# *Llano Estacado Regional Water Planning Area*

## *Regional Water Plan*

***Prepared for***

**Texas Water Development Board**

***by***

**Llano Estacado Regional Water Planning Group**

***With administration by***

**High Plains Underground Water Conservation District No. 1**

***With technical assistance by***

HDR

**HDR Engineering, Inc.**
**Austin, Texas**

**September 2010**

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# *Llano Estacado Regional Water Plan Executive Summary*

## *Background*

In 1997, Senate Bill 1 was enacted by the 75th Texas Legislature to address experiences of drought and the needs of utilities and water management entities to meet the water supply needs of the State's growing population and economy. The new law emphasized the development of water plans at the regional level with greater local participation and input in order to gain acceptance and commitment to implementation. In addition to requiring the best information possible to guide future water resource decisions, Senate Bill 1 also provided that future regulatory and financing decisions of the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB) be consistent with approved regional plans. As stated in Senate Bill 1, the purpose of this regional planning effort is to:

> "Provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

The TWDB is the state agency designated to coordinate the overall statewide planning effort. The TWDB divided the state into 16 planning regions. In the Southern High Plains of Texas, a 21-county area was delineated by the TWDB as Planning Area O, which was subsequently named the Llano Estacado Regional Water Planning Region (herein referred to as the Llano Estacado Region). The counties of the region are:

1. Bailey
2. Briscoe
3. Castro
4. Cochran
5. Crosby
6. Dawson
7. Deaf Smith
8. Dickens
9. Floyd
10. Gaines
11. Garza
12. Hale
13. Hockley
14. Lamb
15. Lubbock
16. Lynn
17. Motley
18. Parmer
19. Swisher
20. Terry
21. Yoakum

The Llano Estacado Regional Water LERWPG (LERWPG) was appointed by the TWDB to represent eleven stakeholder interests, as specified in Senate Bill 1, and to act as the steering and decision-making body of the regional planning effort. Terms of Office of LERWPG members and methods of replacement are specified in the LERWPG By-Laws, with current LERWPG membership listed below. Non-voting members include representatives of state agencies.

***Voting Members — Water User Group***

H. P. Brown, Jr., Chair, — Agriculture/Cattle

Jim Conkwright, Vice Chair — Water Districts

Doug Hutcheson, Secretary/Treasurer — Water Utilities

Melanie Barnes, Ph.D. — Public

Alan Bayer — County Government

Delaine Baucum — Agriculture

Bruce Blalack — Municipalities (Large)

Delmon Ellison, Jr. — Agriculture

Aubrey Spear, — Municipalities, (Large)

Harvey Everheart — Water Districts

Bill Harbin — Electrical Generation

Mark Kirkpatrick — Agriculture

Bob Josserand — Municipalities (Medium)

Richard Leonard — Agriculture

Michael McClendon — River Authorities

Don McElroy — Small Business

E.W. (Gene) Montgomery — Oil & Gas

Ken Rainwater, Ph.D. — Public

Kent Satterwhite — Water Districts

Jim Steiert — Environment

John Taylor – Municipalities (Small)

***Non-voting Members — Agency***

Angela Kennedy, P.E. — Texas Water Development Board

Herb Grubb, Ph.D.—Technical Consultant, HDR Engineering, Inc.

John Clayton — Texas Parks and Wildlife Department

Steve Jones — Texas Department of Agriculture

Malcolm Laing — Texas Commission on Environmental Quality

The LERWPG adopted the following Mission Statement:

> "Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Llano Estacado Regional Water Planning Area of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities."

The LERWPG designated the High Plains Underground Water Conservation District No. 1 as the political subdivision to act as principal contractor to apply for and administer a grant from the TWDB to develop the Water Plan. The prime planning and engineering consultant is HDR Engineering, Inc.

On January 3, 2001, the LERWPG adopted and submitted to the TWDB the "Llano Estacado Regional Water Planning Area Regional Water Plan." In response to directives of Senate Bill 2 (77th Texas Legislature, 2001), the LERWPG prepared a scope of work and budget to update and revise the January 3, 2001, Llano Estacado Regional Water Plan, and on April 1, 2002, the LERWPG applied to the TWDB for funding to accomplish the update and revision directed by Senate Bill 2. The updated and revised 2006 Llano Estacado Regional Water Plan was adopted and submitted to the TWDB on January 3, 2006, and on April 18, 2006, the TWDB approved the 2006 Llano Estacado Regional Water Plan. In response to the February 8, 2008 TWDB requests for proposals, on June 13, 2008, the LERWPG submitted an application and scope of work to the TWDB for Phase II of the third round of regional water planning. The application was approved by the TWDB, and a summary of the updated and revised 2011 Llano Estacado Regional Water Plan is presented below.

The planning horizon used by the LERWPG and all other water LERWPGs is the 50-year period from 2010 to 2060. This planning period allows for a long-term forecast of the prospective water situation, sufficiently in advance of needs, to allow for appropriate management measures to be implemented. As required in Senate Bill 1, the TWDB specified planning rules and guidelines (31 TAC §357.7 and §357.12) to focus the efforts and to provide for general consistency among the regions so that the regional plans can then be aggregated into an overall State Water Plan by January 2012. Besides specifying overall report and data formats, the TWDB rules also require the maximum use of existing state water planning information, except where better information is available. As authorized by Senate Bills 1 and 2, the TWDB has provided for coordination mechanisms among the regions where regions share common water issues.

The LERWPG has developed a regional water plan to serve the needs of the region during all types of weather, but specifically to meet the water needs during drought. Since there is little opportunity to increase the region's water supplies through conventional water development, emphasis has been placed upon water management strategies to increase efficiency of water use in irrigation, and to augment regional supplies through precipitation enhancement and brush management. All of these strategies are aimed directly at sustaining the region's existing groundwater reserves as far into the future as possible.

## *Description of the Region*

The 21-county Llano Estacado Region has an area of 20,294 square miles (12,988,160 acres), or about 7.5 percent of the state's land area. Although the region is located in the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado), almost no surface water leaves the region as runoff into these rivers. Of the 20,294 square miles covered by the area, 94 square miles are located in the Canadian Basin, 6,681 square miles are located in the Red Basin, 8,732 square miles are located in the Brazos Basin, and 4,787 square miles are located in the Colorado Basin. The regional population of 453,997 represents about 2.2 percent of the state total population of about 20.85 million people in 2000.

### *Climate*

The region is characterized as semi-arid, with a wide range in temperatures. In an average year, about 80 percent of the annual rainfall occurs during the period from May through October. The long-term average precipitation received in the region is 18.4 inches. The average ranges from a high of 22 inches per year in a small area in Crosby County, to a low of about 16 inches in Cochran County in the southwestern portion of the region. Mean annual temperature is about 60 degrees Fahrenheit, with mean temperatures in January of 24 degrees Fahrenheit, and mean high temperatures in July of 94 degrees Fahrenheit.

### *Land*

Land elevations in the region generally range from about 1,900 feet-mean sea level in the southeast to 4,300 feet-mean sea level in the northwest. The plateau of the Southern High Plains contains many shallow depressions, or playa basins, a few of which hold water more or less permanently. There is broken terrain in the northwest corner of the planning region and on the eastern side of the planning region, which is a part of the Rolling Plains physiographic region, below the "caprock" escarpment. There are 15 general soil types in the region, 80 to 85 percent of which are suitable for irrigation. About 57 percent of the 20,294 square miles of land area in the planning region is in cropland, approximately one-third of which is irrigated. The major irrigated crops are cotton, corn, grain sorghum, wheat, vegetables, peanuts, and soybeans.

### *Water*

The Ogallala Formation of Pliocene Age houses the principal aquifer in the Llano Estacado Region. The Ogallala Formation rests upon the eroded surface of the underlying Triassic and Cretaceous rocks and consists of beds and lenses of clay, silt, sand, and gravel. In general, the Ogallala Formation is thicker in the northern part of the area, with the thickness ranging from 400 to 500 feet in central Parmer, west-central Castro, and southwestern Floyd Counties, to a knife edge where the formation wedges out against outcrops of older rocks. Erosion has almost completely isolated the formation so that the segment in the Southern High Plains of Texas is cut off in all directions from any underground connection with other water-bearing beds, except through the underlying older rocks, which contain highly mineralized water, unlike the freshwater in the Ogallala Formation.

Generally, the water in the Ogallala Formation occurs under water-table conditions, and occupies the pore spaces and voids in the unconsolidated sediments that occur between the water-table and the underlying older rocks. The thickness of the zone of saturation varies throughout the region, chiefly because of the uneven nature of the bedrock surface. Within the region, the saturated thickness ranges from less than 1 foot to more than 300 feet.

The transmissivity of the Ogallala Formation ranges rather widely. Tests, both in the laboratory and in the field, indicate an average specific gravity yield of about 15 percent. The movement of water in the formation is generally from the northwest to the southeast, with the rate of movement of water in the formation being estimated at about 150 feet per year on a gradient of 10 feet per mile.

The long-term change in the water table throughout the region has generally been a decline; however, in recent years the rate of decline has leveled out and in a few counties in the southern part of the region has risen somewhat.

The principal source of recharge to the Ogallala Formation in the Llano Estacado Region is precipitation on the land surface. The amount of recharge depends on many factors, including the amount, distribution, and intensity of precipitation and the type of soil and vegetative cover. The amount of recharge has been estimated to range from less than 0.5 inch annually to about 3 inches annually. The water in the Ogallala Formation in the Llano Estacado Region is of good chemical quality, except that it is “hard” due to high levels of calcium and magnesium.

Precipitation is the only naturally reoccurring/renewable water supply for the Llano Estacado Region. The average annual precipitation received in the region is 18.4 inches, which is about 19,915,179 acft of water over the 12,988,160-acre region. Precipitation meets about 60 percent of urban landscape water and irrigated crop demands, and provides all the water for surface reservoirs, all the water for rangeland and dryland crop production, and water for wildlife and natural recharge to the region’s aquifers.

There are an estimated 20,000 playa basins (2 percent of the total land surface) on the High Plains of Texas, of which approximately 14,000 are located within the Llano Estacado Region. The majority of playa basins are ephemeral, holding water only during and for a short period of time after rains. Some of the dry playas are planted to crops, some are left fallow, and some are grazed. Approximately 70 percent of playas are modified with pits to recover rainfall runoff for irrigation or to create a water reserve for grazing livestock or wildlife when the bulk of the water collected in the basin from rainfall runoff has soaked into the soil or evaporated.

### *Vegetation*

The original vegetation of the High Plains was classified as mixed prairie, shortgrass prairie, and, in some locations on deep, sandy soils, tallgrass prairie. Blue grama, buffalograss, and galleta were the principal natural vegetation on the clay and clay loam soils. Characteristic grasses that were on sandy loam soils are little bluestem, western wheatgrass, sideoats grama, and sand dropseed.

The High Plains area was characteristically free from brush, but sand sagebrush, along with pricklypear and yucca, have invaded the ranchland that has sandy and sandy loam soils. Honey mesquite has invaded the ranchland on most soils in the region. Several grass species of dropseeds are abundant on land containing coarse sandy soils. The playa depressions, which can contain several feet of water after heavy rains, support unique patterns of vegetation within their confines. Various aquatic species, such as curltop smartweed, are associated with the playa basins.

### *Wildlife*

Virtually all wildlife habitats in the High Plains are on privately owned farms and ranchland. Quail, mourning dove, and feral hogs are abundant, and whitetail deer, mule deer, turkey, and exotic aoudad sheep provide hunting along the breaks and canyons of the caprock. Many playa basins and feedyard lagoons provide migratory waterfowl habitat, with as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes using playa lakes as wintering areas or as rest stops during annual migrations. Pheasants are an economically important gamebird in irrigated areas, but their numbers tend to fluctuate widely with weather and habitat conditions.

In the region, approximately 25 wildlife species are listed by the Texas Parks and Wildlife Department as endangered, threatened, or just rare with no official listing.

### *Population*

The area's population has grown from 11,418 in 1900 to 453,997 in 2000. In 2000, the age distribution across the region was fairly uniform from county to county. The two age groups with the highest percentage of the population in 2000 were the group of 5 to 14 years of age (16.4 percent of the population) and age 60 and above (19.1 percent). The age group with the lowest percentage of the population in 2000 was the 55 to 59 years group (4.8 percent).

### *Economy*

The region's economic base is agricultural crop and livestock production, with significant contributions from manufacturing, oil and gas, and trades and services, such as wholesale and retail trade, and finance, insurance, legal, advertising, medical, personnel, research, entertainment, repair services, and higher education (Figure ES-1). Agricultural processing, oilfield equipment, and electronics form the core of the region's manufacturing base. Beef cattle and cotton are the dominant agricultural enterprises, although peanuts, wheat, grain sorghum, vegetables, and oilseed crops are significant contributors to the region's economy. Reported production of major crops of the region (cotton, wheat, corn, and grain sorghum) increased significantly between 2002 and 2007 in both the Llano Estacado Region and the state. For example, in the region, cotton production increased 49 percent, from 3.06 million bales in 2002 to 4.56 million bales in 2007; state production of cotton increased from 5.06 million bales in 2002 to 8.15 million bales in 2007, for a 61 percent increase. In the region, wheat production increased from 12.11 million bushels in 2002 to 32.25 million bushels in 2007 (166 percent increase), while state wheat production increased from 75 million bushels to 135 million bushels (79 percent increase). In the case of corn production, the regional increase was from 26 million bushels in 2002 to 62 million bushels in 2007 (136 percent increase), while state total corn production increased from 197 million bushels in 2002 to 286 million bushels in 2007 (45 percent increase). Grain sorghum production in the Llano Estacado Region was reported at 20 million bushels in 2002, and 33 million bushels in 2007, or an increase of about 60 percent. Texas total grain sorghum production was reported at 114 million bushels in 2002, with 2007 production reported at 154 million bushels, for an increase of about 35 percent. However, for the region, peanut production decreased about 4 percent, from 506 million pounds in 2002 to 486 million pounds in 2007.

According to the 2007 (most recent) Census of Agriculture, all crops grown in the Llano Estacado Region had a combined market value of over $1.6 billion in 2007. Cotton, a somewhat drought-tolerant plant, is the leading crop of the region, with a calculated value of cotton production in 2007 of about $1.23 billion. With a multiplier of 2.87, the total business effect of crop production in the Llano Estacado Region is estimated at $4.76 billion.

In the Llano Estacado Region, there has been an increase in acres planted to grain sorghum, grain sorghum yields, and use of grain sorghum during the past 60 years. In 2007, the region produced 21 percent (32.67 million bushels) of the state's grain sorghum, with a market value of value of approximately $120.54 million. Approximately 21.6 percent (62 million bushels) of the state's corn crop was grown in the Llano Estacado Region in 2007, with a market value of $270 million. In 2007, 98,411 bushels of soybeans (included in Other Grains), with a calculated value of $1.02 million were grown in the Llano Estacado Region. Soybeans are frequently planted in the region as a "recovery" cash crop if hail destroys cotton; however, soybean production requires irrigation, since soybeans are not a dryland crop.

During the last 25 to 30 years, the South Plains of Texas observed the development of confined feeding of cattle to finish weights before slaughter. Fed cattle marketing in Texas in 1960 was 477,000 head and by 1998 had increased to 6.06 million head. Of the 142 cattle feedlots in the state, 69 (49 percent) are located in the Llano Estacado Region. In 1998, these 69 feedlots marketed over 3.39 million head, or about $2.2 billion (1999 prices) of fed cattle.

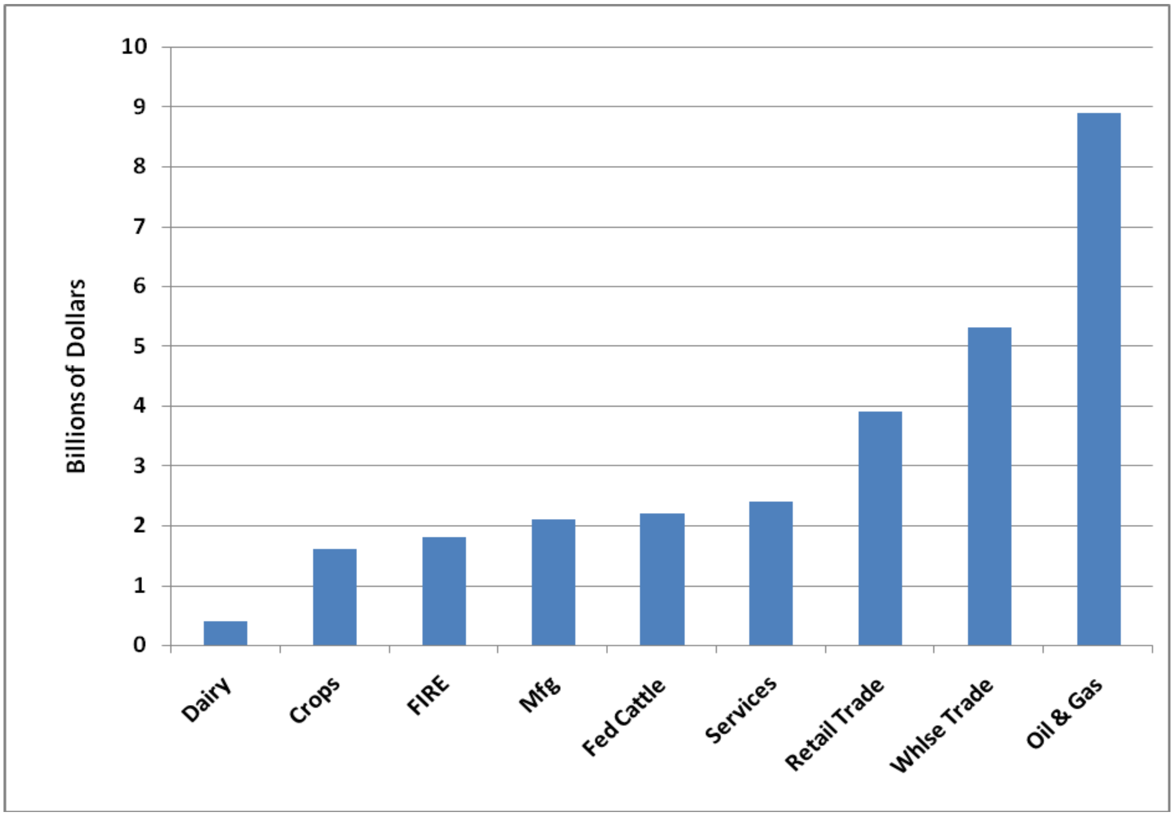


***Figure ES-1. Llano Estacado Regional Economy Annual Value of Sales***

With a multiplier of 2.49, this primary production has an economy-wide business effect of over $6.27 billion annually. Feedyards of the Llano Estacado Region employ about 2,000 people, with an economy-wide effect of an additional 3,600 jobs, or a total employment effect of 5,600.

In recent years, dairy production has increased in the Llano Estacado Region. In 2005, there were 43 dairies, with 27,149 head of dairy cattle. In 2008, the number of dairies had increased to 59, with an estimated number of dairy cattle of about 154,000. Projected numbers of dairy cattle are about 188,500 in 2020, 230,000 in 2040, and 280,700 in 2060. Value of production was reported at $54.9 million in 2002, and $382 million in 2007.

During the early 1920s, oil was discovered in the High Plains Region, and by 1926 the High Plains was a major oil- and gas-producing region. In 2008, the well-head value of oil and gas produced in the Llano Estacado Region was estimated at $8.9 billion.

In 2002, the region's 328 manufacturing establishments contributed over $1.5 billion to the region's economy in value of shipments and provided over 7,400 jobs with an annual payroll of over $231 million. The leading types of manufacturing in the region are food and kindred products, agricultural and industrial machinery and equipment, printing and publishing, and fabricated metal products.

The 8,650 wholesale trade, retail trade, services, finance, insurance, and real estate establishments located in the region have gross value of sales and billings of more than $11.0 billion annually, and employ about 77,500, with payrolls of about $1.5 billion annually.

#### *Water Agencies*

There are two federal water agencies, three state water agencies, three water supply authorities and districts, and six underground water conservation districts in operation in the Llano Estacado Region at the present time. The federal and state agencies perform regulatory and development functions, while the underground water conservation districts were organized to conserve, preserve, protect, recharge, and prevent waste of the underground water.

### *Projections of Population and Water Demands*

#### *Population Projections*

The TWDB provided population projections for the Llano Estacado Region for use in revising and updating the Regional Water Plan. Population of the Region was reported by the U.S. Census at 453,997 in 2000 and was projected to be 551,758 in 2060. Nearly 80 percent of the population of the region is projected to reside in the Brazos River Basin. The population projections for 53 individual cities, rural areas of each county, and parts of a county in each river basin area of the region were tabulated for use in developing the regional water plan.

#### *Water Demand Projections*

In addition to population projections, the TWDB prepared water demand projections for municipal, manufacturing, steam-electric power generation, irrigation, mining, and livestock uses. Municipal water demand includes residential and commercial water uses, and is projected to increase from 99,435 acft/yr in 2010 to 105,939 acft/yr on 2060. Per capita water use, in gallons per person per day, is projected to decline over the planning period, from 180 gallons per person per day to 171 gallons per person per day.

The Llano Estacado Region's major water-using manufacturing sectors are food processing, industrial machinery and equipment, and fabricated metals. These industries used 10,064 acft of water in 2000 and are projected to have a demand of 19,919 acft/yr in 2060.

Only three counties (Lamb, Lubbock, and Yoakum) of the Region currently use or are projected to use water in steam-electric power production during the planning period. In 2000, 25,618 acft of water was used for steam-electric power generation; and by the year 2060, it is estimated that 49,910 acft of water will be needed for the production of steam-electric power.

In the Llano Estacado Region, the principal uses of water for mining are for recovery and processing of crude petroleum and for sand and gravel washing. In the region, mining water use was 21,436 acft in 2000, and is projected to decline to 258 acft in 2060. Overall, water use in this sector is expected to decline due to the fact that the present "water flood" technology will no longer be used, since many of the oil fields of the region will have reached their economic limit, suspended operations, and plugged wells. The continuation of the industry in the region will hinge on new technologies to recover the oil remaining in the reservoirs.

The TWDB irrigation water use data show annual use for irrigation in the Llano Estacado Region in 2000 of 4,347,877 acft. Projected irrigation water demands for the region in 2060 are 3,474,163 acft, or 20 percent less than in 2000. The projected decrease is based upon increased irrigation efficiency, declining well yields due to the decreasing saturated thickness of the aquifer in some areas, economic factors, and reduced government programs affecting the profitability of irrigated agriculture.

Total livestock water demand projections for the Llano Estacado Region are the sum of water demand projections for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry. Total livestock water use in 2000 was estimated at 37,724 acft. Total livestock water demand for the region is projected to be 73,965 acft/yr in 2060.

Total water use in the Llano Estacado Region was 4,530,040 acft in 2000, with projected water demands in 2060 of 3,724,154 acft. The quantity of projected water demands in 2060 are 87 acft/yr for the Canadian River Basin, 819,527 acft/yr for the Red River Basin, 2,194,531 acft/yr for the Brazos River Basin, and 710,010 acft/yr for the Colorado River Basin.

### *Wholesale Water Providers*

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider as follows:

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

There are four Wholesale Water Providers in the Llano Estacado Region—Canadian River Municipal Water Authority, City of Lubbock, Mackenzie Municipal Water Authority, and White River Municipal Water District.

Projected Region O water demands for Canadian River Municipal Water Authority increase from 53,396 acft/yr of use in 2000 to 55,504 acft/yr in 2060. Water use from the City of Lubbock system was 41,917 acft/yr in 2000, and demand is projected to increase to 56,516 acft/yr in 2060.

Water use from the Mackenzie Municipal Water Authority was 2,046 acft/yr in 2000, and demand is projected at 1,936 acft/yr in 2060. Water use from the White River Municipal Water District in 2000 was 3,164 acft/yr in 2000 and demand is projected at 1,489 acft/yr in 2060, with demand for water from the Authority for mining uses declining to zero in 2060.

## *Water Supplies and Water Needs*

### *Water Supplies Available During the Drought of Record*

Two major and two minor aquifers supply water to the area. The two major aquifers are the Ogallala and Seymour aquifers. The two minor aquifers are the Edwards-Trinity (High Plains) and the Dockum. In addition, four reservoirs located within or near the region supply water for municipal and industrial uses within the region. These four reservoirs are Lake Meredith, located in the Canadian River Basin to the north of the Llano Estacado Region, Mackenzie Reservoir located in the Red River Basin in Swisher and Briscoe Counties, White River Reservoir located in the Brazos River Basin in the southeast corner of Crosby County, and Alan Henry Reservoir located on the Double Mountain Fork of the Brazos River in Garza County.

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections were calculated by river basin, county or part of county located within the river basin, and city and rural areas of each county or part of county. Estimates were made of the quantities of water available within each county at each decadal planning date. The supplies are the quantities available during the drought of record (firm yield for reservoirs and quantity that can be obtained from groundwater). These projected water supplies were then compared to projected water demands, and if demands exceeded supplies available, then the differences were shown as the measure of "water needs for that county, river basin, and water user group."

The projected total water demands for the Llano Estacado Region decrease from 4.39 million acft/yr in 2010 to 4.10 million acft/yr in 2030, and 3.70 million acft/yr in 2060. Under drought of record water supply conditions, and with no water management strategies in place, water needs (shortages) are projected to be 1.27 million acft/yr in 2010, increasing to 2.09 million acft/yr in 2030 and to 2.35 million acft/yr by 2060. The water needs assessment identified 29 municipalities and one water supply district, with municipal water needs (shortages), 21 counties with irrigation needs (shortages), 5 counties with beef feedlot needs (shortages), and 4 counties with dairy needs (shortages) during the 2010 through 2060 planning period (Table ES-1).

At the request of the LERWPG, the TWDB performed a socioeconomic economic impact analysis of the effects of not meeting projected water needs. The income losses due to projected water shortages for irrigated agriculture, confined animal feeding, business, and commercial establishments were calculated at $356.1 million/year in 2010, $949 million/year in 2030, and $1,436.8 million/year in 2060. Losses in tax payments to local and state governments were estimated at $17.58 million in 2010, $53.30 million in 2030, and $86.31 million in 2060.

The estimated effects of unmet water needs (projected shortages) upon the size of the population and school enrollment of the region are as follows. Job losses due to water shortages are 5,546 in 2010, 14,760 in 2030, and 23,993 in 2060. The effects of projected water shortages upon population of the region are 7,160 in 2010, 18,670 in 2030, and 30,030 in 2060. School enrollment is projected to be 1,680 less in 2010, 4,380 less in 2030, and 7,040 less in 2060.

***Table ES-1.***
***Water User Groups with Projected Needs (Shortages)***
***Llano Estacado Region***

| *City (County)* | *Year Shortage Develops* | *Shortage in 2060 (acft/yr)* |
|---|---|---|
| **Municipal Shortages** | | |
| Silverton (Briscoe) | 2010 | 108 |
| Dimmitt (Castro) | 2020 | 844 |
| Hart (Castro) | 2040 | 82 |
| Morton (Cochran) | 2010 | 496 |
| Crosbyton Crosby) | 2040 | 336 |
| Lorenzo (Crosby) | 2030 | 108 |
| Ralls (Crosby) | 2030 | 318 |
| Spur (Dickens) | 2040 | 257 |
| Lockney (Floyd) | 2030 | 212 |
| Post (Garza) | 2030 | 206 |
| Lake Alan Henry WSD (Garza) | 2010 | 22 |
| Abernathy (Hale & Lubbock) | 2010 | 446 |
| Petersburg (Hale) | 2050 | 306 |
| Anton (Hockley) | 2010 | 243 |
| Ropesville (Hockley) | 2020 | 81 |
| Smyer (Hockley) | 2050 | 62 |
| Sundown (Hockley) | 2010 | 316 |
| Earth (Lamb) | 2030 | 276 |
| Idalou (Lubbock) | 2040 | 272 |
| Lubbock (Lubbock) | 2010 | 20,649 |
| New Deal (Lubbock) | 2020 | 20 |
| Shallowater (Lubbock) | 2010 | 184 |
| Wolfforth (Lubbock) | 2050 | 388 |
| Wilson (Lynn) | 2010 | 55 |
| Farwell (Parmer) | 2050 | 106 |
| Friona (Parmer) | 2030 | 431 |
| Tulia (Swisher) | 2020 | 417 |
| Brownfield (Terry) | 2010 | 457 |
| Denver City (Yoakum) | 2020 | 1,000 |
| Plains (Yoakum) | 2010 | 457 |
| **Total Mun Shortages** | | **29,155** |

| *County* | *Year Shortage Develops* | *Shortage in 2060 (acft/yr)* |
|---|---|---|
| **Beef Feedlot Shortages** | | |
| Castro | 2020 | 5,144 |
| Deaf Smith | 2040 | 582 |
| Hale | 2030 | 2,058 |
| Lamb | 2030 | 1,730 |
| Parmer | 2040 | 3,377 |
| **Total Feedlot Shortages** | | **12,891** |
| | | |
| **Dairy Shortages** | | |
| Castro | 2030 | 1,228 |
| Hale | 2040 | 460 |
| Lamb | 2030 | 1,280 |
| Parmer | 2030 | 1,715 |
| **Total Dairy Shortages** | | **4,683** |
| | | |
| **Total Feedlot Shortages** | | **17,574** |

*Continued next page*

***Table ES-1 Continued***

| Irrigation Shortages | *Year Shortage Develops* | *Shortage in 2060 (acft/yr)* |
|---|---|---|
| Bailey | 2010 | 83,220 |
| Briscoe | 2010 | 14,610 |
| Castro | 2010 | 345,025 |
| Cochran | 2010 | 72,083 |
| Crosby | 2010 | 6,210 |
| Dawson | 2010 | 72,967 |
| Deaf Smith | 2010 | 242,791 |
| Dickens | 2010 | 2,737 |
| Floyd | 2010 | 99,773 |
| Gaines | 2010 | 139,917 |
| Garza | 2010 | 3,212 |
| Hale | 2010 | 220,240 |
| Hockley | 2010 | 80,582 |
| Lamb | 2010 | 250,327 |
| Lubbock | 2010 | 95,586 |
| Lynn* | 2010 | 402 |
| Motley | 2010 | 1,025 |
| Parmer | 2010 | 345,960 |
| Swisher | 2010 | 107,061 |
| Terry | 2010 | 89,756 |
| Yoakum | 2010 | 17,028 |
| **Total Irrigation Shortages** | | **2,290,512** |

- Shortage in Colorado Basin area of Lynn County.

### Infrastructure Financing Survey

For the Llano Estacado Water Planning Area, all municipal water user groups having water needs and recommended water management strategies in the regional plan were surveyed using the questionnaire provided by the TWDB. Of the 32 municipal water user groups surveyed, 17 responded. The cost of water management strategies of the 17 survey respondents is $690.96 million, which is about 90.70 percent of the estimated $761.54 million of capital costs for water management strategies included in the Regional Water Plan for municipal water user groups. The respondents indicated that $117.54 million is needed from the TWDB funding programs, with $74.56 million needed for planning, design, and permitting, $34.95 million needed for acquisition and construction, $0.06 million needed from the excess capacity fund, $1.18 million needed for Rural categories, and $6.79 million needed from the “disadvantaged” fund.

## *Llano Estacado Regional Water Plan*

The LERWPG identified the following water management strategies as potential strategies to meet the projected needs of the region:

- Municipal and Irrigation Water Conservation;
- Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Water Supply;
- Water Supply from Lake Alan Henry, Groundwater Sources, and Reclaimed Water;
- Lubbock Jim Bertram Lake System Expansion - Lake 7;
- Post Reservoir;
- Lubbock North Fork Diversion Operation;
- Precipitation Enhancement;
- Brush Control;
- Desalt Brackish Groundwater;
- Research and Development of Drought Tolerant Crops and New Technology;
- Reuse of Municipal Effluent;
- Stormwater Capture and Use; and
- Public Education.

Water management strategies selected to be included in the plan to meet the needs of specific water user groups include municipal water conservation, local groundwater development for municipalities, best management irrigation practices by irrigators, and implementation of Lake 7, the Lake Alan Henry Pipeline, and Post Reservoir to meet the needs of Lubbock and its customers, while strategies that are not specific to a particular water user group, but instead are region-wide strategies include precipitation enhancement and brush control.

The proposed plan to meet the specific needs of cities located within the region is to develop additional groundwater supplies located as near as possible to each respective city. Each city with a projected need should gradually increase the number of existing wells and/or expand their well fields. Some cities will need to purchase land or groundwater rights for new well fields.

Also included in the proposed plan are non-specific strategies. These strategies would contribute to increasing the region's water supplies on a widespread scale for use by all water user groups, as opposed to being specifically applicable to an individual user group. These include precipitation enhancement and brush control.

### *Water Supply for Cities Having Projected Water Needs*

Of the 51 cities in the Llano Estacado Region, 29 were projected to need additional water supplies during the planning period. In addition, one water supply district is also projected to have needs, bringing the total number of municipal supply entities with needs to 30 (Table ES-1). In the plan, a water management strategy is presented for each city and the water supply district that is estimated to need additional water supplies. With the exception of the City of Lubbock, the water management strategy selected is “Water Supply from Nearby Groundwater Sources.” The individual plans show the approximate dates at which new supplies will be needed by each city, the distance to potentially available supply, the capacity needed, and the estimated costs for land, wells and equipment, and pipelines. In addition, the costs are expressed as total capital costs, annual debt service, annual power costs, and cost per acre-foot and per 1,000 gallons of water. Total capital cost of the plan to meet municipal water needs of the 29 cities and one water supply district having projected shortages during the period from 2010 to 2060, in September 2008 prices, is estimated at $21.23 million (Table ES-2). In addition, cost estimates for projects for Lubbock are $639.13 million, projects by CRMWA for Region O are approximately $56.57 million, and projects for White River Municipal Water District are approximately $39.15 million. The cost estimates range from $43 per acft ($0.15 per 1,000 gallons) to $3,349 per acft ($10.30 per 1,000 gallons), with one strategy having an estimated cost of $6,340 per acft ($19.45 per 1,000 gallons).

Although water supplies are included as firm yields from surface sources and dependable quantities from groundwater sources, cities are expected to follow their respective Demand Management and Drought Contingency Plans, plus implement additional water conservation, if needed, during drought.

### *Water Supply for Irrigation Having Projected Water Needs*

Of the total 8.3 million acres of cropland in production in the Llano Estacado Region, approximately 60 percent are farmed without irrigation and 40 percent are irrigated. The TWDB irrigation water demand projections for the Llano Estacado Region show a decline from the estimated level of use in year 2000 of about 4.35 million acft/yr to about 4.02 million acft/yr in 2020, and 3.47 million acft/yr in 2060. Projected irrigation water supplies available decline from about 2.94 million acft/yr in year 2010 to 1.84 million ft/yr in 2030, and 1.20 million acft/yr in

**Table ES-2**
**2011 Regional Water Plan**
**Recommended Water Management Strategies**
**Costs and Quantities of Supply**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| REGION | ID | Strategy | Total Capital Costs (Dollars) | First Decade Estimated Annual/Ave. Unit Cost ($/acft/yr) | Water Supply Volume 2010 (acft/yr) | 2020 (acft/yr) | 2030 (acft/yr) | 2040 (acft/yr) | 2050 (acft/yr) | 2060 (acft/yr) | Year 2060 Estimated Annual Average Unit Cost ($/acft/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| O | o.1 | Municipal Water Conservation | | 668 | 5,809 | 10,583 | 10,729 | 10,264 | 10,206 | 10,424 | 550 |
| O | o.2 | Irrigation Water Conservation | 345,730,000 | 63 | 479,466 | 431,517 | 388,366 | 349,528 | 314,577 | 283,118 | 106 |
| O | o.3 | Local Groundwater Development | 13,897,977 | 487 | 837 | 2,725 | 5,521 | 6,745 | 7,769 | 8,376 | 138 |
| O | o.4 | Lake Alan Henry Water District (LAH) | 7,334,502 | 3,349 | 22 | 22 | 22 | 22 | 22 | 22 | 3,349 |
| O | o.5 | Lake Alan Henry Pipeline to Lubbock | 294,329,000 | 1,310 | 21,880 | 21,880 | 21,880 | 21,880 | 21,880 | 21,880 | 1,310 |
| O | o.6 | Lubbock Jim Bertram Lake 7 | 68,288,400 | 451 | 0 | 17,650 | 17,650 | 17,650 | 17,650 | 17,650 | 451 |
| O | o.7 | Lubbock North Fork Diversion* | 153,040,000 | 6,340 | 0 | 3,675 | 3,675 | 3,675 | 3,675 | 3,675 | 6,340 |
| O | o.8 | Post Reservoir--Delivered to LAH Pipeline | 110,307,000 | 695 | 0 | | 25,720 | 25,720 | 25,720 | 25,720 | 695 |
| O | o.9 | Lubbock Brackish Groundwater Desalination | 13,167,000 | 663 | 0 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 | 663 |
| O | o.10 | White River MWD -- Reclaimed Water | 38,089,684 | 1,593 | 0 | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 | 1,593 |
| O | o.11 | White River MWD -- Local Groundwater | 1,063,625 | 43 | 0 | 7,742 | 7,742 | 7,742 | 7,742 | 7,742 | 43 |
| O | o.12 | CRMWA--Region O--Local Groundwater | 56,574,000 | 371 | 0 | 15,700 | 15,700 | 15,700 | 15,700 | 15,700 | 371 |
| | | Totals | 1,101,821,188 | | 508,014 | 517,094 | 502,605 | 464,526 | 430,541 | 399,907 | |

* Lubbock North Fork Diversion is part of a system with Dam 7 and Post Reservoir.

<><><><>

2060 resulting in a projected irrigation water shortage of 1.26 million acft/yr in 2010, and 2.31 million acft/yr in 2060.

The LERWPG recognizes that the High Plains Ogallala aquifer with any appreciable pumping, is not sustainable, however with the implementation of water conservation strategies, the longevity of the Ogallala can be appreciably extended. Ground water is an exceedingly valuable asset to all of the Region O landowners and water rights holders, whether agricultural, municipal or industrial, and justifies implementation of all currently available water conservation strategies and technologies, including refinements thereto, and all strategies which may be developed in the future. The LERWPG believes that water in the ground is like money in a bank and such should be spent wisely.

Irrigation farmers of Region O have implemented many of the irrigation water conservation application methods and farming practices considered to be the most efficient today. For example, irrigation farmers of the Region have adopted and are using the following irrigation water conservation Best Management Practices (BMPs):

1. Contour Farming;
2. Tailwater Recovery and Use;
3. Replacement of On-farm Irrigation Ditches with Pipelines;
4. Gated and Flexible Pipe for Field Water Distribution;
5. Low Pressure Center Pivot Sprinkler Irrigation Systems (LEPA and LESA);
6. Surge Flow Irrigation for Field Water Distribution Systems;
7. Furrow Dikes, Chiseling, and Deep Ripping;
8. Crop Residue Management and Conservation Tillage;
9. Linear Move Sprinkler Irrigation Systems;
10. Drip/Micro-Irrigation Systems; and
11. Volumetric Measuring.

The use of irrigation BMPs in the past has increased water use efficiency and thereby contributed to the current levels of irrigation production in the region. Such contributions are, in effect, operating to offset a part of the irrigation water shortages that have occurred in the past, and are projected to occur in the future as the Ogallala aquifer water levels decline. The Llano Estacado Regional Water Plan includes the recommendation that Llano Estacado Region irrigation farmers continue to use irrigation water conservation BMPs, and further recommends that irrigation farmers of the Region consider installation of efficient irrigation application equipment, such as LEPA and/or LESA systems on approximately 786,000 irrigated acres that have not yet been equipped with such systems. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler-applied water within the furrows, this water management strategy has the potential to meet approximately 38 percent of the projected irrigation shortages in the region in 2010, 19 percent of projected shortages in 2030, and approximately 12 percent of projected shortages in 2060. The capital cost of this irrigation water management strategy is estimated at approximately $346 million in September 2008 prices, with an annual cost of approximately $30 million. Cost per acre-foot of water conserved is estimated at $63 in 2010, $78 in 2030, and $106 in 2060. Cost per acre-foot of water conserved increases over time, since well yields are projected to decline as the aquifer levels decline, thus the irrigation equipment has less total quantity of water with which to work. However, with more efficient irrigation application methods, less water would be pumped per acre irrigated, thereby reducing farm production costs by at least the value of the energy that would have been needed to pump the water saved. Although data are not available with which to estimate its value, it is recognized that efficient irrigation methods are the major sources of income with which to make the payments to meet the capital costs of the irrigation water conservation strategy.

In addition to the recommended irrigation water conservation strategies, the LERWPG recommends the adoption of newly developed irrigation water conservation methods and site specific water management methods that are currently available or may become available in the future, such as remote sensing for irrigation scheduling, and variable rate irrigation application. Particular attention should be given to using any successful management strategies that result from the Texas Alliance for Water Conservation Demonstration Project located in Floyd and Hale Counties. The Texas Alliance for Water Conservation Demonstration Project is an eight-year study to identify and quantify the best agricultural production practices and technologies to reduce groundwater pumpage from the Ogallala aquifer, while maintaining agricultural production and economic opportunities.

### *Region-Wide Water Management Strategies Included in the Llano Estacado Water Plan*

#### *Precipitation Enhancement*

Precipitation enhancement has the potential to increase the quantity of water that would be available to many water user groups in the Llano Estacado Region, as well as reduce pumpage requirements from the Ogallala aquifer. Although available data and cloud seeding results are not adequate to give reliable estimates of long-term increases in precipitation, the present information indicates that precipitation can be increased by cloud seeding.

Additional precipitation during the growing season would directly and immediately benefit dryland and irrigated agriculture. Crop and grazing yields could be increased, irrigation water pumped from the Ogallala aquifer could be reduced, and lawn irrigation could be reduced. The latter effect would contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additional rainfall runoff would be collected in public water supply surface water reservoirs and in playa lakes, which could increase recharge to the aquifer, as well as provide water for wildlife.

### *Brush Control*

Brush control could increase the water supply in the Llano Estacado Region by increasing quantities of water for recharge to the aquifers and increasing runoff into lakes and reservoirs. The areas of the region where significant concentrations of brush occur are in the east "caprock counties" and in the western counties.

Of the 21 counties in the region, 13 counties have 50,000 or more acres of mesquite and shinnery oak combined. The counties located on the eastern side of the planning area below the caprock have the highest acreages of mesquite, salt cedar, and shinnery oak and would primarily be the locations where brush control can be applied to increase water supplies. Salt cedar control is vitally important to the Llano Estacado Water Planning Region, since this plant can consume up to 200 gallons of water per plant per day. As has been demonstrated in Crosby County on the White River Reservoir watershed, brush control can contribute to increased inflows to a reservoir. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. Brush control projects on the watersheds of these two reservoirs could result in increased firm yields and thereby contribute to the region's water supply.

The capital outlay to implement brush control on 50 percent of the mesquite and shinnery oak infested acres in counties having more than 50,000 acres of these two species of brush is estimated at $53.33 million, with an annual cost of $3.53 million. For example, if brush control were to be implemented on the Alan Henry Reservoir contributing watershed, the annual cost would be approximately $420,875. If the yield of the reservoir were increased by 10 percent (or

2,250 acft/yr), the cost per acft of raw water yield at the reservoir would be $187—or $0.57 per 1,000 gallons.

### *Desalination of Brackish Groundwater*

The potential source of water for desalination is the Santa Rosa Aquifer of the Dockum Formation, which underlies the entire area of the Llano Estacado Region. Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment. Water treatment cost estimates vary with salinity concentration, treatment plant size, and method of concentrate disposal. Estimated total cost of desalted water, including raw water, desalination, and concentrate disposal for a 1.0 MGD size facility to desalt 3,000 mg/L water is $1,825 per acft ($5.60 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,909 per acft ($5.86 per 1,000 gallons). Total cost of desalted water, including raw water, desalination, and concentrate disposal for a 3.0 MGD size facility to desalt 3,000 mg/L water is $1,601 per acft ($3.85 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,618 per acft ($4.96 per 1,000 gallons).

### *Use of Reclaimed Water*

Examples of the use of reclaimed water are the use of treated municipal effluent for irrigation of golf courses, parks, cemeteries, and other public lands, irrigation of agricultural land near to or adjacent to the town or city from which the effluent is obtained, and in some cases, for public supply. In the Llano Estacado Region, the primary use of reclaimed municipal and feedlot wastewater is to irrigate farmland. Approximately 95 percent of all the water obtained from the Ogallala aquifer is used for irrigation purposes. By substituting water pumped from the Ogallala aquifer with reclaimed water, the amount of groundwater withdrawal can be decreased.

### *Municipal Water Conservation*

Municipal water is freshwater that meets drinking water standards. Such water is supplied by both public and private utilities. In areas not served by water utilities, private wells supply individual households. The objective of the municipal water conservation option is to reduce per capita water use without adversely affecting the quality of life of the people involved. The municipal water conservation water management strategy is estimated to meet 5,809 acft per year of municipal water needs in Region O in 2010, 10,583 acft per year in 2020, 10,264 acft per year in 2040, and 10,424 acft per year in 2060 (Figure ES-2). In terms of projected municipal water demand, the municipal water conservation water management strategy could meet about 9.8 percent of the projected municipal water demand of 105,939 acft per year in 2060. The proposed municipal water conservation water management strategy has the potential to reduce per capita water use in the region from an average of 180 gallons per person per day in 2010 to 154 gallons per person per day in 2060 (Figure ES-2). Municipal water conservation strategies are strongly recommended.

### *Agricultural Water Conservation Practices on Farms*

Dryland and irrigation farmers in the Llano Estacado Region attempt to obtain maximum benefit from the use of the precipitation they receive on their farms. Irrigation application methods have been the subject of research and development since irrigation became possible in the Llano Estacado Region in the 1930s, and in recent decades there have been significant improvements in irrigation application and conservation methods. The following irrigation practices are currently being used in the planning region; (1) Subsurface Drip Irrigation—SDI, (2) Low Energy Precision Application—LEPA pivot, (3) Low Elevation Spray Applicator/Low Pressure in Canopy—LESA/LPIC, (4) Surge Valves, (5) Pipelines, (6) Lay Flat Tubing, (7) Furrow Diking and Chiseling, and (8) Soil Moisture Monitoring. These methods and practices improve water use efficiencies and sustain present water supplies from the region's aquifers.

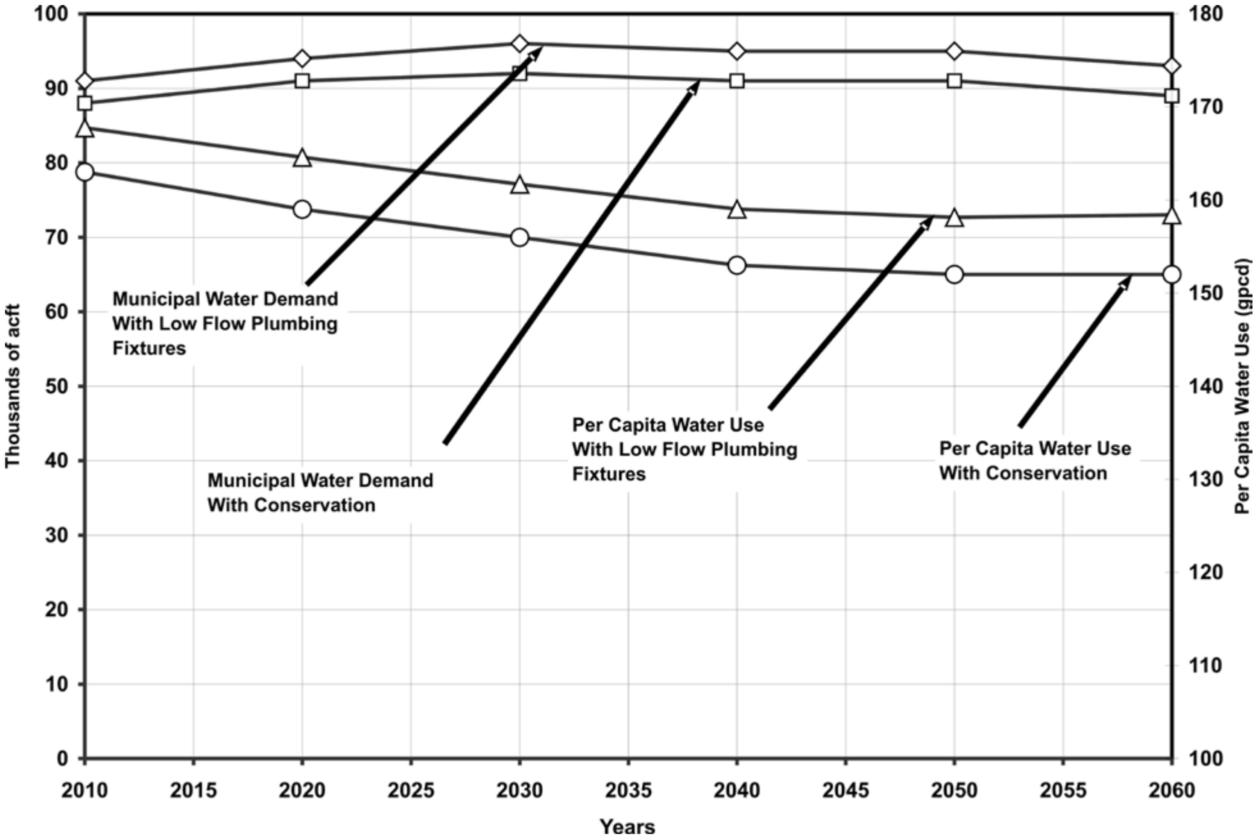


***Figure ES-2. Municipal Water Demand Without and With Water Conservation***

### *Research and Development of Drought Tolerant Crops and New Technology*

Both public and private agricultural research organizations are presently engaged in research on plant crop breeding, plant nutritional needs, and cultural practices to improve the productivity, quality, and other characteristics of crops that can be produced in the Llano Estacado and other regions of Texas, the United States, and other countries of the world. The LERWPG recommends that funding be continued in adequate levels for research and development of new and improved technology in the fields of drought tolerant strains of crops, new or alternative crops for arid and semiarid regions, plant nutritional needs, irrigation application methods, brush control, weather modification, aquifer recharge, and development of better information about the aquifers and other water resources of the region.

### *Reuse of Municipal Effluent*

Of the total quantities of water used for municipal purposes, 45 percent to 65 percent is returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Region, a large percentage of this treated effluent, or reclaimed water, is used for irrigation of open spaces, golf courses, and neighboring farmland. This water could become a significant source of municipal water in the future if treatment levels were increased to the extent that the use of this water does not pose a health risk. The LERWPG highly recommends that funding be made available to universities, water districts, and the cities to further study the quantity of water available from this option and to study treatment technologies to make this option feasible.

### *Stormwater Capture and Use*

In some cities of the Llano Estacado Region, disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, and use this water as a source of supply for non-potable as well as potable uses. The LERWPG strongly recommends that funding be made available to the cities and water districts to further study the quantity of water available from this option and to develop ways to successfully integrate flood protection, storage, and treatment of this storm water for useful purposes, including municipal supply.

### *Protecting and Enhancing Playas and Playa Watersheds*

Protecting uplands surrounding playas can significantly slow their siltation. Maintaining the integrity of these basins ensures that they serve as catchments that provide valuable wildlife habitat and provide recharge to the Ogallala aquifer. Measures to protect playa drainages include planting of native grass buffer strips and fencing to control grazing. The LERWPG recommends best management practices on playa watersheds that enhance their function as wildlife habitat and as a recharge source for the Ogallala aquifer.

### *Public Education*

Underground water conservation districts, cities, universities, the Texas Agricultural Extension Service, and other water agencies will continue existing education and information dissemination programs. In addition, Llano Estacado Region water suppliers and agencies will build a strong cooperative relationship with formal and informal educators including the region's Educational Service Centers and Independent School Districts.

### *Concluding Comments*

**Water Conservation**: In 2003, the 78th Texas Legislature passed Senate Bill 1094 which established a task force to "review, evaluate, and recommend optimum levels of water-use efficiency and conservation for Texas and to concentrate on issues related to (1) best-management practices, (2) implementation of conservation strategies contained in regional water plans, (3) a statewide public-awareness program, (4) state funding of incentive programs, (5) goals and targets for per-capita water use considering climatic and demographic differences, and (6) evaluation of state oversight and support of conservation. In addition, Senate Bill 1094 directed the Task Force to develop a best-management practices guide (BMP Guide) for use by LERWPGs and political subdivisions responsible for water-delivery service."

The Water Conservation Implementation Task Force Report was published in November 2004 and made available to the Regional LERWPGs. The LERWPG has reviewed this document and has incorporated applicable water conservation strategies and best management practices into this water plan. Consistent with the strategies recommended in this plan, the LERWPG believes that:

1. A statewide public awareness initiative is critically needed,
2. Environmental practices should include protection and rehabilitation of playa basins and encouragement of landowners to maintain springs and seeps as they exist,
3. Municipal conservation must be implemented to achieve the goal of 172 GPCD, and
4. Application of new conservation technologies will need to be considered and applied in the future as appropriate.

**Water Planning:** The LERWPG has discussed at great length the planning process and the profound effect which the key parameters (population, water demand, and water supply) have on the accuracy and validity of the final plan and recommendations. All three key parameters for the most part have been provided to the LERWPG by the TWDB, with provisions for review and change to this fundamental data. The data, once accepted, then formed the foundation for the strategies and recommendations that are needed to close the gap between supply and demand.

Major topics of the discussion were the definitions of "water demand" and "water supply." For example, should water demand be the quantity of water that would be needed to irrigate every farmable acre in the region, to grow the crops of choice, and to support the population growth associated with the increased agricultural and industrial activities? Or should demand projections be tempered to recognize the hydrologic limits, economic realities, and acres that can realistically be irrigated? The LERWPG recognizes that this region of the State is and will continue to be water-supply limited, and therefore, the regional water plan should recommend conservation measures and infrastructure changes that will support the population necessary to maintain a realistic level of agriculture and industry.

Within the context of regional water planning, questions regarding water supply are paramount. Once it is recognized that the region is water-supply limited, it becomes clear that the other two key parameters - “actual demand” and “actual population” – are directly dependent on “supply.” The LERWPG then must address two fundamental supply questions – how much do we have and how long can it be made to last? Again, the TWDB has provided data based on GAM runs that predict the supply of water available for use. The accuracy of these numbers has been called into question, as will be illustrated below. At the very least, the LERWPG believes that more study is needed to calibrate the results and to better understand the dynamics of the aquifer (local irrigation withdrawals, local recharge, local irrigation return flows, and lateral flow in the aquifer). More work is clearly needed to determine available water in storage. However, for the 2011 plan, the LERWPG has concluded that the TWDB data must be used as better data cannot be collected and reviewed within the scheduled timeline for this round of planning, but great strides can, and must be made in the next round.

Groundwater modeling and extensive measurements of water in storage strongly suggest that the Ogallala aquifer has greater recharge capability than has been historically estimated. The recharge of the aquifer is obviously a very critical factor in the water planning process. The LERWPG believes that a more aggressive effort is needed to both understand the recharge mechanisms of the Ogallala and to find ways to enhance that recharge. Whatever can be done to increase supply in the aquifer will have a major impact on the region and will improve the economy of the area.

The LERWPG is relatively more comfortable with and confident in the municipal demand and supply estimates than those provided for agricultural irrigation. The municipalities have infrastructure, record-keeping, and reporting procedures that provided the municipal water use data to the TWDB that the TWDB used to make the municipal water demand projections. The municipal water demand projections were reviewed and confirmed in light of municipal water use information.

The dilemma that the LERWPG has tried to resolve, unsuccessfully, has been that the data which has been provided by the TWDB does not appear to realistically represent the irrigation conditions in Llano Estacado Water Planning Region (Region O). For example, the irrigation demands utilized in this plan were strongly impacted by a single high-demand drought year of 2000. In addition, the GAM runs that were provided in support of this planning effort suffer from inaccurate starting storage volumes, as compared to 1995 or 2000 observations, in many of the Region O counties, and provided what appear to many of the LERWPG members to be unrealistic estimates of quantity of water available annually (See Appendix E). For example, the GAM runs of water supply available annually from the aquifer in Bailey and Dawson Counties are cited here to illustrate the LERWPG's questions about the water demand and water supply data from which it was necessary to calculate the projected irrigation water needs (shortages). In the case of Bailey County, the GAM runs resulted in quantity of water supply available to meet only 15 percent of projected demands in 2020 (GAM supply in 2020 = 27,300 acre-feet; Demand in 2020 = 173,622 acre-feet), 12 percent in 2030, and 10 percent in 2060, while leaving over 80 percent of estimated quantity of water in storage in 2004 still in storage in 2060. In the case of Dawson County, the GAM runs provided estimates of supplies available to meet 65 percent of projected 2010 demands, 55 percent of 2030 projected demands, and 60 percent of 2060 projected demands, while adding 10 percent to estimates of quantity of water in storage over the 55-year projections period. Given these examples, the LERWPG made some revisions and adjustments to the water supply data provided by the GAM, however, the LERWPG did not have a fast, low-cost means to develop better data based on sound science with which to improve upon the TWDB estimates. Since better data were not available, the LERWPG had no option but to proceed using the only data available, those from the TWDB.

The LERWPG recognizes that the planning process, with periodic updates to the plan will serve to allow the introduction of new and more advanced BMPs and better data in the longer term. Ongoing and new efforts by the groundwater conservation districts will provide better estimates of actual irrigation withdrawals and volumes of water in storage. The LERWPG recommends that current and future developed and refined irrigation water conservation methods be implemented to the extent possible, in order to extend the life of the irrigation water supply and meet as much of the projected irrigation water demand as possible.

The LERWPG recognizes and emphasizes that the water plan for this region is very heavily driven by agriculture. Therefore, the overall plan for the region will be irrigation water-supply limited and LERWPG recommendations must focus on how to best utilize the available supply to the maximum benefit of the people of the region.

The ultimate water management question is "how long can the available supplies be made to last?" It is well recognized that the freshwater supply in West Texas is a finite resource that is not sustainable. It is being depleted. Should attempts be made to slow the depletion and in so doing restrict the economic vitality of the region? Should the plan favor expanded economic development, recognizing that the available water resource will be depleted more quickly? This is the crux of the water planning process in Region O. For this reason, the LERWPG has chosen to strongly recommend water conservation Best Management Practices (BMPs) for both municipal and irrigated agriculture so that the economy of the region can be sustained as closely as possible to the current level. The projected water use seems to suggest a trend of 50 percent depletion of the current supply over a 50-year period. This 50/50 water use scenario appears to be a trend that is evolving naturally. Conservation efforts coupled with initiatives to supplement the supply such as improving recharge, brush control, and weather modification will all serve to reduce depletion, which will translate into improved economic benefits and longevity of the region. The recommendations that evolve from this strategy of sustaining the economy of the region put a high focus on water conservation and supply enhancements. To the extent that unnecessary water use can be eliminated, those volumes can be applied to other uses beneficial to the economy and people of the region.

In summary, the water plan for the Llano Estacado Region of Texas does not recognize the "demand" projections to be the total volume of water that can be provided through water conservation water management strategies and recommendations. Instead, the LERWPG recognizes that the "supply" projections serve to reflect the total expected quantity of water available for use in the region. The irrigation water conservation strategies can reduce the projected irrigation shortages, however, the irrigation water conservation water management strategy will not result in enough irrigation water savings to meet the total projected irrigation water shortages. For agriculture, the "supply" and "actual demand" curves are synonymous and all implemented conservation measures translate into immediate additional opportunity for the regional economy and extending the longetivity of the Ogalalla aquifer. In the case of municipal water use, water conservation can have an immediate impact on the demand for water. Toward that end, the conservation strategies and recommendations in the plan are aimed at improving the utilization of those projected volumes to the maximum extent practicable.

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# *Section 1*
# *Planning Area Description*
# *[31 TAC §357.7(a)(1)]*

## *1.1 Introduction*

In 1997, Senate Bill 1 was enacted by the 75th Texas Legislature to address experiences of drought and the needs of utilities and water management entities to meet the water supply needs of the State's growing population and economy. The new law emphasized the development of water plans at the regional level with greater local participation and input in order to gain acceptance and commitment to implementation. In addition to requiring the best information possible to guide future water resource decisions, Senate Bill 1 also provided that future regulatory and financing decisions of the Texas Commission on Environmental Quality and the Texas Water Development Board (TWDB) be consistent with approved regional plans. As stated in Senate Bill 1, the purpose of this regional planning effort is to:

> "Provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

The TWDB is the state agency designated to coordinate the overall statewide planning effort. After seeking public input, the TWDB divided the state into 16 planning regions. In the South Plains of Texas, a 21-county area was delineated by the TWDB as Planning Region O, which was subsequently named the Llano Estacado Regional Water Planning Region (herein referred to as the Llano Estacado Region). The counties of the region are:

1. Bailey
2. Briscoe
3. Castro
4. Cochran
5. Crosby
6. Dawson
7. Deaf Smith
8. Dickens
9. Floyd
10. Gaines
11. Garza
12. Hale
13. Hockley
14. Lamb
15. Lubbock
16. Lynn
17. Motley
18. Parmer
19. Swisher
20. Terry
21. Yoakum

The Llano Estacado Regional Water Planning Group (LERWPG) was appointed by the TWDB to represent eleven stakeholder interests, as specified in Senate Bill 1, and to act as the steering and decision-making body of the regional planning effort. Terms of Office of LERWPG

***Table 1-1.***
***Current Members and Representation of the***
***Llano Estacado Regional Water Planning Group***

| |
|---|
| ***Voting Members — Water User Group*** |
| H. P. Brown, Jr., Chair, — Agriculture/Cattle |
| Jim Conkwright, Vice Chair — Water Districts |
| Doug Hutcheson, Secretary/Treasurer — Water Utilities |
| Melanie Barnes, Ph.D. — Public |
| Alan Bayer — County Government |
| Delaine Baucum — Agriculture |
| Bruce Blalack — Municipalities (Large) |
| Delmon Ellison, Jr. — Agriculture |
| Aubrey Spear, — Municipalities (Large) |
| Harvey Everheart, — Water Districts |
| Bill Harbin — Electrical Generation |
| Mark Kirkpatrick — Agriculture |
| Bob Josserand — Municipalities (Medium) |
| Richard Leonard — Agriculture |
| Michael McClendon — River Authorities |
| Don McElroy — Small Business |
| E.W. (Gene) Montgomery — Oil & Gas |
| Ken Rainwater, Ph.D. — Public |
| Kent Satterwhite — Water Districts |
| Jim Steiert — Environment |
| John Taylor – Municipalities (Small) |
| ***Non-voting Members — Agency*** |
| Angela Kennedy, P.E. — Texas Water Development Board |
| Herb Grubb, Ph.D.—Technical Consultant, HDR Engineering, Inc. |
| John Clayton — Texas Parks and Wildlife Department |
| Steve Jones — Texas Department of Agriculture |
| Malcolm Laing — Texas Commission on Environmental Quality |

members and methods of replacement are specified in the LERWPG By-Laws, with current LERWPG membership listed in Table 1-1. Non-voting members include representatives of state agencies.

After considerable discussion, the LERWPG adopted a Mission Statement, dated April 16, 1998, which reads:

> "Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Llano Estacado Regional Water Planning Area of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities."

This Mission Statement is meant to keep the LERWPG focused on the fact that the economy of the region is highly dependent upon agribusiness, which is totally dependent upon a reliable water supply.

The LERWPG designated the High Plains Underground Water Conservation District No. 1 as the political subdivision to act on behalf of LERWPG as principal contractor to apply for and administer a grant from the TWDB to develop the Water Plan. The prime planning and engineering consultant is HDR Engineering, Inc.

On January 3, 2001, the LERWPG adopted and submitted to the TWDB the "Llano Estacado Regional Water Planning Area Regional Water Plan." In response to directives of Senate Bill 2 (77$^{th}$ Texas Legislature, 2001), the LERWPG prepared a Scope of Work and Budget to update and revise the January 3, 2001, Llano Estacado Regional Water Plan, and on April 1, 2002, the LERWPG applied to the TWDB for funding to accomplish the update and revision directed by Senate Bill 2. The updated and revised 2006 Llano Estacado Regional Water Plan was adopted and submitted to the TWDB on January 3, 2006, and on April 18, 2006, the TWDB approved the 2006 Llano Estacado Regional Water Plan. In response to the TWDB requests for proposals of February 8, 2008, on June 13, 2008, the LERWPG submitted an application and scope of work to the TWDB for Phase II of the third round of regional water planning. The application was approved by the TWDB, and the updated and revised 2011 Llano Estacado Regional Water Plan is presented below.

The planning horizon used by the LERWPG and all other water planning groups for the 2011 plan is the 50-year period from 2010 to 2060. This planning period allows for a long-term forecast of the prospective water situation, sufficiently in advance of needs, to allow for appropriate management measures to be implemented. As required in Senate Bill 1, the TWDB specified planning rules and guidelines (31 TAC §357.7 and §357.12) to focus the efforts and to provide for general consistency among the regions so that the regional plans can then be aggregated into an overall State Water Plan by January 2012. Besides specifying overall report and data formats, the TWDB rules also require the maximum use of existing state water planning information, except where better information is available. As authorized by Senate Bills 1 and 2, the TWDB has provided for coordination mechanisms among the regions where regions share common water issues.

## *1.2 Physical Description of the Region, Including the Economy, Water Use, Water Supplies, Water Quality, and Major Entities with Water Resources Management Responsibilities*

### *1.2.1 Description of the Region*

The 21-county Llano Estacado Region has an area of 20,294 square miles (12,988,160 acres), about 7.5 percent of the state's land area (Figure 1-1) and is located in the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado). Of the total area, 94 square miles are located in the Canadian Basin, 6,681 square miles are located in the Red Basin, 8,732 square miles are located in the Brazos Basin, and 4,787 square miles are located in the Colorado Basin. The region is bounded on the west by the Texas-New Mexico border, on the north by TWDB Planning Region A, on the south by TWDB Planning Region F, and on the east by TWDB Planning Regions B and G. The region extends beyond the "caprock" escarpment and the eastern extent of the Ogallala into the Rolling Plains, and although the region is located in the upstream parts of the Canadian, Red, Brazos, and Colorado River Basins, almost no surface water exists within the region.

The regional population of 453,997 represents about 2.2 percent of the state total population of about 20.85 million persons in 2000.[1] Ten major cities with a population greater than 5,000 persons are located in the region, with these population centers relatively equally distributed within the 21 counties of the planning area. Lubbock County is the only county that contains more than one population center of 5,000 or more (Cities of Lubbock and Slaton). Twelve counties in the region (Bailey, Briscoe, Castro, Cochran, Crosby, Dickens, Floyd, Garza, Lynn, Motley, Parmer, and Yoakum) do not contain a city of greater than 5,000 persons.

[1] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.

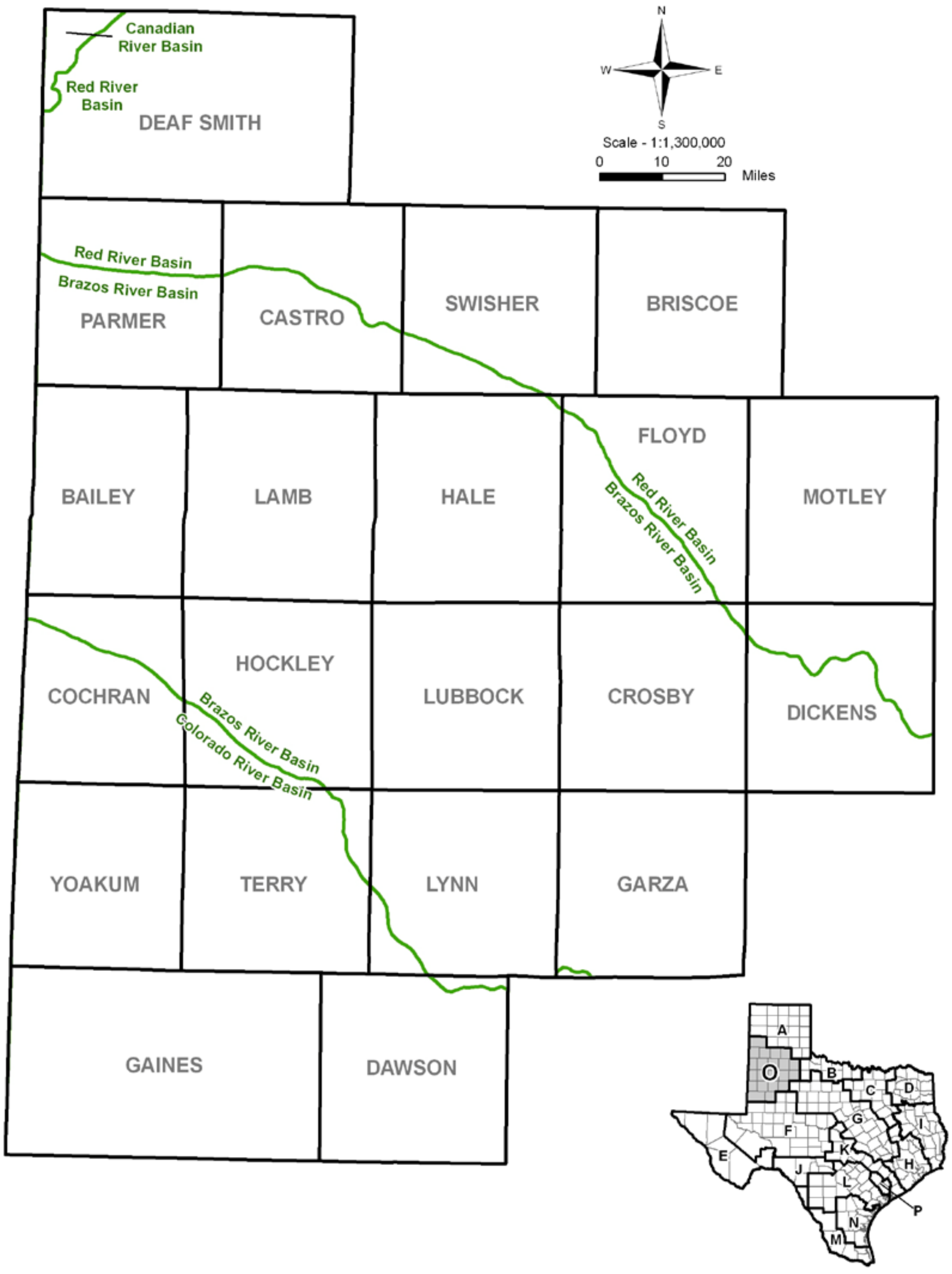


***Figure 1-1. Map of Llano Estacado Water Planning Region***

### *1.2.2 Climate*[2]

The climate of the Llano Estacado Region is classified as a dry, steppe type. The region is characterized as semi-arid and experiences a wide range in temperatures. In spite of occasional periods of very low temperatures, the winters in the region are generally mild. Although afternoon temperatures in the summer are hot, the season is usually a pleasant one with cool nights. Spring offers the greatest variety in weather. It is also the windiest season of the year, and occasionally strong winds carry blowing dust.

In an average year, about 80 percent of the annual rainfall total occurs during the warm season (May through October). Monthly rainfall quantities ordinarily decline markedly in the colder months of the year, when frequent periods of cold, dry air from North American polar regions surge southward and cut off the supply of moisture from the Gulf of Mexico. Mean annual precipitation in the region ranges from a high of 22 inches per year in Crosby County to a low of 16 inches per year in the southern areas of the region. Values for annual net lake surface evaporation range from a high of 65 inches per year for the southern portion of the region to a low of 53 inches per year in the north. A summary of the climatological conditions for the region is shown in Table 1-2.

***Table 1-2.***
***Climatological Data for Llano Estacado Region***

| | | | | *Temperature* | | | | | *Annual Net Lake Surface Evaporation (inches)* |
|---|---|---|---|---|---|---|---|---|---|
| | *Precipitation* | | | | *Mean Daily Minimum* | | *Mean Daily Maximum* | | |
| *River Basin* | *Mean Annual (inches)* | *Wettest Month(s)* | *Driest Month(s)* | *Mean Annual (°F)* | *January (°F)* | *July (°F)* | *January (°F)* | *July (°F)* | |
| Canadian | 23 | July | Jan. | 60 | 21 | 67 | 53 | 93 | 53 |
| Red | 19 | May, June | Jan., Feb. | 58 | 22 | 65 | 51 | 93 | 53 |
| Brazos | 18 | May, June | Dec. | 58 | 25 | 67 | 53 | 92 | 54 |
| Colorado | 16 | May, Sept. | Feb. | 62 | 26 | 67 | 56 | 95 | 65 |

Source: Texas Water Development Board.

[2] "Continuing Water Resources Planning and Development for Texas," Texas Water Development Board, Austin, Texas, May 1977.

### 1.2.3 Physiography, Geology, Soils, and Vegetation[3]

The Southern High Plains area of Texas, spanning much of the Llano Estacado Region, is the most southerly extent of the Southern Great Plains of the United States. Land elevations in the region generally range from about 1,900 feet-mean sea level (ft-msl) in the southeast to 4,300 ft-msl in the northwest. The relatively level plateau of the Southern High Plains contains many shallow depressions, or playa basins, a few of which hold water more or less permanently (Section 1.6.4). There is broken terrain in the northwest corner of the planning region and on the eastern side of the planning region, which is a part of the Rolling Plains physiographic region, below the caprock escarpment.

Fluvial sands, clay, silts, and gravels of the Tertiary Miocene/Pliocene Ogallala Formation underlie the majority of the region. The uppermost portion of the formation is a resistant caprock caliche. The Ogallala Formation is overlain by the Quaternary aged Blackwater Draw Formation. Throughout the area recent aged fluvial deposits occur along major stream valleys.

The principal aquifer in the Llano Estacado region, the High Plains aquifer, is colloquially referred to as the Ogallala aquifer.[4] Although researchers prefer the terminology High Plains aquifer, in order to minimize confusion, this document will use the terminology Ogallala aquifer as a substitute for High Plains aquifer. The Ogallala aquifer (High Plains aquifer) consists of the saturated section of the Ogallala formation as well as those underlying and overlying geologic units that are in hydraulic continuity. The Ogallala formation consists chiefly of sediments deposited by streams with headwaters in the mountainous regions to the west and northwest. The Ogallala formation was deposited on the eroded surfaces of underlying Triassic and Cretaceous aged sediments. In general, the Ogallala formation is thicker in the northern part of the area, with the thickness ranging from 400 to 500 feet in central Parmer, west-central Castro, and southwestern Floyd counties to a knife edge where the formation pinches out against outcrops of older rocks.

The original blanket of sediments which formed the Ogallala Formation extended from the Rocky Mountains eastward through north central Texas. The Ogallala Formation has

[3] Ibid.

[4] McGuire, V.L., M.R. Johnson, R.L. Schieffer, J.S. Stanton, S.K. Sebree, and I.M. Verstraeten, 2003, Water in storage and approaches to ground-water management, High Plains Aquifer, 2000: U.S Geological Survey Circular 1243, U.S. Department of the Interior, Reston, Virginia, 51p.

subsequently been eroded such that the segment in southeastern New Mexico and the Southern High Plains of Texas is isolated in all directions from underground connection with other water-bearing beds, except through underlying older sediments, which may contain highly mineralized water unlike the fresh water in the Ogallala aquifer. This emphasizes the fact that in Texas and New Mexico, the source of the recharge to the Ogallala aquifer is precipitation falling on the unconsolidated lacustrine, fluvial, and eolian deposits sediments which overlie the Ogallala Formation. Thus, these Quaternary aged materials serve as important conduits for recharge to the Ogallala aquifer. The amount of recharge depends on many factors, including the amount, distribution, and intensity of precipitation and the type of soil and vegetative cover. Annually the amount of recharge has been estimated to be from less than one-half inch to about 3 inches. One-half inch of recharge on the 12,988,160 acres of the region would equal 541,173 acre-feet (acft) of water, whereas 3 inches of recharge would equal about 3,247,040 acft of water.

Generally, the water in the Ogallala aquifer occurs under water-table conditions, although locally it may be under slight artesian pressure. The water in the Ogallala aquifer occupies the pore spaces or voids in the unconsolidated sediments. The thickness of the zone of saturation in the Ogallala aquifer varies throughout the Llano Estacado region ranging from less than 1 foot to more than 300 feet. The transmissivity of the Ogallala aquifer varies widely. Tests at Amarillo indicate a coefficient of 6,000 to 7,000 gallons per day (gpd) per foot and tests in the vicinity of Plainview indicate a transmissivity of about 34,000 gpd per foot. Numerous tests, both in the laboratory and in the field, indicate an average specific gravity yield of about 15 percent. In general the movement of water in the Ogallala aquifer is from the northwest to the southeast. The water-table slopes roughly parallel to the slopes of both the bedrock and land surface with the average slope of the water-table being about 8 to10 feet per mile. The rate of movement of water in the formation has been estimated to be about 150 feet per year, on a gradient of 10 feet per mile.

The long-term trend throughout the region has been a steady decline in the water table, due primarily to large quantities of water withdrawn for irrigation. The depth to water below land surface is affected by the topography of the land surface, the proximity to areas of recharge or natural discharge, the proximity of pumping wells, and the configuration of the bedrock surface. The depth to water in the aquifer within the region ranges from less than 50 feet to more than 300 feet.

The Ogallala aquifer is classified as a major drinking water aquifer in the State of Texas. The water in the Ogallala aquifer in the Llano Estacado Region can generally be said to be of good chemical quality, except that it is "hard", due to high levels of calcium and magnesium. This causes the water to consume soap before it will lather. It may result in scale being formed in water heaters and pipes. It also contains a high silica content, which also can cause scale. Most of the water is suitable for irrigation and meets the U.S. Public Health Service recommendations for public supplies, although the water from some wells has excessive fluoride content.

Cretaceous-aged sediments directly underlie the Ogallala Formation in much of the central portion of the Southern High Plains, extending from New Mexico on the west to Garza County on the east and into the southern portions of Bailey and Lamb counties to the north and the northern portions of Gaines and Dawson counties to the south. Cretaceous-aged sediments are comprised of the Trinity, Fredericksburg, and Washita groups, consisting primarily of sandstone, shale, and limestone; the sandstone and limestone being the principal water-bearing units. In places where the Cretaceous rocks are in hydraulic continuity with the overlying Ogallala Formation, moderate quantities of water can be obtained, particularly from the limestone. Locally, the Cretaceous rocks may be important aquifers where other water is not available; however, the Cretaceous-aged sediments generally do not constitute a large source of water for irrigation or municipal use.

