combine	Trinity	Lake Tawakoni	54	61	66	70	73	75
Combine WSC	Trinity	Lake Ray Roberts	98	134	159	180	197	211
Combine WSC	Trinity	Lake Ray Hubbard	37	50	60	69	77	84
Combine WSC	Trinity	Lake Tawakoni	90	124	147	168	185	200
Crandall	Trinity	Lake Texoma	148	158	170	185	208	235
Crandall	Trinity	Lake Lavon	199	213	229	248	280	317
Crandall	Trinity	Lake Chapman	96	101	106	113	126	139
Crandall	Trinity	Indirect Reuse (Lavon)	69	73	79	86	97	109
Forney	Trinity	Lake Texoma	393	635	672	689	700	701
Forney	Trinity	Lake Lavon	528	855	905	928	942	943
Forney	Trinity	Lake Chapman	254	404	420	424	423	416
Forney	Trinity	Indirect Reuse (Lavon)	183	295	312	320	325	326
Forney Lake WSC	Trinity	Lake Texoma	452	373	331	302	285	271
Forney Lake WSC	Trinity	Lake Lavon	609	501	445	407	384	364
Forney Lake WSC	Trinity	Lake Chapman	292	237	207	186	172	161

Kaufman County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Forney Lake WSC	Trinity	Indirect Reuse (Lavon)	210	173	154	140	133	126
Gastonia-Scurry	Trinity	Lake Texoma	171	189	185	195	216	241
Gastonia-Scurry	Trinity	Lake Lavon	231	254	249	261	291	324
Gastonia-Scurry	Trinity	Lake Chapman	110	120	116	120	131	143
Gastonia-Scurry	Trinity	Indirect Reuse (Lavon)	79	88	86	91	100	112
High Point WSC	Trinity	Lake Texoma	78	94	99	106	117	131
High Point WSC	Trinity	Lake Lavon	106	127	133	143	158	177
High Point WSC	Trinity	Lake Terrell	45	40	36	33	31	28
High Point WSC	Trinity	Lake Chapman	51	60	62	65	71	78
High Point WSC	Trinity	Lake Tawakoni	60	53	47	44	42	37
High Point WSC	Trinity	Indirect Reuse (Lavon)	36	44	46	49	54	61
Kaufman	Trinity	Lake Texoma	235	270	272	271	274	301
Kaufman	Trinity	Lake Lavon	315	363	367	364	369	406
Kaufman	Trinity	Lake Chapman	152	172	170	166	165	179
Kaufman	Trinity	Indirect Reuse (Lavon)	109	126	126	126	127	140
Kaufman County-Irrigation	Trinity	Run-of-River - Trinity	64	64	64	64	64	64
Kaufman County-Irrigation	Trinity	TRWD Sources	125	109	92	79	67	57
Kaufman County-Irrigation	Trinity	Nacatoch Aquifer	4	4	4	4	4	4
Kaufman County-Irrigation	Trinity	Direct Reuse	576	758	927	1116	1359	1659
Kaufman County-Livestock	Sabine	Livestock Local Supply	98	98	98	98	98	98
Kaufman County-Livestock	Sabine	Nacatoch Aquifer	10	10	10	10	10	10
Kaufman County-Livestock	Trinity	Livestock Local Supply	1524	1524	1524	1524	1524	1524
Kaufman County-Livestock	Trinity	Nacatoch Aquifer	63	63	63	63	63	63
Kaufman County-Livestock	Trinity	Woodbine Aquifer	121	121	121	121	121	121
Kaufman County-Manufacturing	Trinity	Lake Texoma	102	85	78	73	71	70
Kaufman County-Manufacturing	Trinity	Lake Lavon	137	113	104	99	97	94

Kaufman County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Kaufman County-Manufacturing	Trinity	Lake Terrell	108	101	97	97	97	94
Kaufman County-Manufacturing	Trinity	Lake Chapman	66	54	48	45	43	41
Kaufman County-Manufacturing	Trinity	Lake Tawakoni	143	134	130	130	130	126
Kaufman County-Manufacturing	Trinity	Indirect Reuse (Lavon)	47	39	36	34	33	32
Kaufman County-Mining	Trinity	Other Local Supply	86	86	86	86	86	86
Kaufman County-Other	Sabine	Lake Texoma	68	52	44	39	35	32
Kaufman County-Other	Sabine	Lake Lavon	90	70	59	52	48	43
Kaufman County-Other	Sabine	Lake Chapman	44	33	28	24	21	19
Kaufman County-Other	Sabine	Lake Tawakoni	188	177	169	164	159	154
Kaufman County-Other	Sabine	Other Aquifer	0	0	0	0	0	0
Kaufman County-Other	Sabine	Indirect Reuse (Lavon)	31	24	21	18	16	15
Kaufman County-Other	Trinity	Lake Texoma	154	119	101	89	80	73
Kaufman County-Other	Trinity	Lake Lavon	207	160	136	120	109	99
Kaufman County-Other	Trinity	TRWD sources	234	189	159	135	114	97
Kaufman County-Other	Trinity	Lake Terrell	364	316	283	264	244	222
Kaufman County-Other	Trinity	Lake Chapman	99	75	63	54	48	43
Kaufman County-Other	Trinity	Lake Tawakoni	295	243	208	187	166	141
Kaufman County-Other	Trinity	Nacatoch Aquifer	241	241	241	241	241	241
Kaufman County-Other	Trinity	Indirect Reuse (Lavon)	72	55	47	41	37	34
Kaufman County-Steam Electric Power	Trinity	Direct Reuse	3000	3000	3000	3000	3000	3000
Kemp	Trinity	TRWD Sources	194	155	129	108	90	77
Mabank	Trinity	TRWD Sources	555	541	536	537	536	542
Mac Bee WSC	Sabine	Lake Fork	71	75	80	86	91	95
Mesquite	Trinity	Lake Lavon	0	1	1	1	1	2
Oak Grove	Trinity	Lake Texoma	25	23	23	24	26	28

Kaufman County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Oak Grove	Trinity	Lake Lavon	34	31	31	32	34	38
Oak Grove	Trinity	Lake Chapman	16	15	15	15	16	17
Oak Grove	Trinity	Indirect Reuse (Lavon)	12	11	11	11	12	13
Seagoville	Trinity	Lake Ray Roberts	2	1	2	3	3	5
Seagoville	Trinity	Lake Chapman	0	1	1	1	2	2
Seagoville	Trinity	Trinity Aquifer	1	2	2	3	4	4
Talty	Trinity	Lake Texoma	170	209	246	284	334	389
Talty	Trinity	Lake Lavon	228	280	332	382	449	522
Talty	Trinity	Lake Chapman	110	133	154	175	201	231
Talty	Trinity	Indirect Reuse (Lavon)	79	97	114	132	155	181
Terrell	Trinity	Lake Texoma	0	0	0	0	0	0
Terrell	Trinity	Lake Lavon	0	0	0	0	0	0
Terrell	Trinity	Lake Terrell	1490	1570	1621	1644	1656	1671
Terrell	Trinity	Lake Chapman	0	0	0	0	0	0
Terrell	Trinity	Lake Tawakoni	1981	2086	2155	2186	2201	2222
Terrell	Trinity	Indirect Reuse (Lavon)	0	0	0	0	0	0
West Cedar Creek MUD	Trinity	TRWD Sources	561	648	701	741	777	806

Lamar County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Blossom	Red	Pat Mayse Lake/reservoir	201	216	230	245	245	245
Paris	Red	Pat Mayse Lake/reservoir	10533	10164	9926	9691	9475	9171
Paris	Red	Crook Lake/reservoir	400	400	400	400	400	400
Reno	Red	Pat Mayse Lake/reservoir	102	115	128	138	149	160
County-other	Red	Pat Mayse Lake/reservoir	5	5	6	6	6	6
County-other	Red	Trinity Aquifer	56	59	62	65	64	62
County-other	Red	Woodbine Aquifer	17	17	0	0	0	0

Lamar County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Manufacturing	Red	Pat Mayse Lake/reservoir	805	858	900	941	976	1042
Steam Electric Power	Red	Pat Mayse Lake/reservoir	8961	8961	8961	8961	8961	8961
Mining	Red	Trinity Aquifer	8	8	8	8	8	8
Irrigation	Red	Irrigation Local Supply	3016	3017	3016	3016	3016	3016
Irrigation	Red	Trinity Aquifer	533	533	533	475	475	413
Irrigation	Red	Woodbine Aquifer	2154	2090	2028	2023	1961	1962
Livestock	Red	Trinity Aquifer	264	264	264	235	235	192
Livestock	Red	Woodbine Aquifer	1370	1370	1370	1399	1399	1442
Lamar County Wsd	Red	Pat Mayse Lake/reservoir	1400	1400	1400	1400	1400	1400
Deport	Sulphur	Pat Mayse Lake/reservoir	93	100	106	113	113	113
Paris	Sulphur	Pat Mayse Lake/reservoir	15800	15246	14889	14537	14213	13757
Paris	Sulphur	Crook Lake/reservoir	600	600	600	600	600	600
Roxton	Sulphur	Pat Mayse Lake/reservoir	97	104	111	118	118	118
County-other	Sulphur	Pat Mayse Lake/reservoir	265	269	274	279	277	275
County-other	Sulphur	Trinity Aquifer	46	48	50	53	52	51
Manufacturing	Sulphur	Pat Mayse Lake/reservoir	4775	5091	5340	5580	5787	6183
Mining	Sulphur	Trinity Aquifer	8	7	7	7	7	7
Livestock	Sulphur	Livestock Local Supply	808	808	808	823	823	848
Livestock	Sulphur	Trinity Aquifer	151	151	151	136	136	111
Reno	Sulphur	Pat Mayse Lake/reservoir	455	513	571	616	665	713
Lamar County Wsd	Sulphur	Pat Mayse Lake/reservoir	6861	6822	6784	6751	6728	6704