Upper Triassic-aged rocks underlie the Cretaceous or directly underlie the Ogallala Formation in the Llano Estacado Region. The Dockum sediments are comprised of the Cooper Canyon, Tecovas, Trujillo, and Santa Rosa formations. The Cooper Canyon, Trujillo and Tecovas formations consist chiefly of interbedded siltstone, mudstone, sandstone, and shale, while the Santa Rosa Formation consists mainly of medium to coarse conglomeratic sandstone. The formations of the Dockum Group are capable of yielding small to moderate quantities of water in many parts of the region, particularly in the coarser grained Santa Rosa Formation. However, in most places, the water quality can be saline to briny and probably unsuitable for most purposes. There are some areas, particularly in Deaf Smith County, where good supplies of fresh water are produced from the Dockum aquifer.

Below the Triassic, rocks of Permian Age underlie the entire area and consist chiefly of red sandstone and shale containing numerous beds of gypsum and dolomite. The Permian rocks are not a significant source of water in the Llano Estacado Region. Water in these rocks contains gypsum and salts and is generally unsuitable for domestic use. However, it is used in the Rolling Plains area for livestock water.

The soils and the characteristics of the soils of the region are described in detail in a 1999 report, "Soils of the Llano Estacado Regional Water Planning Region" by Gerald Crenwelge, USDA, NRCS Soil Scientist. There are 15 general soil types in the region, 80 to 85 percent of which are suitable for irrigation.

The original vegetation of the High Plains was variously classified as mixed prairie, shortgrass prairie, and in some locations on deep sandy soils, as tallgrass prairie. Blue grama, buffalograss, and galleta were the principal natural vegetation on the clay and clay loam soils. Characteristic grasses that were on sandy loam soils are little bluestem, western wheatgrass, sideoats grama, and sand dropseed.

The High Plains area is characteristically free from brush, but sand sagebrush, along with pricklypear and yucca, have invaded the ranchland that have sandy and sandy loam soils. Honey mesquite has invaded the ranchland on most soils in the region. Several grass species of dropseeds are abundant on land containing coarse sandy soils. The playa depressions, which can contain several feet of water after heavy rains, support unique patterns of vegetation within their confines. Various aquatic species, such as curltop smartweed, are associated with the playa basins.

### 1.2.4 Natural Resources

#### 1.2.4.1 Water Resources

The Llano Estacado Region includes the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado) and overlies the southern part of the Ogallala aquifer, a small area of the Seymour aquifer, and two minor aquifers [Dockum and Edwards-Trinity (High Plains) aquifers], as shown in Figures 1-2 and 1-3. Details about the surface water and groundwater resources are presented in Section 1.6. Within the Llano Estacado Planning Area, none of the streams carry much water, except briefly after heavy precipitation events. Almost no water flows from the region via the rivers.

Precipitation is the only reoccurring/renewable water supply for the Llano Estacado Region, with an average annual value of 18.4 inches (1945 through 2002), or 19,915,179 acft of water over the 12,988,160-acre region (Figure 1-4). Precipitation meets about 60 percent of urban landscape water and irrigated crop demands, provides all the water available for surface

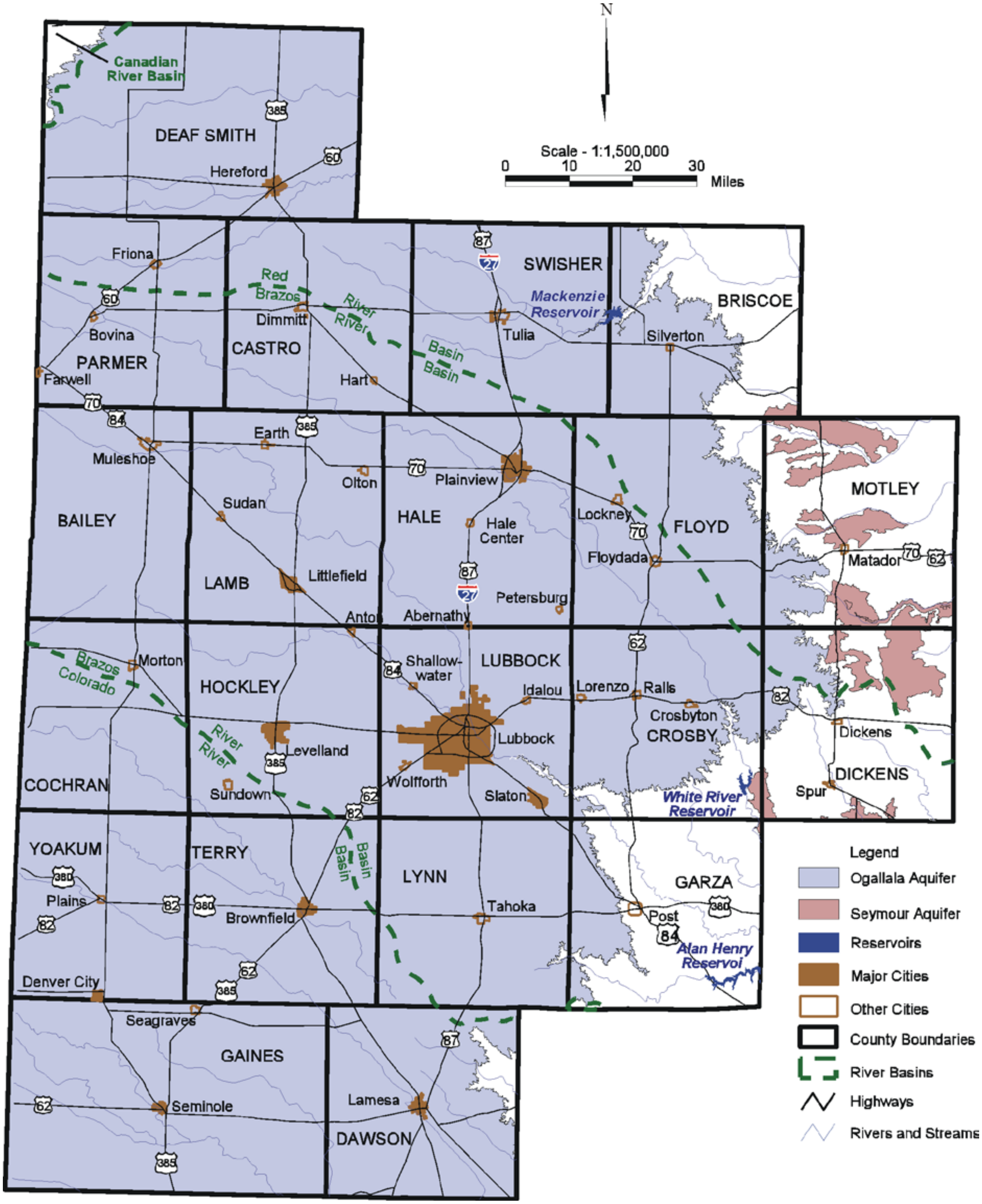


***Figure 1-2. Map of Llano Estacado Region — Major Aquifers and River Basin Boundaries***

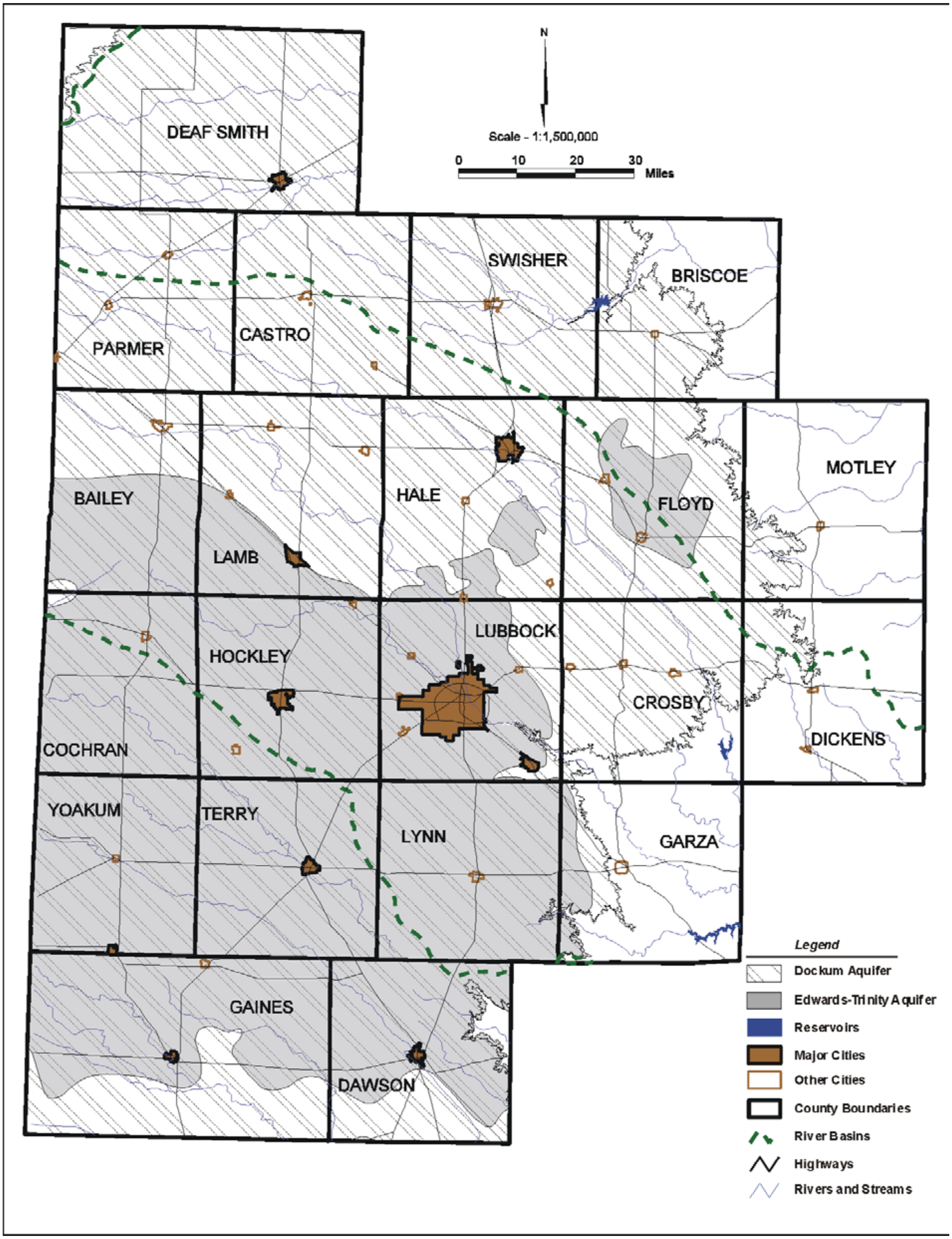


***Figure 1-3. Map of Llano Estacado Region — Minor Aquifers and River Basin Boundaries***

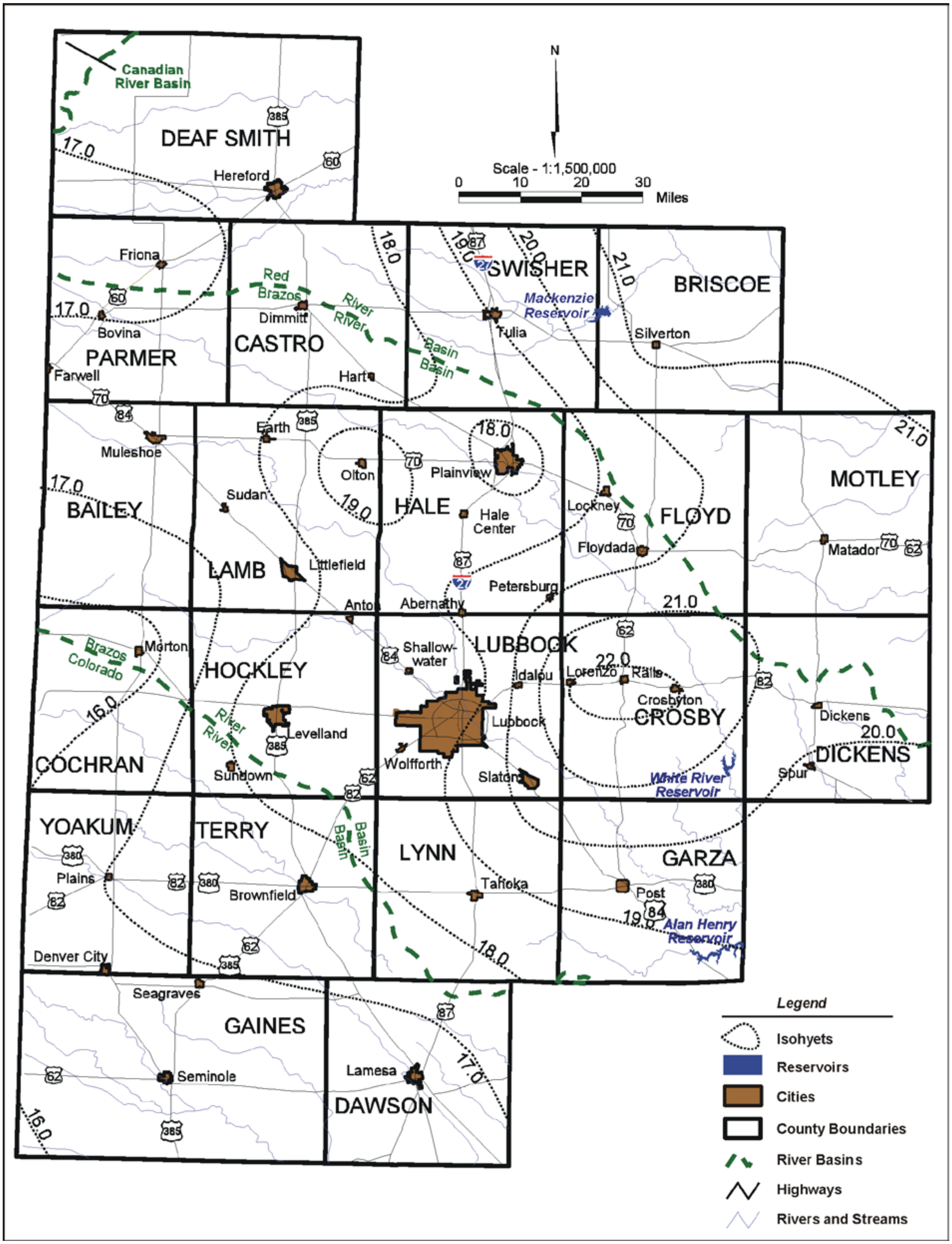


***Figure 1-4. Average Annual Precipitation for the Llano Estacado Region (Inches per Year; 1945 to 1997)***

reservoirs, rangeland and dryland crop production, wildlife, and natural recharge to the region's aquifers.

Less than 1 percent of the precipitation escapes from the area as runoff in streams or rivers, with the remainder of runoff being collected in approximately 14,000 playa basins located within the Llano Estacado Region.[5] Playas comprise approximately 2 percent of the total land surface. The majority of playa basins are ephemeral, holding water only during and for a short period of time after rains, unless augmented by irrigation tailwater. Some of the playas are planted to crops, some are left fallow, and some are grazed. Approximately 70 percent of playas are modified with pits to recover rainfall runoff for irrigation or to create a water reserve for grazing livestock or wildlife when the bulk of the water collected in the basin from rainfall runoff has soaked into the soil or evaporated (Section 1.6.4).

#### 1.2.4.2 Land Resources

About 57 percent of the 20,294 square miles of land area in the planning region is in cropland, one-third of which is irrigated. The major irrigated crops are cotton, corn, grain sorghum, wheat, vegetables, peanuts and soybeans. Winter cereals are used for stocker grazing operations in preparation for feedlotting, and for green chopping and baling for cattle feed. Rangeland grazing, in the form of cow-calf and stocker operations, is carried out on about 38 percent of the area, with urban and other land uses constituting about 5 percent of the regional land area.

#### 1.2.4.3 Wildlife Resources

Virtually all wildlife habitat in the High Plains is on privately-owned farm and ranchland. Quail and mourning dove are abundant, and whitetail deer, mule deer, turkey, and exotic aoudad sheep provide hunting along the breaks and canyons of the caprock. Pronghorn Antelope were once common, but now only remnant populations are present.[6] Many playa basins provide migratory waterfowl habitat, with as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes using playa lakes as wintering areas or as rest stops during annual migrations.[7]

[5] Guthery, F.S., F.C. Bryant, B. Kramer, A. Stoecker, and M. Dvoracek, "Playa Assessment Study," U.S. Water and Power Resources Service, Southwest Region, Amarillo, Texas, 1981.
[6] Steiert, Jim, Unpublished, Ogallala Area Regional Water Planning information, 1996.
[7] Ibid.

Pheasants are an economically important gamebird in irrigated areas, but their numbers tend to fluctuate widely with weather and habitat conditions.

In the region, approximately 25 wildlife species are listed by the Texas Parks and Wildlife Department as endangered, threatened, or just rare with no official listing (Appendix A).

## *1.3 Population and Demography*

### *1.3.1 Historical and Recent Trends in Population*

The area's population has grown from 11,418 in the year 1900 to 453,997 in year 2000 (Table 1-3 and Figure 1-5.)[8] From 1900 to 1920, the region experienced steady population growth as the large ranches that were predominant in the area, such as the XIT Ranch, and the railroads began to sell land to farmers. As ranchland was converted to row crops and small grains, the economy of the region broadened to an economy of broad-based agribusiness, including the use of agricultural inputs from the non-farm manufacturing, trades and services sectors, including marketing and processing of agricultural commodities.

***Table 1-3. Population Growth (1900 to 2000) Llano Estacado Region***

| *Year* | *Population* |
|---|---|
| 1900 | 11,420 |
| 1910 | 47,020 |
| 1920 | 80,720 |
| 1930 | 206,020 |
| 1940 | 229,280 |
| 1950 | 309,330 |
| 1960 | 402,530 |
| 1970 | 408,580 |
| 1980 | 449,550 |
| 1990 | 438,490 |
| 2000 | 453,997 |

Source: U.S. Census Bureau.

[8] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.

As settlers moved to the area between 1920 and 1930, the population increased 154 percent. During the late 1920s, the number of farms peaked at 25,595; however, due to farm consolidation, the number has declined slightly almost every year since. In 2007, there were 12,287 farms in the region.[9,10]

Irrigation was introduced to the area about 1908. In the late 1940s, following World War II, an irrigated agricultural boom began, and during the period from 1940 to 1960, population growth was almost as high as the growth rate of the 1920s. It was during this period

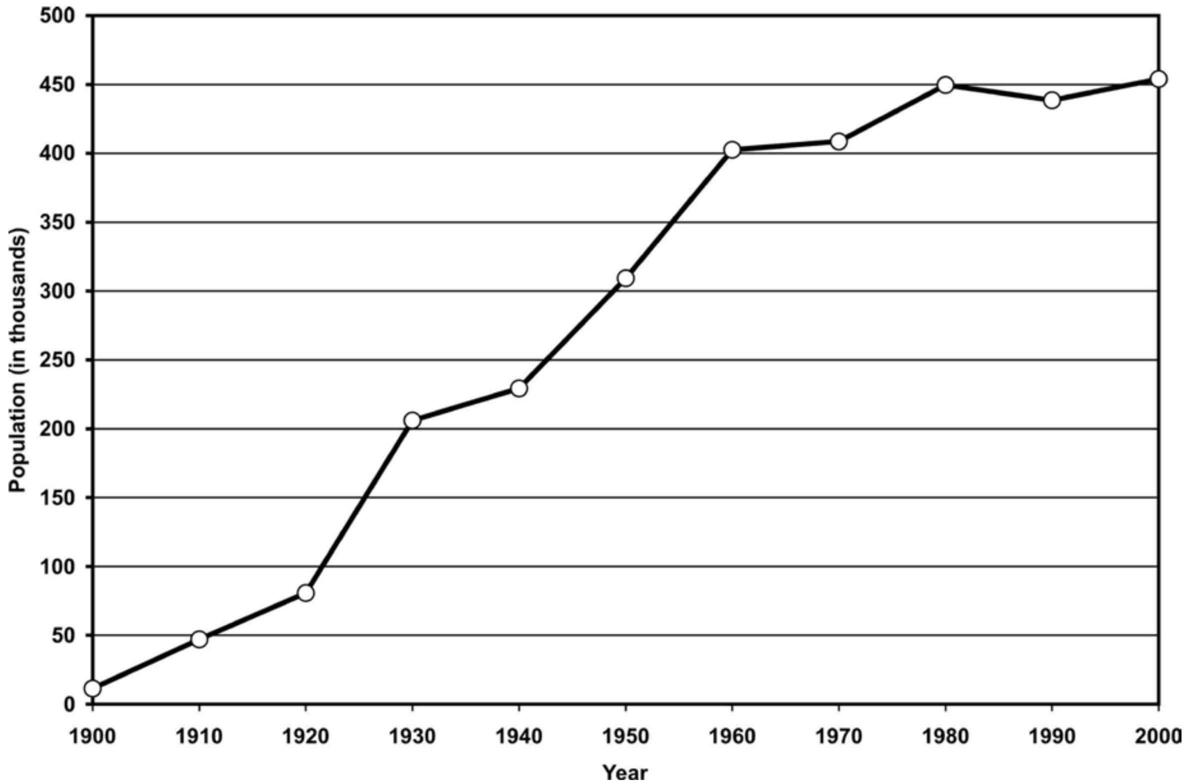


***Figure 1-5. Population Growth (1900 to 2000)***
***Llano Estacado Region***

that petroleum production was begun, particularly in the southern counties of the region. However, the region's population growth has leveled out since 1960 (Figure 1-5), with much of this slowdown in growth being attributed to the mechanization of agriculture, other improvements in farm technology, and a reduction in the petroleum and related work force.

[9] Inter-University Consortium for Political and Social Research Study 00003: Historical Demographic, Economic, and Social Data: U.S., 1790-1970.
[10] 2007 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2007."

Ten cities in the region have a population greater than 5,000 (Table 1-4). These larger urban areas constituted 64.3 percent of the region's 2000 population of 453,997, with the majority of this urban population located in the City of Lubbock, which had a year 2000 population of 199,564 persons.[11]

***Table 1-4.***
***Major Cities and Population (1990 and 2000)***
***Llano Estacado Region***

| City | County | 1990 Population | 1990 Percent of Region | 2000 Population | 2000 Percent of Region |
|---|---|---|---|---|---|
| Brownfield | Terry | 9,560 | 2.2 | 9,488 | 2.1 |
| Hereford | Deaf Smith | 14,745 | 3.4 | 14,597 | 3.2 |
| Lamesa | Dawson | 10,809 | 2.5 | 9,952 | 2.2 |
| Levelland | Hockley | 13,986 | 3.2 | 12,866 | 2.8 |
| Littlefield | Lamb | 6,489 | 1.5 | 6,507 | 1.4 |
| Lubbock | Lubbock | 186,206 | 42.5 | 199,564 | 44.0 |
| Plainview | Hale | 21,700 | 5.0 | 22,336 | 4.9 |
| Seminole | Gaines | 6,342 | 1.4 | 5,910 | 1.3 |
| Slaton | Lubbock | 6,078 | 1.4 | 6,109 | 1.3 |
| Tulia | Swisher | 4,703 | 1.1 | 5,117 | 1.1 |
| **Total** | | **280,618** | **64.2** | **292,446** | **64.3** |

Source: U.S. Census Bureau.

### *1.3.2 Demographic and Socioeconomic Characteristics*

In terms of population density, Motley County was the least populated, with 1,426 residents or 1.4 persons per square mile (Table 1-5). Lubbock County had the highest population density in the region, with 242,628 residents or 267.2 persons per square mile. The regional average population density is 22.3 persons per square mile (Table 1-5).

In 2000, the age distribution across the region was fairly uniform from county to county (Table 1-6).[12] The two age groups that included the highest percentage of the population in 2000 were 5 to 14 years (16.4 percent), and age 60 and above (19.1 percent). The age group with the lowest percentage of the population in 2000 is the 55 to 59 years group (4.8 percent).

[11] Ibid.
[12] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.

With respect to level of education, of those residents in the Llano Estacado Region who are 25 years of age or older, 65.6 percent have at least a high school diploma (State of Texas average is 75.7 percent), while only 12.7 percent have a college degree (State of Texas average is 23.2 percent) (Table 1-7).[13] The region's unemployment rate was 3.98 percent in 2008.[14] Per capita income in 2007 was $28,986.[15]

***Table 1-5.***
***County Population and Area***
***Llano Estacado Region***

| *County* | *Population[1] (2000)* | *Area[2] (sq. mi.)* | *Density[2] (sq. mi.)* | *County* | *Population[1] (2000)* | *Area[2] (sq. mi.)* | *Density[2] (sq. mi.)* |
|---|---|---|---|---|---|---|---|
| Bailey | 6,594 | 843 | 7.8 | Hale | 36,602 | 1,033 | 35.4 |
| Briscoe | 1,790 | 911 | 1.9 | Hockley | 22,716 | 914 | 24.8 |
| Castro | 8,285 | 911 | 9.1 | Lamb | 14,709 | 1,013 | 14.5 |
| Cochran | 3,730 | 776 | 4.8 | Lubbock | 242,628 | 908 | 267.2 |
| Crosby | 7,072 | 904 | 7.8 | Lynn | 6,550 | 893 | 7.3 |
| Dawson | 14,985 | 900 | 16.6 | Motley | 1,426 | 994 | 1.4 |
| Deaf Smith | 18,561 | 1,485 | 12.5 | Parmer | 10,016 | 854 | 11.7 |
| Dickens | 2,762 | 912 | 3.0 | Swisher | 8,378 | 915 | 9.2 |
| Floyd | 7,771 | 1,015 | 7.6 | Terry | 12,761 | 904 | 14.1 |
| Gaines | 14,467 | 1,507 | 9.6 | Yoakum | 7,322 | 798 | 9.2 |
| Garza | 4,872 | 904 | 5.4 | **Total** | **453,997** | **20,294** | **22.3** |

[1] U.S. Census Bureau.
[2] State of Texas General Land Office.

[13] Ibid.
[14] Texas Workforce Commission, Austin, Texas, http://www.census.gov/epcd/naics.html. 2009.
[15] United States Department of Agriculture, Economic Research Service, State Fact Sheets: Texas; http://www.ers.usda.gov/StateFacts/TX.htm.

***Table 1-6.***
***Age Distribution of the Population in 2000***
***Llano Estacado Region***

| *County* | *Total Population (2000)* | *Age Distribution (values are percent of population)* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *0 - 4* | *5 - 14* | *15 - 19* | *20 - 24* | *25 - 34* | *35 - 44* | *45 - 54* | *55 - 59* | *60 +* |
| Bailey | 6,594 | 8.1 | 16.9 | 8.6 | 5.4 | 11.3 | 13.5 | 12.0 | 4.9 | 19.5 |
| Briscoe | 1,790 | 6.4 | 15.7 | 7.9 | 3.9 | 9.2 | 12.8 | 14.1 | 5.3 | 24.7 |
| Castro | 8,285 | 8.5 | 18.4 | 9.5 | 5.7 | 10.9 | 13.4 | 12.4 | 4.8 | 16.4 |
| Cochran | 3,730 | 6.5 | 17.9 | 10.6 | 4.6 | 10.4 | 14.5 | 10.9 | 4.8 | 20.0 |
| Crosby | 7,072 | 7.8 | 17.5 | 8.3 | 5.7 | 11.6 | 12.4 | 11.1 | 5.7 | 20.1 |
| Dawson | 14,985 | 6.3 | 14.2 | 7.7 | 6.3 | 14.6 | 16.2 | 12.6 | 4.2 | 17.9 |
| Deaf Smith | 18,561 | 9.0 | 18.8 | 8.7 | 6.5 | 12.5 | 13.0 | 11.4 | 4.1 | 16.0 |
| Dickens | 2,762 | 4.2 | 10.3 | 5.6 | 8.8 | 14.9 | 14.8 | 11.9 | 5.4 | 24.0 |
| Floyd | 7,771 | 8.2 | 17.5 | 8.3 | 4.8 | 11.5 | 12.9 | 11.5 | 4.9 | 20.4 |
| Gaines | 14,467 | 8.4 | 20.0 | 10.1 | 6.1 | 11.7 | 15.0 | 10.8 | 4.0 | 14.0 |
| Garza | 4,872 | 6.5 | 16.5 | 7.6 | 5.3 | 13.9 | 14.7 | 12.0 | 4.7 | 18.7 |
| Hale | 36,602 | 8.3 | 16.7 | 9.2 | 7.4 | 12.9 | 14.3 | 10.4 | 4.3 | 16.4 |
| Hockley | 22,716 | 7.2 | 16.1 | 10.4 | 7.2 | 11.1 | 14.8 | 12.0 | 4.7 | 16.7 |
| Lamb | 14,709 | 7.4 | 16.2 | 8.8 | 5.3 | 10.8 | 13.4 | 11.3 | 4.8 | 22.1 |
| Lubbock | 242,628 | 7.2 | 14.1 | 9.0 | 11.7 | 13.8 | 14.0 | 11.7 | 4.1 | 14.4 |
| Lynn | 6,550 | 7.3 | 17.9 | 9.1 | 4.8 | 10.7 | 15.3 | 11.2 | 5.0 | 18.8 |
| Motley | 1,426 | 5.9 | 12.9 | 7.2 | 4.1 | 8.0 | 13.1 | 12.8 | 6.9 | 29.1 |
| Parmer | 10,016 | 8.6 | 18.6 | 9.0 | 5.2 | 12.2 | 14.0 | 11.1 | 4.5 | 16.7 |
| Swisher | 8,378 | 7.4 | 15.4 | 8.3 | 7.1 | 12.5 | 13.0 | 11.0 | 4.8 | 20.4 |
| Terry | 12,761 | 7.3 | 15.6 | 8.5 | 6.4 | 12.2 | 14.8 | 11.7 | 4.9 | 18.7 |
| Yoakum | 7,322 | 7.5 | 17.8 | 10.2 | 4.9 | 10.7 | 16.1 | 12.7 | 4.7 | 15.4 |
| **Region Totals** | **453,997** | **7.3** | **16.4** | **8.7** | **6.1** | **11.8** | **14.1** | **11.7** | **4.8** | **19.1** |
| **State Totals** | **20,851,820** | **7.8** | **15.7** | **7.8** | **7.4** | **15.2** | **15.9** | **12.5** | **4.3** | **13.3** |

Source: 2000 U.S. Census, U.S. Department of Commerce, Washington, D.C., 2001.

**Table 1-7.**
**Summary of Selected Socioeconomic Indicators (2000 and 2003)**
**Llano Estacado Region**

| County | High School Graduates (% of Population) (2000)[1] | College Graduates (% of Population) (2000)[1] | Civilian Labor Force (2003)[2] | Unemployment Rate (2003)[2] | Median Household Income (1999)[1] |
|---|---|---|---|---|---|
| Bailey | 61.5 | 9.3 | 3,813 | 5.5 | $27,901 |
| Briscoe | 74.8 | 17.5 | 711 | 4.8 | $29,917 |
| Castro | 65.4 | 14.7 | 3,319 | 5.2 | $30,619 |
| Cochran | 62.7 | 10.2 | 1,426 | 10.4 | $27,525 |
| Crosby | 61.8 | 10.5 | 2,928 | 6.9 | $25,769 |
| Dawson | 65.2 | 10.5 | 5,805 | 6.5 | $28,211 |
| Deaf Smith | 60.9 | 11.8 | 6,941 | 6.0 | $29,601 |
| Dickens | 70.6 | 8.4 | 835 | 4.9 | $25,898 |
| Floyd | 63.5 | 12.3 | 3,123 | 9.0 | $26,851 |
| Gaines | 56.2 | 10.5 | 6,959 | 4.3 | $30,432 |
| Garza | 70.1 | 10.0 | 2,459 | 4.7 | $27,206 |
| Hale | 65.9 | 14.4 | 17,162 | 6.4 | $31,280 |
| Hockley | 68.2 | 13.6 | 11,493 | 4.5 | $31,085 |
| Lamb | 63.7 | 11.1 | 6,854 | 6.2 | $27,898 |
| Lubbock | 78.4 | 24.4 | 130,645 | 3.6 | $32,198 |
| Lynn | 61.9 | 13.4 | 2,777 | 5.3 | $26,694 |
| Motley | 73.5 | 14.7 | 637 | 1.7 | $28,348 |
| Parmer | 60.7 | 13.4 | 4,590 | 3.0 | $30,813 |
| Swisher | 69.7 | 16.2 | 3,582 | 4.7 | $29,846 |
| Terry | 62.5 | 9.5 | 5,402 | 6.9 | $28,090 |
| Yoakum | 59.4 | 10.2 | 3,035 | 5.0 | $32,672 |
| **Region Totals** | **65.6** | **12.7** | **224,496** | **5.5** | **$28,993** |
| **State Totals** | **75.7** | **23.2** | **10,910,344** | **6.8** | **$39,927** |

[1] 2000 U.S. Census, U.S. Department of Commerce, Washington, D.C.
[2] Texas Workforce Commission., Austin, Texas, 2003.

## 1.4 Economy – Major Sectors and Industries

### 1.4.1 The Llano Estacado Region's Economy

The region's economic base is agriculture, with significant contributions from manufacturing, oil and gas, and trades and services, such as wholesale and retail trade, finance, insurance, legal, advertising, medical, personal, research, entertainment, repair services, and higher education. Agricultural processing, oilfield equipment, and electronics form the core of the region's manufacturing base. Beef cattle and cotton are the predominant agricultural enterprises, although vegetables and oilseed crops are significant contributors to the region's economy. Statistics for the major economic sectors are presented below.

The interests of small business in the region are the same as agricultural interests, since without agriculture, the area would never have been developed and would most likely not be very populated today.

### 1.4.2 Crop Production

Due to the arid climate, limited water, and a relatively short growing season, the region can only grow certain crops. The major crops grown are cotton, grain sorghum, wheat, corn, soybeans, and peanuts (Table 1-8). Reported production of these major crops is shown for each county of the region for 2007 (most recent census of agriculture), along with the 2007 and 2002 region and state totals. (Note: The region and state totals for 2002, as included in the 2006 Regional Water Plan, are shown for comparison purposes). It is important to note that between 2002 and 2007, reported production of major crops of the region (cotton, wheat, corn, and grain sorghum) increased significantly in both the Llano Estacado Region, and the state as is shown in Table 1-8 and stated below. For example, cotton production increased 49 percent, from 3.06 million bales in 2002 to 4.56 million bales in 2007. State production of cotton increased from 5.06 million bales in 2002 to 8.15 million bales in 2007, for a 61 percent increase. In the region, wheat production increased from 12.11 million bushels in 2002 to 32.25 million bushels in 2007 (166 percent increase), while state wheat production increased from 75.13 million bushels to 134.64 million bushels (79 percent increase). In the case of corn production, the regional increase was from 26.28 million bushels in 2002 to 62.06 million bushel in 2007 (136 percent increase), while state total corn production increased from 197.11 million bushels in 2002 to 286.39 million bushels in 2007 (45 percent increase). Grain sorghum production in the Llano

Estacado Region was reported at 20.47 million bushels in 2002, and 32.67 million bushels in 2007, or an increase of about 60 percent. Texas total grain sorghum production was reported at 114.13 million bushels in 2002, with 2007 production reported at 153.53 million bushels, for an increase of about 35 percent. However, for the region, peanut production decreased about 4 percent, from 506.21 million pounds in 2002 to 486.45 million pounds in 2007.

Although, no studies have been done that explain the trends in production nor the reported differences between years 2002 and 2007 levels of production at either the regional or state levels, it appears that both public policy that encouraged use of grain for production of bio-fuels (ethanol, in particular), and 2007 weather conditions that were more favorable than in 2002 contributed to the increased grain production in 2007 in comparison to 2002.

The 2007 values of crop production are presented below for the purpose of showing these contributions to the regional and state economies in this “Planning Area Description.” According to the 2007 (most recent) Census of Agriculture, all crops grown in the Llano Estacado Region had a combined market value of over $1.6 billion in 2007.[16] Cotton, a somewhat drought tolerant plant, is the leading crop of the region, with a calculated value of cotton production in 2007 of about $1.23 billion.[17]

In the Llano Estacado Region, there has been an increase in acres planted to grain sorghum, grain sorghum yields, and use of grain sorghum during the past 60 years. In 2007, the region produced 21 percent (32.67 million bushels) of the state’s grain sorghum, with a market value of value of approximately $120.54 million.[18] Approximately 21.6 percent (62 million bushels) of the state’s corn crop was grown in the Llano Estacado Region in 2007, with a market value of $270 million.[19] In 2007, 98,411 bushels of soybeans (included in Other Grains), with a calculated value of $1.02 million were grown in the Llano Estacado Region.[20] Soybeans are frequently planted in the region as a “recovery” cash crop if hail destroys cotton; however, soybean production requires irrigation, since soybeans are not a dryland crop.

[16] 2007 Census of Agriculture, Volume 1 Geographic Area Series, “Table 1. County Summary Highlights: 2007.”
[17] Calculated using the production value from Table 1-8 times the reported year 2007 price of $0.604/lb from “Crop Values, 2008 Summary,” published by USDA in February 2009. Also assumes a bale equals 480 lbs.
[18] Calculated using the production value from Table 1-8 times the reported year 2007 price of $3.69/bushel from “Crop Values, 2008 Summary,” published by USDA in February 2009.
[19] Calculated using the production value from Table 1-8 times the reported year 2007 price of $4.35/bushel from “Crop Values, 2008 Summary,” published by USDA in February 2009.
[20] Calculated using the production value from Table 1-8 times the reported year 2007 price of $10.40/bushel from “Crop Values, 2008 Summary,” published by USDA in February 2009.

***Table 1-8.***
***Crop Production -- 2007***
***Llano Estacado Region***

| County | Selected Crops Harvested | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cotton (bales) | Wheat (bushels) | Corn (bushels) | Grain Sorghum (bushels) | Peanuts (lbs.) | Other Grains (bushels)* | Hay, alfalfa, other (tons) |
| Bailey | 58,599 | 1,058,577 | 784,283 | 2,111,934 | 10,337,444 | 192,730 | 75,719 |
| Briscoe | 55,207 | 696,150 | 119,678 | 556,981 | 0 | 0 | 21,897 |
| Castro | 74,741 | 3,901,406 | 21,517,582 | 1,761,655 | 0 | 31,644 | 144,284 |
| Cochran | 167,324 | 524,278 | D | 1,137,380 | 33,274,443 | 68,907 | 2,589 |
| Crosby | 311,988 | 335,890 | 205,330 | 1,121,755 | D | 112,948 | 11,728 |
| Dawson | 409,486 | 277,734 | 0 | 683,383 | 18,766,611 | 0 | 18,483 |
| Deaf Smith | 23,525 | 6,919,758 | 5,302,261 | 2,778,897 | 0 | 27,748 | 109,102 |
| Dickens | 38,901 | 388,136 | 0 | 231,060 | (D) | 0 | 20,674 |
| Floyd | 292,216 | 2,616,377 | 1,417,490 | 4,060,825 | 0 | 15,286 | 20,769 |
| Gaines | 505,464 | 899,634 | (D) | 598,858 | 228,879,533 | 0 | 65,401 |
| Garza | 82,610 | 36,409 | 0 | 26,643 | D | D | 7,572 |
| Hale | 363,594 | 1,889,645 | 6,736,141 | 3,630,299 | 0 | 0 | 53,225 |
| Hockley | 367,299 | 210,467 | 34,843 | 882,397 | 10,776,950 | 0 | 17,717 |
| Lamb | 223,026 | 1,738,298 | 9,943,166 | 4,513,180 | 13,532,678 | 463,719 | 87,400 |
| Lubbock | 457,246 | 543,667 | 445,528 | 1,516,786 | D | 47,416 | 27,882 |
| Lynn | 423,888 | 201,495 | (D) | 410,014 | D | 56,804 | 11,290 |
| Motley | 32,873 | 117,455 | 0 | D | D | 0 | 19,819 |
| Parmer | 63,741 | 4,944,341 | 12,783,871 | 3,354,437 | 1,522,486 | 65,686 | 83,457 |
| Swisher | 120,747 | 3,868,704 | 2,714,418 | 1,639,866 | 0 | 0 | 29,757 |
| Terry | 340,765 | 610,312 | D | 738,491 | 66,279,675 | 81,982 | 17,447 |
| Yoakum | 172,016 | 475,775 | 54,000 | 912,476 | 103,084,147 | 186,163 | 19,403 |
| **Region Total[1]** | **4,585,256** | **32,254,508** | **62,058,591** | **32,667,317** | **486,453,967** | **1,348,033** | **865,615** |
| **State Total** | **8,147,970** | **134,643,897** | **286,386,341** | **153,531,033** | **699,723,146** | **8,878,816** | **14,477,068** |
| **Region % Tx** | **56.27%** | **23.95%** | **21.67%** | **21.28%** | **69.52%** | **15.18%** | **5.98%** |
| **Region 2002** | **3,059,924** | **12,112,688** | **26,284,860** | **20,047,257** | **506,213,899** | **-----** | **11,407,323** |
| **State 2002** | **5,060,144** | **75,131,556** | **197,109,321** | **114,127,221** | **807,510,593** | **-----** | **11,407,323** |

[1] Total does not include data that were withheld for individual producers; see (D) below.
(D) – Withheld to avoid disclosing data for individual producers.
* Other Grains includes Soybeans, Sunflower Seed, Oats, Barley, and Dry Edible Beans.

Source: 2007 and 2002 Censuses of Agriculture, Volume 1 Geographic Area Series, “Table 1. County Summary Highlights: 2007,” except where noted.

Peanut production is relatively new to the Llano Estacado Region, with peanut production having become a valuable crop for the region during the past 20 years. The 2007 Census of Agriculture reported that the area produced about 70 percent of the state's year 2007 peanut crop, with a value of calculated at $114.32 million for 2007.[21]

#### *1.4.2.1 Irrigated Crops*

In the semi-arid Llano Estacado Region, irrigation from groundwater is used to supplement precipitation to increase crop yields, with the level of irrigation being determined by the quantities of precipitation received during the growing season and the quantities of irrigation water available to individual producers.. During wetter years, less irrigation water needs to be pumped from the aquifer than during drought years and during periods of severe drought, such as 1998, only irrigated crops produce "harvestable" yields. The 2007 Census of Agriculture indicates that while irrigated lands were about 2.5 million acres (32 percent) of the cropland in the region, irrigation in 2007 was responsible for about $1.38 billion in value of farm sales, or about 75 percent of the value of major crop production.

When extensive irrigation was begun in the 1940s, and for more than two decades thereafter, little thought was given to irrigation water use efficiency. However, at the present time, the Llano Estacado Region is a leader in adoption and use of highly efficient water use technology, and as new technology becomes available, it is adopted as rapidly as economics allow. In fact, the region has developed better and better water conservation methods and equipment, and in some cases, individual farmers have built prototypes of equipment that have been produced and sold by specialized manufacturers.

In the Llano Estacado Region, drought planning is a way of life as opposed to being a contingency plan. Farmers are always aware of how precious water is, and they work hard to make efficient use of precipitation, while saving the groundwater supply for use when precipitation is not adequate to grow crops.

#### *1.4.2.2 Dryland Crops*

Dryland farming produces crops without irrigation using only the precipitation provided by nature. Approximately 75 percent of the average annual precipitation, or about 13.8 inches,

[21] Calculated using the production value from Table 1-8 times the reported year 2007 price of $0.235/lb from "Crop Values, 2008 Summary," published by USDA in February 2009.

occurs during the summer crop growing season, which is from May through September. Maximum conservation of this precipitation is the key to producing acceptable crop yields. This is accomplished by holding the rainfall, which often falls in high intensity, short duration precipitation events, in place until it has time to soak into the soil. Methods that are effective at holding rainfall on the soil include bench leveling, parallel terraces, contour farming, furrow dikes, deep chiseling, and crop residue management. Minimum tillage using chemicals to control weeds instead of plowing also conserves moisture, since plowing provides an opportunity for moisture to evaporate when moist soil is turned to the surface.

Crops produced by the dryland farming method include cotton, wheat, rye, and grain sorghum. According to the 2007 Census of Agriculture, approximately 5.1 million acres (68 percent) of the Llano Estacado Region's total cropland was dryland farmed. The value of production from dryland farming in the region was $459 million in 2007, or about 25 percent of the value of crop sales in the region.

### *1.4.3 Livestock Production*

Total livestock water use in 2000 accounted for 0.83 percent of the water used in the Llano Estacado Region. Major types of livestock produced in the area include feedlot cattle, range cattle, dairy cattle, swine, and sheep. The largest classification of livestock in the area is cattle and calves, which includes feedlot livestock, followed by beef cows and sheep and lambs. The most recent information available about cattle feedlots in the Llano Estacado Region is from a Southwestern Public Service Company, Amarillo, Texas, survey in 1998, provided by the Texas Cattle Feeders Association. The survey indicates that the one-time feedlot capacity in 1997 was 1.69 million head (Table 1-9).

#### *1.4.3.1 Beef Cows*

Beef cows, which include any cow kept primarily for calf production, make up 6.3 percent of the total livestock in the Llano Estacado Region. In 2007, there were approximately 157,665 beef cows in the region, which is 3 percent of the state's total beef cow population, and was 28.87 percent greater than the reported 122,350 head in 2002 (Table 1-9). The leading counties in beef cow numbers are Deaf Smith, Castro, and Motley (Table 1-9).

#### *1.4.3.2 Feedlot Livestock*

During the last 25 to 30 years, the South Plains of Texas observed the development and growth of the confined feeding of cattle industry to finish weights before slaughter. In the early years of development, feedlots were built and operated by individual ranchers to add value to their own cattle. During the 1960s, feedlot operators expanded the size and numbers of feedlots, and began feeding cattle for others (custom feeding). This procedure opened a new market for ranchers across the region and the state—they could now have their own cattle custom-fed in a custom cattle feedlot. Farmers saw immediate grain marketing benefits from the establishment of feedlots in the Llano Estacado Region.

Fed cattle marketings in Texas increased from 477,000 head in 1960 to 2.7 million in 1969, a 467 percent growth rate as new capital flowed into the industry and many new feedlots were built. During the 1970s, fed cattle marketings grew to 4.9 million head. The more modest 82 percent growth rate reflected the "market crash" of 1973 to 1974 that led to fewer new feedlots and slowed expansion of existing feedlots. During the 1980s, fed cattle marketings peaked at 5.3 million head in 1986, reflecting an 8.2 percent growth for the decade, with expansion during the 1980s being predominantly from expansion of existing feedlots. During the 1990s, the Texas feedlot industry matured with a 12 percent growth rate and marketings of 6.06 million head in 1998—resulting primarily from expansion of existing feedlots. Of the 142 feedlots in Texas in 1998, almost 50 percent were located in the Llano Estacado Region. In 1998, the cattle feedlots in the Llano Estacado Region marketed over 3.39 million head of fed cattle from 69 feedlots located in the 21 counties in the region. In 2007, reported value of sales of cattle and calves in the Llano Estacado Water Planning Region was $3.33 billion, or 31.75 percent of the value of cattle and calves sold in Texas in 2007.[22]

#### *1.4.3.3 Dairies*

In 2002, the number of milk cows in the Llano Estacado Water Planning Region was reported at 27,149; in 2007 the number was reported at 148,421, or 4.46 times the number in 2002 (Table 1-9). In January 2005, the total number of dairies in the six county dairy-producing area of the Llano Estacado Water Planning Region of Bailey, Castro, Deaf Smith, Hale, Lamb, and Parmer was 37, with average daily production of 4.14 million pounds of milk.[23] By January of 2006, there were 44 dairies, with average daily milk production of 5.52 million pounds. In

[22] Census of Agriculture,Vol. I, Geographic Area Series, Table 11: Cattle and Calves – Inventory and Sales, 2007.
[23] "Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan Phase I Report: (1) Estimates of Population and Water Demands for New Ethanol Industries and Expanding dairies; (2) Evaluation of Water Supplies and Desalination Costs of Dockum Aquifer Water; and (3) Video Conferencing Facilities Available for Coordination Between Regions A and O," Llano Estacado Regional Water Planning Group and Texas Water Development Board, Austin, Texas, April 30, 2009.

***Table 1-9.***
***Livestock Numbers -- 2007[1]***
***Llano Estacado Region***

| County | Livestock and Poultry | | | | | | |
|---|---|---|---|---|---|---|---|
| | ***Feedlot Capacity[2] (number)*** | ***Cattle & Calves[3] (number)*** | ***Beef Cows (number)*** | ***Milk Cows (number)*** | ***Swine (Hogs & Pigs) (number)*** | ***Sheep & Lambs (number)*** | ***Layers & Pullets (number)*** |
| Bailey | 68,000 | 80,544 | 6,685 | 17,015 | 32 | 665 | 258 |
| Briscoe | 0 | 19,471 | 11,269 | 0 | 0 | 305 | 0 |
| Castro | 325,000 | 365,792 | 11,458 | 28,702 | 323 | (D) | 50 |
| Cochran | 36,000 | 7,659 | 4,120 | 0 | (D) | (D) | 38 |
| Crosby | 0 | 10,951 | 7,934 | 0 | 12 | (D) | 67 |
| Dawson | 0 | 5,204 | 4,519 | 0 | 256 | 34 | 81 |
| Deaf Smith | 467,000 | 527,338 | 20,783 | 33,265 | 77 | 398 | 583 |
| Dickens | 0 | 26,170 | 10,771 | 0 | (D) | 742 | 103 |
| Floyd | 35,000 | 79,644 | 12,756 | 3 | 71 | (D) | 212 |
| Gaines | 35,000 | 36,490 | 6,122 | 0 | 37 | 477 | (D) |
| Garza | 0 | 10,651 | (D) | (D) | (D) | (D) | 227 |
| Hale | 83,000 | 93,924 | 7,199 | 14,715 | 276 | 446 | 620 |
| Hockley | 16,000 | 33,209 | 3,428 | 3 | 179 | 522 | 205 |
| Lamb | 104,000 | 118,499 | 7,090 | 20,860 | (D) | 165 | (D) |
| Lubbock | 48,000 | 46,795 | 4,872 | 16 | 489 | 833 | (D) |
| Lynn | 0 | 3,742 | 2,687 | 0 | (D) | 546 | (D) |
| Motley | 0 | 21,810 | 15,250 | 0 | (D) | 0 | 0 |
| Parmer | 303,800 | 354,035 | 6,720 | 33,842 | 99 | 1,316 | 124 |
| Swisher | 170,000 | 219,539 | 8246 | 0 | (D) | 657 | 161 |
| Terry | 0 | 7,823 | (D) | (D) | 158 | 677 | 210 |
| Yoakum | 0 | 16,473 | 5,756 | 0 | (D) | (D) | 182 |
| **Total 2007[4]** | **1,690,800** | **2,085,763** | **157,665** | **148,421** | **2,009** | **7,783** | **3,121** |
| **Total 2002** | **1,691,100** | **2,085,763** | **122,350** | **27,149** | **4,747** | **30,323** | **3,664** |
| **% Change** | **0.00** | **0.00** | **28.87** | **446.69** | **-57.67** | **-74.33** | **14.82** |

[1] Source: 2007 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2007" except where noted.

[2] Source: Bilbrey, D., B. Holland, & G. Boggs, "Cattle Feeding Capital of the World: 1998 Fed Cattle Survey," Southwestern Public Service Company, Amarillo, Texas, 1998, most recent information provided by Texas Cattle Feeders Association.

[3] "Cattle and calves" includes feedlot cattle.

[4] Total does not include data that were withheld for individual producers; see (D) below.

(D) – Withheld to avoid disclosing data for individual producers.

March of 2008, there were 59 dairies with average daily milk production reported at 9.01 million pounds, and by August of 2009, there were 62 dairies with average daily production reported at 9.93 million pounds of milk. In 2007, there were approximately 148,421 head of milk cows in Bailey, Castro, Deaf Smith, Hale, Lamb, and Parmer Counties (Table 1-9). The dairy industry is projected to grow to a total of about 155,750 head of dairy cattle (milking and dry cows and replacement heifers) in 2010, to about 188,540 head by 2020, and to about 230,060 in 2040 and to 280,700 in 2060.[24] Value of milk sales in the region was $381.97 million or 30 percent of the value of milk sales from dairies in Texas in 2007.[25]

#### *1.4.3.4 Other Livestock*

In the Llano Estacado Water Planning Region, Swine, Sheep, and Poultry are produced, however the numbers are relatively low, and showed significant declines between 2002 and 2007; i.e.; the number of hogs and pigs was reported at 4,747 in 2002, and 57 percent to 2,009 in 2007 (Table 1-9). The reported number of sheep and lambs declined from 30,323 in 2002 to 7,783 in 2007 (a 74 percent decline), and the reported number of layers and pullets declined from 3,664 in 2002 to 3,121 in 2007 (Table 1-9).

### *1.4.4 Oil and Gas*

In the Llano Estacado Region, most of the oil and gas production activity is concentrated in the southern counties. Gaines County is the leading oil and gas-producing county in the region (Table 1-10). In 2003, oil production in the Llano Estacado Water Planning Region was 104.97 million barrels, and in 2008 had declined 14 percent to 90.34 million barrels, or 25.77 percent of total production in Texas in 2008 (Table 1-10). The 2003 natural gas production (casinghead gas plus gas well gas) was 228.1 mcf, and in 2008 had declined to 80.9 mcf, a decline of 64.5 percent. The 2008 regional production was about 8.9 percent of Texas production in 2008 (Table 1-10). The well-head value of oil and gas production of the region in 2008 is estimated at about $8.9 billion.

Oil reservoirs are developed by drilling wells into the production zones of the oil-bearing formations, and as primary production approaches its economic limit, perhaps only a few percent and no more than about 25 percent of the crude oil will have been withdrawn from a given

[24] Ibid.
[25] Ibid.

***Table 1-10.***
***Oil and Gas Production -- 2008***
***Llano Estacado Region***

| ***County*** | ***Oil (bbl)*** | ***Condensate (bbl)*** | ***Casinghead Gas (mcf)*** | ***Gas Well Gas (mcf)*** |
|---|---|---|---|---|
| Bailey | 0 | 0 | 0 | 0 |
| Briscoe | 0 | 0 | 0 | 0 |
| Castro | 0 | 0 | 0 | 0 |
| Cochran | 3,805,010 | 1,450 | 2,228,122 | 246,317 |
| Crosby | 556,525 | 0 | 48,679 | 0 |
| Dawson | 4,215,178 | 0 | 2,429,257 | 0 |
| Deaf Smith | 0 | 0 | 0 | 0 |
| Dickens | 1,286,198 | 0 | 119,239 | 0 |
| Floyd | 1,408 | 0 | 0 | 0 |
| Gaines | 25,439,660 | 14,736 | 20,577,095 | 14,805,947 |
| Garza | 3,663,977 | 0 | 720,368 | 0 |
| Hale | 2,806,339 | 0 | 1,485,485 | 0 |
| Hockley | 18,384,558 | 2,049 | 9,043,266 | 94,363 |
| Lamb | 684,309 | 0 | 188,561 | 0 |
| Lubbock | 1,413,921 | 0 | 88,858 | 0 |
| Lynn | 268,494 | 0 | 103,606 | 0 |
| Motley | 28,083 | 0 | 0 | 0 |
| Parmer | 0 | 0 | 0 | 0 |
| Swisher | 0 | 0 | 0 | 0 |
| Terry | 4,266,824 | 0 | 1,138,856 | 0 |
| Yoakum | 23,524,476 | 121 | 26,572,132 | 962,453 |
| **Region Total 2008** | **90,344,960** | **18,356** | **64,743,524** | **16,109,080** |
| **Region Total 2003** | **104,973,722** | **9,553** | **214,298,263** | **13,830,973** |
| **Region Change 03/08** | **-14,628,762 (14%)** | **8,803 (92%)** | **-149,554,739 (70%)** | **2,278,107 (17%)** |
| **Texas Total 2008** | **350,571,741** | **50,140,475** | **739,513,755** | **6,831,555,360** |
| **Texas Total 2003** | **359,423,559** | **41,254,871** | **838,140,027** | **4,985,436,990** |
| **Percent of Tx 2003/08** | **(29.2%) (25.77%)** | **(.02%) (0.04%)** | **(25.56%) (8.75%)** | **(0.28%) (0.24%)** |

Source: The Railroad Commission of Texas, 2009.

reservoir. In response to this, the oil industry has developed methods collectively known as enhanced recovery, which can increase the percentage of recoverable crude oil. In this way, the production of crude oil can be increased to obtain over 50 percent of the oil in the formation. Two methods of enhanced oil recovery are in use within the region at this time: water injection and carbon dioxide injection. Water injection, or water flooding, is a process of injecting water, and recycling brine-water through the formation to force the oil out. In the region, some 90 percent of the injected water volumes are recycled water.

Natural gas almost always occurs along with oil deposits in the Llano Estacado Region and is brought to the surface with the oil when an oil well is produced. Such gas, called casinghead gas, contains valuable organic elements that are important raw materials of the natural gasoline and chemical industries. Before natural gas is used as fuel, heavy hydrocarbons such as butane and propane are extracted as liquids. The remaining gas constitutes so-called dry gas, which is piped to domestic and industrial consumers for use as fuels. Composed of the lighter hydrocarbons, methane and ethane, dry gas is also used in the manufacture of plastics, drugs, and dyes.

### *1.4.5 Manufacturing*

The leading types of manufacturing plants in the region are food and kindred products, agricultural and industrial machinery and equipment, printing and publishing, and fabricated metal products, with ethanol plants having been added recently. In 2002, information from the most recent Census of Manufacturing, the region's 328 manufacturing establishments contributed $1.51 billion to the region's economy in value of shipments and provided 7,412 jobs with an annual payroll of $230.7 million (Table 1-11). However, the number of manufacturing establishments had decreased by 4.3 percent between 1997 and 2002, with a decrease in employment of 1,680 (22.6 percent), a decrease in payroll of $18.7 million (8.1 percent), and a decrease in value of shipments of $556.5 million or 36.8 percent (Table 1-11).

### *1.4.6 Wholesale Trade*

The wholesale trade classification includes durable goods such as motor vehicles, furniture and home furnishings, lumber and construction materials, electrical goods, and non-durable goods, such as farm products, chemicals and allied products, and petroleum and petroleum products, with the leading type of wholesale trade within the Llano Estacado Region being non-durable

***Table 1-11.***
***Manufacturing Activity -- 2002***
***Llano Estacado Region***

| ***County*** | ***Total Number of Establishments*** | ***Total Number of Employees*** | ***Annual Payroll (million dollars)*** | ***Value of Shipments (million dollars)*** |
|---|---|---|---|---|
| Bailey | 0 | 0 | 0 | 0 |
| Briscoe | 0 | 0 | 0 | 0 |
| Castro | 0 | 0 | 0 | 0 |
| Cochran | 0 | 0 | 0 | 0 |
| Crosby | 0 | 0 | 0 | 0 |
| Dawson | 0 | 0 | 0 | 0 |
| Deaf Smith | 26 | 701 | 24.3 | 303.4 |
| Dickens | 0 | 0 | 0 | 0 |
| Floyd | 0 | 0 | 0 | 0 |
| Gaines | 0 | 0 | 0 | 0 |
| Garza | 0 | 0 | 0 | 0 |
| Hale | 28 | (D) | (D) | (D) |
| Hockley | 0 | 0 | 0 | 0 |
| Lamb | 13 | 693 | 21.1 | 90.7 |
| Lubbock | 261 | 6,018 | 185.3 | 1,115.4 |
| Lynn | 0 | 0 | 0 | 0 |
| Motley | 0 | 0 | 0 | 0 |
| Parmer | 6 | (D) | (D) | (D) |
| Swisher | 0 | 0 | 0 | 0 |
| Terry | 0 | 0 | 0 | 0 |
| Yoakum | 0 | 0 | 0 | 0 |
| **Region Total 2002** | **328** | **7,412+(D)** | **230.7+(D)** | **1,509.5+(D)** |
| **Region Total 1997** | **342** | **9,092+(D)** | **249.4+(D)** | **2,066+(D)** |
| **Change 1997 to 2002** | **-14 (4.3%)** | **-1,680+(D)( 22.6%)** | **-18.7+(D) (8.1%)** | **-556.5+(D) (36.8%)** |
| **State Total 2002** | **21,450** | **855,658** | **34,105.2** | **310,815.9** |
| **State Total 1997** | **21,808** | **959,665** | **32,760.8** | **297,657.0** |
| **Percent of Tx (97/02)** | **(1.5%) (1.5 %)** | **(0.95% ) (0.86 %)** | **(0.76%) (0.67 %)** | **(0.69%) (0.48 %)** |
| (D) – Withheld to avoid disclosing data for individual firms. | | | | |

Source: 2002 Economic Census, U.S. Census Bureau, Washington D.C., November 2005.

**Table 1-12.**
**Wholesale Trade -- 2002**
**Llano Estacado Region**

| County | Total Number of Establishments | Total Number of Employees | Annual Payroll (million dollars) | Value of Shipments (million dollars) |
|---|---|---|---|---|
| Bailey | 20 | 174 | 4.1 | 96.9 |
| Briscoe | 4 | 33 | 0.6 | 6.4 |
| Castro | 17 | (D) | (D) | (D) |
| Cochran | 3 | 9 | 0.1 | 0.9 |
| Crosby | 12 | (D) | (D) | (D) |
| Dawson | 21 | 139 | 3.6 | 49.3 |
| Deaf Smith | 36 | 320 | 9.9 | 327.3 |
| Dickens | 11 | 56 | 0.8 | 9.7 |
| Floyd | 19 | (D) | (D) | (D) |
| Gaines | 22 | 227 | 6.1 | 57.6 |
| Garza | 5 | 19 | 0.7 | 3.6 |
| Hale | 56 | 505 | 14.8 | 242.6 |
| Hockley | 30 | 232 | 6.8 | 45.1 |
| Lamb | 23 | 160 | 4.5 | 47.0 |
| Lubbock* | 468 | 6,628* | 181.2* | 3,867.8* |
| Lynn | 7 | 30 | 0.8 | 6.9 |
| Motley | 4 | (D) | (D) | (D) |
| Parmer | 24 | 163 | 4.5 | 66.2 |
| Swisher | 17 | 132 | 2.6 | 24.5 |
| Terry | 17 | 169 | 4.9 | 56.6 |
| Yoakum | 18 | 132 | 4.5 | 30.3 |
| **Region Total 2002** | **834** | **9,128+(D)** | **250.5+(D)** | **4,939.7+(D)** |
| **Region Total 1997** | **927** | **9,493+(D)** | **249.7+(D)** | **5,274.7+(D)** |
| **Change 1997 to 2002** | **-93 (10%)** | **-365+(D) (3.8%)** | **0.8+(D) (0.3%)** | **-335+(D) (6.4%)** |
| **State Total 2002** | **31,832** | **439,755** | **18,808.6** | **397,405.1** |
| **State Total 1997** | **33,346** | **425,750** | **15,504.9** | **323,111.7** |
| **Percent of Tx (97/02)** | **(2.6 %)** | **(2.1 %)** | **(1.3 %)** | **(1.2 %)** |

(D) - Withheld to avoid disclosing data for individual firms.

Source: 2002 Economic Census, U.S. Department of Commerce, Washington, D.C., 2005.
*In the case of Lubbock County, 1997 values for employment, payroll, and value of shipments were used, since the 2002 Census did not provide values to avoid disclosure for individual firms.

goods. The region's 834 wholesale trade establishments contributed over $4.9 billion to the region's economy in value of shipments and provided over 9,128 jobs with an annual payroll of over $250 million in 2002 (Table 1-12). However, between 1997 and 2002, the number of wholesale trade establishments declined by 10 percent from 927 to 834, with a decline in number of employees of 365 (3.8 percent) an increase in annual payroll of $0.8 million (0.3Percent), and a decline in value of shipments of $335 million (6.4 percent) Table 1-12).

### *1.4.7 Retail Trade*

The retail trade classification includes building materials and garden supplies, general merchandise stores, food stores, automotive dealers and service stations, apparel and accessory stores, furniture and home furnishing stores, household appliance stores, restaurants, and retail stores. The leading areas of retail trade within the Llano Estacado Region are restaurants, food stores, automotive dealers and service stations, and general merchandise stores.[26] In 2002, the region's reported 1,867 retail trade establishments contributed over $4.5 billion to the region's economy in value of shipments and provided over 22,390 jobs with an annual payroll of over $424 million (Table 1-13).[27] As in the cases of manufacturing, and wholesale trade, the number of retail trade establishments located in the Llano Estacado Water Planning Region declined between 1997 and 2002 from 2,026 to 1,867 (7.8 percent). However, employment increased by 4.1 percent, from 21,498 to 22,391, annual payroll increased by 24.7 percent, from $340 million to $424.4 million, and value of shipments increased by 15.8 percent from $3.92 billion to $4.54 billion (Table 1-13).

### *1.4.8 Services*

The services group of businesses includes hotels and motels, personal services, photographic studios, beauty shops, barber shops, shoe repair, funeral services, business services, credit reporting, services to buildings, personnel supply services, computer services, auto repair, automobile parking, motion pictures, amusement services, commercial sports, health services, legal services, educational services, social services, membership organizations, engineering

[26] 2002 County Business Patterns, U.S. Department of Commerce, Washington, D.C., 2005.
[27] Data for 2002 are the most recent data available.

***Table 1-13.***
***Retail Trade -- 2002***
***Llano Estacado Region***

| County | Total Number of Establishments | Total Number of Employees | Annual Payroll (million dollars) | Value of Shipments (million dollars) |
|---|---|---|---|---|
| Bailey | 28 | 273 | 4.1 | 42.1 |
| Briscoe | 5 | 20 | 0.3 | 3.6 |
| Castro | 42 | 236 | 3.5 | 50.4 |
| Cochran | 13 | 65 | 1.3 | 19.4 |
| Crosby | 28 | 195 | 3.3 | 40.9 |
| Dawson | 52 | 473 | 8.1 | 87.4 |
| Deaf Smith | 83 | 610 | 10.5 | 130.1 |
| Dickens | 11 | 56 | 0.8 | 9.7 |
| Floyd | 27 | 173 | 3.0 | 41.0 |
| Gaines | 58 | 467 | 7.5 | 73.4 |
| Garza | 28 | 142 | 1.8 | 21.4 |
| Hale | 141 | 1,581 | 26.5 | 268.5 |
| Hockley | 87 | 786 | 13.5 | 155.9 |
| Lamb | 53 | 434 | 7.0 | 86.8 |
| Lubbock | 1,055 | 15,625 | 311.7 | 3,274.2 |
| Lynn | 16 | 91 | 1.5 | 17.9 |
| Motley | 8 | 34 | 0.4 | 4.0 |
| Parmer | 33 | 243 | 3.1 | 38.3 |
| Swisher | 25 | 215 | 3.5 | 39.2 |
| Terry | 42 | 444 | 9.1 | 102.1 |
| Yoakum | 32 | 228 | 3.9 | 36.0 |
| **Region Total 2002** | **1,867** | **22,391** | **424.4** | **4,542.3** |
| **Region Total 1997** | **2,026** | **21,498** | **340.3** | **3,920.5** |
| **Change 1997 to 2002** | **-159 (7.8%)** | **893 (4.1%)** | **84 (24.7%)** | **622 (15.8%)** |
| **State Total 2002** | **75,703** | **1,026,326** | **21,104.6** | **228,694.7** |
| **State Total 1997** | **74,105** | **950,848** | **16,197** | **182,516.1** |
| **Percent of Tx (97/02)** | **(2.7%) (2.5 %)** | **(2.3%) (2.2 %)** | **(2.1%) (2.0 %)** | **(2.1%) (2.0 %)** |

Source: 2002 Economic Census, U.S. Department of Commerce, Washington, D.C., 2005.

services, accounting services, research services, management services, and services provided by local, state and federal agencies. The leading types of services within the Llano Estacado Region are health services, business services, social services, and membership organizations.[28] The 2002 Economic Census reported 4,849 services establishments in the Llano Estacado Water Planning Region, with a value of receipts of over $1.5 billion (Table 1-14). These service establishments had 38,672 employees, and an annual payroll of over $644.6 million (Table 1-14).[29] Between 1997 and 2002, the reported number of service establishments increased by 1,059 (27.9 percent), however the number of employees declined by 6,141 (13.7 percent), annual payrolls declined by $264 million (29.1 percent), and value of receipts declined an estimated $947 million (38.5 percent) (Table 1-14).

The total number of local, state, and federal agencies employees in 2002 was 41,516, which was 2.5 percent of the number of public sector employees in Texas in 2002. However, the employment reports do not provide county-level wage and salary information for public sector employment.

### *1.4.9 Finance, Insurance, and Real Estate*

The finance, insurance, and real estate classification includes banks, savings and loans, non-depository institutions, security and commodity brokers, insurance carriers, insurance agents, brokers and services, real estate holdings and other investment offices. Since the 2002 Economic Census did not report information at the county level for Finance, Insurance and Real Estate, it was not possible to update this sector. In 1997, the region's 1,107 finance, insurance, and real estate establishments provided over 7,200 jobs with an annual payroll of over $180 million in 1997 (Table 1-15).[30]

[28] 2002 County Business Patterns, U.S. Department of Commerce, Washington, D.C., 2005.
[29] Data for 2002 are the most recent data available.
[30] Data for finance, insurance, and real estate were not reported on a county level for the 2002 Economic Census, therefore, the data are from 1997 County Business Patterns conducted by the U.S. Bureau of the Census.

***Table 1-14.***
***Services -- 2002***
***Llano Estacado Region***

| *County* | *Total Number of Establishments* | *Total Number of Employees* | *Annual Payroll (million dollars)* | *Value of Receipts (million dollars)* | *Public Sector Number of Employees** |
|---|---|---|---|---|---|
| Bailey | 65 | 507 | 8.0 | 24.4 | 631 |
| Briscoe | 13 | 10 | 0.1 | 0.4 | 130 |
| Castro | 59 | 355 | 7.1 | 19.3 | 725 |
| Cochran | 19 | 27 | 0.3 | 1.0 | 389 |
| Crosby | 36 | 33 | 0.2 | 0.7 | 542 |
| Dawson | 126 | 945 | 16.8 | 44.7 | 1,572 |
| Deaf Smith | 150 | 1,188 | 22.8 | 53.8 | 1,332 |
| Dickens | 23 | 60 | 0.5 | 1.8 | 209 |
| Floyd | 69 | 383 | 6.3 | 18.9 | 590 |
| Gaines | 99 | 407 | 6.1 | 26.1 | 1,254 |
| Garza | 40 | 191 | 2.4 | 7.3 | 409 |
| Hale | 341 | 3,415 | 59.3 | 160.3 | 2,611 |
| Hockley | 174 | 2,251 | 25.3 | 73.8 | 1,966 |
| Lamb | 102 | 694 | 12.5 | 31.7 | 1,114 |
| Lubbock | 3,185 | 26,543 | 447.0 | 959.9 | 24,053 |
| Lynn | 35 | 236 | 3.4 | 8.7 | 585 |
| Motley | 18 | 14 | 0.1 | 0.6 | 114 |
| Parmer | 66 | 261 | 4.6 | 14.6 | 894 |
| Swisher | 64 | 80 | 1.3 | 5.2 | 779 |
| Terry | 101 | 738 | 13.9 | 37.0 | 1,123 |
| Yoakum | 64 | 334 | 6.6 | 21.3 | 494 |
| **Region Total 2002** | **4,849** | **38,672** | **644.6** | **1,511.5** | **41,516** |
| **Region Total 1997** | **3,790** | **44,813** | **909.0** | **2,458.1** | **----** |
| **Change 1997 to 2002** | **1,059 (27.9%)** | **-6,141 (13.7%)** | **-264 (29.1%)** | **-947 (38.5%)** | **----** |
| **State Total 2002** | **272,063** | **4,403,498** | **147,768.8** | **278,102.1** | **1,648,436** |
| **State Total 1997** | **171,136** | **2,555,781** | **67,426.9** | **262,144.1** | **-----** |
| **Percent of Tx (97/02)** | **(2.2%) (1.8 %)** | **(1.7%) (0.8 %)** | **(1.3%) (0.4 %)** | **(0.09%) (0.5 %)** | **(2.5 %)** |

Source: 2002 Economic Census, U.S. Department of Commerce, Washington, D.C., 2005.
*Source: Texas Workforce Commission, Austin, Texas, December 2002.

***Table 1-15.***
***Finance, Insurance, and Real Estate (1997)***
***Llano Estacado Region***

| *County* | *Total Number of Establishments* | *Total Number of Employees* | *Annual Payroll (million dollars)* |
|---|---|---|---|
| Bailey | 11 | 73 | 1.8 |
| Briscoe | 6 | 33 | 0.9 |
| Castro | 22 | 118 | 2.8 |
| Cochran | 4 | 29 | 0.9 |
| Crosby | 20 | 129 | 3.1 |
| Dawson | 31 | 225 | 4.9 |
| Deaf Smith | 33 | 125 | (D) |
| Dickens | 9 | 27 | 0.7 |
| Floyd | 22 | 75 | 1.5 |
| Gaines | 22 | 131 | 3.1 |
| Garza | 12 | 53 | 0.8 |
| Hale | 85 | 435 | 9.8 |
| Hockley | 47 | 214 | 5.0 |
| Lamb | 33 | 162 | 3.4 |
| Lubbock | 664 | 4,979 | 132.1 |
| Lynn | 13 | 72 | 2.2 |
| Motley | 3 | 10 | (D) |
| Parmer | 14 | 128 | 2.6 |
| Swisher | 19 | 50 | (D) |
| Terry | 23 | 129 | 3.3 |
| Yoakum | 14 | 50 | 1.3 |
| **Region Total** | **1,107** | **7,247** | **180.2** |

(D) - Withheld to avoid disclosing data for individual firms.

Source: Bureau of the Census, U.S. Department of Commerce, Washington, D.C., 1998.

### *1.4.10 Recreation*

Most of the area's revenue derived from recreation opportunities comes from spending on hunting and fishing. Based on 1985 data from the U.S. Fish and Wildlife Service, adjusted for inflation in a 1989 report by Comptroller Bob Bullock, hunters spent $48.2 million in the High Plains in 1989 on food, lodging, leases, equipment and other trip-related expenses. This equates to an average of $832 per hunter. Spending on fishing in the High Plains region was reported at $32.3 million in 1989, or an average of $736 per angler. Using a 3 percent rate of inflation (factor of 1.8), spending on hunting in 2009 is projected to be $86.7 million, while spending on fishing would be $58.1 million, for a total projected recreation spending of $144.8 million.

While hunting and fishing will probably remain a substantial part of the outdoor recreation picture, the activity of ecotourism has been growing rapidly in the region since 1980. Ecotourism is defined as discretionary travel to natural areas that conserve the environmental, social and cultural values while generating an economic benefit to the local community. Ecotourists engage in activities including bird watching, wildlife viewing, hiking, rock climbing, backpacking, camping, and outdoor photography. This activity is expected to increase within the Llano Estacado Region in the future, especially where water is available to attract wildlife. Also, landowners can increase opportunities to attract hunters and ecotourists at fairly low cost and little effort.

## *1.5 Water Use*

There are seven major types of water use in the Llano Estacado Region: (1) municipal; (2) manufacturing; (3) steam-electric power generation; (4) mining; (5) irrigation; (6) livestock (feedlots and range); and (7) environmental and recreation. Each of these types of water use is described below, and projections of demand for each type of use are shown in Section 2, Tables 2-4 through 2-19.

### *1.5.1 Municipal Water Use*

Municipal water use, as defined by the TWDB, includes water used for residential and commercial purposes. Residential water use includes water for drinking, cooking, bathing, flushing toilets, general cleaning and sanitation, swimming pools, car washing, gardening, and lawn watering. A 1984 U.S. Department of Housing and Urban Development study found that toilet flushing (39 percent) and bathing (30 percent) are the largest components of inside household use. Outside household use ranges from near zero in humid areas to 60 percent of total domestic use in arid areas.

The TWDB municipal water use definition also includes water used by commercial facilities such as hotels, restaurants, laundries, car washes, office buildings, educational institutions, prisons, government and military facilities, retail establishments, public swimming pools, fire protection, and irrigation of public parks and open spaces. In the Llano Estacado Region, per capita municipal water use in 2000 was about 172 gallons per day (87,322 acft/yr ÷ 453,997 people x 325,851 gal/acft ÷ 365 days/yr) (Tables 2-2 and 2-4).

Effective January 1, 1992, the Water-Efficient Plumbing Standards Act of the 73rd Texas Legislature required that certain plumbing fixtures (toilets, showerheads, and faucet aerators) sold after that date be water-efficient devices. In addition, the Federal Energy Policy Act of 1992 required that all new toilets produced for home use must operate on 1.6 gallons per flush or less. Older toilets used 3.5 to 5 gallons or more of water per flush. Other low-flow plumbing fixtures include low-flow showerheads that use 2.5 gallons per minute (gpm), instead of the standard 4.5 gpm and faucet aerators that can be installed in sinks to reduce water use. Water-conserving dishwashers and washing machines are also available, although they are still more expensive to buy than other appliances. As these water conserving fixtures and appliances are adopted, it is reasonable to assume a decreased per capita water use within the Llano Estacado Region in future years.

Outside of the home, landscaping that includes directing the water which runs off the roof, sidewalks and driveways onto the lawn, garden, trees and shrubs can reduce irrigation water demand. Borders can be built around yards, flower beds, and gardens to hold their rainfall runoff until it soaks into the soil. Additionally, if mulch is used on the soil surfaces in the garden, flowerbeds, and around shrubs and trees to reduce evaporation from the soil surface, the rainfall harvested plus this conservation effort can reduce outside of the home water use by 50 percent or more.

### *1.5.2 Manufacturing Water Use*

Water is used in a variety of ways for manufacturing purposes, including process uses (water used in the manufacture of products), cooling of portions of the manufacturing process, wash-down water for cleaning, water for employee drinking purposes, sanitary uses in restrooms, and landscape irrigation. The amount of water used for each purpose is usually particular to the type of industry. In the Llano Estacado Region, the major manufacturing uses of water are for food processing, industrial machinery and equipment, and fabricated metal products.

In response to the high costs to treat and dispose of wastewater, rising energy costs, and environmental considerations, industries use water more efficiently now than they did in the past. Some specific areas where savings are taking place are process modification or substitution, cooling water recycling and reuse, and steam and hot water conservation. Methods used in manufacturing to conserve cooling water may include use of saline water or treated wastewater, air cooling, and using recirculating cooling systems. Methods used to conserve water used for steam and hot water manufacturing processes include energy conservation and waste heat recovery.

### *1.5.3 Steam-Electric Power Water Use*

A steam-electric plant basically works by heating water in a boiler until it is turned into steam. The steam is used to turn the turbine-generator, which produces electricity, after which the steam is sent to the condenser to be cooled back into water. Most of the water used in steam-electric power generation is to cool the steam back into water. The condensed water is pumped back to the steam generator to become steam again, while the cooling water is discharged as wastewater or is recycled through cooling ponds or towers. Within a steam-electric plant, water is also used for make-up water to replace the water lost as steam, blowdown (purging) of boilers, washing of stacks, and power plant and employee sanitation. In the Llano Estacado Region, steam-electric power generation is done in Lamb, Lubbock, and Yoakum Counties.