Montague County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Bowie	Red	Amon Carter	1,303	1,234	1,172	1,112	1,056	997
County-Other	Red	Amon Carter	222	233	236	238	235	236
County-Other	Red	Trinity Aquifer	200	200	200	200	200	200
County-Other	Red	Lake Nocona	52	55	56	56	55	56
County-Other	Red	Other Aquifer	700	700	700	700	700	700
Irrigation	Red	Trinity Aquifer	184	184	184	184	184	184
Irrigation	Red	Other Aquifer	60	60	60	60	60	60
Irrigation	Red	Lake Nocona	100	100	100	100	100	100
Irrigation	Red	Run-of-River	47	47	47	47	47	47
Livestock	Red	Trinity Aquifer	79	79	79	79	79	79
Livestock	Red	Other Aquifer	106	106	106	106	106	106
Livestock	Red	Stock Ponds	1,665	1,665	1,665	1,665	1,665	1,665
Manufacturing	Red	Lake Nocona	11	14	18	23	29	29
Mining	Red	Other Aquifer	248	248	248	248	248	248
Mining	Red	Trinity Aquifer	80	80	80	80	80	80
Mining	Red	Amon Carter	64	61	59	56	54	51
Mining	Red	Run-of-River	0	0	0	0	0	0
Nocona	Red	Lake Nocona	1,097	1,091	1,086	1,081	1,076	1,075
Saint Jo	Red	Trinity Aquifer	211	211	211	211	211	211

Navarro County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Blooming Grove	Trinity	Navarro Mills Reservoir	163	146	133	121	109	98
Brandon-Irene WSC	Trinity	Lake Aquilla	27	28	30	31	33	36
Chatfield WSC	Trinity	Navarro Mills Reservoir	589	809	907	989	1080	1166
Community Water Company	Trinity	Navarro Mills Reservoir	116	156	178	203	230	258
Corsicana	Trinity	Lake Halbert	0	0	0	0	0	0
Corsicana	Trinity	Navarro Mills Reservoir	6373	5986	5709	5463	5222	4986
Dawson	Trinity	Navarro Mills Reservoir	193	184	180	175	172	168

Navarro County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Frost	Trinity	Navarro Mills Reservoir	95	91	88	84	82	80
Frost	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Kerens	Trinity	Navarro Mills Reservoir	436	393	359	328	296	266
Kerens	Trinity	Trinity Run-of-River	252	252	252	252	252	252
M E N WSC	Trinity	Navarro Mills Reservoir	482	469	471	465	447	438
Navarro County-Livestock	Trinity	Livestock Local Supply	1603	1603	1603	1603	1603	1603
Navarro County-Livestock	Trinity	Other Aquifer	104	104	104	104	104	104
Navarro County-Livestock	Trinity	Carrizo-Wilcox Aquifer	15	15	15	15	15	15
Navarro County-Livestock	Trinity	Nacatoch Aquifer	10	10	10	10	10	10
Navarro County-Manufacturing	Trinity	TRWD Sources	617	567	532	500	456	419
Navarro County-Manufacturing	Trinity	Lake Navarro Mills	653	675	692	703	691	673
Navarro County-Manufacturing	Trinity	Lake Halbert	0	0	0	0	0	0
Navarro County-Manufacturing	Trinity	Other Aquifer	0	0	0	0	0	0
Navarro County-Mining	Trinity	Carrizo-Wilcox Aquifer	73	73	73	73	73	73
Navarro County-Mining	Trinity	Nacatoch Aquifer	38	38	38	38	38	38
Navarro County-Other	Trinity	TRWD Sources	134	106	88	74	62	52
Navarro County-Other	Trinity	Lake Navarro Mills	137	122	110	100	90	81
Navarro County-Other	Trinity	Lake Halbert	0	0	0	0	0	0
Navarro County-Other	Trinity	Trinity Aquifer	0	0	0	0	0	0
Navarro County-Other	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Navarro Mills WSC	Trinity	Navarro Mills Reservoir	374	479	541	621	702	789
Rice	Trinity	Lake Bardwell	0	0	0	0	0	0
Rice	Trinity	Navarro Mills Reservoir	250	264	281	298	312	326
Rice WSC	Trinity	Navarro Mills Reservoir	906	1000	1101	1186	1286	1384

Parker County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Aledo	Trinity	Trinity Aquifer	291	291	291	291	291	291
Annetta	Trinity	Trinity Aquifer	139	139	139	139	139	139
Annetta	Trinity	Other Aquifer	0	0	0	0	0	0
Annetta South	Trinity	Trinity Aquifer	76	76	76	76	76	76
Azle	Trinity	TRWD Sources	304	279	249	220	203	199
Fort Worth	Trinity	TRWD Sources	3046	10512	13577	13281	12775	11881
Hudson Oaks	Trinity	Trinity Aquifer	206	206	206	206	206	206
Hudson Oaks	Trinity	TRWD Sources	102	102	102	102	102	102
Mineral Wells	Brazos	Lake Palo Pinto	766	753	744	730	726	726
Mineral Wells	Brazos	Lake Mineral Wells	0	0	0	0	0	0
Parker County-Irrigation	Trinity	Run-of-River - Trinity	122	122	122	122	122	122
Parker County-Irrigation	Trinity	Direct Reuse	11	11	11	11	11	11
Parker County-Irrigation	Brazos	Run-of-River - Brazos	117	117	117	117	117	117
Parker County-Irrigation	Brazos	Trinity Aquifer	88	88	88	88	88	88
Parker County-Irrigation	Brazos	Direct Reuse	202	202	202	202	202	202
Parker County-Livestock	Trinity	Livestock Local Supply	1019	1019	1019	1019	1019	1019
Parker County-Livestock	Trinity	Trinity Aquifer	213	213	213	213	213	213
Parker County-Livestock	Brazos	Livestock Local Supply	903	903	903	903	903	903
Parker County-Livestock	Brazos	Trinity Aquifer	0	0	0	0	0	0
Parker County-Manufacturing	Brazos	TRWD Sources	169	168	171	180	185	191
Parker County-Manufacturing	Brazos	Lake Weatherford	223	188	162	144	126	109
Parker County-Manufacturing	Brazos	Trinity Aquifer	18	18	18	18	18	18
Parker County-Manufacturing	Trinity	Lake Weatherford	45	45	45	45	45	45
Parker County-Manufacturing	Trinity	Other Local Supply	0	0	0	0	0	0
Parker County-Manufacturing	Trinity	Lake Palo Pinto	25	25	25	24	25	25
Parker County-Manufacturing	Trinity	Trinity Aquifer	0	0	0	0	0	0
Parker County-Mining	Trinity	Trinity Aquifer	59	59	59	59	59	59
Parker County-Mining	Trinity	Other Local Supply	4	4	5	5	6	6
Parker County-Mining	Brazos	Other Local Supply	16	16	15	15	14	14
Parker County-Mining	Brazos	Brazos River Authority	2000	2000	2000	2000	2000	2000

Parker County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Parker County-Other	Trinity	TRWD Sources	173	125	102	88	76	67
Parker County-Other	Trinity	Lake Weatherford	15	12	11	9	8	8
Parker County-Other	Trinity	Trinity Aquifer	2848	2722	2722	2722	2722	2722
Parker County-Other	Brazos	Lake Palo Pinto	479	479	479	479	479	479
Parker County-Other	Brazos	Trinity Aquifer	1967	2093	2093	2093	2093	2093
Parker County-Other	Brazos	Other Aquifer	33	33	33	33	33	33
Parker County-Steam Electric Power	Trinity	Lake Weatherford	30	24	28	32	38	46
Reno	Trinity	TRWD Sources	164	129	109	93	83	75
Reno	Trinity	Trinity Aquifer	167	167	167	167	167	167
Springtown	Trinity	Trinity Aquifer	236	236	236	236	236	236
Springtown	Trinity	TRWD Sources	288	369	422	460	472	473
Walnut Creek SUD	Trinity	TRWD Sources	1743	1595	1516	1463	1439	1407
Weatherford	Trinity	TRWD sources	1486	1629	1769	1903	2042	2184
Weatherford	Trinity	Lake Weatherford	2289	2196	2080	1955	1830	1700
Weatherford	Trinity	Trinity Aquifer	50	50	50	50	50	50
Weatherford	Brazos	TRWD sources	70	77	88	97	107	117
Weatherford	Brazos	Lake Weatherford	110	105	104	101	97	92
Willow Park	Trinity	Trinity Aquifer	642	642	642	642	642	642

Red River County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
County-other	Red	Pat Mayse Lake/reservoir	118	118	118	118	118	118
County-other	Red	Wright Patman Lake/reservoir	72	72	72	72	72	72
County-other	Red	Trinity Aquifer	23	23	23	23	23	23
Irrigation	Red	Irrigation Local Supply	2024	2003	1982	1961	1941	1921
Livestock	Red	Livestock Local Supply	396	396	396	396	396	396
Livestock	Red	Blossom Aquifer	94	94	94	94	94	94
Livestock	Red	Woodbine Aquifer	170	170	170	170	170	170
Red River County Wsc	Red	Pat Mayse Lake/reservoir	184	184	184	184	184	184
Red River County Wsc	Red	Wright Patman Lake/reservoir	22	21	21	21	21	21

Red River County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Red River County WSC	Red	Blossom Aquifer	30	30	30	30	30	30
Bogata	Sulphur	Nacatoch Aquifer	358	358	358	358	358	358
Clarksville	Sulphur	Langford Lake/reservoir	377	377	377	377	377	377
Clarksville	Sulphur	Blossom Aquifer	360	360	360	360	360	360
Detroit	Sulphur	Pat Mayse Lake/reservoir	41	41	41	41	41	41
Detroit	Sulphur	Trinity Aquifer	59	59	59	59	59	59
County-other	Sulphur	Pat Mayse Lake/reservoir	138	135	132	129	129	129
County-other	Sulphur	Wright Patman Lake/reservoir	112	112	112	112	112	112
County-other	Sulphur	Nacatoch Aquifer	45	44	43	42	42	42
County-other	Sulphur	Nacatoch Aquifer	12	12	12	12	12	12
Manufacturing	Sulphur	Langford Lake/reservoir	6	7	7	7	7	8
Steam Electric Power	Sulphur	Sulphur River Combined Run-of-river	534	425	497	585	692	823
Steam Electric Power	Sulphur	River Crest Lake/reservoir	80	64	75	88	104	123
Irrigation	Sulphur	Irrigation Local Supply	1689	1672	1655	1638	1621	1603
Livestock	Sulphur	Livestock Local Supply	911	911	911	911	911	911
Livestock	Sulphur	Nacatoch Aquifer	38	38	38	38	38	38
Deport	Sulphur	Pat Mayse Lake/reservoir	7	7	7	7	7	7
Red River County WSC	Sulphur	Pat Mayse Lake/reservoir	0	0	0	0	0	0
Red River County WSC	Sulphur	Wright Patman Lake/reservoir	41	41	41	41	41	41
Red River County WSC	Sulphur	Blossom Aquifer	223	223	223	223	223	223
Red River County WSC	Sulphur	Nacatoch Aquifer	204	204	204	204	204	204

Rockwall County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Blackland WSC	Sabine	Lake Texoma	68	77	79	83	90	98
Blackland WSC	Sabine	Lake Lavon	88	97	100	102	108	110
Blackland WSC	Sabine	Lake Chapman	44	49	49	51	55	58

Rockwall County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Blackland WSC	Sabine	Indirect Reuse (Lavon)	32	36	37	39	42	46
Blackland WSC	Trinity	Lake Texoma	29	33	34	35	39	42
Blackland WSC	Trinity	Lake Lavon	39	44	45	48	52	56
Blackland WSC	Trinity	Lake Chapman	19	21	21	22	23	25
Blackland WSC	Trinity	Indirect Reuse (Lavon)	13	15	16	16	18	20
Cash WSC	Sabine	Lake Texoma	10	8	7	19	21	23
Cash WSC	Sabine	Lake Lavon	13	11	9	26	28	30
Cash WSC	Sabine	Lake Chapman	6	5	4	12	13	14
Cash WSC	Sabine	Lake Tawakoni	42	58	62	40	33	26
Cash WSC	Sabine	Indirect Reuse (Lavon)	4	4	3	9	10	11
Dallas	Trinity	Lake Ray Roberts	1	1	1	1	1	1
Dallas	Trinity	Lake Ray Hubbard	4	4	4	4	4	4
Dallas	Trinity	Lake Tawakoni	1	1	1	1	1	1
East Fork SUD	Trinity	Lake Texoma	2	1	1	1	1	1
East Fork SUD	Trinity	Lake Lavon	2	1	1	1	1	2
East Fork SUD	Trinity	Lake Chapman	1	1	1	1	1	0
East Fork SUD	Trinity	Indirect Reuse (Lavon)	1	1	1	0	0	0
Forney Lake WSC	Trinity	Lake Texoma	355	373	331	302	285	271
Forney Lake WSC	Trinity	Lake Lavon	477	501	445	407	384	364
Forney Lake WSC	Trinity	Lake Chapman	229	237	207	186	172	161
Forney Lake WSC	Trinity	Indirect Reuse (Lavon)	165	173	154	140	133	126
Heath	Trinity	Lake Texoma	357	404	432	464	512	563
Heath	Trinity	Lake Lavon	479	542	583	624	690	757
Heath	Trinity	Lake Chapman	231	257	270	285	309	334
Heath	Trinity	Indirect Reuse (Lavon)	166	188	201	216	238	262
High Point WSC	Trinity	Lake Texoma	8	10	11	12	13	15
High Point WSC	Trinity	Lake Lavon	10	13	14	16	18	19
High Point WSC	Trinity	Lake Terrell	5	4	3	4	4	3
High Point WSC	Trinity	Lake Chapman	5	6	7	7	8	9
High Point WSC	Trinity	Lake Tawakoni	6	5	6	5	4	5
High Point WSC	Trinity	Indirect Reuse (Lavon)	3	5	5	5	6	7

Rockwall County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Lavon WSC	Trinity	Lake Texoma	68	92	102	112	126	141
Lavon WSC	Trinity	Lake Lavon	91	124	138	151	170	189
Lavon WSC	Trinity	Lake Chapman	44	58	64	69	76	84
Lavon WSC	Trinity	Indirect Reuse (Lavon)	31	43	47	52	59	66
McLendon-Chisholm	Trinity	Lake Texoma	39	39	39	41	43	46
McLendon-Chisholm	Trinity	Lake Lavon	54	52	53	54	58	62
McLendon-Chisholm	Trinity	Lake Chapman	25	25	25	25	26	28
McLendon-Chisholm	Trinity	Indirect Reuse (Lavon)	18	18	18	19	20	22
Mt Zion WSC	Trinity	Lake Texoma	90	101	96	93	92	86
Mt Zion WSC	Trinity	Lake Lavon	120	136	128	124	124	116
Mt Zion WSC	Trinity	Lake Chapman	58	64	60	57	55	51
Mt Zion WSC	Trinity	Indirect Reuse (Lavon)	42	47	45	43	43	40
R-C-H WSC	Trinity	Lake Texoma	83	69	63	59	58	58
R-C-H WSC	Trinity	Lake Lavon	112	94	85	80	78	79
R-C-H WSC	Trinity	Lake Chapman	54	44	40	36	35	34
R-C-H WSC	Trinity	Indirect Reuse (Lavon)	39	32	29	28	27	27
Rockwall	Trinity	Lake Texoma	1710	2358	2591	2572	2407	2196
Rockwall	Trinity	Lake Lavon	2300	3173	3486	3461	3237	2955
Rockwall	Trinity	Lake Chapman	1105	1499	1620	1581	1453	1303
Rockwall	Trinity	Indirect Reuse (Lavon)	795	1096	1204	1195	1119	1021
Rockwall County-Irrigation	Trinity	Direct Reuse	784	784	784	784	784	784
Rockwall County-Livestock	Sabine	Livestock Local Supply	32	32	32	32	32	32
Rockwall County-Livestock	Sabine	Other Aquifer	0	0	0	0	0	0
Rockwall County-Livestock	Trinity	Livestock Local Supply	136	136	136	136	136	136
Rockwall County-Livestock	Trinity	Other Aquifer	21	21	21	21	21	21
Rockwall County-Manufacturing	Trinity	Lake Lavon	3	4	3	3	3	3
Rockwall County-Manufacturing	Trinity	Lake Chapman	2	1	1	1	1	1
Rockwall County-Manufacturing	Trinity	Indirect Reuse (Lavon)	1	1	1	1	1	1