Steam-electric power generation closely resembles manufacturing uses of water where steam is required; therefore, conservation practices in the two industries closely resemble each other. Since water used for cooling purposes constitutes the majority of water use in a steam-electric plant, this is perhaps where the greatest water saving can be achieved. Methods used to conserve freshwater may include use of saline water or treated wastewater, air cooling, and using recirculating cooling systems.

### *1.5.4 Mining Water Use*

Water is used in differing ways in the various types of mining or extractive industries. The primary water use in the mining industry in the Llano Estacado Region is for enhanced recovery of petroleum, such as with water injection. Water is also used in sand and gravel mining operations for washing mined deposits, although there is very little such activity in the Llano Estacado Region.

Several strategies have been used and continue to be used by the oil and gas industry to conserve fresh water. For example, the use of freshwater has been reduced by the use of poorer quality water for injection. In some oil-producing geologic formations, this is not feasible because of the precipitation of a solid when water that contains a different combination of minerals is introduced into oil and gas formations. Water with a different chemical quality could be treated before use, although in the past, treating this water has proven to be cost-prohibitive. An optional water supply for the oil and gas industry is treated municipal wastewater. This has been used in the past, but the water must be treated thoroughly to eliminate oxygen and to prevent growth of bacteria, which can clog the formation in the well. Another potential option for conserving freshwater in the oil and gas industry would be to develop new technology and/or expand the use of the carbon dioxide method of petroleum recovery.

### *1.5.5 Irrigation Water Use*

In the Llano Estacado Region, water is pumped from aquifers to supplement precipitation for crop production. This means that more water is pumped during periods of drought than during years when precipitation is higher. The five main methods used in the Llano Estacado Region to apply supplemental irrigation to crops are furrow, sprinkler, low-energy precision application, surge valves, and drip (trickle) irrigation. Each method is described below.

*Furrow irrigation* is used to apply water to row crops, such as cotton, corn, grain sorghum, and vegetables. Water is siphoned or released into furrows and allowed to flow down the furrow until the entire length is wetted.

*Sprinkler irrigation* uses drop lines that are spaced along an elevated pipe and extend to within 16 inches of the land surface. A sprinkler head is attached to each drop line to distribute the water evenly across the field. In the Llano Estacado Region, sprinkler systems are usually of the center-pivot type, most of which are sized to irrigate the center 123 acres of a one-quarter section (160 acres) of cropland. The center pad is located in the center of the tract to be irrigated and the system moves in a circular path around the center to irrigate the entire tract. Although more efficient than the furrow method, the center-pivot sprinklers lose to evaporation a part of the water that is sprayed out.

*Low-Energy Precision Application* (LEPA) is a technological improvement upon the partial drop center-pivot sprinkler irrigation system described above. LEPA systems use the center-pivot piping and transport systems; but instead of spraying water into the atmosphere, the water is delivered through lines hanging from the overhead transport frame and dragged on or near the land surface between crop rows. The advantages of LEPA systems are low pressure to operate, little evaporation from the application process, and control of rate of delivery of irrigation water. Also, they can be used with furrow dikes, which hold moisture in the furrows until it soaks into the ground. More uniform and timely applications of irrigation water results in higher yields (uniform production over the entire field), and usually results in less water pumped per acre, which reduces both energy and labor costs per acre.

*Surge valves* are a variation of furrow irrigation in which gated pipes are used to release irrigation water into the furrows to be irrigated. The gates of the pipes are spaced to deliver a stream of water into a set of furrows. Surge irrigation consists of a time-controlled valve placed between two sets of gated pipe, and the system alternately waters two sets of furrows in a series of timed “surges,” with each cycle supplying only enough water to flow a part of the length of the field. During the off period of the cycle, the water in the furrows infiltrates into the soil and creates a surface sealing effect that reduces infiltration in that section of furrows when the valve recycles to the set. Through this method of alternating watering of the sets, water flows down the previously wetted section of the furrow more rapidly, reducing deep percolation at the top end of the field. The cycle continues until enough water has been discharged into each set to wet the soil uniformly throughout the field. Surge irrigation improves irrigation efficiency in comparison to the standard furrow method and is low cost in terms of capital investment.

*Drip irrigation* delivers small but frequent quantities of moisture to plants by means of buried small-diameter, plastic tubes with small orifices or holes spaced to allow the release of water near the plant roots. This method results in a minimum loss of water through evaporation or deep percolation into the ground. Yields have been increased from 500 to 1,500 pounds of lint cotton per acre on some drip irrigation tracts.

Adoption and use of equipment to improve irrigation application efficiencies was begun in the mid-1980s and has continued at a rapid pace to the present. As an example, in 1995, 12,931 center pivot systems were in place. This increased to 18,602 systems by 2008, an increase of about 2.83 percent per year since 1995. The TWDB inventory of irrigated acres in the Llano Estacado Region showed an irrigated acreage of 3,280,576 acres in 2000.[31] In 2008,

***Table 1-16.***
***List of Irrigation Systems and Efficiency***
***Llano Estacado Region***

| *Irrigation Systems* | *Range of Application Efficiency (percent)* |
|---|---|
| Drip Irrigation | 96 to 98% |
| LEPA Center Pivots | 96 to 98% |
| Center Pivots w/ Low Heads (16") | 86 to 90% |
| Furrow w/ Surge & Tailwater Pit (30 to 40%) | 80 to 90% |
| Furrow w/ Surge (10 to 40%) | 80 to 90% |
| Furrow w/ Tailwater Pit (15 to 20%) | 70 to 85% |
| Over Crop Center Pivots | 75 to 80% |
| Furrow w/ Pipeline (15 to 20%) | 50 to 70% |
| Furrow w/ Ditch | 40 to 60% |

Source: High Plains Underground Water Conservation District No 1, Lubbock, Texas, 1997.

2,493,373 acres were irrigated with center pivot systems, which is about 76 percent of the 3,274,756 total reported irrigated acres in the region in 2008.[32] These center pivot systems deliver water at an efficiency of 75 percent or higher (Table 1-16).

During the late 1940s and early 1950s, furrow irrigation was the primary method used to provide irrigation water to crops in the region. Water losses of 50 percent or more occurred through deep percolation and irrigation tailwater when open ditches were used to transport the water from the field to the crop. In the late 1950s and during the 1960s, underground pipelines were installed to replace open ditches, thereby reducing losses from deep percolation and evaporation from the open unlined ditches. Additionally, during the 1960s and 1970s, irrigation

[31] TWDB, "Report 347: Surveys of Irrigation in Texas," August 2001.
[32] High Plains Underground Water District No. 1, "Center Pivot Inventory," Lubbock, Texas, August 2009.

tailwater return systems were installed on a high percentage of the farms in the tighter soils (clay) areas to reuse tailwater that would have been lost from previously used technologies. During this same time period, high-pressure and side-roll sprinkler systems were used to irrigate the sandy soil areas of the region. Although an improvement over furrow irrigation, these sprinkler systems had water losses in the range of 50 percent due to evaporation from the small drops of water as water was sprayed above the crops and from the irrigation water that wet the crop canopy.

Beginning in the early 1980s, high-pressure center pivot irrigation systems were modified or replaced with center pivot systems equipped with drop lines, which discharge water at lower pressure with a large water drop size at about 4 feet above land surface, reducing losses from 50 percent to about 20 percent, as compared to the previously used furrow irrigation method.

In 1983, time-controlled surge valves were added to the underground pipe systems used to provide water for furrow irrigation. These surge valves provided a method to alternate the flow of water down two sets of furrows on a timed sequence. Their addition greatly reduced deep percolation and irrigation tailwater. Water losses were reduced to about 20 percent.

In the late 1980s and early 1990s, many of the partial drop center pivot systems were further modified to deliver the water into the furrow through socks or drag hoses, further reducing water losses to as little as 2 or 3 percent during irrigation applications.

In 1998, about 75 percent of the total irrigated acreage (2,297,406 acres) in the Llano Estacado Region was irrigated with center pivot irrigation systems. Of these systems, about 25 percent utilized full drops, and about 50 percent had drops 4 feet above the ground. Of the remaining irrigated acreage, about 20 percent was furrow irrigated, utilizing underground pipe and surge valves, with the remaining 5 percent irrigated by some combination of side roll sprinkler systems, hand moved sprinkler line systems, drip irrigation systems, and conventional furrow irrigation systems without surge valves. (In 2008, acreages irrigated with center pivots were estimated at 2,493,373, an increase from 1998 of about 196 thousand acres, however, information is not available about types of drops, and other types of sprinkler systems in use for dates since 1998.)

By the end of the 1990s, tailwater return systems had almost disappeared from use, since there was no tailwater from the irrigation systems being used. However, some have been left in place to provide holding ponds for water for wildlife, where there are small quantities of runoff.

### *1.5.6 Livestock Water Use*

Cattle feeding and dairy operations constitute approximately 60 to 70 percent of water used for consumption by cattle, sanitation, and for dust control at feedlots in the Llano Estacado Region. Reducing the amount of water used for dust control is an important component of reducing overall water use at a feedlot. Feedlots continue to experiment and quantify the smallest amount of water for effective dust control. Additionally, feedlot feedmills use a small amount of water to steam-flake grain and for office and sanitary purposes.

### *1.5.7 Environmental and Recreational Water Use*

As mentioned in Section 1.2.4.3, as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes use playas as wintering areas or as rest stops during annual migrations.[33] In addition, small mammals, amphibians, and reptiles depend on playas for water and habitat. Those playas and other areas that have been historically important for waterfowl and sandhill cranes are listed in Table 1-17. In years of good rainfall, habitat is excellent for big game, upland game, and waterfowl, and runoff to the region's few streams, rivers, and area reservoirs benefits fish and water recreational opportunities. Wildlife resources indirectly benefit from the Ogallala and other aquifers, primarily due to irrigation and production of grain crops. In fact, the best pheasant and waterfowl populations are generally found in areas of intensive irrigated grain production.

Since the flows of the rivers or streams (or instream flows) are extremely limited, the productivity and diversity of aquatic species is quite limited. Nevertheless, these intermittent streams are a source of inflow to area lakes, helping to support the aquatic environment and fisheries of those water bodies.

The Llano Estacado Region has several water-oriented recreational facilities, which are summarized below. The location of these recreational facilities is shown in Figure 1-6.

> **White River Lake**: White River Lake, located on the Salt Fork tributary of the Brazos River in Crosby County, covers 1,808 acres and supplies water for Crosbyton, Post, Spur, and Ralls. The lake features camping areas, lakeside cabins, boat rentals, picnic areas, and fishing supplies. Principal recreational activities are fishing and water skiing.

[33] Steiert, Jim, Unpublished, Ogallala Area Regional Water Planning Information, 1996.

**Lake Mackenzie:** Lake Mackenzie, near Tulia in Briscoe County, covers 296 acres and offers facilities for fishing, picnicking, camping, RV hookups, boat ramps, and a swimming area.

**Buffalo Springs Lake:** Buffalo Springs Lake is a 200-acre lake on the Double Mountain Fork of the Brazos River in Lubbock County that serves as a fishing, boating, and picnicking facility.

**Lake Meredith National Recreation Center:** Lake Meredith, built by the U.S. Bureau of Reclamation and operated by the Canadian River Municipal Water Authority, is located on the Canadian River to the north of the Llano Estacado Region and covers 16,504 acres. Eight public parks are located around the lake with facilities for camping and picnicking

**Lake Alan Henry:** Lake Alan Henry, located near Post in Garza County, covers approximately 3,504 acres. The primary recreational activities associated with the lake are fishing, boating, and camping.

**Caprock Canyons State Park:** Caprock Canyons State Park covers 13,960 acres near Quitaque in Briscoe County. The park has facilities for hiking, picnicking, fishing, and swimming in the 100-acre lake.

**Armstrong Playa Project:** The Texas Parks and Wildlife Department owns a conservation easement on this property. It is located near Dimmitt in Castro County.

**Lubbock City Park Playas:** Many of the city parks in Lubbock are located around playa lakes. Many of these lakes are used for recreational purposes such as bird watching, fishing, and picnicking.

**Lubbock Lake Landmark State Historical Park:** This 336.6-acre, day-use only, historic site, is an archaeological and nature preserve located in Lubbock County. It is jointly operated by Texas Parks and Wildlife Department and Texas Tech University. The park lies along Yellowhouse Draw, a typically dry tributary of the Brazos River.

Hunting and fishing have become important economic enterprises in the Southern High Plains area, with an estimated annual expenditure of sportsmen of over $143 million in 2009.

**Table 1-17.**
**Areas Identified as Historically Important for Waterfowl and Sandhill Cranes Llano Estacado Region**

| Area Historically Important to Waterfowl | Location |
|---|---|
| Armstrong Playa | Dimmitt |
| Beefco Cattle Feeders | near Easter |
| Bud Hill Feedlot | Dimmitt |
| Buffalo Springs, Ransom Canyon | Lubbock |
| Bull Lake | Littlefield |
| Cedar Lake | Seagraves |
| Dead Horse Lake (at Bartlett Feedyard No. 2) | north of Hereford |
| Cargill Beef, Friona | west of Friona |
| Solutions, Plainview | Plainview |
| Frost & Gooch Lakes | south of Lubbock |
| Fry Lake on Frio Draw | near Friona |
| A-2 Cattle Feeding | Flagg area in Castro County |
| GW Sugar Playa | Deaf Smith County |
| Hale County Feedlot | Hale Center |
| Happy Feedlot | Happy |
| Hill Feedlot & Hart Playa | Hart |
| Sugarland Feed Yard Playa | Hereford |
| Ivy Lake (east of Easter) | Castro County |
| Lake Mackenzie | Silverton |
| Muleshoe NWR | Needmore |
| Paco-Bovina Feedyards | western Parmer County |
| Veigel pasture lake | Summerfield |
| Rafter 3 Feedyard | west of Dimmitt |
| Rich & Mound Lakes | Brownfield |
| Simpson Lake (north of Dimmitt Feed Yard) | Dimmitt |
| Stud Horse Playa | Parmer County |
| Tahoka-Gordon Lakes | Tahoka |
| Upper Paul's Lake | Bailey County |
| Various City Park Lakes | Lubbock |
| White River Lake | Near Crosbyton |

Source: Playa Lakes Joint Venture Management Board, “Final Implementation Plan,” Albuquerque, NM, November 1994.

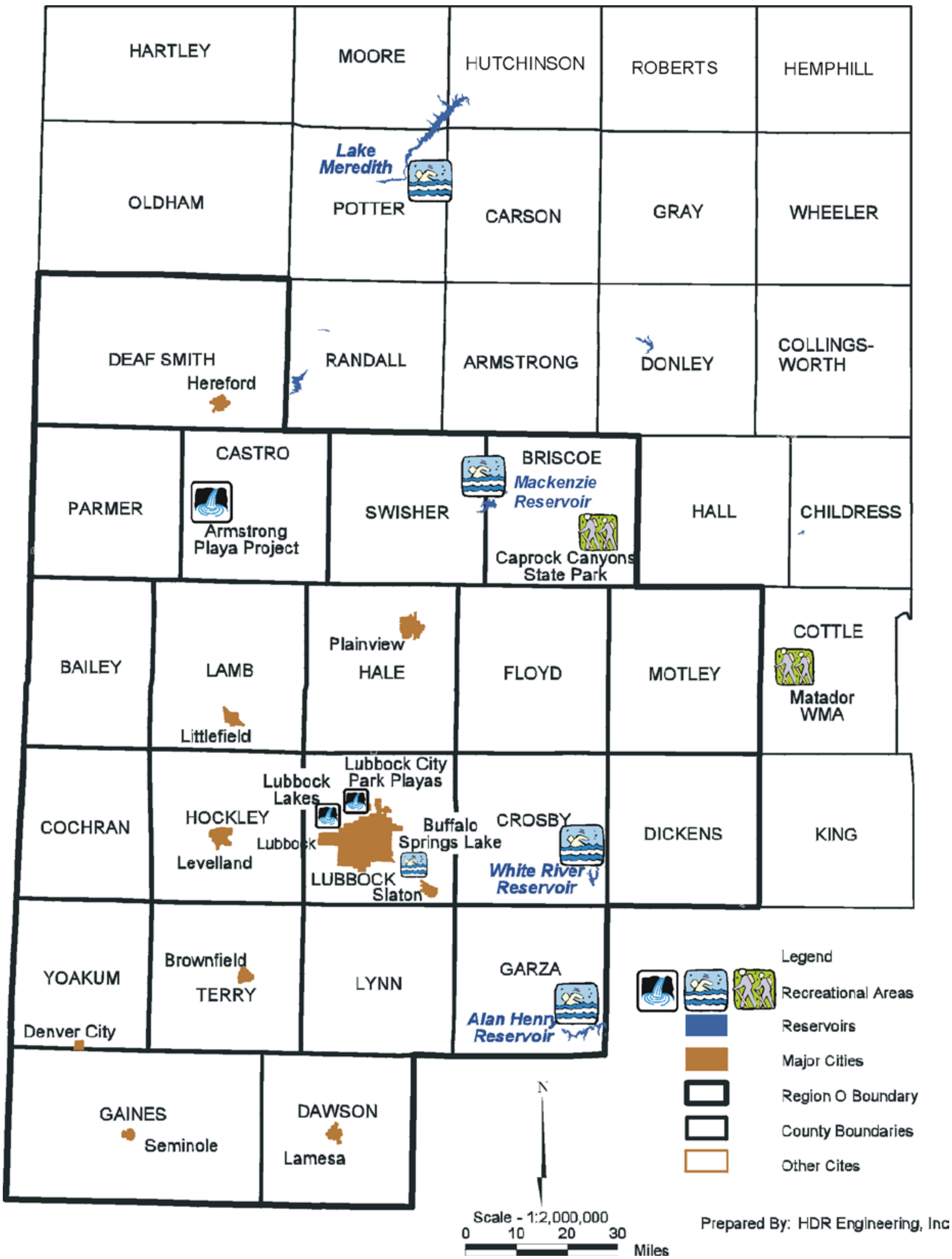


***Figure 1-6. Location of Water-Oriented Recreational Facilities Llano Estacado Region***

### 1.5.8 Major Demand Centers

Although most of the counties of the Llano Estacado Region have small towns and communities, several major municipal demand centers exist within the region. The City of Lubbock is the largest demand center in the region for municipal and manufacturing water use. The major water demand centers for water used in oil and gas extraction are in counties located in the southern portion of the region, while large cattle feedlots, most of which are located in the northern half of the region, are the major demand centers for livestock water. Unlike water demand for municipal, manufacturing, electric power generation, and mining purposes, water demand for irrigation is spread throughout the region.

## 1.6 Water Supplies

### 1.6.1 Groundwater[34]

Two major and two minor aquifers supply water to the area. The two major aquifers are the Ogallala and Seymour Aquifers. The two minor aquifers are the Edwards-Trinity (High Plains) and the Dockum Aquifers.

#### 1.6.1.1 Ogallala Aquifer

The Ogallala Aquifer is the major water-bearing formation of the 21 counties of the Llano Estacado Region. Vertical hydrologic communication occurs between the overlying Quaternary Blackwater Draw Formation, where present and the Cretaceous or Triassic formations which lie directly below the Ogallala Formation in a portion of the planning region. Although many communities use water from the Ogallala Aquifer as their primary source for drinking water, approximately 95 percent of the water obtained from the Ogallala is used for irrigation.

The Ogallala is composed primarily of sand, gravel, clay, and silt deposited during the Tertiary Period. Groundwater, under water-table conditions, moves slowly through the aquifer in a southeasterly direction toward the caprock edge or eastern escarpment of the High Plains. Saturated thickness of the aquifer is generally greater in the northern part of the region and thinner in the southern part where the formation overlaps Cretaceous rock units. The saturated thickness which is greatest where sediments have filled previously eroded drainage channels,

[34] Ashworth, John B., and Janie Hopkins, "Major and Minor Aquifers of Texas" Report 345, Texas Water Development Board, Austin, Texas, November 1995.

ranges up to approximately 300 feet. Well yields range from as little as 10 gpm to as much as 1,000 gpm. The majority of wells yield between 200 to 600 gpm.

Recharge to the aquifer occurs primarily by infiltration of precipitation from the surface, and to a lesser extent, by upward leakage from underlying formations. Recharge rates vary from 0.3 inches to 3.0 inches per year, depending upon annual rainfall and geographic area. Playa basins appear to be areas of focused recharge.

Since the expansion of irrigated agriculture in the mid-1940s, greater amounts of water have been pumped from the aquifer than have been recharged. As a result, some areas have experienced water level declines in excess of 100 feet. However, conservation efforts have resulted in a reduction in the rate of water level declines.

#### *1.6.1.2 Seymour Aquifer*

The Seymour Formation consists of isolated areas of alluvium found in parts of 23 north-central and Panhandle counties, including parts of Briscoe, Motley, Dickens, and Crosby Counties of the Llano Estacado Region. The Seymour aquifer supplies small quantities of water for municipal uses in these four counties.

#### *1.6.1.3 Edwards-Trinity (High Plains) Aquifer*

The Edwards-Trinity (High Plains) aquifer is a minor aquifer in the State of Texas that includes Cretaceous aged water-bearing formations of the Fredericksburg, Trinity, and Washita groups. These formations underlie the Ogallala Formation in 11 counties in the southwestern corner of the Llano Estacado Region and extend westward into New Mexico. The majority of the wells completed in the aquifer provide yield 50 to 200 gpm and provide water for irrigation.

Two distinct groundwater zones occur in the Edwards-Trinity (High Plains) aquifer. One occurs in the basal sand and sandstone deposits of the Antlers Formation (Trinity Group) and is usually under artesian pressure. The other water-bearing zone occurs primarily in the joints, solution cavities, and bedding planes in limestones of the Edwards Formation. In much of the area, the Edwards-Trinity (High Plains) zone is hydrologically connected to the overlying Ogallala aquifer, with recharge occurring directly from the bounding Ogallala Formation along northern and western parts of the subcrop and by downward percolation from overlying units at other locations. Upward movement of groundwater from the Triassic Dockum aquifer into the Edwards-Trinity (High Plains) aquifer is also believed to occur in Lynn County. Some groundwater may also occur in the porous and permeable sections of the Duck Creek and Kiamichi formations.

Groundwater movement is generally to the southeast. In many places, the groundwater potentiometric surface in the Edwards-Trinity (High Plains) aquifer is higher than in the Ogallala aquifer, resulting in upward movement of water from the Edwards-Trinity (High Plains). In these areas, the Edwards-Trinity (High Plains) has a significant impact on the water levels and quality of the overlying Ogallala.

#### 1.6.1.4 Dockum (Santa Rosa) Aquifer

Triassic Dockum Group rocks underlie the Ogallala Formation in portions of the High Plains area of Texas and New Mexico, the northern part of the Edwards Plateau, and the eastern part of the Cenozoic Pecos Alluvium. Where the Dockum Group is exposed east of the High Plains caprock and in the Canadian River Basin, the land surface takes on a reddish color. In the subsurface, the Dockum is commonly referred to as the "red bed." The primary water-bearing zone in the formation, the Santa Rosa, consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale at the base of the Dockum section.

### 1.6.2 Surface Water

Although the Llano Estacado Region lies within four river basins, the region has very little surface water (Figure 1-2). Dams have been built to take advantage of what surface water exists. In other segments of rivers, surface water amounts to a trickle. Very little, if any, water leaves the region via streamflow. The surface water resources of the region are described below.

#### 1.6.2.1 Canadian River Basin

Beginning in northeastern New Mexico, the Canadian River flows eastward across the Texas Panhandle into Oklahoma and merges with the Arkansas River in eastern Oklahoma. Total drainage area of the basin is 12,700 square miles, of which 94 square miles are located in the Llano Estacado Region (Figure 1-2).[35] Most of its course across the Panhandle is in a deep gorge. A tributary dips into Texas' northern Panhandle and then flows to a confluence with the main channel in Oklahoma. Lake Meredith, formed by the Sanford Dam on the Canadian,

[35] "Water for Texas," Texas Water Development Board, Austin, Texas, August 1997.

provides water for 11 Panhandle cities, including Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Plainview, Slaton, and Tahoka within the Llano Estacado Region.

#### *1.6.2.2 Red River Basin*

In the Llano Estacado Region, this basin is bounded on the north by the Canadian River Basin and on the south by the Brazos River Basin (Figure 1-2). The Red River Basin extends from the headwaters in eastern Curry County, New Mexico, across the Texas High Plains to the southwestern corner of Oklahoma, near Childress, Texas, where the river becomes the Texas-Oklahoma border. The Red River Basin encompasses 6,681 square miles in the region.[36] The uppermost tributary of the Red River in Texas is Tierra Blanca Creek, which rises in Curry County, New Mexico, and drains into the Prairie Dog Town Fork a few miles east of Canyon. However, these tributaries do not supply significant quantities of water to water users of the Llano Estacado Region. Major population centers located in the basin include the Cities of Hereford (Deaf Smith County) and Tulia (Swisher County).

#### *1.6.2.3 Brazos River Basin*

In the Llano Estacado Region, the Brazos River Basin is bounded on the north by the Red River Basin and on the south by the Colorado River Basin and includes 8,732 square miles in the Llano Estacado Region (Figure 1-2).[37] In the region, the Brazos River rises in three upper forks, the Double Mountain, Salt, and Clear Forks of the Brazos. However, the Brazos River proper is considered to begin where the Double Mountain and Salt Forks flow together in Stonewall County, east of the Llano Estacado Region. Major population centers located in the basin include the Cities of Muleshoe (Bailey County), Littlefield (Lamb County), Plainview (Hale County), Levelland (Hockley County), Lubbock and Slaton (Lubbock County), and Post (Garza County). Alan Henry Reservoir on the Double Mountain Fork in southeastern Garza County was built to supply municipal water and industrial water to Lubbock, and at the present time (2009), Lubbock is in the advanced stages of plans to build a treatment plant and pipeline to bring water from Lake Alan Henry for Lubbock's use.

[36] Ibid.
[37] Ibid.

#### *1.6.2.4 Colorado River Basin*

In the Llano Estacado Region, this basin is bounded on the north by the Brazos River Basin and on the south by the Rio Grande Basin (Figure 1-2). The Colorado River Basin contains 4,787 square miles in the Llano Estacado Region.[38] The headwaters of the Colorado River occur in eastern New Mexico, and the river course is to the southeast across Texas approximately 600 miles, discharging into Matagorda Bay and the Gulf of Mexico. However, there is very little flow within the Llano Estacado Region. Major population centers of the planning region that are located in the basin include the Cities of Brownfield (Terry County), Denver City (Yoakum County), Lamesa (Dawson County), and Seminole (Gaines County). However, neither the Colorado River nor its tributaries supply water to any of these cities.

### *1.6.3 Developed Surface Water Resources*

Development of surface water supply sources has been limited in the Llano Estacado Region simply because the area does not have flowing streams of any significance (Section 1.6.2). However, four reservoirs are located nearby and supply water for municipal and industrial uses within the region (Figure 1-6). These four reservoirs are identified and described below. Those cities that do not receive water from these reservoirs rely on groundwater to supply their water needs for both municipal and industrial purposes.

#### *1.6.3.1 Lake Meredith*

Lake Meredith, located in Region A in the Canadian River Basin in Potter, Moore, and Hutchinson Counties, has a total storage capacity of 920,300 acft and can supply approximately 76,000 acft of water per year when at conservation pool elevation. Associated, supplemental projects to supply groundwater from Roberts County in Region A have been implemented to firm up the reliability and improve the quality of currently contracted supplies. From Lake Meredith, a pipeline extends southward and delivers water for municipal and industrial purposes to Brownfield, Lamesa, Levelland, Lubbock, Plainview, O’Donnell, Slaton, and Tahoka within the Llano Estacado Region.

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[38] Ibid.

#### *1.6.3.2 Mackenzie Reservoir*

Mackenzie Reservoir is located in the Red River Basin in Swisher and Briscoe Counties, and supplies water to Silverton, Tulia, Floydada, and Lockney. The reservoir has a total storage capacity of 45,500 acft and can supply approximately 5,200 acft of water per year when at conservation pool elevation. During recent dry conditions, Lake Mackenzie was unable to meet its contracted demands.

#### *1.6.3.3 White River Lake*

White River Lake is located in the Brazos River Basin in the southeast corner of Crosby County. It is owned and operated by the White River Municipal Water District, which supplies water to Ralls, Spur, Post, and Crosbyton. The lake has a surface area of 1,808 acres at conservation pool elevation, a drainage area of 173 square miles, a total storage capacity of 44,897 acft, and a water right of 6,000 acft/yr. White River Municipal Water District has purchased groundwater rights and has drilled wells to supply its customers should the water levels in the reservoir drop below the level at which water can be removed.

#### *1.6.3.4 Lake Alan Henry*

Lake Alan Henry is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties and is owned by the City of Lubbock. The lake has a total storage capacity of 115,937 acft and a firm yield of approximately 22,500 acft of water per year. Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In 2003, the Texas Legislature enacted legislation to create the Lake Alan Henry Water Supply District for the purpose of supplying water from the lake to developing areas adjacent to and near the lake. The District was confirmed in 2004 by voters of the service area. At the time of this plan, Lubbock is in the advanced stages of planning and construction of water treatment, storage, pipeline(s), and pumping facilities to bring Lake Alan Henry water to the city for use.

### *1.6.4 Playa Basins*

In addition to the rivers and streams in the planning area, there are as many as 20,000 playa basins located on the High Plains of Texas, of which about 14,000 are located in the Llano

Estacado Region (Table 1-18).[39] Playas are naturally occurring depressions in the landscape of the Southern High Plains that provide the internal drainage for much of the region.

Playa watersheds are closed systems, with playa floors representing the deepest point of the watershed. In times of abundant rainfall, they collect water and form lakes. Playas have little elevational change as one proceeds across them in a horizontal gradient; playa floors are flat. Some playa floors are defined as wetlands by the presence of hydric, vertisol clay soil, usually

***Table 1-18.***
***Number and Total Area of Playas in Planning Area***
***Llano Estacado Region***

| County | Number | Acres Covered | County | Number | Acres Covered |
|---|---|---|---|---|---|
| Bailey | 598 | 4,772 | Hale | 1,383 | 23,263 |
| Briscoe | 787 | 12,266 | Hockley | 1,171 | 8,388 |
| Castro | 621 | 19,756 | Lamb | 1,280 | 13,405 |
| Cochran | 395 | 1,815 | Lubbock | 934 | 15,503 |
| Crosby | 925 | 18,278 | Lynn | 842 | 9,172 |
| Dawson | 702 | 7,074 | Motley | 0 | 0 |
| Deaf Smith | 451 | 14,069 | Parmer | 455 | 9,935 |
| Dickens | 0 | 0 | Swisher | 910 | 20,117 |
| Floyd | 1,783 | 40,605 | Terry | 532 | 3,022 |
| Gaines | 65 | 210 | Yoakum | 38 | 187 |
| Garza | 283 | 4,676 | **Total** | **14,155** | **226,513** |

Source: Guthery, F.S., F.C. Bryant, B. Kramer, A. Stoecker, and M. Dvoracek, "Playa Assessment Study," U.S. Water and Power Resources Service, Southwest Region, Amarillo, TX, 1981.

Randall Clay, and despite being surrounded by intensive agricultural activities, the playas perform many functions beneficial to humans and biota of the region, as will be explained below.

The majority of playa basins are ephemeral, meaning that they only hold water during and for a period of time after rainfall events. In earlier days, irrigation tailwater kept many playa basins partially supplied for part or all of the year. However, as irrigation efficiency has improved, most playas have water in them only after a rainfall event, with the quantity of rainfall received during the spring months of March, April, and May being a critical factor in the life expectancy of a wet playa. Some playas have been modified by landowners to concentrate the

[39] Playa Lakes Joint Venture Management Board, "Final Implementation Plan," Albuquerque, NM, November 1994.

stored water into deeper pools with smaller surfaces, which decreases evaporation. Some farmers recirculate this water for irrigation. However, the capacities of many playas to hold water have been reduced, since in the days of straight row furrow irrigation, soil was washed down the furrows into the playas. As they gradually silted in, the water-holding capacity has been lowered, and at the present rate of siltation, playas in heavily farmed areas may disappear in the next 20 years.[40]

Given their sheer number and ability to retain water in arid and semi-arid periods, playas are especially important to numerous wildlife species. However, the abundance and diversity of wildlife species that use them depend on several factors, including the size of a basin and agricultural activity around the playa. Since larger basins are less likely to be tilled for crops or weed control, a large basin is more likely than a small basin to have natural vegetation to support wildlife year-round. With respect to activity around the playa, studies have found that playas surrounded by grain fields such as grain sorghum, small grains, corn, or some combination of these crops support a wider diversity of species than playas surrounded by cotton, potatoes, or sugar beets, but cropping activity without a grass buffer around the playas contributes a heavy load of silt to the basins.

Most, if not all, species of wildlife in the region use playas and many species are dependent on playas for their existence. Nearly 200 species of birds have been identified in playas. Nine species of amphibians, which consume a multitude of agricultural pest insects, would not exist in much of the region without playas. A minimum of 37 species of mammals have been associated with playas. Several species of reptiles use playas throughout the year. In fall and spring, migratory birds rest at playas during migration to and from wintering and summering grounds. Playas are of critical importance as habitat for wintering waterfowl. Some birds also use playas as breeding and nesting areas. A total of 346 plants are now reported in playa basins.

About 30 feedyards use playa basins and catchment ponds for feedlot runoff. Testing of pond water and soil below and around the pond shows no leaching of nutrients below 20 feet, and testing around the pond shows no sign of pollution. In fact, research by the Texas A&M

[40] Steiert, Jim, Unpublished, Ogallala Area Regional Water Planning Information, 1996.

Extension Service has shown that a natural Randall Clay bottom on a playa seals the bottom as effectively as any other liner.[41]

### 1.6.5 Springs

According to "Major and Historical Springs of Texas," published by the TWDB, there are four active springs located within the planning area (Hylsey, Roaring, Buffalo, and Couch Springs).[42] Hylsey Springs is located approximately 9 miles north of Vigo Park within Palo Duro Canyon in Briscoe County. Hylsey Springs produces water from the Santa Rosa Sandstone, which is the primary water-bearing unit of the Dockum Aquifer. Roaring Springs is located approximately 4 miles south of the Town of Roaring Springs in Motley County. Roaring Springs produces water from the Santa Rosa Sandstone (Dockum Aquifer) and the Ogallala Aquifer. Buffalo Springs is located approximately 9 miles southeast of the City of Lubbock. Buffalo Springs produces water from the Edwards-Trinity (High Plains) Aquifer. Couch Springs, located approximately 8 miles east of Crosbyton in Crosby County, produces water from the Ogallala Aquifer. Information obtained from area residents indicates that following unusually heavy rainfall in 2004, there has been renewed spring and seep flows in some locations (Appendix B).

## 1.7 Water Quality

### 1.7.1 Groundwater Quality[43]

#### 1.7.1.1 Ogallala Aquifer

The chemical quality of water in the Ogallala aquifer is generally fresh; however, both dissolved solids and chloride concentrations increase from north to south. In the Northern portion of the Llano Estacado Region, total dissolved solids are generally less than 400 milligrams per liter (mg/L). Total dissolved-solids concentrations typically exceed 400 mg/L in the Southern portion of the regional planning area, with some parts of the area having groundwater with concentrations exceeding 1,000 mg/L of total dissolved solids, especially in the vicinity of alkali lakes. Upward leakage and subsequent mixing of water from the underlying Cretaceous aquifers

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[41] Smith, B.A., et al., "Nitrate and Other Nutrients Associated with Playa Storage of Feedlot Wastes," Texas Agricultural Extension Service, November 1993.

[42] TWDB, "Major and Historical Springs of Texas (Report No. 189)," March 1975.

[43] Ashworth, John B., and Janie Hopkins, "Major and Minor Aquifers of Texas" Report 345, Texas Water Development Board, Austin, Texas, November 1995.

probably influences the chemical quality in the south. Fluoride content is commonly high, and selenium concentrations locally are in excess of drinking water standards.[44]

In the spring of 2002, the Texas Commission on Environmental Quality determined that perchlorate (a salt comprising a chlorine atom and four oxygen atoms), which had been added to the USEPAs' Contaminant Candidate List in 1998, was present in groundwater from well fields that supply water to the City of Midland, Texas, and funded a sampling program to determine sources and distribution of perchlorate in the southern High Plains of Texas.[45] Perchlorate was detected in 56 percent of the more than 1,000 wells sampled, with measured concentrations ranging from 0.19 to 179 ug/L.[46] However, the study was not conclusive as to the source(s) of perchlorate.

#### *1.7.1.2 Seymour Aquifer*

Water quality in these alluvial remnants generally ranges from fresh to slightly saline. Total dissolved solids range from 500 to 3,000 mg/L in Motley County, while parts of the aquifer underlying Dickens County have a total dissolved solids concentration greater than 3,000 mg/L. High nitrate concentrations in excess of drinking water standards in Seymour groundwater may also occur in these two counties. However, as was noted in Section 1.6.1.2, very little water is used from this aquifer in the Llano Estacado Region.

#### *1.7.1.3 Edwards-Trinity (High Plains) Aquifer*

Water quality in the aquifer is typically fresh to slightly saline and is generally poorer in quality than water in the overlying Ogallala Aquifer. Water quality deteriorates in the vicinity of the saline lakes in Lynn, Dawson, Terry, and Gaines Counties.

#### *1.7.1.4 Dockum Aquifer*

Concentrations of dissolved solids in the groundwater range from less than 1,000 mg/L near the eastern outcrop to more than 35,000 mg/L in the deeper parts of the aquifer in Garza, Hockley, Lubbock, Lynn, and Terry Counties. Relatively high sodium concentrations make the water undesirable for irrigation use in some areas, although this aquifer is used for irrigation in other areas of the region. Irrigation and public supply use is limited to the areas of the Dockum

[44] Water-Quality Evaluation of the Ogallala Aquifer, Texas, Texas Water Development Board, Austin, Texas, 1993.
[45] Rajagopalan, Srinath, "Distribution and Source Evaluation of Perchlorate in Arid and Semi-Arid Regions," PhD Dissertation, Department of Civil Engineering, Texas Tech University, Lubbock, Texas, 2006.

Aquifer where water quality is acceptable. The Cities of Dickens, Happy, Hereford, and Tulia use or have used water from the aquifer. In addition, some livestock feedlots use water from the aquifer as their primary water supply. In areas where the water quality is not acceptable for irrigation, public supply, or livestock, the water may be suited for use in petroleum-related activities.

### 1.7.2 Surface Water Quality[47]

#### 1.7.2.1 Canadian River Basin

The principal water quality problems in the Canadian River Basin are elevated total dissolved solids and chloride levels. The Canadian River at the New Mexico-Texas state line is moderately saline during low flow due to natural conditions. Additionally, a natural brine artesian aquifer with total dissolved solids greater than 30,000 mg/L seeps into the river near the Texas-New Mexico border. The high chloride levels affect water quality in Lake Meredith. The Canadian River Municipal Water Authority, owner of the lake, has implemented a chloride control project to alleviate this problem. The Cities of Brownfield, Lamesa, Levelland, Lubbock, Plainview, O'Donnell, Slaton, and Tahoka located in the Llano Estacado Region are provided water by the CRMWA from Lake Meredith.

#### 1.7.2.2 Red River Basin

High concentrations of total dissolved solids, sulfate, and chloride are a general problem in most streams of the Red River Basin under low flow conditions. These high salt concentrations are caused, in large part, by natural conditions due to the presence of saltwater springs, seeps, and gypsum outcrops. Saltwater springs are located in the western portion of the basin in the upper reaches of the Wichita River, the North and South Forks of the Pease River and the Little Red, which is a tributary to the Prairie Dog Town Fork of the Red River. Gypsum outcrops are found in the area ranging westward from Wichita County to the High Plains Caprock Escarpment. The water in these areas usually contains extremely high levels of dissolved solids. At times, the total dissolved solids are comparable to those found in seawater. However, since streams of the basin supply practically no water to the Llano Estacado Region, the water quality in the basin is of little, if any, importance to this planning effort.

[46] Ibid.
[47] "Water for Texas," Texas Water Development Board, Austin, Texas, August 1997.

#### *1.7.2.3 Brazos River Basin*

Water quality in most reaches of the upper Brazos River Basin is considered to be good, although in some areas of the upper basin high concentrations of natural salt contribute salt loads to area streams and rivers. Primary sources of salt include the watersheds of the Double Mountain and Salt Forks of the river. The Brazos River segment from the confluence with the Salt Fork of the Brazos River in Kent County to White River Dam in Crosby County contains above average concentrations of chloride, sulfate, and total dissolved solids. Since this is a source of water for some cities of the region, this quality condition is important to this regional water supply planning effort.

#### *1.7.2.4 Colorado River Basin*

Due to a lack of perennially flowing streams in the upper Colorado River Basin, there are no regularly monitored water quality gauging stations along these streams (i.e., no water, no water quality concerns).

### *1.7.3 Water Quality Issues*

#### *1.7.3.1 Drinking Water Standards Governing Drinking Water Quality for Public Water Systems*

The Texas Commission on Environmental Quality has adopted standards to assure the safety of public water supplies with respect to microbiological, chemical, and radiological quality.[48] Maximum Contaminant Levels (MCLs) have been adopted for the following 15 inorganic compounds: Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Cyanide, Flouride, Mercury, Nitrate, Nitrite, Nitrate & Nitrite (Total), Selenium, and Thallium.[49]

MCLs have been established for the following 30 synthetic organic contaminants: Alachor, Atrazine, Benzopyrene, Carbofuran, Chlordane, Dalapon, Dibromochloropropane, Di(2-ethylhexyl)adipate, Di(2-ethylhexyl)phthalate. Dinoseb, Diquat, Endothall, Endrin, Ethylene dibromide, Glyphosate, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, Hexachlorocyclopetadiene, Lindane, Methoxychlor, Oxyamyl (Vydate), Pentachlorophenol, Picloram, Polychlorinated biphenyls (PCBs), Simazine, Toxaphene, 2,3,7,8-TCDD (Dioxin), 2,4,5-TP, and 2,4-D.[50] MCLs have been established for the following 21 volatile organic contaminants: 1,1-Dichlorethylene, 1,1,1-Trichlorethane, 1,1,2-Trichlorethane, 1,2-

[48] Texas Commission on Environmental Quality, Chapter 290-Public Drinking Water, Austin, Texas, January 2008.
[49] Ibid.

Dichlorobenzen, 1,2-Dichloropropane, 1,2,4-Trichlorobenzene, Benzene, Carbon tetrachloride, cis-1,2-Dichlorethylene, Dichloromethane, Ethylbenzene, Monochlorobenzene, o-Dichlorobenzene, para-Dichlorobenzene, Styrene, Tetrachloroethylene, Toluene, trans-1,2-Dichloroethylene, Trichloroethylene, Vinyl chloride, and Xylenes (total).[51]

In addition to the MCLs listed above, secondary standards have been established for the following 16 constituents: Aluminum, Chloride, Color, Copper, Corrosivity, Flouride, Foaming agents, Hydrogen sulfide, Iron, Manganese, Odor, pH, Silver, Sulfate, Total Dissolved Solids, and Zinc.[52]

In 2006, USEPA presented a status report on the assessment for perchlorate without proposing a regulatory determination, and in 2008 issued a preliminary regulatory determination that a National Primary Drinking Water Regulation for perchlorate would not present "a meaningful opportunity for health risk reduction," and in January 2009, issued an Interim Drinking Water Health Advisory Level of 15 ug/L based upon analysis by the Office of Water (USEPA, 2008c).[53] Before these actions were taken, several states, including Texas, established guidelines or enforceable limits for perchlorate in drinking water. The Texas action level is 4 ug/L.[54] However, at this time (December 2009), the regulatory environment for perchlorate is uncertain. The AWWA 2009 national assessment of perchlorate occurrence within the United States concluded that perchlorate in drinking water is widespread but at concentrations of less than 12 ug/L. Extrapolations from the AWWA 2009 Assessment Report indicate less than 1 percent of drinking water systems would be affected at maximum contaminant levels (MCLs) of 20 ug/L, 4 percent would be affected at MCLs of 2 ug/L.[55]

#### *1.7.3.2 Natural Chlorides*

Chloride contamination of groundwater in the Ogallala Aquifer in several of the southern counties in the Llano Estacado Region appears to be from wind blowing dry soil material that contains chlorides and other minerals out of some of the older lake basins located in the region. Storm runoff water collects in the lake basins, as does water discharged from springs from the

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[50] Ibid.
[51] Ibid.
[52] Ibid.
[53] "A Review of Perchlorate Occurrence in Public Drinking Water Systems," Brandhuber, Philip, American Water Works Association, November 2009.
[54] Ibid.

Ogallala. Even though the Ogallala water is considered to be fresh, it does contain minerals. When the water evaporates from the basins, the minerals are left behind. When these minerals dry, they are picked up by the wind and distributed across the countryside. They are then dissolved in rainwater, some of which may find its way into the aquifer (see Sections 1.7.2.1, 1.7.2.2, and 1.7.2.3 for references to natural chlorides in surface water).

#### 1.7.3.3 Saltwater Disposal

Oilfields developed throughout the Llano Estacado Region contribute brine to area aquifers, lakes, streams, and rivers. Collective efforts of several state and local agencies have led the oil industry to eliminate the evaporation pit method of brine disposal. By 1983, most of the produced oilfield brine, not utilized in secondary recovery operations, was being properly disposed of by injection into deep formations. Both injection and disposal operations are performed under permits issued by the Railroad Commission of Texas. However, residual salts contained in and on soils near disposal sites that were in existence prior to 1983 continue to seep into groundwater aquifers in the general proximity of each active or inactive oilfield. Other contributing sources are identified as originating from failures of abandoned wells that were improperly plugged, commingling between saltwater injection zones and freshwater formations, and accidental spills.

#### 1.7.3.4 Pesticides

Several water quality studies that tested for the presence of pesticides in the groundwater have been conducted in the planning region. In 1988, the High Plains Underground Water Conservation District No. 1 sampled approximately 90 wells located within the District's boundaries. The samples analyzed indicated no significant contamination from pesticides.[56] The few wells from which water samples showed trace amounts of pesticides were revisited, and further investigation indicated that the pesticides may have been introduced into the wells through openings at the well-heads. Follow-up samples indicated no traces of pesticides.

In addition, in August 1993, the Texas Water Development Board released a report entitled "Water-Quality Evaluation of the Ogallala Aquifer, Texas," (Report No. 342) which

[55] Ibid.
[56] "The Cross Section," High Plains Underground Water Conservation District No. 1, Lubbock, Texas, November 1988.

covered all or parts of the 21 counties in the Llano Estacado Region. This study also concluded pesticides were not a significant contaminant in the groundwater underlying the region.

#### *1.7.3.5 Urban Stormwater Runoff* [57]

Stormwater runoff from city streets generated during a storm event is perceived as a source of possible contamination of surrounding playa basins. To determine if contamination is occurring, the City of Lubbock initiated the sampling of two local playas in 1993 as a part of the application process for the City's National Pollutant Discharge Elimination System Permit. The playas sampled in this study were located at Buster Long Park and Maxey Park. The results of the sampling showed that lead in both locations exceeded water quality standards on more than one occasion, but the level of pesticides was found to be low in both locations, with the exception of chlordane at the Buster Long Park location. Overall, the water quality remained high in both playas. Water in urban playas continues to be monitored to be sure quality remains high.

#### *1.7.3.6 Nutrients Associated with Agricultural Production*

As explained in Section 1.2, the semi-arid climate, uniform topography, low-permeability soils, large depth to groundwater, and gradually sloping terrain of the Llano Estacado Region restrict the movement of agricultural nutrients. The geographic features of the region, in combination with farm and livestock management practices, reduce the threat to surface water and groundwater quality.

Best Management Practices (BMPs) implemented by farmers include application of fertilizers at rates equal to the nutrient requirements for crops, wellhead buffers for land application of fertilizers, incorporation of fertilizers following application, and tillage practices to minimize runoff from fields.

Confined Animal Feeding Operations (CAFOs) are required to use BMPs, pursuant to Texas Commission on Environmental Quality (TCEQ) permits. Some of these BMPs include buffer zones around water wells, construction of berms to divert rainwater around the facility, protection of retention facilities from 100-year flood events, proper removal of pond sediments to maintain retention capacity, and proper removal of mortalities (dead animals).

[57] Information from Stormwater Management Water Quality Report, City of Lubbock, February 1998.

Fertilizers enhance plant growth and thereby contribute to increased production of cotton, corn, grain sorghum, peanuts, vegetables, and wheat throughout the Llano Estacado Region. In addition to commercially prepared fertilizers, manure from CAFOs is used in the production of cotton and grains, since it contains many crop nutrients and enhances soil quality by improving the organic matter content in the soil, which increases the water holding capacity of the soil and reduces the demand for irrigation.

#### *1.7.3.7 Confined Animal Feeding Operations*

There are approximately 69 cattle feedlots in the planning area, which utilize manmade retention ponds and playa lakes, as allowed by state and federal permits, to contain runoff from the feedlot surface. Potential point sources of groundwater contamination in livestock feeding operations include open, unpaved feedlots, runoff-holding ponds, manure treatment and storage lagoons, silos, and manure stockpiles. Insecticide spray equipment, and disposal sites for waste pesticides, rinsates or containers also may contribute to localized groundwater contamination because of the possibility of direct entry runoff or infiltration around or through well casings or abandoned wells. However, results from a 1990 study of water samples from wells at 26 large commercial feedlots in Castro, Deaf Smith, and Parmer Counties, which, at that time, had operated for more than 25 years, showed that feedlots had not contaminated groundwater in their respective vicinities.[58]

The primary constituents of livestock manure that can contaminate groundwater include pathogenic organisms, nitrates, and ammonia. Other constituents such as potassium, sodium, chloride, and sulfate also may leach through the soil and impair the quality of an aquifer. However, studies to evaluate playas as runoff holding ponds conducted by the USDA Agricultural Research Service in Bushland, Texas, at the time the feedlots were being established indicated this was an environmentally sound practice, because the playa clay bottoms were impermeable and the underlying water-table was generally more than 200 feet below the soil surface.[59]

Results from a recent study conducted by Texas A&M University, Texas Tech University, and the High Plains Underground Water Conservation District involving beef and

[58] Davis, Kathleen, "Study Shows Area Feedlots Have Not Contaminated Ground Water," "The Cross Section," High Plains Underground Water Conservation District, No. 1, Lubbock, Texas, January 1992.
[59] Smith, B.A., et al., "Nitrate and Other Nutrients Associated with Playa Storage of Feedlot Wastes," Texas Agricultural Extension Service, November 1993.

dairy operations support earlier views that the playas having Randall Clay bottoms and other properly constructed retention ponds can be used for facility waste runoff/storage without posing a significant contamination threat to the underlying groundwater. However, caution needs to be observed around the coarser-textured playa rim, because this area is a more permeable zone, where deeper leaching of soluble nutrients may occur.[60] At the conclusion of the study, it was determined that most accumulations occurred in the top foot of the playa soil surface. Nitrate was the nutrient that leached most. Its maximum concentrations in the top 5 feet of soil were, on average, about 65 parts per million (ppm) reported as N. At no location was there evidence that nitrate had penetrated the playa bottom proper below 10 feet, indicating no aquifer contamination associated with any feedlot.

Environmental protection has been an integral part of designing, building, operating and maintaining cattle feedlots in the Llano Estacado Region. The dry climate, low average annual rainfall, large depth to groundwater, and farmland application of manure as fertilizer, have provided a means by which feedlots can operate without threatening the natural resources of the region.[61]

For more than 30 years, cattle feedlots have been permitted to operate by the Texas water and air quality agencies, currently the TCEQ. TCEQ permits are among the most stringent in the nation, requiring certification of pond liner permeability and certification of retention pond capacity by a licensed professional engineer. In addition, feedlots must conduct periodic inspections of the site and document these inspections in a Pollution Prevention Plan maintained at each feedlot.[62]

Feedlot manure has provided nutrients for cotton, corn, grain sorghum, and wheat in parts of the region. Manure provides nutrients such as nitrogen, phosphorus and potassium, and micronutrients such as iron, magnesium, and sulfur. The addition of organic matter from manure also improves soil structure and water holding capacity of the soil, somewhat reducing the demand for irrigation.[63]

TCEQ permits also require implementation of BMPs, such as buffer zones around water wells, construction of berms to divert rainwater around feedlots, protection of retention facilities

[60] Sweeten, John M., "Groundwater Quality Protection for Livestock Operations," Texas Agricultural Extension Service, October 1993.
[61] Correspondence with Texas Cattle Feeders Association, Amarillo, Texas, July 13, 1999.
[62] Ibid.
[63] Ibid.

from 100-year flood events, proper removal of pond sediments to maintain retention capacity, and proper removal of mortalities.[64]

## 1.8 Threats to Agriculture and Natural Resources

Playa basins occupy about 1.74 percent of the total area of the Llano Estacado Region (226,513 acres shown in Table 1-18 of the area's 12,988,160 acres mentioned on Page 1-4). As discussed in Section 1.6.4, playa basins serve not only as crop and grazing land, but are the principal habitat for wildlife in this flat, arid region. Threats to playas are identified and described below.

### 1.8.1 Modification and Reduction of Playas and Corrective Measures

Playa basin habitats appear to be subject to the following threats:

(a) Management of Drainage Areas: If the drainage area above a playa basin is improperly managed, soil erosion from washing can occur and the basin can, over time, be filled with silt that robs it of water-holding capacity. In areas of intensive row-cropping, siltation of playas has resulted in diminished playa basin capacity over a large portion of the Llano Estacado Region, particularly where irrigation rows have run directly downhill into playa basins.[65] Some playas have lost 50 percent or more of their capacity to siltation, and may disappear within 20 years unless this trend is reversed. BMPs, such as farming parallel to the slope of the watershed and leaving buffer strips of native grasses around playa perimeters, protect playa basins from siltation, ensuring their ability to seasonally pool water and provide wildlife habitat.

(b) Production in Playa Basins: Plowing, planting and cultivating of playas that harbor native vegetation can spread noxious weeds onto farmland on surrounding upslopes, denude the basin of emergent vegetation, deprive wildlife species of habitat, and may even diminish the basin's ability to hold water. Playas produce valuable forages, and grazing is an historic and contemporary use of playa basins, employed in continuous or seasonal patterns. BMPs of prescribed, short duration, or limited grazing that does not remove all vegetation from the basin, can allow utilization of valuable forage, yet ensure protection of naturally-occurring plant and seed production activities of moist soil plants. These plants provide wildlife cover and feed during winter and spring months when they may represent the only pool of available habitat.

(c) Irrigation Water Application Methods: Large-scale conversion from furrow irrigation to more efficient sprinkler irrigation has become a practical water conserving necessity and a BMP to prolong the life of the Ogallala Aquifer in the Llano Estacado Region. Conversion to more efficient irrigation methods has eliminated the tailwater runoff that once supplemented many playa lakes, thus impacting wildlife habitat.

[64] Ibid.

[65] Luo, Hong-Ren, "Effects of Land Use on Sediment Deposition in Playas," submitted to the graduate faculty of Texas Tech University in partial fulfillment of the requirements of the degree of Master of Science, May 1994.

With little or no irrigation tailwater flowing into playa basins in years of low rainfall, little open water may be available to ducks, geese, sandhill cranes, and shorebirds in the playas.

### 1.8.2 Playa Enhancements and Protective Measures

Playa habitats may be enhanced, as follows:

(a) Supplemental Sources of Water: (1) Overflow from watering troughs in cattle feedlots can collect in and sustain a water level in some playas used as drainage basins. During dry years and in periods of cold weather when shallow playas freeze, overflow from feedlot waterers into drainage playas can be especially important in providing open water areas to migrating and wintering waterfowl. Feedlot drainage playas and municipal and industrial effluent playas provide the only available surface water in dry times and the only open water during freezing weather. (2) Irrigation tailwater flowing through drainage ditches can supplement the water in playa lakes and create edge vegetation in playa basins that might otherwise be dry. Moist soil management techniques that manipulate water in playa basins may also enhance production of moist soil plants that benefit wildlife as food and habitat. It is noted, however, that these sources of water are being reduced through improved irrigation efficiency and water conservation measures on the playa watersheds.

(b) Soil Erosion Control on Playa Watersheds: A BMP of contour farming to minimize soil erosion that results in silt transport into playas is important to wildlife in the region and to contributing to recharge of the Ogallala Aquifer. Silted playas will not hold the volume of rainfall runoff that non-silted playas can contain.[66] A BMP of maintaining a native grass cover in areas surrounding playas protects the basins from volume-robbing siltation through natural filtration and can allow playas to more significantly contribute to aquifer recharge.

Best Land Management Practices and rainfall enhancement can benefit wildlife in the Llano Estacado Region without severely impacting groundwater supplies and can protect and enhance playa basins.

### 1.8.3 Drought

#### 1.8.3.1 Drought Impact on Aquatic Ecosystems

Freshwater rivers and streams and reservoirs within the Llano Estacado Region are vulnerable to the effects of drought conditions and are manifested as reductions in streamflow and, primarily, in declines in the level of area reservoirs. Immediate drought impacts to freshwater ecosystems in the Llano Estacado Region can be losses in available habitat and a reduction in water available to municipal water supply systems from reservoirs.

[66] Ibid.

Reservoir fisheries can be affected by drought. Reduced reservoir levels can have considerable impacts on reservoir fisheries as the amount of available habitat for spawning, feeding, nursery cover, and resting declines. As water levels decline, brush piles, rocks, and vegetated areas are exposed, affecting habitat complexity. The relative impact will be greatest to those species that utilize habitat close to shore or those fish that prey on such species. Negative impacts to the largemouth bass population in Lake Meredith (Section 1.6.3.1) due to reduced lake levels as a result of drought have been reported. Similar declines in available habitat for fish have also been noted at Lake Mackenzie and White River Lake within the Llano Estacado Region. Impacts include increased mortality of young fish, increased competition for space and food, impaired reproduction and growth rates, and reduced food sources.

Water quality problems may develop with reduced inflows to reservoirs. Lower dissolved oxygen levels, coupled with higher water temperatures, can limit fish distribution or contribute to diminished survival rates. Additional problems could develop or current problems worsen if surrounding land practices or municipal/industrial effluent contributes nutrients, organic matter, and/or toxic material.

#### *1.8.3.2 Drought Impact on Terrestrial Ecosystems*

Drought conditions during the crop-growing season dramatically increase pumpage for irrigation water from the Ogallala Aquifer. In addition, populations of terrestrial wildlife are put under stress when severe drought conditions develop. Habitat quantity and quality may gradually decline from lack of moisture and increasing competition for limited resources. Both wildlife and domesticated animals may suffer from lack of drinking water, a shortage of forage and cover, and heat stress, although this impact may be mitigated slightly in irrigated areas of the Llano Estacado Region.

Deer on poor range conditions can be severely impacted by drought, as can antelope. Pheasant and wild turkey populations in the Llano Estacado Region are severely reduced in the presence of drought, and quail suffer significant losses due to drought. However, data show that no significant or long-term impacts for waterfowl are typically detected for overwintering populations, although lack of playa water in the Llano Estacado Region can leave populations of up to 400,000 sandhill cranes and 2 million waterfowl short of wintering habitat that they must then find elsewhere. Drought has triggered severe outbreaks of botulism in past years that have affected waterfowl and shorebirds. Botulism may occur in the region when playas are drying and anaerobic conditions are created.

In the past, during droughts, migratory waterfowl have been crowded on roosting playas. Under these conditions they are more vulnerable to disease transmission outbreaks of avian cholera that have the potential to kill thousands of birds.

Periodic drying of playas can encourage moist-soil plant growth in their basins. If mudflat conditions that give rise to moist-soil plant populations are followed by fall rains, significant quantities of moist-soil plant seeds can be available as food to wintering birds.

Currently, terrestrial wildlife recreation and sportfishing account for an estimated $125 million impact to the Texas High Plains economy (Section 1.4.10). Drought has significant adverse effects upon aquatic and terrestrial ecosystems in the Llano Estacado Region and participation in and value of terrestrial wildlife recreation and sportfishing activities.

### 1.8.4 Water Quality

At the present time, the quality of Ogallala Aquifer water, the principle source of water for all water user groups of the region, is well suited for current uses. Obviously, if contamination of existing supplies occurs, the quantities contaminated could become unusable or only usable after treatment, and thereby the quantities of supply would be reduced to the extent that contamination occurs.

## 1.9 Major Entities with Water Resources Responsibilities

### 1.9.1 Federal and State

#### 1.9.1.1 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USCOE) was charged by Congress in 1972 in the Federal Clean Water Act, Section 404, as one of the regulatory agencies to protect our nation's waters (including lakes, rivers, aquifers and coastal areas) from the discharge of dredge and fill material in defined U.S. waters. The Federal Clean Water Act's primary objective is to restore and maintain the integrity of the nation's waters. This objective translates into two fundamental national goals:

1. Eliminate the discharge of pollutants into the nation's waters; and
2. Achieve water quality levels that are fishable and support contact use.

Practically speaking, construction activities occurring in and around defined U.S. waters require the acquisition of a Section 404 permit and associated National Environmental Policy Act (NEPA) review. The USCOE also regulates the construction of dams in navigable waters through its Section 10 permit program.

#### *1.9.1.2 U.S. Environmental Protection Agency*

The U.S. Environmental Protection Agency (USEPA) administers several environmental programs authorized by Congress. The three principal acts and related programs are described below.

The Clean Water Act requires major industries to meet performance standards to ensure pollution control, charges states and tribes with setting specific water quality criteria appropriate for their waters and developing pollution control programs to meet them, provides funding to states and communities to help them meet their clean water infrastructure needs, and requires a permitting process to ensure that development and other activities are conducted in an environmentally sound manner. The Clean Water Act had its beginnings in the Water Pollution Control Act of 1948, which authorized the Surgeon General of the Public Health Service, in cooperation with other Federal, state, and local entities, to prepare comprehensive programs for eliminating or reducing the pollution of interstate water and tributaries and improving the sanitary condition of surface and underground waters. With the Clean Water Act Amendments in 1977, the Federal Water Pollution Control Act became known as the Clean Water Act.

Also included in the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES) Permitting process. Facilities that discharge pollutants from point sources (such as discharge pipes) into waters of the United States are required to obtain a NPDES permit. The NPDES program falls under Section 402 of the Clean Water Act. Wastewater discharges regulated under the NPDES program include industrial wastewater, stormwater, and treated effluent from municipal sewage treatment plants.

The primary objective of the Safe Drinking Water Act of 1974, as amended in 1986 and 1996, is twofold: (1) to protect the Nation's sources of drinking water and (2) to protect public health to the maximum extent possible, using proper water treatment techniques. The Safe Drinking Water Act directs the USEPA and states to establish national primary and secondary drinking water standards and to establish techniques to meet those standards. States are responsible for enforcement and must submit regulatory programs to the USEPA for approval.

Underground sources of drinking water are also protected through applying the same drinking water standards, identifying critical aquifer protection areas, and programs to protect wellhead areas from contaminants.

The Resource Conservation and Recovery Act (RCRA) of 1976 governs the disposal of solid waste. Subtitle D of the Act, as amended November 1984, establishes Federal standards and requirements for state and regional solid waste authorities. The objective of this subtitle is to assist in developing and encouraging methods for the disposal of solid waste which are environmentally sound and which maximize the utilization of valuable resources recovered from solid wastes. Subtitle C of this law establishes standards and procedures for the handling, storage, treatment, and disposal of hazardous wastes. Generators, transporters, and owners of treatment, storage, and disposal (TSD) facilities are subject to its regulatory scheme. RCRA also regulates the transportation and tracking of hazardous waste; establishes standards for the storage and treatment of hazardous wastes by generators; provides a procedure for identifying waste as hazardous; provides minimum technology standards for TSDs; provides for corrective actions for historic solid and hazardous waste management units; establishes land disposal prohibitions and restrictions; regulates the installation, testing, and removal and remediation of underground storage tanks; regulates the management of used oil; and provides an enforcement mechanism.

#### *1.9.1.3 Texas Water Development Board*

The TWDB was established in 1957 through a state constitutional amendment. The agency’s original function was to provide loan assistance to political subdivisions for the development of surface water supply projects that could not be financed through commercial channels. During the 1960s, the Board’s responsibilities grew to include the authority to obtain and develop water conservation storage facilities, prepare a state water plan, and assume operations of the Texas Water Commission not related to the question of water rights. The state water planning functions are described in more detail later in Section 1.10.1.

Currently, the TWDB has a number of broad responsibilities. One primary function is still providing loans and grants for local governments for:

- Water supply, water treatment, and distribution;
- Wastewater treatment and other pollution control;
- Municipal and solid waste management;
- Economically distressed areas;
- Flood protection;

- Agricultural water conservation; and
- Regional water, wastewater, and flood protection planning.

The agency is also responsible for collecting data and conducting studies regarding agricultural water conservation, freshwater needs of Texas estuaries and bays, and surface and groundwater resources. As the agency responsible for developing a state water plan, the TWDB uses a number of research programs to assess and project water availability, environmental impact, and water uses for both agricultural and municipal areas. The Board continually collects surface and underground water information through hydrologic monitoring. It provides technical evaluation of water resource problems and promotes programs on conservation education.

#### *1.9.1.4 Texas Commission on Environmental Quality*

The TCEQ was formed by the Texas Legislature in 1991 by joining the former Texas Water Commission, the Texas Air Control Board, portions of the Texas Department of Health and other smaller agencies into the state's environmental regulatory and enforcement agency.

The TCEQ operates a number of water-related regulatory and pollution prevention programs, including:

- Water rights permitting;
- NPDES wastewater and urban stormwater permitting;
- Clean Rivers (water quality) Program;
- Leaky underground storage tank removal and remediation program;
- Priority Groundwater Management Area program (in conjunction with TWDB);
- Injection and disposal well permitting (in conjunction with the Railroad Commission of Texas);
- Wellhead protection;
- Solid waste permitting;
- Weather modification permitting; and
- Others.

#### *1.9.1.5 Railroad Commission of Texas*

The Railroad Commission of Texas (RRC) is the state agency responsible for regulating the oil and gas industry's safety and compliance. The cornerstone of the Oil and Gas Division's environmental effort are two programs funded by the Oilfield Cleanup (OFC) Fund, which was enacted in Senate Bill 1103 in 1991. The OFC Fund provides money to administer the Commission's well plugging and site remediation programs. The Underground Injection Control (UIC) program requires a RRC permit for every injection and disposal well in both productive and non-productive formations. The UIC program coordination has been delegated to the RRC by the USEPA, as mandated by the Safe Drinking Water Act. The RRC rules have been approved by the USEPA and they set very specific standards for well construction and testing to protect fresh water zones.

The RRC also administers several other environmental services. The Rule 8 Permitting Section handles permitting for management of oil and gas wastes at the surface including the use of pits for storage or disposal of waste, disposal methods including discharge to surface water or landspreading and commercial hauling of oil and gas. The Hazardous Waste Program regulates management of hazardous oil and gas wastes under Rule 98. This section coordinates with the TCEQ while actively seeking RCRA authorization from the USEPA for the Commission's hazardous waste program. The Waste Minimization Program works with the oil and gas industry to reduce the volume of waste that must be treated or disposed. The RRC is also responsible for the permitting and monitoring of underground hydrocarbon storage in salt caverns and depleted reservoirs. The UIC program administers that portion of the federal UIC program relating to injection/disposal wells for disposal of oil and gas wastes and enhanced recovery of oil and gas under Rules 9 and 46. The RRC rules have been approved by the USEPA and they set very specific standards for well construction and testing to protect fresh water zones.

### *1.9.2 Regional*

#### *1.9.2.1 Underground Water Conservation Districts*

The establishment of underground water conservation districts (UWCDs) was authorized by the 51st Texas Legislature in 1949 to provide for the conservation, preservation, recharging, and prevention of waste of groundwater, and to control subsidence. Chapter 36 of the Texas Water Code lays out numerous powers and duties, both required and allowed, of underground water conservation districts. Underground water conservation districts can make and enforce rules providing for the conservation, preservation, protection, and control of those resources. In addition, these districts may participate in the Agricultural Water Conservation Loan Program administered by the TWDB. The Agricultural Water Conservation Loan Program was established in 1985 with authority to issue up to $200 million in agricultural water conservation bonds. The TWDB may make loans to Districts that in turn make loans to irrigation farmers to make improvements to their irrigation facilities, and for the purchase and installation of more water-use-efficient irrigation equipment. The funds may also be used to prepare irrigated lands to be converted to dryland conditions and to prepare drylands for more efficient use of natural precipitation.

Six districts are currently in operation in the Llano Estacado Region. They are the High Plains, Sandy Land, Mesa, South Plains, Garza County, and Llano Estacado. Figure 1-7 shows the area served by each of these districts. The districts have adopted and are enforcing well spacing rules and other regulations, such as prevention of waste. In addition, they have extensive water quality and water level monitoring networks, and public education programs that have been designed to meet the needs of their respective constituents, as is presented below.

*High Plains Underground Water Conservation District No. 1*

The Texas State Board of Water Engineers delineated the original boundaries of the High Plains Underground Water Conservation District No. 1 in March 1951, and on September 19, 1951, the people in all or parts of 13 Southern High Plains counties voted to create the District in accordance with the Underground Water Conservation Districts Act of 1949. Additional territory has been annexed, with the District now consisting of six whole counties (Bailey, Cochran, Hale, Lubbock, Lynn, and Parmer) and parts of nine counties (Armstrong, Castro, Crosby, Deaf Smith, Floyd, Hockley, Lamb, Potter, and Randall). The activities and programs of the District are described below and in Table 1-19.

The purpose of this District, as stated in the Texas Water Code, Chapter 36, is to provide for the conserving, preserving, protecting, and recharging of the underground water and prevention of waste of the underground water. The five-member Board makes and enforces rules with the advice and consent of 75 appointed County Committee members to accomplish the purposes of the District. During its history, the High Plains Underground Water Conservation District No. 1 has developed a management philosophy and associated management strategies.

The District's current activities and programs include: (a) data collection and distribution (A database of water quality and approximate quantities of water in storage in the formation is maintained and made available to the public by publication of the hydrologic atlas series and in the district's monthly newsletter.), (b) Non-Point Source and Point Source Regulations (Contamination of groundwater is addressed under the District's Waste Rule. It is a violation of High Plains Underground Water District rules to "pollute or harmfully alter the character of the underground water reservoir of the District by means of salt water or other deleterious material admitted from some other stratum or from the surface of the ground."), (c) Public Education (The Cross Section monthly newsletter, web site at www.hpwd.com, frequent public service

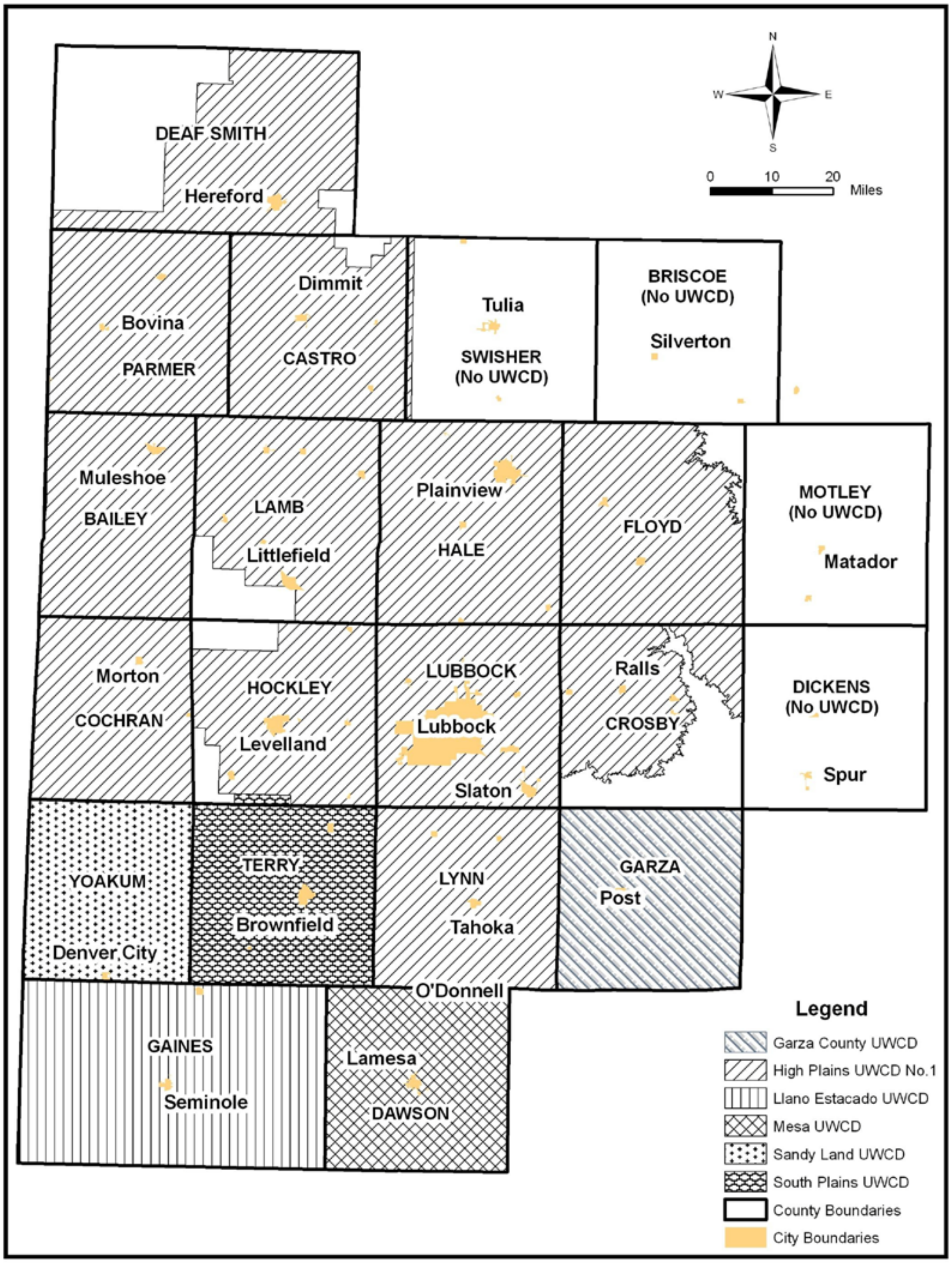


***Figure 1-7. Underground Water Conservation District Boundaries Llano Estacado Region***

***Table 1-19.***
***Summary of High Plains UWCD's Activities and Programs***

<table>
<tr><th>Activities</th><th>Comment</th></tr>
<tr><td>Well Permitting</td><td>The District requires permits for all new wells capable of more than 25,000 gallons of water per day (17.5 gpm)</td></tr>
<tr><td>Well Construction Standards</td><td>Texas Department of Licensing and Regulation Water Well Drillers and Pump Installers Rules.</td></tr>
<tr><td>Well Spacing For Wells Drilled Into The Ogallala Aquifer</td><td>Spacing is based upon the production capability of the new well as follows:
<table>
<tr><th>Well Production (Factor that determines spacing of proposed wells)</th><th>Minimum Distance from nearest valid well drilled into or proposed well site located in Ogallala aquifer</th><th>Minimum Distance From Property Line</th></tr>
<tr><td>17.5 to 70 gpm</td><td>100 yards</td><td>25 yards</td></tr>
<tr><td>>70 to 165 gpm</td><td>200 yards</td><td>50 yards</td></tr>
<tr><td>>165 up to 265 gpm</td><td>300 yards</td><td>75 yards</td></tr>
<tr><td>>265 up to 390 gpm</td><td>350 yards</td><td>87.5 yards</td></tr>
<tr><td>>390 to 560 gpm</td><td>400 yards</td><td>100 yards</td></tr>
<tr><td>>560 up to 1,000 gpm</td><td>500 yards</td><td>125 yards</td></tr>
<tr><td>>1,000 gpm</td><td>540 yards</td><td>135 yards</td></tr>
</table></td></tr>
<tr><td>Well Spacing For Wells Drilled Into The Dockum Aquifer</td><td>Spacing is based upon the production capability of the new well as follows:
<table>
<tr><th>Well Production (Factor that determines spacing of proposed wells)</th><th>Minimum Distance from nearest valid well drilled into or proposed well site located in Dockum aquifer</th><th>Minimum Distance From Property Line</th></tr>
<tr><td>17.5 to 70 gpm</td><td>100 yards</td><td>25 yards</td></tr>
<tr><td>>70 to 165 gpm</td><td>200 yards</td><td>50 yards</td></tr>
<tr><td>>165 up to 265 gpm</td><td>300 yards</td><td>75 yards</td></tr>
<tr><td>>265 up to 500 gpm</td><td>880 yards (1/2 mile)</td><td>100 yards</td></tr>
<tr><td>>500 gpm</td><td>1,760 yards (1 mile)</td><td>135 yards</td></tr>
</table></td></tr>
<tr><td>Production Regulations</td><td>Production regulations are implemented through the spacing of wells.</td></tr>
<tr><td>Water Level Monitoring</td><td>Annual depth-to-water level measurements are taken in a network of more than 1,200 privately-owned water wells within the District.</td></tr>
<tr><td>Water Quality/Quantity Management Programs</td><td>Hydrologic atlases showing approximate altitude of the base of the Ogallala formation, approximate altitude of the land surface, approximate altitude of the water table in the Ogallala formation, and approximate saturated thickness in the Ogallala formation are published.</td></tr>
</table>

announcements on radio and TV, distribution of educational materials in public schools, presentations to civic and professional groups, media interviews, and educational displays), and

(d) Special Activities (Programs of soil moisture monitoring, pump plant efficiency testing, tailwater abatement, open hole closing, leak detection for towns and cities, cost-in-water income tax depletion allowance, irrigation assessment, water well site validation, water well flow testing, and abandoned well closure). Between 1987 and 2002, the High Plains Underground Water Conservation District No. 1 participated in the Agricultural Water Conservation Loan Program. During this period, the District loaned over $15.3 million to area farmers and ranchers who used the loans to install over 480 new center pivot irrigation systems.

Sandy Land *Underground Water Conservation District*

The Sandy Land Underground Water Conservation District was created in November 1989 by authority of Senate Bill 1777 of the 71st Legislature and has the same areal extent as Yoakum County. The District participates in the Agricultural Water Conservation Loan Program.

The District recognizes that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy, and environment within the District. The District's Board feels that the preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's well permitting and well spacing rules. Table 1-20 shows a summary of the District's activities and programs.