Rockwall County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Rockwall County-Manufacturing	Sabine	Lake Texoma	4	3	3	3	3	3
Rockwall County-Manufacturing	Sabine	Lake Lavon	2	2	2	2	2	2
Rockwall County-Manufacturing	Sabine	Lake Chapman	1	1	1	1	1	1
Rockwall County-Manufacturing	Sabine	Indirect Reuse (Lavon)	1	1	1	1	1	1
Rockwall County-Mining	Sabine	Other Local Supply	33	33	33	33	33	33
Rockwall County-Other	Sabine	Lake Texoma	38	29	25	22	20	18
Rockwall County-Other	Sabine	Lake Lavon	51	39	33	30	28	25
Rockwall County-Other	Sabine	Lake Chapman	24	19	16	14	12	11
Rockwall County-Other	Sabine	Other Aquifer	187	187	187	187	187	187
Rockwall County-Other	Sabine	Indirect Reuse (Lavon)	17	14	12	10	9	9
Rockwall County-Other	Trinity	Lake Texoma	21	16	14	12	11	10
Rockwall County-Other	Trinity	Lake Lavon	28	22	18	16	15	14
Rockwall County-Other	Trinity	Lake Chapman	14	10	9	8	7	6
Rockwall County-Other	Trinity	Direct Reuse	0	0	0	0	0	0
Rockwall County-Other	Trinity	Indirect Reuse (Lavon)	10	8	7	6	5	5
Rowlett	Trinity	Lake Texoma	320	262	223	196	178	162
Rowlett	Trinity	Lake Lavon	429	351	299	264	239	219
Rowlett	Trinity	Lake Chapman	207	166	139	120	107	96
Rowlett	Trinity	Indirect Reuse (Lavon)	149	122	103	91	83	75
Royse City	Sabine	Lake Texoma	491	689	579	631	677	628
Royse City	Sabine	Lake Lavon	662	926	779	848	911	845
Royse City	Sabine	Lake Chapman	318	438	362	388	409	373
Royse City	Sabine	Indirect Reuse (Lavon)	228	320	269	293	315	292
Wylie	Trinity	Lake Texoma	27	35	40	44	49	48
Wylie	Trinity	Lake Lavon	36	48	53	58	66	64
Wylie	Trinity	Lake Chapman	17	23	25	27	30	28
Wylie	Trinity	Indirect Reuse (Lavon)	13	16	18	20	23	22

Tarrant County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Arlington	Trinity	TRWD Sources	76445	72096	65012	57061	49111	42177
Arlington	Trinity	Lake Arlington	8333	8267	8200	8133	8067	8000
Azle	Trinity	TRWD Sources	1376	1401	1431	1460	1477	1481
Bedford	Trinity	TRWD Sources	10200	8738	7569	6592	5695	4941
Bedford	Trinity	Trinity Aquifer	425	425	425	425	425	425
Benbrook	Trinity	TRWD Sources	4235	4128	4265	4466	4591	4705
Benbrook	Trinity	Trinity Aquifer	950	950	950	950	950	950
Bethesda WSC	Trinity	TRWD Sources	1606	1582	1587	1592	1578	1583
Bethesda WSC	Trinity	Trinity Aquifer	35	35	35	35	35	35
Blue Mound	Trinity	TRWD Sources	122	102	82	65	54	46
Blue Mound	Trinity	Trinity Aquifer	183	183	183	183	183	183
Burleson	Trinity	TRWD Sources	858	862	880	887	889	898
Colleyville	Trinity	TRWD Sources	8015	7757	6791	5904	5013	4268
Colleyville	Trinity	Trinity Aquifer	574	574	574	574	574	574
Community WSC	Trinity	TRWD Sources	458	367	307	258	220	191
Crowley	Trinity	TRWD Sources	1297	1274	1382	1619	1663	1541
Crowley	Trinity	Trinity Aquifer	153	153	153	153	153	153
Dalworthington Gardens	Trinity	TRWD Sources	625	547	486	427	368	317
Dalworthington Gardens	Trinity	Trinity Aquifer	189	189	189	189	189	189
Edgecliff	Trinity	TRWD Sources	494	393	327	276	230	195
Euless	Trinity	TRWD Sources	8743	8569	7559	6588	5617	4802
Euless	Trinity	Trinity Aquifer	931	931	931	931	931	931
Everman	Trinity	TRWD Sources	425	390	365	340	320	277
Everman	Trinity	Trinity Aquifer	412	412	412	412	412	412
Forest Hill	Trinity	TRWD Sources	1915	1650	1476	1347	1229	1095
Fort Worth	Trinity	TRWD Sources	155849	140347	138184	143469	152464	163088
Grand Prairie	Trinity	Lake Ray Roberts	1269	1453	1567	1581	1472	1322
Grand Prairie	Trinity	TRWD Sources	1203	976	828	711	602	511
Grand Prairie	Trinity	Lake Ray Hubbard	473	549	599	613	578	526
Grand Prairie	Trinity	Lake Tawakoni	1170	1347	1461	1482	1387	1253
Grand Prairie	Trinity	Trinity Aquifer	341	347	331	302	270	241
Grand Prairie	Trinity	Trinity Aquifer	0	0	0	0	0	0
Grapevine	Trinity	Lake Ray Roberts	1470	1315	1203	1100	967	832
Grapevine	Trinity	TRWD Sources	6894	6894	6894	6894	6667	5872

Tarrant County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Grapevine	Trinity	Lake Grapevine	1833	1767	1700	1633	1567	1500
Grapevine	Trinity	Indirect Reuse	1824	2033	2180	2278	2352	2412
Haltom City	Trinity	TRWD Sources	7663	6831	6018	5226	4448	3801
Haslet	Trinity	Trinity Aquifer	153	153	153	153	153	153
Haslet	Trinity	TRWD Sources	278	574	930	794	673	571
Hurst	Trinity	TRWD Sources	6920	5901	5124	4437	3804	3272
Hurst	Trinity	Trinity Aquifer	1081	1081	1081	1081	1081	1081
Johnson County Rural WSC	Trinity	Trinity Aquifer	1	0	0	0	1	1
Johnson County Rural WSC	Trinity	Brazos River Authority	210	210	210	210	210	210
Keller	Trinity	TRWD Sources	9838	9441	7964	6772	5736	4870
Keller	Trinity	Trinity Aquifer	0	0	0	0	0	0
Kennedale	Trinity	Trinity Aquifer	805	805	805	805	805	805
Lake Worth	Trinity	Trinity Aquifer	345	345	345	345	345	345
Lake Worth	Trinity	TRWD Sources	628	580	560	536	508	456
Lakeside	Trinity	Trinity Aquifer	267	267	267	267	267	267
Mansfield	Trinity	TRWD Sources	10860	10856	10829	10788	10710	10566
North Richland Hills	Trinity	TRWD Sources	10472	10064	9717	9360	8430	7309
North Richland Hills	Trinity	Trinity Aquifer	14	14	14	14	14	14
Pantego	Trinity	Trinity Aquifer	469	469	469	469	469	469
Pelican Bay	Trinity	Trinity Aquifer	80	80	80	80	80	80
Richland Hills	Trinity	TRWD Sources	1261	1071	952	862	755	652
Richland Hills	Trinity	Trinity Aquifer	153	153	153	153	153	153
River Oaks	Trinity	TRWD Sources	1085	860	705	591	496	421
Saginaw	Trinity	TRWD Sources	3099	3086	2914	2692	2392	2109
Sansom Park Village	Trinity	Trinity Aquifer	422	422	422	422	422	422
Sansom Park Village	Trinity	TRWD Sources	194	163	138	116	100	88
Southlake	Trinity	TRWD Sources	12356	12009	11025	9825	8491	7284
Tarrant County-Irrigation	Trinity	Run-of-river - Trinity	549	549	549	549	549	549
Tarrant County-Irrigation	Trinity	TRWD Sources	2187	2187	2187	1941	1644	1396
Tarrant County-Irrigation	Trinity	Trinity Aquifer	15	15	15	15	15	15
Tarrant County-Irrigation	Trinity	Direct Reuse	1708	1986	2381	2827	3300	3715

Tarrant County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Tarrant County-Irrigation	Trinity	Indirect Reuse	1493	1663	1784	1864	1924	1974
Tarrant County-Livestock	Trinity	Livestock Local Supply	442	442	442	442	442	442
Tarrant County-Livestock	Trinity	Trinity Aquifer	361	361	361	361	361	361
Tarrant County-Manufacturing	Trinity	Lake Arlington	0	0	0	0	0	0
Tarrant County-Manufacturing	Trinity	TRWD Sources	18536	17824	17465	17093	16087	14819
Tarrant County-Manufacturing	Trinity	Trinity Aquifer	0	0	0	0	0	0
Tarrant County-Manufacturing	Trinity	Indirect Reuse	0	0	0	0	0	0
Tarrant County-Mining	Trinity	Other Local Supply	342	342	342	342	342	342
Tarrant County-Mining	Trinity	TRWD Sources	0	0	0	0	0	0
Tarrant County-Other	Trinity	TRWD Sources	3740	2966	2475	2075	1743	1480
Tarrant County-Other	Trinity	Other Aquifer	0	0	0	0	0	0
Tarrant County-Other	Trinity	Trinity Aquifer	354	354	354	354	354	354
Tarrant County-Other	Trinity	Woodbine Aquifer	0	0	0	0	0	0
Tarrant County-Other	Trinity	Direct Reuse	0	0	0	0	0	0
Tarrant County-Steam Electric Power	Trinity	Lake Arlington	0	0	0	0	0	0
Tarrant County-Steam Electric Power	Trinity	TRWD Sources	4213	2818	2919	3063	3167	3282
Tarrant County-Steam Electric Power	Trinity	Trinity Aquifer	0	0	0	0	0	0
Tarrant County-Steam Electric Power	Trinity	Run-of-river - Trinity	235	187	219	257	304	362
Watauga	Trinity	TRWD Sources	3691	3079	2649	2287	1966	1700
Westover Hills	Trinity	TRWD Sources	296	239	201	171	144	122
Westworth Village	Trinity	TRWD Sources	262	250	220	196	176	165
White Settlement	Trinity	TRWD Sources	1828	1585	1470	1271	1184	1107
White Settlement	Trinity	Trinity Aquifer	829	829	829	829	829	829

Wise County

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Alvord	Trinity	Trinity Aquifer	114	114	114	114	114	114
Aurora	Trinity	TRWD Sources	33	37	40	44	47	51
Aurora	Trinity	Trinity Aquifer	98	98	98	98	98	98
Bolivar WSC	Trinity	Trinity Aquifer	141	141	141	141	141	141
Boyd	Trinity	TRWD Sources	56	80	75	62	53	46
Boyd	Trinity	Trinity Aquifer	150	150	150	150	150	150
Bridgeport	Trinity	TRWD Sources	1686	1656	1700	1700	1700	1700
Chico	Trinity	TRWD Sources	96	101	111	111	111	111
Chico	Trinity	Trinity Aquifer	119	119	119	119	119	119
Community WSC	Trinity	TRWD Sources	19	15	13	10	9	7
Decatur	Trinity	TRWD Sources	1754	1753	1754	1754	1754	1754
Fort Worth	Trinity	TRWD Sources	508	2022	2376	2599	2920	3099
New Fairview	Trinity	TRWD Sources	0	0	0	0	0	0
New Fairview	Trinity	Trinity Aquifer	103	103	103	103	103	103
Newark	Trinity	Trinity Aquifer	92	92	92	92	92	92
Newark	Trinity	TRWD Sources	0	0	0	0	0	0
Rhome	Trinity	Trinity Aquifer	125	125	125	125	125	125
Rhome	Trinity	TRWD Sources	389	619	748	837	882	930
Runaway Bay	Trinity	TRWD Sources	345	340	336	331	320	313
Walnut Creek SUD	Trinity	TRWD Sources	213	194	190	190	194	197
West Wise Rural WSC	Trinity	TRWD Sources	521	435	383	343	306	277
Wise County-Irrigation	Trinity	Run-of-river - Trinity	139	139	139	139	139	139
Wise County-Irrigation	Trinity	TRWD Sources	124	108	92	79	67	57
Wise County-Irrigation	Trinity	Trinity Aquifer	251	251	251	251	251	251
Wise County-Livestock	Trinity	Livestock Local Supply	1117	1117	1117	1117	1117	1117
Wise County-Livestock	Trinity	Trinity Aquifer	807	807	807	807	807	807
Wise County-Manufacturing	Trinity	Other Local Supply	0	0	0	0	0	0
Wise County-Manufacturing	Trinity	TRWD Sources	2469	2307	2191	2072	1895	1755
Wise County-Manufacturing	Trinity	Other Aquifer	14	14	14	14	14	14
Wise County-Mining	Trinity	Other Local Supply	0	0	0	0	0	0

Wise County (Cont.)

WUG	Basin	Source	2010	2020	2030	2040	2050	2060
Wise County-Mining	Trinity	TRWD Sources	2896	2525	2140	1839	1557	1322
Wise County-Mining	Trinity	Trinity Aquifer	239	239	239	239	239	239
Wise County-Mining	Trinity	Run-of-river - Trinity	51	51	51	51	51	51
Wise County-Mining	Trinity	Direct Reuse	15930	14074	12152	10643	9236	8061
Wise County-Other	Trinity	TRWD Sources	1024	926	772	647	541	458
Wise County-Other	Trinity	Trinity Aquifer	2161	2161	2161	2161	2161	2161
Wise County-Steam Electric Power	Trinity	TRWD sources	4600	4010	3400	2920	2473	2100

Sources: Brazos G – Brazos G Regional Water Planning Group et al., 2006

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Appendix 3. Total Water Demand Projections in the Study Area

County Name	Demand Category	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Collin								
	Irrigation	2,995	2,995	2,995	2,995	2,995	2,995	2,995
	Livestock	884	884	884	884	884	884	884
	Manufacturing	2,728	3,607	4,137	4,654	5,170	5,633	6,115
	Mining	195	341	341	341	341	341	341
	Municipal	129,603	202,093	277,630	329,895	391,260	449,184	513,544
	Steam Electric	1,901	1,581	1,260	1,473	1,733	2,050	2,436
Cooke								
	Irrigation	0	444	444	444	444	444	444
	Livestock	1,762	1,898	1,898	1,898	1,898	1,898	1,898
	Manufacturing	221	273	306	335	364	389	421
	Mining	289	321	334	341	348	355	361
	Municipal	4,998	6,918	7,662	8,450	9,029	10,033	10,969
	Steam Electric	0	0	0	0	0	0	0
Dallas								
	Irrigation	13,087	13,087	13,087	13,087	13,087	13,087	13,087
	Livestock	482	482	482	482	482	482	482
	Manufacturing	28,159	34,115	37,791	41,148	44,214	46,703	46,983
	Mining	2,910	2,910	2,910	2,910	2,910	2,910	2,910
	Municipal	565,148	652,094	720,676	763,392	805,183	873,943	974,790
	Steam Electric	13,749	12,264	10,842	11,918	13,230	14,829	16,778
Delta								
	Irrigation	585	578	572	566	559	553	547
	Livestock	344	344	344	344	344	344	344
	Manufacturing	0	0	0	0	0	0	0
	Mining	0	0	0	0	0	0	0
	Municipal	815	853	906	961	1,022	1,019	1,019
	Steam Electric	0	0	0	0	0	0	0

County Name	Demand Category	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Denton								
	Irrigation	2,108	2,108	2,108	2,108	2,108	2,108	2,108
	Livestock	1,235	1,235	1,235	1,235	1,235	1,235	1,235
	Manufacturing	807	1,068	1,239	1,408	1,579	1,731	1,880
	Mining	139	341	341	341	341	341	341
	Municipal	89,062	156,727	206,870	258,013	302,113	347,705	400,328
	Steam Electric	631	524	418	489	575	680	808
Ellis								
	Irrigation	583	583	583	583	583	583	583
	Livestock	1,183	1,183	1,183	1,183	1,183	1,183	1,183
	Manufacturing	3,049	3,466	3,670	3,841	3,987	4,089	3,912
	Mining	90	90	90	90	90	90	90
	Municipal	19,820	27,008	33,645	41,126	49,430	59,502	71,808
	Steam Electric	744	14,237	20,379	23,825	28,027	33,148	39,391
Fannin								
	Irrigation	4,608	4,608	4,608	4,608	4,608	4,608	4,608
	Livestock	1,270	1,270	1,270	1,270	1,270	1,270	1,270
	Manufacturing	58	73	82	90	98	105	114
	Mining	12	12	12	12	12	12	12
	Municipal	5,349	6,487	7,125	8,451	10,471	13,145	15,665
	Steam Electric	5,638	5,152	4,748	5,184	5,717	6,366	7,157
Grayson								
	Irrigation	3,382	3,561	3,751	3,950	4,158	4,381	4,616
	Livestock	1,297	1,297	1,297	1,297	1,297	1,297	1,297
	Manufacturing	5,685	7,010	7,781	8,453	9,088	9,621	10,444
	Mining	1,058	1,052	1,050	1,049	1,048	1,047	1,046
	Municipal	21,056	25,736	32,075	36,471	40,022	44,259	49,312
	Steam Electric	0	0	0	0	0	0	0

County Name	**Demand Category**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**	**D2060**
Hood								
	Irrigation	3,240	3,179	3,120	3,062	3,005	2,948	2,893
	Livestock	623	623	623	623	623	623	623
	Manufacturing	20	25	28	30	32	34	37
	Mining	167	162	161	160	159	158	157
	Municipal	7,794	9,135	10,666	12,077	13,616	15,557	17,897
	Steam Electric	2,573	6,594	8,098	9,467	11,137	13,172	15,653
Hunt								
	Irrigation	1,938	1,938	1,938	1,938	1,938	1,938	1,938
	Livestock	1,121	1,121	1,121	1,121	1,121	1,121	1,121
	Manufacturing	762	1,009	1,232	1,463	1,713	1,951	2,115
	Mining	67	57	55	54	53	52	51
	Municipal	12,922	13,693	15,182	17,282	20,795	28,913	41,683
	Steam Electric	0	8,639	12,366	14,457	17,006	20,114	23,902
Johnson								
	Irrigation	164	240	240	240	240	240	240
	Livestock	2,117	2,117	2,117	2,117	2,117	2,117	2,117
	Manufacturing	1,533	2,121	2,517	2,903	3,295	3,646	3,994
	Mining	324	370	390	403	415	427	436
	Municipal	21,507	26,359	31,014	36,048	41,845	49,292	58,055
	Steam Electric	0	1,200	1,200	1,200	1,200	1,200	1,200
Kaufman								
	Irrigation	2,916	2,916	2,916	2,916	2,916	2,916	2,916
	Livestock	1,545	1,545	1,545	1,545	1,545	1,545	1,545
	Manufacturing	711	760	813	869	928	993	1,061
	Mining	75	79	80	81	82	83	84
	Municipal	10,276	17,657	24,154	28,667	32,828	37,592	43,715
	Steam Electric	0	8,979	17,798	20,808	24,478	28,950	34,403