**Table 1-20.**
**Summary of Sandy Land UWCD's Activities and Programs**

| Activities | Comment |
|---|---|
| Well Permitting | The District requires well permits for any wells capable of producing in excess of 25,000 gpd. |
| Well Construction Standards | The District requires proper completion of wells in accordance with Texas Water Well Drillers Board requirements. |
| Well Spacing | From property lines: 4-inch or smaller pump - 100 yards from the nearest property line; 5-inch pump - 125 yards from the nearest property line; 6-inch pump - 150 yards from nearest property line; 8-inch pump – 200 yards from nearest property line. Any pump larger than 8-inch – 300 yards from nearest property line. |
| Production Regulations | 5 gpm per acre owned. |
| Water Level Monitoring | Measures approximately 100 wells within the District annually for water level. Data from measurements sent to the TWDB for their water level database. Data is used by the District to construct annual water level decline maps. |
| Water Quality/Quantity Management Programs | Water quality program consisting of approximately 100 wells, monitored yearly for various constituents. Coliform bacteria test upon request. Mineral analysis conducted on wells selected by the District upon request. |
| Water Quality Testing and Monitoring | Maintains an in-house lab where testing can be done at no cost to the well owner as well as no cost through certified labs, if deemed necessary. Works with the Railroad Commission in protecting the groundwater from certain oilfield activities such as saltwater storage and disposal. Conducts pesticide study in the southern and northern portions of Yoakum County. |
| Data Collection and Distribution | Gathers data through the District's annual water level monitoring program. Uses data to construct District's decline maps. Also, supplies data to the TWDB for their water level database. District also collects data from in-house lab. |
| NPS and Point Source Regulations | Conducts pesticide studies to evaluate point source possibilities. |
| ***Programs*** | ***Comment*** |
| Public Education | The Education Cooperative (the program) was created in 2007 by Llano Estacado UWCD, Permian Basin UWCD, Sandy Land UWCD, and South Plains UWCD. The managing office for the cooperative is Sandy Land UWCD. The four districts share equally in program costs and employ an education and public relations coordinator to carry out the mission of the cooperative. |
| Special Activities | Pumping efficiency test, flow tests, pumping level and pressure tests for sprinkler systems. Distributes the "Sandy Land News" quarterly. Awards two $1,000 scholarships and two $500 scholarships to area high school seniors based on essays relating to conservation and suggestions for future conservation. Free low flow shower heads available to the public. Grants to area farmers, IRS Depletion Program, Ag Water Conservation Equipment Loan Program, managing entity for Yoakum County Landfill. Participates in Precipitation Enhancement Program. |

<u>*Mesa Underground Water Conservation District*</u>

The citizens of Dawson County, through a local election in January 1990, created the Mesa Underground Water Conservation District, which has boundaries the same as Dawson County. The District has five board members: one member representing each of the four county precincts and one at-large member elected by and representing all residents of the county.

The District believes its most valuable natural resource—water—can be managed at the local level in a prudent and cost-effective manner by regulating the spacing of wells and production of water from wells. A summary of the activities and programs of the District is shown in Table 1-21.

***Table 1-21.***
***Summary of Mesa UWCD's Activities and Programs***

| ***Activities*** | ***Comment*** |
|---|---|
| Well Permitting | All new wells are registered prior to drilling. |
| Well Construction Standards | Consistent with Water Well Drillers and Pump Installers Rules. |
| Well Spacing | Permitted wells must be drilled no closer than 300 feet from the adjoining landowner's property line. Exceptions may be available with Board approval or with a signed waiver from the adjoining property owner. Exempt wells must meet Water Well Drillers State Rules. |
| Production Regulations | 5 gpm per acre, not to exceed 4 acft per acre per year. |
| Water Level Monitoring | The District annually measures 188 wells for baseline comparison. This information is shared with the TWDB. |
| Water Quality/Quantity Management Programs | The District is involved with the City of Lamesa in a Wellhead Protection Plan. Plans are scheduled for the Cities of O'Donnell, Ackerly, Welch, and Gail. |
| Water Quality Testing and Monitoring | All wells registered with the District will be tested. The District annually monitors 47 wells for quality comparison. |
| Data Collection and Distribution | The District collects data and shares data with the TWDB. The District collects data from used oil collection and used oil filter collection and provides information to the TCEQ. |
| NPS and Point Source Regulations | The District provides drip oil containers for irrigation wells and is working on an oil drain container for irrigation engines. The District has implemented used oil collection, used oil filter collection, and crushing programs. |
| ***Programs*** | ***Comment*** |
| Public Education | The District distributes educational materials including conservation book covers to all schools in the District. The District also provides education booths at the County Fair, with presentations of "Willie the Water Dog" to younger students and demonstrations of their water model to older students. |
| Special Activities | The District provides news articles for the local newspaper and participates in Texas Recycles Day. |

*South Plains Underground Water Conservation District.*

The South Plains Underground Water Conservation District (SPUWCD) was created by House Bill 281, (72nd Legislature) in 1991. The District was confirmed by voter approval, the initial Board elected, and an ad valorem tax rate cap of $0.025/$100 valuation was set in an election held in August 1992.

The District currently employs a set of rules governing the spacing and production of wells, as well as production limitations based on tract size. It is expected that this approach will remain the foundation of the Board's strategies for groundwater management. As conditions dictate, and as the DFC (Desired Future Conditions) process is completed, it may require that the specific provisions within the existing rules be modified. The District's Board of Directors is responsible for that determination. See Table 1-22 for a summary of the District's activities.

**Table 1-22.**
**Summary of South Plains UWCD's Activities and Programs**

| *Activities* | *Comment* |
|---|---|
| Well Permitting | The District requires permits for wells producing 25,000 gpd (17.36 gpm) or more. Exempt wells require registration prior to drilling. |
| Well Construction Standards | Consistent with the Texas Department of Licensing and Regulation |
| Well Spacing | From property lines and between wells, based on the anticipated rate of production. |
| Production Regulations | 5 gpm per acre, not to exceed 4 acft per acre per year. |
| Water Level Monitoring | Measures approximately 135 wells in the District annually. Data from measurements are sent to the TWDB for their water level database. Minor aquifer water level observations began in 2007. |
| Water Quality/Quantity Management Programs | Construct saturated thickness maps every 5 years, calculating estimated volume changes and recharge each year. Meter cooperators report irrigation applications. District calculates and reports irrigation water use efficiency. |
| Water Quality Testing and Monitoring | The District conducts an annual water quality sampling program. Water quality testing services are extended to the District's residents at no charge and include coliform bacteria testing |
| Data Collection and Distribution | The District collects and distributes water level measurement data, rainfall data and other information as requested. Quarterly newsletters and hydrologic maps are also posted on the District's website. |
| NPS and Point Source Regulations | The District has well construction standards and addresses pollution of groundwater in its rules. |
| ***Programs*** | ***Comment*** |
| Public Education | The District educates the public through schools, speaking engagements, workshops, literature distribution, and its website. The District employs an education coordinator. |
| Special Activities | Water well and irrigation system flow testing, well capping, and device give-aways (rain gauges, lawn sprinkler gauges). Recent special projects also include: 1) cost-sharing irrigation telemetry equipment and 2) equipping wells with continuous monitoring water level recorders. |

*Llano Estacado Underground Water Conservation District*

The Llano Estacado Underground Water Conservation District was created in 1991 by the 72nd Texas Legislature and encompasses all of Gaines County. District creation was confirmed by the voters in November 1998. The District adopted rules and a management plan in September 1999 and April 2000, respectively. Table 1-23 shows a summary of the District's activities and programs.

**Table 1-23.**
**Summary Llano Estacado UWCD's Activities and Programs**

| ***Activities*** | ***Comment*** |
|---|---|
| Well Permitting | The District requires drilling permits for wells whose expected production capability will be 25,000 gpd (17.36 gpm) or more. |
| Well Construction Standards | Same as those set by the state. |
| Well Spacing | From property lines and between wells. Based on the size of pump installed and corresponding gallon per minute pumping rate. |
| Production Regulations | 10 gpm per acre, per contiguous acre owned. |
| Water Level Monitoring | Measures approximately 175 wells in the District annually. Data from measurements are sent to the TWDB for their water-level database. Data are used by the District to construct annual water level change maps and periodic saturated thickness maps. |
| Water Quality/Quantity Management Programs | The District works with local and state agencies on water analysis and management programs. |
| Water Quality Testing and Monitoring | The District annually monitors water quality of approximately 100 water wells. Water quality testing services are extended to the District's residents at no charge and include coliform bacteria testing. |
| Data Collection and Distribution | The District collects and distributes water-level measurement data to state agencies and to local government and individuals upon request. Quarterly newsletters and hydrologic maps are also posted on the District's website. |
| NPS and Point Source Regulations | The District has well construction standards and addresses pollution of groundwater in its rules. |
| ***Programs*** | ***Comment*** |
| Public Education | The District educates the public through schools, speaking engagements and literature distribution. |
| Special Activities | The District sponsors free flow testing and efficiency testing for local irrigated agricultural producers. The District sponsors educational curriculum for all fourth-graders in Gaines County, sponsors awards for 4-H, and assists in Natural Resources projects. The District participates in the Southern Ogallala Aquifer Rainfall Enhancement Program. |

*Garza County Underground and Fresh Water Conservation District*

The Garza County Underground and Fresh Water Conservation District was created and organized under the terms and provisions of Section 59, Article XVI, Texas Constitution and House Bill 846, including all amendments and additions, of the 74th Legislature in 1995. The District has all of the rights, powers, privileges, authority, functions, and duties provided by the general laws of this state, including Chapter 36 of the Texas Water Code, Vernon's Texas Codes Annotated, applicable to underground water conservation districts created under Section 59, Article XVI, Texas Constitution.

The District recognizes that the groundwater resources of the region are of vital importance to the residents of the District and that this resource must be managed and protected from contamination and waste. To accomplish these objectives, the District has instituted regulations governing well permitting and well spacing along with other regulations (Table 1-24).

**Table 1-24.**
**Summary of Garza County Underground and Freshwater Conservation District's Activities and Programs**

| Activities | Comment |
|---|---|
| Well Permitting | The District requires well permits for any well capable of producing in excess of 25,000 gallons of water per day. |
| Well Construction Standards | The District requires proper completion of wells in accordance with Texas Water Well Driller's Board requirements. |
| Well Spacing | Based on size of pump installed and corresponding gpm pumping rate. |
| Production Regulations | Production allowable is based on distance from other wells, starting at 50 yards for a 1.5-inch pump or well producing 40 to 70 gpm. |
| Water Level Monitoring | At least 20 wells are monitored each year to check water levels. |
| Water Quality/Quantity Management Programs | The District works with local and state agencies on water analysis and management programs. |
| Water Quality Testing and Monitoring | Pending. |
| Data Collection and Distribution | Results of water level monitoring are published each year in Soil Conservation NRCS Publication. |
| NPS and Point Source Regulations | The District rules state that all wells drilled will be at least 150 feet from any contamination (e.g., livestock or poultry yards, septic absorption fields or privies) and not located in an area generally subject to flooding. In case of a flood area, a sanitary water tight seal must be installed at least 24 inches above the known flood level. |
| ***Programs*** | ***Comment*** |
| Public Education | Yes. |
| Special Activities | Yes. |

#### *1.9.2.2 Surface Water Supply and Management Authorities and Districts*

The Canadian River Municipal Water Authority (CRMWA), the White River Municipal Water District (WRMWD), the Mackenzie Municipal Water Authority (MMWA), the Red River Authority (RRA), and the Brazos River Authority (BRA) are present and have water supply and management functions in the Llano Estacado Region, as presented below.

*Canadian River Municipal Water Authority*

In 1953 the Texas Legislature authorized the Canadian River Municipal Water authority (CRMWA) to organize as a legal entity and independent political subdivision of Texas for the purpose of implementing the Canadian River Project, which had been authorized by Congress in 1950. Eleven cities formed the Authority: Amarillo, Borger, Pampa, Plainview, Lubbock, Slaton, Brownfield, Levelland, Lamesa, Tahoka, and O'Donnell. Under a tri-state compact, Texas was entitled to impound up to 500,000 acre-feet of water in conservation storage in the (South) Canadian River Basin. CRMWA obtained a permit from the State of Texas to impound the water as allowed by the Compact and to divert 100,000 acft of water per year for municipal use by the member cities and 51,200 acft for industrial use.[67] A dam was constructed on the Canadian river 9 miles west of Borger, Texas, and an aqueduct was constructed to deliver water from the reservoir to the member cities. The dam crossing the Canadian River 9 miles west of Borger is 226 feet high and 6,380 feet long. The aqueduct system, with 322 miles of pipeline, ten pumping plants, and three regulating reservoirs, has furnished municipal and industrial water to the cities of the Authority since 1968. In recent years, CRMWA has acquired groundwater rights from property located in Region A to improve the quality and increase the quantity of water delivered via its aqueduct to its member cities. Since the end of 2001, a blend of surface water and groundwater has been supplied to the CRMWA member cities. Due to diminished storage of surface water in Lake Meredith, the groundwater supply is being expanded. A summary of CRMWA's programs and activities is shown in Table 1-25.

[67] **Canadian River Compact.** Entered into by New Mexico, Oklahoma, and Texas, the compact guarantees that Oklahoma shall have free and unrestricted use of all waters of the Canadian River in Oklahoma and that Texas shall have free and unrestricted use of all water of the Canadian River in Texas subject to limitations upon storage of water (500,000 acft of storage until such time as Oklahoma has acquired 300,000 acft of conservation storage, at which time Texas's limitation shall be 200,000 acft plus the amount stored in Oklahoma reservoirs). New Mexico shall have free and unrestricted use of all waters originating in the drainage basin of the Canadian River above Conchas Dam and free and unrestricted use of all waters originating in the drainage basin of the Canadian River

***Table 1-25.***
***Summary of Canadian River Municipal Water Authority's Programs and Activities***

| *Programs & Activities* | *Comment* |
|---|---|
| Chloride Control | The Authority has implemented a plan to reduce the natural salt flow into Lake Meredith. The plan includes pump saltwater from wells drilled into a natural brine artesian aquifer currently discharging into the Canadian River. The saltwater disposed is by deep-well injection into a formation below those that affect local aquifers and streams. |
| Water Quality Improvements | A Conjunctive Use Groundwater Supply Project has been developed in Roberts and Hutchinson Counties which is supplying groundwater that is being mixed with surface water before being delivered to member cities. |
| Water Quality Monitoring | The Authority regularly monitors the water quality of Lake Meredith. |
| Water Supply Programs | The Authority supplies water from Lake Meredith and a well field to its 11 member cities. |
| Salt-Cedar Control | The Authority has implemented activities to control the growths of salt-cedar in the Canadian River Basin above Lake Meredith. Over 10,000 acres of the growth has been treated by the aerial application of herbicides with helicopters since beginning the project in 2004. |

*White River Municipal Water District*

The WRMWD owns and operates White River Reservoir, from which the District's water right authorizes the diversion of up to 6,000 acft of water per year for municipal and mining purposes. The District delivers water to Crosbyton, Ralls, Spur, and Post. In addition, the WRMWD holds a permit for the construction of the Post Reservoir located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas, in Garza County. The Post Reservoir conservation pool would have a surface area of 2,280 acres, and provide approximately 56,000 acft of storage before sedimentation and 37,000 acft of storage after 50 years of sedimentation. A 1968 reservoir analysis indicated that the Post Reservoir would have a firm yield of approximately 9,500 acft/yr in 2020 considering runoff declines and sedimentation.[68] The 1968 construction cost estimate was $2.2 million. Table 1-26 shows a summary of WRMWD's activities and programs.

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below Conchas Dam, provided that the amount of conservation storage in New Mexico available for impounding water originating below Conchas Dam be limited to 200,000 acft.

[68] Freese, Nichols, and Endress, "Feasibility Report on Post Reservoir Site," prepared for White River Municipal Water District, September 1968.

WRMWD has obtained groundwater rights and drilled and equipped several wells so that groundwater will be available to supplement the surface water in times of drought.

***Table 1-26.***
***Summary of White River Municipal Water District's Programs and Activities***

| ***Programs & Activities*** | ***Comment*** |
|---|---|
| Water Quality Monitoring | The District maintains a water quality monitoring program at its treatment plant. |
| Water Supply Programs | The District supplies water to communities located in five counties. |
| ***Public Participation & Education*** | ***Comment*** |
| Educational Programs | The District hosts field trips by area schools to view its facilities. |

*Mackenzie Municipal Water Authority*

The MMWA owns and operates Lake Mackenzie located in Swisher and Briscoe Counties. The Authority delivers water to the Cities of Silverton, Tulia, Floydada, and Lockney. Table 1-27 shows a summary of MMWA's activities and programs.

***Table 1-27.***
***Summary of Mackenzie Municipal Water Authority's Programs and Activities***

| ***Programs & Activities*** | ***Comment*** |
|---|---|
| Water Quality Monitoring | The Authority maintains a water quality monitoring program. |
| Water Supply Programs | The Authority supplies water to four cities. |
| ***Public Participation & Education*** | ***Comment*** |
| Educational Programs | The Authority hosts field trips by area school children to view its facilities. |

*Brazos River Authority*

The BRA was established in 1929 by the Texas Legislature as a public agency of the state of Texas. It has statutory responsibility for developing and conserving the surface water resources of the Brazos River Basin in Texas and for putting these resources to use in the best interest of the people of Texas. The Brazos River Basin covers some 42,000 square miles in Texas, about one-sixth of the area of the state; the boundaries of the river authority include all or part of 65 Texas counties. About 8,732 square miles (43 percent) of the Llano Estacado Region lie in the Brazos Basin or BRA management area. Table 1-28 shows a summary of BRA's programs and activities.

***Table 1-28.***
***Summary of Brazos River Authority's Programs and Activities***

| ***Programs & Activities*** | ***Comment*** |
|---|---|
| Texas Clean Rivers Program | The Authority contracts with the TCEQ to conduct the Clean Rivers Program for the Brazos River Basin. |
| Watershed Protection | The Authority established the Watershed Protection Program in 1994 to focus attention on watersheds where water quality problems have been identified and to establish instream water quality targets. |
| Water Quality Monitoring | The Authority evaluates water quality conditions of the reservoirs and stream segments that comprise the Authority's basin-wide water supply system. The Authority also maintains a water quality testing lab. |
| Water Supply Programs | The Authority supplies water to numerous entities in the Brazos River Basin. It owns and operates three reservoirs for water supply – Possum Kingdom Lake, Lake Granbury, and Lake Limestone. The Authority also contracts with the U.S. Army Corps of Engineers for storage and space in eight federal reservoirs. |
| Water & Wastewater Treatment Program | The Authority owns and or operates several drinking water treatment systems for cities in addition to regional treatment facilities at Lakes Granbury and Granger. The Authority also owns and or operates numerous wastewater treatment plants and regional wastewater treatment facilities. |
| ***Public Participation & Education*** | ***Comment*** |
| Newsletter | The Brazos Basin Update is a quarterly newsletter about Authority programs and activities. |
| Educational Programs | The Authority participates in the Major Rivers Water Education Program, which targets fourth-grade students throughout the Brazos River Basin. |

*Red River Authority*

The RRA of Texas, a political subdivision of the State, was created by acts of the 56th Legislature in 1959. It has jurisdiction over the entire Red River watershed in Texas, including all or part of 43 counties, an area encompassing 40,266 square miles. About 6,681 square miles (32.9 percent) of the Llano Estacado Region is in the Red River Basin and within the RRA management area. The RRA has broad powers over the conservation, reclamation, protection and development of the water resources along the Red River and its Texas tributaries. Headquarters for the authority is located in Wichita Falls. The Authority assists communities, towns, municipalities, and other entities in an effort to identify and encourage development of potential water supply sources, to conserve and protect existing water supplies, and to develop and improve water and wastewater facilities. In compliance with the Clean Rivers Act, the RRA has prepared a 5-year work plan for water quality assessment of the Red River Basin. Table 1-29 shows a summary of the RRA's activities and programs.

***Table 1-29.***
***Summary of Red River Authority's Programs and Activities***

| ***Programs & Activities*** | ***Comment*** |
|---|---|
| Texas Clean Rivers Program | The RRA contracts to perform Clean River Act duties on behalf of both the Canadian River Basin and the Red River Basin. |
| Chloride Control | The RRA is the local sponsor for the Red River Basin Chloride Control Project, a federal endeavor to reduce the naturally occurring levels of chlorides in the Red River and its tributaries. |
| Water Quality Monitoring | The Authority collects water quality samples to determine quantitative cause and effect relationships of water quality, obtain sufficient data for updating water quality management plans, set effluent limits, identify non-point sources of pollution and classify stream segments. |
| Water Supply Programs | The Authority supplies water to several entities and rural areas within the Red River Basin. |
| ***Public Participation & Education*** | ***Comment*** |
| Texas Rivers Project | The Texas Rivers Project is a grassroots initiative developed and implemented in various school systems throughout the basin. The program consists of a multi-disciplinary curriculum with focus on math, science, technology and social studies relating to water ecology and includes volunteer environmental monitoring. |
| Educational Programs | The Authority participates in the Major Rivers Water Education Program, which is intended to help fourth-grade children throughout Texas learn about how we get and use water and how important it is for us to conserve water. |

### *1.9.3 Local*

#### *1.9.3.1 City of Lubbock*

The City of Lubbock is supplied water by CRMWA and obtains water from its own well fields in Bailey and Lamb Counties. In addition, Lubbock uses water from wells within the City for irrigation of parks and open spaces. In the foreseeable future, Lubbock will continue to rely on surface water from CRMWA, groundwater from CRMWA's new Roberts County well field and from the City's own well fields to meet its needs. The City also has water rights in Lake Alan Henry, and is developing a pipeline and water treatment plant to use this source of supply.

## *1.10 Existing Water-Related Plans*

### *1.10.1 State Water Plan* [69]

In Section 16.051 of the Texas Water Code, the Executive Administrator of the TWDB is charged with producing a State Water Plan that addresses the broad public interest of the state. As currently specified in Section 16.055 and 16.056, the Plan is to be periodically reviewed and updated and serves as a flexible guide to state policy for the development of its water resources.

The Plan provides a statewide perspective that places local and regional needs in a broader context. New legislation, passed by the 75th Legislature in 1997, specifies a 5-year update period for the Plan, which is to be based on regional planning studies, and provides that related financial assistance applications must be consistent with the regional and state plans for regulatory approval by state agencies. The ultimate goal of the State Water Plan is to identify those policies and actions that may be needed to meet Texas' near- and long-term water needs, based on a reasonable projected use of water, affordable water supply availability, and a goal of conservation of the state's natural resources. The 2007 State Water Plan, contains information about the projected water needs of the Llano Estacado (Region O) Water Planning Region and provides recommendations to meet the projected needs, as summarized below.

The Llano Estacado Region (Region O) primarily depends upon groundwater from the Ogallala Aquifer, with 93 percent of the region's supply in 2010 coming from this source. Approximately 95 percent of the water obtained from the aquifer is used for irrigation. Surface water supply within the region is obtained from Lake Meredith, located in Region A, and White River Lake, located in Crosby County within Region O. By 2060, the total ground and surface water supply is projected to decline 55 percent, from 3,155,216 acre-feet per year in 2010 to 1,421,978 acre-feet in 2060. "The projected decline in water supply is due to the managed depletion of the Ogallala Aquifer."[70]

The projected municipal and irrigation needs (shortages) for the Llano Estacado Region increase from 1,266,820 acre-feet per year in 2010 to 2,349,124 acre-feet per year in 2060. The regional and state plans include water conservation for municipal, industrial, mining, and

[69] "Water for Texas, 2007," Document No. GP-8-1, Texas Water Development Board, Austin, Texas, January 2007.
[70] Ibid.

agricultural irrigation water users. In addition, the plans include groundwater development and connection of the existing Lake Alan Henry to meet projected municipal needs, water reuse, and groundwater desalination, at an estimated capital cost of $818.63 million for the 50-year planning period of 2010 through 2060.

The primary recommended water management strategy for the region is irrigation water conservation, which produces 74 percent of the water quantities of the recommended water management strategies in 2060. However, the plan recognizes unmet needs for irrigation of 1,261,453 acre-feet per year in 2010 to 2,322,544 acre-feet per year in 2060.

The 2007 State Water Plan includes the Llano Estacado Regional Water Plan policy recommendations of: (1) encouraging legislative support for conservation programs; (2) managing groundwater through underground water conservation districts; (3) supporting rule of capture as modified by rules of existing conservation districts, and (4) supporting vegetation control as a water conservation practice, particularly in the watersheds of Lakes Mackenzie, White River and Alan Henry.

### *1.10.2 Regional Drought Contingency and Groundwater Management Plans*

#### *1.10.2.1 Brazos River Authority* [71]

The BRA's drought contingency plan defines triggering conditions, based on reservoir levels, for water shortage conditions and actions designed to lower water use during these conditions. Upon the declaration of drought conditions for a particular reservoir, the Authority will develop a specific drought contingency plan for the system or local use reservoir. In addition to the drought contingency plan, the Authority has also developed a water conservation plan which outlines several goals to encourage water conservation within the Brazos River Basin, including developing and implementing a water conservation education and information program and encouraging and assisting contract users in developing and implementing water conservation programs.

[71] Brazos River Authority, "Drought Contingency Policy," July 1999, and "Water Conservation Policy," July 1999.

#### *1.10.2.2 Canadian River Municipal Water Authority* [72]

The CRMWA supplies raw water to 11 Member Cities via a 322-mile aqueduct system. The CRMWA's primary sources of water are Lake Meredith located in the Canadian River Basin and groundwater from Aquifers located on property in Region A. The CRMWA's water conservation plan provides conservation goals, as well as setting standards for leak control and repair, measurement of diverted water, and records management. The CRMWA has also adopted a drought contingency plan which defines trigger conditions for water shortage conditions and goals of water use reduction while the water shortage condition persists. To achieve the water use reduction goals, during times of water shortages CRMWA's Member Cities will implement their individual drought contingency plans.

#### *1.10.2.3 Garza County Underground and Freshwater Conservation District* [73]

This management plan becomes effective upon Certification by the TWDB after adoption by the District Board of Directors and remains in effect until September 1, 2008, or for a period of 10 years, whichever is later. The plan may be revised at any time or after 5 years, when the plan will be reviewed to insure that it is consistent with the applicable Regional Water Plan and the State Water Plan. The overall objective of the District is the conservation, preservation, protection, recharge, and enhancement of the groundwater supplies within the boundaries of the District and to make wise and beneficial use of the resources for the benefit of the citizens and economy of the District. To accomplish these goals, the District plans to implement a program to monitor both the quantity and quality of these water supplies and also to promote a brush control program for the District.

In developing a drought contingency plan, the District will consider the economic effects of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage and weather conditions, and the appropriate conditions under which to implement the contingency plan.

[72] Canadian River Municipal Water Authority, "Drought Contingency Plan," July 14, 1999, and "Water Conservation Plan," July 14, 1999.
[73] Garza County Underground and Freshwater Conservation District, "Water Management Plan," 1998.

#### *1.10.2.4 High Plains Underground Water Conservation District No. 1*[74]

This current management plan is a revision of the management plan adopted by the Board in June 1998. This plan became effective August 11, 1998, upon adoption by the Board of Directors of the District and will remain in effect until a revised plan is approved or until August 31, 2013, whichever is earlier. From the District's inception, the Board of Directors has upheld the philosophy that ownership of the groundwater is a private property right. The Directors continue to support this right for the landowners. The philosophy of groundwater management in the District was established early and formally adopted by the Board; the District is dedicated to the principle that conservation is best accomplished through public education.

The District enforces its rules to conserve, preserve, protect, and prevent the waste of groundwater resources in its jurisdiction. Besides public education, the District management plan outlines its well registration, well spacing, water level monitoring, pre-plant soil moisture, potential evapotranspiration irrigation scheduling, and agricultural water conservation loan equipment programs. The District also publishes an annual report outlining its performance in achieving its goals.

All of the District's programs and activities are directed at promoting maximum conservation of the area's water resources. The adoption and utilization of the best available technology and equipment by area water users, on a continuous basis, is the best drought contingency plan possible. Installing and utilizing equipment that result in minimum loss or waste of water prior to a drought reduces the impact of a drought when one occurs.

#### *1.10.2.5 Mackenzie Municipal Water Authority*[75]

The MMWA owns and operates Lake Mackenzie from which the Authority supplies water to the Cities of Floydada, Lockney, Silverton, and Tulia, located within the planning area. The triggering criteria for water allocation in this plan are based entirely on the water level in Lake Mackenzie. This plan also identifies water conservation goals that will be placed into effect during water shortage conditions. Under this plan, during a mild water shortage condition, the Authority will try to achieve a voluntary 10 to 20 percent reduction in total water use, while

[74] High Plains Underground Water Conservation District No. 1, "10-Year Management Plan—2003-2013" January 29, 2004.
[75] Mackenzie Municipal Water Authority, "Drought Contingency Plan for Mackenzie Municipal Water Authority," August 1, 1999.

during a severe water shortage condition, the Authority's goal is to achieve a voluntary 50 to 60 percent reduction in total water use.

#### *1.10.2.6 Mesa Underground Water Conservation District* [76]

The District's August 31, 1998 management plan has been readopted, following adoption by the local Board of Directors and certification as administratively complete by the TWDB. As a result of SB 2, a new management plan had to be prepared. The new District management plan became effective January 2, 2009 and will remain in effect for a period of 10 years (minimum planning period), until a revised or amended plan is certified or January 2, 2014, whichever comes first. The guiding principles in developing the management plan is to better understand groundwater conditions, to encourage the most effective use of groundwater, to preserve and protect groundwater quality, to increase public awareness and education, and to monitor legislative activities along with rules and orders of state agencies which may effect the private ownership of groundwater including the authority to manage at the local level.

A contingency plan to cope with the effects of water supply shortages due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrologic conditions of the aquifer, and the appropriate conditions under which to implement the contingency plan.

#### *1.10.2.7 Sandy Land Underground Water Conservation District* [77]

This management plan became effective on September 1, 1998 upon adoption by the Sandy Land Underground Water Conservation District Board of Directors and certification as administratively complete by the TWDB. The plan will remain in effect through September 2013 or until a revised plan is adopted and certified. The Sandy Land Underground Water Conservation District recognizes that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy and environment within the District. The District feels that the preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's well permitting and well spacing rules. This management plan is intended as a tool

[76] Mesa Underground Water Conservation District, "Management Plan," January 2, 2004.
[77] Sandy Land Underground Water Conservation District, "Groundwater Management Plan," July 10, 2004.

to focus the thoughts and actions of those individuals charged with the responsibility for the execution of District activities.

A contingency plan to cope with the effects of water supply deficits due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrogeologic conditions of the aquifers within the District, and the appropriate conditions under which to implement the contingency plan.

#### *1.10.2.8 South Plains Underground Water Conservation District* [78]

This management plan became effective September 1, 1998, upon adoption by the Board of Directors of the District and will remain in effect until a revised plan is approved or until August 31, 2013, whichever is earlier. The District was formed, and has been operated from its inception, with the guiding belief that the ownership and pumpage of groundwater is a private property right. The Board has adopted the principle of "education first" and regulation as a last resort in their effort to encourage conservation of the resource. As a result, the rules of the District were designed to give all landowners a fair and equal opportunity to use the groundwater resource underlying their property for beneficial purposes. Effective July 1, 1999, the District adopted new rules that regulate the spacing between wells.

In the District, groundwater conservation is stressed at all times. The Board recognizes that irrigated agriculture provides the economic stability to the communities within the District. Therefore, through the notice and hearing provisions required in the development and adoption of this management plan, the Board has adopted the official position that, in times of precipitation shortage, irrigated agricultural producers will not be limited to any less pumpage of groundwater than is provided for by District rules. In order to treat all other groundwater user groups fairly and equally, the District will encourage more stringent measures, where practical, but will not limit groundwater use in any way not already provided for by District rules.

[78] South Plains Underground Water Conservation District, "Management Plan," September 1, 2008.

#### 1.10.2.9 White River Municipal Water District [79]

The White River Municipal Water District's primary water supply is obtained from surface water diverted from White River Lake; however, the District has purchased groundwater rights and drilled wells to supplement its surface water supply during times of prolonged drought. The District's Water Conservation Plan applies to each of the District's customers which the District bills directly. However, the plan does not apply to the District's member cities (Crosbyton, Post, Ralls, and Spur).

It is the goal of the District to maintain unaccounted-for water at 15 percent or less and to achieve a 1 percent reduction in average day municipal per capita water use by the year 2050. In order to achieve these goals the District will promote water conservation by informing the public of ways to conserve water, adopting a new plumbing code, and instituting a plumbing retrofit program. In addition to these measures, the District will also test or replace meters that appear to have abnormally high or low water usage and will establish a leak detection and repair program.

### 1.10.3 Local Drought Contingency Plans

#### 1.10.3.1 City of Brownfield [80]

The City of Brownfield's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of drought response stages as well as the water use restrictions in effect during times of water shortages. It is the goal of this plan to reduce total water use by 50 percent during "critical water shortage conditions" and 75 percent during "emergency water shortage conditions." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender to penalties such as fines or citations.

[79] White River Municipal Water District, "Water Conservation Plan," July 2, 1999.
[80] City of Brownfield, "Drought Contingency Plan for the City of Brownfield," August 19, 1999.

#### *1.10.3.2 City of Denver City* [81]

The City of Denver City owns and operates the water system and provides potable water to its residents. The city's current water supply is well water from the Ogallala Aquifer system and the Trinity Group. Six wells are located 1 mile west of the city; and other wells are located 7 miles west of the city. The total pumping capacity of these wells is 6.5 million gallons per day (MGD). The city leases the water rights of the wells 1 mile west of the city from Exxon, Inc. Additional water rights are owned on two sections 7.5 miles northwest of the city. The city is planning to extend water lines east of the city and expects to provide water to approximately 40 customers who currently have domestic water wells. Some of these privately-owned wells are threatened with contamination.

Denver City's average daily usage was 126 gallons per capita per day (gpcd) in 1987 and 149 gpcd in 1988. It is the goal of the water conservation plan to reduce water usage to 140 gpcd.

The city's drought contingency program includes measures to significantly reduce water use on a temporary basis. These measures involve voluntary reductions, restrictions and/or elimination of certain types of water use, and water rationing. It is the goal of the drought contingency plan to reduce water use during an emergency or prolonged drought by 35 percent.

#### *1.10.3.3 City of Lamesa* [82]

The City of Lamesa's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of drought response stages, as well as the water use restrictions in effect during times of water shortages. It is the goal of this plan to reduce total water use by 50 percent during "critical water shortage conditions" and 75 percent during "emergency water shortage conditions." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use.

[81] City of Denver City, "Water Conservation and Drought Contingency Plan," December 4, 1989.
[82] City of Lamesa, "Drought Contingency Plan," August 16, 1999.

#### *1.10.3.4 City of Levelland* [83]

The City of Levelland's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of five water shortage conditions, as well as the water use restrictions in effect during these stages. The goals of this plan are to achieve a voluntary 3 percent reduction in daily water demand during mild water shortage conditions and to achieve an 18 percent reduction in daily water demand when under a "critical water shortage condition." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender to penalties such as fines or citations.

#### *1.10.3.5 City of Littlefield* [84]

The City of Littlefield owns, operates, and manages the waterworks system. The city's waterworks system serves approximately 2,921 connections. The majority of these connections are within the city limits of Littlefield; however, a few of the customers live outside the corporate limits of the city. The waterworks system covers approximately 3.5 square miles. Over the past several years the city has experienced moderate growth. The city's waterworks system has not been exceeded in its available capacity to supply the customers' demand. Littlefield is considering obtaining additional water rights to assure future water for its customers. From the Utility Evaluation, the City of Littlefield has set a goal of per capita water use reduction of 15 percent.

The City of Littlefield's Emergency Water Demand Management Plan contains trigger conditions to stipulate when water use should be curtailed. The plan includes restrictions on lawn watering, car washing, and certain public water uses that are not essential for public health or safety.

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[83] City of Levelland, "Drought Contingency Plan," July 29, 1999.
[84] Oller Engineering, Inc. for the City of Littlefield, "Water Conservation Plan and Drought Contingency Plan," March 1997.

#### *1.10.3.6 City of Lubbock* [85]

The purpose of the City of Lubbock's Water Conservation Plan is to promote the responsible use of water by (1) supporting public education programs, (2) maintaining policies that support wise use of water, and (3) providing for enforcement of water conservation policies and practices. It is the goal of the Plan to reduce water usage by 20 gpcd by the year 2014. To achieve this goal, the City of Lubbock will continue its programs for universal metering and controlling unaccounted-for uses of water, as well as continue the city's program of continuing education regarding water conservation.

The City of Lubbock's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of the four water shortage conditions, as well as the water use restrictions in effect during times of water shortages. The plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water that subjects the offender to penalties such as fines or discontinuance by the city of water services to water utility customers or other users.

#### *1.10.3.7 City of Plainview* [86]

The City of Plainview's Conservation and Drought Contingency Plan outlines ordinances the city has put into effect to reduce per capita use and to curtail water use during times of drought. In order to lower the city's per capita water use, the city has adopted a plumbing code that limits residential meters to 1-inch or smaller, has initiated a water meter retrofit program, provides educational materials on water conserving landscaping, and maintains a leak detection and repair program.

The city's drought contingency plan outlines the city's drought response procedures. The plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, and other restrictions on outdoor water use.

[85] City of Lubbock, "Water Conservation Plan," August 26, 1999, and "Drought Contingency Plan," August 26, 1999.

#### *1.10.3.8 City of Seminole* [87]

The City of Seminole operates a water system for approximately 2,400 utility customers. It has the capability of producing 5.5 MGD of potable water from 18 wells in the Ogallala Aquifer system. Seven of these wells are located inside the city limits with the other eleven scattered over five sections of land. All wells are included in a computerized water automation system in which radio signals sent to a computer control the levels of water in the groundwater storage and elevated storage tanks along with the operation of the wells. This system also allows the city to sequence the wells desired so that different wells turn on at different times and under different conditions.

In an additional effort to conserve water, a policy of voluntary conservation is in effect. There are two additional stages of conservation that may be implemented by the Mayor upon the recommendation of the City Administrator and Public Works Director. The first is to move the voluntary conservation policy into a water warning in which outdoor watering is curtailed. The second is to declare a water emergency, prohibit all outdoor watering, and limit all other water use to essential domestic purposes.

#### *1.10.3.9 City of Tulia* [88]

The City of Tulia waterworks system serves approximately 2,033 connections. The majority of these connections are within the city limits of Tulia, although a few customers live outside the corporate limits of the city. The waterworks system covers approximately 3.72 square miles. Over the past several years, the city has experienced moderate growth. The city's waterworks system has not been exceeded in its available capacity to supply the customers' demand. Tulia is a member of the Mackenzie Municipal Water Authority (MMWA), but since drought conditions in the area have reduced the reservoir's available supply to all member cities Tulia has obtained its own groundwater supplies to assure future water supplies for its customers.

The City of Tulia's Emergency Water Demand Management plan contains trigger conditions to stipulate when water use should be curtailed. The plan includes restrictions on lawn watering, car washing, and certain public water uses that are not essential for public health or safety.

[86] Freese & Nichols for the City of Plainview, "Drought Contingency Plan," July 26, 1994.
[87] Information transmitted in a letter received from the City of Seminole dated October 26, 1999.
[88] Oller Engineering, Inc. for the City of Tulia, "Water Conservation Plan and Drought Contingency Plan," March 1997.

### *1.10.4 Water Availability Requirements Promulgated by County Commissioners Courts*

In Region O, there are no known actions by county commissioners courts to establish water availability requirements.

### *1.10.5 Summary of Current Preparations for Drought*

During periods of drought, water usage quite often exceeds the capacity of the distribution systems of many of the small towns in the region. Citizens are notified by the local news media that they need to curtail usage to prevent emptying the water tower storage. The reason given is that water may be needed to fight a fire. Most citizens readily comply without ordinances. Most water supply entities have indicated they will adopt mandatory water conservation during times of prolonged drought, which may include limitations on outdoor and recreational water use. Because of recent droughts in the region, many local planning authorities are now looking more towards future drought planning.

### *1.10.6 Other Relevant Natural Resource Plans*

#### *1.10.6.1 Playa Lakes Joint Venture* [89]

The Playa Lakes Joint Venture (PLJV) was organized to implement the North American Waterfowl Management Plan in the Playa Lakes Region (PLR). The PLR includes portions of southeastern Colorado, southwestern Kansas, eastern New Mexico, western Oklahoma, and northwestern Texas. The goal of the PLJV is successful accommodation of objective numbers of waterfowl, migratory birds, and other wildlife, wintering in, migrating through, and breeding in the PLR. The five general objectives of the PLJV are:

- No loss or further degradation of playa wetlands, saline lakes, reservoirs, tanks, riparian areas, or other wetlands in the PLR;
- To have sufficient high-quality wetland habitat to permit wide-spread dispersion of waterfowl within the PLR;
- To have sufficient seasonal food resources for waterfowl and other wetland-dependent wildlife populations in the PLR;
- To have healthy and secure wetland and upland habitats to ensure optimum survival and diversity of waterfowl and other wildlife in the PLR; and
- To maintain successful reproduction of waterfowl and other wildlife breeding in the PLR.

[89] Playa Lakes Joint Venture Management Board, “Final Implementation Plan,” Albuquerque, NM, November 1994.

There are six specific habitat objectives:

- Protection of valuable historical migratory bird use areas;
- Protection and enhancement of wetland areas that are adequately distributed throughout the PLR;
- Direct conservation of 10 percent of playas and associated uplands;
- Indirect conservation of 10 percent of playas and associated uplands;
- Protection and enhancement of important riparian areas; and
- Conservation of at least 10,000 acres of other wetlands (e.g., seepage areas, saline lakes) and their associated habitats.

#### *1.10.6.2 Wholesale Water Providers*

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider as follows:

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

There are four Wholesale Water Providers in the Llano Estacado Region, as follows:

***Canadian River Municipal Water Authority***

(1) City of Brownfield
(2) City of Lamesa
(3) City of Levelland
(4) City of Lubbock
(5) City of O'Donnell
(6) City of Plainview
(7) City of Slaton
(8) City of Tahoka

***City of Lubbock***

(1) Buffalo Springs Lake Water Supply Corporation
(2) Lake Ransom Canyon
(3) City of Shallowater
(4) Lubbock-Reese Redevelopment Authority
(5) City of Littlefield (emergency supply, only)
(6) Lake Alan Henry Water Supply District (contract in negotiation).

***White River Municipal Water District***

(1) City of Crosbyton
(2) City of Post
(3) City of Ralls
(4) City of Spur

***Mackenzie Municipal Water Authority***

(1) City of Floydada
(2) City of Lockney
(3) City of Silverton
(4) City of Tulia

## 1.11 Water Loss Audits

In accordance with 31 TAC 357.7(a)(1)(M), the Llano Estacado 2011 Regional Water Plan includes information below that was compiled by the Texas water development Board (TWDB) from water loss audits performed by retail public utilities pursuant to §358.6 of this title (relating to Water Loss "Audits). In addition, in accordance with 3. 31 TAC 357.7 (a)(7)(A)(iv) The regional water planning group shall consider strategies to address any issues identified in the information compiled by the Board from the water loss audits performed by retail public utilities pursuant to §358.6 of this title (relating to Water Loss Audits).

The 2005 Water Loss Data presented below were submitted to the TWDB by water utilities in Texas as required by HB 3338. HB 3338 required the TWDB to compile the information included in the water audits by type of retail public utility and by regional water planning area, and provide that information to the regional planning groups for use in identifying appropriate water management strategies in the development of their regional water plan. These data were acquired as part of the 2005 Water Loss Audit reporting requirements, and this was the first time that this particular water loss methodology was utilized in Texas. The methodology relies upon self-reporting by public utilities, and due to this, the self-reported data discussed in the TWDB Water Loss Report indicates that some of the data may be suspect and in need of further refinement.[90] In addition, HB 3338 required the TWDB to compile the information

[90] "An Analysis of Water Loss, as Reported by Water Suppliers in Texas," Alan Plummer Associates, Inc. and Water Prospecting and Resource Consulting, LLC, Texas Water Development Board, Austin, Texas, January, 2007.

included in the water audits by type of retail public utility and by regional water planning area and provide that information to the regional planning groups for use in identifying appropriate water management strategies in the development of their regional water plan.

Of the 95 public water utilities in the Llano Estacado Water Planning Region, 47 filed water loss audit reports with the TWDB. The TWDB provided the list of public utilities of the Llano Estacado Water Planning Region that filed a report, including the reported information for each of the following 27 factors: (1) population served, (2) quantity of water delivered, (3) percent of master meter accuracy, (4) quantity of water billed and metered, (5) quantity of water billed and unmetered, (6) quantity of water unbilled and metered, (7) quantity of water unbilled and unmetered, (8) total quantity of authorized consumption, (9) percent of customer meter accuracy, (10) quantity of customer meter accuracy loss, (11) quantity of unauthorized consumption, (12) quantity of apparent loss, (13) quantity of main line leaks, (14) quantity of customer line leaks, (15) quantity of storage tank overflows, (16) quantity of real loss, (17) quantity of total loss, (18) quantity of total water loss plus authorized consumption, (19) number of service connections, (20) number of miles of main lines, (21) number of connections per mile of mail lines, (22) quantity of loss per mile of mail lines. (23) quantity of loss per connection, (24) production water cost, (25) dollar value of real loss, (26) retail water cost, and (27) dollar value of apparent loss.

Of the information provided, those most relevant to regional water planning are item number 2 (quantity of water delivered) and item number 17 (quantity of real loss), since these two factors provide an indication the total quantity of water diverted from the source, (i.e., the factor needed for regional water planning), with the quantity of loss being also relevant to water conservation. These two factors: quantity of water delivered and quantity of water loss are shown in Table 1-30.

The 47 public utilities reporting served 327,235 people (about 74.6 percent of the regional population) in 2005 (Table 1-30). Total reported quantity of water delivered was 62,340.00 acre-feet, with a reported quantity of water loss of 847.31 acre-feet, giving a total estimated quantity of water originating at the source of 63,187.31 acre-feet (62,340.00 + 847.31) (Table 1-30). The quantity of water loss, as a percent of estimated total water originating at the source is calculated at 1.34 percent.

Of the 47 utilities reporting, 7, or 15 percent reported estimated water loss at zero in 2005, 21 (45 percent) reported losses of less than one percent, 10 (21 percent) reported losses in the 1 to 2 percent range, 4 (8.5 percent) reported losses in the 3 to 4.6 percent range, 3 reported losses in the 6.3 to 7.7 percent range, and 2 (4.25 percent) reported losses of about 8.25 percent (Table 1-30). Since rate of water loss in relation to estimated quantity of water diverted from the source is quite low, leak detection and repair, one of the leading water conservation measures does not appear to provide much opportunity for water conservation via this measure.

## Table 1-30
## Water Loss Audit – 2005
## Llano Estacado Water Planning Region

| Utility Name | Population Served | Water Produced (acre-feet) | Water Delivered (acre-feet) | Water Loss (acre-feet) | Percent Loss (Percent) |
|---|---|---|---|---|---|
| Ackerly WSC | 225 | 43.70 | 43.38 | 0.32 | 0.74 |
| Bledsoe WSC | 70 | 18.17 | 17.83 | 0.34 | 1.86 |
| Bovina | 2,000 | 288.07 | 287.92 | 0.15 | 0.05 |
| Brownfield | 9,488 | 1,501.14 | 1,500.80 | 0.34 | 0.02 |
| Denver City | 4,500 | 956.65 | 946.21 | 10.43 | 1.09 |
| Floydada | 3,676 | 503.61 | 499.37 | 4.14 | 0.82 |
| Hale Center | 2,000 | 320.18 | 320.18 | 0.00 | 0.00 |
| Lamesa | 9,952 | 2,105.16 | 2,099.66 | 5.50 | 0.26 |
| Levelland | 12,866 | 1,918.92 | 1,910.08 | 8.84 | 0.46 |
| Lorenzo | 1,837 | 204.54 | 201.68 | 2.86 | 1.40 |
| Meadow | 658 | 57.38 | 55.21 | 2.17 | 3.78 |
| O’Donnell | 1,011 | 143.72 | 142.57 | 1.15 | 0.80 |
| Plains | 1,450 | 337.42 | 315.94 | 21.48 | 6.37 |
| Ropesville | 517 | 117.03 | 111.66 | 5.37 | 4.59 |
| Seagraves | 2396 | 452.55 | 445.06 | 7.49 | 1.65 |
| Seminole | 5910 | 1,797.23 | 1,787.41 | 9.82 | 0.55 |
| Shallowater | 2,500 | 332.32 | 331.93 | 0.38 | 0.12 |
| Slaton | 6,109 | 987.27 | 987.11 | 0.16 | 0.02 |
| Smyer | 480 | 58.99 | 58.99 | 0.00 | 0.00 |
| Spur | 1,088 | 336.71 | 331.33 | 5.39 | 1.60 |
| Wilson | 537 | 65.05 | 64.91 | 0.14 | 0.21 |
| Coronado Shores WS | 84 | 7.53 | 7.02 | 0.52 | 6.84 |
| Cotton Center WSC | 250 | 43.38 | 41.56 | 1.83 | 4.21 |
| Cox Addition WS | 120 | 18.19 | 17.35 | 0.84 | 4.62 |
| Dougherty Water Works | 64 | 7.67 | 7.65 | 0.02 | 0.20 |
| Halfway WSC | 100 | 31.05 | 31.05 | 0.00 | 0.00 |
| Happy | 647 | 87.08 | 86.94 | 0.13 | 0.15 |
| Hart | 1,198 | 158.25 | 158.02 | 0.23 | 0.15 |
| Littlefield | 6,507 | 1,629.58 | 1,605.03 | 24.55 | 1.51 |
| Loop WSC | 320 | 39.38 | 39.05 | 0.32 | 0.82 |
| Lubbock Co WCID 1 | 600 | 72.03 | 72.03 | 0.00 | 0.00 |
| Lubbock Public WS | 209,120 | 40,559.19 | 39,859.02 | 700.17 | 1.73 |
| Morton | 2,249 | 394.38 | 393.66 | 0.72 | 0.18 |
| Muleshoe | 4,531 | 815.52 | 801.56 | 13.96 | 1.71 |
| Nazareth | 356 | 71.14 | 70.88 | 0.26 | 0.37 |
| North Univ. Estates | 600 | 68.86 | 67.57 | 1.29 | 1.87 |
| Petersburg Mun WS | 1,250 | 241.37 | 241.30 | 0.08 | 0.03 |
| Plainview Mun WS | 22,336 | 5,223.67 | 5,220.38 | 3.28 | 0.06 |
| Plott Acres | 180 | 25.70 | 23.58 | 2.12 | 8.24 |
| Rio Blanca Estates | 72 | 2.86 | 2.86 | 0.00 | 0.00 |

Continued next page

**Table 1-30 Continued**

| Utility Name | Population Served | Water Produced (acre-feet) | Water Delivered (acre-feet) | Water Loss (acre-feet) | Percent Loss (Percent) |
|---|---|---|---|---|---|
| South Haven MHP | 63 | 4.09 | 4.09 | 0.00 | 0.00 |
| Sunnydale WSC | 171 | 29.37 | 29.37 | 0.00 | 0.00 |
| Town North Estates | 200 | 19.51 | 18.01 | 1.50 | 7.68 |
| Town North Village WS | 350 | 41.29 | 37.88 | 3.41 | 8.26 |
| Town of Ransom Canyon | 1,200 | 287.29 | 282.20 | 5.09 | 1.77 |
| Tulia | 5,017 | 721.30 | 720.85 | 0.45 | 0.06 |
| Wolfforth Place | 380 | 41.94 | 41.88 | 0.06 | 0.15 |
| Total | 327,235 | 63,187.31 | 62,340.00 | 847.31 | 1.34 |

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# *Section 2*
# *Population and Water Demand Projections*
# *[31 TAC §357.7(a)(2)]*

In order to develop water plans to meet future water needs, it is necessary to make projections of future population and water demands for the region. The TWDB has made both population and municipal water demand projections for cities, rural areas, and other water use purposes for each of the 21 counties in the region. These counties are located in four major river basins—Canadian, Red, Brazos, and Colorado (Table 2-1). In accordance with TWDB Rules, Section 357.5(d), these projections are presented below.

## *2.1 Population Projections*

The 2000 Census of Population and Housing by the U.S. Bureau of the Census indicates that Texas has the second highest number of people among the states in the nation, with a population of 20.85 million. The population of the Llano Estacado Region was reported at 453,997 in 2000 and is projected to be 551,758 in 2060 (Table 2-2 and Figure 2-1), with nearly 80 percent of the population of the region projected to reside in the Brazos River Basin. The population projections for 53 individual cities and 35 rural areas of each county and part of county of each river basin area of the region are shown in Table 2-3.

***Table 2-1.***
***Llano Estacado Region—List of Counties***
***Location by River Basin***

| County Number | County | River Basin[1] | | | |
|---|---|---|---|---|---|
| | | Canadian Basin | Red Basin | Brazos Basin | Colorado Basin |
| 1 | Bailey | | | X | |
| 2 | Briscoe | | X | | |
| 3 | Castro | | X | X | |
| 4 | Cochran | | | X | X |
| 5 | Crosby | | X | X | |
| 6 | Dawson | | | X | X |
| 7 | Deaf Smith | X | X | | |
| 8 | Dickens | | X | X | |
| 9 | Floyd | | X | X | |
| 10 | Gaines | | | | X |
| 11 | Garza | | | X | X |
| 12 | Hale | | X | X | |
| 13 | Hockley | | | X | X |
| 14 | Lamb | | | X | |
| 15 | Lubbock | | | X | |
| 16 | Lynn | | | X | X |
| 17 | Motley | | X | | |
| 18 | Parmer | | X | X | |
| 19 | Swisher | | X | X | |
| 20 | Terry | | | X | X |
| 21 | Yoakum | | | | X |

[1] An X in the column indicates that all or part of the county is located in the River Basin named in the column heading

**Table 2-2.**
**Population Projections[1]**
**Llano Estacado Region**
**Individual Counties with River Basin Summaries**

| County Number | County | Census 2000 | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| 1 | Bailey | 6,594 | 7,060 | 7,558 | 7,875 | 8,207 | 8,238 | 8,086 |
| 2 | Briscoe | 1,790 | 1,862 | 1,899 | 1,865 | 1,779 | 1,747 | 1,700 |
| 3 | Castro | 8,285 | 9,070 | 9,762 | 10,224 | 10,587 | 10,567 | 10,381 |
| 4 | Cochran | 3,730 | 4,086 | 4,338 | 4,449 | 4,375 | 4,193 | 3,989 |
| 5 | Crosby | 7,072 | 7,678 | 8,174 | 8,514 | 8,856 | 8,873 | 8,731 |
| 6 | Dawson | 14,985 | 15,523 | 16,010 | 16,421 | 16,665 | 16,268 | 15,652 |
| 7 | Deaf Smith | 18,561 | 20,533 | 22,685 | 24,568 | 26,152 | 26,716 | 26,911 |
| 8 | Dickens | 2,762 | 2,712 | 2,661 | 2,547 | 2,375 | 2,304 | 2,221 |
| 9 | Floyd | 7,771 | 8,173 | 8,580 | 8,723 | 8,793 | 8,491 | 8,053 |
| 10 | Gaines | 14,467 | 16,130 | 17,663 | 18,774 | 19,560 | 19,434 | 19,169 |
| 11 | Garza | 4,872 | 5,072 | 5,265 | 5,158 | 4,961 | 4,733 | 4,416 |
| 12 | Hale | 36,602 | 39,456 | 42,103 | 44,034 | 45,204 | 44,940 | 44,069 |
| 13 | Hockley | 22,716 | 24,432 | 25,495 | 26,114 | 26,141 | 25,129 | 23,896 |
| 14 | Lamb | 14,709 | 15,515 | 16,500 | 17,355 | 17,995 | 17,900 | 17,668 |
| 15 | Lubbock | 242,628 | 265,547 | 280,449 | 289,694 | 294,476 | 299,218 | 303,857 |
| 16 | Lynn | 6,550 | 6,969 | 7,280 | 7,243 | 7,216 | 6,891 | 6,413 |
| 17 | Motley | 1,426 | 1,409 | 1,359 | 1,262 | 1,143 | 1,060 | 1,008 |
| 18 | Parmer | 10,016 | 10,641 | 11,302 | 11,585 | 11,666 | 11,301 | 10,674 |
| 19 | Swisher | 8,378 | 8,772 | 9,103 | 9,329 | 9,423 | 9,250 | 8,849 |
| 20 | Terry | 12,761 | 13,804 | 14,778 | 15,704 | 16,608 | 16,700 | 16,607 |
| 21 | Yoakum | 7,322 | 8,183 | 8,966 | 9,470 | 10,006 | 9,738 | 9,408 |
| | Total | 453,997 | 492,627 | 521,930 | 540,908 | 552,188 | 553,691 | 551,758 |
| | Canadian | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| | Red | 36,821 | 39,679 | 42,590 | 44,763 | 46,309 | 46,383 | 45,720 |
| | Brazos | 365,628 | 397,123 | 419,631 | 433,432 | 440,715 | 442,945 | 443,096 |
| | Colorado | 51,545 | 55,821 | 59,704 | 62,707 | 65,157 | 64,356 | 62,935 |
| | Total | 453,997 | 492,627 | 521,930 | 540,908 | 552,188 | 553,691 | 551,758 |

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003.

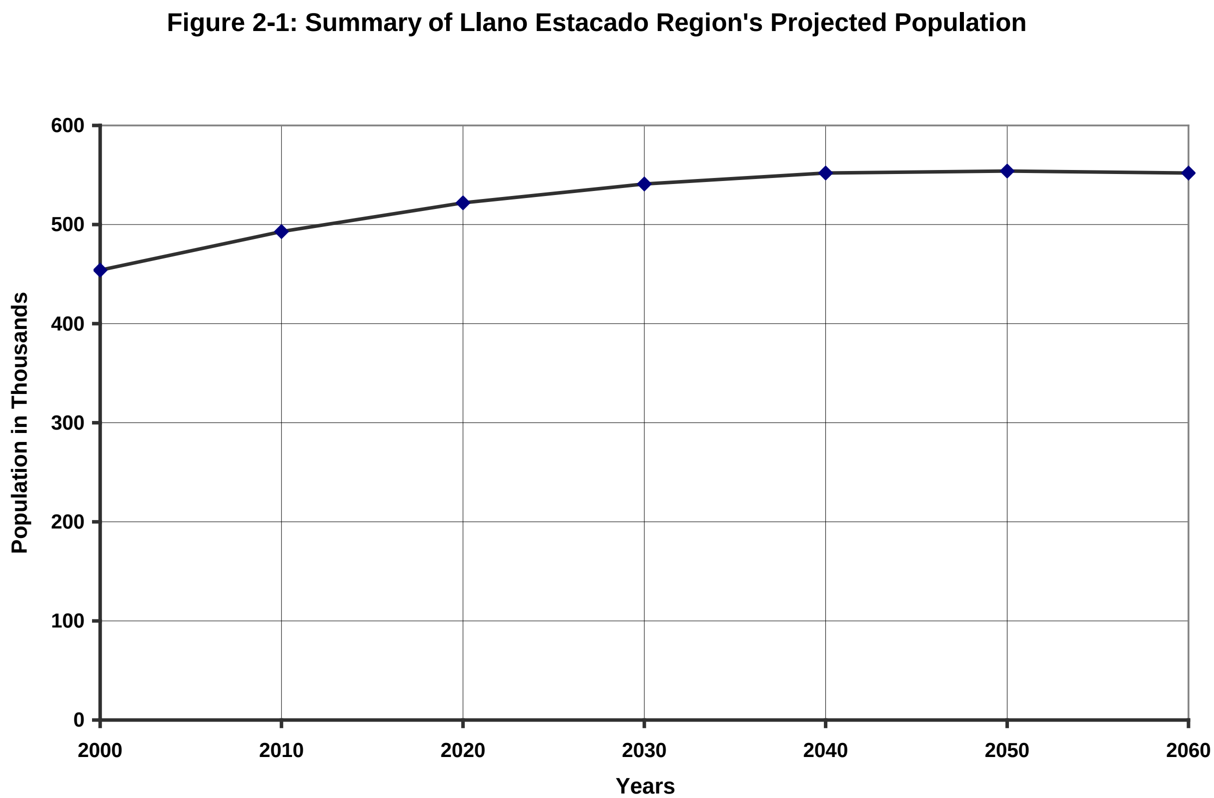


***Figure 2-1. Summary of Llano Estacado Region's Projected Population***

**Table 2-3.**
**Population Projections**
**Llano Estacado Region**
**River Basins, Counties, and Cities[1]**

| | *Census* | *Projections* | | | | | |
|---|---|---|---|---|---|---|---|
| ***Basin-County-City*** | ***2000*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
| **Canadian Basin (part)** | | | | | | | |
| Deaf Smith (part) | | | | | | | |
| Rural | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| Total | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| **Canadian Basin Total** | **3** | **4** | **5** | **6** | **7** | **7** | **7** |
| **Red Basin (part)** | | | | | | | |
| Briscoe (all) | | | | | | | |
| Silverton | 771 | 802 | 818 | 803 | 766 | 752 | 732 |
| Rural | 1,019 | 1,060 | 1,081 | 1,062 | 1,013 | 995 | 968 |
| Total | 1,790 | 1,862 | 1,899 | 1,865 | 1,779 | 1,747 | 1,700 |
| Castro (part) | | | | | | | |
| Rural | 1,472 | 1,611 | 1,734 | 1,817 | 1,880 | 1,877 | 1,844 |
| Total | 1,472 | 1,611 | 1,734 | 1,817 | 1,880 | 1,877 | 1,844 |
| Crosby (part) | | | | | | | |
| Rural | 6 | 6 | 7 | 7 | 7 | 8 | 7 |
| Total | 6 | 6 | 7 | 7 | 7 | 8 | 7 |
| Deaf Smith (part) | | | | | | | |
| Hereford | 14,597 | 15,090 | 15,628 | 16,099 | 16,495 | 16,636 | 16,685 |
| Rural | 3,961 | 5,439 | 7,052 | 8,463 | 9,650 | 10,073 | 10,219 |
| Total | 18,558 | 20,529 | 22,680 | 24,562 | 26,145 | 26,709 | 26,904 |
| Dickens (part) | | | | | | | |
| Rural | 272 | 264 | 256 | 237 | 209 | 197 | 184 |
| Total | 272 | 264 | 256 | 237 | 209 | 197 | 184 |
| Floyd (part) | | | | | | | |
| Rural | 748 | 787 | 826 | 840 | 847 | 817 | 775 |
| Total | 748 | 787 | 826 | 840 | 847 | 817 | 775 |
| Hale (part) | | | | | | | |
| Rural | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Motley (all) | | | | | | | |
| Matador | 740 | 732 | 708 | 662 | 606 | 567 | 542 |
| Rural | 686 | 677 | 651 | 600 | 537 | 493 | 466 |
| Total | 1,426 | 1,409 | 1,359 | 1,262 | 1,143 | 1,060 | 1,008 |

Continued on next page

***Table 2-3 Continued***

| | Census | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| ***Basin-County-City*** | ***2000*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
| Parmer (part) | | | | | | | |
| Friona | 3,854 | 4,094 | 4,349 | 4,458 | 4,489 | 4,348 | 4,107 |
| Rural | 790 | 840 | 891 | 913 | 919 | 892 | 842 |
| Total | 4,644 | 4,934 | 5,240 | 5,371 | 5,408 | 5,240 | 4,949 |
| Swisher (part) | | | | | | | |
| Happy | 612 | 641 | 665 | 681 | 688 | 676 | 646 |
| Kress | 652 | 683 | 708 | 726 | 733 | 720 | 689 |
| Tulia | 5,117 | 5,358 | 5,560 | 5,698 | 5,755 | 5,650 | 5,405 |
| Rural | 1,524 | 1,595 | 1,656 | 1,697 | 1,715 | 1,682 | 1,609 |
| Total | 7,905 | 8,277 | 8,589 | 8,802 | 8,891 | 8,728 | 8,349 |
| **Red Basin Total** | **36,821** | **39,679** | **42,590** | **44,763** | **46,309** | **46,383** | **45,720** |
| **Brazos Basin (part)** | | | | | | | |
| Bailey (all) | | | | | | | |
| Muleshoe | 4,530 | 4,850 | 5,192 | 5,410 | 5,638 | 5,659 | 5,555 |
| Rural | 2,064 | 2,210 | 2,366 | 2,465 | 2,569 | 2,579 | 2,531 |
| Total | 6,594 | 7,060 | 7,558 | 7,875 | 8,207 | 8,238 | 8,086 |
| Castro (part) | | | | | | | |
| Dimmitt | 4,375 | 4,790 | 5,155 | 5,399 | 5,591 | 5,580 | 5,482 |
| Hart | 1,198 | 1,312 | 1,412 | 1,478 | 1,531 | 1,528 | 1,501 |
| Rural | 1,240 | 1,357 | 1,461 | 1,530 | 1,585 | 1,582 | 1,554 |
| Total | 6,813 | 7,459 | 8,028 | 8,407 | 8,707 | 8,690 | 8,537 |
| Cochran (part) | | | | | | | |
| Morton | 2,249 | 2,464 | 2,616 | 2,683 | 2,638 | 2,528 | 2,405 |
| Rural | 963 | 1,055 | 1,120 | 1,148 | 1,129 | 1,083 | 1,030 |
| Total | 3,212 | 3,519 | 3,736 | 3,831 | 3,767 | 3,611 | 3,435 |
| Crosby (part) | | | | | | | |
| Crosbyton | 1,874 | 2,035 | 2,166 | 2,256 | 2,347 | 2,351 | 2,314 |
| Lorenzo | 1,372 | 1,490 | 1,586 | 1,652 | 1,718 | 1,721 | 1,694 |
| Ralls | 2,252 | 2,445 | 2,603 | 2,711 | 2,820 | 2,826 | 2,780 |
| Rural | 1,568 | 1,702 | 1,812 | 1,888 | 1,964 | 1,967 | 1,936 |
| Total | 7,066 | 7,672 | 8,167 | 8,507 | 8,849 | 8,865 | 8,724 |
| Dawson (part) | | | | | | | |
| O'Donnell | 111 | 115 | 119 | 122 | 123 | 121 | 116 |
| Rural | 145 | 150 | 154 | 158 | 161 | 157 | 151 |
| Total | 256 | 265 | 273 | 280 | 284 | 278 | 267 |

Continued on next page

***Table 2-3 Continued***

| | Census | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| ***Basin-County-City*** | ***2000*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
| Dickens (part) | | | | | | | |
| Spur | 1,088 | 1,088 | 1,088 | 1,088 | 1,088 | 1,088 | 1,088 |
| Rural | 1,402 | 1,360 | 1,317 | 1,222 | 1,078 | 1,019 | 949 |
| Total | 2,490 | 2,448 | 2,405 | 2,310 | 2,166 | 2,107 | 2,037 |
| Floyd (part) | | | | | | | |
| Floydada | 3,676 | 3,866 | 4,059 | 4,126 | 4,159 | 4,017 | 3,809 |
| Lockney | 2,056 | 2,162 | 2,270 | 2,308 | 2,326 | 2,246 | 2,131 |
| Rural | 1,291 | 1,358 | 1,425 | 1,449 | 1,461 | 1,411 | 1,338 |
| Total | 7,023 | 7,386 | 7,754 | 7,883 | 7,946 | 7,674 | 7,278 |
| Garza (part) | | | | | | | |
| Post | 3,708 | 3,860 | 4,007 | 3,926 | 3,776 | 3,602 | 3,361 |
| Rural | 1,164 | 1,212 | 1,258 | 1,232 | 1,185 | 1,131 | 1,055 |
| Total | 4,872 | 5,072 | 5,265 | 5,158 | 4,961 | 4,733 | 4,416 |
| Hale (part) | | | | | | | |
| Abernathy (part) | 2,131 | 2,297 | 2,451 | 2,564 | 2,632 | 2,616 | 2,566 |
| Hale Center | 2,263 | 2,439 | 2,603 | 2,722 | 2,795 | 2,779 | 2,725 |
| Petersburg | 1,262 | 1,360 | 1,452 | 1,518 | 1,559 | 1,549 | 1,519 |
| Plainview | 22,336 | 24,078 | 25,693 | 26,871 | 27,585 | 27,424 | 26,893 |
| Rural | 8,610 | 9,282 | 9,904 | 10,359 | 10,633 | 10,572 | 10,366 |
| Total | 36,602 | 39,456 | 42,103 | 44,034 | 45,204 | 44,940 | 44,069 |
| Hockley (part) | | | | | | | |
| Anton | 1,200 | 1,291 | 1,347 | 1,380 | 1,381 | 1,327 | 1,262 |
| Levelland | 12,866 | 13,838 | 14,440 | 14,791 | 14,806 | 14,233 | 13,534 |
| Ropesville | 517 | 556 | 580 | 594 | 595 | 572 | 544 |
| Smyer | 480 | 516 | 539 | 552 | 553 | 532 | 506 |
| Rural | 5,860 | 6,302 | 6,577 | 6,736 | 6,743 | 6,481 | 6,164 |
| Total | 20,923 | 22,503 | 23,483 | 24,053 | 24,078 | 23,145 | 22,010 |
| Lamb (all) | | | | | | | |
| Amherst | 791 | 834 | 887 | 933 | 968 | 963 | 950 |
| Earth | 1,109 | 1,170 | 1,244 | 1,308 | 1,357 | 1,350 | 1,332 |
| Littlefield | 6,507 | 6,864 | 7,299 | 7,678 | 7,961 | 7,919 | 7,816 |
| Olton | 2,288 | 2,413 | 2,567 | 2,700 | 2,799 | 2,784 | 2,748 |
| Sudan | 1,039 | 1,096 | 1,166 | 1,226 | 1,271 | 1,264 | 1,248 |
| Rural | 2,975 | 3,138 | 3,337 | 3,510 | 3,639 | 3,620 | 3,574 |
| Total | 14,709 | 15,515 | 16,500 | 17,355 | 17,995 | 17,900 | 17,668 |

Continued on next page

***Table 2-3 Continued***

| | Census | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| **Basin-County-City** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Lubbock (all) | | | | | | | |
| Abernathy (part) | 708 | 808 | 878 | 916 | 922 | 949 | 928 |
| Idalou | 2,157 | 2,226 | 2,275 | 2,301 | 2,305 | 2,324 | 2,310 |
| Lubbock | 199,564 | 216,974 | 227,996 | 235,151 | 239,591 | 242,831 | 248,622 |
| New Deal | 708 | 863 | 972 | 1,031 | 1,041 | 1,083 | 1,051 |
| Ransom Canyon | 1,011 | 1,461 | 1,911 | 2,361 | 2,811 | 3,261 | 3,433 |
| Shallowater | 2,086 | 2,400 | 2,621 | 2,740 | 2,760 | 2,846 | 2,780 |
| Slaton | 6,109 | 6,135 | 6,153 | 6,163 | 6,165 | 6,172 | 6,167 |
| Wolfforth | 2,554 | 9,360 | 11,457 | 12,047 | 12,645 | 13,270 | 13,566 |
| Rural | 27,731 | 25,320 | 26,186 | 26,984 | 26,236 | 26,482 | 25,000 |
| Total | 242,628 | 265,547 | 280,449 | 289,694 | 294,476 | 299,218 | 303,857 |
| Lynn (part) | | | | | | | |
| O'Donnell | 900 | 958 | 1,000 | 995 | 992 | 947 | 881 |
| Tahoka | 2,910 | 3,096 | 3,234 | 3,218 | 3,206 | 3,061 | 2,849 |
| Wilson | 532 | 566 | 591 | 588 | 586 | 560 | 521 |
| Rural | 2,160 | 2,298 | 2,402 | 2,389 | 2,379 | 2,273 | 2,115 |
| Total | 6,502 | 6,918 | 7,227 | 7,190 | 7,163 | 6,841 | 6,366 |
| Parmer (part) | | | | | | | |
| Bovina | 1,874 | 1,991 | 2,115 | 2,168 | 2,183 | 2,114 | 1,997 |
| Farwell | 1,364 | 1,449 | 1,539 | 1,578 | 1,589 | 1,539 | 1,454 |
| Rural | 2,134 | 2,267 | 2,408 | 2,468 | 2,486 | 2,408 | 2,274 |
| Total | 5,372 | 5,707 | 6,062 | 6,214 | 6,258 | 6,061 | 5,725 |
| Swisher (part) | | | | | | | |
| Kress | 174 | 182 | 189 | 194 | 196 | 192 | 184 |
| Rural | 299 | 313 | 325 | 333 | 336 | 330 | 316 |
| Total | 473 | 495 | 514 | 527 | 532 | 522 | 500 |
| Terry (part) | | | | | | | |
| Rural | 93 | 101 | 107 | 114 | 122 | 122 | 121 |
| Total | 93 | 101 | 107 | 114 | 122 | 122 | 121 |
| **Brazos Basin Total** | **365,628** | **397,123** | **419,631** | **433,432** | **440,715** | **442,945** | **443,096** |
| **Colorado Basin (part)** | | | | | | | |
| Cochran (part) | | | | | | | |
| Rural | 518 | 567 | 602 | 618 | 608 | 582 | 554 |
| Total | 518 | 567 | 602 | 618 | 608 | 582 | 554 |
| Dawson (part) | | | | | | | |
| Lamesa | 9,952 | 10,309 | 10,633 | 10,906 | 11,068 | 10,804 | 10,395 |
| Rural | 4,777 | 4,949 | 5,104 | 5,235 | 5,313 | 5,186 | 4,990 |
| Total | 14,729 | 15,258 | 15,737 | 16,141 | 16,381 | 15,990 | 15,385 |

Continued on next page

***Table 2-3 Concluded***

| Basin-County-City | Census 2000 | Projections 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| Gaines (all) | | | | | | | |
| Seagraves | 2,334 | 2,602 | 2,850 | 3,029 | 3,156 | 3,135 | 3,093 |
| Seminole | 5,910 | 6,589 | 7,216 | 7,669 | 7,991 | 7,939 | 7,831 |
| Rural | 6,223 | 6,939 | 7,597 | 8,076 | 8,413 | 8,360 | 8,245 |
| Total | 14,467 | 16,130 | 17,663 | 18,774 | 19,560 | 19,434 | 19,169 |
| Garza (part) | | | | | | | |
| Rural | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hockley (part) | | | | | | | |
| Sundown | 1,505 | 1,619 | 1,689 | 1,730 | 1,732 | 1,665 | 1,583 |
| Rural | 288 | 310 | 323 | 331 | 331 | 319 | 303 |
| Total | 1,793 | 1,929 | 2,012 | 2,061 | 2,063 | 1,984 | 1,886 |
| Lynn (part) | | | | | | | |
| O'Donnell (part) | | | | | | | |
| Rural | 48 | 51 | 53 | 53 | 53 | 50 | 47 |
| Total | 48 | 51 | 53 | 53 | 53 | 50 | 47 |
| Terry (part) | | | | | | | |
| Brownfield | 9,488 | 10,263 | 10,988 | 11,676 | 12,348 | 12,417 | 12,348 |
| Meadow | 658 | 712 | 762 | 810 | 856 | 861 | 856 |
| Rural | 2,522 | 2,728 | 2,921 | 3,104 | 3,282 | 3,300 | 3,282 |
| Total | 12,668 | 13,703 | 14,671 | 15,590 | 16,486 | 16,578 | 16,486 |
| Yoakum (all) | | | | | | | |
| Denver City | 3,985 | 4,454 | 4,880 | 5,154 | 5,446 | 5,300 | 5,120 |
| Plains | 1,450 | 1,621 | 1,776 | 1,875 | 1,982 | 1,928 | 1,863 |
| Rural | 1,887 | 2,108 | 2,310 | 2,441 | 2,578 | 2,510 | 2,425 |
| Total | 7,322 | 8,183 | 8,966 | 9,470 | 10,006 | 9,738 | 9,408 |
| **Colorado Basin Total** | **51,545** | **55,821** | **59,704** | **62,707** | **65,157** | **64,356** | **62,935** |
| **Llano Estacado Region** | **453,997** | **492,627** | **521,930** | **540,908** | **552,188** | **553,691** | **551,758** |
| **River Basin Summary** | | | | | | | |
| Canadian | 3 | 4 | 5 | 6 | 7 | 7 | 7 |
| Red | 36,821 | 39,679 | 42,590 | 44,763 | 46,309 | 46,383 | 45,720 |
| Brazos | 365,628 | 397,123 | 419,631 | 433,432 | 440,715 | 442,945 | 443,096 |
| Colorado | 51,545 | 55,821 | 59,704 | 62,707 | 65,157 | 64,356 | 62,935 |
| **Llano Estacado Region** | **453,997** | **492,627** | **521,930** | **540,908** | **552,188** | **553,691** | **551,758** |

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

### *2.2 Municipal Water Demand Projections*

Municipal water is water for drinking, bathing, food preparation, dishwashing, laundry, toilet flushing, lawn watering and landscape irrigation, sanitation, restaurants, office buildings and institutions, fire protection, and cleaning and sanitation. The projected quantity of water needed for municipal purposes depends upon the number of people who reside in an area, population growth of the area, climatic conditions, and water conservation measures. For planning purposes, municipal water demand includes residential and commercial water uses. Commercial water use includes business establishments and public offices and institutions. Residential and commercial uses are categorized together because they are similar types of uses (i.e., they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering), and are served from the same water distribution systems.

In the Llano Estacado Region, per capita daily water use, the basic municipal water use planning statistic, is projected to decline over the planning period from 172 gpcd in 2000 to 158 gpcd in 2060 (Figure 2-2). However, with population growth, total municipal water demand is projected to increase at a compound annual rate of 0.32 percent per year between 2000 and 2060, from 87,322 acft/yr in 2000 to 105,939 acft/yr in 2060 (Table 2-4 and Figure 2-2.). The projected municipal water demand for individual counties of the region is shown in Table 2-4. Since Lubbock County has the largest population, it also has the largest projected water demand, with 53.1 percent of the regional total in 2000 and 58.4 percent in 2060 (Table 2-4).

**Table 2-4.**
**Municipal Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County Number | County | Total in 2000 (acft) | Projections 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| 1 | Bailey | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| 2 | Briscoe | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| 3 | Castro | 1,653 | 1,764 | 1,866 | 1,920 | 1,952 | 1,937 | 1,904 |
| 4 | Cochran | 763 | 816 | 853 | 860 | 831 | 792 | 753 |
| 5 | Crosby | 1,104 | 1,159 | 1,207 | 1,233 | 1,252 | 1,245 | 1,226 |
| 6 | Dawson | 3,126 | 3,185 | 3,220 | 3,254 | 3,245 | 3,151 | 3,031 |
| 7 | Deaf Smith | 4,136 | 4,378 | 4,627 | 4,852 | 5,032 | 5,088 | 5,119 |
| 8 | Dickens | 554 | 538 | 520 | 495 | 462 | 445 | 432 |
| 9 | Floyd | 1,181 | 1,211 | 1,232 | 1,222 | 1,203 | 1,153 | 1,093 |
| 10 | Gaines | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| 11 | Garza | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| 12 | Hale | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| 13 | Hockley | 3,800 | 3,953 | 4,040 | 4,050 | 3,966 | 3,784 | 3,599 |
| 14 | Lamb | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| 15 | Lubbock | 46,408 | 56,596 | 58,856 | 59,878 | 60,071 | 60,719 | 61,897 |
| 16 | Lynn | 973 | 1,009 | 1,026 | 995 | 967 | 916 | 852 |
| 17 | Motley | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| 18 | Parmer | 1,875 | 1,951 | 2,029 | 2,040 | 2,016 | 1,940 | 1,832 |
| 19 | Swisher | 1,476 | 1,515 | 1,532 | 1,540 | 1,525 | 1,488 | 1,423 |
| 20 | Terry | 3,038 | 3,210 | 3,387 | 3,547 | 3,696 | 3,697 | 3,676 |
| 21 | Yoakum | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| | Total | 87,322 | 99,435 | 103,472 | 105,474 | 106,040 | 105,856 | 105,939 |
| | Canadian | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Red | 7,548 | 7,875 | 8,177 | 8,378 | 8,474 | 8,417 | 8,301 |
| | Brazos | 68,459 | 79,564 | 82,673 | 84,037 | 84,194 | 84,293 | 84,773 |
| | Colorado | 11,315 | 11,995 | 12,621 | 13,058 | 13,371 | 13,145 | 12,864 |
| | Total | 87,322 | 99,435 | 103,472 | 105,474 | 106,040 | 105,856 | 105,939 |

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

**Figure 2-2. Projected Per Capita Water Use and Municipal Water Demand: Llano Estacado Region -- 2000 to 2060**

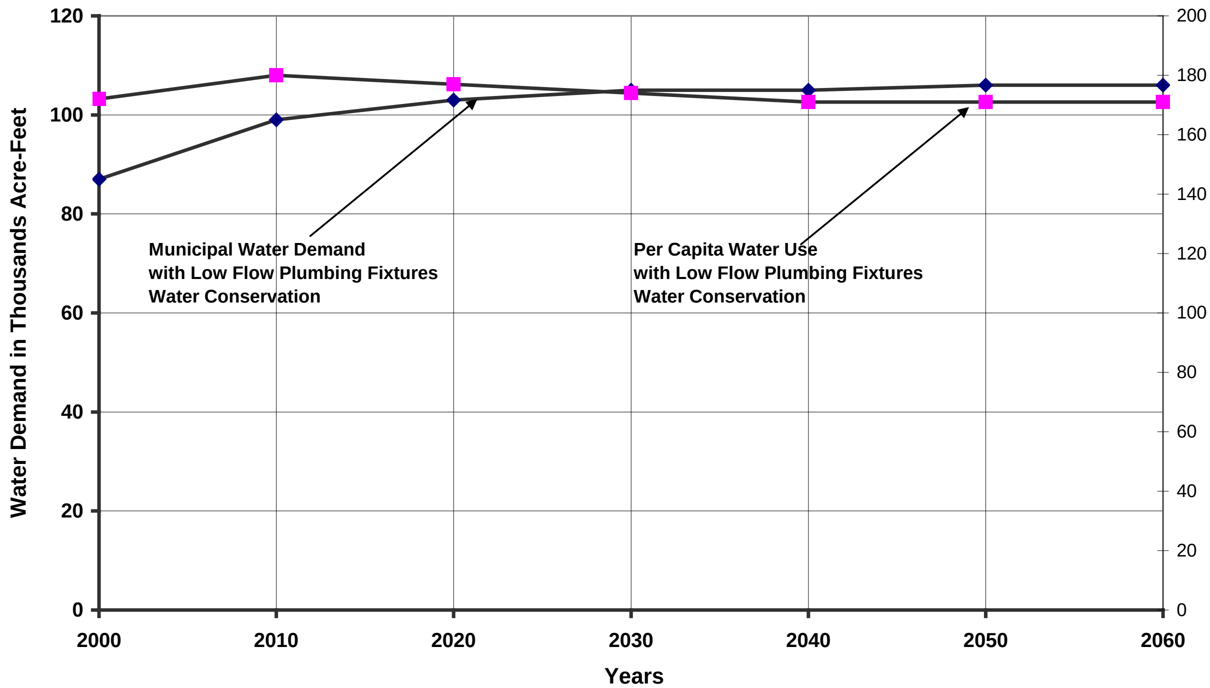


***Figure 2-2. Projected Per Capita Water Use and Municipal Water Demand: Llano Estacado Region – 2000 to 2060***

## *2.3 Manufacturing Water Demand Projections*

Manufactured products in Texas range from food and clothing to refined chemical and petroleum products, computers, and automobiles. Some processes incorporate water as part of the products being manufactured, while others use large volumes of water for cooling or cleaning purposes. Five manufacturing industries (chemical products, petroleum refining pulp and paper, food and kindred products, and primary metals) account for approximately 90 percent of water used by all manufacturing industries in Texas. The chemical and petroleum refining industries account for nearly 60 percent of the state's annual manufacturing water use.

The Llano Estacado Region's major water using manufacturing sectors are food processing, industrial machinery and equipment, and fabricated metals. These industries used 10,064 acft of water in 2000 and are projected to have a demand of 19,919 acft/yr in 2060 (Table 2-5 and Figure 2-3). As can be seen in Figure 2-3, manufacturing water demand is projected to increase at a steady rate throughout the planning period.

### *Table 2-5. Manufacturing Water Demand Projections Llano Estacado Region[1] Individual Counties with River Basin Summaries*

| County Number | County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| 1 | Bailey | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| 2 | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Castro | 1,732 | 2,035 | 2,203 | 2,341 | 2,473 | 2,587 | 2,769 |
| 4 | Cochran | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Crosby | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| 6 | Dawson | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| 7 | Deaf Smith | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| 8 | Dickens | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Floyd | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Gaines | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Garza | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 12 | Hale | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,440 |
| 13 | Hockley | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| 14 | Lamb | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| 15 | Lubbock | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| 16 | Lynn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Motley | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| 18 | Parmer | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| 19 | Swisher | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Terry | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 21 | Yoakum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | 10,064 | 15,698 | 16,669 | 17,460 | 18,216 | 18,865 | 19,919 |
| | Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 3,404 | 6,239 | 6,578 | 6,856 | 7,124 | 7,356 | 7,714 |
| | Brazos | 6,558 | 9,339 | 9,961 | 10,466 | 10,947 | 11,358 | 12,042 |
| | Colorado | 102 | 120 | 130 | 138 | 145 | 151 | 163 |
| | Total | 10,064 | 15,698 | 16,669 | 17,460 | 18,216 | 18,865 | 19,919 |

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003. With projections for new ethanol plants in Deaf Smith, Hockley and Hale Counties obtained from : "Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan Phase I Report: (1) Estimates of Population and Water Demands for New Ethanol Plants and Expanding Dairies; (2) Evaluation of Water Supplies and Desalination Costs of Dockum Aquifer Water; and (3) Video Conferencing Facilities Available for Coordination Between Regions A and O;" HPUWCD and TWDB, Austin, Texas, April 30, 2009.

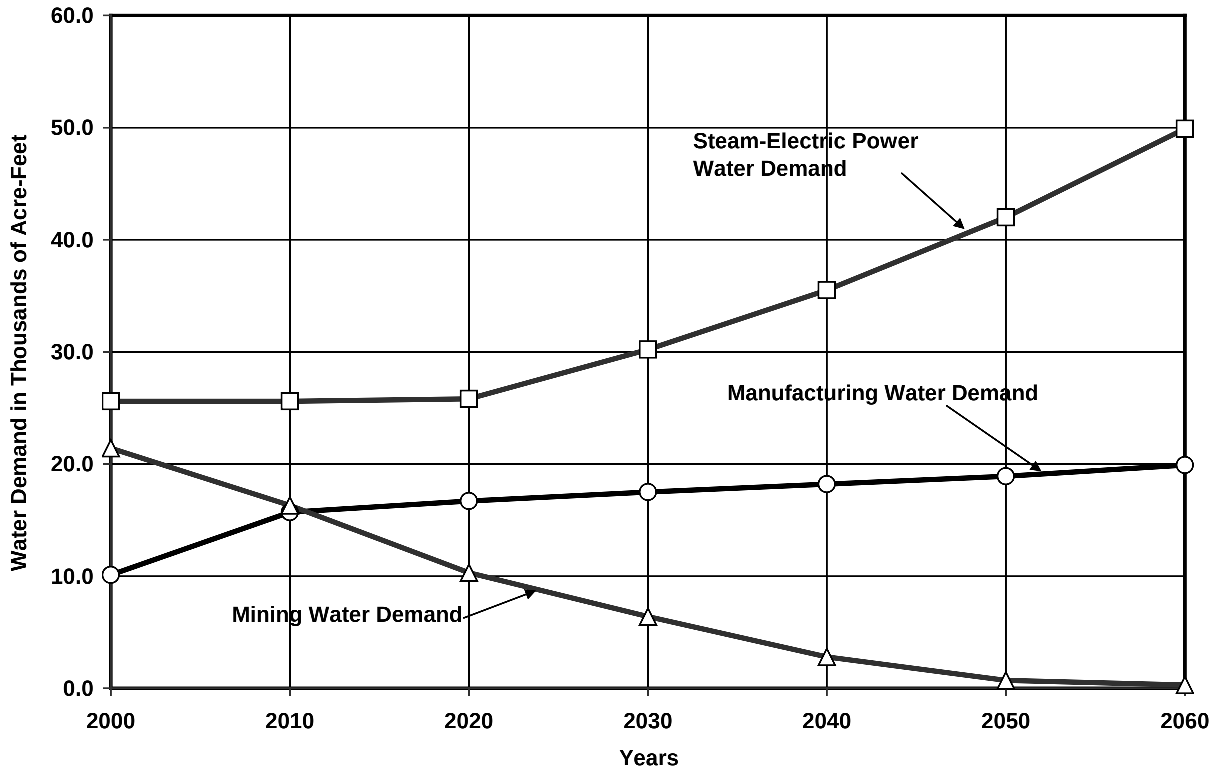


***Figure 2-3. Projections of Manufacturing, Steam-Electric, and Mining Water Demands: Llano Estacado Region – 2000 to 2060***

## *2.4 Steam-Electric Power Water Demand Projections*

Although Texas has the second highest population of states in the United States, it is the largest generator and consumer of electricity. Power production in Texas is concentrated in ten privately owned utilities, which account for 85 percent of production. Nine percent is both publicly and privately held, while only 6 percent are publicly owned. The industry has faced and will continue to face significant changes in the structure of power generation. These changes range from new generation technology to government regulations on the marketing of electricity. These changes will not only have an impact on how and where power will be generated, but also on how water will be used in the process.

Only three counties (Lamb, Lubbock, and Yoakum) of the Llano Estacado Region currently use water in steam-electric power production or are projected to use water in steam-electric power production. In 2000, 25,618 acft of water was used for steam-electric power generation; by the year 2060, it is estimated that 49,910 acft of water will be needed for the production of steam-electric power (Table 2-6 and Figure 2-3).

***Table 2-6.***
***Steam-Electric Water Demand Projections***
***Llano Estacado Region[1]***
***Individual Counties with River Basin Summaries***

| County Number | County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| 1 | Bailey | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Castro | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Cochran | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Crosby | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Dawson | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Deaf Smith | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Dickens | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Floyd | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Gaines | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Garza | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Hale | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Hockley | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Lamb | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| 15 | Lubbock | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| 16 | Lynn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Motley | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Parmer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Swisher | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Terry | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Yoakum | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
|  | Total | 25,618 | 25,645 | 25,821 | 30,188 | 35,511 | 42,000 | 49,910 |
|  | Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | Red | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|  | Brazos | 23,766 | 23,048 | 22,103 | 25,842 | 30,398 | 35,953 | 42,724 |
|  | Colorado | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
|  | Total | 25,618 | 25,645 | 25,821 | 30,188 | 35,511 | 42,000 | 49,910 |

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

### 2.5 Mining Water Demand Projections

Although the Texas mineral industry is foremost in the production of crude petroleum and natural gas in the United States, it also produces a wide variety of important non-fuel minerals. Texas is the only state to produce native asphalt and is the leading producer nationally of Frasch-mined sulfur. It is also one of the leading states in the production of clay, gypsum, lime, salt, stone, and aggregate. In the Llano Estacado Region, the principal uses of water for mining are for recovery of crude petroleum and for sand and gravel washing.

In the region, mining water use was 21,436 acft in 2000, and is projected to decline to 258 acft in 2060 (Table 2-7 and Figure 2-3). Mining water demand projections are based upon major water conservation activity by the mining water user group, as opposed to considering mining water conservation as a separate water management strategy, since water conservation measures are integral to regular operations. Overall, water use in this sector is expected to decline by 98 percent by 2060, due to water conservation by operators, including recycling and reuse of water produced from operating fields, and the fact that the presently used “water flood” technology will no longer be used, as many of the oil fields of the region will have reached their economic limit, suspended operations, and plugged the wells. The continuation of the industry in the region will hinge on yet to be developed technologies to recover the oil remaining in the reservoirs.

### 2.6 Irrigation Water Demand Projections

Irrigated agriculture accounts for almost 65 percent of the total water used in the state. Currently, approximately 10 million acft of water is used to grow a variety of crops ranging from food and feed grains to fruits, vegetables, and cotton. Of this 10 million acft, groundwater resources provide approximately 70 percent of the water used for irrigation purposes, with surface water supplies accounting for the remaining 30 percent. The TWDB irrigation water use data show annual use for irrigation in the Llano Estacado Region in 2000 of 4,347,877 acft/yr, or 37 percent of the total irrigation water use in Texas in 2000 (Table 2-8 and Figure 2-4). For dry-weather precipitation conditions, the TWDB’s projected irrigation water demands for the region in 2060 are 3,474,163 acft/yr, or 20 percent less than in 2000 (Table 2-8 and Figure 2-4). The projected declining trend in irrigation water demand in future years is based upon increased irrigation efficiency, economic factors, and government programs affecting the profitability of irrigated agriculture.

**Table 2-7.**
**Mining Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County Number | County | Total in 2000 (acft) | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| 1 | Bailey | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Castro | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Cochran | 1,720 | 1,462 | 1,032 | 860 | 645 | 430 | 258 |
| 5 | Crosby | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| 6 | Dawson | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| 7 | Deaf Smith | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Dickens | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| 9 | Floyd | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Gaines | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| 11 | Garza | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| 12 | Hale | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| 13 | Hockley | 4,416 | 3,154 | 2,019 | 1,312 | 505 | 25 | 0 |
| 14 | Lamb | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| 15 | Lubbock | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| 16 | Lynn | 81 | 48 | 23 | 13 | 6 | 0 | 0 |
| 17 | Motley | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| 18 | Parmer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Swisher | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Terry | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| 21 | Yoakum | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| | Total | 21,436 | 16,324 | 10,280 | 6,359 | 2,852 | 728 | 258 |
| | Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 85 | 50 | 24 | 14 | 6 | 0 | 0 |
| | Brazos | 5,630 | 3,681 | 2,141 | 1,351 | 530 | 23 | 2 |
| | Colorado | 15,721 | 12,593 | 8,115 | 4,994 | 2,316 | 705 | 256 |
| | Total | 21,436 | 16,324 | 10,280 | 6,359 | 2,852 | 728 | 258 |

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

### *Table 2-8.*
### *Irrigation Water Demand Projections*
### *Llano Estacado Region[1]*
### *Individual Counties with River Basin Summaries*

| County Number | County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| 1 | Bailey | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| 2 | Briscoe | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| 3 | Castro | 503,792 | 484,475 | 465,902 | 448,039 | 430,861 | 414,342 | 398,457 |
| 4 | Cochran | 119,985 | 115,352 | 110,903 | 106,623 | 102,506 | 98,549 | 94,744 |
| 5 | Crosby | 112,135 | 107,617 | 103,281 | 99,120 | 95,126 | 91,295 | 87,618 |
| 6 | Dawson | 146,039 | 137,803 | 130,036 | 122,705 | 115,786 | 109,260 | 103,102 |
| 7 | Deaf Smith | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| 8 | Dickens | 9,486 | 9,203 | 8,928 | 8,663 | 8,405 | 8,153 | 7,908 |
| 9 | Floyd | 237,020 | 227,579 | 218,516 | 209,812 | 201,454 | 193,431 | 185,727 |
| 10 | Gaines | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| 11 | Garza | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| 12 | Hale | 367,700 | 355,516 | 343,737 | 332,349 | 321,337 | 310,690 | 300,396 |
| 13 | Hockley | 174,996 | 168,151 | 161,578 | 155,261 | 149,188 | 143,354 | 137,749 |
| 14 | Lamb | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| 15 | Lubbock | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| 16 | Lynn | 120,372 | 113,895 | 107,766 | 101,972 | 96,482 | 91,295 | 86,387 |
| 17 | Motley | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| 18 | Parmer | 415,449 | 411,037 | 406,673 | 402,356 | 398,084 | 393,858 | 389,676 |
| 19 | Swisher | 171,706 | 170,725 | 163,566 | 168,780 | 167,816 | 166,857 | 165,903 |
| 20 | Terry | 203,141 | 192,725 | 182,844 | 173,471 | 164,577 | 156,139 | 148,133 |
| 21 | Yoakum | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| | Total | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |
| | Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 909,585 | 883,748 | 855,251 | 834,628 | 811,278 | 788,702 | 766,868 |
| | Brazos | 2,497,120 | 2,409,240 | 2,322,320 | 2,244,092 | 2,166,425 | 2,091,863 | 2,020,262 |
| | Colorado | 941,172 | 893,030 | 847,371 | 804,060 | 762,975 | 724,003 | 687,033 |
| | Total | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

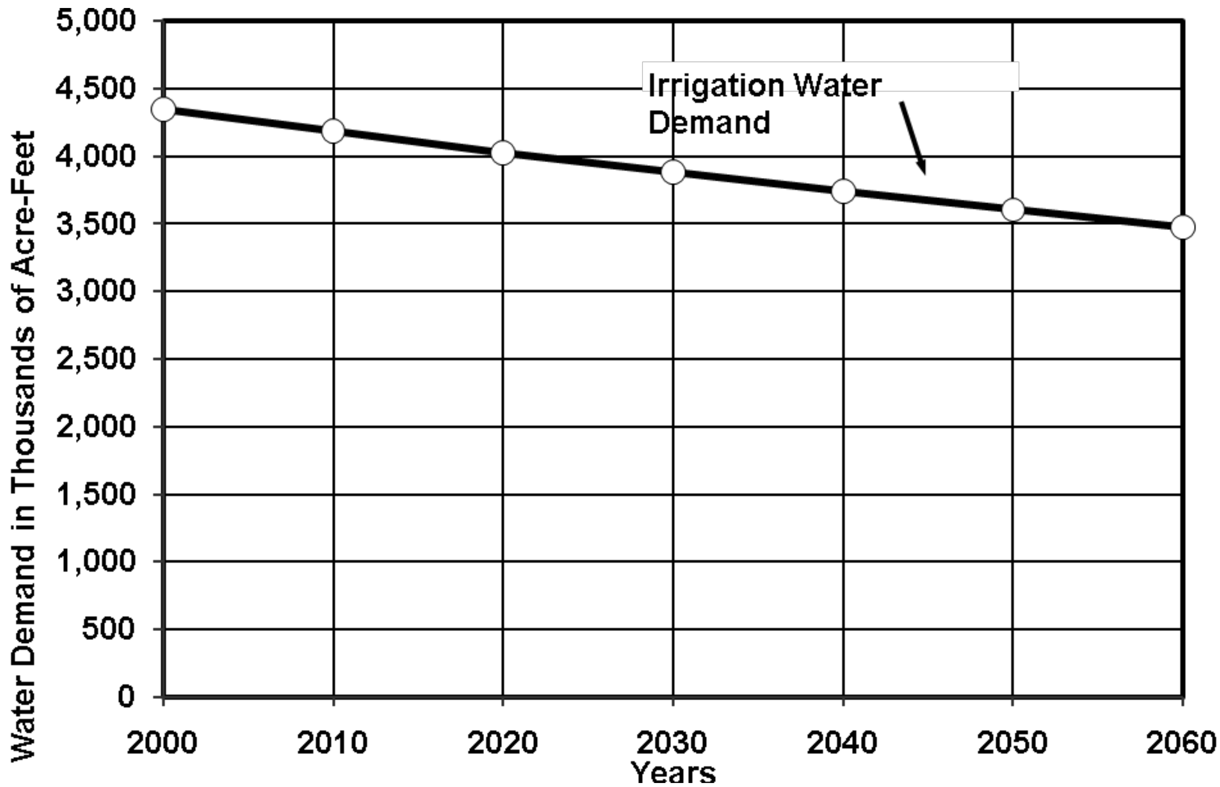


***Figure 2-4. Projections of Irrigation Water Demands: Llano Estacado Region – 2000 to 2060***

## *2.7 Livestock Water Demand Projections*

For the Llano Estacado Region, livestock water demand projections are presented separately for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry.[1] The projections for all types of livestock were based upon data obtained from the Texas Cattle Feeders Association and the Texas A&M University and Research Center. In 2000, water use in the Llano Estacado Region for beef cattle feedlot purposes was estimated at 26,215 acft/yr, with projections of beef cattle feedlot water demands in 2060 of 45,512 acft/yr (Table 2-9 and Figure 2-5).

Swine feedlot water use in the region in 2000 was estimated at 58.8 acft/yr with projected demands at this level throughout the planning period to 2060 (Table 2-10).

### *Table 2-9.*
### *Beef Cattle Feedlots Water Demand Projections*
### *Llano Estacado Region[1]*
### *Individual Counties with River Basin Summaries*

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Briscoe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Castro | 5,370 | 6,546 | 7,339 | 7,791 | 8,272 | 8,782 | 9,323 |
| Cochran | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Crosby | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dawson | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deaf Smith | 7,041 | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| Dickens | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floyd | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Gaines | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Garza | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hale | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| Hockley | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Lamb | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| Lubbock | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Lynn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Motley | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parmer | 4,863 | 5,928 | 6,646 | 7,056 | 7,491 | 7,953 | 8,443 |
| Swisher | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Terry | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yoakum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 26,215 | 31,955 | 35,826 | 38,035 | 40,380 | 42,869 | 45,512 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | 14,811 | 18,054 | 20,242 | 21,491 | 22,815 | 24,222 | 25,715 |
| Brazos | 10,861 | 13,239 | 14,843 | 15,756 | 16,729 | 17,760 | 18,855 |
| Colorado | 543 | 662 | 741 | 787 | 836 | 887 | 942 |
| Total | 26,215 | 31,955 | 35,826 | 38,035 | 40,380 | 42,869 | 45,512 |
| **Numbers*** | 1,560,175 | 1,901,845 | 2,132,229 | 2,263,673 | 2,403,220 | 2,551,369 | 2,708,652 |

1. [2]Water Demand calculated at 15 gallons per head per day.
* Numbers (Head) of Beef Cattle.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

[1] The TWDB presented livestock water demand for all types of livestock grouped together. For purposes of this report, beef cattle feedlot, swine feedlot, dairy, horse, range beef cows/bulls, range beef stocker cattle, sheep, goats, and poultry livestock water demands are shown separately (Tables 2-9 through 2-16).

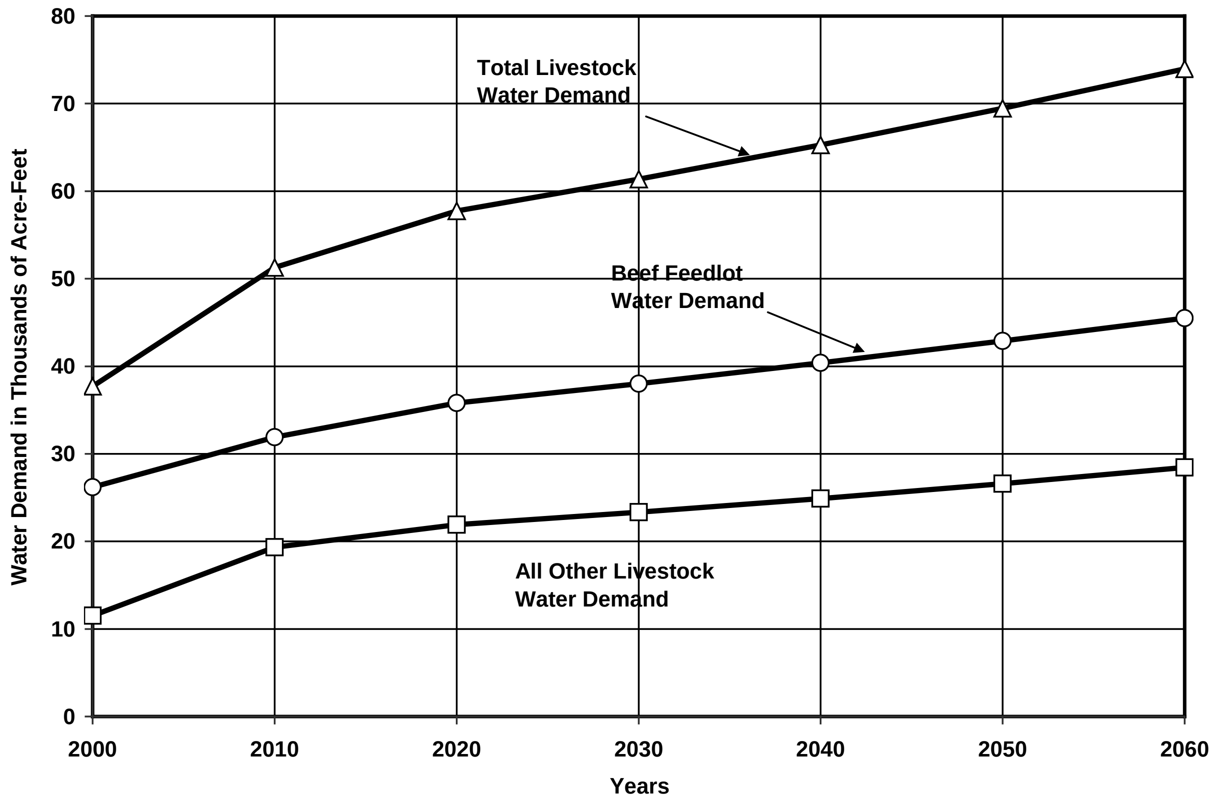


***Figure 2-5. Projections of Beef Feedlot and All Other Livestock Water Demands: Llano Estacado Region – 2000 to 2060***

**Table 2-10.**
**Swine Feedlots Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Briscoe | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Castro | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Cochran | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Crosby | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Dawson | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Deaf Smith | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Dickens | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Floyd | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Gaines | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Garza | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Hale | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Hockley | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Lamb | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Lubbock | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Lynn | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Motley | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Parmer | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Swisher | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Terry | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Yoakum | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Total | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Red | 33.2 | 33.2 | 33.2 | 33.2 | 33.2 | 33.2 | 33.2 |
| Brazos | 24.4 | 24.4 | 24.4 | 24.4 | 24.4 | 24.4 | 24.4 |
| Colorado | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Total | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 | 58.8 |
| **Numbers *** | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 | 10,500 |

1. Water Demand calculated at 5 gallons per head per day.
* Numbers (Head) of Swine.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

In 2000, water use in the Llano Estacado Region for dairies was estimated at 1,183.2 acft/yr, with projections of dairy water demands increasing to 10,663 acft/yr in 2020, and increasing to 15,619 in 2060, a 13.2 fold increase during the planning period (Table 2-11). Only six counties (Bailey, Castro, Deaf Smith, Lamb, Parmer, and Swisher) in the Llano Estacado Region have one or more dairies located within them (Table 2-11).

Horse water use in the region in 2000 was estimated at 227.9 acft/yr with projected demands of 414 acft/yr in 2060, an increase of 81 percent of the estimated 2000 use (Table 2-12).

In 2000, water use in the Llano Estacado Region for range beef cows and bulls was estimated at 4,032.6 acft/yr (Table 2-13). The water use for this type of livestock is projected to remain constant at 4,032.6 acft/yr throughout the planning period (Table 2-13).

Range beef stocker cattle water use in the region in 2000 was estimated at 5,937 acft/yr with projected demands of 8,008.2 acft/yr in 2060; a 34 percent increase over the estimated 2000 use (Table 2-14).

In 2000, sheep and goat water use in the Llano Estacado Region was estimated at 69.5 acft/yr (Table 2-15). Water use for this type of livestock is projected to remain at this level to 2060 (Table 2-15).

Poultry water use in the region in 2000 was estimated at 0 acft/yr, but is projected to be 252 acft/yr in 2020, and remain constant at 252 acft/yr throughout the planning period (Table 2-16). All commercial poultry water demand occurs in Castro, Cochran, Garza, Hockley, and Yoakum Counties.

Total livestock water demand projections for the Llano Estacado Region are the sum of water demand projections for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry (Tables 2-9 through 2-16) and are shown in Table 2-17. Total livestock water use in 2000 was estimated to be 37,724 acft/yr (Table 2-17), with projected total livestock water demand for the region of 73,965 acft/yr in 2060 (Table 2-17).

Projections of total livestock water demand for all livestock other than beef feedlot livestock are shown in Table 2-18 and Figure 2-5. Livestock water demand for all livestock other than beef feedlot livestock was estimated at 11,509 acft/yr in 2000 (Table 2-18 and Figure 2-5). Projected water demand for all types of livestock other than beef cattle feedlot for the region is 28,455 acft/yr in 2060 (Table 2-18 and Figure 2-5).

**Table 2-11.**
**Dairy Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Briscoe | 32 | 33 | 33 | 33 | 33 | 33 | 33 |
| Castro | 146 | 1,476 | 1,919 | 2,120 | 2,342 | 2,587 | 2,858 |
| Cochran | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Crosby | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dawson | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Deaf Smith | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Dickens | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floyd | 33 | 104 | 175 | 175 | 175 | 175 | 175 |
| Gaines | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Garza | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hale | 29 | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| Hockley | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lamb | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| Lubbock | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Lynn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Motley | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Parmer | 29 | 1,667 | 2,043 | 2,257 | 2,493 | 2,754 | 3,042 |
| Swisher | 33 | 108 | 184 | 184 | 184 | 184 | 184 |
| Terry | 0 | 113 | 150 | 165 | 183 | 202 | 223 |
| Yoakum | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1,183 | 8,686 | 10,663 | 11,723 | 12,895 | 14,189 | 15,619 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | 254 | 3,319 | 4,057 | 4,458 | 4,902 | 5,392 | 5,934 |
| Brazos | 866 | 5,254 | 6,456 | 7,100 | 7,810 | 8,595 | 9,462 |
| Colorado | 63 | 113 | 150 | 165 | 183 | 202 | 223 |
| Total | 1,183 | 8,686 | 10,663 | 11,723 | 12,895 | 14,189 | 15,619 |
| **Numbers*** | 16,250 | 155,750 | 188,544 | 208,270 | 230,059 | 254,129 | 280,714 |

1. Water Demand calculated at 48 gallons per head per day.
* Numbers (Head) of Dairy Cattle.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.

Source: "Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan Phase I Report: (1) Estimates of Population and Water Demands for New Ethanol Plants and Expanding Dairies; (2) Evaluation of Water Supplies and Desalination Costs of Dockum Aquifer Water; and (3) Video Conferencing Facilities Available for Coordination Between Regions A and O;" HPUWCD and TWDB, Austin, Texas, April 30, 2009.

**Table 2-12.**
**Horse Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 8.0 | 8.8 | 9.7 | 10.7 | 11.9 | 13.1 | 14.5 |
| Briscoe | 12.6 | 13.9 | 15.4 | 17.0 | 18.8 | 20.7 | 22.9 |
| Castro | 7.3 | 8.0 | 8.9 | 9.8 | 10.8 | 12.0 | 13.2 |
| Cochran | 3.6 | 4.0 | 4.4 | 4.9 | 5.4 | 5.9 | 6.5 |
| Crosby | 4.9 | 5.4 | 5.9 | 6.6 | 7.2 | 8.0 | 8.8 |
| Dawson | 4.9 | 5.4 | 6.0 | 6.6 | 7.3 | 8.1 | 9.0 |
| Deaf Smith | 20.0 | 22.1 | 24.4 | 27.0 | 29.8 | 32.9 | 36.3 |
| Dickens | 21.0 | 23.2 | 25.6 | 28.3 | 31.2 | 34.5 | 38.1 |
| Floyd | 4.4 | 4.8 | 5.3 | 5.9 | 6.5 | 7.2 | 7.9 |
| Gaines | 8.6 | 9.5 | 10.5 | 11.6 | 12.8 | 14.2 | 15.7 |
| Garza | 15.3 | 16.9 | 18.7 | 20.7 | 22.8 | 25.2 | 27.9 |
| Hale | 11.8 | 13.0 | 14.4 | 15.9 | 17.6 | 19.4 | 21.4 |
| Hockley | 10.1 | 11.1 | 12.3 | 13.6 | 15.0 | 16.6 | 18.3 |
| Lamb | 7.0 | 7.7 | 8.5 | 9.4 | 10.4 | 11.5 | 12.7 |
| Lubbock | 33.7 | 37.2 | 41.1 | 45.4 | 50.1 | 55.4 | 61.1 |
| Lynn | 6.2 | 6.8 | 7.6 | 8.4 | 9.2 | 10.2 | 11.3 |
| Motley | 8.0 | 8.9 | 9.8 | 10.8 | 12.0 | 13.2 | 14.6 |
| Parmer | 19.3 | 21.3 | 23.5 | 26.0 | 28.7 | 31.7 | 35.0 |
| Swisher | 13.5 | 15.0 | 16.5 | 18.2 | 20.2 | 22.3 | 24.6 |
| Terry | 3.3 | 3.7 | 4.1 | 4.5 | 5.0 | 5.5 | 6.1 |
| Yoakum | 4.4 | 4.9 | 5.4 | 6.0 | 6.6 | 7.3 | 8.1 |
| Total | 227.9 | 251.7 | 278.1 | 307.1 | 339.3 | 374.8 | 414.0 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 1.7 | 1.8 | 1.7 | 1.7 | 1.7 | 1.8 | 1.9 |
| Red | 46.9 | 50.0 | 60.3 | 66.2 | 77.5 | 85.8 | 94.8 |
| Brazos | 90.5 | 96.4 | 110.6 | 125.6 | 137.8 | 154.1 | 170.2 |
| Colorado | 88.8 | 103.5 | 105.5 | 113.7 | 122.3 | 133.1 | 147.0 |
| Total | 227.9 | 251.7 | 278.1 | 307.1 | 339.3 | 374.8 | 414.0 |
| **Numbers *** | 16,953 | 18,727 | 20,686 | 22,850 | 25,241 | 27,882 | 30,799 |

1. Water Demand calculated at 12 gallons per head per day.
* Numbers (Head) of Horses.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

**Table 2-13.**
**Range Beef Cows/Bulls Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 |
| Briscoe | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 |
| Castro | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 |
| Cochran | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 |
| Crosby | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 |
| Dawson | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 | 89.6 |
| Deaf Smith | 492.9 | 492.9 | 492.9 | 492.9 | 492.9 | 492.9 | 492.9 |
| Dickens | 380.9 | 380.9 | 380.9 | 380.9 | 380.9 | 380.9 | 380.9 |
| Floyd | 224.0 | 224.0 | 224.0 | 224.0 | 224.0 | 224.0 | 224.0 |
| Gaines | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 |
| Garza | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 | 201.6 |
| Hale | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 | 179.2 |
| Hockley | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 |
| Lamb | 112.0 | 112.0 | 112.0 | 112.0 | 112.0 | 112.0 | 112.0 |
| Lubbock | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 |
| Lynn | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 |
| Motley | 425.7 | 425.7 | 425.7 | 425.7 | 425.7 | 425.7 | 425.7 |
| Parmer | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 | 156.8 |
| Swisher | 336.0 | 336.0 | 336.0 | 336.0 | 336.0 | 336.0 | 336.0 |
| Terry | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 | 67.2 |
| Yoakum | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 | 134.4 |
| Total | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 |
| Red | 1,296.3 | 1,296.3 | 1,296.3 | 1,296.3 | 1,296.3 | 1,296.3 | 1,296.3 |
| Brazos | 2,129.8 | 2,129.8 | 2,129.8 | 2,129.8 | 2,129.8 | 2,129.8 | 2,129.8 |
| Colorado | 572.1 | 572.1 | 572.1 | 572.1 | 572.1 | 572.1 | 572.1 |
| Total | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 | 4,032.6 |
| **Numbers *** | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 |

1. Water Demand calculated at 20 gallons per head per day.
* Numbers (Head) of Range Beef Cows/Bulls.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

**Table 2-14.**
**Range Beef Stocker Cattle Water Demand Projections**
**Llano Estacado Region[1]**
**Individual Counties with River Basin Summaries**

| County | Total in 2000 (acft) | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| Bailey | 405.0 | 425.8 | 447.5 | 470.4 | 494.5 | 519.8 | 546.3 |
| Briscoe | 134.4 | 141.3 | 148.5 | 156.1 | 164.1 | 172.5 | 181.3 |
| Castro | 80.7 | 84.8 | 89.1 | 93.7 | 98.5 | 103.5 | 108.8 |
| Cochran | 35.8 | 37.7 | 39.6 | 41.6 | 43.8 | 46.0 | 48.3 |
| Crosby | 107.5 | 113.0 | 118.8 | 124.9 | 131.3 | 138.0 | 145.0 |
| Dawson | 53.8 | 56.5 | 59.4 | 62.4 | 65.6 | 69.0 | 72.5 |
| Deaf Smith | 2,562.5 | 2,693.5 | 2,831.3 | 2,976.0 | 3,128.2 | 3,288.2 | 3,456.4 |
| Dickens | 215.1 | 226.1 | 237.6 | 249.8 | 262.6 | 276.0 | 290.1 |
| Floyd | 217.8 | 228.9 | 240.6 | 252.9 | 265.8 | 279.4 | 293.7 |
| Gaines | 127.7 | 134.2 | 141.1 | 148.3 | 155.9 | 163.9 | 172.2 |
| Garza | 134.4 | 141.3 | 148.5 | 156.1 | 164.1 | 172.5 | 181.3 |
| Hale | 129.5 | 136.1 | 143.1 | 150.4 | 158.1 | 166.2 | 174.7 |
| Hockley | 95.0 | 99.8 | 105.0 | 110.3 | 116.0 | 121.9 | 128.1 |
| Lamb | 349.0 | 366.9 | 385.7 | 405.4 | 426.1 | 447.9 | 470.8 |
| Lubbock | 62.7 | 65.9 | 69.3 | 72.9 | 76.6 | 80.5 | 84.6 |
| Lynn | 62.7 | 65.9 | 69.3 | 72.9 | 76.6 | 80.5 | 84.6 |
| Motley | 188.2 | 197.8 | 207.9 | 218.6 | 229.7 | 241.5 | 253.8 |
| Parmer | 623.5 | 655.4 | 688.9 | 724.1 | 761.1 | 800.1 | 841.0 |
| Swisher | 235.2 | 247.3 | 259.9 | 273.2 | 287.2 | 301.9 | 317.3 |
| Terry | 44.8 | 47.1 | 49.5 | 52.0 | 54.7 | 57.5 | 60.4 |
| Yoakum | 71.7 | 75.4 | 79.2 | 83.3 | 87.5 | 92.0 | 96.7 |
| Total | 5,937.0 | 6,240.7 | 6,559.8 | 6,895.3 | 7,247.9 | 7,618.6 | 8,008.2 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 37.7 | 38.8 | 41.1 | 43.1 | 45.4 | 47.4 | 49.8 |
| Red | 2,636.9 | 2,777.0 | 2,913.2 | 3,063.2 | 3,221.9 | 3,385.4 | 3,558.5 |
| Brazos | 2,811.6 | 2,951.9 | 3,105.4 | 3,262.7 | 3,426.2 | 3,601.4 | 3,785.5 |
| Colorado | 450.9 | 473.0 | 500.0 | 526.2 | 554.3 | 584.4 | 614.3 |
| Total | 5,937.0 | 6,240.7 | 6,559.8 | 6,895.3 | 7,247.9 | 7,618.6 | 8,008.2 |
| **Numbers *** | 662,525 | 696,407 | 732,021 | 769,457 | 808,807 | 850,169 | 893,647 |

1. Water Demand calculated at 8 gallons per head per day.
* Numbers (Head) of Range Beef Stocker Cattle.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

### *Table 2-15.*
### *Sheep and Goats Water Demand Projections*
### *Llano Estacado Region[1]*
### *Individual Counties with River Basin Summaries*

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 | 13.7 |
| Briscoe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Castro | 37.6 | 37.6 | 37.6 | 37.6 | 37.6 | 37.6 | 37.6 |
| Cochran | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Crosby | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Dawson | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Deaf Smith | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| Dickens | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Floyd | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 |
| Gaines | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Garza | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Hale | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| Hockley | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Lamb | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Lubbock | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| Lynn | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Motley | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Parmer | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Swisher | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Terry | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Yoakum | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Total | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Red | 11.9 | 12.9 | 12.4 | 12.4 | 11.8 | 11.9 | 11.9 |
| Brazos | 47.4 | 46.9 | 47.9 | 48.3 | 48.6 | 49.0 | 49.0 |
| Colorado | 10.2 | 9.7 | 9.3 | 8.8 | 9.0 | 8.6 | 8.6 |
| Total | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 |
| **Numbers *** | 49,050 | 49,050 | 49,050 | 49,050 | 49,050 | 49,050 | 49,050 |

1. Water Demand calculated at 1.33 gallons per head per day.
* Numbers (Head) of Sheep and Goats.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

***Table 2-16.***
***Poultry Water Demand Projections***
***Llano Estacado Region[1]***
***Individual Counties with River Basin Summaries***

| County | Total in 2000 (acft) | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| Bailey | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Briscoe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Castro | 0.0 | 0.0 | 50.4 | 50.4 | 50.4 | 50.4 | 50.4 |
| Cochran | 0.0 | 0.0 | 50.4 | 50.4 | 50.4 | 50.4 | 50.4 |
| Crosby | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dawson | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Deaf Smith | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dickens | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Floyd | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gaines | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Garza | 0.0 | 0.0 | 50.4 | 50.4 | 50.4 | 50.4 | 50.4 |
| Hale | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Hockley | 0.0 | 0.0 | 50.4 | 50.4 | 50.4 | 50.4 | 50.4 |
| Lamb | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lubbock | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Lynn | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Motley | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Parmer | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Swisher | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Terry | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Yoakum | 0.0 | 0.0 | 50.4 | 50.4 | 50.4 | 50.4 | 50.4 |
| Total | 0.0 | 0.0 | 252.0 | 252.0 | 252.0 | 252.0 | 252.0 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Red | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Brazos | 0.0 | 0.0 | 252.0 | 252.0 | 252.0 | 252.0 | 252.0 |
| Colorado | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 0.0 | 0.0 | 252.0 | 252.0 | 252.0 | 252.0 | 252.0 |
| **Numbers *** | 0 | 0 | 2,500,000 | 2,500,000 | 2,500,000 | 2,500,000 | 2,500,000 |

1. Water Demand calculated at 0.09 gallons per head per day.
* Numbers (Head) of Poultry.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.
Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

### Table 2-17.
### Total Livestock Water Demand Projections
### Llano Estacado Region[1]
### Individual Counties with River Basin Summaries

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 1,723 | 3,053 | 3,618 | 3,904 | 4,216 | 4,555 | 4,924 |
| Briscoe | 317 | 325 | 334 | 343 | 353 | 363 | 374 |
| Castro | 5,846 | 8,357 | 9,649 | 10,308 | 11,016 | 11,777 | 12,595 |
| Cochran | 647 | 828 | 1,024 | 1,070 | 1,119 | 1,170 | 1,225 |
| Crosby | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| Dawson | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| Deaf Smith | 10,156 | 13,354 | 14,803 | 15,735 | 16,731 | 17,796 | 18,935 |
| Dickens | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| Floyd | 1,371 | 1,647 | 1,861 | 1,949 | 2,042 | 2,140 | 2,244 |
| Gaines | 796 | 913 | 995 | 1,045 | 1,099 | 1,156 | 1,216 |
| Garza | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Hale | 1,540 | 2,633 | 2,921 | 3,130 | 3,356 | 3,601 | 3,867 |
| Hockley | 608 | 689 | 796 | 832 | 870 | 910 | 952 |
| Lamb | 2,412 | 3,400 | 3,723 | 4,002 | 4,304 | 4,632 | 4,987 |
| Lubbock | 972 | 1,222 | 1,361 | 1,440 | 1,526 | 1,617 | 1,715 |
| Lynn | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| Motley | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Parmer | 5,695 | 8,432 | 9,562 | 10,223 | 10,934 | 11,698 | 12,521 |
| Swisher | 3,121 | 3,757 | 4,216 | 4,442 | 4,681 | 4,935 | 5,205 |
| Terry | 119 | 234 | 274 | 293 | 313 | 336 | 360 |
| Yoakum | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total | 37,724 | 51,295 | 57,740 | 61,374 | 65,275 | 69,464 | 73,965 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 73 | 88 | 99 | 100 | 102 | 103 | 108 |
| Red | 20,143 | 26,264 | 29,320 | 31,127 | 33,059 | 35,124 | 37,332 |
| Brazos | 16,090 | 23,286 | 26,444 | 28,188 | 30,076 | 32,106 | 34,290 |
| Colorado | 1,417 | 1,656 | 1,877 | 1,959 | 2,038 | 2,132 | 2,235 |
| Total | 37,724 | 51,295 | 57,740 | 61,374 | 65,275 | 69,464 | 73,965 |

1. Total Livestock Water Demand is the sum of demands of Tables 2-9 through 2-16.
** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.

**Table 2-18.**
***All Livestock Other than Beef Feedlot Livestock Water Demand Projections***
***Llano Estacado* Region[1]**
***Individual Counties with River Basin Summaries***

| County | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Bailey | 752 | 1,869 | 2,290 | 2,495 | 2,720 | 2,967 | 3,238 |
| Briscoe | 317 | 325 | 334 | 343 | 353 | 363 | 374 |
| Castro | 476 | 1,811 | 2,310 | 2,516 | 2,744 | 2,995 | 3,272 |
| Cochran | 133 | 202 | 321 | 324 | 327 | 329 | 332 |
| Crosby | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| Dawson | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| Deaf Smith | 3,115 | 4,771 | 5,180 | 5,519 | 5,885 | 6,282 | 6,711 |
| Dickens | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| Floyd | 485 | 568 | 651 | 664 | 678 | 692 | 707 |
| Gaines | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Garza | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Hale | 354 | 1,188 | 1,301 | 1,410 | 1,530 | 1,663 | 1,809 |
| Hockley | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| Lamb | 1,084 | 1,781 | 1,908 | 2,075 | 2,258 | 2,460 | 2,681 |
| Lubbock | 258 | 351 | 385 | 404 | 426 | 449 | 475 |
| Lynn | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| Motley | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Parmer | 832 | 2,504 | 2,916 | 3,167 | 3,443 | 3,746 | 4,078 |
| Swisher | 622 | 711 | 800 | 815 | 831 | 848 | 866 |
| Terry | 119 | 234 | 274 | 293 | 313 | 336 | 360 |
| Yoakum | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total | 11,509 | 19,339 | 21,914 | 23,339 | 24,895 | 26,595 | 28,455 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 73 | 88 | 99 | 100 | 102 | 103 | 108 |
| Red | 5,409 | 8,305 | 9,183 | 9,751 | 10,366 | 11,035 | 11,756 |
| Brazos | 5,107 | 9,898 | 11,434 | 12,252 | 13,159 | 14,145 | 15,223 |
| Colorado | 917 | 1,047 | 1,194 | 1,234 | 1,268 | 1,315 | 1,367 |
| Total | 11,509 | 19,339 | 21,914 | 23,339 | 24,895 | 26,595 | 28,455 |

Source: For livestock other than dairies; Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003. For dairies; : "Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan Phase I Report: (1) Estimates of Population and Water Demands for New Ethanol Plants and Expanding Dairies; (2) Evaluation of Water Supplies and Desalination Costs of Dockum Aquifer Water; and (3) Video Conferencing Facilities Available for Coordination Between Regions A and O;" HPUWCD and TWDB, Austin, Texas, April 30, 2009.

** See Table 2-21 for River Basin Tabulations of Counties, Cities, and Rural Areas.

### *2.8 Total Water Demand Projections*

Total water demand projections for the Llano Estacado Region are the sum of water demand projections for municipal, industrial, steam-electric power generation, mining, irrigation, and total livestock water demand projections (Tables 2-4 through 2-8, and 2-17), and are shown in Table 2-19 and Figure 2-6. Total water use in 2000 was estimated at 4,530,040 acft/yr (Table 2-19). Projected total water demand for the region is 4,103,635 acft/yr in 2030 and 3,724,154 acft/yr in 2060 (Table 2-19 and Figure 2-6). Projections of future water demands for municipal, industrial, steam-electric power, and livestock increase, while projections for irrigation and mining purposes decrease. The reasons for the decline in the projections of demand in future years for irrigation are predictions of increased efficiency in irrigation, economic factors adversely affecting the profitability of irrigation in future years, and expectation of decreased government programs supporting agricultural incomes, and supplies of water available for irrigation are projected to decrease. Projections for mining water demand decrease due to the expectation that secondary recovery of crude petroleum using water flooding will decrease in future years as this method is phased out or is no longer a viable technology for the industry in the Llano Estacado Region.

Projections of future water demands for the Llano Estacado Region show irrigation demand at 95.98 percent of total demand in 2000 and 93.29 percent in 2060 (Table 2-20). Municipal demand, as a percent of total demand, increases from 1.93 percent in 2000 to 2.84 percent in 2060 (Table 2-20), with beef cattle feedlot livestock demand as a percent of total demand increasing from 0.58 percent in 2000 to 1.22 percent in 2060 (Table 2-20).

***Table 2-19.***
***Total Water Demand Projections***
***Llano Estacado Region[1]***
***Individual Counties with River Basin Summaries***

| County | Total in 2000 (acft) | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| Bailey | 186,162 | 183,203 | 179,571 | 175,721 | 171,998 | 168,361 | 164,837 |
| Briscoe | 26,952 | 26,009 | 25,098 | 24,208 | 23,343 | 22,519 | 21,728 |
| Castro | 513,023 | 496,631 | 479,620 | 462,608 | 446,302 | 430,643 | 415,725 |
| Cochran | 123,115 | 118,458 | 113,812 | 109,413 | 105,101 | 100,941 | 96,980 |
| Crosby | 113,728 | 109,195 | 104,855 | 100,704 | 96,718 | 92,875 | 89,186 |
| Dawson | 152,146 | 142,886 | 134,322 | 126,713 | 119,536 | 112,731 | 106,469 |
| Deaf Smith | 388,353 | 382,441 | 372,844 | 363,041 | 353,604 | 344,437 | 335,690 |
| Dickens | 10,825 | 10,473 | 10,143 | 9,847 | 9,557 | 9,293 | 9,052 |
| Floyd | 239,572 | 230,437 | 221,609 | 212,983 | 204,699 | 196,724 | 189,064 |
| Gaines | 424,778 | 403,246 | 381,382 | 360,671 | 341,024 | 322,724 | 305,980 |
| Garza | 14,563 | 13,355 | 12,367 | 11,559 | 10,810 | 10,133 | 9,573 |
| Hale | 378,473 | 368,467 | 357,422 | 346,557 | 335,933 | 325,560 | 315,630 |
| Hockley | 183,873 | 177,128 | 169,618 | 162,643 | 155,720 | 149,266 | 143,498 |
| Lamb | 402,158 | 388,549 | 374,848 | 364,781 | 355,855 | 348,137 | 341,917 |
| Lubbock | 298,052 | 294,396 | 283,258 | 273,107 | 262,982 | 254,144 | 246,777 |
| Lynn | 121,566 | 115,095 | 108,962 | 103,132 | 97,611 | 92,372 | 87,405 |
| Motley | 10,200 | 9,922 | 9,645 | 9,370 | 9,094 | 8,839 | 8,604 |
| Parmer | 425,089 | 423,847 | 420,881 | 417,391 | 413,955 | 410,547 | 407,290 |
| Swisher | 176,303 | 175,997 | 169,314 | 174,762 | 174,022 | 173,280 | 172,531 |
| Terry | 207,229 | 196,724 | 186,772 | 177,467 | 168,653 | 160,173 | 152,170 |
| Yoakum | 133,881 | 127,955 | 122,581 | 116,958 | 112,056 | 107,784 | 104,047 |
| Total | 4,530,040 | 4,394,415 | 4,238,924 | 4,103,635 | 3,968,572 | 3,841,481 | 3,724,154 |
| **River Basin Summary **** | | | | | | | |
| Canadian | 74 | 76 | 78 | 80 | 82 | 84 | 87 |
| Red | 939,712 | 923,455 | 898,644 | 880,297 | 859,240 | 838,902 | 819,527 |
| Brazos | 2,618,360 | 2,548,614 | 2,466,168 | 2,394,489 | 2,323,052 | 2,256,056 | 2,194,531 |
| Colorado | 971,891 | 922,269 | 874,034 | 828,770 | 786,198 | 746,439 | 710,010 |
| Total | 4,530,040 | 4,394,415 | 4,238,924 | 4,103,635 | 3,968,572 | 3,841,481 | 3,724,154 |

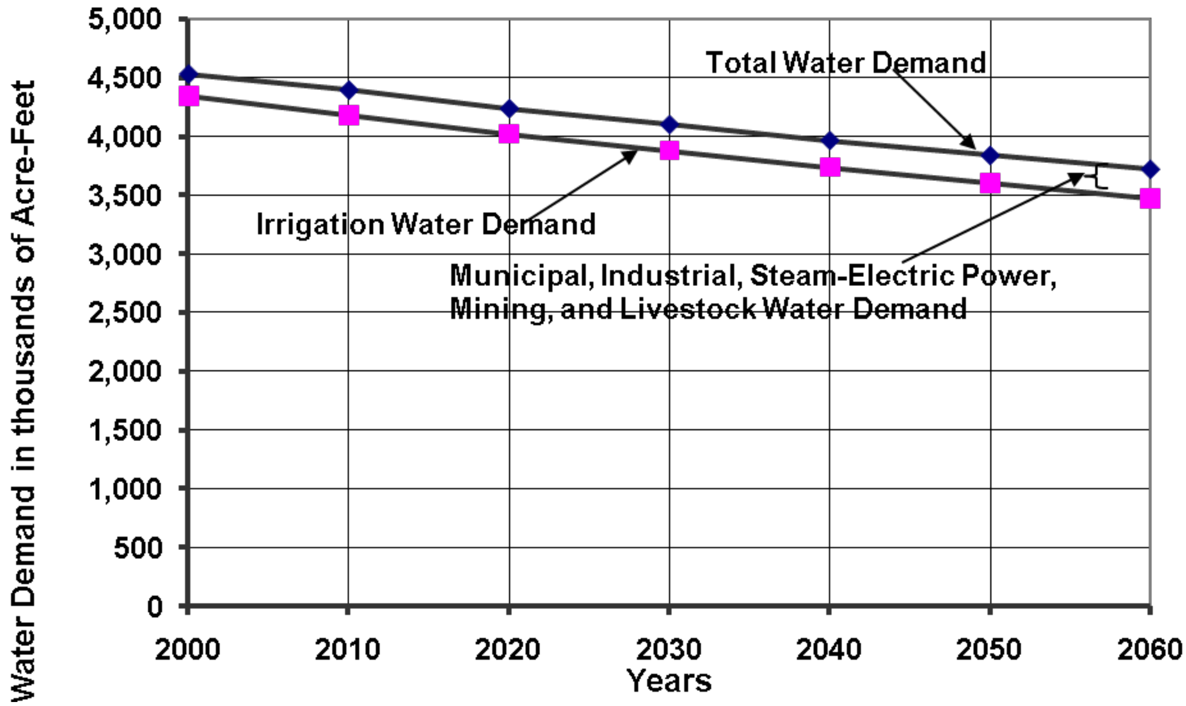


***Figure 2-6. Total Water Demand Projections: Llano Estacado Region – 2000 to 2060***

***Table 2-20.
Composition of Projected Total Water Demand
Llano Estacado Region
2000, 2030, and 2060***

| | *2000* | | *2030* | | *2060* | |
|---|---|---|---|---|---|---|
| ***Purpose of Use*** | ***acft*** | ***% of total*** | ***(acft)*** | ***% of total*** | ***(acft)*** | ***% of total*** |
| Municipal | 87,322 | 1.93% | 105,474 | 2.57% | 105,939 | 2.84% |
| Industrial | 10,064 | 0.22% | 17,460 | 0.43% | 19,919 | 0.53% |
| Steam-Electric Power | 25,618 | 0.57% | 30,188 | 0.74% | 49,910 | 1.34% |
| Mining | 21,436 | 0.47% | 6,359 | 0.15% | 258 | 0.01% |
| Irrigation | 4,347,877 | 95.98% | 3,882,780 | 94.62% | 3,474,163 | 93.29% |
| Beef Feedlot Livestock | 26,215 | 0.58% | 38,035 | 0.93% | 45,512 | 1.22% |
| Range & All Other Livestock | 11,510 | 0.25% | 23,339 | 0.57% | 28,454 | 0.76% |
| Total | 4,530,040 | 100.00% | 4,103,635 | 100.00% | 3,704,336 | 100.00% |

### *2.9 Water Demand Projections for Counties and Parts of Counties of River Basins of the Llano Estacado Region*

For purposes of this regional planning project, and in accordance with TWDB Rules, Section 357.7(a)(2), water demand projections are tabulated by river basin, county or part of county located within a river basin, as well as city and rural areas of each county or part of county for the Llano Estacado Region (Table 2-21).[3] For example, a part of the rural area of Deaf Smith County is located in the Canadian River Basin. The projected 1 acft/yr of water demand for the people who live in this rural area is shown as municipal water demand (Table 2-21). There is no manufacturing, steam-electric power, irrigation, mining, or beef feedlot livestock demand projected for the part of Deaf Smith County located in the Canadian River Basin. However, there is a range and all other livestock demand of 73 acft/yr in 2000 with a projection of 108 acft/yr in 2060 (Table 2-21).

All of Briscoe County is located in the Red River Basin. Most of the county is rural, but it contains the City of Silverton. The municipal water use by Silverton in 2000 was 126 acft/yr, with projected 2060 municipal water demands of 108 acft/yr (Table 2-21). Rural areas of Briscoe County located in the Red River Basin used 180 acft/yr for household purposes (municipal type of water use) in 2000, with projections for 2060 of 155 acft/yr (Table 2-21).

There are no industrial, steam-electric power, mining, or feedlot livestock water demands in Briscoe County in the Red River Basin. However, an estimated 26,329 acft/yr of water was used for irrigation in 2000, with projected irrigation water demand in 2060 of 21,091 acft/yr (Table 2-21). Dairy water use in 2000 was estimated at 33 acft/yr, with projected dairy water demand in 2060 of 33acft/yr (Table 2-21). All other livestock water demand in Briscoe County was estimated at 284 acft/yr in 2000 and is projected to increase to 341 acft/yr in 2060 (Table 2-21).

Total water use in Briscoe County in 2000 was 26,952 acft/yr, with projected total water demand of 21,728 acft/yr in 2060 (Table 2-21).

Projections for each county or part of county of each respective river basin of the region are shown in Table 2-21. Total projections for counties and parts of counties of each river basin area located in the Llano Estacado Planning Region are shown at the end of the listing of

[3] 31 Texas Administrative Code, Chapter 357, Regional Water Planning Guidelines Rules, TWDB, Austin, Texas, March 11, 1998.

individual counties and parts of counties of each river basin. In addition, the basin totals are listed at the end of Table 2-21. For example, total water use in 2000 in the Red River Basin part of the Llano Estacado Planning Region was 940,764 acft/yr, of which 7,548 acft/yr was for municipal purposes, 3,404 acft/yr was for manufacturing purposes, 909,585 acft/yr was for irrigation, 85 acft/yr was for mining, 14,733 acft/yr was for beef feedlot livestock, 164 acft/yr was for dairies, and 5,245 acft/yr was for all other livestock. Projected water demand for the Red River Basin part of the planning region in 2060 is 820,216 acft/yr, with 8,301 acft/yr being municipal demand, 7,714 acft/yr being for manufacturing, zero acft/yr being for steam-electric power, 766,868 acft/yr being for irrigation, zero acft/yr being for mining, 25,577 acft/yr being for beef feedlot livestock, 5,176 for dairies, and 6,580 acft/yr being for all other livestock. The reader can readily see the projections, by type of demand, for the Canadian, Red, Brazos, and Colorado River Basin areas of the Llano Estacado Planning Region in Table 2-21.

Total water use in the Llano Estacado Region was 4,530,040 acft/yr in 2000, with projected 2060 water demands of 3,724,154 acft/yr. The quantity of projected water demands in 2060 are 109 acft/yr for the Canadian River Basin areas of the Region, 820,216 acft/yr for the Red River Basin areas of the Region, 2,194,093 acft/yr for the Brazos River Basin areas of the Region, and 709,737 acft/yr for the Colorado River Basin areas of the Region (Table 2-21).

**Table 2-21.**
**Water Demand Projections**
**Llano Estacado Region**
**River Basins, Counties, and Cities[1]**

| ` Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| **Canadian Basin (part)** | | | | | | | |
| Deaf Smith (part) | | | | | | | |
| Rural (Municipal) | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Municipal Demand | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 73 | 88 | 99 | 100 | 102 | 103 | 108 |
| Total Demand | 73 | 89 | 100 | 101 | 103 | 104 | 109 |
| **Canadian Basin Total Demand** | **73** | **89** | **100** | **101** | **103** | **104** | **109** |
| **Red Basin (part)** | | | | | | | |
| Briscoe County (all) | | | | | | | |
| (Left Blank Intentionally) | | | | | | | |
| Silverton (Municipal) | 126 | 128 | 128 | 123 | 115 | 111 | 108 |
| Rural (Municipal) | 180 | 183 | 183 | 176 | 165 | 159 | 155 |
| Total Municipal Demand | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| All Other Livestock Demand | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total Demand | 26,952 | 26,009 | 25,098 | 24,208 | 23,343 | 22,519 | 21,728 |
| Castro County (part) | | | | | | | |
| Rural (Municipal) | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Total Municipal Demand | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Manufacturing Demand | 95 | 112 | 121 | 128 | 136 | 142 | 152 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 166,251 | 159,877 | 153,748 | 147,853 | 142,184 | 136,733 | 131,491 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 3,145 | 3,834 | 4,299 | 4,563 | 4,845 | 5,143 | 5,461 |
| Dairy Demand | 66 | 664 | 863 | 954 | 1,054 | 1,163 | 1,285 |
| All Other Livestock Demand | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Total Demand | 169,953 | 164,901 | 159,485 | 153,961 | 148,688 | 143,652 | 138,858 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Crosby County (part) | | | | | | | |
| Rural (Municipal) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Municipal Demand | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 2,243 | 2,152 | 2,066 | 1,982 | 1,903 | 1,826 | 1,752 |
| Mining Demand | 70 | 41 | 20 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Total Demand | 2,317 | 2,197 | 2,090 | 1,998 | 1,913 | 1,831 | 1,757 |
| | | | | | | | |
| Deaf Smith (part) | | | | | | | |
| Hereford (Municipal) | 3,564 | 3,634 | 3,694 | 3,751 | 3,788 | 3,801 | 3,813 |
| Rural (Municipal) | 572 | 743 | 932 | 1,100 | 1,243 | 1,286 | 1,305 |
| Total Municipal Demand | 4,136 | 4,377 | 4,626 | 4,851 | 5,031 | 5,087 | 5,118 |
| Manufacturing Demand | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 7,043 | 8,583 | 9,623 | 10,218 | 10,845 | 11,514 | 12,224 |
| Dairy Demand | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| All Other Livestock Demand | 3,006 | 3,124 | 3,253 | 3,400 | 3,553 | 3,715 | 3,881 |
| Total Demand | 388,282 | 382,352 | 372,744 | 362,942 | 353,501 | 344,333 | 335,581 |
| | | | | | | | |
| Dickens County (part) | | | | | | | |
| Rural (Municipal) | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Total Municipal Demand | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 4,079 | 3,957 | 3,839 | 3,725 | 3,614 | 3,506 | 3,400 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Total Demand | 4,354 | 4,233 | 4,119 | 4,009 | 3,898 | 3,794 | 3,692 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Floyd County (part) | | | | | | | |
| Rural (Municipal) | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Total Municipal Demand | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 106,659 | 102,411 | 98,332 | 94,415 | 90,654 | 87,044 | 83,577 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| All Other Livestock Demand | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Total Demand | 107,031 | 102,828 | 98,793 | 94,880 | 91,125 | 87,520 | 84,056 |
| | | | | | | | |
| Hale County (part) | | | | | | | |
| Rural (Municipal) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 3,677 | 3,555 | 3,437 | 3,323 | 3,213 | 3,107 | 3,004 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Demand | 3,678 | 3,556 | 3,438 | 3,324 | 3,214 | 3,108 | 3,005 |
| | | | | | | | |
| Motley County (all) | | | | | | | |
| Matador (Municipal) | 239 | 234 | 224 | 207 | 187 | 174 | 166 |
| Rural (Municipal) | 148 | 143 | 136 | 123 | 108 | 98 | 93 |
| Total Municipal Demand | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Manufacturing Demand | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| Mining Demand | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total Demand | 10,200 | 9,922 | 9,645 | 9,370 | 9,094 | 8,839 | 8,604 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Parmer County (part) | | | | | | | |
| Friona (Municipal) | 803 | 835 | 872 | 879 | 870 | 838 | 791 |
| Rural (Municipal) | 106 | 110 | 113 | 112 | 110 | 106 | 100 |
| Total Municipal Demand | 909 | 945 | 985 | 991 | 980 | 944 | 891 |
| Manufacturing Demand | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 120,480 | 119,201 | 117,935 | 116,683 | 115,444 | 114,219 | 113,006 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 2,046 | 2,494 | 2,797 | 2,968 | 3,153 | 3,347 | 3,553 |
| Dairy Demand | 10 | 566 | 694 | 768 | 847 | 933 | 1,031 |
| All Other Livestock Demand | 273 | 286 | 298 | 309 | 324 | 341 | 356 |
| Total Demand | 125,788 | 125,919 | 125,326 | 124,491 | 123,669 | 122,835 | 122,098 |
| | | | | | | | |
| Swisher County (part) | | | | | | | |
| Happy | 107 | 109 | 110 | 111 | 110 | 108 | 103 |
| Kress (Municipal) | 80 | 82 | 82 | 83 | 81 | 79 | 76 |
| Tulia (Municipal) | 1,020 | 1,050 | 1,065 | 1,072 | 1,064 | 1,038 | 993 |
| Rural (Municipal) | 207 | 211 | 211 | 211 | 207 | 202 | 193 |
| Total Municipal Demand | 1,414 | 1,452 | 1,468 | 1,477 | 1,462 | 1,427 | 1,365 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 97,872 | 97,313 | 93,233 | 96,205 | 95,655 | 95,108 | 94,565 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Dairy Demand | 3 | 11 | 18 | 18 | 18 | 18 | 18 |
| All Other Livestock Demand | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Total Demand | 102,209 | 102,258 | 98,610 | 101,819 | 101,497 | 101,171 | 100,838 |
| | | | | | | | |
| **Red Basin Total** | | | | | | | |
| Total Municipal Demand | 7,548 | 7,875 | 8,177 | 8,378 | 8,474 | 8,417 | 8,301 |
| Manufacturing Demand | 3,404 | 6,239 | 6,578 | 6,856 | 7,124 | 7,356 | 7,714 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 909,585 | 883,748 | 855,251 | 834,628 | 811,278 | 788,702 | 766,868 |
| Mining Demand | 85 | 50 | 24 | 14 | 6 | 0 | 0 |
| Beef Feedlot Livestock Demand | 14,733 | 17,958 | 20,135 | 21,375 | 22,693 | 24,091 | 25,577 |
| Dairy Demand | 164 | 2,885 | 3,524 | 3,880 | 4,270 | 4,698 | 5,176 |
| All Other Livestock Demand | 5,245 | 5,420 | 5,659 | 5,871 | 6,096 | 6,337 | 6,580 |
| **Red Basin Total Demand** | **940,764** | **924,175** | **899,348** | **881,002** | **859,941** | **839,601** | **820,216** |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| **Brazos Basin (part)** | | | | | | | |
| Bailey County (all) | | | | | | | |
| Muleshoe (Municipal) | 979 | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| Rural (Municipal) | 331 | 342 | 358 | 364 | 371 | 370 | 363 |
| Total Municipal Demand | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Manufacturing Demand | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Dairy Demand | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| All Other Livestock Demand | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total Demand | 186,162 | 183,203 | 179,570 | 175,721 | 171,997 | 168,361 | 164,837 |
| | | | | | | | |
| Castro County (part) | | | | | | | |
| Dimmitt (Municipal) | 975 | 1,041 | 1,103 | 1,137 | 1,159 | 1,150 | 1,130 |
| Hart (Municipal) | 223 | 238 | 251 | 258 | 262 | 260 | 256 |
| Rural (Municipal) | 208 | 222 | 234 | 240 | 243 | 241 | 237 |
| Total Municipal Demand | 1,406 | 1,501 | 1,588 | 1,635 | 1,664 | 1,651 | 1,623 |
| Manufacturing Demand | 1,637 | 1,923 | 2,082 | 2,213 | 2,337 | 2,445 | 2,617 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 337,541 | 324,598 | 312,154 | 300,186 | 288,677 | 277,609 | 266,966 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 2,225 | 2,712 | 3,040 | 3,228 | 3,427 | 3,638 | 3,862 |
| Dairy Demand | 80 | 812 | 1,056 | 1,166 | 1,289 | 1,424 | 1,573 |
| All Other Livestock Demand | 181 | 184 | 214 | 218 | 220 | 223 | 227 |
| Total Demand | 343,070 | 331,730 | 320,134 | 308,646 | 297,614 | 286,990 | 276,868 |
| | | | | | | | |
| Cochran County (part) | | | | | | | |
| Morton (Municipal) | 499 | 535 | 560 | 565 | 547 | 521 | 496 |
| Left Blank Intentionally | | | | | | | |
| Rural (Municipal) | 172 | 183 | 191 | 192 | 185 | 176 | 167 |
| Total Municipal Demand | 671 | 718 | 751 | 757 | 732 | 697 | 663 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 76,790 | 73,825 | 70,978 | 68,239 | 65,604 | 63,071 | 60,636 |
| Mining Demand | 16 | 14 | 10 | 8 | 6 | 4 | 2 |
| Beef Feedlot Livestock Demand | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Dairy Demand | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| All Other Livestock Demand | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Total Demand | 78,036 | 75,297 | 72,640 | 69,951 | 67,337 | 64,817 | 62,398 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Crosby County (part) | | | | | | | |
| Crosbyton (Municipal) | 351 | 369 | 386 | 394 | 402 | 400 | 394 |
| Lorenzo (Municipal) | 260 | 275 | 288 | 296 | 302 | 301 | 296 |
| Ralls (Municipal) | 290 | 304 | 315 | 322 | 325 | 323 | 318 |
| Rural (Municipal) | 202 | 210 | 217 | 220 | 222 | 220 | 217 |
| Total Municipal Demand | 1,103 | 1,158 | 1,206 | 1,232 | 1,251 | 1,244 | 1,225 |
| Manufacturing Demand | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 109,892 | 105,465 | 101,215 | 97,138 | 93,223 | 89,469 | 85,866 |
| Mining Demand | 119 | 71 | 34 | 20 | 8 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Total Demand | 111,411 | 106,998 | 102,764 | 98,706 | 94,806 | 91,044 | 87,429 |
| | | | | | | | |
| Dawson (part) | | | | | | | |
| O'Donnell | 17 | 17 | 17 | 17 | 17 | 17 | 16 |
| Rural (Municipal) | 18 | 18 | 18 | 19 | 18 | 18 | 17 |
| Total Municipal Demand | 35 | 35 | 35 | 36 | 35 | 35 | 33 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 1,460 | 1,378 | 1,300 | 1,227 | 1,158 | 1,093 | 1,031 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Total Demand | 1,496 | 1,414 | 1,337 | 1,264 | 1,195 | 1,130 | 1,066 |
| | | | | | | | |
| Dickens County (part) | | | | | | | |
| Dickens (Municipal) | | | | | | | |
| Spur (Municipal) | 275 | 271 | 267 | 263 | 260 | 257 | 257 |
| Rural (Municipal) | 234 | 224 | 212 | 194 | 169 | 158 | 147 |
| Total Municipal Demand | 509 | 495 | 479 | 457 | 429 | 415 | 404 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 5,407 | 5,246 | 5,089 | 4,938 | 4,791 | 4,647 | 4,508 |
| Mining Demand | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Total Demand | 6,472 | 6,240 | 6,023 | 5,839 | 5,659 | 5,499 | 5,361 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Floyd County (part) | | | | | | | |
| Floydada (Municipal) | 663 | 680 | 696 | 693 | 685 | 657 | 623 |
| Lockney (Municipal) | 237 | 242 | 244 | 240 | 234 | 224 | 212 |
| Rural (Municipal) | 178 | 183 | 185 | 183 | 180 | 172 | 163 |
| Total Municipal Demand | 1,078 | 1,105 | 1,125 | 1,116 | 1,099 | 1,053 | 998 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 130,361 | 125,168 | 120,184 | 115,397 | 110,800 | 106,387 | 102,150 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Dairy Demand | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| All Other Livestock Demand | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Total Demand | 132,539 | 127,609 | 122,817 | 118,104 | 113,574 | 109,205 | 105,009 |
| | | | | | | | |
| Garza County (part) | | | | | | | |
| Post (Municipal) | 623 | 631 | 642 | 616 | 579 | 549 | 512 |
| Lake Alan Henry WSD (from rural) | 0 | 22 | 22 | 22 | 22 | 22 | 22 |
| Rural (Municipal) | 154 | 134 | 134 | 128 | 119 | 110 | 101 |
| Total Municipal Demand | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| Manufacturing Demand | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| Mining Demand | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Total Demand | 14,563 | 13,355 | 12,367 | 11,559 | 10,810 | 10,133 | 9,573 |
| | | | | | | | |
| Hale County (part) | | | | | | | |
| Abernathy (part) (Municipal) | 461 | 486 | 508 | 526 | 531 | 525 | 514 |
| Hale Center (Municipal) | 446 | 470 | 493 | 509 | 513 | 507 | 498 |
| Petersburg (Municipal) | 276 | 289 | 304 | 313 | 316 | 312 | 306 |
| Plainview (Municipal) | 4,078 | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |
| Rural (Municipal) | 1,109 | 1,144 | 1,187 | 1,207 | 1,203 | 1,184 | 1,161 |
| Total Municipal Demand | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| Manufacturing Demand | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 364,023 | 351,961 | 340,300 | 329,026 | 318,124 | 307,583 | 297,392 |
| Mining Demand | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| Dairy Demand | 29 | 854 | 955 | 1,057 | 1,168 | 1,291 | 1,427 |
| All Other Livestock Demand | 324 | 331 | 342 | 349 | 358 | 368 | 379 |
| Total Demand | 374,794 | 364,909 | 353,981 | 343,230 | 332,716 | 322,450 | 312,623 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Hockley County (part) | | | | | | | |
| Anton (Municipal) | 250 | 263 | 270 | 272 | 268 | 256 | 243 |
| Levelland (Municipal) | 2,219 | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| Ropesville | 85 | 89 | 91 | 91 | 89 | 85 | 81 |
| Smyer | 67 | 69 | 70 | 70 | 68 | 65 | 62 |
| Rural (Municipal) | 814 | 840 | 855 | 853 | 831 | 791 | 753 |
| Total Municipal Demand | 3,435 | 3,571 | 3,648 | 3,655 | 3,578 | 3,413 | 3,246 |
| Manufacturing Demand | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 157,496 | 151,336 | 145,420 | 139,735 | 134,269 | 129,019 | 123,974 |
| Mining Demand | 3,302 | 2,358 | 1,510 | 981 | 378 | 19 | 0 |
| Beef Feedlot Livestock Demand | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Total Demand | 164,850 | 159,090 | 152,504 | 146,336 | 140,230 | 134,497 | 129,312 |
| | | | | | | | |
| Lamb County (all) | | | | | | | |
| Amherst (Municipal) | 163 | 168 | 176 | 182 | 185 | 183 | 181 |
| Earth (Municipal) | 248 | 257 | 268 | 277 | 283 | 280 | 276 |
| Littlefield (Municipal) | 1,480 | 1,530 | 1,602 | 1,660 | 1,694 | 1,676 | 1,655 |
| Olton (Municipal) | 474 | 492 | 512 | 532 | 542 | 536 | 529 |
| Sudan (Municipal) | 218 | 226 | 236 | 244 | 249 | 246 | 243 |
| Rural (Municipal) | 766 | 794 | 830 | 861 | 880 | 872 | 861 |
| Total Municipal Demand | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| Manufacturing Demand | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Steam-Electric Power Demand | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Irrigation Demand | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| Mining Demand | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Beef Feedlot Livestock Demand | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| Dairy Demand | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| All Other Livestock Demand | 472 | 491 | 510 | 529 | 553 | 577 | 598 |
| Total Demand | 402,158 | 388,549 | 374,848 | 364,779 | 355,856 | 348,138 | 341,915 |
| | | | | | | | |
| Lubbock County (all) | | | | | | | |
| Abernathy (part) (Municipal) | 153 | 171 | 182 | 188 | 186 | 190 | 186 |
| Idalou (Municipal) | 288 | 289 | 288 | 281 | 274 | 273 | 272 |
| Lubbock (Municipal) | 40,460 | 49,822 | 51,587 | 52,416 | 52,600 | 53,040 | 54,305 |
| New Deal (Municipal) | 126 | 149 | 165 | 173 | 173 | 178 | 173 |
| Ransom Canyon (Municipal) | 310 | 440 | 569 | 698 | 825 | 953 | 1,004 |
| Reese Redevelopment (Municipal) | | | | | | | |
| Shallowater (Municipal) | 311 | 344 | 367 | 377 | 371 | 379 | 371 |
| Slaton (Municipal) | 931 | 907 | 889 | 870 | 849 | 837 | 836 |
| Wolfforth (Municipal) | 412 | 1,468 | 1,758 | 1,822 | 1,884 | 1,962 | 2,006 |
| Rural (Municipal) | 3,417 | 3,006 | 3,051 | 3,053 | 2,909 | 2,907 | 2,744 |
| Total Municipal Demand | 46,408 | 56,596 | 58,856 | 59,878 | 60,071 | 60,719 | 61,897 |
| Manufacturing Demand | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Steam-Electric Power Demand | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Irrigation Demand | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| Mining Demand | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Beef Feedlot Livestock Demand | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Dairy Demand | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| All Other Livestock Demand | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total Demand | 298,052 | 294,395 | 283,257 | 273,107 | 262,982 | 254,144 | 246,777 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Lynn County (part) | | | | | | | |
| O'Donnell | 139 | 144 | 146 | 142 | 138 | 130 | 121 |
| Tahoka (Municipal) | 473 | 492 | 504 | 490 | 478 | 453 | 421 |
| Wilson (Municipal) | 65 | 67 | 68 | 65 | 63 | 60 | 55 |
| Rural (Municipal) | 290 | 299 | 301 | 292 | 282 | 267 | 249 |
| Total Municipal Demand | 967 | 1002 | 1019 | 989 | 961 | 910 | 846 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 119,289 | 112,870 | 106,796 | 101,054 | 95,614 | 90,473 | 85,610 |
| Mining Demand | 66 | 39 | 19 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Total Demand | 120,450 | 114,043 | 107,970 | 102,193 | 96,724 | 91,532 | 86,609 |
| | | | | | | | |
| Parmer County (part) | | | | | | | |
| Bovina (Municipal) | 309 | 321 | 334 | 335 | 330 | 317 | 300 |
| Farwell (Municipal) | 370 | 388 | 405 | 410 | 408 | 393 | 371 |
| Rural (Municipal) | 287 | 297 | 305 | 304 | 298 | 286 | 270 |
| Total Municipal Demand | 966 | 1006 | 1044 | 1049 | 1036 | 996 | 941 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 294,969 | 291,836 | 288,738 | 285,673 | 282,640 | 279,639 | 276,670 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 2,817 | 3,434 | 3,849 | 4,087 | 4,338 | 4,606 | 4,890 |
| Dairy Demand | 20 | 1,103 | 1,353 | 1,491 | 1,647 | 1,824 | 2,014 |
| All Other Livestock Demand | 530 | 551 | 575 | 601 | 626 | 651 | 680 |
| Total Demand | 299,302 | 297,930 | 295,559 | 292,901 | 290,287 | 287,716 | 285,195 |
| | | | | | | | |
| Swisher County (part) | | | | | | | |
| Kress | 21 | 22 | 22 | 22 | 22 | 21 | 20 |
| Rural (Municipal) | 41 | 41 | 42 | 41 | 41 | 40 | 38 |
| Total Municipal Demand | 62 | 63 | 64 | 63 | 63 | 61 | 58 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 73,834 | 73,412 | 70,333 | 72,575 | 72,161 | 71,749 | 71,338 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 29 | 97 | 165 | 165 | 165 | 165 | 165 |
| All Other Livestock Demand | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Total Demand | 74,093 | 73,739 | 70,703 | 72,942 | 72,525 | 72,108 | 71,693 |