County Name	**Demand Category**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**	**D2060**
Lamar								
	Irrigation	5,768	5,703	5,640	5,577	5,514	5,452	5,391
	Livestock	2,593	2,593	2,593	2,593	2,593	2,593	2,593
	Manufacturing	4,804	5,580	5,949	6,240	6,521	6,763	7,225
	Mining	22	16	15	15	15	15	15
	Municipal	8,896	9,444	10,022	10,578	11,122	11,084	11,084
	Steam Electric	1,783	5,940	8,503	9,941	11,694	13,831	16,435
Montague								
	Irrigation	60	297	297	297	297	297	297
	Livestock	1,501	1,850	1,850	1,850	1,850	1,850	1,850
	Manufacturing	6	9	12	15	19	24	24
	Mining	627	505	481	473	477	490	490
	Municipal	2,517	3,126	3,141	3,124	3,113	3,078	3,088
	Steam Electric	0	0	0	0	0	0	0
Navarro								
	Irrigation	0	0	0	0	0	0	0
	Livestock	1,543	1,543	1,543	1,543	1,543	1,543	1,543
	Manufacturing	949	1,172	1,328	1,468	1,607	1,730	1,872
	Mining	89	89	89	89	89	89	89
	Municipal	8,426	9,399	10,282	11,049	11,866	12,984	14,444
	Steam Electric	0	0	0	0	0	0	0
Parker								
	Irrigation	422	422	422	422	422	422	422
	Livestock	1,856	1,856	1,856	1,856	1,856	1,856	1,856
	Manufacturing	607	779	879	974	1,068	1,150	1,248
	Mining	75	98	112	122	132	142	150
	Municipal	12,621	18,498	30,052	38,735	43,242	47,970	52,470
	Steam Electric	36	30	4,617	5,397	6,349	7,509	8,923

County Name	Demand Category	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Red River								
	Irrigation	3,751	3,713	3,675	3,637	3,599	3,562	3,524
	Livestock	1,609	1,609	1,609	1,609	1,609	1,609	1,609
	Manufacturing	5	6	7	7	7	7	8
	Mining	0	0	0	0	0	0	0
	Municipal	2,135	2,100	2,075	2,051	2,028	2,019	2,019
	Steam Electric	738	614	489	572	673	796	946
Rockwall								
	Irrigation	1,125	1,125	1,125	1,125	1,125	1,125	1,125
	Livestock	131	131	131	131	131	131	131
	Manufacturing	15	20	23	26	29	32	35
	Mining	33	33	33	33	33	33	33
	Municipal	9,046	18,446	29,349	34,721	39,397	42,521	44,415
	Steam Electric	0	0	0	0	0	0	0
Tarrant								
	Irrigation	8,417	8,417	8,417	8,417	8,417	8,417	8,417
	Livestock	803	803	803	803	803	803	803
	Manufacturing	13,407	17,258	20,444	23,630	26,924	29,919	32,457
	Mining	342	433	484	519	554	589	616
	Municipal	303,194	368,645	417,969	464,453	517,871	587,070	668,255
	Steam Electric	4,903	4,158	3,419	4,168	5,081	6,194	7,550
Wise								
	Irrigation	502	502	502	502	502	502	502
	Livestock	1,714	1,714	1,714	1,714	1,714	1,714	1,714
	Manufacturing	1,793	2,313	2,660	2,979	3,277	3,539	3,858
	Mining	17,441	23,627	27,824	30,530	33,303	36,168	38,866
	Municipal	6,617	10,456	14,544	17,868	20,955	24,915	29,288
	Steam Electric	0	3,949	5,653	6,609	7,774	9,195	10,927

Study Area Total

	Demand Category	2000	2010	2020	2030	2040	2050	2060
	Irrigation	55,651	56,416	56,440	56,474	56,517	56,578	56,653
	Livestock	25,613	26,098	26,098	26,098	26,098	26,098	26,098
	Manufacturing	65,319	80,664	90,898	100,533	109,920	118,059	123,803
	Mining	23,955	30,536	34,802	37,563	40,402	43,342	46,088
	Municipal	1,241,802	1,584,874	1,885,039	2,123,412	2,367,208	2,661,785	3,023,848
	Steam Electric	32,696	73,861	99,790	115,508	134,674	158,034	186,509
Study Area Total		**1,445,036**	**1,852,449**	**2,193,067**	**2,459,588**	**2,734,819**	**3,063,896**	**3,462,999**

All water demand projections are in acre-feet.
Sources: Biggs and Mathews, Inc. et al., 2006; Brazos G Regional Water Planning Group et al., 2006; Burcher Willis and Ratliff Corp. et al., 2006; and, Freese and Nichols, Inc., et al., 2006.

Appendix 4. 1990 Critical Area Report Summary for Texas Water Commission

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GROUND-WATER PROTECTION AND MANAGEMENT STRATEGIES
FOR NORTH-CENTRAL TEXAS
(A Critical Area Ground-Water Study)
Chapter 52, Subchapter C, Texas Water Code

TECHNICAL SUMMARY

A potential critical area in the north-central Texas, consisting of all or part of Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Hunt, Jack, Johnson, Kaufman, Montague, Navarro, Parker, Rockwall, Tarrant, and Wise Counties, was identified and nominated for detailed study by the Texas Water Commission and the Texas Water Development Board in a joint press release dated January 13, 1987. A study of the area was requested by the Executive Director in a letter to the Executive Administrator of the Water Development Board dated September 1, 1989. A draft of Report 318 entitled <u>Evaluation of Water Resources in Part of North-Central Texas</u>, currently in press, contains the results of the study conducted by the Board and was received from the Executive Administrator in November, 1989. A Critical Area Report has been prepared by the Commission staff recommending that the area not be designated as a Critical Area at this time. Information supporting this recommendation is contained within the Commission report which describes hydrogeologic conditions within the area and contains a discussion of issues affecting ground and surface water.

A public meeting was held in Arlington, Texas on September 9, 1986, to solicit comments regarding critical area designation for the study area. Interviews of members of local government, industry, and concerned citizens were conducted in March and April of 1989. A ten-member advisory committee, composed of representatives from throughout the study area, was formed on July 10, 1989, to assist TWC staff in assessing local ground-water conditions and to provide input and comments on both ground- and surface-water issues on a local level. The advisory committee had significant influence on the recommendations in the TWC report and, as reflected throughout the report, members of the committee felt strongly about the issues of "critical" designation, surface water conversion, and ad valorem taxation for district funding. The advisory committee concurs with the conclusions and recommendations contained in the Critical Area Report.

In the North-Central Texas study area, more ground water is being withdrawn than recharged to the aquifers. Pumpage has historically exceeded recharge, resulting in declining water levels and possibly deteriorating chemical quality in the Antlers, Twin Mountains, and Paluxy Formations of the Trinity Group and the Woodbine Group aquifers. In 1984, it was recognized by the Texas Department of Water Resources that overdrafts are occurring in the Trinity Group aquifer in Cooke, Dallas, Denton, Grayson, Hood, Johnson, and Tarrant Counties. The effective recharge to the Trinity Group aquifer is less than 50,000 acre-feet per year and from the Woodbine Group aquifer is 24,000 acre-feet per year. However, in 1985, approximately 106,000 acre-feet of ground water was pumped from the Trinity and Woodbine Group aquifers in the study area, resulting in a net loss of approximately 32,000 acre-feet of water from both aquifers in 1985. Water-level declines and associated reduction in artesian pressure caused by the continued deficit-removal of water from storage are a regional ground-water problem.

Current and projected water demand for the area is based on three factors, increased population growth, water use, and current availability of both ground and surface water. The Texas Water Development Board projects the population to grow thirty-six percent between 1990 and 2010. The annual water requirement for the study area is expected to increase by approximately forty-seven percent from 1985 to 2010. A total of 976,752 acre-feet of water was used for public supply, irrigation, industrial, domestic, and livestock purposes in the area with ground water supplying approximately 10.8 percent of the total and surface water supplying 870,814 acre-feet, the remainder.

Present and future supplies of ground water may pose a serious problem for the study area. However, the area is not facing a "critical" water supply problem due to the vast reserves of surface water. Surface water supplies are adequate to meet current and projected needs beyond 2010. Many large-volume ground-water users, concentrated in the Dallas-Fort Worth area, have converted to surface-water sources in recent years. However, the reduction of pumpage by the large volume users has been offset by continued sharp increases by numerous small municipal users, utility districts, and water-supply corporations outside of the Dallas-Fort Worth area. While an underground water conservation district has broad powers to regulate activities that endanger the aquifers either from overpumpage or pollution, protection of existing ground-water supplies through large-quantity producer conversion to surface water may be the best regional management method for the area. However, to convert to surface-water supplies, costly treatment and conveyance systems will have to be built.