Continued on next page

***Table 2-21 Continued***

| ` Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Terry County (part) | | | | | | | |
| Rural (Municipal) | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Total Municipal Demand | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 10,157 | 9,636 | 9,142 | 8,674 | 8,229 | 7,807 | 7,407 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Total Demand | 10,174 | 9,657 | 9,166 | 8,697 | 8,257 | 7,832 | 7,429 |
| | | | | | | | |
| **Brazos Basin Total** | | | | | | | |
| Total Municipal Demand | 68,459 | 79,564 | 82,673 | 84,037 | 84,194 | 84,293 | 84,773 |
| Manufacturing Demand | 6,558 | 9,339 | 9,961 | 10,466 | 10,947 | 11,358 | 12,042 |
| Steam-Electric Power Demand | 23,766 | 23,048 | 22,103 | 25,842 | 30,398 | 35,953 | 42,724 |
| Irrigation Demand | 2,497,120 | 2,409,240 | 2,322,320 | 2,244,092 | 2,166,425 | 2,091,863 | 2,020,262 |
| Mining Demand | 5,630 | 3,681 | 2,141 | 1,351 | 530 | 23 | 2 |
| Beef Feedlot Livestock Demand | 10,982 | 13,388 | 15,008 | 15,935 | 16,917 | 17,961 | 19,067 |
| Dairy Demand | 1,019 | 5,689 | 6,988 | 7,677 | 8,442 | 9,289 | 10,219 |
| All Other Livestock Demand | 4,088 | 4,209 | 4,446 | 4,575 | 4,717 | 4,856 | 5,004 |
| **Brazos Basin Total Demand** | **2,617,622** | **2,548,158** | **2,465,640** | **2,393,975** | **2,322,570** | **2,255,596** | **2,194,093** |
| | | | | | | | |
| **Colorado Basin (part)** | | | | | | | |
| Cochran County (part) | | | | | | | |
| Rural (Municipal) | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Total Municipal Demand | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 43,195 | 41,527 | 39,925 | 38,384 | 36,902 | 35,478 | 34,108 |
| Mining Demand | 1,704 | 1,448 | 1,022 | 852 | 639 | 426 | 256 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Total Demand | 45,078 | 43,161 | 41,172 | 39,462 | 37,764 | 36,124 | 34,582 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Dawson County (part) | | | | | | | |
| Lamesa (Municipal) | 2,486 | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| Rural (Municipal) | 605 | 610 | 612 | 616 | 607 | 587 | 565 |
| Total Municipal Demand | 3,091 | 3,150 | 3,185 | 3,218 | 3,210 | 3,116 | 2,998 |
| Manufacturing Demand | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 144,579 | 136,425 | 128,736 | 121,478 | 114,628 | 108,167 | 102,071 |
| Mining Demand | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Total Demand | 150,649 | 141,472 | 132,985 | 125,449 | 118,341 | 111,601 | 105,403 |
| | | | | | | | |
| Gaines County (all) | | | | | | | |
| Seagraves (Municipal) | 416 | 449 | 482 | 502 | 513 | 506 | 499 |
| Seminole (Municipal) | 2,019 | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| Rural (Municipal) | 704 | 754 | 800 | 823 | 839 | 824 | 813 |
| Total Municipal Demand | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| Mining Demand | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Beef Feedlot Livestock Demand | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total Demand | 424,778 | 403,246 | 381,382 | 360,671 | 341,024 | 322,723 | 305,980 |
| | | | | | | | |
| Garza County (part) | | | | | | | |
| Rural (Municipal) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Hockley (part) | | | | | | | |
| Sundown (Municipal) | 325 | 341 | 350 | 353 | 347 | 332 | 316 |
| Rural (Municipal) | 40 | 41 | 42 | 42 | 41 | 39 | 37 |
| Total Municipal Demand | 365 | 382 | 392 | 395 | 388 | 371 | 353 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 17,500 | 16,815 | 16,158 | 15,526 | 14,919 | 14,335 | 13,775 |
| Mining Demand | 1,114 | 796 | 509 | 331 | 127 | 6 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Total Demand | 19,023 | 18,038 | 17,114 | 16,307 | 15,490 | 14,769 | 14,187 |
| | | | | | | | |
| Lynn County (part) | | | | | | | |
| Left Blank Intentionally | | | | | | | |
| Rural (Municipal) | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Total Municipal Demand | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 1,083 | 1,025 | 970 | 918 | 868 | 822 | 777 |
| Mining Demand | 15 | 9 | 4 | 2 | 1 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Total Demand | 1,115 | 1,052 | 992 | 938 | 887 | 841 | 797 |
| | | | | | | | |
| Terry County (part) | | | | | | | |
| Brownfield (Municipal) | 2,593 | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| Meadow (Municipal) | 70 | 73 | 75 | 78 | 80 | 79 | 79 |
| Rural (Municipal) | 362 | 376 | 393 | 407 | 419 | 418 | 415 |
| Total Municipal Demand | 3,025 | 3,196 | 3,373 | 3,532 | 3,680 | 3,682 | 3,661 |
| Manufacturing Demand | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 192,984 | 183,089 | 173,702 | 164,797 | 156,348 | 148,332 | 140,726 |
| Mining Demand | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| All Other Livestock Demand | 115 | 115 | 114 | 119 | 118 | 124 | 130 |
| Total Demand | 197,055 | 187,067 | 177,606 | 168,770 | 160,396 | 152,341 | 144,741 |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| Yoakum County (all) | | | | | | | |
| Denver City (Municipal) | 955 | 1,043 | 1,126 | 1,172 | 1,220 | 1,181 | 1,141 |
| Plains (Municipal) | 378 | 416 | 448 | 468 | 488 | 473 | 457 |
| Rural (Municipal) | 264 | 286 | 305 | 314 | 323 | 312 | 302 |
| Total Municipal Demand | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation Demand | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| Mining Demand | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total Demand | 133,881 | 127,955 | 122,581 | 116,958 | 112,056 | 107,784 | 104,047 |
| | | | | | | | |
| **Colorado Basin Total** | | | | | | | |
| Total Municipal Demand | 11,315 | 11,995 | 12,621 | 13,058 | 13,371 | 13,145 | 12,864 |
| Manufacturing Demand | 102 | 120 | 130 | 138 | 145 | 151 | 163 |
| Steam-Electric Power Demand | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation Demand | 941,172 | 893,030 | 847,371 | 804,060 | 762,975 | 724,003 | 687,033 |
| Mining Demand | 15,721 | 12,593 | 8,115 | 4,994 | 2,316 | 705 | 256 |
| Beef Feedlot Livestock Demand | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairy Demand | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| All Other Livestock Demand | 917 | 935 | 1,044 | 1,068 | 1,085 | 1,113 | 1,144 |
| **Colorado Basin Total Demand** | **971,579** | **921,991** | **873,832** | **828,555** | **785,958** | **746,183** | **709,737** |
| | | | | | | | |
| **Llano Estacado Region** | | | | | | | |
| **River Basin Summaries** | | | | | | | |
| **Canadian River Basin (part)** | | | | | | | |
| Total Municipal Demand | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Manufacturing Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairy Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock Demand | 73 | 88 | 99 | 100 | 102 | 103 | 108 |
| **Canadian Basin Total Demand** | **73** | **89** | **100** | **101** | **103** | **104** | **109** |

Continued on next page

***Table 2-21 Continued***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| **Red River Basin (part)** | | | | | | | |
| Total Municipal Demand | 7,548 | 7,875 | 8,177 | 8,378 | 8,474 | 8,417 | 8,301 |
| Manufacturing Demand | 3,404 | 6,239 | 6,578 | 6,856 | 7,124 | 7,356 | 7,714 |
| Steam-Electric Power Demand | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation Demand | 909,585 | 883,748 | 855,251 | 834,628 | 811,278 | 788,702 | 766,868 |
| Mining Demand | 85 | 50 | 24 | 14 | 6 | 0 | 0 |
| Beef Feedlot Livestock Demand | 14,733 | 17,958 | 20,135 | 21,375 | 22,693 | 24,091 | 25,577 |
| Dairy Demand | 164 | 2,885 | 3,524 | 3,880 | 4,270 | 4,698 | 5,176 |
| All Other Livestock Demand | 5,245 | 5,420 | 5,659 | 5,871 | 6,096 | 6,337 | 6,580 |
| **Red Basin Total Demand** | **940,764** | **924,175** | **899,348** | **881,002** | **859,941** | **839,601** | **820,216** |
| **Brazos River Basin (part)** | | | | | | | |
| Total Municipal Demand | 68,459 | 79,564 | 82,673 | 84,037 | 84,194 | 84,293 | 84,773 |
| Manufacturing Demand | 6,558 | 9,339 | 9,961 | 10,466 | 10,947 | 11,358 | 12,042 |
| Steam-Electric Power Demand | 23,766 | 23,048 | 22,103 | 25,842 | 30,398 | 35,953 | 42,724 |
| Irrigation Demand | 2,497,120 | 2,409,240 | 2,322,320 | 2,244,092 | 2,166,425 | 2,091,863 | 2,020,262 |
| Mining Demand | 5,630 | 3,681 | 2,141 | 1,351 | 530 | 23 | 2 |
| Beef Feedlot Livestock Demand | 10,982 | 13,388 | 15,008 | 15,935 | 16,917 | 17,961 | 19,067 |
| Dairy Demand | 1,019 | 5,689 | 6,988 | 7,677 | 8,442 | 9,289 | 10,219 |
| All Other Livestock Demand | 4,088 | 4,209 | 4,446 | 4,575 | 4,717 | 4,856 | 5,004 |
| **Brazos Basin Total Demand** | **2,617,622** | **2,548,158** | **2,465,640** | **2,393,975** | **2,322,570** | **2,255,596** | **2,194,093** |
| **Colorado River Basin (part)** | | | | | | | |
| Total Municipal Demand | 11,315 | 11,995 | 12,621 | 13,058 | 13,371 | 13,145 | 12,864 |
| Manufacturing Demand | 102 | 120 | 130 | 138 | 145 | 151 | 163 |
| Steam-Electric Power Demand | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation Demand | 941,172 | 893,030 | 847,371 | 804,060 | 762,975 | 724,003 | 687,033 |
| Mining Demand | 15,721 | 12,593 | 8,115 | 4,994 | 2,316 | 705 | 256 |
| Beef Feedlot Livestock Demand | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairy Demand | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| All Other Livestock Demand | 917 | 935 | 1,044 | 1,068 | 1,085 | 1,113 | 1,144 |
| **Colorado Basin Total Demand** | **971,579** | **921,991** | **873,832** | **828,555** | **785,958** | **746,183** | **709,737** |

Continued on next page

***Table 2-21 Concluded***

| Basin/County/City/Rural | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|
| **Llano Estacado Region Total** | | | | | | | |
| Total Municipal Demand | 87,322 | 99,435 | 103,472 | 105,474 | 106,040 | 105,856 | 105,939 |
| Manufacturing Demand | 10,064 | 15,698 | 16,669 | 17,460 | 18,216 | 18,865 | 19,919 |
| Steam-Electric Power Demand | 25,618 | 25,645 | 25,821 | 30,188 | 35,511 | 42,000 | 49,910 |
| Irrigation Demand | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |
| Mining Demand | 21,436 | 16,324 | 10,280 | 6,359 | 2,852 | 728 | 258 |
| Beef Feedlot Livestock Demand | 26,215 | 31,955 | 35,826 | 38,035 | 40,380 | 42,869 | 45,512 |
| Dairy Demand | 1,183 | 8,686 | 10,663 | 11,723 | 12,895 | 14,189 | 15,619 |
| All Other Livestock Demand | 10,323 | 10,652 | 11,248 | 11,614 | 12,000 | 12,409 | 12,836 |
| **Llano Estacado Region Total** | **4,530,040** | **4,394,415** | **4,238,924** | **4,103,635** | **3,968,572** | **3,841,481** | **3,724,154** |
| **River Basin Summary** | | | | | | | |
| Canadian | 73 | 89 | 100 | 101 | 103 | 104 | 109 |
| Red | 940,764 | 924,175 | 899,348 | 881,002 | 859,941 | 839,601 | 820,216 |
| Brazos | 2,617,622 | 2,548,158 | 2,465,640 | 2,393,975 | 2,322,570 | 2,255,596 | 2,194,093 |
| Colorado | 971,579 | 921,991 | 873,832 | 828,555 | 785,958 | 746,183 | 709,737 |
| **Llano Estacado Region Total** | **4,530,040** | **4,394,415** | **4,238,924** | **4,103,635** | **3,968,572** | **3,841,481** | **3,724,154** |

<><><><>

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003. Updated May 19, 2009.

## *2.10 Water Demand Projections for Wholesale Water Providers in the Llano Estacado Region*

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider (WWP) as follows:

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

There are four WWPs in the Llano Estacado Region. The four WWPs and the water user groups to which they provide water are described below.

### *2.10.1 Canadian River Municipal Water Authority* [4]

The CRMWA supplies water to eight cities (Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Plainview, Slaton, and Tahoka) located within the Llano Estacado Planning Area as well as several entities located in Planning Region A.[5] Historically, CRMWA has been the sole provider of water to the City of O'Donnell; the remaining seven cities have historically obtained a portion of their water supply from self-supplied groundwater. The total quantity of water used by these CRMWA customers in 2000 was 53,396 acft. Projected demand of these CRMWA customers in 2030 is 56,794 acft/yr and in 2060 is 55,504 acft/yr (Table 2-22).

CRMWA is not projected to supply water to industrial customers located within the region, however some cities to which CRMWA supplies water may supply water to industrial customers during the planning period. In the projections shown in Table 2-22, these amounts are included in the municipal total for CRMWA's customers.

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[4] The values in Table 2-22 for CRMWA during planning years 2000 through 2060 reflect the lesser of the City's combined entire municipal demand and the maximum delivery rate from CRMWA.

[5] The City of Lubbock is also a Wholesale Water Provider, whose customer list is presented in Section 2.10.2, and Slaton supplies a part of its CRMWA water to the City of Post.

***Table 2-22.***
***Water Demand Projections for Wholesale Water Providers***
***Llano Estacado Region***

| ***Wholesale Water Providers with Lists of Customers*** | ***Total in 2000 (acft)*** | ***Projections*** | | | | | |
|---|---|---|---|---|---|---|---|
| | | ***2010 (acft)*** | ***2020 (acft)*** | ***2030 (acft)*** | ***2040 (acft)*** | ***2050 (acft)*** | ***2060 (acft)*** |
| **Canadian River MWA** | | | | | | | |
| City of Brownfield | 2,593 | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| City of Lamesa | 2,486 | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| City of Levelland | 2,219 | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| City of Lubbock | 40,460 | 41,765 | 42,580 | 42,652 | 42,033 | 42,349 | 41,915 |
| City of O'Donnell | 156 | 161 | 163 | 159 | 155 | 147 | 137 |
| City of Plainview | 4,078 | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |
| City of Slaton | 931 | 907 | 889 | 870 | 849 | 837 | 836 |
| City of Tahoka | 473 | 492 | 504 | 490 | 478 | 453 | 421 |
| Llano Estacado Region (Region O) Total | 53,396 | 55,210 | 56,466 | 56,794 | 56,256 | 56,293 | 55,504 |
| Panhandle Region (Region A) Total | | | | | | | |
| CRMWA Total | | | | | | | |
| **City of Lubbock** | | | | | | | |
| City of Lubbock Municipal | 40,460 | 49,822 | 51,587 | 52,416 | 52,600 | 53,040 | 54,305 |
| Buffalo Springs Lake Water Supply Corp. Mun.[2] | 807 | 807 | 807 | 807 | 807 | 807 | 807 |
| Ransom Canyon | 310 | 440 | 569 | 698 | 825 | 953 | 1,004 |
| Shallowater | 311 | 344 | 367 | 377 | 371 | 379 | 371 |
| Lake Alan Henry Water District[2] | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Lubbock-Reese Redevelopment Authority[2] | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Lubbock Total | 41,917 | 51,442 | 53,359 | 54,327 | 54,632 | 55,208 | 56,516 |
| **Mackenzie MWA** | | | | | | | |
| City of Floydada | 663 | 680 | 696 | 693 | 685 | 657 | 623 |
| City of Lockney | 237 | 242 | 244 | 240 | 234 | 224 | 212 |
| City of Silverton | 126 | 128 | 128 | 123 | 115 | 111 | 108 |
| City of Tulia | 1,020 | 1,050 | 1,065 | 1,072 | 1,064 | 1,038 | 993 |
| MMWA Total | 2,046 | 2,100 | 2,133 | 2,128 | 2,098 | 2,030 | 1,936 |

Continued on next page

***Table 2-22 Concluded***

| Wholesale Water Providers with Lists of Customers | | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **White River MWD** | | | | | | | | |
| City of Crosbyton | | | | | | | | |
| | Municipal | 351 | 369 | 386 | 394 | 402 | 400 | 394 |
| | Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| City of Post | | | | | | | | |
| | Municipal | 623 | 631 | 642 | 616 | 579 | 549 | 512 |
| | Industrial | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| City of Ralls | | | | | | | | |
| | Municipal | 290 | 304 | 315 | 322 | 325 | 323 | 318 |
| | Industrial | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| City of Spur | | | | | | | | |
| | Municipal | 275 | 271 | 267 | 263 | 260 | 257 | 257 |
| | Industrial | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | | | | | | | |
| | Crosby County | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| | Dickens county | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| | Garza County | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| WRMWD | | | | | | | | |
| | Municipal | 1,539 | 1,575 | 1,610 | 1,595 | 1,566 | 1,529 | 1,481 |
| | Industrial | 7 | 8 | 8 | 8 | 8 | 8 | 8 |
| | Mining | 1,618 | 962 | 462 | 269 | 115 | 0 | 0 |
| WRMWD Total | | 3,164 | 2,545 | 2,080 | 1,872 | 1,689 | 1,537 | 1,489 |

### *2.10.2 City of Lubbock*

The City of Lubbock has wholesale water supply contracts with Buffalo Springs Lake Water Supply Corporation, Lake Ransom Canyon, Shallowater, Lubbock-Reese Redevelopment Authority, and is in the process of negotiating a wholesale water supply contract with the Lake Alan Henry Water Supply District. In addition, Lubbock has a contract to supply water to the City of Littlefield in cases of emergency. Total water use by Lubbock and its customers was 49,917 acft in 2000 (Table 2-22). Projected water demand by Lubbock and its customers in 2030 is 54,327 acft/yr and in 2060 is 56,516 acft/yr (Table 2-22)

### *2.10.3 Mackenzie Municipal Water Authority*

The MMWA supplies water to Floydada, Lockney, Silverton, and Tulia. Floydada, Lockney, and Tulia also meet a part of their needs from groundwater (i.e., their own wells). The total amount of water supplied by the Authority in 2000 was 2,046 acft (Table 2-22). The projected total quantity of water needed by the Authority's customers in 2030 and 2060 is 2,128 acft/yr and 1,936 acft/yr, respectively (Table 2-22).

### *2.10.4 White River Municipal Water District*

The WRMWD supplies water to Crosbyton, Post, Ralls, and Spur. Historically, the District has been the sole water provider for these cities. The total amount of water used by the District's customers in 2000 was 1,546 acft, of which 1,539 acft was for municipal purposes, and 7 acft was for industrial purposes (Table 2-22). The projected total quantity of water needed to meet WRMWD's customers' projected demands in 2030 is 1,603 acft/yr, with 1,595 acft/yr being for municipal purposes and 8 acft/yr being for industrial purposes. Projected demand in 2060 is 1,489 acft/yr, of which 1,481 acft/yr is for municipal purposes and 8 acft/yr is for industry (Table 2-22). WRMWD purchased groundwater rights in Crosby County in 1998, and drilled several wells in 1999. The groundwater will be used during periods of drought when the water level in the reservoir is low. In addition, the City of Post has constructed a pipeline to Slaton and has a contract with Slaton for a part of Slaton's CRMWA supply for a minimum of 153.44 acft/yr and a maximum of 306.88 acft/yr, provided Slaton's CRMWA supply is not reduced.

The Cities of Post and Ralls are projected to utilize water obtained from the District for industrial purposes during the planning period (Table 2-22).

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# Section 3
# Water Supply Analysis
# [31 TAC §357.7(a)(3)

The Llano Estacado Region is located in a semiarid climatic area of west Texas. Precipitation ranges from an average annual level of about 18 inches on the eastern border to only about 14 inches on the west at the New Mexico state line. Therefore, surface water supplies are very low. However, the region is underlain with aquifers in which large quantities of water have been captured and stored over very long periods of time. The ground and surface water resources of the region are identified and described below.

## 3.1 Groundwater

The major sources of water in the Llano Estacado Region are the Ogallala, Seymour, Edwards-Trinity (High Plains), and Dockum Aquifers. Each of these aquifers is identified and characterized briefly below. A more complete description of these aquifers is presented in Section 1, and is not repeated here.

### 3.1.1 Ogallala Aquifer

The Ogallala Aquifer is the major water-bearing formation in most of the 21 counties of the Llano Estacado Region. Most of the communities within the region obtain water from the Ogallala Aquifer as their primary source of drinking water; however, approximately 95 percent of the water obtained from the Ogallala is used for irrigation.

### 3.1.2 Seymour Aquifer

The Seymour Formation consists of isolated areas of alluvium found in parts of 23 north-central and High Plains counties, including parts of Briscoe, Motley, Dickens, and Crosby Counties of the Llano Estacado Region. The Seymour Aquifer supplies small quantities of water for municipal and irrigation use in these four counties.

### 3.1.3 Edwards-Trinity (High Plains) Aquifer

The Edwards-Trinity (High Plains) Aquifer includes Cretaceous Age water-bearing formations of the Fredericksburg and Trinity Groups. These formations underlie the Ogallala Formation in 11 counties in the southwestern corner of the Llano Estacado Region and extend westward into New Mexico. The Edwards-Trinity (High Plains) Aquifer supplies water for municipal and irrigation use in Lynn County.

### *3.1.4 Dockum (Santa Rosa) Aquifer*

The Dockum Group of Triassic Age underlies the Ogallala Formation of the High Plains area of Texas and New Mexico, the northern part of the Edwards Plateau, and the eastern part of the Cenozoic Pecos Alluvium. The Dockum Aquifer supplies small quantities of water for municipal and irrigation use in Briscoe, Deaf Smith, Garza, and Swisher Counties.

## *3.2 Surface Water*

Although the Llano Estacado Region lies within the headwaters areas of the Canadian, Red, Brazos, and Colorado River Basins, the region has very little surface water; rainfall is less than 18 inches per year, and is not adequate to result in any sustained runoff to streams. Even though streamflow in the region is relatively low, four dams and reservoirs (Lake Meredith, Mackenzie, White River, and Alan Henry) have been built within and near the region to capture and store most of the surface water that is available from the streams on which they are located. The four reservoirs supply water for municipal and industrial uses to 15 of the 46 cities located in the region. These four reservoirs are described below. In segments of rivers where dams have not been built, surface water amounts to a trickle, with very little water leaving the region. Those entities that do not obtain water from the reservoirs mentioned above must rely upon groundwater to supply their water needs due to the lack of a reliable surface water source.

There are a limited number of surface water rights within the region; however, none of these rights are reliable during a drought according the Texas Commission on Environmental Quality’s (TCEQ) WAM model. A total of 94 water rights, included rights for reservoirs, exist in the Llano Estacado Region, with a total authorized diversion of approximately 116,500 acft/yr. It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the region, five water rights (5.3 percent) make up 100,910 acft/yr (86.6 percent) of the authorized diversion volume. The remaining 89 water rights primarily consists of small irrigation and municipal rights distributed throughout the region. Appendix F contains a list of all surface water rights in the region and their authorized diversion volumes.

### *3.2.1 Lake Meredith*

Lake Meredith, operated by the CRMWA, is located in the Canadian River Basin to the north of the Llano Estacado Region, in Potter, Moore, and Hutchinson Counties. From Lake Meredith, a pipeline extends southward and delivers water for municipal and industrial purposes to Brownfield, Lamesa, Levelland, Lubbock, Plainview, O'Donnell, Slaton, and Tahoka of the Llano Estacado Region. The lake has a total storage capacity of 920,300 acft, a firm yield of approximately 69,750 acft of water per year, and a safe yield of 63,750 acft per year. Groundwater projects that obtain water from the Ogallala Aquifer in Roberts County have been added to increase the supply to entities obtaining water from Lake Meredith. In addition, this water from the Ogallala Aquifer is firming up the reliability and improving the quality of current supplies from Lake Meredith.

### *3.2.2 Mackenzie Reservoir*

Mackenzie Reservoir is located in the Red River Basin in Swisher and Briscoe Counties. Mackenzie Reservoir has a total storage capacity of 45,500 acft and can supply approximately 5,200 acft of water per year when the reservoir is at conservation pool elevation. Mackenzie Reservoir supplies water to Silverton, Tulia, Floydada, and Lockney. However, during recent dry years, Mackenzie Reservoir was unable to meet its contracted demands.

### *3.2.3 White River Lake*

White River Lake is located in the Brazos River Basin in the southeast corner of Crosby County. It is owned and operated by the WRMWD, which supplies water to Ralls, Spur, Post, and Crosbyton. The lake has a surface area of 1,808 acres at conservation pool elevation, a drainage area of 173 square miles, total storage capacity of 31,846 acft, and can supply approximately 4,000 acft/yr when at conservation pool elevation. WRMWD has purchased groundwater rights and has drilled wells to augment its supply to customers should the water levels in the reservoir drop below the level at which water can be removed.

### *3.2.4 Lake Alan Henry*

Lake Alan Henry, owned by the City of Lubbock, Texas, is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties. TCEQ Permit 4146, with Priority Date of October 5, 1981, authorizes impoundment of 115,937 acft and the diversion of up to 35,000 acft/yr of water for municipal purposes. Based upon the hydrologic record for the period 1940 through 2002, the firm yield of Lake Alan Henry was calculated at 22,500 acft/yr.[1] Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In addition, Lubbock has contracted to sell 520 acft/yr to the Lake Alan Henry Water Supply District, and 20 acft/yr to the South Garza Water Supply Corporation. The Lake Alan Henry and South Garza Water Supply Districts will supply municipal water to developing areas in southeastern Garza County of the Llano Estacado Region and western Kent County of the neighboring Brazos G Water Planning Region.

### *3.2.5 Surface Water Rights*

Lake Alan Henry, owned by the City of Lubbock, Texas, is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties. TCEQ Permit 4146, with Priority Date of October 5, 1981, authorizes impoundment of 115,937 acft and the diversion of up to 35,000 acft/yr of water for municipal purposes. Based upon the hydrologic record for the period 1940 through 2002, the firm yield of Lake Alan Henry was calculated at 22,500 acft/yr.[2] Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In addition, Lubbock has contracted to sell 520 acft/yr to the Lake Alan Henry Water Supply District, and 20 acft/yr to the South Garza Water Supply Corporation (see Section 3.2.4 above).

## *3.3 Methodology to Calculate the Water Supplies Available to the Llano Estacado Region and Methodology for Calculating Water Supplies Available for Water User Groups*

The water supplies available to the Llano Estacado Region during the 1947--1957 “drought of record” were calculated from the following data sources:

A. The LERWPG requested that TWDB run the Southern Ogallala Groundwater Availability Model (GAM) using the water demand projections for water user groups (WUGs) of LERWPG, as approved by the TWDB on September 17, 2003, for the planning period of 2010 through 2060. The TWDB performed the runs, as requested, and provided information showing the volume of groundwater present in each county-basin area of the Llano Estacado Region (Region O) for each of the projection dates 2004,

[1] “Draft Memorandum to File,” Gooch, Thomas C., P.E., and Andres A. Salazar, Ph.D., Freese and Nichols, March 19, 2003.
[2] “Draft Memorandum to File,” Gooch, Thomas C., P.E., and Andres A. Salazar, Ph.D., Freese and Nichols, March 19, 2003.

2010, 2020, 2030, 2040, 2050 and 2060. The quantity of water that could be pumped from each of the county-basin areas at each of the projection dates was calculated based upon the recharge and aquifer parameters of the Southern Ogallala GAM, and the water wells in place at the present time (the quantity of water available annually from the aquifer in the immediate future could be increased by adding more wells). However, well spacing is regulated by the Underground Water Conservation Districts of the area, and the addition of wells requires permits from the Districts. In a second request by the LERWPG, the TWDB made volumetric calculations for the counties in the region using a mass balance approach with 1995 as the base starting point and continuing through 2060 with only average recharge from the model as the primary input and projected water demands, as approved by the TWDB on September 17, 2003, as the primary output. The results of the GAM and the mass balance calculations were used to obtain estimates of the quantities of water available from the Ogallala Aquifer for use in meeting projected water demand of the region (Table 3-1).

B. Groundwater availability by aquifer for the Dockum, Edwards-Trinity (High Plains), and Seymour Aquifers was obtained from the TWDB. The groundwater availability by county was further subdivided into river basin parts of each county according to the TWDB estimates.

C. Surface water availability for cities obtaining all or part of their water supply from surface water sources is based upon firm yield as determined using the Texas Commission on Environmental Quality Water Availability Model Run 3.

D. Water availability from reclaimed water was obtained from TCEQ discharge permits.

E. Range livestock water supply was allocated to local sources (stock tanks and windmills) and set at projected quantities of range livestock water demands.

The estimated quantity of water available from each source (Aquifer and Surface Source) to meet projected water demands in each county-basin area of the planning region is presented in Tables 3-1 and 3-2, and Tables 4-1 through 4-21.

## *3.4 Projected Water Supplies Available to the Llano Estacado Region*

Water demand projections for water user groups of each county and river basin area of the Llano Estacado Region were presented in Section 2, Table 2-21. The projected quantity of water in storage, along with the projected quantity available from the Ogallala aquifer in each county is shown in Table 3-1. The estimated quantity of water pumped (annual supply) from the Ogallala aquifer in year 2000 was 4,489,390 adft, with annual pumpage projected in year 2020 of 3,044,897 acft, projected pumpage in year 2040 of 1,565,152 acft, and annual projected pumpage in year 2060 of 1,325,057 acft (Table 3-1). The projected quantities of pumpage (supply) in each county are also shown in Table 3-1 and are the Ogallala aquifer sources of supply shown in Table 3-2 and in Section 4, Tables 4-1 through 4-21.

The estimated quantity of water in storage in the Ogallala Aquifer in 2000 was 124,653,395 acft and is projected to decline to 62,418,860 acft in 2060 (i.e., in 2060, it is projected that the quantity of water remaining in storage will be about 50.1 percent of the quantity estimated to have been in storage in 2000) (Table 3-1 and Figure 3-1). However, the estimated quantities or water remaining in storage in 2060 as shown in Table 3-1 varies widely among the counties of the region. For example, for 10 of the counties of the region (Bailey, Castro, Cochran, Deaf Smith, Gaines, Hale, Lamb, Motley, Parmer, and Yoakum) show that less than 40 percent of estimated quantities of water in storage in year 2000 are projected to be remaining in storage in 2060 (Table 3-1). For 7 counties (Briscoe, Crosby, Dickens, Floyd, Hockley, Lubbock, Swisher, and Terry), between 56 percent and about 82 percent of estimated quantities of water in storage in year 2000 are projected to remain in storage in 2060. The results for these 17 counties appear to be consistent with expectations of declining quantities of water in storage in view of the water level declines, as shown in long term water level measurements of monitoring wells in the region. However, the results for 4 counties (Dawson, Garza, and Lynn) show that more than 95 percent of estimated quantities of water in storage in year 2000 are projected to be remaining in storage in 2060. In the case of Dawson County, the quantity of water projected to remain in storage remains constant at 7,202,322 acft (Table 3-1). A similar result is shown for Garza County, with projected quantity of water in storage remaining constant at 643,700 acft (Table 3-1), and in the case of Lynn County, projected quantities of water in storage remain in the range of 3,645,979 acft/yr to 3,655,103 (Table 3-1). It appears that the calculations of quantities of water remaining in storage for Dawson, Garza, and Lynn Counties, as provided by the Southern Ogallala GAM may be the result of errors in the locations of irrigation demands, in relation to locations of areas of the counties having water in storage and therefore should be checked before making further use of the GAM model for developing water supply information for regional water planning purposes.

## Table 3-1
## Projected Quantity of Water in Storage and Projected Annual Pumpage (Supply)
## Llano Estacado Water Planning Region—Ogallala Aquifer

| County | Ogallala Aquifer<br>Quantity in Storage<br>Annual Pumpage | 2000 (ac-ft) | 2010 (ac-ft) | 2020 (ac-ft) | 2030 (ac-ft) | 2040 (ac-ft) | 2050 (ac-ft) | 2060 (ac-ft) | Percent Remaining (2000--2060) |
|---|---|---|---|---|---|---|---|---|---|
| Bailey | Quantity in Storage (acft) | 4,272,200 | 3,380,925 | 2,546,788 | 1,769,102 | 1,229,855 | 1,216,106 | 1,212,373 | 28.38% |
| Bailey | Annual Pumpage (acft/yr) | 186,162 | 110,276 | 100,461 | 95,662 | 90,331 | 86,250 | 83,125 | NA |
| Briscoe | Quantity in Storage (acft) | 2,164,466 | 2,036,351 | 1,870,525 | 1,756,762 | 1,680,434 | 1,650,541 | 1,632,676 | 75.43% |
| Briscoe | Annual Pumpage (acft/yr) | 26,952 | 22,800 | 15,867 | 9,872 | 7,460 | 5,388 | 4,888 | NA |
| Castro | Quantity in Storage (acft) | 8,801,770 | 6,895,847 | 4,238,764 | 2,254,998 | 1,223,544 | 1,054,373 | 897,274 | 10.19% |
| Castro | Annual Pumpage (acft/yr) | 513,023 | 345,762 | 283,725 | 192,530 | 85,667 | 68,616 | 58,956 | NA |
| Cochran | Quantity in Storage (acft) | 2,578,704 | 1,834,111 | 1,308,992 | 813,743 | 347,354 | 81,708 | 37,705 | 1.46% |
| Cochran | Annual Pumpage (acft/yr) | 123,115 | 78,121 | 75,030 | 72,128 | 69,255 | 23,909 | 23,909 | NA |
| Crosby | Quantity in Storage (acft) | 10,949,015 | 10,612,852 | 10,085,108 | 9,980,291 | 9,152,440 | 9,038,236 | 8,946,553 | 81.71% |
| Crosby | Annual Pumpage (acft/yr) | 113,728 | 98,017 | 94,100 | 90,352 | 86,751 | 84,239 | 80,913 | NA |
| Dawson | Quantity in Storage (acft) | 7,266,792 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 | 99.11% |
| Dawson | Annual Pumpage (acft/yr) | 152,165 | 45,213 | 37,527 | 34,566 | 31,284 | 31,257 | 31,212 | NA |
| Deaf Smith | Quantity in Storage (acft) | 7,851,767 | 6,647,546 | 5,230,982 | 4,163,213 | 3,383,867 | 3,152,925 | 3,000,017 | 38.21% |
| Deaf Smith | Annual Pumpage (acft/yr) | 388,353 | 204,814 | 170,770 | 128,079 | 88,181 | 86,200 | 81,705 | NA |
| Dickens | Quantity in Storage (acft) | 1,119,192 | 1,037,297 | 1,032,409 | 1,027,698 | 862,252 | 817,846 | 813,589 | 72.69% |
| Dickens | Annual Pumpage (acft/yr) | 10,825 | 6,247 | 6,043 | 5,869 | 5,698 | 5,549 | 5,420 | NA |
| Floyd | Quantity in Storage (acft) | 13,012,008 | 11,832,107 | 11,397,458 | 10,489,267 | 9,764,296 | 9,587,136 | 9,409,491 | 72.31% |
| Floyd | Annual Pumpage (acft/yr) | 239,572 | 138,793 | 114,294 | 103,249 | 94,917 | 90,719 | 88,098 | NA |
| Gaines | Quantity in Storage (acft) | 12,495,883 | 10,232,860 | 7,998,429 | 6,120,700 | 4,493,051 | 3,708,105 | 3,651,389 | 29.22% |
| Gaines | Annual Pumpage (acft/yr) | 424,778 | 335,917 | 275,995 | 241,173 | 213,273 | 188,235 | 165,735 | NA |
| Garza | Quantity in Storage (acft) | 662,851 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 | 97.11% |
| Garza | Annual Pumpage (acft/yr) | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 | NA |
| Hale | Quantity in Storage (acft) | 9,867,018 | 8,192,891 | 5,591,955 | 3,651,208 | 2,463,726 | 2,164,064 | 1,886,697 | 19.12% |
| Hale | Annual Pumpage (acft/yr) | 378,473 | 349,130 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 | NA |
| Hockley | Quantity in Storage (acft) | 5,480,511 | 4,993,208 | 4,432,736 | 3,965,426 | 3,615,247 | 3,591,108 | 3,533,107 | 64.47% |
| Hockley | Annual Pumpage (acft/yr) | 183,913 | 109,650 | 90,093 | 76,015 | 64,062 | 61,631 | 58,229 | NA |
| Lamb | Quantity in Storage (acft) | 8,246,693 | 6,944,619 | 5,155,582 | 3,861,385 | 2,953,511 | 2,743,521 | 2,533,373 | 30.72% |
| Lamb | Annual Pumpage (acft/yr) | 402,158 | 267,764 | 210,668 | 156,745 | 109,741 | 91,026 | 81,651 | NA |
| Lubbock | Quantity in Storage (acft) | 7,439,809 | 6,632,577 | 5,611,743 | 4,952,167 | 4,159,806 | 4,141,607 | 4,114,001 | 55.30% |
| Lubbock | Annual Pumpage (acft/yr) | 298,052 | 163,283 | 131,367 | 110,204 | 88,545 | 85,490 | 80,557 | NA |
| Lynn | Quantity in Storage (acft) | 3,786,579 | 3,645,979 | 3,655,103 | 3,655,103 | 3,655,103 | 3,655,103 | 3,655,103 | 96.53% |
| Lynn | Annual Pumpage (acft/yr) | 121,566 | 120,916 | 120,897 | 120,886 | 120,892 | 120,847 | 120,805 | NA |
| Motley | Quantity in Storage (acft) | 355,295 | 282,644 | 231,003 | 180,893 | 132,340 | 85,257 | 39,482 | 11.11% |
| Motley | Annual Pumpage (acft/yr) | 10,200 | 5,717 | 5,565 | 5,411 | 5,254 | 5,115 | 4,991 | NA |
| Parmer | Quantity in Storage (acft) | 1,775,591 | 1,228,925 | 732,604 | 512,575 | 436,291 | 416,838 | 401,421 | 22.61% |
| Parmer | Annual Pumpage (acft/yr) | 425,089 | 258,862 | 86,439 | 51,780 | 51,780 | 51,780 | 51,780 | NA |
| Swisher | Quantity in Storage (acft) | 7,568,857 | 6,816,315 | 5,837,065 | 5,156,220 | 4,622,929 | 4,392,133 | 4,184,417 | 55.28% |
| Swisher | Annual Pumpage (acft/yr) | 176,303 | 152,893 | 108,391 | 78,271 | 67,924 | 64,888 | 64,145 | NA |
| Terry | Quantity in Storage (acft) | 4,576,781 | 4,161,424 | 3,801,304 | 3,563,138 | 3,428,883 | 3,520,915 | 3,619,055 | 79.07% |
| Terry | Annual Pumpage (acft/yr) | 166,519 | 119,234 | 92,007 | 73,445 | 59,299 | 59,283 | 59,271 | NA |
| Yoakum | Quantity in Storage (acft) | 4,381,613 | 3,620,371 | 3,017,014 | 2,457,580 | 1,939,772 | 1,457,384 | 1,005,116 | 22.94% |
| Yoakum | Annual Pumpage (acft/yr) | 133,881 | 103,958 | 99,734 | 95,204 | 91,342 | 88,062 | 85,269 | NA |
| Region | Quantity in Storage (acft) | 124,653,395 | 108,874,870 | 91,621,586 | 78,177,491 | 67,390,724 | 64,320,927 | 62,418,860 | 50.07% |
| Region | Annual Pumpage (acft/yr) | 4,489,390 | 3,044,897 | 2,428,556 | 1,954,641 | 1,565,152 | 1,402,760 | 1,325,057 | NA |
| **BASIN TOTALS--QUANTITY IN STORAGE** | | | | | | | | | |
| Canadian | | 2,599 | 1,798 | 894 | 684 | 684 | 684 | 684 | 26.32% |
| Red | | 26,802,969 | 23,822,702 | 20,386,139 | 17,699,494 | 15,718,619 | 15,035,381 | 14,476,096 | 54.01% |
| Brazos | | 66,322,545 | 57,639,248 | 47,478,393 | 39,860,073 | 33,829,805 | 32,839,469 | 31,939,798 | 48.16% |
| Colorado | | 31,525,282 | 27,411,121 | 23,756,159 | 20,617,240 | 17,841,616 | 16,445,393 | 16,002,283 | 50.76% |
| **Total** | | 124,653,395 | 108,874,870 | 91,621,586 | 78,177,491 | 67,390,724 | 64,320,927 | 62,418,860 | 50.07% |
| | | | | | | | | | <><><><> |

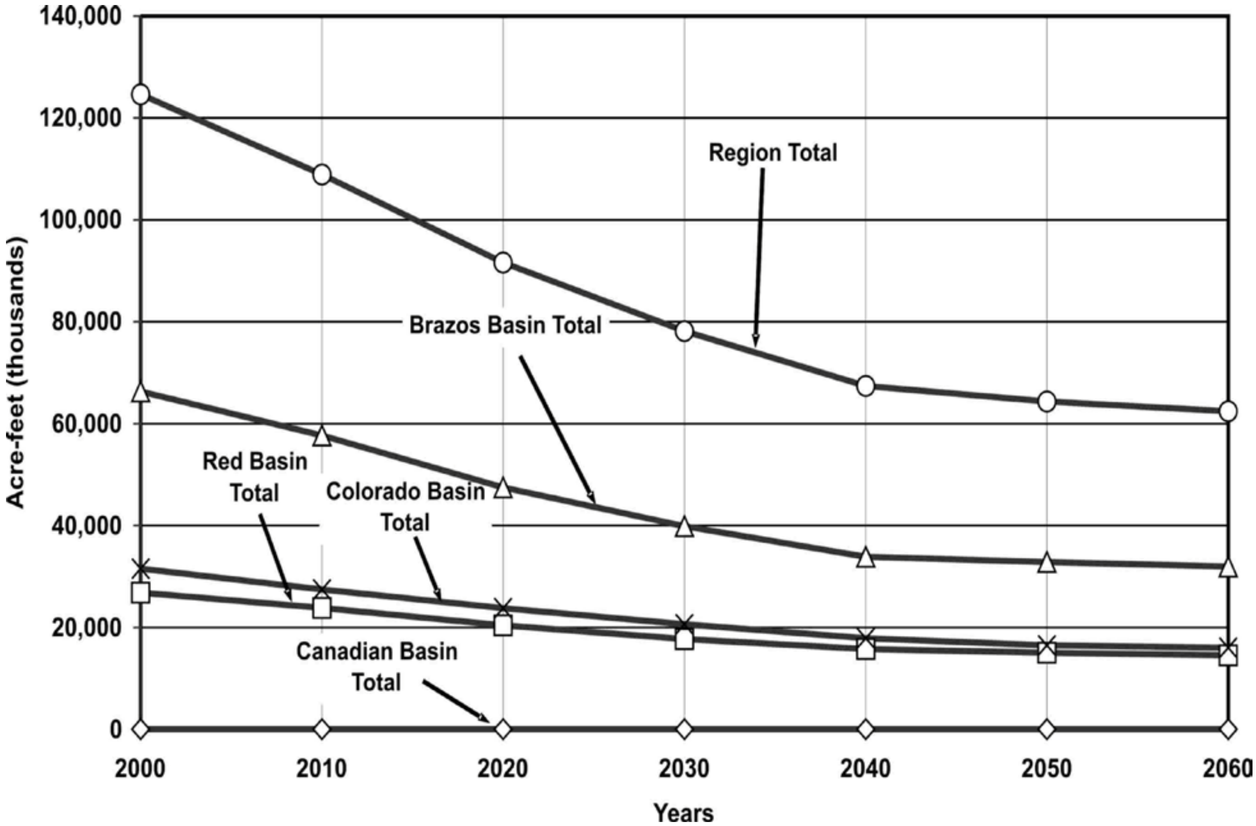


***Figure 3-1. Projected Quantity of Water in Storage—Ogallala Aquifer Llano Estacado Water Planning Region—by River Basin***

The projected annual water supply available from the Ogallala and other aquifers and other water sources to meet the projected needs in each county and river basin area of each county of the Llano Estacado Water Planning Region is presented in Table 3-2. The water supply information is explained briefly below for Bailey and Castro Counties and for the region. The explanations for Bailey and Castro Counties are illustrative as to how to read Tables 3-1 and 3-2.

The total quantity of water used in Bailey County, which is located entirely in the Brazos River Basin, in 2000 was 187,506 acft (Table 3-2). The quantity estimated to be available for use in 2010 is 111,641 acft, of which 110,276 acft are from the Ogallala Aquifer, 541 acft are from stock tanks and windmills, and 825 acft are reclaimed wastewater (Table 3-2). The projected quantity available in 2060 in Bailey County is 84,617 acft, which is only 45 percent as much as was available in 2000 (Table 3-2). The reason for the decline in quantity available between 2000 and 2060 is the decline in the quantity available from the Ogallala Aquifer (i.e., more water is being withdrawn from the aquifer than is being recharged to it).

The total quantity of water used in Castro County, which is located partially in the Red River Basin and partially in the Brazos River Basin, in 2000 was 517,384 acft (Table 3-2). The quantity estimated to be available for use in 2010 is 350,128 acft, of which 110,256 acft are from the Ogallala Aquifer in the Red River Basin and 235,507 acft are from the Ogallala Aquifer in the Brazos River Basin, 151 acft are from stock tanks and windmills in the Red River Basin and 184 acft are from stock tanks and windmills in the Brazos River Basin. In addition, in 2010 Castro County has available a projected quantity of 4,031 acft of reclaimed wastewater in the Brazos River Basin (Table 3-2). The projected quantity available in 2060 in Castro County is 63,402 acft, which is only 12 percent as much as was available in 2000, with the reason for the decline in quantity available between 2000 and 2060 the same as for Bailey County (i.e., more water is being withdrawn from the Ogallala Aquifer than is being recharged to it) (Table 3-2).

The total quantity of water used in the Llano Estacado Region in 2000 was 4,667,123 acft, of which 96.44 percent was from the Ogallala Aquifer, 0.83 percent was from Lake Meredith of the CRMWA System, and 1.09 percent was from reclaimed wastewater (Table 3-2). The estimated total quantity of water available for use in the Region in 2060 is 1,482,145 acft, or only 31.78 percent as much as was available in 2000. As was explained above for Bailey and Castro Counties, more water is being withdrawn from the Ogallala Aquifer than is being recharged to it (Table 3-2 and Figure 3-1).

The Ogallala Aquifer supplied 96 percent of the water used in the Llano Estacado Region in 2000, and even though the quantity available annually from the Ogallala Aquifer is projected to decline from 4.50 million acft/yr in 2000 to 1.33 million acft/yr in 2060, it is still projected to provide about 89.5 percent of the region's total water supply in 2060 (Table 3-1 and Figure 3-1).

**Table 3-2**
**Annual Water Supply Projections**
**Individual Counties with River Basin Summaries**
**Llano Estacado Region**

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| Bailey | Brazos | Ogallala Aquifer | 186,162 | 110,276 | 100,461 | 95,662 | 90,331 | 86,250 | 83,125 |
| Bailey | Brazos | Stock Tanks and Windmills | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Bailey | Brazos | Reclaimed | 825 | 825 | 825 | 825 | 825 | 825 | 825 |
| Bailey | | Total | 187,506 | 111,641 | 101,849 | 97,074 | 91,768 | 87,714 | 84,617 |
| Briscoe | Red | Ogallala Aquifer | 26,952 | 22,800 | 15,867 | 9,872 | 7,460 | 5,388 | 4,888 |
| Briscoe | Red | Dockum Aquifer | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Briscoe | Red | Seymour Aquifer | 4,063 | 4,063 | 4,063 | 1,821 | 1,821 | 1,821 | 1,821 |
| Briscoe | Red | Other Aquifers | 115 | 109 | 96 | 94 | 95 | 91 | 91 |
| Briscoe | Red | Stock Tanks and Windmills | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Briscoe | Red | Lake Mackenzie | 85 | 0 | 0 | 0 | 0 | 0 | 0 |
| Briscoe | | Total | 31,599 | 27,364 | 20,427 | 12,197 | 9,797 | 7,731 | 7,241 |
| Castro | Red | Ogallala Aquifer | 163,591 | 110,256 | 72,609 | 45,405 | 25,992 | 23,784 | 20,890 |
| Castro | Red | Stock Tanks and Windmills | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Castro | Brazos | Ogallala Aquifer | 349,432 | 235,507 | 211,116 | 147,124 | 59,674 | 44,832 | 38,066 |
| Castro | Brazos | Stock Tanks and Windmills | 181 | 184 | 214 | 218 | 220 | 223 | 227 |
| Castro | Brazos | Reclaimed | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 |
| Castro | | Total | 517,384 | 350,128 | 288,146 | 196,957 | 90,099 | 73,055 | 63,402 |
| Cochran | Brazos | Ogallala Aquifer | 77,961 | 44,285 | 43,420 | 36,681 | 33,797 | 12,126 | 12,157 |
| Cochran | Brazos | Stock Tanks and Windmills | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Cochran | Brazos | Reclaimed | 267 | 267 | 267 | 267 | 267 | 267 | 267 |
| Cochran | Colorado | Ogallala Aquifer | 45,154 | 33,836 | 31,610 | 35,447 | 35,458 | 11,783 | 11,752 |
| Cochran | Colorado | Stock Tanks and Windmills | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Cochran | Colorado | Reclaimed | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| Cochran | | Total | 123,542 | 78,550 | 75,511 | 72,612 | 69,742 | 24,398 | 24,401 |
| Crosby | Red | Ogallala Aquifer | 1,391 | 1,307 | 1,256 | 1,204 | 1,158 | 1,101 | 1,078 |
| Crosby | Red | Stock Tanks and Windmills | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Crosby | Brazos | Ogallala Aquifer | 112,337 | 96,710 | 92,844 | 89,147 | 85,593 | 83,138 | 79,835 |
| Crosby | Brazos | Seymour Aquifer | 483 | 483 | 483 | 474 | 474 | 474 | 474 |
| Crosby | Brazos | Stock Tanks and Windmills | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Crosby | Brazos | White River Reservoir | 707 | 707 | 707 | 707 | 707 | 389 | 8 |
| Crosby | Brazos | Reclaimed | 583 | 583 | 583 | 583 | 583 | 583 | 583 |
| Crosby | | Total | 115,796 | 100,091 | 96,179 | 92,430 | 88,836 | 86,014 | 82,314 |
| Dawson | Brazos | Ogallala Aquifer | 19 | 19 | 19 | 19 | 18 | 18 | 17 |
| Dawson | Brazos | Stock Tanks and Windmills | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Dawson | Colorado | Ogallala Aquifer | 152,146 | 45,194 | 37,508 | 34,547 | 31,266 | 31,239 | 31,195 |
| Dawson | Colorado | Ogallala (Roberts Co.) | 892 | 1,708 | 1,486 | 1,486 | 1,486 | 1,369 | 1,369 |
| Dawson | Colorado | Stock Tanks and Windmills | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Dawson | Colorado | Lake Meredith (CRMWA) | 1,694 | 854 | 1,076 | 1,076 | 1,076 | 992 | 992 |
| Dawson | | Total | 154,903 | 47,930 | 40,247 | 37,290 | 34,012 | 33,788 | 33,747 |

Continued on next page

***Table 3-2 Continued***

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| Deaf Smith | Canadian | Ogallala Aquifer | 171 | 112 | 74 | 1 | 1 | 1 | 1 |
| Deaf Smith | Canadian | Stock Tanks and Windmills | 220 | 281 | 317 | 326 | 336 | 344 | 353 |
| Deaf Smith | Red | Ogallala Aquifer | 388,182 | 204,702 | 170,696 | 128,078 | 88,180 | 86,199 | 81,704 |
| Deaf Smith | Red | Dockum Aquifer | 930 | 720 | 578 | 7,502 | 7,576 | 7,602 | 7,602 |
| Deaf Smith | Red | Stock Tanks and Windmills | 2,859 | 2,931 | 3,035 | 3,174 | 3,319 | 3,474 | 3,636 |
| Deaf Smith | Red | Reclaimed | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 |
| Deaf Smith | | Total | 395,172 | 211,556 | 177,511 | 141,891 | 102,222 | 100,430 | 96,106 |
| | | | | | | | | | |
| Dickens | Red | Ogallala Aquifer | 4,626 | 2,662 | 2,575 | 2,503 | 2,217 | 2,159 | 2,108 |
| Dickens | Red | Seymour Aquifer | 7,937 | 7,937 | 7,937 | 5,217 | 5,217 | 5,217 | 5,217 |
| Dickens | Red | Stock Tanks and Windmills | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Dickens | Brazos | Ogallala Aquifer | 6,199 | 3,585 | 3,468 | 3,366 | 3,481 | 3,390 | 3,312 |
| Dickens | Brazos | Seymour Aquifer | 4,348 | 4,348 | 4,348 | 2,858 | 2,858 | 2,858 | 2,858 |
| Dickens | Brazos | Stock Tanks and Windmills | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Dickens | Brazos | White River Reservoir | 275 | 271 | 267 | 263 | 260 | 106 | 0 |
| Dickens | | Total | 24,005 | 19,437 | 19,243 | 14,869 | 14,711 | 14,425 | 14,207 |
| | | | | | | | | | |
| Floyd | Red | Ogallala Aquifer | 101,292 | 52,505 | 32,434 | 25,205 | 21,096 | 20,270 | 19,510 |
| Floyd | Red | Stock Tanks and Windmills | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Floyd | Brazos | Ogallala Aquifer | 138,280 | 86,288 | 81,860 | 78,044 | 73,821 | 70,449 | 68,588 |
| Floyd | Brazos | Stock Tanks and Windmills | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Floyd | Brazos | Lake Mackenzie | 362 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floyd | Brazos | Reclaimed | 449 | 449 | 449 | 449 | 449 | 449 | 449 |
| Floyd | | Total | 240,835 | 139,706 | 115,219 | 104,187 | 95,868 | 91,685 | 89,079 |
| | | | | | | | | | |
| Gaines | Colorado | Ogallala Aquifer | 424,778 | 335,917 | 275,995 | 241,173 | 213,273 | 188,235 | 165,735 |
| Gaines | Colorado | Stock Tanks and Windmills | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Gaines | | Total | 425,074 | 336,221 | 276,307 | 241,493 | 213,602 | 188,573 | 166,083 |
| | | | | | | | | | |
| Garza | Brazos | Ogallala Aquifer | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 |
| Garza | Brazos | Dockum Aquifer | 136 | 136 | 136 | 136 | 136 | 136 | 136 |
| Garza | Brazos | Stock Tanks and Windmills | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Garza | Brazos | White River Reservoir | 1,021 | 1,021 | 973 | 493 | 12 | 0 | 0 |
| Garza | Brazos | Lake Alan Henry (WSD) | 0 | 540 | 540 | 540 | 540 | 540 | 540 |
| Garza | Brazos | Slaton CRMWA Supply | 0 | 306 | 306 | 306 | 306 | 306 | 306 |
| Garza | Colorado | Ogallala Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Garza | Colorado | Stock Tanks and Windmills | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Garza | | Total | 16,075 | 9,893 | 9,257 | 8,301 | 7,382 | 6,989 | 6,709 |
| | | | | | | | | | |
| Hale | Red | Ogallala Aquifer | 3,499 | 829 | 0 | 0 | 0 | 0 | 0 |
| Hale | Red | Stock Tanks and Windmills | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hale | Brazos | Ogallala Aquifer | 374,974 | 348,301 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 |
| Hale | Brazos | Ogallala (Roberts Co.) | 1,476 | 2,854 | 2,482 | 2,482 | 2,482 | 2,250 | 2,250 |
| Hale | Brazos | Stock Tanks and Windmills | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| Hale | Brazos | Lake Meredith (CRMWA) | 2,805 | 1,427 | 1,799 | 1,799 | 1,799 | 1,631 | 1,631 |
| Hale | Brazos | Reclaimed | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 |
| Hale | | Total | 388,556 | 359,221 | 312,803 | 216,915 | 137,668 | 108,448 | 98,874 |
| | | | | | | | | | |

Continued on next page

*Table 3-2 Continued*

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| Hockley | Brazos | Ogallala Aquifer | 163,639 | 96,889 | 79,415 | 67,208 | 55,876 | 53,945 | 50,540 |
| Hockley | Brazos | Ogallala (Roberts Co.) | 1,116 | 1,116 | 1,116 | 1,116 | 1,116 | 688 | 688 |
| Hockley | Brazos | Stock Tanks and Windmills | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Hockley | Brazos | Lake Meredith (CRMWA) | 2,120 | 2,120 | 2,120 | 2,120 | 2,120 | 2,120 | 2,120 |
| Hockley | Brazos | Reclaimed | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 |
| Hockley | Colorado | Ogallala Aquifer | 20,274 | 12,761 | 10,678 | 8,807 | 8,186 | 7,686 | 7,689 |
| Hockley | Colorado | Stock Tanks and Windmills | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Hockley | Colorado | Reclaimed | 162 | 162 | 162 | 162 | 162 | 162 | 162 |
| Hockley | | Total | 188,935 | 114,679 | 95,178 | 81,107 | 69,160 | 66,309 | 62,915 |
| | | | | | | | | | |
| Lamb | Brazos | Ogallala Aquifer | 402,158 | 267,764 | 210,668 | 156,745 | 109,741 | 91,026 | 81,651 |
| Lamb | Brazos | Stock Tanks and Windmills | 472 | 491 | 510 | 531 | 552 | 575 | 599 |
| Lamb | Brazos | Reclaimed | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 |
| Lamb | | Total | 409,829 | 275,454 | 218,377 | 164,475 | 117,492 | 98,801 | 89,449 |
| | | | | | | | | | |
| Lubbock | Brazos | Ogallala Aquifer | 298,052 | 163,283 | 131,367 | 110,204 | 88,545 | 85,490 | 80,557 |
| Lubbock | Brazos | Ogallala Aquifer (Bailey Co) | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 | 3,000 | 3,000 |
| Lubbock | Brazos | Ogallala (Roberts Co.) | 15,453 | 21,466 | 19,599 | 19,470 | 19,343 | 18,056 | 18,005 |
| Lubbock | Brazos | Stock Tanks and Windmills | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Lubbock | Brazos | Lake Meredith (CRMWA) | 30,082 | 11,123 | 14,861 | 14,861 | 14,861 | 14,020 | 14,020 |
| Lubbock | Brazos | Lake Alan Henry | 0 | 21,960 | 21,960 | 21,960 | 21,960 | 21,960 | 21,960 |
| Lubbock | Brazos | Reclaimed Lubbock-El Pr. | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Lubbock | Brazos | Reclaimed Lubbock-Irrig. | 7,958 | 9,166 | 0 | 0 | 0 | 0 | 0 |
| Lubbock | Brazos | Reclaimed Other Mun & Ind | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 |
| Lubbock | | Total | 373,788 | 246,693 | 204,708 | 182,175 | 159,312 | 154,255 | 150,641 |
| | | | | | | | | | |
| Lynn | Brazos | Ogallala Aquifer | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 |
| Lynn | Brazos | Edwards-Trinity (H-P Aqu) | 4,944 | 4,160 | 3,580 | 2,802 | 2,335 | 2,065 | 2,065 |
| Lynn | Brazos | Ogallala (Roberts Co.) | 184 | 548 | 477 | 477 | 477 | 417 | 417 |
| Lynn | Brazos | Stock Tanks and Windmills | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Lynn | Brazos | Lake Meredith (CRMWA) | 350 | 274 | 345 | 345 | 345 | 302 | 302 |
| Lynn | Brazos | Reclaimed (Lubbock-Irrig) | 6,496 | 6,496 | 0 | 0 | 0 | 0 | 0 |
| Lynn | Brazos | Reclaimed Other Mun & Ind | 346 | 346 | 346 | 346 | 346 | 346 | 346 |
| Lynn | Colorado | Ogallala Aquifer | 1,141 | 491 | 473 | 462 | 467 | 422 | 381 |
| Lynn | Colorado | Ogallala (Roberts Co.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lynn | Colorado | Stock Tanks and Windmills | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Lynn | Colorado | Lake Meredith (CRMWA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lynn | | Total | 134,026 | 132,884 | 125,793 | 125,008 | 124,551 | 124,138 | 124,102 |
| | | | | | | | | | |
| Motley | Red | Ogallala Aquifer | 10,200 | 5,717 | 5,565 | 5,411 | 5,254 | 5,115 | 4,991 |
| Motley | Red | Seymour Aquifer | 18,817 | 18,817 | 18,817 | 13,507 | 13,507 | 13,507 | 13,507 |
| Motley | Red | Other Aquifers | 239 | 234 | 224 | 207 | 187 | 174 | 166 |
| Motley | Red | Stock Tanks and Windmills | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Motley | | Total | 29,881 | 25,404 | 25,253 | 19,784 | 19,619 | 19,480 | 19,362 |
| | | | | | | | | | |
| Parmer | Red | Ogallala Aquifer | 135,705 | 76,545 | 26,066 | 19,901 | 36,235 | 37,658 | 35,109 |
| Parmer | Red | Stock Tanks and Windmills | 273 | 286 | 298 | 309 | 324 | 341 | 356 |
| Parmer | Red | Reclaimed | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 |
| Parmer | Brazos | Ogallala Aquifer | 289,384 | 182,317 | 60,373 | 31,879 | 15,545 | 14,122 | 16,671 |

Continued on next page

***Table 3-2 Continued***

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| Parmer | Brazos | Stock Tanks and Windmills | 530 | 551 | 575 | 601 | 626 | 651 | 680 |
| Parmer | Brazos | Reclaimed | 401 | 401 | 401 | 401 | 401 | 401 | 401 |
| Parmer | | Total | 430,779 | 264,596 | 92,219 | 57,607 | 57,657 | 57,709 | 57,763 |
| | | | | | | | | | |
| Swisher | Red | Ogallala Aquifer | 109,814 | 93,170 | 84,809 | 75,784 | 66,827 | 64,355 | 63,614 |
| Swisher | Red | Dockum Aquifer | 846 | 846 | 846 | 846 | 846 | 846 | 846 |
| Swisher | Red | Stock Tanks and Windmills | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Swisher | Red | Lake Mackenzie | 417 | 0 | 0 | 0 | 0 | 0 | 0 |
| Swisher | Brazos | Ogallala Aquifer | 66,489 | 59,724 | 23,582 | 2,488 | 1,098 | 533 | 531 |
| Swisher | Brazos | Stock Tanks and Windmills | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Swisher | Brazos | Total | 178,155 | 154,342 | 109,854 | 79,749 | 69,418 | 66,398 | 65,673 |
| | | | | | | | | | |
| Terry | Brazos | Ogallala Aquifer | 8,237 | 6,069 | 5,756 | 5,461 | 4,704 | 4,713 | 4,719 |
| Terry | Brazos | Stock Tanks and Windmills | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Terry | Colorado | Ogallala Aquifer | 158,282 | 113,165 | 86,251 | 67,983 | 54,595 | 54,570 | 54,553 |
| Terry | Colorado | Ogallala (Roberts Co.) | 879 | 1,699 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| Terry | Colorado | Stock Tanks and Windmills | 115 | 115 | 114 | 119 | 118 | 124 | 130 |
| Terry | Colorado | Lake Meredith (CRMWA) | 1,670 | 850 | 1,071 | 1,071 | 1,071 | 1,071 | 1,071 |
| Terry | | Total | 169,187 | 121,904 | 94,681 | 76,121 | 61,979 | 61,966 | 61,958 |
| | | | | | | | | | |
| Yoakum | Colorado | Ogallala Aquifer | 133,881 | 103,958 | 99,734 | 95,204 | 91,342 | 88,062 | 85,269 |
| Yoakum | Colorado | Stock Tanks and Windmills | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Yoakum | | Total | 134,095 | 104,176 | 100,007 | 95,482 | 91,624 | 88,350 | 85,562 |
| | | | | | | | | | |
| | | | | | | | | | |
| **RIVER BASINS** | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Canadian | | Ogallala Aquifer | 171 | 112 | 74 | 1 | 1 | 1 | 1 |
| Canadian | | Ogallala (Roberts Co.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Dockum Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Seymour Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Other Aquifers | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Stock Tanks and Windmills | 220 | 281 | 317 | 326 | 336 | 344 | 353 |
| Canadian | | Lake Mackenzie | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | White River Reservoir | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Lake Meredith (CRMWA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Reclaimed Lubbock-El Pr. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Reclaimed Lubbock-Irrig. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Reclaimed Other Mun & Ind | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canadian | | Total | 390 | 393 | 391 | 327 | 337 | 345 | 354 |
| | | | | | | | | | |

Continued on next page

***Table 3-2 Continued***

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| Red | | Ogallala Aquifer | 945,251 | 570,492 | 411,878 | 313,364 | 254,419 | 246,029 | 233,892 |
| Red | | Ogallala (Roberts Co.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | Dockum Aquifer | 1,876 | 1,666 | 1,524 | 8,448 | 8,522 | 8,548 | 8,548 |
| Red | | Seymour Aquifer | 30,817 | 30,817 | 30,817 | 20,545 | 20,545 | 20,545 | 20,545 |
| Red | | Other Aquifers | 354 | 343 | 320 | 301 | 282 | 265 | 257 |
| Red | | Stock Tanks and Windmills | 5,100 | 5,227 | 5,442 | 5,645 | 5,863 | 6,095 | 6,335 |
| Red | | Lake Mackenzie | 502 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | White River Reservoir | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | Lake Meredith (CRMWA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | Reclaimed Lubbock-El Pr. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | Reclaimed Lubbock-Irrig. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red | | Reclaimed Other Mun & Ind | 5,296 | 5,296 | 5,296 | 5,296 | 5,296 | 5,296 | 5,296 |
| Red | | Total | 989,196 | 613,841 | 455,277 | 353,599 | 294,927 | 286,779 | 274,873 |
| | | | | | | | | | |
| | | | | | | | | | |
| Brazos | | Ogallala Aquifer | 2,620,312 | 1,838,970 | 1,482,356 | 1,163,654 | 880,144 | 777,733 | 737,591 |
| Brazos | | Ogallala (Roberts Co.) | 18,229 | 25,984 | 23,674 | 23,545 | 23,418 | 21,411 | 21,360 |
| Brazos | | Dockum Aquifer | 136 | 136 | 136 | 136 | 136 | 136 | 136 |
| Brazos | | Seymour Aquifer | 4,831 | 4,831 | 4,831 | 3,332 | 3,332 | 3,332 | 3,332 |
| Brazos | | Edwards-Trinity (H-P Aqu) | 4,944 | 4,160 | 3,580 | 2,802 | 2,335 | 2,065 | 2,065 |
| Brazos | | Stock Tanks and Windmills | 4,088 | 4,210 | 4,446 | 4,577 | 4,716 | 4,854 | 5,003 |
| Brazos | | Lake Mackenzie | 362 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos | | White River Reservoir | 2,003 | 1,999 | 1,947 | 1,463 | 979 | 495 | 8 |
| Brazos | | Lake Meredith (CRMWA) | 35,357 | 15,250 | 19,431 | 19,431 | 19,431 | 18,379 | 18,379 |
| Brazos | | Lake Alan Henry | 0 | 22,500 | 22,500 | 22,500 | 22,500 | 22,500 | 22,500 |
| Brazos | | Reclaimed Lubbock-El Pr. | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Brazos | | Reclaimed Lubbock-Irrig. | 14,454 | 15,662 | 0 | 0 | 0 | 0 | 0 |
| Brazos | | Reclaimed Other Mun & Ind | 25,146 | 25,146 | 25,146 | 25,146 | 25,146 | 25,146 | 25,146 |
| Brazos | | Total | 2,735,638 | 1,964,068 | 1,592,487 | 1,271,776 | 988,243 | 883,273 | 844,102 |
| | | | | | | | | | |
| | | | | | | | | | |
| Colorado | | Ogallala Aquifer | 935,656 | 645,323 | 542,249 | 483,623 | 434,588 | 381,997 | 356,573 |
| Colorado | | Ogallala (Roberts Co.) | 1,771 | 3,407 | 2,964 | 2,964 | 2,964 | 2,847 | 2,847 |
| Colorado | | Dockum Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Seymour Aquifer | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Other Aquifers | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Stock Tanks and Windmills | 918 | 936 | 1,045 | 1,068 | 1,086 | 1,113 | 1,144 |
| Colorado | | Lake Mackenzie | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | White River Reservoir | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Lake Meredith (CRMWA) | 3,364 | 1,704 | 2,147 | 2,147 | 2,147 | 2,063 | 2,063 |
| Colorado | | Reclaimed Lubbock-El Pr. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Reclaimed Lubbock-Irrig. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado | | Reclaimed Other Mun & Ind | 189 | 189 | 189 | 189 | 189 | 189 | 189 |
| | | Total | 941,899 | 651,558 | 548,594 | 489,991 | 440,974 | 388,209 | 362,816 |
| | | | | | | | | | |

Continued on next page

***Table 3-2 Concluded***

| Counties | River Basin | Source | 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **LLANO ESTACADO REGION ---- TOTALS** | | | | | | | | | |
| Region | | Ogallala Aquifer | 4,501,390 | 3,054,897 | 2,436,556 | 1,960,641 | 1,569,152 | 1,405,760 | 1,328,057 |
| Region | | Ogallala (Roberts Co.) | 20,000 | 29,391 | 26,638 | 26,509 | 26,382 | 24,258 | 24,207 |
| Region | | Dockum Aquifer | 2,012 | 1,802 | 1,660 | 8,584 | 8,658 | 8,684 | 8,684 |
| Region | | Seymour Aquifer | 35,648 | 35,648 | 35,648 | 23,877 | 23,877 | 23,877 | 23,877 |
| Region | | Other Aquifers | 5,298 | 4,503 | 3,900 | 3,103 | 2,617 | 2,330 | 2,322 |
| Region | | Stock Tanks and Windmills | 10,326 | 10,653 | 11,250 | 11,616 | 12,000 | 12,406 | 12,835 |
| Region | | Lake Mackenzie | 864 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region | | White River Reservoir | 2,003 | 1,999 | 1,947 | 1,463 | 979 | 495 | 8 |
| Region | | Lake Meredith (CRMWA) | 38,721 | 16,954 | 21,578 | 21,578 | 21,578 | 20,442 | 20,442 |
| Region | | Lake Alan Henry | 0 | 22,500 | 22,500 | 22,500 | 22,500 | 22,500 | 22,500 |
| Region | | Reclaimed Lubbock-El Pr. | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Region | | Reclaimed Lubbock-Irrig. | 14,454 | 15,662 | 0 | 0 | 0 | 0 | 0 |
| Region | | Reclaimed Other Mun & Ind | 30,631 | 30,631 | 30,631 | 30,631 | 30,631 | 30,631 | 30,631 |
| Region | | Total | 4,667,123 | 3,229,860 | 2,596,748 | 2,115,693 | 1,724,480 | 1,558,605 | 1,482,145 |
| **LLANO ESTACADO REGION --- Percent of Total** | | | | | | | | | |
| Region | | Ogallala Aquifer | 96.45% | 94.58% | 93.83% | 92.67% | 90.99% | 90.19% | 89.60% |
| Region | | Ogallala (Roberts Co.) | 0.43% | 0.91% | 1.03% | 1.25% | 1.53% | 1.56% | 1.63% |
| Region | | Dockum Aquifer | 0.04% | 0.06% | 0.06% | 0.41% | 0.50% | 0.56% | 0.59% |
| Region | | Seymour Aquifer | 0.76% | 1.10% | 1.37% | 1.13% | 1.38% | 1.53% | 1.61% |
| Region | | Other Aquifers | 0.11% | 0.14% | 0.15% | 0.15% | 0.15% | 0.15% | 0.16% |
| Region | | Stock Tanks and Windmills | 0.22% | 0.33% | 0.43% | 0.55% | 0.70% | 0.80% | 0.87% |
| Region | | Lake Mackenzie | 0.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Region | | White River Reservoir | 0.04% | 0.06% | 0.07% | 0.07% | 0.06% | 0.03% | 0.00% |
| Region | | Lake Meredith (CRMWA) | 0.83% | 0.52% | 0.83% | 1.02% | 1.25% | 1.31% | 1.38% |
| Region | | Lake Alan Henry | 0.00% | 0.70% | 0.87% | 1.06% | 1.30% | 1.44% | 1.52% |
| Region | | Reclaimed Lubbock-El Pr. | 0.12% | 0.16% | 0.17% | 0.25% | 0.35% | 0.46% | 0.58% |
| Region | | Reclaimed Lubbock-Irrig. | 0.31% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Region | | Reclaimed Other Mun & Ind | 0.66% | 0.95% | 1.18% | 1.45% | 1.78% | 1.97% | 2.07% |
| Region | | Total | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |
| | | | | | | | | | <><><><> |

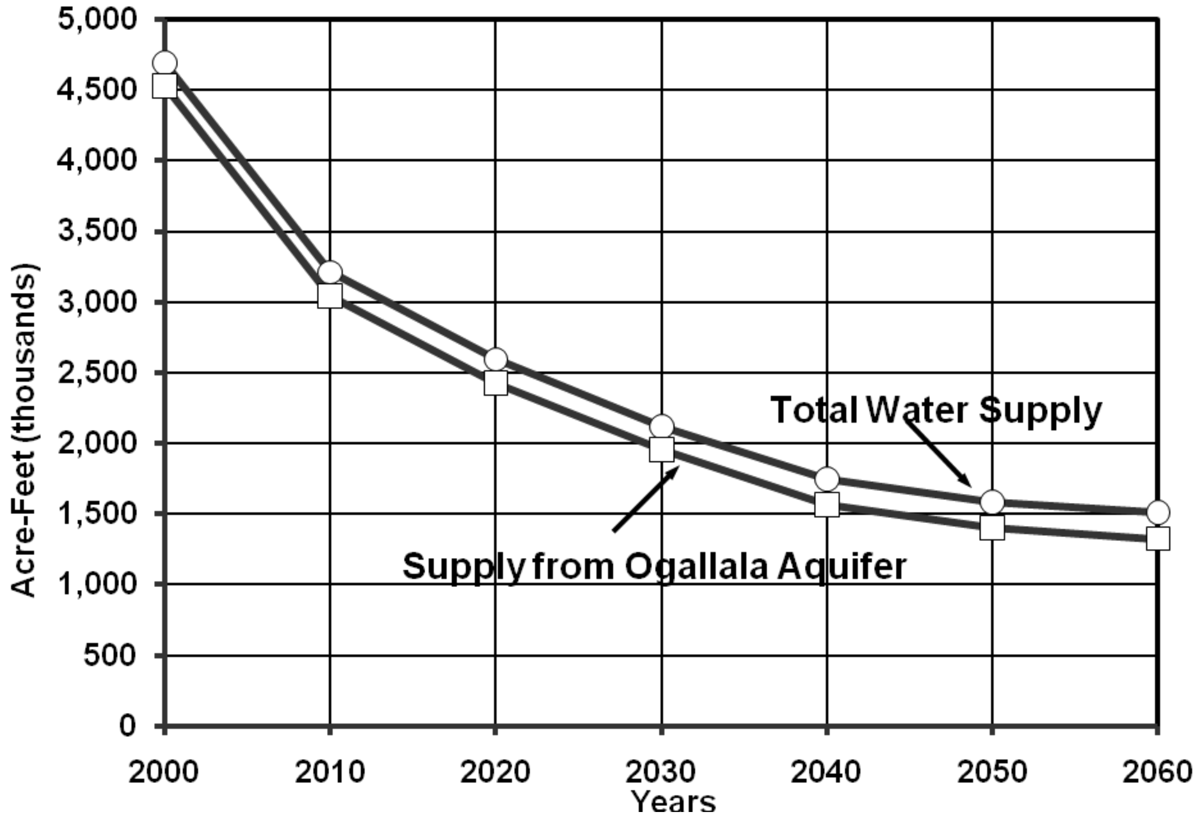


***Figure 3-2. Projected Annual Water Supply for the Llano Estacado Water Planning Region***

It is reiterated that the quantity of water available from the Ogallala and the quantity remaining in storage at each of the projection dates was calculated using the TWDB GAM, and is based upon the capability of the aquifer to yield water to the wells presently in place. If the number of water wells is increased in future years, the Model Runs could result in larger quantities of water available per year in the early years of the projections, but due to the fact that pumpage is much greater than recharge, water availability would be lower in later years. The calculated quantity that could be pumped for use by water user groups for each county-basin area for each projected year is less than the projected water demands for the same area (i.e., water supplies available annually are projected to be less than projected water demands) (Table 3-1).