In general, it is recognized that regional management practices are needed to stabilize ground-water levels and to help preserve the aquifers for future use. Interviews indicated that the area, as a whole, would probably not support the formation of a district created under Chapter 52 Subchapter C, Texas Water Code, mainly due to the ad valorem taxing structure. There is a large dichotomy in the population distribution and water-supply source, mainly divided between the large population centers on, or soon to be on, surface water supplies and small population centers, rural, and farming areas on ground-water supplies. As a result, an underground water conservation district would probably be viewed as only benefitting a relative few on ground water while being financed by the majority on surface water. The punitive measures under §52.063 Texas Water Code that would result from the failure of a district to pass, would prevent the granting of state funds which would aid the area in converting to surface water, resulting in probable continued development and depletion of ground water.

Although many cities are currently experiencing problems with ground-water level declines in the aquifers that supply their water, they are implementing plans that will alleviate their water supply problems in the future. Planning in many areas relies on surface water for future supplies. The ground-water supply in these areas will not be critical if future surface-water supply plans are implemented. The major blockage to surface-water conversion is the initially large expense to build treatment plants and conveyance systems.

Creation by the legislature of special single- or multi-county districts with a regional coordinating board and technical staff may provide one solution to the conversion problem. These districts could be empowered to monetarily encourage conversion to available surface water, possible through use of the state-participation fund created by House Bill 2 and authorized by constitutional amendment in 1985. By providing financial incentives for the conversion to surface water by large quantity users, these districts would aid in the preservation of ground-water resources for more isolated and rural areas. The management strategy of these special districts should focus regionally on ground water as part of an overall water-resource plan with high priority placed on conversion to surface water or conjunctive use of both surface and ground water.

It is recommended that the Texas Water Commission not designate the North Central Texas area as critical at this time. Progress towards the conversion from ground- to surface-water usage should be monitored by the Texas Water Commission over the next five years, and if conversion plans are not being implemented or if districts are not being formed, consideration should again be given to "critical area" designation provided that Chapter 52 Subchapter C of the Texas Water Code is modified to furnish other means to finance an underground water conservation district than ad valorem taxes.

The advisory committee concurred with this recommendation, and the concept of special districts to monetarily encourage conversion of large quantity ground-water users to surface water. It is suggested that local entities approach the Legislature and lobby for the formation of these special districts.

Prepared by:	Mary L. Ambrose, Geologist Ground Water Conservation Section Texas Water Commission	March 23, 1990
Approved by:	Bill Klemt, Chief Ground Water Conservation Section Texas Water Commission	March 24, 1990

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Appendix 5. 2006 Regional Water Plan Estimates of Safe Supply – Trinity and Woodbine Aquifers

County	Trinity Aquifer	Woodbine Aquifer	Total
Collin	2,100	2,500	4,600
Cooke	6,400	NA	6,400
Dallas	4,400	1,100	5,500
Delta	364	12	376
Denton	10,400	4,700	15,100
Ellis	4,000	4,400	8,400
Fannin	700	3,300	4,000
Grayson	9,400	12,100	21,500
Hood	6,163	NA	6,163
Hunt	551	2,840	3,391
Johnson	2,053	866	2,919
Kaufman	NA	200	200
Lamar	1,320	3,658	4,978
Montague	2,682	NA	2,682
Navarro	NA	300	300
Parker	7,000	NA	7,000
Red River	528	170	698
Rockwall	NA	NA	NA
Tarrant	9,200	NA	9,200
Wise	4,400	NA	4,400

Tabulated values in acre-feet per year.

Sources:
Biggs and Mathews, Inc. et al., 2006, Table 3-8.
Brazos G Regional Water Planning Group et al., 2006, Table 3.4-2.
Burcher Willis and Ratliff Corp. et al., 2006, Table 3.7.
Freese and Nichols, Inc., et al., 2006, Table 3.5.

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Appendix 6. Groundwater Use Projections for Development of Barnett Shale

Low Scenario Groundwater Use Projections for Study Area Counties

County	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Cooke	28.5	14.3	0.0	2.0	2.0	3.6	5.6	9.5	11.2	34.1	34.1	50.8	39.1	39.1	21.2	21.2	14.5	14.5	14.5	14.5	14.5
DentonR	1,070.4	1,111.8	1,153.2	989.4	434.7	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9
DentonU	126.1	79.9	33.6	19.2	19.2	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
Ellis	11.0	7.6	4.2	7.6	8.4	26.9	26.9	35.6	25.5	25.5	13.6	13.6	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Hood	190.0	122.1	54.3	108.6	108.6	380.0	380.0	380.0	217.1	217.1	108.6	108.6	108.6	108.6	108.6	108.6	108.6	108.6	108.6	108.6	108.6
JohnsonH	976.1	564.7	153.4	536.9	536.9	536.9	306.8	306.8	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4
JohnsonV	113.4	66.8	20.2	20.2	70.6	70.6	70.6	40.4	40.4	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2
Montague	35.7	17.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parker	417.3	320.5	223.7	223.7	782.8	782.8	782.8	447.3	447.3	223.7	223.7	223.7	223.7	223.7	223.7	223.7	223.7	223.7	223.7	223.7	223.7
TarrantH	154.3	109.9	65.6	37.5	37.5	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
TarrantVR	254.3	202.5	150.7	83.5	76.4	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
TarrantVU	339.1	228.5	118.0	67.4	67.4	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7	33.7
WiseH	50.5	57.7	64.9	64.9	227.2	227.2	227.2	129.8	129.8	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9	64.9
WiseV	505.9	574.5	643.1	626.9	301.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9	82.9
Total	4,272.5	3,478.7	2,684.8	2,787.6	2,673.6	2,242.5	2,014.4	1,563.8	1,239.2	953.3	832.9	849.6	834.4	834.4	816.5	816.5	809.8	809.8	809.8	809.8	809.8

Notes: Values in acre-feet. H= Horizontal, V= Viola, R= Rural, U= Urban, some counties are divided into polygons corresponding to the main completion type (presence or not Viola Limestone, urban or rural setting).

Source: Bené, Harden, Griffin, and Nicot, 2007.

Medium Scenario Groundwater Use Projections for Study Area Counties

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooke	28.5	14.3	0.0	4.1	4.1	26.1	15.2	23.9	33.3	91.3	92.3	167.1	146.3	147.9	109.7	110.8	81.7	68.3	69.0	59.9	60.5
DentonR	1,070.4	1,222.1	1,373.9	1,221.1	576.1	755.1	273.7	233.1	235.8	238.4	241.1	243.7	246.2	248.8	251.3	253.8	256.3	258.8	261.2	263.6	266.0
DentonU	126.1	140.7	155.3	89.9	91.0	46.0	46.6	47.1	47.7	48.2	48.7	49.3	49.8	50.3	50.8	51.3	51.8	52.3	52.8	53.3	53.8
Ellis	11.0	10.9	10.9	18.0	22.3	72.5	69.2	114.3	97.2	98.2	76.7	77.6	60.4	49.4	49.9	42.4	42.8	43.2	43.6	44.0	44.4
Hood	190.0	220.3	250.7	507.9	514.2	1,821.6	1,843.4	1,864.9	1,077.9	1,090.0	551.0	556.9	562.8	568.7	574.4	580.2	585.8	591.5	597.0	602.5	608.0
JohnsonH	976.1	842.3	708.5	2,511.5	2,542.7	2,573.7	1,488.3	1,505.7	761.5	770.0	778.5	786.9	795.2	803.5	811.6	819.7	827.7	835.7	843.5	851.3	859.0
JohnsonV	113.4	86.2	59.0	59.8	211.9	214.5	224.2	140.0	141.6	116.1	117.4	118.7	96.9	97.9	83.3	84.1	84.9	85.8	86.6	87.4	88.2
Montague	35.7	17.8	0.0	0.0	0.0	30.7	11.8	45.1	57.7	82.7	124.1	319.5	322.9	686.0	628.5	634.8	435.7	439.9	295.6	257.8	260.2
Parker	417.3	725.2	1,033.1	1,046.2	3,707.3	3,752.5	3,797.3	2,195.3	2,220.4	1,122.7	1,135.0	1,147.3	1,159.4	1,171.4	1,183.4	1,195.2	1,206.8	1,218.4	1,229.9	1,241.2	1,252.5
TarrantH	154.3	228.7	303.1	175.4	177.6	89.9	91.0	92.0	93.1	94.1	95.2	96.2	97.2	98.2	99.2	100.2	101.2	102.1	103.1	104.1	105.0
TarrantVR	254.3	217.8	181.4	113.8	97.0	161.4	38.5	32.8	33.1	33.5	33.9	34.2	34.6	35.0	35.3	35.7	36.0	36.4	36.7	37.0	37.4
TarrantVU	339.1	442.0	544.8	315.3	319.2	161.6	163.5	165.4	167.3	169.2	171.0	172.9	174.7	176.5	178.3	180.1	181.8	183.6	185.3	187.0	188.7
WiseH	50.5	202.0	353.4	357.9	1,268.2	1,283.7	1,299.0	751.0	759.6	384.1	388.3	392.5	396.6	400.7	404.8	408.8	412.8	416.8	420.7	424.6	428.5
WiseV	505.9	747.4	989.0	984.8	529.9	572.5	448.5	382.0	386.4	390.7	395.0	399.3	403.5	407.7	411.8	415.9	420.0	424.0	428.0	432.0	435.9
Total	4,272.5	5,117.8	5,963.1	7,405.5	10,061.5	10,061.5	9,810.1	7,592.6	6,112.4	4,729.4	3,853.2	4,562.0	4,546.7	4,941.9	4,872.4	4,913.0	4,725.7	4,756.8	4,653.1	4,645.9	4,687.9

Notes: Values in acre-feet. H= Horizontal, V= Viola, R= Rural, U= Urban, some counties are divided into polygons corresponding to the main completion type (presence or not Viola Limestone, urban or rural setting).