# Section 4
# Identification, Evaluation, and Selection of Water Management Strategies Based on Needs [31 TAC §357.7(a)(5-7)]

## 4.1 Water Needs Projections by Water User Group

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections are tabulated by river basin, county or part of county located within each river basin, and city and rural areas of each county or part of county for the Llano Estacado Region (Tables 4-1 through 4-22). The water demands by river basin and water user group were brought forward from Section 2, Population and Water Demand Projections, Tables 2-4 through 2-12. The water supplies were brought forward from Section 3, Water Supply Projections for the Planning Region, Tables 3-1 and 3-2.

An illustration of how to read Tables 4-1 through 4-22 is given below. For example, as shown in Table 4-3, a portion of Castro County is located in the Red River Basin, and a portion is located in the Brazos River Basin. The county's projected water supplies are shown by river basin for each decade of the planning period (Table 4-3). The total projected water supplies available to Castro County in 2000 were 517,384 acft, of which 163,740 acft were located in the Red Basin and 353,644 acft were located in the Brazos Basin. Of the total projected water supply of 350,128 acft in 2010 for Castro County, 345,762 acft is projected to be available from the Ogallala Aquifer (Table 4-3). Castro County is not projected to obtain water from any other aquifers during the planning period. However, in addition to the projected groundwater supplies, Castro County is projected to obtain 4,031 acft of reclaimed water and 335 acft of water from local supplies for range and all other livestock use in 2010 (Table 4-3).

That part of Castro County located in the Brazos River Basin contains the cities of Dimmitt and Hart, and rural areas. The projected municipal water demand for Dimmitt is 1,041 acft in 2010 and 1,130 acft in 2060, while the projected municipal water supply for Dimmitt is 1,041 acft in 2010, 1,540 acft in 2020, and 286 acft in 2060 (Table 4-3). Comparing the projected demands with the projected supplies for Dimmitt in Castro County results in a surplus/shortage of zero acft in 2010, a surplus of 437 acft in 2020, a shortage of 744 acft in 2030, a shortage of 805 acft in 2040, a shortage of 832 acft in 2050, and a shortage of 844 in 2060 (Table 4-3). This type of analysis is shown for each water user group for each county located within the Llano Estacado Region, and is the source of information as to time additional water supply is needed, and the quantity needed by each water user group. In Section 4.5, water plans to meet the projected needs (shortages) are presented.

Total projections for counties and parts of counties of each river basin area located in the Llano Estacado Region are shown at the end of each county's supplies and needs analysis table. In addition, the basin totals are listed in Table 4-22. For example, total water supply in the Red River Basin is projected to be 616,680 acft in 2010, of which 8,045 acft is for municipal purposes, 6,239 acft is for industrial purposes, 550,845 acft is for irrigation purposes, 50 acft is for mining purposes, 17,958 is for beef feedlot livestock purposes, 2,884 acft is for dairies, and 5,419 is for range and all other livestock purposes (Table 4-22). In 2010 the Red River Basin part of the Llano Estacado Region is projected to have an irrigation water shortage of 332,903 acft and in 2060 is projected to have an irrigation shortage of 558,961 acft (Table 4-22).

The reader can readily see the projections for water demand, water supply, and surplus/shortage, by type of demand, for the Canadian, Red, Brazos, and Colorado River Basin areas of the Llano Estacado Region (Table 4-22).

Total estimated water supply in the Llano Estacado Region in 2000 was 4,654,963 acft and in 2060 is 1,441,846 acft (Table 4-22). The projected water supply in 2060 is 90,204 acft for municipal use, 19,919 acft for industrial use, 49,910 acft for steam-electric use, 1,204,352 acft for irrigation use, 258 acft for mining use, 32,621 acft for beef feedlot livestock use, 10,934 acft for dairies, and 12,834 acft for range and other livestock use. In 2010, the Llano Estacado Region is projected to have a municipal water surplus of 7,804 acft and an irrigation water shortage of 1,245,326 acft; in 2060 the region is projected to have a municipal water shortage of 15,736 acft and an irrigation water shortage of 2,269,811 acft (Table 4-22).

Of the 169 water user groups of the region (73 municipalities and rural domestic users, 13 industry groups, 3 steam-electric users, 21 counties with irrigation use, 14 counties with mining water use, 12 counties with beef feed-lot uses, 12 counties with dairy uses, and 21 counties with range and other livestock uses), it has been calculated that 59 will have a shortage sometime during the 50-year projection period. Of the estimated 59 water user groups showing shortages, 29 are municipalities, one (Lake Alan Henry WSD) will serve the area around Lake Alan Henry, 20 are counties in which projected irrigation water demands exceed projected irrigation water supplies, 5 are counties in which 30 beef feedlots are projected to have shortages, and 4 are counties in which 20 dairies are projected to have shortages.

## *Table 4-1.*
## *Projected Water Demands, Supplies, and Needs*
## *Bailey County*
## *Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 4,272,200 | 3,380,925 | 2,546,788 | 1,769,102 | 1,229,855 | 1,216,106 | 1,212,373 |
| | Quantity Pumped[2] | Ogallala | 186,162 | 110,276 | 100,461 | 95,662 | 90,331 | 86,250 | 83,125 |
| | Supply | (Ogallala)[3] | 186,162 | 110,276 | 100,461 | 95,662 | 90,331 | 86,250 | 83,125 |
| | Local Surface | Stock Tanks and Windmills | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| | Reclaimed Water[4] | | 825 | 825 | 825 | 825 | 825 | 825 | 825 |
| | Total Supply | | 187,506 | 111,641 | 101,849 | 97,074 | 91,768 | 87,714 | 84,617 |
| | Supply from Ogallala (Bailey County) | | 174,162 | 100,276 | 92,461 | 89,662 | 86,331 | 83,250 | 80,125 |
| Data LERWPG | Supply from Ogallala (To Lubbock County)[5] | | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 | 3,000 | 3,000 |
| Oct. 28, 04 | Total Supply from Ogallala | | 186,162 | 110,276 | 100,461 | 95,662 | 90,331 | 86,250 | 83,125 |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Muleshoe | | | 979 | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| Rural | | | 331 | 342 | 358 | 364 | 371 | 370 | 363 |
| | Subtotal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Total Municipal Demand | | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Muleshoe | | Ogallala | 979 | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| Rural | | Ogallala | 331 | 342 | 358 | 364 | 371 | 370 | 363 |
| | Subtotal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Total Municipal Existing Supply | | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Muleshoe | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Muleshoe | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Total Industrial Demand | | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Total Industrial Existing Supply | | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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***Table 4-1 Continued***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Brazos Basin | | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| Total Irrigation Demand | | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 171,384 | 96,092 | 87,651 | 84,546 | 80,885 | 77,486 | 74,026 |
| | Reclaimed Water | 825 | 825 | 825 | 825 | 825 | 825 | 825 |
| Total Irrigation Supply | | 172,209 | 96,917 | 88,476 | 85,371 | 81,710 | 78,311 | 74,851 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |
| Total Irrigation Surplus/Shortage | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Total Beef Feedlot Livestock Demand | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Total Beef Feedlot Livestock Supply | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Total Dairies Demand | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Total Dairies Supply | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total Range & All Other Livestock Demand | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total Range & All Other Livestock Supply | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Industrial | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |

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### *Table 4-1 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| Dairies | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Range & All Other Livestock | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total County Demand | | 186,162 | 183,203 | 179,571 | 175,721 | 171,997 | 168,361 | 164,837 |
| | | | | | | | | |
| **Total Supply** | | | | | | | | |
| Municipal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Industrial | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 172,209 | 96,917 | 88,476 | 85,371 | 81,710 | 78,311 | 74,851 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Dairies | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Range & All Other Livestock | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total County Supply | | 175,506 | 101,641 | 93,849 | 91,074 | 87,768 | 84,714 | 81,617 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total County Surplus/Shortage | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Industrial | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Dairies | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Range & All Other Livestock | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total Brazos Basin Demand | | 186,162 | 183,203 | 179,571 | 175,721 | 171,997 | 168,361 | 164,837 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,310 | 1,369 | 1,440 | 1,473 | 1,508 | 1,505 | 1,477 |
| Industrial | | 264 | 303 | 316 | 326 | 335 | 343 | 365 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 172,209 | 96,917 | 88,476 | 85,371 | 81,710 | 78,311 | 74,851 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 971 | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| Dairies | | 233 | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| Range & All Other Livestock | | 519 | 541 | 563 | 587 | 612 | 639 | 667 |
| Total Brazos Basin Supply | | 175,506 | 101,641 | 93,849 | 91,074 | 87,768 | 84,714 | 81,617 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | -10,656 | -81,561 | -85,721 | -84,647 | -84,229 | -83,647 | -83,220 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Muleshoe and Minsa Southwest. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entites, the quantity was calculated as 75 percent of the maximum waste discharge permit.

[5] The annual use goal is 10,000 acft/yr or less, in order to conserve the source. Modeling analyses show that by 2050 the quantity of water available will decrease to the estimated recharge level of 3,000 acft/yr.

<><><>

## *Table 4-2.*
## *Projected Water Demands, Supplies, and Needs*
## *Briscoe County*
## *Llano Estacado Region*

| Demand | Updated 6-4-09 | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 2,164,466 | 2,036,351 | 1,870,525 | 1,756,762 | 1,680,434 | 1,650,541 | 1,632,676 |
| | Quantity Pumped[2] | Ogallala | 26,952 | 22,800 | 15,867 | 9,872 | 7,460 | 5,388 | 4,888 |
| | Supply | (Ogallala)[3] | 26,952 | 22,800 | 15,867 | 9,872 | 7,460 | 5,388 | 4,888 |
| | Dockum Aquifer | | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Seymour Aquifer | | 4,063 | 4,063 | 4,063 | 1,821 | 1,821 | 1,821 | 1,821 |
| | Other Aquifers | | 115 | 109 | 96 | 94 | 95 | 91 | 91 |
| | Local Surface | Stock Tanks and Windmills | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| | Other Surface | Lake Mackenzie | 85 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 31,599 | 27,364 | 20,427 | 12,197 | 9,797 | 7,731 | 7,241 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Silverton | | | 126 | 128 | 128 | 123 | 115 | 111 | 108 |
| Rural | Includes Quitaque demands | | 180 | 183 | 183 | 176 | 165 | 159 | 155 |
| | Subtotal | | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| Total Municipal Demand | | | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Silverton | | Ogallala | 41 | 204 | 183 | 165 | 148 | 134 | 120 |
| | | Lake Mackenzie | 85 | 0 | 0 | 0 | 0 | 0 | 0 |
| Silverton Subtotal | | | 126 | 204 | 183 | 165 | 148 | 134 | 120 |
| Rural | Includes Quitaque supply | Ogallala + other | 295 | 295 | 295 | 295 | 295 | 295 | 295 |
| | Subtotal | | 421 | 499 | 478 | 460 | 443 | 429 | 415 |
| Total Municipal Existing Supply | | | 421 | 499 | 478 | 460 | 443 | 429 | 415 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Silverton | | | 0 | 76 | 55 | 42 | 33 | 23 | 12 |
| Rural | | | 115 | 112 | 112 | 119 | 130 | 136 | 140 |
| | Subtotal | | 115 | 188 | 167 | 161 | 163 | 159 | 152 |
| Total Municipal Surplus/Shortage | | | 115 | 188 | 167 | 161 | 163 | 159 | 152 |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | Silverton | Replace present supply (Re: WQ) | | 128 | 128 | 123 | 115 | 111 | 108 |
| Silverton | | Revise WQ Problem | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-2 Continued***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Steam-Electric Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Red Basin | | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| Total Irrigation Demand | | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| **Irrigation Supply** | | | | | | | | |
| Red Basin | Ogallala | 26,624 | 22,539 | 15,606 | 9,616 | 7,212 | 5,144 | 4,647 |
| | Dockum | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Seymour | 4,063 | 4,063 | 4,063 | 1,821 | 1,821 | 1,821 | 1,821 |
| Total Irrigation Supply | | 30,787 | 26,702 | 19,769 | 11,537 | 9,133 | 7,065 | 6,568 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Red Basin | | 4,458 | 1,329 | -4,684 | -12,029 | -13,577 | -14,821 | -14,523 |
| Total Irrigation Surplus/Shortage | | 4,458 | 1,329 | -4,684 | -12,029 | -13,577 | -14,821 | -14,523 |
| **Mining Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Total Dairies Demand | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| **Dairies Supply** | | | | | | | | |
| Red Basin | Ogallala | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Total Dairies Supply | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total Range & All Other Livestock Demand | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total Range & All Other Livestock Supply | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |

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### *Table 4-2 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Range & All Other Livestock | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total County Demand | | 26,952 | 26,009 | 25,098 | 24,208 | 23,343 | 22,519 | 21,728 |
| | | | | | | | | |
| **Total Supply** | Unallocated | 115 | 109 | 96 | 94 | 95 | 91 | 91 |
| Municipal | | 421 | 499 | 478 | 460 | 443 | 429 | 415 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 30,787 | 26,702 | 19,769 | 11,537 | 9,133 | 7,065 | 6,568 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Range & All Other Livestock | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total County Supply | | 31,640 | 27,635 | 20,677 | 12,434 | 10,024 | 7,948 | 7,448 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 115 | 188 | 167 | 161 | 163 | 159 | 152 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 4,458 | 1,329 | -4,684 | -12,029 | -13,577 | -14,821 | -14,523 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 4,573 | 1,517 | -4,517 | -11,868 | -13,414 | -14,662 | -14,371 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 306 | 311 | 311 | 299 | 280 | 270 | 263 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Range & All Other Livestock | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total Red Basin Demand | | 26,952 | 26,009 | 25,098 | 24,208 | 23,343 | 22,519 | 21,728 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | Unallocated | 115 | 109 | 96 | 94 | 95 | 91 | 91 |
| Municipal | | 421 | 499 | 478 | 460 | 443 | 429 | 415 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 30,787 | 26,702 | 19,769 | 11,537 | 9,133 | 7,065 | 6,568 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Range & All Other Livestock | | 284 | 292 | 301 | 310 | 320 | 330 | 341 |
| Total Red Basin Supply | | 31,640 | 27,635 | 20,677 | 12,434 | 10,024 | 7,948 | 7,448 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 115 | 188 | 167 | 161 | 163 | 159 | 152 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 4,458 | 1,329 | -4,684 | -12,029 | -13,577 | -14,821 | -14,523 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | 4,573 | 1,517 | -4,517 | -11,868 | -13,414 | -14,662 | -14,371 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid. 3 Supply means quantity of water available from the Ogallala Aquifer in the year projected.

4 Silverton's present supply from existing wells must be replaced due to high arsenic levels. In the water supply accounting, this is an exchange for other sources. <><><>

**Table 4-3.**
**Projected Water Demands, Supplies, and Needs**
**Castro County**
**Llano Estacado Region**

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 2,817,626 | 2,222,567 | 1,460,181 | 991,079 | 743,569 | 678,750 | 633,894 |
| | Quantity Pumped[2] | Ogallala | 163,591 | 110,256 | 72,609 | 45,405 | 25,992 | 23,784 | 20,890 |
| | Supply | (Ogallala)[3] | 163,591 | 110,256 | 72,609 | 45,405 | 25,992 | 23,784 | 20,890 |
| | Local Surface | Stock Tanks and Windmills | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 163,740 | 110,406 | 72,785 | 45,584 | 26,174 | 23,969 | 21,078 |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 5,984,144 | 4,673,280 | 2,778,583 | 1,263,919 | 479,975 | 375,623 | 263,380 |
| | Quantity Pumped[2] | Ogallala | 349,432 | 235,507 | 211,116 | 147,124 | 59,674 | 44,832 | 38,066 |
| | Supply | (Ogallala)[3] | 349,432 | 235,507 | 211,116 | 147,124 | 59,674 | 44,832 | 38,066 |
| | Local Surface | Stock Tanks and Windmills | 181 | 184 | 214 | 218 | 220 | 223 | 227 |
| | Reclaimed Water[4] | | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 |
| | Total Supply | | 353,644 | 239,722 | 215,362 | 151,373 | 63,926 | 49,086 | 42,323 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 8,801,770 | 6,895,847 | 4,238,764 | 2,254,998 | 1,223,544 | 1,054,373 | 897,274 |
| | Quantity Pumped[2] | Ogallala | 513,023 | 345,762 | 283,725 | 192,530 | 85,667 | 68,616 | 58,956 |
| | Supply | (Ogallala)[3] | 513,023 | 345,762 | 283,725 | 192,530 | 85,667 | 68,616 | 58,956 |
| | Local Surface | Stock Tanks and Windmills | 330 | 335 | 390 | 396 | 402 | 408 | 414 |
| | Reclaimed Water[4] | | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 |
| | Total Supply | | 517,384 | 350,128 | 288,146 | 196,957 | 90,099 | 73,055 | 63,402 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| | Subtotal | | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Brazos Basin | | | | | | | | | |
| Dimmitt | | | 975 | 1,041 | 1,103 | 1,137 | 1,159 | 1,150 | 1,130 |
| Hart | | | 223 | 238 | 251 | 258 | 262 | 260 | 256 |
| Rural | | | 208 | 222 | 234 | 240 | 243 | 241 | 237 |
| | Subtotal | | 1,406 | 1,501 | 1,588 | 1,635 | 1,664 | 1,651 | 1,623 |
| Total Municipal Demand | | | 1,653 | 1,764 | 1,866 | 1,920 | 1,952 | 1,937 | 1,904 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | Ogallala | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| | Subtotal | | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Brazos Basin | | | | | | | | | |
| Dimmitt | | Ogallala | 975 | 1,041 | 1,540 | 393 | 354 | 318 | 286 |
| Hart | | Ogallala | 223 | 238 | 251 | 258 | 262 | 193 | 174 |
| Rural | | Ogallala | 208 | 222 | 234 | 240 | 243 | 241 | 237 |
| | Subtotal | | 1,406 | 1,501 | 2,025 | 891 | 859 | 752 | 697 |
| Total Municipal Existing Supply | | | 1,653 | 1,764 | 2,303 | 1,176 | 1,147 | 1,038 | 978 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Dimmitt | | | 0 | 0 | 437 | -744 | -805 | -832 | -844 |
| Hart | | | 0 | 0 | 0 | 0 | 0 | -67 | -82 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 437 | -744 | -805 | -899 | -926 |
| Total Municipal Surplus/Shortage | | | 0 | 0 | 437 | -744 | -805 | -899 | -926 |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-3 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Projections | | | | | |
| Brazos Basin | | | | | | | | | |
| Dimmitt | | | 0 | 0 | 0 | 744 | 805 | 832 | 844 |
| Hart | | | 0 | 0 | 0 | 0 | 0 | 67 | 82 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 744 | 805 | 899 | 926 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 744 | 805 | 899 | 926 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 95 | 112 | 121 | 128 | 136 | 142 | 152 |
| Brazos Basin | | | 1,637 | 1,923 | 2,082 | 2,213 | 2,337 | 2,445 | 2,617 |
| Total Industrial Demand | | | 1,732 | 2,035 | 2,203 | 2,341 | 2,473 | 2,587 | 2,769 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 95 | 112 | 121 | 128 | 136 | 142 | 152 |
| Brazos Basin | | Ogallala | 1,637 | 1,923 | 2,082 | 2,213 | 2,337 | 2,445 | 2,617 |
| Total Industrial Existing Supply | | | 1,732 | 2,035 | 2,203 | 2,341 | 2,473 | 2,587 | 2,769 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 166,251 | 159,877 | 153,748 | 147,853 | 142,184 | 136,733 | 131,491 |
| Brazos Basin | | | 337,541 | 324,598 | 312,154 | 300,186 | 288,677 | 277,609 | 266,966 |
| Total Irrigation Demand | | | 503,792 | 484,475 | 465,902 | 448,039 | 430,861 | 414,342 | 398,457 |
| **Irrigation Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 160,038 | 106,357 | 68,873 | 42,660 | 25,028 | 23,039 | 20,113 |
| Brazos Basin | | Ogallala | 344,084 | 227,392 | 201,208 | 137,499 | 50,509 | 35,268 | 28,147 |
| Brazos Basin | | Reclaimed Water | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 | 4,031 |
| Brazos Basin Subtotal | | | 348,115 | 231,423 | 205,239 | 141,530 | 54,540 | 39,299 | 32,178 |
| Total Irrigation Supply | | | 508,153 | 337,780 | 274,112 | 184,190 | 79,568 | 62,338 | 52,291 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | -6,213 | -53,520 | -84,875 | -105,193 | -117,156 | -113,694 | -111,378 |
| Brazos Basin | | | 10,574 | -93,175 | -106,915 | -158,656 | -234,137 | -238,310 | -234,788 |
| Total Irrigation Surplus/Shortage | | | 4,361 | -146,695 | -191,790 | -263,849 | -351,293 | -352,004 | -346,166 |
| **Mining Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

### *Table 4-3 Continued*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 3,145 | 3,834 | 4,299 | 4,563 | 4,845 | 5,143 | 5,461 |
| Brazos Basin | | 2,225 | 2,712 | 3,040 | 3,228 | 3,427 | 3,638 | 3,862 |
| Total Beef Feedlot Livestock Demand | | 5,370 | 6,546 | 7,339 | 7,791 | 8,272 | 8,782 | 9,323 |
| | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | Ogallala | 3,145 | 3,834 | 4,299 | 4,563 | 3,993 | 3,936 | 4,179 |
| Brazos Basin | Ogallala | 2,225 | 2,712 | 2,281 | 1,616 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 5,370 | 6,546 | 6,580 | 6,179 | 3,993 | 3,936 | 4,179 |
| | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | -852 | -1,207 | -1,282 |
| Brazos Basin | | 0 | 0 | -759 | -1,612 | -3,427 | -3,638 | -3,862 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | -759 | -1,612 | -4,279 | -4,846 | -5,144 |
| | | | | | | | | |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 66 | 664 | 863 | 954 | 1,054 | 1,163 | 1,285 |
| Brazos Basin | | 80 | 812 | 1,056 | 1,166 | 1,289 | 1,424 | 1,573 |
| Total Dairies Demand | | 146 | 1,476 | 1,920 | 2,120 | 2,343 | 2,587 | 2,857 |
| | | | | | | | | |
| **DairiesSupply** | | | | | | | | |
| Red Basin | Ogallala | 66 | 664 | 863 | 954 | 1,054 | 1,163 | 1,285 |
| Brazos Basin | Ogallala | 80 | 812 | 1,056 | 716 | 540 | 317 | 344 |
| Total Dairies Supply | | 146 | 1,476 | 1,920 | 1,670 | 1,594 | 1,480 | 1,629 |
| | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | -450 | -749 | -1,107 | -1,229 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | -450 | -749 | -1,107 | -1,228 |
| | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Brazos Basin | | 181 | 184 | 214 | 218 | 220 | 223 | 228 |
| Total Range & All Other Livestock Demand | | 330 | 335 | 390 | 396 | 402 | 408 | 416 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Brazos Basin | Local | 181 | 184 | 214 | 218 | 220 | 223 | 228 |
| Total Range & All Other Livestock Supply | | 330 | 335 | 390 | 396 | 402 | 408 | 416 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,653 | 1,764 | 1,866 | 1,920 | 1,952 | 1,937 | 1,904 |
| Industrial | | 1,732 | 2,035 | 2,203 | 2,341 | 2,473 | 2,587 | 2,769 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 503,792 | 484,475 | 465,902 | 448,039 | 430,861 | 414,342 | 398,457 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 5,370 | 6,546 | 7,339 | 7,791 | 8,272 | 8,782 | 9,323 |
| Dairies | | 146 | 1,476 | 1,920 | 2,120 | 2,343 | 2,587 | 2,857 |
| Range & All Other Livestock | | 330 | 335 | 390 | 396 | 402 | 408 | 416 |
| Total County Demand | | 513,023 | 496,631 | 479,620 | 462,608 | 446,302 | 430,643 | 415,726 |
| | | | | | | | | |
| **Total Supply** | | | | | | | | |
| Municipal | | 1,653 | 1,957 | 2,496 | 1,369 | 1,340 | 1,038 | 978 |
| Industrial | | 1,732 | 2,035 | 2,203 | 2,341 | 2,473 | 2,587 | 2,769 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 508,153 | 337,780 | 274,112 | 184,190 | 79,568 | 62,338 | 52,291 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-3 Continued***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| Beef Feedlot Livestock | | 5,370 | 6,546 | 6,580 | 6,179 | 3,993 | 3,936 | 4,179 |
| Dairies | | 146 | 1,476 | 1,920 | 1,670 | 1,594 | 1,480 | 1,629 |
| Range & All Other Livestock | | 330 | 335 | 390 | 396 | 402 | 408 | 416 |
| Total County Supply | | 517,384 | 350,129 | 287,701 | 196,146 | 89,369 | 71,787 | 62,262 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 193 | 630 | -551 | -612 | -899 | -926 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 4,361 | -146,695 | -191,790 | -263,849 | -351,293 | -352,004 | -346,166 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | -759 | -1,612 | -4,279 | -4,846 | -5,144 |
| Dairies | | 0 | 0 | 0 | -450 | -749 | -1,107 | -1,228 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 4,361 | -146,502 | -191,919 | -266,462 | -356,933 | -358,856 | -353,464 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Industrial | | 95 | 112 | 121 | 128 | 136 | 142 | 152 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 166,251 | 159,877 | 153,748 | 147,853 | 142,184 | 136,733 | 131,491 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 3,145 | 3,834 | 4,299 | 4,563 | 4,845 | 5,143 | 5,461 |
| Dairies | | 66 | 664 | 863 | 954 | 1,054 | 1,163 | 1,285 |
| Range & All Other Livestock | | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Total Red Basin Demand | | 169,953 | 164,901 | 159,485 | 153,962 | 148,688 | 143,652 | 138,857 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,406 | 1,501 | 1,588 | 1,635 | 1,664 | 1,651 | 1,623 |
| Industrial | | 1,637 | 1,923 | 2,082 | 2,213 | 2,337 | 2,445 | 2,617 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 337,541 | 324,598 | 312,154 | 300,186 | 288,677 | 277,609 | 266,966 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,225 | 2,712 | 3,040 | 3,228 | 3,427 | 3,638 | 3,862 |
| Dairies | | 80 | 812 | 1,056 | 1,166 | 1,289 | 1,424 | 1,573 |
| Range & All Other Livestock | | 181 | 184 | 214 | 218 | 220 | 223 | 228 |
| Total Brazos Basin Demand | | 343,070 | 331,730 | 320,135 | 308,645 | 297,614 | 286,991 | 276,869 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 247 | 263 | 278 | 285 | 288 | 286 | 281 |
| Industrial | | 95 | 112 | 121 | 128 | 136 | 142 | 152 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 160,038 | 106,357 | 68,873 | 42,660 | 25,028 | 23,039 | 20,113 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 3,145 | 3,834 | 4,299 | 4,563 | 3,993 | 3,936 | 4,179 |
| Dairies | | 66 | 664 | 863 | 954 | 1,054 | 1,163 | 1,285 |
| Range & All Other Livestock | | 149 | 151 | 176 | 178 | 181 | 185 | 188 |
| Total Red Basin Supply | | 163,740 | 111,381 | 74,610 | 48,769 | 30,680 | 28,751 | 26,198 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,406 | 1,694 | 2,218 | 1,084 | 1,052 | 752 | 697 |
| Industrial | | 1,637 | 1,923 | 2,082 | 2,213 | 2,337 | 2,445 | 2,617 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 348,115 | 231,423 | 205,239 | 141,530 | 54,540 | 39,299 | 32,178 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,225 | 2,712 | 2,281 | 1,616 | 0 | 0 | 0 |
| Dairies | | 80 | 812 | 1,056 | 716 | 540 | 317 | 344 |
| Range & All Other Livestock | | 181 | 184 | 214 | 218 | 220 | 223 | 228 |
| Total Brazos Basin Supply | | 353,644 | 238,748 | 213,091 | 147,377 | 58,689 | 43,036 | 36,064 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -6,213 | -53,520 | -84,875 | -105,193 | -117,156 | -113,694 | -111,378 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | -852 | -1,207 | -1,282 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | -6,213 | -53,520 | -84,875 | -105,193 | -118,008 | -114,901 | -112,659 |

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### *Table 4-3 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage (cont.)** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 193 | 630 | -551 | -612 | -899 | -926 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 10,574 | -93,175 | -106,915 | -158,656 | -234,137 | -238,310 | -234,788 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | -759 | -1,612 | -3,427 | -3,638 | -3,862 |
| Dairies | | 0 | 0 | 0 | -450 | -749 | -1,107 | -1,229 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 10,574 | -92,982 | -107,044 | -161,269 | -238,925 | -243,955 | -240,805 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Dimmitt, Nazareth Water & Sewer Supply, City of Hart, and Chestar USA Dimmitt, Inc.. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projeciton period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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## *Table 4-4.*
## *Projected Water Demands, Supplies, and Needs*
## *Cochran County*
## *Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 459,890 | 309,727 | 192,301 | 117,170 | 46,347 | 10,920 | 5,038 |
| | Quantity Pumped[2] | Ogallala | 77,961 | 44,285 | 43,420 | 36,681 | 33,797 | 12,126 | 12,157 |
| | Supply | (Ogallala)[3] | 77,961 | 44,285 | 43,420 | 36,681 | 33,797 | 12,126 | 12,157 |
| | Local Surface | Stock Tanks and Windmills | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| | Reclaimed Water[4] | | 267 | 267 | 267 | 267 | 267 | 267 | 267 |
| | Total Supply | | 78,274 | 44,599 | 43,751 | 37,015 | 34,132 | 12,463 | 12,495 |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 2,118,814 | 1,524,384 | 1,116,691 | 696,573 | 301,008 | 70,788 | 32,667 |
| | Quantity Pumped[2] | Ogallala | 45,154 | 33,836 | 31,610 | 35,447 | 35,458 | 11,783 | 11,752 |
| | Supply | (Ogallala)[3] | 45,154 | 33,836 | 31,610 | 35,447 | 35,458 | 11,783 | 11,752 |
| | Local Surface | Stock Tanks and Windmills | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| | Reclaimed Water[4] | | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| | Total Supply | | 45,268 | 33,951 | 31,760 | 35,597 | 35,609 | 11,936 | 11,907 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 2,578,704 | 1,834,111 | 1,308,992 | 813,743 | 347,354 | 81,708 | 37,705 |
| | Quantity Pumped[2] | Ogallala | 123,115 | 78,121 | 75,030 | 72,128 | 69,255 | 23,909 | 23,909 |
| | Supply | (Ogallala)[3] | 123,115 | 78,121 | 75,030 | 72,128 | 69,255 | 23,909 | 23,909 |
| | Local Surface | Stock Tanks and Windmills | 133 | 135 | 187 | 190 | 193 | 195 | 198 |
| | Reclaimed Water[4] | | 294 | 294 | 294 | 294 | 294 | 294 | 294 |
| | Total Supply | | 123,542 | 78,550 | 75,511 | 72,612 | 69,742 | 24,398 | 24,401 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Morton | | | 499 | 535 | 560 | 565 | 547 | 521 | 496 |
| Rural | | | 172 | 183 | 191 | 192 | 185 | 176 | 167 |
| | Subtotal | | 671 | 718 | 751 | 757 | 732 | 697 | 663 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| | Subtotal | | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Total Municipal Demand | | | 763 | 816 | 853 | 860 | 831 | 792 | 753 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Morton | | Ogallala | 499 | 535 | 0 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 172 | 183 | 191 | 192 | 185 | 176 | 167 |
| | Subtotal | | 671 | 718 | 191 | 192 | 185 | 176 | 167 |
| Colorado Basin | | | | | | | | | |
| Rural | | Ogallala | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| | Subtotal | | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Total Municipal Existing Supply | | | 763 | 816 | 293 | 295 | 284 | 271 | 257 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Morton | | | 0 | 0 | -560 | -565 | -547 | -521 | -496 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | -560 | -565 | -547 | -521 | -496 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Surplus/Shortage | | | 0 | 0 | -560 | -565 | -547 | -521 | -496 |

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### *Table 4-4 Continued*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | |
| Brazos Basin | | | | | | | | |
| Morton | | 0 | 0 | 560 | 565 | 547 | 521 | 496 |
| Rural | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 0 | 0 | 560 | 565 | 547 | 521 | 496 |
| Colorado Basin | | | | | | | | |
| Rural | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | 0 | 0 | 560 | 565 | 547 | 521 | 496 |
| **Industrial Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Brazos Basin | | 76,790 | 73,825 | 70,978 | 68,239 | 65,604 | 63,071 | 60,636 |
| Colorado Basin | | 43,195 | 41,527 | 39,925 | 38,384 | 36,902 | 35,478 | 34,108 |
| Total Irrigation Demand | | 119,985 | 115,352 | 110,903 | 106,623 | 102,506 | 98,549 | 94,744 |
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 76,760 | 42,859 | 41,527 | 34,831 | 31,987 | 10,348 | 10,400 |
| | Reclaimed Water | 267 | 267 | 267 | 267 | 267 | 267 | 267 |
| Brazos Basin Subtotal | | 77,027 | 43,126 | 41,794 | 35,098 | 32,254 | 10,615 | 10,667 |
| Colorado Basin | Ogallala | 43,358 | 32,290 | 30,486 | 34,492 | 34,720 | 11,262 | 11,406 |
| | Reclaimed Water | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| Colorado Basin Subtotal | | 43,385 | 32,317 | 30,513 | 34,519 | 34,747 | 11,289 | 11,433 |
| Total Irrigation Supply | | 120,412 | 75,443 | 72,307 | 69,617 | 67,001 | 21,904 | 22,100 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 237 | -30,699 | -29,184 | -33,141 | -33,350 | -52,456 | -49,969 |
| Colorado Basin | | 190 | -9,210 | -9,412 | -3,865 | -2,155 | -24,189 | -22,675 |
| Total Irrigation Surplus/Shortage | | 427 | -39,909 | -38,596 | -37,006 | -35,505 | -76,645 | -72,644 |

Continued on next page

***Table 4-4 Continued***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 16 | 14 | 10 | 8 | 6 | 4 | 2 |
| Colorado Basin | | 1,704 | 1,448 | 1,022 | 852 | 639 | 426 | 256 |
| Total Mining Demand | | 1,720 | 1,462 | 1,032 | 860 | 645 | 430 | 258 |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 16 | 14 | 10 | 8 | 6 | 4 | 2 |
| Colorado Basin | Ogallala | 1,704 | 1,448 | 1,022 | 852 | 639 | 426 | 256 |
| Total Mining Supply | | 1,720 | 1,462 | 1,032 | 860 | 645 | 430 | 258 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Colorado Basin | | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Total Range & All Other Livestock Demand | | 133 | 135 | 187 | 190 | 193 | 195 | 198 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Colorado Basin | Local | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Total Range & All Other Livestock Supply | | 133 | 135 | 187 | 190 | 193 | 195 | 198 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 763 | 816 | 853 | 860 | 831 | 792 | 753 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 119,985 | 115,352 | 110,903 | 106,623 | 102,506 | 98,549 | 94,744 |
| Mining | | 1,720 | 1,462 | 1,032 | 860 | 645 | 430 | 258 |
| Beef Feedlot Livestock | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Dairies | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Range & All Other Livestock | | 133 | 135 | 187 | 190 | 193 | 195 | 198 |
| Total County Demand | | 123,115 | 118,458 | 113,812 | 109,413 | 105,101 | 100,941 | 96,980 |

Continued on next page

### *Table 4-4 Continued*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 763 | 816 | 293 | 295 | 284 | 271 | 257 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 120,412 | 75,443 | 72,307 | 69,617 | 67,001 | 21,904 | 22,100 |
| Mining | | 1,720 | 1,462 | 1,032 | 860 | 645 | 430 | 258 |
| Beef Feedlot Livestock | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Dairies | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Range & All Other Livestock | | 133 | 135 | 187 | 190 | 193 | 195 | 198 |
| Total County Supply | | 123,542 | 78,549 | 74,656 | 71,842 | 69,049 | 23,776 | 23,840 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 0 | -560 | -565 | -547 | -521 | -496 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 427 | -39,909 | -38,596 | -37,006 | -35,505 | -76,645 | -72,644 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 427 | -39,909 | -39,156 | -37,571 | -36,052 | -77,166 | -73,140 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 671 | 718 | 751 | 757 | 732 | 697 | 663 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 76,790 | 73,825 | 70,978 | 68,239 | 65,604 | 63,071 | 60,636 |
| Mining | | 16 | 14 | 10 | 8 | 6 | 4 | 2 |
| Beef Feedlot Livestock | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Dairies | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Range & All Other Livestock | | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Total Brazos Basin Demand | | 78,037 | 75,297 | 72,640 | 69,951 | 67,336 | 64,817 | 62,398 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 43,195 | 41,527 | 39,925 | 38,384 | 36,902 | 35,478 | 34,108 |
| Mining | | 1,704 | 1,448 | 1,022 | 852 | 639 | 426 | 256 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Total Colorado Basin Demand | | 45,078 | 43,161 | 41,172 | 39,462 | 37,764 | 36,124 | 34,582 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 671 | 718 | 191 | 192 | 185 | 176 | 167 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 77,027 | 43,126 | 41,794 | 35,098 | 32,254 | 10,615 | 10,667 |
| Mining | | 16 | 14 | 10 | 8 | 6 | 4 | 2 |
| Beef Feedlot Livestock | | 514 | 627 | 703 | 746 | 792 | 841 | 893 |
| Dairies | | 0 | 67 | 134 | 134 | 134 | 134 | 134 |
| Range & All Other Livestock | | 45 | 46 | 64 | 67 | 69 | 70 | 70 |
| Total Brazos Basin Supply | | 78,274 | 44,598 | 42,896 | 36,245 | 33,439 | 11,840 | 11,933 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 92 | 98 | 102 | 103 | 99 | 95 | 90 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 43,385 | 32,317 | 30,513 | 34,519 | 34,747 | 11,289 | 11,433 |
| Mining | | 1,704 | 1,448 | 1,022 | 852 | 639 | 426 | 256 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 87 | 88 | 123 | 123 | 124 | 125 | 128 |
| Total Colorado Basin Supply | | 45,268 | 33,951 | 31,760 | 35,597 | 35,609 | 11,936 | 11,907 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 0 | -560 | -565 | -547 | -521 | -496 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 237 | -30,699 | -29,184 | -33,141 | -33,350 | -52,456 | -49,969 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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### *Table 4-4 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 237 | -30,699 | -29,744 | -33,706 | -33,897 | -52,977 | -50,465 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 190 | -9,210 | -9,412 | -3,865 | -2,155 | -24,189 | -22,675 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 190 | -9,210 | -9,412 | -3,865 | -2,155 | -24,189 | -22,675 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Morton, Girls Town USA, and City of Whiteface. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waster discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste.

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## *Table 4-5.*
## *Projected Water Demands, Supplies, and Needs*
## *Crosby County*
## *Llano Estacado Region*

| Demand | Updated 6-4-09 | and 6/8/2009 | Total in | Projections | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | | |
| | **Red Basin** | | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 88,869 | 94,099 | 80,773 | 76,630 | 72,995 | 72,514 | 72,127 |
| | Quantity Pumped[2] | Ogallala | 1,391 | 1,307 | 1,256 | 1,204 | 1,158 | 1,101 | 1,078 |
| | Supply | (Ogallala)[3] | 1,391 | 1,307 | 1,256 | 1,204 | 1,158 | 1,101 | 1,078 |
| | Local Surface | Stock Tanks and Windmills | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 1,394 | 1,310 | 1,259 | 1,208 | 1,161 | 1,105 | 1,082 |
| | **Brazos Basin** | | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 10,860,146 | 10,518,753 | 10,004,335 | 9,903,661 | 9,079,445 | 8,965,722 | 8,874,426 |
| | Quantity Pumped[2] | Ogallala | 112,337 | 96,710 | 92,844 | 89,147 | 85,593 | 83,138 | 79,835 |
| | Supply | (Ogallala)[3] | 112,337 | 96,710 | 92,844 | 89,147 | 85,593 | 83,138 | 79,835 |
| | Seymour Aquifer | | 483 | 483 | 483 | 474 | 474 | 474 | 474 |
| | Local Surface | Stock Tanks and Windmills | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| | Other Surface | White River Reservoir | 707 | 707 | 707 | 707 | 707 | 389 | 8 |
| | Reclaimed Water[4] | | 583 | 583 | 583 | 583 | 583 | 583 | 583 |
| | Total Supply | | 114,402 | 98,781 | 94,921 | 91,222 | 87,675 | 84,909 | 81,232 |
| | **County Total** | | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 10,949,015 | 10,612,852 | 10,085,108 | 9,980,291 | 9,152,440 | 9,038,236 | 8,946,553 |
| | Quantity Pumped[2] | Ogallala | 113,728 | 98,017 | 94,100 | 90,352 | 86,751 | 84,239 | 80,913 |
| | Supply | (Ogallala)[3] | 113,728 | 98,017 | 94,100 | 90,352 | 86,751 | 84,239 | 80,913 |
| | Seymour Aquifer | | 483 | 483 | 483 | 474 | 474 | 474 | 474 |
| | Local Surface | Stock Tanks and Windmills | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| | Other Surface | White River Reservoir | 707 | 707 | 707 | 707 | 707 | 389 | 707 |
| | Reclaimed Water[4] | | 583 | 583 | 583 | 583 | 583 | 583 | 583 |
| | Total Supply | | 115,796 | 100,091 | 96,179 | 92,430 | 88,836 | 86,014 | 82,314 |
| Data LERWPG | | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | | |
| Red Basin | | | | | | | | | | |
| Rural | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Subtotal | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Brazos Basin | | | | | | | | | | |
| Crosbyton | | | 351 | 369 | 386 | 394 | 402 | 400 | 394 |
| Lorenzo | | | 260 | 275 | 288 | 296 | 302 | 301 | 296 |
| Ralls | | | 290 | 304 | 315 | 322 | 325 | 323 | 318 |
| Rural | | | 202 | 210 | 217 | 220 | 222 | 220 | 217 |
| | Subtotal | | 1,103 | 1,158 | 1,206 | 1,232 | 1,251 | 1,244 | 1,225 |
| Total Municipal Demand | | | 1,104 | 1,159 | 1,207 | 1,233 | 1,252 | 1,245 | 1,226 |
| **Municipal Existing Supply** | | | | | | | | | | |
| Red Basin | | | | | | | | | | |
| Rural | | Ogallala | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Subtotal | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Brazos Basin | | | | | | | | | | |
| Crosbyton | 1998 obtained 464 acft | White River Reservoir | 389 | 389 | 389 | 389 | 389 | 389 | 8 |
| | | Ogallala | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Crosbyton Subtotal | | | 439 | 439 | 439 | 439 | 439 | 439 | 58 |
| Lorenzo | | Ogallala | 260 | 275 | 288 | 259 | 233 | 209 | 188 |
| Ralls | 1994 obtained 352 acft | White River Reservoir | 318 | 318 | 318 | 318 | 318 | 0 | 0 |
| Rural | | Ogallala | 202 | 210 | 217 | 220 | 222 | 220 | 217 |
| | | Seymour | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Rural Subtotal | | | 302 | 310 | 317 | 320 | 322 | 320 | 317 |
| | Subtotal | | 1,269 | 1,292 | 1,312 | 1,286 | 1,262 | 918 | 513 |
| Total Municipal Existing Supply | | | 1,270 | 1,293 | 1,313 | 1,287 | 1,263 | 919 | 514 |
| **Municipal Surplus/Shortage** | | | | | | | | | | |
| Red Basin | | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

### *Table 4-5 Continued*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage (Cont.)** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Crosbyton | | | 88 | 70 | 53 | 45 | 37 | 39 | -336 |
| Lorenzo | | | 0 | 0 | 0 | -37 | -69 | -92 | -108 |
| Ralls | | | 28 | 14 | 3 | -4 | -7 | -323 | -318 |
| Rural | | | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Subtotal | | 216 | 184 | 156 | 104 | 61 | -276 | -662 |
| Total Municipal Surplus/Shortage | | | 216 | 184 | 156 | 104 | 61 | -276 | -662 |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Crosbyton | | | 0 | 0 | 0 | 0 | 0 | 0 | 336 |
| Lorenzo | | | 0 | 0 | 0 | 37 | 69 | 92 | 108 |
| Ralls | | | 0 | 0 | 0 | 4 | 7 | 323 | 318 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 41 | 76 | 415 | 762 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 41 | 76 | 415 | 762 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Total Industrial Demand | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | Ogallala | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Total Industrial Existing Supply | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Shortage/Surplus | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 2,243 | 2,152 | 2,066 | 1,982 | 1,903 | 1,826 | 1,752 |
| Brazos Basin | | | 109,892 | 105,465 | 101,215 | 97,138 | 93,223 | 89,469 | 85,866 |
| Total Irrigation Demand | | | 112,135 | 107,617 | 103,281 | 99,120 | 95,126 | 91,295 | 87,618 |
| **Irrigation Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 1,320 | 1,265 | 1,235 | 1,192 | 1,152 | 1,100 | 1,077 |
| Brazos Basin | | Ogallala | 111,701 | 88,356 | 84,507 | 80,644 | 77,147 | 74,744 | 71,482 |
| | | Seymour | 383 | 383 | 383 | 374 | 374 | 374 | 374 |
| | | Reclaimed Water | 583 | 583 | 583 | 583 | 583 | 583 | 583 |
| Brazos Basin Subtotal | | | 112,667 | 89,322 | 85,473 | 81,601 | 78,104 | 75,701 | 72,439 |
| Total Irrigation Supply | | | 113,987 | 90,587 | 86,708 | 82,793 | 79,256 | 76,801 | 73,516 |

Continued on next page

### *Table 4-5 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Red Basin | | -923 | -887 | -831 | -790 | -751 | -726 | -675 |
| Brazos Basin | | 2,775 | -16,143 | -15,742 | -15,537 | -15,119 | -13,768 | -13,427 |
| Total Irrigation Surplus/Shortage | | 1,852 | -17,030 | -16,573 | -16,327 | -15,870 | -14,494 | -14,102 |
| **Mining Demand** | | | | | | | | |
| Red Basin | | 70 | 41 | 20 | 11 | 5 | 0 | 0 |
| Brazos Basin | | 119 | 71 | 34 | 20 | 8 | 0 | 0 |
| Total Mining Demand | | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Red Basin | Ogallala | 70 | 41 | 20 | 11 | 5 | 0 | 0 |
| Brazos Basin | Ogallala | 119 | 71 | 34 | 20 | 8 | 0 | 0 |
| Total Mining Supply | | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Red Basin | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Brazos Basin | | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Total Range & All Other Livestock Demand | | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Brazos Basin | Local | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Total Range & All Other Livestock Supply | | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,104 | 1,159 | 1,207 | 1,233 | 1,252 | 1,245 | 1,226 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 112,135 | 107,617 | 103,281 | 99,120 | 95,126 | 91,295 | 87,618 |
| Mining | | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| Total County Demand | | 113,728 | 109,195 | 104,855 | 100,704 | 96,718 | 92,875 | 89,186 |

Continued on next page

***Table 4-5 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 1,270 | 1,293 | 1,313 | 1,287 | 1,263 | 919 | 514 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 113,987 | 90,587 | 86,708 | 82,793 | 79,256 | 76,801 | 73,516 |
| Mining | | 189 | 112 | 54 | 31 | 13 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 295 | 301 | 307 | 314 | 321 | 329 | 336 |
| Total County Supply | | 115,746 | 92,299 | 88,387 | 84,432 | 80,859 | 78,055 | 74,372 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 166 | 134 | 106 | 54 | 11 | -326 | -712 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,852 | -17,030 | -16,573 | -16,327 | -15,870 | -14,494 | -14,102 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 2,018 | -16,896 | -16,467 | -16,273 | -15,859 | -14,820 | -14,814 |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,243 | 2,152 | 2,066 | 1,982 | 1,903 | 1,826 | 1,752 |
| Mining | | 70 | 41 | 20 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Total Red Basin Demand | | 2,317 | 2,197 | 2,090 | 1,998 | 1,913 | 1,831 | 1,757 |
| **Brazos** | | | | | | | | |
| Municipal | | 1,103 | 1,158 | 1,206 | 1,232 | 1,251 | 1,244 | 1,225 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 109,892 | 105,465 | 101,215 | 97,138 | 93,223 | 89,469 | 85,866 |
| Mining | | 119 | 71 | 34 | 20 | 8 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Total Brazos Basin Demand | | 111,411 | 106,998 | 102,764 | 98,706 | 94,806 | 91,044 | 87,429 |
| **Total Basin Supply** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,320 | 1,265 | 1,235 | 1,192 | 1,152 | 1,100 | 1,077 |
| Mining | | 70 | 41 | 20 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 3 | 3 | 3 | 4 | 4 | 4 | 4 |
| Total Red Basin Supply | | 1,394 | 1,310 | 1,259 | 1,208 | 1,161 | 1,105 | 1,082 |
| **Brazos** | | | | | | | | |
| Municipal | | 1,269 | 1,292 | 1,312 | 1,286 | 1,262 | 918 | 513 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 112,667 | 89,322 | 85,473 | 81,601 | 78,104 | 75,701 | 72,439 |
| Mining | | 119 | 71 | 34 | 20 | 8 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 292 | 298 | 303 | 310 | 318 | 325 | 332 |
| Total Brazos Basin Supply | | 114,352 | 90,989 | 87,128 | 83,223 | 79,698 | 76,950 | 73,290 |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -923 | -887 | -831 | -790 | -751 | -726 | -675 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | -923 | -887 | -831 | -790 | -751 | -726 | -675 |

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### *Table 4-5 Concluded*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage (Cont.)** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 166 | 134 | 106 | 54 | 11 | -326 | -712 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,775 | -16,143 | -15,742 | -15,537 | -15,119 | -13,768 | -13,427 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 2,941 | -16,009 | -15,636 | -15,483 | -15,108 | -14,094 | -14,139 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from City of Lorenzo, City of Ralls, City of Crosbyton, and the White River MWD. The quantity of reclaimed water availabe from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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## *Table 4-6.*
## *Projected Water Demands, Supplies, and Needs*
## *Dawson County*
## *Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 160,390 | 160,390 | 160,390 | 160,390 | 160,390 | 160,390 | 160,390 |
| | Quantity Pumped[2] | Ogallala | 19 | 19 | 19 | 19 | 18 | 18 | 17 |
| | Supply | (Ogallala)[3] | 19 | 19 | 19 | 19 | 18 | 18 | 17 |
| | Local Surface | Stock Tanks and Windmills | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 21 | 20 | 21 | 20 | 20 | 20 | 19 |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,106,402 | 7,041,932 | 7,041,932 | 7,041,932 | 7,041,932 | 7,041,932 | 7,041,932 |
| | Quantity Pumped[2] | Ogallala | 152,146 | 45,194 | 37,508 | 34,547 | 31,266 | 31,239 | 31,195 |
| | Supply | (Ogallala)[3] | 152,146 | 45,194 | 37,508 | 34,547 | 31,266 | 31,239 | 31,195 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,676 | 1,708 | 1,486 | 1,486 | 1,486 | 1,369 | 1,369 |
| | Local Surface | Stock Tanks and Windmills | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| | Other Surface | Lake Meredith (CRMWA) | 910 | 854 | 1,076 | 1,076 | 1,076 | 992 | 992 |
| | Total Supply | | 154,882 | 47,910 | 40,226 | 37,270 | 33,992 | 33,768 | 33,728 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,266,792 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 | 7,202,322 |
| | Quantity Pumped[2] | Ogallala | 152,165 | 45,213 | 37,527 | 34,566 | 31,284 | 31,257 | 31,212 |
| | Supply | (Ogallala)[3] | 152,165 | 45,213 | 37,527 | 34,566 | 31,284 | 31,257 | 31,212 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,676 | 1,708 | 1,486 | 1,486 | 1,486 | 1,369 | 1,369 |
| | Local Surface | Stock Tanks and Windmills | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| | Other Surface | Lake Meredith (CRMWA) | 910 | 854 | 1,076 | 1,076 | 1,076 | 992 | 992 |
| | Total Supply | | 154,903 | 47,930 | 40,247 | 37,290 | 34,012 | 33,788 | 33,747 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| O'Donnell (part) | | | 17 | 17 | 17 | 17 | 17 | 17 | 16 |
| Rural | | | 18 | 18 | 18 | 19 | 18 | 18 | 17 |
| | Subtotal | | 35 | 35 | 35 | 36 | 35 | 35 | 33 |
| Colorado Basin | | | | | | | | | |
| Lamesa | | | 2,486 | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| Rural | | | 605 | 610 | 612 | 616 | 607 | 587 | 565 |
| | Subtotal | | 3,091 | 3,150 | 3,185 | 3,218 | 3,210 | 3,116 | 2,998 |
| Total Municipal Demand | | | 3,126 | 3,185 | 3,220 | 3,254 | 3,245 | 3,151 | 3,031 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | Ogallala | 18 | 18 | 18 | 19 | 18 | 18 | 17 |
| | Subtotal | | 18 | 18 | 18 | 19 | 18 | 18 | 17 |
| Colorado Basin | | | | | | | | | |
| Lamesa | | Ogallala | 628 | 565 | 508 | 457 | 411 | 370 | 333 |
| | | Lake Meredith (CRMWA)[4] | 872 | 843 | 1,062 | 1,062 | 1,062 | 978 | 978 |
| | | Ogallala (CRMWA - Roberts Co.)[4] | 1,656 | 1,685 | 1,466 | 1,466 | 1,466 | 1,350 | 1,350 |
| Lamesa Subtotal | | | 3,156 | 3,093 | 3,036 | 2,985 | 2,939 | 2,698 | 2,661 |
| O'Donnell (part) | | Lake Meredith (CRMWA) | 38 | 11 | 14 | 14 | 14 | 14 | 14 |
| | | Ogallala (CRMWA - Roberts Co.) | 20 | 23 | 20 | 20 | 20 | 19 | 19 |
| O'Donnell (part) Subtotal | | | 58 | 34 | 34 | 34 | 34 | 33 | 33 |
| Rural | | Ogallala | 605 | 610 | 612 | 616 | 607 | 587 | 565 |
| | Subtotal | | 3,819 | 3,737 | 3,682 | 3,635 | 3,580 | 3,318 | 3,259 |
| Total Municipal Existing Supply | | | 3,837 | 3,755 | 3,700 | 3,654 | 3,598 | 3,336 | 3,276 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | | | | | | | |
| Lamesa | | | 670 | 553 | 463 | 383 | 336 | 169 | 228 |
| O'Donnell (part) | | | 41 | 17 | 17 | 17 | 17 | 16 | 17 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 711 | 570 | 480 | 400 | 353 | 185 | 245 |
| Total Municipal Surplus/Shortage | | | 711 | 570 | 480 | 400 | 353 | 185 | 245 |

Continued on next page

***Table 4-6 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | |
| Brazos Basin | | | | | | | | |
| Rural | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | | | | | | |
| Lamesa | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O'Donnell (part) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Total Industrial Demand | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| **Industrial Existing Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | Ogallala | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Total Industrial Existing Supply | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| **Industrial Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Brazos Basin | | 1,460 | 1,378 | 1,300 | 1,227 | 1,158 | 1,093 | 1,031 |
| Colorado Basin | | 144,579 | 136,425 | 128,736 | 121,478 | 114,628 | 108,167 | 102,071 |
| Total Irrigation Demand | | 146,039 | 137,803 | 130,036 | 122,705 | 115,786 | 109,260 | 103,102 |
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 1 | 423 | 355 | 329 | 299 | 301 | 301 |
| Colorado Basin | Ogallala | 148,084 | 41,752 | 35,024 | 32,452 | 29,509 | 29,730 | 29,733 |
| Total Irrigation Supply | | 148,085 | 42,175 | 35,379 | 32,781 | 29,808 | 30,031 | 30,034 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | -1,459 | -955 | -945 | -898 | -859 | -792 | -730 |
| Colorado Basin | | 3,505 | -94,673 | -93,712 | -89,026 | -85,119 | -78,437 | -72,338 |
| Total Irrigation Surplus/Shortage | | 2,046 | -95,628 | -94,657 | -89,924 | -85,978 | -79,229 | -73,068 |

Continued on next page

### *Table 4-6 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Total Mining Demand | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | Ogallala | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Total Mining Supply | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Colorado Basin | | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Total Range & All Other Livestock Demand | | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Colorado Basin | Local | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Total Range & All Other Livestock Supply | | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 3,126 | 3,185 | 3,220 | 3,254 | 3,245 | 3,151 | 3,031 |
| Industrial | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 146,039 | 137,803 | 130,036 | 122,705 | 115,786 | 109,260 | 103,102 |
| Mining | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| Total County Demand | | 152,146 | 142,886 | 134,322 | 126,713 | 119,536 | 112,731 | 106,469 |

Continued on next page

***Table 4-6 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 3,837 | 3,755 | 3,700 | 3,654 | 3,598 | 3,336 | 3,276 |
| Industrial | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 148,085 | 42,175 | 35,379 | 32,781 | 29,808 | 30,031 | 30,034 |
| Mining | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 152 | 155 | 158 | 162 | 166 | 170 | 174 |
| Total County Supply | | 154,903 | 47,828 | 40,145 | 37,189 | 33,911 | 33,687 | 33,646 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 711 | 570 | 480 | 400 | 353 | 185 | 245 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,046 | -95,628 | -94,657 | -89,924 | -85,978 | -79,229 | -73,068 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 2,757 | -95,058 | -94,177 | -89,524 | -85,625 | -79,044 | -72,823 |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 35 | 35 | 35 | 36 | 35 | 35 | 33 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,460 | 1,378 | 1,300 | 1,227 | 1,158 | 1,093 | 1,031 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Total Brazos Basin Demand | | 1,496 | 1,414 | 1,337 | 1,264 | 1,195 | 1,130 | 1,066 |
| **Colorado** | | | | | | | | |
| Municipal | | 3,091 | 3,150 | 3,185 | 3,218 | 3,210 | 3,116 | 2,998 |
| Industrial | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 144,579 | 136,425 | 128,736 | 121,478 | 114,628 | 108,167 | 102,071 |
| Mining | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Total Colorado Basin Demand | | 150,649 | 141,472 | 132,985 | 125,449 | 118,341 | 111,601 | 105,403 |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 18 | 18 | 18 | 19 | 18 | 18 | 17 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1 | 423 | 355 | 329 | 299 | 301 | 301 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| Total Brazos Basin Supply | | 21 | 442 | 375 | 349 | 319 | 321 | 320 |
| **Colorado** | | | | | | | | |
| Municipal | | 3,819 | 3,737 | 3,682 | 3,635 | 3,580 | 3,318 | 3,259 |
| Industrial | | 101 | 119 | 129 | 137 | 144 | 150 | 162 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 148,084 | 41,752 | 35,024 | 32,452 | 29,509 | 29,730 | 29,733 |
| Mining | | 2,728 | 1,624 | 779 | 455 | 195 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 150 | 154 | 156 | 161 | 164 | 168 | 172 |
| Total Colorado Basin Supply | | 154,882 | 47,386 | 39,770 | 36,840 | 33,592 | 33,366 | 33,326 |

Concluded on next page

### *Table 4-6 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | -17 | -17 | -17 | -17 | -17 | -17 | -16 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -1,459 | -955 | -945 | -898 | -859 | -792 | -730 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | -1,476 | -972 | -962 | -915 | -876 | -809 | -746 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 728 | 587 | 497 | 417 | 370 | 202 | 261 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 3,505 | -94,673 | -93,712 | -89,026 | -85,119 | -78,437 | -72,338 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 4,233 | -94,086 | -93,215 | -88,609 | -84,749 | -78,235 | -72,077 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

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### *Table 4-7. Projected Water Demands, Supplies, and Needs Deaf Smith County Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Canadian Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 2,599 | 1,798 | 894 | 684 | 684 | 684 | 684 |
| | Quantity Pumped[2] | Ogallala | 171 | 112 | 74 | 1 | 1 | 1 | 1 |
| | Supply | (Ogallala)[3] | 171 | 112 | 74 | 1 | 1 | 1 | 1 |
| | Local Surface | Stock Tanks and Windmills | 220 | 281 | 317 | 326 | 336 | 344 | 353 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 390 | 393 | 391 | 327 | 337 | 345 | 354 |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,849,168 | 6,645,748 | 5,230,088 | 4,162,529 | 3,383,183 | 3,152,241 | 2,999,333 |
| | Quantity Pumped[2] | Ogallala | 388,182 | 204,702 | 170,696 | 128,078 | 88,180 | 86,199 | 81,704 |
| | Supply | (Ogallala)[3] | 388,182 | 204,702 | 170,696 | 128,078 | 88,180 | 86,199 | 81,704 |
| | Dockum Aquifer | | 930 | 720 | 578 | 7,502 | 7,576 | 7,602 | 7,602 |
| | Local Surface | Stock Tanks and Windmills | 2,859 | 2,931 | 3,035 | 3,174 | 3,319 | 3,474 | 3,636 |
| | Reclaimed Water[4] | | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 |
| | Total Supply | | 394,781 | 211,163 | 177,119 | 141,564 | 101,885 | 100,085 | 95,752 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,851,767 | 6,647,546 | 5,230,982 | 4,163,213 | 3,383,867 | 3,152,925 | 3,000,017 |
| | Quantity Pumped[2] | Ogallala | 388,353 | 204,814 | 170,770 | 128,079 | 88,181 | 86,200 | 81,705 |
| | Supply | (Ogallala)[3] | 388,353 | 204,814 | 170,770 | 128,079 | 88,181 | 86,200 | 81,705 |
| | Dockum Aquifer | | 930 | 720 | 578 | 7,502 | 7,576 | 7,602 | 7,602 |
| | Local Surface | Stock Tanks and Windmills | 3,079 | 3,212 | 3,352 | 3,500 | 3,655 | 3,818 | 3,989 |
| | Reclaimed Water[4] | | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 |
| | Total Supply | | 395,172 | 211,556 | 177,511 | 141,891 | 102,222 | 100,430 | 96,106 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Canadian Basin | | | | | | | | | |
| Rural | | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Subtotal | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Red Basin | | | | | | | | | |
| Hereford | | | 3,564 | 3,634 | 3,694 | 3,751 | 3,788 | 3,801 | 3,813 |
| Rural | | | 572 | 743 | 932 | 1,100 | 1,243 | 1,286 | 1,305 |
| | Subtotal | | 4,136 | 4,377 | 4,626 | 4,851 | 5,031 | 5,087 | 5,118 |
| Total Municipal Demand | | | 4,136 | 4,378 | 4,627 | 4,852 | 5,032 | 5,088 | 5,119 |
| **Municipal Existing Supply** | | | | | | | | | |
| Canadian Basin | | | | | | | | | |
| Rural | | Ogallala | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Subtotal | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Red Basin | | | | | | | | | |
| Hereford[5] | | Ogallala | 3,099 | 3,274 | 3,405 | 0 | 0 | 0 | 0 |
| | | Dockum (Santa Rosa) | 930 | 720 | 578 | 7,502 | 7,576 | 7,602 | 7,602 |
| Hereford Subtotal | | | 4,029 | 3,994 | 3,983 | 7,502 | 7,576 | 7,602 | 7,602 |
| Rural | | Ogallala | 572 | 743 | 932 | 1,100 | 1,243 | 1,286 | 1,305 |
| | Subtotal | | 4,601 | 4,737 | 4,915 | 8,602 | 8,819 | 8,888 | 8,907 |
| Total Municipal Existing Supply | | | 4,601 | 4,738 | 4,916 | 8,603 | 8,820 | 8,889 | 8,908 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Canadian Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | | | | | | | |
| Hereford | | | 465 | 360 | 289 | 3,751 | 3,788 | 3,801 | 3,789 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 465 | 360 | 289 | 3,751 | 3,788 | 3,801 | 3,789 |
| Total Municipal Surplus/Shortage | | | 465 | 360 | 289 | 3,751 | 3,788 | 3,801 | 3,789 |

Continued on next page

***Table 4-7 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | | |
| Canadian Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | | | | | | | |
| Hereford | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Total Industrial Demand | | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| **Industrial Existing Supply** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | Ogallala | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Total Industrial Existing Supply | | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| Total Irrigation Demand | | | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| **Irrigation Supply** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | Ogallala | 376,200 | 186,724 | 150,949 | 110,693 | 70,216 | 67,276 | 61,726 |
| | | Reclaimed Water | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 | 2,810 |
| Red Basin Subtotal | | | 379,010 | 189,534 | 153,759 | 113,503 | 73,026 | 70,086 | 64,536 |
| Total Irrigation Supply | | | 379,010 | 189,534 | 153,759 | 113,503 | 73,026 | 70,086 | 64,536 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Canadian Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | | 6,183 | -171,481 | -195,821 | -225,001 | -254,754 | -247,310 | -242,805 |
| Total Irrigation Surplus/Shortage | | | 6,183 | -171,481 | -195,821 | -225,001 | -254,754 | -247,310 | -242,805 |

Continued on next page

***Table 4-7 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 7,041 | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| Total Beef Feedlot Livestock Demand | | 7,041 | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | Ogallala | 7,041 | 8,583 | 9,623 | 10,216 | 10,329 | 10,966 | 11,642 |
| Total Beef Feedlot Livestock Supply | | 7,041 | 8,583 | 9,623 | 10,216 | 10,329 | 10,966 | 11,642 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | -517 | -548 | -582 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | -517 | -548 | -582 |
| **Dairies Demand** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Total Dairies Demand | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| **DairiesSupply** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | Ogallala | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Total Dairies Supply | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Canadian Basin | | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| Red Basin | | 3,006 | 3,124 | 3,253 | 3,399 | 3,552 | 3,715 | 3,881 |
| Total Range & All Other Livestock Demand | | 3,079 | 3,213 | 3,352 | 3,499 | 3,654 | 3,818 | 3,989 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Canadian Basin | Local | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| Red Basin | Local | 3,006 | 3,124 | 3,253 | 3,399 | 3,552 | 3,715 | 3,881 |
| Total Range & All Other Livestock Supply | | 3,079 | 3,213 | 3,352 | 3,499 | 3,654 | 3,818 | 3,989 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Canadian Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 4,136 | 4,378 | 4,627 | 4,852 | 5,032 | 5,088 | 5,119 |
| Industrial | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 7,041 | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| Dairies | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Range & All Other Livestock | | 3,079 | 3,213 | 3,352 | 3,499 | 3,654 | 3,818 | 3,989 |
| Total County Demand | | 388,353 | 382,442 | 372,844 | 363,040 | 353,604 | 344,437 | 335,690 |

Continued on next page

***Table 4-7 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 4,601 | 4,738 | 4,916 | 8,603 | 8,820 | 8,889 | 8,908 |
| Industrial | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 379,010 | 189,534 | 153,759 | 113,503 | 73,026 | 70,086 | 64,536 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 7,041 | 8,583 | 9,623 | 10,216 | 10,329 | 10,966 | 11,642 |
| Dairies | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Range & All Other Livestock | | 3,079 | 3,213 | 3,352 | 3,499 | 3,654 | 3,818 | 3,989 |
| Total County Supply | | 395,001 | 211,321 | 177,312 | 141,790 | 102,121 | 100,380 | 96,092 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 465 | 360 | 289 | 3,751 | 3,788 | 3,801 | 3,789 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 6,183 | -171,481 | -195,821 | -225,001 | -254,754 | -247,310 | -242,805 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | -517 | -548 | -582 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 6,648 | -171,121 | -195,532 | -221,250 | -251,483 | -244,057 | -239,598 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Canadian** | | | | | | | | |
| Municipal | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| Total Canadian Basin Demand | | 73 | 90 | 100 | 101 | 103 | 104 | 109 |
| | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 4,136 | 4,377 | 4,626 | 4,851 | 5,031 | 5,087 | 5,118 |
| Industrial | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 7,041 | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| Dairies | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Range & All Other Livestock | | 3,006 | 3,124 | 3,253 | 3,399 | 3,552 | 3,715 | 3,881 |
| Total Red Basin Demand | | 388,280 | 382,352 | 372,744 | 362,939 | 353,501 | 344,333 | 335,581 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Canadian** | | | | | | | | |
| Municipal | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| Total Canadian Basin Supply | | 73 | 90 | 100 | 101 | 103 | 104 | 109 |
| | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 4,601 | 4,737 | 4,915 | 8,602 | 8,819 | 8,888 | 8,907 |
| Industrial | | 1,234 | 3,694 | 3,834 | 3,950 | 4,061 | 4,157 | 4,295 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 379,010 | 189,534 | 153,759 | 113,503 | 73,026 | 70,086 | 64,536 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 7,041 | 8,583 | 9,623 | 10,216 | 10,329 | 10,966 | 11,642 |
| Dairies | | 36 | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| Range & All Other Livestock | | 3,006 | 3,124 | 3,253 | 3,399 | 3,552 | 3,715 | 3,881 |
| Total Red Basin Supply | | 394,928 | 211,231 | 177,212 | 141,689 | 102,018 | 100,276 | 95,983 |

Concluded on next page

***Table 4-7 Concluded***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Canadian** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Canadian Basin Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 465 | 360 | 289 | 3,751 | 3,788 | 3,801 | 3,789 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 6,183 | -171,481 | -195,821 | -225,001 | -254,754 | -247,310 | -242,805 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | -517 | -548 | -582 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | 6,648 | -171,121 | -195,532 | -221,250 | -251,483 | -244,057 | -239,598 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from T.J. Powers & Co., Nutra-Feeds, Caviness Meat Packing Co., Hereford Grain Corp., Dick Barrett Produce, City of Hereford, M.W. Carrot Inc., M. Bradford Cattle Truck Washing, and Hereford Bi-Products. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held constant throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

[5] Hereford is obtaining a part of its municipal water from the Santa Rosa Formation. The information available indicates that the aquifer can supply the quantities shown here from the projection period.