Source: Bené, Harden, Griffin, and Nicot, 2007.

High Scenario Groundwater Use Projections for Study Area Counties

County	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cooke	28.5	14.3	0.0	9.9	7.5	46.2	24.7	42.1	53.6	138.9	136.2	198.1	187.1	199.6	219.3	215.9	178.9	140.7	153.4	129.5	135.3
DentonR	1,070.4	1,368.9	1,667.3	1,527.1	683.6	1,439.0	646.5	487.0	439.6	402.0	385.3	372.1	388.2	390.9	453.0	446.5	496.5	493.2	534.2	561.3	586.6
DentonU	126.1	216.8	307.5	179.3	136.1	62.1	71.7	74.4	62.0	64.0	63.1	55.1	57.9	64.9	79.3	78.2	94.6	92.5	99.2	98.9	105.7
Ellis	11.0	16.5	21.9	36.7	34.0	103.9	113.4	192.4	149.1	145.3	140.7	143.7	128.6	86.5	97.5	74.6	82.9	82.4	89.2	93.8	98.0
Hood	190.0	343.2	496.5	1,013.6	769.1	2,456.2	2,838.2	2,943.1	1,402.5	1,447.9	713.3	622.8	654.1	733.4	895.9	884.3	1,069.3	1,045.7	1,121.4	1,117.7	1,194.9
JohnsonH	976.1	1,189.6	1,403.1	5,012.6	3,803.1	3,470.3	2,291.5	2,376.1	990.8	1,022.9	1,007.8	880.0	924.2	1,036.3	1,265.8	1,249.5	1,510.9	1,477.5	1,584.4	1,579.3	1,688.3
JohnsonV	113.4	116.0	118.5	120.9	321.1	293.0	368.0	261.7	229.4	250.4	234.1	245.8	179.3	171.6	150.1	148.0	164.5	163.4	177.0	186.0	194.4
Montague	35.7	17.8	0.0	0.0	0.0	78.2	44.6	98.5	120.7	204.3	287.4	682.7	716.2	1,285.6	1,343.6	1,325.4	1,275.0	1,281.8	1,120.0	937.5	967.1
Parker	417.3	1,231.5	2,045.7	2,088.1	5,544.9	5,059.7	5,846.7	3,464.4	2,889.1	1,491.4	1,469.4	1,283.0	1,347.5	1,510.8	1,845.5	1,821.7	2,202.8	2,154.1	2,310.1	2,302.5	2,461.6
TarrantH	154.3	377.2	600.2	350.1	265.6	121.2	140.0	145.2	121.1	125.0	123.2	107.6	113.0	126.7	154.7	152.7	184.7	180.6	193.7	193.0	206.4
TarrantVR	254.3	238.3	222.4	155.3	112.7	317.3	90.8	68.4	61.8	56.5	54.1	52.3	54.5	54.9	63.7	62.7	69.8	69.3	75.1	78.9	82.4
TarrantVU	339.1	709.0	1,078.9	629.3	477.4	217.8	251.7	261.0	217.7	224.7	221.4	193.3	203.0	227.7	278.1	274.5	331.9	324.6	348.1	346.9	370.9
WiseH	50.5	375.2	699.8	714.3	1,896.8	1,730.9	2,000.1	1,185.1	988.3	510.2	502.7	438.9	461.0	516.8	631.3	623.2	753.6	736.9	790.2	787.7	842.1
WiseV	505.9	976.2	1,446.6	1,459.3	692.0	974.7	1,059.4	798.0	720.4	658.8	631.3	609.7	636.1	640.6	742.4	731.7	813.6	808.2	875.4	919.7	961.2
Total	4,272.5	7,190.4	10,108.4	13,296.5	14,743.9	16,370.4	15,787.3	12,397.3	8,446.1	6,742.3	5,970.1	5,885.2	6,050.7	7,046.2	8,220.0	8,088.9	9,228.9	9,051.0	9,471.2	9,332.7	9,894.7

Notes: Values in acre-feet. H= Horizontal, V= Viola, R= Rural, U= Urban, some counties are divided into polygons corresponding to the main completion type (presence or not Viola Limestone, urban or rural setting).

Source: Bené, Harden, Griffin, and Nicot, 2007.

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Appendix 7. Proposed Boundary for Recommended Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area

(a) All of the areas of Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant, and Wise counties are designated as the Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area.

(b) The boundaries of the Northern Trinity and Woodbine Aquifers Priority Groundwater Management Area are coterminous with and include all territory within Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, Tarrant, and Wise counties.

(1) From east to west, the northern boundary is coterminous with the northern boundary lines for Montague, Cooke, Grayson, and Fannin counties.

(2) From north to south, the eastern boundary is coterminous with:

(A) the eastern and southern boundary lines for Fannin County,

(B) the eastern and southeastern boundary lines for Collin County, and

(C) the eastern boundary lines for Dallas and Ellis counties.

(3) From east to west, the southern boundary line is coterminous with:

(A) the southern boundary lines for Ellis County,

(B) the southern and southwestern boundary lines for Johnson County, and

(C) the southern boundary lines for Hood County.

(4) From south to north, the western boundary line is coterminous with:

(A) the western boundary line for Hood County,

(B) the western and northwestern boundary lines for Parker County,

(C) the western boundary line for Wise County, and

(D) the southwestern and western boundary lines for Montague County.

(5) The boundary forms a closure.

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Appendix 8. Recommended Regional Groundwater Conservation District

Recommended Name for the Groundwater Conservation District

North Texas Groundwater Conservation District (District)

Purpose for District

The purpose of the District is to provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater in the Trinity, Woodbine, and other aquifers under the authority of Texas Water Code, Chapter 36. The primary problems identified in the District at this time include 1) the historic and continued overdevelopment of the Trinity and Woodbine aquifers, 2) recommended and projected mining of groundwater from aquifer storage to meet existing and future demands, and 3) the potential for competing interest between historic rural groundwater users and urbanizing and natural gas exploration interests' intent on using the common resource.

The District would implement the following groundwater management programs and goals for the benefit the residents to help address identified problems and issues:

- quantify groundwater availability and quality, understand aquifer characteristics, and identify groundwater problems that should be addressed (both quantity and quality) through aquifer- and area-specific research, monitoring, data collection, and assessment programs;

- quantify aquifer impacts from pumpage and establish an overall understanding of groundwater use through a comprehensive water well inventory, registration, and permitting program;

- evaluate and understand aquifers sufficiently to establish spacing regulations to minimize drawdown of water levels and to prevent interference from neighboring wells;

- cooperate and work with the TCEQ, RCT, and other state agencies to inventory sites, wells, boreholes, or other man-made structures that could potentially impact groundwater supplies;

- establish programs that encourage conservation of fresh groundwater and the use of poorer-quality groundwater when feasible and practicable and facilitate such transitions;

- quantify aquifer and other contributing characteristics sufficiently to evaluate the feasibility and practicability for weather enhancement and aquifer recharge projects in the outcrop areas;

- establish school and public educational programs to increase awareness of the finite water resources and actions that can be taken to conserve the resources;

- protect water quality by encouraging water well construction to be protective of fresh-water zones and by administering a program to locate and plug abandoned water wells; and,

- participate in the Groundwater Management Area #8 and regional water planning processes, groundwater availability model refinements, and regional groundwater management and protection programs with other entities.

Recommended Area and Boundaries

The District's boundaries would be coterminous with the boundaries of Collin, Cooke, Dallas, Denton, Ellis, Fannin, Grayson, Hood, Johnson, Montague, Parker, and Wise counties. Tarrant County is not included in the District's boundaries.

Recommended Board of Directors

The District would be governed by a board of 12 elected directors. The commissioners court of each of the 12 counties would appoint one temporary director for the District. The temporary director from each county would serve until an initial director is elected from the county and has qualified for office. The initial directors would draw lots to determine which six would serve two-year terms and which six would serve four-year terms. As initial director terms expire, permanent directors would be elected to serve four-year terms.

Recommended Revenue for District

The District would be funded by well production fees assessed to permitted water wells. Such production fees are capped by state law at $1 per acre-foot/year for agricultural use, and $10 per acre-foot/year for other uses. Based on year 2003 groundwater use data, and assuming that county-other, livestock, and mining uses would be exempt from potential regulation and fees, about $740,000 of revenue could be generated annually at rates authorized by state law. It is anticipated that District revenue needs may decrease once District administrative start-up actions and well inventory, registration and permitting programs are established.