<><><><>

### *Table 4-8. Projected Water Demands, Supplies, and Needs Dickens County Llano Estacado Region*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 531,570 | 491,678 | 491,839 | 492,810 | 413,130 | 385,091 | 382,820 |
| | Quantity Pumped[2] | Ogallala | 4,626 | 2,662 | 2,575 | 2,503 | 2,217 | 2,159 | 2,108 |
| | Supply | (Ogallala)[3] | 4,626 | 2,662 | 2,575 | 2,503 | 2,217 | 2,159 | 2,108 |
| | Seymour Aquifer | | 7,937 | 7,937 | 7,937 | 5,217 | 5,217 | 5,217 | 5,217 |
| | Local Surface | Stock Tanks and Windmills | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 12,792 | 10,832 | 10,751 | 7,966 | 7,685 | 7,634 | 7,589 |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 587,623 | 545,618 | 540,569 | 534,888 | 449,122 | 432,755 | 430,768 |
| | Quantity Pumped[2] | Ogallala | 6,199 | 3,585 | 3,468 | 3,366 | 3,481 | 3,390 | 3,312 |
| | Supply | (Ogallala)[3] | 6,199 | 3,585 | 3,468 | 3,366 | 3,481 | 3,390 | 3,312 |
| | Seymour Aquifer | | 4,348 | 4,348 | 4,348 | 2,858 | 2,858 | 2,858 | 2,858 |
| | Local Surface | Stock Tanks and Windmills | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| | Other Surface | White River Reservoir | 275 | 271 | 267 | 263 | 260 | 106 | 0 |
| | Total Supply | | 11,213 | 8,605 | 8,491 | 6,903 | 7,026 | 6,791 | 6,619 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 1,119,192 | 1,037,297 | 1,032,409 | 1,027,698 | 862,252 | 817,846 | 813,589 |
| | Quantity Pumped[2] | Ogallala | 10,825 | 6,247 | 6,043 | 5,869 | 5,698 | 5,549 | 5,420 |
| | Supply | (Ogallala)[3] | 10,825 | 6,247 | 6,043 | 5,869 | 5,698 | 5,549 | 5,420 |
| | Seymour Aquifer | | 12,285 | 12,285 | 12,285 | 8,075 | 8,075 | 8,075 | 8,075 |
| | Local Surface | Stock Tanks and Windmills | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| | Other Surface | White River Reservoir | 275 | 271 | 267 | 263 | 260 | 106 | 257 |
| | Total Supply | | 24,005 | 19,437 | 19,243 | 14,869 | 14,711 | 14,425 | 14,207 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| | Subtotal | | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Brazos Basin | | | | | | | | | |
| Dickens | Decision -- delete. | | | | | | | | |
| Spur | | | 275 | 271 | 267 | 263 | 260 | 257 | 257 |
| Rural | Includes Dickens. | | 234 | 224 | 212 | 194 | 169 | 158 | 147 |
| | Subtotal | | 509 | 495 | 479 | 457 | 429 | 415 | 404 |
| Total Municipal Demand | | | 554 | 538 | 520 | 495 | 462 | 445 | 432 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | Ogallala | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| | Subtotal | | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Brazos Basin | | | | | | | | | |
| Dickens | | Seymour | | | | | | | |
| Spur | 1998 obtained 434 acft | White River Reservoir | 275 | 271 | 267 | 263 | 260 | 106 | 0 |
| Rural | Includes Dickens. | Ogallala + Seymour | 325 | 310 | 293 | 274 | 247 | 234 | 221 |
| | Subtotal | | 600 | 581 | 560 | 537 | 507 | 340 | 221 |
| Total Municipal Existing Supply | | | 645 | 624 | 601 | 575 | 540 | 370 | 249 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Dickens | | | | | | | | | |
| Spur | | | 0 | 0 | 0 | 0 | 0 | -151 | -257 |
| Rural | | | 91 | 86 | 81 | 80 | 78 | 76 | 74 |
| | Subtotal | | 91 | 86 | 81 | 80 | 78 | -75 | -183 |
| Total Municipal Surplus/Shortage | | | 91 | 86 | 81 | 80 | 78 | -75 | -183 |

Continued on next page

***Table 4-8 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Dickens | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spur | | | 0 | 0 | 0 | 0 | 0 | 151 | 257 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 151 | 257 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 151 | 257 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 4,079 | 3,957 | 3,839 | 3,725 | 3,614 | 3,506 | 3,400 |
| Brazos Basin | | | 5,407 | 5,246 | 5,089 | 4,938 | 4,791 | 4,647 | 4,508 |
| Total Irrigation Demand | | | 9,486 | 9,203 | 8,928 | 8,663 | 8,405 | 8,153 | 7,908 |
| **Irrigation Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 4,581 | 2,619 | 2,534 | 2,465 | 2,184 | 2,129 | 2,080 |
| Brazos Basin | | Ogallala | 5,709 | 3,263 | 3,209 | 3,145 | 3,300 | 3,232 | 3,165 |
| Total Irrigation Supply | | | 10,290 | 5,882 | 5,743 | 5,610 | 5,484 | 5,361 | 5,245 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 502 | -1,338 | -1,305 | -1,260 | -1,430 | -1,377 | -1,320 |
| Brazos Basin | | | 302 | -1,983 | -1,880 | -1,793 | -1,491 | -1,415 | -1,343 |
| Total Irrigation Surplus/Shortage | | | 804 | -3,321 | -3,185 | -3,053 | -2,921 | -2,792 | -2,663 |
| **Mining Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Total Mining Demand | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |

Continued on next page

### *Table 4-8 Continued*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Mining Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | Ogallala | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Total Mining Supply | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| | | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Dairies Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Dairies Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | | |
| Red Basin | | | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Brazos Basin | | | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Total Range & All Other Livestock Demand | | | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| | | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | | |
| Red Basin | | Local | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Brazos Basin | | Local | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Total Range & All Other Livestock Supply | | | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| | | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Total Demand** | | | | | | | | | |
| Municipal | Dickens included in Co other | | 554 | 538 | 520 | 495 | 462 | 445 | 432 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 9,486 | 9,203 | 8,928 | 8,663 | 8,405 | 8,153 | 7,908 |
| Mining | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| Total County Demand | | | 10,825 | 10,473 | 10,143 | 9,847 | 9,557 | 9,293 | 9,052 |
| | | | | | | | | | |
| **Total Supply** | | Unallocated | 12,285 | 12,285 | 12,285 | 8,075 | 8,075 | 8,075 | 8,075 |
| Municipal | | | 645 | 624 | 601 | 575 | 540 | 370 | 249 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 10,290 | 5,882 | 5,743 | 5,610 | 5,484 | 5,361 | 5,245 |
| Mining | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 620 | 634 | 648 | 662 | 678 | 695 | 712 |
| Total County Supply | | | 24,005 | 19,522 | 19,324 | 14,949 | 14,789 | 14,501 | 14,281 |

Continued on next page

***Table 4-8 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Total Surplus/Shortage** | | | | | | | | | |
| Municipal | | | 91 | 86 | 81 | 80 | 78 | -75 | -183 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 804 | -3,321 | -3,185 | -3,053 | -2,921 | -2,792 | -2,663 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | | 895 | -3,235 | -3,104 | -2,973 | -2,843 | -2,867 | -2,846 |
| | | | | | | | | | |
| **Total Basin Demand** | | | | | | | | | |
| **Red** | | | | | | | | | |
| Municipal | | | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 4,079 | 3,957 | 3,839 | 3,725 | 3,614 | 3,506 | 3,400 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Total Red Basin Demand | | | 4,354 | 4,233 | 4,119 | 4,009 | 3,898 | 3,794 | 3,692 |
| | | | | | | | | | |
| **Brazos** | | | | | | | | | |
| Municipal | | | 509 | 495 | 479 | 457 | 429 | 415 | 404 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 5,407 | 5,246 | 5,089 | 4,938 | 4,791 | 4,647 | 4,508 |
| Mining | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Total Brazos Basin Demand | | | 6,472 | 6,240 | 6,023 | 5,839 | 5,659 | 5,499 | 5,361 |
| | | | | | | | | | |
| **Total Basin Supply** | | | | | | | | | |
| **Red** | Unallocated | | 7,478 | 7,631 | 7,631 | 4,909 | 4,911 | 4,913 | 4,909 |
| Municipal | | | 45 | 43 | 41 | 38 | 33 | 30 | 28 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 4,581 | 2,619 | 2,534 | 2,465 | 2,184 | 2,129 | 2,080 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 230 | 233 | 239 | 246 | 251 | 258 | 264 |
| Total Red Basin Supply | | | 12,333 | 10,525 | 10,445 | 7,658 | 7,380 | 7,330 | 7,281 |
| | | | | | | | | | |
| **Brazos** | Unallocated | | 4,807 | 4,654 | 4,654 | 3,166 | 3,164 | 3,162 | 3,166 |
| Municipal | | | 600 | 581 | 560 | 537 | 507 | 340 | 221 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 5,709 | 3,263 | 3,209 | 3,145 | 3,300 | 3,232 | 3,165 |
| Mining | | | 165 | 98 | 47 | 27 | 12 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 391 | 401 | 408 | 417 | 427 | 437 | 449 |
| Total Brazos Basin Supply | | | 11,672 | 8,997 | 8,878 | 7,291 | 7,409 | 7,171 | 7,000 |
| | | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | | |
| **Red** | | | | | | | | | |
| Municipal | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 502 | -1,338 | -1,305 | -1,260 | -1,430 | -1,377 | -1,320 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | | 502 | -1,338 | -1,305 | -1,260 | -1,430 | -1,377 | -1,320 |

Concluded on next page

***Table 4-8 Concluded)***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage (Cont.)** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 91 | 86 | 81 | 80 | 78 | -75 | -183 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 302 | -1,983 | -1,880 | -1,793 | -1,491 | -1,415 | -1,343 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 393 | -1,897 | -1,799 | -1,713 | -1,413 | -1,490 | -1,526 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

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## *Table 4-9. Projected Water Demands, Supplies, and Needs Floyd County Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 5,491,376 | 5,163,180 | 4,909,263 | 4,577,147 | 4,384,446 | 4,345,782 | 4,267,211 |
| | Quantity Pumped[2] | Ogallala | 101,292 | 52,505 | 32,434 | 25,205 | 21,096 | 20,270 | 19,510 |
| | Supply | (Ogallala)[3] | 101,292 | 52,505 | 32,434 | 25,205 | 21,096 | 20,270 | 19,510 |
| | Local Surface | Stock Tanks and Windmills | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 101,545 | 52,764 | 32,700 | 25,476 | 21,375 | 20,558 | 19,806 |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,520,632 | 6,668,927 | 6,488,195 | 5,912,120 | 5,379,850 | 5,241,354 | 5,142,280 |
| | Quantity Pumped[2] | Ogallala | 138,280 | 86,288 | 81,860 | 78,044 | 73,821 | 70,449 | 68,588 |
| | Supply | (Ogallala)[3] | 138,280 | 86,288 | 81,860 | 78,044 | 73,821 | 70,449 | 68,588 |
| | Local Surface | Stock Tanks and Windmills | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| | Other Surface | Lake Mackenzie | 362 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water[4] | | 449 | 449 | 449 | 449 | 449 | 449 | 449 |
| | Total Supply | | 139,290 | 86,942 | 82,519 | 78,711 | 74,493 | 71,127 | 69,273 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 13,012,008 | 11,832,107 | 11,397,458 | 10,489,267 | 9,764,296 | 9,587,136 | 9,409,491 |
| | Quantity Pumped[2] | Ogallala | 239,572 | 138,793 | 114,294 | 103,249 | 94,917 | 90,719 | 88,098 |
| | Supply | (Ogallala)[3] | 239,572 | 138,793 | 114,294 | 103,249 | 94,917 | 90,719 | 88,098 |
| | Local Surface | Stock Tanks and Windmills | 452 | 464 | 476 | 489 | 502 | 517 | 532 |
| | Other Surface | Lake Mackenzie | 362 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water[4] | | 449 | 449 | 449 | 449 | 449 | 449 | 449 |
| | Total Supply | | 240,835 | 139,706 | 115,219 | 104,187 | 95,868 | 91,685 | 89,079 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| | Subtotal | | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Brazos Basin | | | | | | | | | |
| Floydada | | | 663 | 680 | 696 | 693 | 685 | 657 | 623 |
| Lockney | | | 237 | 242 | 244 | 240 | 234 | 224 | 212 |
| Rural | | | 178 | 183 | 185 | 183 | 180 | 172 | 163 |
| | Subtotal | | 1,078 | 1,105 | 1,125 | 1,116 | 1,099 | 1,053 | 998 |
| Total Municipal Demand | | | 1,181 | 1,211 | 1,232 | 1,222 | 1,203 | 1,153 | 1,093 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | Ogallala | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| | Subtotal | | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Brazos Basin | | | | | | | | | |
| Floydada | | Ogallala | 663 | 680 | 696 | 693 | 685 | 657 | 623 |
| | | Lake Mackenzie | 212 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floydada Subtotal | | | 875 | 680 | 696 | 693 | 685 | 657 | 623 |
| Lockney | | Ogallala | 237 | 242 | 244 | 0 | 0 | 0 | 0 |
| | | Lake Mackenzie | 150 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lockney Subtotal | | | 387 | 242 | 244 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 178 | 183 | 185 | 183 | 180 | 172 | 163 |
| | Subtotal | | 1,440 | 1,105 | 1,125 | 876 | 865 | 829 | 786 |
| Total Municipal Existing Supply | | | 1,543 | 1,211 | 1,232 | 982 | 969 | 929 | 881 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Floydada | | | 212 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lockney | | | 150 | 0 | 0 | -240 | -234 | -224 | -212 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 362 | 0 | 0 | -240 | -234 | -224 | -212 |
| Total Municipal Surplus/Shortage | | | 362 | 0 | 0 | -240 | -234 | -224 | -212 |

Continued on next page

***Table 4-9 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Floydada | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lockney | | | 0 | 0 | 0 | 240 | 234 | 224 | 212 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 240 | 234 | 224 | 212 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 240 | 234 | 224 | 212 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 106,659 | 102,411 | 98,332 | 94,415 | 90,654 | 87,044 | 83,577 |
| Brazos Basin | | | 130,361 | 125,168 | 120,184 | 115,397 | 110,800 | 106,387 | 102,150 |
| Total Irrigation Demand | | | 237,020 | 227,579 | 218,516 | 209,812 | 201,454 | 193,431 | 185,727 |
| **Irrigation Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 101,173 | 52,347 | 32,239 | 25,011 | 20,904 | 20,082 | 19,327 |
| Brazos Basin | | Ogallala | 136,300 | 84,052 | 79,437 | 75,385 | 71,135 | 67,752 | 65,878 |
| | | Reclaimed Water | 449 | 449 | 449 | 449 | 449 | 449 | 449 |
| Brazos Basin Subtotal | | | 136,749 | 84,501 | 79,886 | 75,834 | 71,584 | 68,201 | 66,327 |
| Total Irrigation Supply | | | 237,922 | 136,848 | 112,125 | 100,845 | 92,488 | 88,283 | 85,654 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | -5,486 | -50,064 | -66,093 | -69,404 | -69,750 | -66,962 | -64,250 |
| Brazos Basin | | | 6,388 | -40,667 | -40,298 | -39,563 | -39,216 | -38,186 | -35,823 |
| Total Irrigation Surplus/Shortage | | | 902 | -90,731 | -106,391 | -108,967 | -108,966 | -105,148 | -100,073 |

Continued on next page

***Table 4-9 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Mining Supply** | | | | | | | | |
| Red Basin | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Total Beef Feedlot Livestock Demand | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | Ogallala | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Total Beef Feedlot Livestock Supply | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Brazos Basin | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Total Dairies Demand | | 33 | 104 | 175 | 175 | 175 | 175 | 175 |
| | | | | | | | | |
| **Dairies Supply** | | | | | | | | |
| Red Basin | Ogallala | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Brazos Basin | Ogallala | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Total Dairies Supply | | 33 | 104 | 175 | 175 | 175 | 175 | 175 |
| | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Brazos Basin | | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Total Range & All Other Livestock Demand | | 452 | 464 | 476 | 489 | 502 | 517 | 532 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Brazos Basin | Local | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Total Range & All Other Livestock Supply | | 452 | 464 | 476 | 489 | 502 | 517 | 532 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,181 | 1,211 | 1,232 | 1,222 | 1,203 | 1,153 | 1,093 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 237,020 | 227,579 | 218,516 | 209,812 | 201,454 | 193,431 | 185,727 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Dairies | | 33 | 104 | 175 | 175 | 175 | 175 | 175 |
| Range & All Other Livestock | | 452 | 464 | 476 | 489 | 502 | 517 | 532 |
| Total County Demand | | 239,572 | 230,437 | 221,609 | 212,983 | 204,699 | 196,724 | 189,064 |

Continued on next page

### *Table 4-9 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 1,543 | 1,211 | 1,232 | 982 | 969 | 929 | 881 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 237,922 | 136,848 | 112,125 | 100,845 | 92,488 | 88,283 | 85,654 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Dairies | | 33 | 104 | 175 | 175 | 175 | 175 | 175 |
| Range & All Other Livestock | | 452 | 464 | 476 | 489 | 502 | 517 | 532 |
| Total County Supply | | 240,835 | 139,706 | 115,218 | 103,776 | 95,499 | 91,352 | 88,779 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 362 | 0 | 0 | -240 | -234 | -224 | -212 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 902 | -90,731 | -106,391 | -108,967 | -108,966 | -105,148 | -100,073 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 1,264 | -90,731 | -106,391 | -109,207 | -109,200 | -105,372 | -100,285 |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 106,659 | 102,411 | 98,332 | 94,415 | 90,654 | 87,044 | 83,577 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Range & All Other Livestock | | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Total Red Basin Demand | | 107,032 | 102,828 | 98,792 | 94,880 | 91,125 | 87,520 | 84,055 |
| **Brazos** | | | | | | | | |
| Municipal | | 1,078 | 1,105 | 1,125 | 1,116 | 1,099 | 1,053 | 998 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 130,361 | 125,168 | 120,184 | 115,397 | 110,800 | 106,387 | 102,150 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Dairies | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Range & All Other Livestock | | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Total Brazos Basin Demand | | 132,540 | 127,610 | 122,817 | 118,103 | 113,574 | 109,204 | 105,009 |
| **Total Basin Supply** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 103 | 106 | 107 | 106 | 104 | 100 | 95 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 101,173 | 52,347 | 32,239 | 25,011 | 20,904 | 20,082 | 19,327 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Range & All Other Livestock | | 253 | 259 | 266 | 271 | 279 | 288 | 296 |
| Total Red Basin Supply | | 101,545 | 52,764 | 32,699 | 25,476 | 21,375 | 20,558 | 19,805 |
| **Brazos** | | | | | | | | |
| Municipal | | 1,440 | 1,105 | 1,125 | 876 | 865 | 829 | 786 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 136,749 | 84,501 | 79,886 | 75,834 | 71,584 | 68,201 | 66,327 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 885 | 1,079 | 1,210 | 1,285 | 1,364 | 1,448 | 1,537 |
| Dairies | | 16 | 52 | 88 | 88 | 88 | 88 | 88 |
| Range & All Other Livestock | | 199 | 205 | 210 | 218 | 223 | 229 | 236 |
| Total Brazos Basin Supply | | 139,290 | 86,943 | 82,519 | 78,300 | 74,124 | 70,794 | 68,974 |

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### *Table 4-9 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -5,486 | -50,064 | -66,093 | -69,404 | -69,750 | -66,962 | -64,250 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | -5,486 | -50,064 | -66,093 | -69,404 | -69,750 | -66,962 | -64,250 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 362 | 0 | 0 | -240 | -234 | -224 | -212 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 6,388 | -40,667 | -40,298 | -39,563 | -39,216 | -38,186 | -35,823 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 6,750 | -40,667 | -40,298 | -39,803 | -39,450 | -38,410 | -36,035 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Lockney and the City of Floydada. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste dicharge permit.

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## *Table 4-10.*
## *Projected Water Demands, Supplies, and Needs*
## *Gaines County*
## *Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 12,495,883 | 10,232,860 | 7,998,429 | 6,120,700 | 4,493,051 | 3,708,105 | 3,651,389 |
| | Quantity Pumped[2] | Ogallala | 424,778 | 335,917 | 275,995 | 241,173 | 213,273 | 188,235 | 165,735 |
| | Supply | (Ogallala)[3] | 424,778 | 335,917 | 275,995 | 241,173 | 213,273 | 188,235 | 165,735 |
| | Local Surface | Stock Tanks and Windmills | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 425,074 | 336,221 | 276,307 | 241,493 | 213,602 | 188,573 | 166,083 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Seagraves | | | 416 | 449 | 482 | 502 | 513 | 506 | 499 |
| Seminole | | | 2,019 | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| Rural | | | 704 | 754 | 800 | 823 | 839 | 824 | 813 |
| | Subtotal | | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| Total Municipal Demand | | | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| **Municipal Existing Supply** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Seagraves | | Ogallala | 416 | 645 | 790 | 711 | 640 | 576 | 519 |
| Seminole | | Ogallala | 2,019 | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| Rural | | Ogallala | 704 | 754 | 800 | 823 | 839 | 824 | 813 |
| | Subtotal | | 3,139 | 3,613 | 3,991 | 4,059 | 4,084 | 3,979 | 3,876 |
| Total Municipal Existing Supply | | | 3,139 | 3,613 | 3,991 | 4,059 | 4,084 | 3,979 | 3,876 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Seagraves | | | 0 | 196 | 308 | 209 | 127 | 70 | 20 |
| Seminole | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 196 | 308 | 209 | 127 | 70 | 20 |
| Total Municipal Surplus/Shortage | | | 0 | 196 | 308 | 209 | 127 | 70 | 20 |
| **Municipal New Supply Need** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Seagraves | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Seminole | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | | |
| Colorado Basin | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-10 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Steam-Electric Existing Supply** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Colorado Basin | | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| Total Irrigation Demand | | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| **Irrigation Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 415,068 | 325,885 | 267,246 | 233,832 | 207,271 | 183,157 | 160,927 |
| Total Irrigation Supply | | 415,068 | 325,885 | 267,246 | 233,832 | 207,271 | 183,157 | 160,927 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 296 | -67,285 | -105,447 | -119,451 | -127,613 | -134,285 | -139,981 |
| Total Irrigation Surplus/Shortage | | 296 | -67,285 | -105,447 | -119,451 | -127,613 | -134,285 | -139,981 |
| **Mining Demand** | | | | | | | | |
| Colorado Basin | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Total Mining Demand | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| **Mining Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Total Mining Supply | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Colorado Basin | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Total Beef Feedlot Livestock Demand | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Total Beef Feedlot Livestock Supply | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Colorado Basin | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total Range & All Other Livestock Demand | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Colorado Basin | Local | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total Range & All Other Livestock Supply | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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### *Table 4-10 Concluded*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Demand** | | | | | | | | |
| Municipal | | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| Mining | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Beef Feedlot Livestock | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total County Demand | | 424,778 | 403,246 | 381,382 | 360,671 | 341,024 | 322,724 | 305,980 |
| **Total Supply** | | | | | | | | |
| Municipal | | 3,139 | 3,613 | 3,991 | 4,059 | 4,084 | 3,979 | 3,876 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 415,068 | 325,885 | 267,246 | 233,832 | 207,271 | 183,157 | 160,927 |
| Mining | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Beef Feedlot Livestock | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total County Supply | | 425,074 | 336,157 | 276,243 | 241,429 | 213,538 | 188,509 | 166,019 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 196 | 308 | 209 | 127 | 70 | 20 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 296 | -67,285 | -105,447 | -119,451 | -127,613 | -134,285 | -139,981 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 296 | -67,089 | -105,139 | -119,242 | -127,486 | -134,215 | -139,961 |
| **Total Basin Demand** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 3,139 | 3,417 | 3,683 | 3,850 | 3,957 | 3,909 | 3,856 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| Mining | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Beef Feedlot Livestock | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total Colorado Basin Demand | | 424,778 | 403,246 | 381,382 | 360,671 | 341,024 | 322,724 | 305,980 |
| **Total Basin Supply** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 3,139 | 3,613 | 3,991 | 4,059 | 4,084 | 3,979 | 3,876 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 415,068 | 325,885 | 267,246 | 233,832 | 207,271 | 183,157 | 160,927 |
| Mining | | 6,071 | 5,746 | 4,011 | 2,493 | 1,084 | 217 | 0 |
| Beef Feedlot Livestock | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 296 | 304 | 312 | 320 | 329 | 338 | 348 |
| Total Colorado Basin Supply | | 425,074 | 336,157 | 276,243 | 241,429 | 213,538 | 188,509 | 166,019 |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 196 | 308 | 209 | 127 | 70 | 20 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 296 | -67,285 | -105,447 | -119,451 | -127,613 | -134,285 | -139,981 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 296 | -67,089 | -105,139 | -119,242 | -127,486 | -134,215 | -139,961 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

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### *Table 4-11.*
### *Projected Water Demands, Supplies, and Needs*
### *Garza County*
### *Llano Estacado Region*

| Demand | Updated 6-4-09 | and 6/8/2009 and 8/13/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 662,851 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 |
| | Quantity Pumped[2] | Ogallala | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 |
| | Supply | (Ogallala)[3] | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 |
| | Dockum Aquifer | | 136 | 136 | 136 | 136 | 136 | 136 | 136 |
| | Local Surface | Stock Tanks and Windmills | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| | Other Surface | White River Reservoir | 1,021 | 1,021 | 973 | 493 | 12 | 0 | 0 |
| | Other Surface | Lake Alan Henry (WSD Contract) | 0 | 540 | 540 | 540 | 540 | 540 | 540 |
| | Slaton Contract | Part of Slaton CRMWA Supply | 0 | 306 | 306 | 306 | 306 | 306 | 306 |
| | Total Supply | | 16,075 | 9,893 | 9,257 | 8,301 | 7,382 | 6,989 | 6,709 |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Quantity Pumped[2] | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Supply | (Ogallala)[3] | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Local Surface | Stock Tanks and Windmills | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 662,851 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 | 643,700 |
| | Quantity Pumped[2] | Ogallala | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 |
| | Supply | (Ogallala)[3] | 14,563 | 7,527 | 6,879 | 6,394 | 5,946 | 5,554 | 5,262 |
| | Dockum Aquifer | | 136 | 136 | 136 | 136 | 136 | 136 | 136 |
| | Local Surface | Stock Tanks and Windmills | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| | Other Surface | White River Reservoir | 1,021 | 1,021 | 973 | 493 | 12 | 0 | 0 |
| | Other Surface | Lake Alan Henry (WSD Contract) | 0 | 540 | 540 | 540 | 540 | 540 | 540 |
| | Slaton Contract | Part of Slaton CRMWA Supply | 0 | 306 | 306 | 306 | 306 | 306 | 306 |
| | Total Supply | | 16,075 | 9,893 | 9,257 | 8,301 | 7,382 | 6,989 | 6,709 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Post | | | 623 | 631 | 642 | 616 | 579 | 549 | 512 |
| Lake Alan Henry WSD | Shift from Rural | | 0 | 22 | 22 | 22 | 22 | 22 | 22 |
| Rural | | | 154 | 134 | 134 | 128 | 119 | 110 | 101 |
| | Subtotal | | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Demand | | | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Post | 1989 obtained 674 acft | White River Reservoir | 1,021 | 1,021 | 973 | 493 | 12 | 0 | 0 |
| Post | | Slaton (CRMWA Source) | 0 | 306 | 306 | 306 | 306 | 306 | 306 |
| Post Subtotal | | | 1,021 | 1,327 | 1,279 | 799 | 318 | 306 | 306 |
| Lake Alan WSD | | Lubbock (Lake Alan Henry) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 154 | 134 | 134 | 128 | 119 | 110 | 101 |
| | | Dockum | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Rural Subtotal | | | 190 | 170 | 170 | 164 | 155 | 146 | 137 |
| | Subtotal | | 1,211 | 1,497 | 1,449 | 963 | 473 | 452 | 443 |
| Colorado Basin | | | | | | | | | |
| Rural | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Existing Supply | | | 1,211 | 1,497 | 1,449 | 963 | 473 | 452 | 443 |

Continued on next page

***Table 4-11 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Post | | | 398 | 696 | 637 | 183 | -261 | -243 | -206 |
| Lake Alan Henry WSD | | | 0 | -22 | -22 | -22 | -22 | -22 | -22 |
| Rural | | | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Subtotal | | 434 | 710 | 651 | 197 | -247 | -229 | -192 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Surplus/Shortage | | | 434 | 710 | 651 | 197 | -247 | -229 | -192 |
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Post | | | 0 | 0 | 0 | 0 | 261 | 243 | 206 |
| Lake Alan Henry WSD | | | 0 | 22 | 22 | 22 | 22 | 22 | 22 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 22 | 22 | 22 | 283 | 265 | 228 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 22 | 22 | 22 | 283 | 265 | 228 |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Brazos Basin | | | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Irrigation Demand | | | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| **Irrigation Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 13,143 | 6,639 | 6,382 | 6,053 | 5,735 | 5,442 | 5,159 |
| | | Dockum | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Brazos Basin Subtotal | | | 13,243 | 6,739 | 6,482 | 6,153 | 5,835 | 5,542 | 5,259 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Irrigation Supply | | | 13,243 | 6,739 | 6,482 | 6,153 | 5,835 | 5,542 | 5,259 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 1,078 | -4,712 | -4,301 | -3,995 | -3,721 | -3,455 | -3,212 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Irrigation Surplus/Shortage | | | 1,078 | -4,712 | -4,301 | -3,995 | -3,721 | -3,455 | -3,212 |

Continued on next page

***Table 4-11 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| | | | | | | | | |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Demand | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Colorado Basin | Local | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Supply | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| Industrial | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| Mining | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Total County Demand | | 14,563 | 13,355 | 12,367 | 11,559 | 10,810 | 10,133 | 9,573 |

Continued on next page

### *Table 4-11 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 1,211 | 1,497 | 1,449 | 963 | 473 | 452 | 443 |
| Industrial | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 13,243 | 6,739 | 6,482 | 6,153 | 5,835 | 5,542 | 5,259 |
| Mining | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Total County Supply | | 16,075 | 9,353 | 8,717 | 7,761 | 6,842 | 6,449 | 6,169 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 434 | 710 | 651 | 197 | -247 | -229 | -192 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,078 | -4,712 | -4,301 | -3,995 | -3,721 | -3,455 | -3,212 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 1,512 | -4,002 | -3,650 | -3,798 | -3,968 | -3,684 | -3,404 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 777 | 787 | 798 | 766 | 720 | 681 | 635 |
| Industrial | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| Mining | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Total Brazos Basin Demand | | 14,563 | 13,355 | 12,367 | 11,559 | 10,810 | 10,133 | 9,573 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,211 | 1,497 | 1,449 | 963 | 473 | 452 | 443 |
| Industrial | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 13,243 | 6,739 | 6,482 | 6,153 | 5,835 | 5,542 | 5,259 |
| Mining | | 1,264 | 752 | 361 | 211 | 90 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 355 | 363 | 423 | 432 | 442 | 453 | 465 |
| Total Brazos Basin Supply | | 16,075 | 9,353 | 8,717 | 7,761 | 6,842 | 6,449 | 6,169 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Concluded on next page

***Table 4-11 Concluded***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 434 | 710 | 651 | 197 | -247 | -229 | -192 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,078 | -4,712 | -4,301 | -3,995 | -3,721 | -3,455 | -3,212 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 1,512 | -4,002 | -3,650 | -3,798 | -3,968 | -3,684 | -3,404 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

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## Table 4-12.
## Projected Water Demands, Supplies, and Needs
## Hale County
## Llano Estacado Region

| Demand | Updated 6-4-09 | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Abernethy supply updated 10/20/2009 | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| | | | | | | | | | |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 29,446 | 18,450 | 16,419 | 6,085 | 5,484 | 5,410 | 5,342 |
| | Quantity Pumped[2] | Ogallala | 3,499 | 829 | 0 | 0 | 0 | 0 | 0 |
| | Supply | (Ogallala)[3] | 3,499 | 829 | 0 | 0 | 0 | 0 | 0 |
| | Local Surface | Stock Tanks and Windmills | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 3,500 | 830 | 1 | 1 | 1 | 1 | 1 |
| | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 9,837,572 | 8,174,441 | 5,575,536 | 3,645,123 | 2,458,242 | 2,158,654 | 1,881,355 |
| | Quantity Pumped[2] | Ogallala | 374,974 | 348,301 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 |
| | Supply | (Ogallala)[3] | 374,974 | 348,301 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,476 | 2,482 | 2,482 | 2,482 | 2,482 | 2,250 | 2,250 |
| | Local Surface | Stock Tanks and Windmills | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| | Other Surface | Lake Meredith (CRMWA) | 2,805 | 1,427 | 1,799 | 1,799 | 1,799 | 1,631 | 1,631 |
| | Reclaimed Water[4] | | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 |
| | Total Supply | | 385,056 | 358,019 | 312,802 | 216,914 | 137,667 | 108,447 | 98,873 |
| | | | | | | | | | |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 9,867,018 | 8,192,891 | 5,591,955 | 3,651,208 | 2,463,726 | 2,164,064 | 1,886,697 |
| | Quantity Pumped[2] | Ogallala | 378,473 | 349,130 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 |
| | Supply | (Ogallala)[3] | 378,473 | 349,130 | 302,704 | 206,807 | 127,551 | 98,721 | 89,136 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,476 | 2,482 | 2,482 | 2,482 | 2,482 | 2,250 | 1,476 |
| | Local Surface | Stock Tanks and Windmills | 325 | 333 | 341 | 350 | 359 | 369 | 380 |
| | Other Surface | Lake Meredith (CRMWA) | 2,805 | 1,427 | 1,799 | 1,799 | 1,799 | 1,631 | 1,631 |
| | Reclaimed Water[4] | | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 |
| | Total Supply | | 388,556 | 358,849 | 312,803 | 216,915 | 137,668 | 108,448 | 98,874 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | | 461 | 486 | 508 | 526 | 531 | 525 | 514 |
| Hale Center | | | 446 | 470 | 493 | 509 | 513 | 507 | 498 |
| Petersburg | | | 276 | 289 | 304 | 313 | 316 | 312 | 306 |
| Plainview | | | 4,078 | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |
| Rural | | | 1,109 | 1,144 | 1,187 | 1,207 | 1,203 | 1,184 | 1,161 |
| | Subtotal | | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| | | | | | | | | | |
| Total Municipal Demand | | | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| | | | | | | | | | |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | Ogallala | 461 | 486 | 386 | 348 | 314 | 282 | 254 |
| Hale Center | | Ogallala | 446 | 470 | 493 | 607 | 740 | 666 | 599 |
| Petersburg | | Ogallala | 276 | 289 | 304 | 313 | 316 | 0 | 0 |
| Plainview | | Ogallala | 11,855 | 11,721 | 10,596 | 9,579 | 8,659 | 8,128 | 7,076 |
| | | Lake Meredith (CRMWA) | 2,805 | 1,427 | 1,799 | 1,799 | 1,799 | 1,631 | 1,631 |
| | | Ogallala (CRMWA - Roberts Co.) | 1,476 | 2,482 | 2,482 | 2,482 | 2,482 | 2,250 | 2,250 |
| Plainview Subtotal | | | 16,136 | 15,630 | 14,877 | 13,860 | 12,940 | 12,009 | 10,957 |
| Rural | | Ogallala | 1,109 | 1,144 | 1,187 | 1,207 | 1,203 | 1,184 | 1,161 |
| | Subtotal | | 18,428 | 18,019 | 17,247 | 16,335 | 15,513 | 14,141 | 12,971 |
| | | | | | | | | | |
| Total Municipal Existing Supply | | | 18,428 | 18,019 | 17,247 | 16,335 | 15,513 | 14,141 | 12,971 |

Continued on next page

### *Table 4-12 Continued*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | | 0 | 0 | -122 | -178 | -217 | -243 | -260 |
| Hale Center | | | 0 | 0 | 0 | 98 | 227 | 159 | 101 |
| Petersburg | | | 0 | 0 | 0 | 0 | 0 | -312 | -306 |
| Plainview | | | 12,058 | 11,342 | 10,387 | 9,255 | 8,305 | 7,432 | 6,469 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 12,058 | 11,342 | 10,265 | 9,175 | 8,315 | 7,036 | 6,004 |
| Total Municipal Surplus/Shortage | | | 12,058 | 11,342 | 10,265 | 9,175 | 8,315 | 7,036 | 6,004 |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | | 0 | 0 | 122 | 178 | 217 | 243 | 260 |
| Hale Center | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Petersburg | | | 0 | 0 | 0 | 0 | 0 | 312 | 306 |
| Plainview | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 122 | 178 | 217 | 555 | 566 |
| Total Municipal New Supply Need | | | 0 | 0 | 122 | 178 | 217 | 555 | 566 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Total Industrial Demand | | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | Ogallala | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Total Industrial Existing Supply | | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 3,677 | 3,555 | 3,437 | 3,323 | 3,213 | 3,107 | 3,004 |
| Brazos Basin | | | 364,023 | 351,961 | 340,300 | 329,026 | 318,124 | 307,583 | 297,392 |
| Total Irrigation Demand | | | 367,700 | 355,516 | 343,737 | 332,349 | 321,337 | 310,690 | 300,396 |

Continued on next page

***Table 4-12 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Supply** | | | | | | | | |
| Red Basin | Ogallala | 3,499 | 3,282 | 2,834 | 1,886 | 1,101 | 832 | 747 |
| Brazos Basin | Ogallala | 356,750 | 324,540 | 280,114 | 186,357 | 108,465 | 81,510 | 73,122 |
| | Reclaimed Water | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 | 5,477 |
| Brazos Basin Subtotal | | 362,227 | 330,017 | 285,591 | 191,834 | 113,942 | 86,987 | 78,599 |
| Total Irrigation Supply | | 365,726 | 333,299 | 288,425 | 193,720 | 115,043 | 87,819 | 79,346 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Red Basin | | -178 | -273 | -603 | -1,437 | -2,112 | -2,275 | -2,257 |
| Brazos Basin | | -1,796 | -21,944 | -54,709 | -137,192 | -204,182 | -220,596 | -218,793 |
| Total Irrigation Surplus/Shortage | | -1,974 | -22,217 | -55,312 | -138,629 | -206,294 | -222,871 | -221,050 |
| **Mining Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Total Mining Demand | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | Ogallala | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Total Mining Supply | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| Total Beef Feedlot Livestock Demand | | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | Ogallala | 1,185 | 1,445 | 1,620 | 1,147 | 1,217 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 1,185 | 1,445 | 1,620 | 1,147 | 1,217 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | -573 | -609 | -1,939 | -2,058 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | -573 | -609 | -1,939 | -2,058 |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 29 | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| Total Dairies Demand | | 29 | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| **Dairies Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 29 | 855 | 960 | 1,060 | 984 | 1,086 | 969 |
| Total Dairies Supply | | 29 | 855 | 960 | 1,060 | 984 | 1,086 | 969 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | -187 | -208 | -460 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | -187 | -208 | -460 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Brazos Basin | | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| Total Range & All Other Livestock Demand | | 325 | 333 | 341 | 350 | 359 | 369 | 380 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Brazos Basin | Local | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| Total Range & All Other Livestock Supply | | 325 | 333 | 341 | 350 | 359 | 369 | 380 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-12 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Demand** | | | | | | | | |
| Municipal | | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| Industrial | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 367,700 | 355,516 | 343,737 | 332,349 | 321,337 | 310,690 | 300,396 |
| Mining | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| Dairies | | 29 | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| Range & All Other Livestock | | 325 | 333 | 341 | 350 | 359 | 369 | 380 |
| Total County Demand | | 378,472 | 368,467 | 357,422 | 346,557 | 335,933 | 325,561 | 315,630 |
| | | | | | | | | |
| **Total Supply** | | | | | | | | |
| Municipal | | 18,428 | 18,019 | 17,247 | 16,335 | 15,513 | 14,141 | 12,971 |
| Industrial | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 365,726 | 333,299 | 288,425 | 193,720 | 115,043 | 87,819 | 79,346 |
| Mining | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 1,185 | 1,445 | 1,620 | 1,147 | 1,217 | 0 | 0 |
| Dairies | | 29 | 855 | 960 | 1,060 | 984 | 1,086 | 969 |
| Range & All Other Livestock | | 325 | 333 | 341 | 350 | 359 | 369 | 380 |
| Total County Supply | | 388,556 | 357,592 | 312,375 | 216,530 | 137,159 | 107,579 | 98,066 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 12,058 | 11,342 | 10,265 | 9,175 | 8,315 | 7,036 | 6,004 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -1,974 | -22,217 | -55,312 | -138,629 | -206,294 | -222,871 | -221,050 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | -573 | -609 | -1,939 | -2,058 |
| Dairies | | 0 | 0 | 0 | 0 | -187 | -208 | -460 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 10,084 | -10,875 | -45,047 | -130,027 | -198,775 | -217,981 | -217,564 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 3,677 | 3,555 | 3,437 | 3,323 | 3,213 | 3,107 | 3,004 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Red Basin Demand | | 3,678 | 3,556 | 3,438 | 3,324 | 3,214 | 3,108 | 3,005 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 6,370 | 6,677 | 6,982 | 7,160 | 7,198 | 7,105 | 6,967 |
| Industrial | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 364,023 | 351,961 | 340,300 | 329,026 | 318,124 | 307,583 | 297,392 |
| Mining | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 1,185 | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| Dairies | | 29 | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| Range & All Other Livestock | | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| Total Brazos Basin Demand | | 374,794 | 364,910 | 353,984 | 343,233 | 332,719 | 322,453 | 312,625 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 3,499 | 3,282 | 2,834 | 1,886 | 1,101 | 832 | 747 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Red Basin Supply | | 3,500 | 3,283 | 2,835 | 1,887 | 1,102 | 833 | 748 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 18,428 | 18,019 | 17,247 | 16,335 | 15,513 | 14,141 | 12,971 |
| Industrial | | 2,605 | 3,553 | 3,748 | 3,899 | 4,042 | 4,164 | 4,400 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 362,227 | 330,017 | 285,591 | 191,834 | 113,942 | 86,987 | 78,599 |
| Mining | | 258 | 88 | 34 | 19 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 1,185 | 1,445 | 1,620 | 1,147 | 1,217 | 0 | 0 |
| Dairies | | 29 | 855 | 960 | 1,060 | 984 | 1,086 | 969 |
| Range & All Other Livestock | | 324 | 331 | 340 | 349 | 358 | 368 | 379 |
| Total Brazos Basin Supply | | 385,056 | 354,308 | 309,540 | 214,642 | 136,056 | 106,746 | 97,318 |

Concluded on next page

### *Table 4-12 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -178 | -273 | -603 | -1,437 | -2,112 | -2,275 | -2,257 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | -178 | -273 | -603 | -1,437 | -2,112 | -2,275 | -2,257 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 12,058 | 11,342 | 10,265 | 9,175 | 8,315 | 7,036 | 6,004 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -1,796 | -21,944 | -54,709 | -137,192 | -204,182 | -220,596 | -218,793 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | -573 | -609 | -1,939 | -2,058 |
| Dairies | | 0 | 0 | 0 | 0 | -187 | -208 | -460 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 10,262 | -10,602 | -44,444 | -128,590 | -196,663 | -215,706 | -215,307 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The value is the sum of reclaimed water from the City of Petersburg, City of Abernathy, City of Hale Center, City of Plainview, City of Edmonson, Excel Corp., John's Washout, Azteca Milling Co., Southern Cotton Oil Mill, Panhandle Processing Co., and Walker Brothers Produce. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated at 75 percent of the maximum waste discharge permit.

<><><><>

# Table 4-13.
# Projected Water Demands, Supplies, and Needs
# Hockley County
# Llano Estacado Region

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 4,445,678 | 4,012,574 | 3,520,944 | 3,122,056 | 2,822,881 | 2,814,561 | 2,768,066 |
| | Quantity Pumped[2] | Ogallala | 163,639 | 96,889 | 79,415 | 67,208 | 55,876 | 53,945 | 50,540 |
| | Supply | (Ogallala)[3] | 163,639 | 96,889 | 79,415 | 67,208 | 55,876 | 53,945 | 50,540 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,116 | 2,157 | 1,876 | 1,876 | 1,876 | 1,628 | 1,628 |
| | Local Surface | Stock Tanks and Windmills | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| | Other Surface | Lake Meredith (CRMWA) | 2,120 | 1,079 | 1,360 | 1,360 | 1,360 | 1,180 | 1,180 |
| | Reclaimed Water[5] | | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 |
| | Total Supply | | 168,455 | 101,711 | 84,283 | 72,083 | 60,756 | 58,405 | 55,006 |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 1,034,833 | 980,634 | 911,792 | 843,370 | 792,366 | 776,547 | 765,041 |
| | Quantity Pumped[2] | Ogallala | 20,274 | 12,761 | 10,678 | 8,807 | 8,186 | 7,686 | 7,689 |
| | Supply | (Ogallala)[3] | 20,274 | 12,761 | 10,678 | 8,807 | 8,186 | 7,686 | 7,689 |
| | Local Surface | Stock Tanks and Windmills | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| | Reclaimed Water[5] | | 162 | 162 | 162 | 162 | 162 | 162 | 162 |
| | Total Supply | | 20,480 | 12,968 | 10,895 | 9,024 | 8,404 | 7,904 | 7,909 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 5,480,511 | 4,993,208 | 4,432,736 | 3,965,426 | 3,615,247 | 3,591,108 | 3,533,107 |
| | Quantity Pumped[2] | Ogallala | 183,913 | 109,650 | 90,093 | 76,015 | 64,062 | 61,631 | 58,229 |
| | Supply | (Ogallala)[3] | 183,913 | 109,650 | 90,093 | 76,015 | 64,062 | 61,631 | 58,229 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 1,116 | 2,157 | 1,876 | 1,876 | 1,876 | 1,628 | 1,628 |
| | Local Surface | Stock Tanks and Windmills | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| | Other Surface | Lake Meredith (CRMWA) | 2,120 | 1,079 | 1,360 | 1,360 | 1,360 | 1,180 | 2,120 |
| | Reclaimed Water[5] | | 1,521 | 1,521 | 1,521 | 1,521 | 1,521 | 1,521 | 1,521 |
| | Total Supply | | 188,935 | 114,679 | 95,178 | 81,107 | 69,160 | 66,309 | 62,915 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Anton | | | 250 | 263 | 270 | 272 | 268 | 256 | 243 |
| Levelland | | | 2,219 | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| Ropesville | | | 85 | 89 | 91 | 91 | 89 | 85 | 81 |
| Smyer | | | 67 | 69 | 70 | 70 | 68 | 65 | 62 |
| Rural | | | 814 | 840 | 855 | 853 | 831 | 791 | 753 |
| | Subtotal | | 3,435 | 3,571 | 3,648 | 3,655 | 3,578 | 3,413 | 3,246 |
| Colorado Basin | | | | | | | | | |
| Sundown | | | 325 | 341 | 350 | 353 | 347 | 332 | 316 |
| Rural | | | 40 | 41 | 42 | 42 | 41 | 39 | 37 |
| | Subtotal | | 365 | 382 | 392 | 395 | 388 | 371 | 353 |
| Total Municipal Demand | | | 3,800 | 3,953 | 4,040 | 4,050 | 3,966 | 3,784 | 3,599 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Anton | | Ogallala | 250 | 0 | 0 | 0 | 0 | 0 | 0 |
| Levelland | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Lake Meredith (CRMWA)[4] | 2,120 | 1,079 | 1,360 | 1,360 | 1,360 | 1,180 | 1,180 |
| | | Ogallala (CRMWA - Roberts Co.)[4] | 1,116 | 2,157 | 1,876 | 1,876 | 1,876 | 1,628 | 1,628 |
| Levelland Subtotal | | | 3,236 | 3,236 | 3,236 | 3,236 | 3,236 | 2,808 | 2,808 |
| Ropesville | | Ogallala | 85 | 89 | 91 | 0 | 0 | 0 | 0 |
| Smyer | | Ogallala | 67 | 69 | 70 | 70 | 68 | 65 | 0 |
| Rural | | Ogallala | 814 | 840 | 855 | 853 | 831 | 791 | 753 |
| | Subtotal | | 4,452 | 4,234 | 4,252 | 4,159 | 4,135 | 3,664 | 3,561 |
| Colorado Basin | | | | | | | | | |
| Sundown | | Ogallala | 325 | 341 | 0 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 40 | 41 | 42 | 42 | 41 | 39 | 37 |
| | Subtotal | | 365 | 382 | 42 | 42 | 41 | 39 | 37 |
| Total Municipal Existing Supply | | | 4,817 | 4,616 | 4,294 | 4,201 | 4,176 | 3,703 | 3,598 |

Continued on next page

***Table 4-13 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Anton | | | 0 | -263 | -270 | -272 | -268 | -256 | -243 |
| Levelland | | | 1,017 | 926 | 874 | 867 | 914 | 592 | 701 |
| Ropesville | | | 0 | 0 | 0 | -91 | -89 | -85 | -81 |
| Smyer | | | 0 | 0 | 0 | 0 | 0 | 0 | -62 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 1,017 | 663 | 604 | 504 | 557 | 251 | 315 |
| Colorado Basin | | | | | | | | | |
| Sundown | | | 0 | 0 | -350 | -353 | -347 | -332 | -316 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | -350 | -353 | -347 | -332 | -316 |
| Total Municipal Surplus/Shortage | | | 1,017 | 663 | 254 | 151 | 210 | -81 | -1 |
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Anton | | | 0 | 263 | 270 | 272 | 268 | 256 | 243 |
| Levelland | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ropesville | | | 0 | 0 | 0 | 91 | 89 | 85 | 81 |
| Smyer | | | 0 | 0 | 0 | 0 | 0 | 0 | 62 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 263 | 270 | 363 | 357 | 341 | 386 |
| Colorado Basin | | | | | | | | | |
| Sundown | | | 0 | 0 | 350 | 353 | 347 | 332 | 316 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 350 | 353 | 347 | 332 | 316 |
| Total Municipal New Supply Need | | | 0 | 263 | 620 | 716 | 704 | 673 | 702 |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Brazos Basin | | | 157,496 | 151,336 | 145,420 | 139,735 | 134,269 | 129,019 | 123,974 |
| Colorado Basin | | | 17,500 | 16,815 | 16,158 | 15,526 | 14,919 | 14,335 | 13,775 |
| Total Irrigation Demand | | | 174,996 | 168,151 | 161,578 | 155,261 | 149,188 | 143,354 | 137,749 |

Continued on next page

### *Table 4-13 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 158,725 | 91,365 | 74,667 | 63,016 | 52,330 | 50,816 | 47,347 |
| | Reclaimed Water | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 | 1,359 |
| Brazos Basin Subtotal | | 160,084 | 92,724 | 76,026 | 64,375 | 53,689 | 52,175 | 48,706 |
| Colorado Basin | Ogallala | 18,795 | 11,583 | 9,715 | 7,865 | 7,506 | 7,180 | 7,237 |
| | Reclaimed Water | 162 | 162 | 162 | 162 | 162 | 162 | 162 |
| Colorado Basin Subtotal | | 18,957 | 11,745 | 9,877 | 8,027 | 7,668 | 7,342 | 7,399 |
| Total Irrigation Supply | | 179,041 | 104,469 | 85,903 | 72,402 | 61,357 | 59,517 | 56,105 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 2,588 | -58,612 | -69,394 | -75,360 | -80,580 | -76,844 | -75,268 |
| Colorado Basin | | 1,457 | -5,070 | -6,281 | -7,499 | -7,251 | -6,993 | -6,376 |
| Total Irrigation Surplus/Shortage | | 4,045 | -63,682 | -75,675 | -82,859 | -87,831 | -83,837 | -81,644 |
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 3,302 | 2,358 | 1,510 | 981 | 378 | 19 | 0 |
| Colorado Basin | | 1,114 | 796 | 509 | 331 | 127 | 6 | 0 |
| Total Mining Demand | | 4,416 | 3,154 | 2,019 | 1,312 | 505 | 25 | 0 |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 3,302 | 2,358 | 1,510 | 981 | 378 | 19 | 0 |
| Colorado Basin | Ogallala | 1,114 | 796 | 509 | 331 | 127 | 6 | 0 |
| Total Mining Supply | | 4,416 | 3,154 | 2,019 | 1,312 | 505 | 25 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Colorado Basin | | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Total Range & All Other Livestock Demand | | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Colorado Basin | Local | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Total Range & All Other Livestock Supply | | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

### *Table 4-13 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Demand** | | | | | | | | |
| Municipal | | 3,800 | 3,953 | 4,040 | 4,050 | 3,966 | 3,784 | 3,599 |
| Industrial | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 174,996 | 168,151 | 161,578 | 155,261 | 149,188 | 143,354 | 137,749 |
| Mining | | 4,416 | 3,154 | 2,019 | 1,312 | 505 | 25 | 0 |
| Beef Feedlot Livestock | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| Total County Demand | | 183,873 | 177,128 | 169,618 | 162,643 | 155,720 | 149,266 | 143,498 |
| **Total Supply** | | | | | | | | |
| Municipal | | 4,817 | 4,616 | 4,294 | 4,201 | 4,176 | 3,703 | 3,598 |
| Industrial | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 179,041 | 104,469 | 85,903 | 72,402 | 61,357 | 59,517 | 56,105 |
| Mining | | 4,416 | 3,154 | 2,019 | 1,312 | 505 | 25 | 0 |
| Beef Feedlot Livestock | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 265 | 271 | 328 | 335 | 342 | 349 | 357 |
| Total County Supply | | 188,935 | 114,109 | 94,197 | 79,935 | 68,099 | 65,348 | 61,853 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 1,017 | 663 | 254 | 151 | 210 | -81 | -1 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 4,045 | -63,682 | -75,675 | -82,859 | -87,831 | -83,837 | -81,644 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 5,062 | -63,019 | -75,421 | -82,708 | -87,621 | -83,918 | -81,645 |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 3,435 | 3,571 | 3,648 | 3,655 | 3,578 | 3,413 | 3,246 |
| Industrial | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 157,496 | 151,336 | 145,420 | 139,735 | 134,269 | 129,019 | 123,974 |
| Mining | | 3,302 | 2,358 | 1,510 | 981 | 378 | 19 | 0 |
| Beef Feedlot Livestock | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Total Brazos Basin Demand | | 164,850 | 159,090 | 152,505 | 146,336 | 140,230 | 134,497 | 129,312 |
| **Colorado** | | | | | | | | |
| Municipal | | 365 | 382 | 392 | 395 | 388 | 371 | 353 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 17,500 | 16,815 | 16,158 | 15,526 | 14,919 | 14,335 | 13,775 |
| Mining | | 1,114 | 796 | 509 | 331 | 127 | 6 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Total Colorado Basin Demand | | 19,023 | 18,038 | 17,114 | 16,307 | 15,490 | 14,769 | 14,187 |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 4,452 | 4,234 | 4,252 | 4,159 | 4,135 | 3,664 | 3,561 |
| Industrial | | 53 | 1,181 | 1,185 | 1,188 | 1,191 | 1,193 | 1,198 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 160,084 | 92,724 | 76,026 | 64,375 | 53,689 | 52,175 | 48,706 |
| Mining | | 3,302 | 2,358 | 1,510 | 981 | 378 | 19 | 0 |
| Beef Feedlot Livestock | | 343 | 418 | 468 | 497 | 528 | 561 | 595 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 221 | 226 | 273 | 280 | 286 | 292 | 299 |
| Total Brazos Basin Supply | | 168,455 | 101,141 | 83,715 | 71,480 | 60,207 | 57,904 | 54,359 |
| **Colorado** | | | | | | | | |
| Municipal | | 365 | 382 | 42 | 42 | 41 | 39 | 37 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 18,957 | 11,745 | 9,877 | 8,027 | 7,668 | 7,342 | 7,399 |
| Mining | | 1,114 | 796 | 509 | 331 | 127 | 6 | 0 |

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### *Table 4-13 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 44 | 45 | 55 | 55 | 56 | 57 | 59 |
| Total Colorado Basin Supply | | 20,480 | 12,968 | 10,483 | 8,455 | 7,892 | 7,444 | 7,495 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,017 | 663 | 604 | 504 | 557 | 251 | 315 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,588 | -58,612 | -69,394 | -75,360 | -80,580 | -76,844 | -75,268 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 3,605 | -57,949 | -68,790 | -74,856 | -80,023 | -76,593 | -74,953 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | -350 | -353 | -347 | -332 | -316 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,457 | -5,070 | -6,281 | -7,499 | -7,251 | -6,993 | -6,376 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 1,457 | -5,070 | -6,631 | -7,852 | -7,598 | -7,325 | -6,692 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

[5] Value is the sum of reclaimed water from the City of Anton, City of Levelland, Bowman Enterprises, City of Smyer, City of Ropesville, City of Sundown, and United Cotton Growers Coop & Whitharrel Water Supply Corp. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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### Table 4-14.
### Projected Water Demands, Supplies, and Needs
### Lamb County
### Llano Estacado Region

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 8,246,693 | 6,944,619 | 5,155,582 | 3,861,385 | 2,953,511 | 2,743,521 | 2,533,373 |
| | Quantity Pumped[2] | Ogallala | 402,158 | 267,764 | 210,668 | 156,745 | 109,741 | 91,026 | 81,651 |
| | Supply | (Ogallala)[3] | 402,158 | 267,764 | 210,668 | 156,745 | 109,741 | 91,026 | 81,651 |
| | Local Surface | Stock Tanks and Windmills | 472 | 491 | 510 | 531 | 552 | 575 | 599 |
| | Reclaimed Water[4] | | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 |
| | Total Supply | | 409,829 | 275,454 | 218,377 | 164,475 | 117,492 | 98,801 | 89,449 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Amherst | | | 163 | 168 | 176 | 182 | 185 | 183 | 181 |
| Earth | | | 248 | 257 | 268 | 277 | 283 | 280 | 276 |
| Littlefield | | | 1,480 | 1,530 | 1,602 | 1,660 | 1,694 | 1,676 | 1,655 |
| Olton | | | 474 | 492 | 512 | 532 | 542 | 536 | 529 |
| Sudan | | | 218 | 226 | 236 | 244 | 249 | 246 | 243 |
| Rural | | | 766 | 794 | 830 | 861 | 880 | 872 | 861 |
| | Subtotal | | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| Total Municipal Demand | | | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Amherst | | Ogallala | 163 | 168 | 391 | 352 | 317 | 285 | 257 |
| Earth | | Ogallala | 248 | 257 | 268 | 277 | 0 | 0 | 0 |
| Littlefield | | Ogallala | 1,480 | 2,430 | 2,412 | 2,389 | 2,350 | 2,266 | 2,186 |
| Olton | | Ogallala | 474 | 1,329 | 1,265 | 1,210 | 1,352 | 1,088 | 1,028 |
| Sudan | | Ogallala | 218 | 226 | 432 | 389 | 350 | 315 | 283 |
| Rural | | Ogallala | 766 | 794 | 830 | 861 | 880 | 872 | 861 |
| | Subtotal | | 3,349 | 5,204 | 5,598 | 5,478 | 5,249 | 4,826 | 4,615 |
| Total Municipal Existing Supply | | | 3,349 | 5,204 | 5,598 | 5,478 | 5,249 | 4,826 | 4,615 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Amherst | | | 0 | 0 | 215 | 170 | 132 | 102 | 76 |
| Earth | | | 0 | 0 | 0 | 0 | -283 | -280 | -276 |
| Littlefield | | | 0 | 900 | 810 | 729 | 656 | 590 | 531 |
| Olton | | | 0 | 837 | 753 | 678 | 810 | 552 | 499 |
| Sudan | | | 0 | 0 | 196 | 145 | 101 | 69 | 40 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 1,737 | 1,974 | 1,722 | 1,416 | 1,033 | 870 |
| Total Municipal Surplus/Shortage | | | 0 | 1,737 | 1,974 | 1,722 | 1,416 | 1,033 | 870 |
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Amherst | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Earth | | | 0 | 0 | 0 | 0 | 283 | 280 | 276 |
| Littlefield | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Olton | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sudan | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 283 | 280 | 276 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 283 | 280 | 276 |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Total Industrial Demand | | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Total Industrial Existing Supply | | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |

Continued on next page

### *Table 4-14 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Industrial Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | |
| Brazos Basin | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Total Steam-Electric Demand | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| **Steam-Electric Existing Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Total Steam-Electric Existing Supply | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Brazos Basin | | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| Total Irrigation Demand | | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 378,365 | 241,282 | 183,650 | 126,964 | 77,105 | 54,827 | 40,581 |
| | Reclaimed Water | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 | 7,199 |
| Total Irrigation Supply | | 385,564 | 248,481 | 190,849 | 134,163 | 84,304 | 62,026 | 47,780 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 7,671 | -114,832 | -158,445 | -201,653 | -238,554 | -248,375 | -250,645 |
| Total Irrigation Surplus/Shortage | | 7,671 | -114,832 | -158,445 | -201,653 | -238,554 | -248,375 | -250,645 |
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Total Mining Demand | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Total Mining Supply | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| Total Beef Feedlot Livestock Demand | | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 1,328 | 1,619 | 1,815 | 1,686 | 1,023 | 814 | 576 |
| Total Beef Feedlot Livestock Supply | | 1,328 | 1,619 | 1,815 | 1,686 | 1,023 | 814 | 576 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | -241 | -1,023 | -1,358 | -1,730 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | -241 | -1,023 | -1,358 | -1,730 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| Total Dairies Demand | | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 612 | 1,290 | 1,398 | 1,410 | 1,111 | 894 | 801 |
| Total Dairies Supply | | 612 | 1,290 | 1,398 | 1,410 | 1,111 | 894 | 801 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | -134 | -595 | -990 | -1,280 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | -134 | -595 | -990 | -1,280 |

Continued on next page

***Table 4-14 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total Range & All Other Livestock Demand | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total Range & All Other Livestock Supply | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| Industrial | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Steam-Electric | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Irrigation | | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| Mining | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| Dairies | | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| Range & All Other Livestock | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total County Demand | | 402,158 | 388,549 | 374,849 | 364,781 | 355,855 | 348,137 | 341,917 |
| | | | | | | | | |
| **Total Supply** | | | | | | | | |
| Municipal | | 3,349 | 5,204 | 5,598 | 5,478 | 5,249 | 4,826 | 4,615 |
| Industrial | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Steam-Electric | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Irrigation | | 385,564 | 248,481 | 190,849 | 134,163 | 84,304 | 62,026 | 47,780 |
| Mining | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 1,328 | 1,619 | 1,815 | 1,686 | 1,023 | 814 | 576 |
| Dairies | | 612 | 1,290 | 1,398 | 1,410 | 1,111 | 894 | 801 |
| Range & All Other Livestock | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total County Supply | | 409,829 | 275,454 | 218,378 | 164,475 | 117,099 | 98,447 | 89,132 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 1,737 | 1,974 | 1,722 | 1,416 | 1,033 | 870 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 7,671 | -114,832 | -158,445 | -201,653 | -238,554 | -248,375 | -250,645 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | -241 | -1,023 | -1,358 | -1,730 |
| Dairies | | 0 | 0 | 0 | -134 | -595 | -990 | -1,280 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 7,671 | -113,095 | -156,471 | -200,306 | -238,756 | -249,690 | -252,785 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 3,349 | 3,467 | 3,624 | 3,756 | 3,833 | 3,793 | 3,745 |
| Industrial | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Steam-Electric | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Irrigation | | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| Mining | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 1,328 | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| Dairies | | 612 | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| Range & All Other Livestock | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total Brazos Basin Demand | | 402,158 | 388,549 | 374,849 | 364,781 | 355,855 | 348,137 | 341,917 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 3,349 | 5,204 | 5,598 | 5,478 | 5,249 | 4,826 | 4,615 |
| Industrial | | 426 | 490 | 519 | 541 | 562 | 580 | 618 |
| Steam-Electric | | 17,990 | 17,827 | 17,663 | 20,651 | 24,292 | 28,731 | 34,142 |
| Irrigation | | 385,564 | 248,481 | 190,849 | 134,163 | 84,304 | 62,026 | 47,780 |
| Mining | | 88 | 52 | 25 | 15 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 1,328 | 1,619 | 1,815 | 1,686 | 1,023 | 814 | 576 |
| Dairies | | 612 | 1,290 | 1,398 | 1,410 | 1,111 | 894 | 801 |
| Range & All Other Livestock | | 472 | 491 | 511 | 531 | 552 | 576 | 600 |
| Total Brazos Basin Supply | | 409,829 | 275,454 | 218,378 | 164,475 | 117,099 | 98,447 | 89,132 |

Concluded on next page

***Table 4-14 Concluded***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 1,737 | 1,974 | 1,722 | 1,416 | 1,033 | 870 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 7,671 | -114,832 | -158,445 | -201,653 | -238,554 | -248,375 | -250,645 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | -241 | -1,023 | -1,358 | -1,730 |
| Dairies | | 0 | 0 | 0 | -134 | -595 | -990 | -1,280 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 7,671 | -113,095 | -156,471 | -200,306 | -238,756 | -249,690 | -252,785 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from Southwestern Public Service Tolk, City of Littlefield, Plains Cotton Growers, City of Earth, Springlake-Earth ISD, City of Sudan, City of Olton, Southwestern Public Service Plant X, City of Springlake, and City of Amherst. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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## *Table 4-15. Projected Water Demands, Supplies, and Needs Lubbock County Llano Estacado Region*

| Demand | Updated 6-4-09 | and 6/8/2009 and 8/13/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,439,809 | 6,632,577 | 5,611,743 | 4,952,167 | 4,159,806 | 4,141,607 | 4,114,001 |
| | Quantity Pumped[2] | Ogallala | 298,052 | 163,283 | 131,367 | 110,204 | 88,545 | 85,490 | 80,557 |
| | Supply | (Ogallala)[3] | 298,052 | 163,283 | 131,367 | 110,204 | 88,545 | 85,490 | 80,557 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 15,453 | 21,466 | 19,599 | 19,470 | 19,343 | 18,056 | 18,005 |
| | Bailey County | Ogallala | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 | 3,000 | 3,000 |
| | Local Surface | Stock Tanks and Windmills | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| | Other Surface | Lake Meredith (CRMWA) | 28,451 | 11,123 | 14,861 | 14,861 | 14,861 | 14,020 | 14,020 |
| | Other Surface | Lake Alan Henry (21,960 in Plan) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water (Lubbock-Electric Power)[4] | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| | Reclaimed Water (Lubbock-Irrigation)[4] | | 7,958 | 9,166 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water [7] | | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 |
| | Total Supply | | 372,157 | 224,733 | 182,748 | 160,215 | 137,352 | 132,295 | 128,681 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | | 153 | 171 | 182 | 188 | 186 | 190 | 186 |
| Idalou | | | 288 | 289 | 288 | 281 | 274 | 273 | 272 |
| Lubbock | Includes Reese Center | (Seven acre-feet per year) | 40,460 | 49,824 | 51,588 | 52,417 | 52,602 | 53,041 | 54,306 |
| New Deal | | | 126 | 149 | 165 | 173 | 173 | 173 | 173 |
| Ransom Canyon | | | 310 | 440 | 569 | 698 | 825 | 953 | 1,004 |
| Shallowater | | | 311 | 344 | 367 | 377 | 371 | 379 | 371 |
| Slaton | | | 931 | 907 | 889 | 870 | 849 | 837 | 836 |
| Wolfforth | | | 412 | 1,468 | 1,758 | 1,822 | 1,884 | 1,962 | 2,006 |
| Rural | | | 3,417 | 3,006 | 3,051 | 3,053 | 2,909 | 2,907 | 2,744 |
| | Subtotal | | 46,408 | 56,598 | 58,857 | 59,879 | 60,073 | 60,715 | 61,898 |
| Total Municipal Demand | | | 46,408 | 56,598 | 58,857 | 59,879 | 60,073 | 60,715 | 61,898 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | Ogallala | 153 | 171 | 0 | 0 | 0 | 0 | 0 |
| Idalou | | Ogallala | 288 | 289 | 288 | 281 | 0 | 0 | 0 |
| Lubbock | | Lake Meredith (CRMWA)[5] | 27,712 | 10,667 | 14,286 | 14,286 | 14,286 | 13,445 | 13,445 |
| | | Ogallala (CRMWA - Roberts Co.)[5] | 14,823 | 20,553 | 18,805 | 18,676 | 18,549 | 17,262 | 17,211 |
| | | Lake Alan Henry (21,960 in Plan) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Ogallala (Bailey County)[6] | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 | 3,000 | 3,000 |
| Lubbock Subtotal | Includes Reese Center | | 54,535 | 41,220 | 41,091 | 38,962 | 36,835 | 33,707 | 33,656 |
| New Deal | | Lubbock (CRMWA--Roberts Co.) | 126 | 153 | 153 | 153 | 153 | 153 | 153 |
| Ransom Canyon | | Lubbock (CRMWA--Roberts Co.) | 310 | 440 | 569 | 698 | 825 | 953 | 1,004 |
| Shallowater | | Lubbock (CRMWA--Roberts Co.) | 187 | 187 | 187 | 187 | 187 | 187 | 187 |
| | | Ogallala | 311 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shallowater Subtotal | | | 498 | 187 | 187 | 187 | 187 | 187 | 187 |
| Slaton | | (CRMWA--Lake Meredith)[5] | 739 | 456 | 575 | 575 | 575 | 575 | 575 |
| | | (CRMWA -Ogallala--Roberts Co.)[5] | 630 | 913 | 794 | 794 | 794 | 794 | 794 |
| | | To Post | | -306 | -306 | -306 | -306 | -306 | -306 |
| Slaton Subtotal | | | 1,369 | 1,063 | 1,063 | 1,063 | 1,063 | 1,063 | 1,063 |
| Wolfforth | | Ogallala | 412 | 1,535 | 2,466 | 2,219 | 1,997 | 1,797 | 1,618 |
| Rural | | Ogallala | 3,417 | 3,006 | 3,051 | 3,053 | 2,909 | 2,907 | 2,744 |
| | Subtotal | | 61,108 | 48,064 | 48,868 | 46,616 | 43,969 | 40,767 | 40,425 |
| Total Municipal Existing Supply | | | 61,108 | 48,064 | 48,868 | 46,616 | 43,969 | 40,767 | 40,425 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Abernathy (part) | | | 0 | 0 | -182 | -188 | -186 | -190 | -186 |
| Idalou | | | 0 | 0 | 0 | 0 | -274 | -273 | -272 |
| Lubbock | | | 14,075 | -8,604 | -10,497 | -13,455 | -15,767 | -19,334 | -20,650 |
| New Deal | | | 0 | 4 | -12 | -20 | -20 | -20 | -20 |
| Ransom Canyon | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shallowater | | | 187 | -157 | -180 | -190 | -184 | -192 | -184 |
| Slaton | | To Post | 438 | 156 | 174 | 193 | 214 | 226 | 227 |
| Wolfforth | | | 0 | 67 | 708 | 397 | 113 | -165 | -388 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 14,700 | -8,534 | -9,989 | -13,263 | -16,104 | -19,948 | -21,473 |
| Total Municipal Surplus/Shortage | | | 14,700 | -8,534 | -9,989 | -13,263 | -16,104 | -19,948 | -21,473 |

Continued on next page

***Table 4-15 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | |
| Brazos Basin | | | | | | | | |
| Abernathy (part) | | 0 | 0 | 182 | 188 | 186 | 190 | 186 |
| Idalou | | 0 | 0 | 0 | 0 | 274 | 273 | 272 |
| Lubbock | | 0 | 8,604 | 10,497 | 13,455 | 15,767 | 19,334 | 20,650 |
| New Deal | | 0 | 0 | 12 | 20 | 20 | 20 | 20 |
| Ransom Canyon | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Shallowater | | 0 | 157 | 180 | 190 | 184 | 192 | 184 |
| Slaton | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wolfforth | | 0 | 0 | 0 | 0 | 0 | 165 | 388 |
| Rural | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Subtotal | | 0 | 8,761 | 10,871 | 13,853 | 16,431 | 20,174 | 21,700 |
| | | | | | | | | |
| Total Municipal New Supply Need | | 0 | 8,761 | 10,871 | 13,853 | 16,431 | 20,174 | 21,700 |
| | | | | | | | | |
| **Industrial Demand** | | | | | | | | |
| Brazos Basin | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Total Industrial Demand | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| | | | | | | | | |
| **Industrial Existing Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Total Industrial Existing Supply | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| | | | | | | | | |
| **Industrial Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Industrial New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Steam-Electric Demand** | | | | | | | | |
| Brazos Basin | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Total Steam-Electric Demand | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| | | | | | | | | |
| **Steam-Electric Existing Supply** | | | | | | | | |
| Brazos Basin | Reclaimed Water (From Lubbock) | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Total Steam-Electric Existing Supply | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| | | | | | | | | |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Irrigation Demand** | | | | | | | | |
| Brazos Basin | | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| Total Irrigation Demand | | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| | | | | | | | | |
| **Irrigation Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 291,150 | 154,847 | 121,535 | 100,464 | 78,870 | 75,459 | 70,692 |
| | Reclaimed Water (Lubbock) [4] | 7,958 | 9,166 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water [7] | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 | 4,209 |
| Total Irrigation Supply | | 303,317 | 168,222 | 125,744 | 104,673 | 83,079 | 79,668 | 74,901 |
| | | | | | | | | |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 60,339 | -61,046 | -90,653 | -99,575 | -109,703 | -102,293 | -96,846 |
| Total Irrigation Surplus/Shortage | | 60,339 | -61,046 | -90,653 | -99,575 | -109,703 | -102,293 | -96,846 |
| | | | | | | | | |
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Total Mining Demand | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| | | | | | | | | |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Total Mining Supply | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

### *Table 4-15 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Total Beef Feedlot Livestock Demand | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Total Beef Feedlot Livestock Supply | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Total Dairies Demand | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Total Dairies Supply | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total Range & All Other Livestock Demand | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total Range & All Other Livestock Supply | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 46,408 | 56,598 | 58,857 | 59,879 | 60,073 | 60,715 | 61,898 |
| Industrial | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Steam-Electric | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Irrigation | | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| Mining | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Beef Feedlot Livestock | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Dairies | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Range & All Other Livestock | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total County Demand | | 298,052 | 294,398 | 283,258 | 273,108 | 262,984 | 254,140 | 246,778 |
| **Total Supply** | | | | | | | | |
| Municipal | | 61,108 | 48,064 | 48,868 | 46,616 | 43,969 | 40,767 | 40,425 |
| Industrial | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Steam-Electric | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Irrigation | | 303,317 | 168,222 | 125,744 | 104,673 | 83,079 | 79,668 | 74,901 |
| Mining | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Beef Feedlot Livestock | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Dairies | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Range & All Other Livestock | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total County Supply | | 373,091 | 224,818 | 182,616 | 160,270 | 137,177 | 131,899 | 128,459 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 14,700 | -8,534 | -9,989 | -13,263 | -16,104 | -19,948 | -21,473 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 60,339 | -61,046 | -90,653 | -99,575 | -109,703 | -102,293 | -96,846 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 75,039 | -69,580 | -100,642 | -112,838 | -125,807 | -122,241 | -118,319 |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 46,408 | 56,598 | 58,857 | 59,879 | 60,073 | 60,715 | 61,898 |
| Industrial | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Steam-Electric | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Irrigation | | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| Mining | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Beef Feedlot Livestock | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Dairies | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Range & All Other Livestock | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total Brazos Basin Demand | | 298,052 | 294,398 | 283,258 | 273,108 | 262,984 | 254,140 | 246,778 |

Concluded on next page

***Table 4-15 Concluded***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 61,108 | 48,064 | 48,868 | 46,616 | 43,969 | 40,767 | 40,425 |
| Industrial | | 1,566 | 1,881 | 2,103 | 2,291 | 2,472 | 2,625 | 2,836 |
| Steam-Electric | | 5,776 | 5,221 | 4,440 | 5,191 | 6,106 | 7,222 | 8,582 |
| Irrigation | | 303,317 | 168,222 | 125,744 | 104,673 | 83,079 | 79,668 | 74,901 |
| Mining | | 352 | 209 | 101 | 59 | 25 | 0 | 0 |
| Beef Feedlot Livestock | | 714 | 870 | 976 | 1,036 | 1,100 | 1,168 | 1,240 |
| Dairies | | 0 | 86 | 112 | 124 | 137 | 151 | 167 |
| Range & All Other Livestock | | 258 | 265 | 272 | 280 | 289 | 298 | 308 |
| Total Brazos Basin Supply | | 373,091 | 224,818 | 182,616 | 160,270 | 137,177 | 131,899 | 128,459 |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 14,700 | -8,534 | -9,989 | -13,263 | -16,104 | -19,948 | -21,473 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 60,339 | -61,046 | -90,653 | -99,575 | -109,703 | -102,293 | -96,846 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 75,039 | -69,580 | -100,642 | -112,838 | -125,807 | -122,241 | -118,319 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Total supply of reclaimed water is estimated at 50 percent of Lubbock's projected municipal water use shown as Lubbock municipal water demand. Reclaimed water is used for steam-electric power generation, with the remaineder used to irrigate hay and forage crops in Lubbock and Lynn Counties. Of the total, 6,496 acft/yr is shown as being transferred to Lynn County. See Table 4-16. Plans are to discontinue use of reclaimed water for irrigation by 2020.

[5] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA. Quantity reduced by quantities to New Deal, Ransom Canyon, and Shallowater.

[6] The City of Lubbock's policy is to reduce annual supply from Bailey County from an estimated 12,000 acft/yr in 2000 to an estimated 3,000 acft/yr in 2060.

[7] Value is the sum of reclaimed water from the City of Idalou, City of Wolfforth, City of New Deal, City of Slaton, City of Shallowater, SPS, Environmental Protection Services of Lubbock, Acid Delinting Inc., Texas Winery Inc., Town & Country Mobile Home Park, Paymaster Oil Mill, Lubbock, Cooper ISD, Ransom, Canyon, Plains Coop Oil Mill, and Gifford Hill American. The quantity of reclaimed water from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held constant throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

<><><><>

### *Table 4-16. Projected Water Demands, Supplies, and Needs Lynn County Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 and 8/13/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 3,528,278 | 3,372,428 | 3,382,679 | 3,377,853 | 3,375,361 | 3,384,834 | 3,393,991 |
| | Quantity Pumped[2] | Ogallala | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 |
| | Supply | (Ogallala)[3] | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 | 120,425 |
| | Edwards-Trinity (High Plains) Aquifer | | 4,944 | 4,160 | 3,580 | 2,802 | 2,335 | 2,065 | 2,065 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 275 | 548 | 477 | 477 | 477 | 417 | 417 |
| | Local Surface | Stock Tanks and Windmills | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| | Other Surface | Lake Meredith (CRMWA) | 523 | 274 | 345 | 345 | 345 | 302 | 302 |
| | Reclaimed Water (Lubbock-Irrigation)[5] | | 6,496 | 6,496 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water[6] | | 346 | 346 | 346 | 346 | 346 | 346 | 346 |
| | Total Supply | | 133,137 | 132,381 | 125,309 | 124,534 | 124,072 | 123,703 | 123,708 |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 258,301 | 273,551 | 272,424 | 277,251 | 279,742 | 270,270 | 261,112 |
| | Quantity Pumped[2] | Ogallala | 1,141 | 491 | 473 | 462 | 467 | 422 | 381 |
| | Supply | (Ogallala)[3] | 1,141 | 491 | 473 | 462 | 467 | 422 | 381 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Local Surface | Stock Tanks and Windmills | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| | Other Surface | Lake Meredith (CRMWA) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 1,153 | 503 | 484 | 474 | 480 | 435 | 394 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 3,786,579 | 3,645,979 | 3,655,103 | 3,655,103 | 3,655,103 | 3,655,103 | 3,655,103 |
| | Quantity Pumped[2] | Ogallala | 121,566 | 120,916 | 120,897 | 120,886 | 120,892 | 120,847 | 120,805 |
| | Supply | (Ogallala)[3] | 121,566 | 120,916 | 120,897 | 120,886 | 120,892 | 120,847 | 120,805 |
| | Edwards-Trinity (High Plains) Aquifer | | 4,944 | 4,160 | 3,580 | 2,802 | 2,335 | 2,065 | 2,065 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 275 | 548 | 477 | 477 | 477 | 417 | 417 |
| | Local Surface | Stock Tanks and Windmills | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| | Other Surface | Lake Meredith (CRMWA) | 523 | 274 | 345 | 345 | 345 | 302 | 302 |
| | Reclaimed Water (Lubbock-Irrigation) | | 6,496 | 6,496 | 0 | 0 | 0 | 0 | 0 |
| | Reclaimed Water[6] | | 346 | 346 | 346 | 346 | 346 | 346 | 346 |
| | Total Supply | | 134,290 | 132,884 | 125,793 | 125,008 | 124,551 | 124,138 | 124,102 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| O'Donnell (part) | | | 139 | 144 | 146 | 142 | 138 | 130 | 121 |
| Tahoka | | | 473 | 492 | 504 | 490 | 478 | 453 | 421 |
| Wilson | | | 65 | 67 | 68 | 65 | 63 | 60 | 55 |
| Rural | | | 290 | 299 | 301 | 292 | 282 | 267 | 249 |
| | Subtotal | | 967 | 1,002 | 1,019 | 989 | 961 | 910 | 846 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| | Subtotal | | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Total Municipal Demand | | | 973 | 1,009 | 1,026 | 995 | 967 | 916 | 852 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| O'Donnell (part) | | Lake Meredith (CRMWA) | 173 | 96 | 121 | 121 | 121 | 109 | 109 |
| | | Ogallala (CRMWA - Roberts Co.) | 91 | 192 | 167 | 167 | 167 | 150 | 150 |
| O'Donnell (part) Subtotal | | | 264 | 288 | 288 | 288 | 288 | 259 | 259 |
| Tahoka | | Ogallala | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Lake Meredith (CRMWA)[4] | 350 | 178 | 224 | 224 | 224 | 193 | 193 |
| | | Ogallala (CRMWA - Roberts Co.)[4] | 184 | 356 | 310 | 310 | 310 | 267 | 267 |
| Tahoka Subtotal | | | 534 | 534 | 534 | 534 | 534 | 460 | 460 |
| Wilson | | Ogallala | 65 | 67 | 0 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 290 | 299 | 301 | 292 | 282 | 267 | 249 |
| | | Edwards-Trinity (High Plains) | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Rural Subtotal | | | 390 | 399 | 401 | 392 | 382 | 367 | 349 |
| | Subtotal | | 1,253 | 1,288 | 1,223 | 1,214 | 1,204 | 1,086 | 1,068 |
| Colorado Basin | | | | | | | | | |
| Rural | | Ogallala | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| | Subtotal | | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Total Municipal Existing Supply | | | 1,259 | 1,295 | 1,230 | 1,220 | 1,210 | 1,092 | 1,074 |

Continued on next page

### *Table 4-16 Continued*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Tahoka | | | 61 | 42 | 30 | 44 | 56 | 7 | 39 |
| Wilson | | | 0 | 0 | -68 | -65 | -63 | -60 | -55 |
| Rural | | | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| O'Donnell (part) | | | 125 | 144 | 142 | 146 | 150 | 129 | 138 |
| | Subtotal | | 286 | 286 | 204 | 225 | 243 | 176 | 222 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Surplus/Shortage | | | 286 | 286 | 204 | 225 | 243 | 176 | 222 |
| | | | | | | | | | |
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Tahoka | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wilson | | | 0 | 0 | 68 | 65 | 63 | 60 | 55 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O'Donnell (part) | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 68 | 65 | 63 | 60 | 55 |
| Colorado Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 68 | 65 | 63 | 60 | 55 |
| | | | | | | | | | |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Irrigation Demand** | | | | | | | | | |
| Brazos Basin | | | 119,289 | 112,870 | 106,796 | 101,054 | 95,614 | 90,473 | 85,610 |
| Colorado Basin | | | 1,083 | 1,025 | 970 | 918 | 868 | 822 | 777 |
| Total Irrigation Demand | | | 120,372 | 113,895 | 107,766 | 101,972 | 96,482 | 91,295 | 86,387 |
| | | | | | | | | | |
| **Irrigation Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 120,004 | 120,020 | 119,912 | 119,948 | 119,981 | 120,017 | 120,049 |
| | | Edwards-Trinity (High Plains) | 4,844 | 4,060 | 3,480 | 2,702 | 2,235 | 1,965 | 1,965 |
| | | Reclaimed Water (Lubbock) [5] | 6,496 | 6,496 | 0 | 0 | 0 | 0 | 0 |
| | | Reclaimed Water [6] | 346 | 346 | 346 | 346 | 346 | 346 | 346 |
| Brazos Basin Subtotal | | | 131,690 | 130,922 | 123,738 | 122,996 | 122,562 | 122,328 | 122,360 |
| Colorado Basin | | Ogallala | 1,120 | 475 | 462 | 454 | 460 | 416 | 375 |
| Total Irrigation Supply | | | 132,810 | 131,397 | 124,200 | 123,450 | 123,022 | 122,744 | 122,735 |

Continued on next page

### *Table 4-16 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 12,401 | 18,052 | 16,942 | 21,942 | 26,948 | 31,855 | 36,750 |
| Colorado Basin | | 37 | -550 | -508 | -464 | -408 | -406 | -402 |
| Total Irrigation Surplus/Shortage | | 12,438 | 17,502 | 16,434 | 21,478 | 26,540 | 31,449 | 36,348 |
| | | | | | | | | |
| **Mining Demand** | | | | | | | | |
| Brazos Basin | | 66 | 39 | 19 | 11 | 5 | 0 | 0 |
| Colorado Basin | | 15 | 9 | 4 | 2 | 1 | 0 | 0 |
| Total Mining Demand | | 81 | 48 | 23 | 13 | 6 | 0 | 0 |
| | | | | | | | | |
| **Mining Supply** | | | | | | | | |
| Brazos Basin | Ogallala | 66 | 39 | 19 | 11 | 5 | 0 | 0 |
| Colorado Basin | Ogallala | 15 | 9 | 4 | 2 | 1 | 0 | 0 |
| Total Mining Supply | | 81 | 48 | 23 | 13 | 6 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Demand** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Supply** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Brazos Basin | | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Colorado Basin | | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Total Range & All Other Livestock Demand | | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Brazos Basin | Local | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Colorado Basin | Local | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Total Range & All Other Livestock Supply | | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 973 | 1,009 | 1,026 | 995 | 967 | 916 | 852 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 120,372 | 113,895 | 107,766 | 101,972 | 96,482 | 91,295 | 86,387 |
| Mining | | 81 | 48 | 23 | 13 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| Total County Demand | | 121,566 | 115,095 | 108,962 | 103,132 | 97,611 | 92,372 | 87,405 |

Continued on next page

### *Table 4-16 Continued*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 1,259 | 1,295 | 1,230 | 1,220 | 1,210 | 1,092 | 1,074 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 132,810 | 131,397 | 124,200 | 123,450 | 123,022 | 122,744 | 122,735 |
| Mining | | 81 | 48 | 23 | 13 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 140 | 143 | 147 | 152 | 156 | 161 | 166 |
| Total County Supply | | 134,290 | 132,884 | 125,600 | 124,834 | 124,395 | 123,997 | 123,975 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 286 | 286 | 204 | 225 | 243 | 176 | 222 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,438 | 17,502 | 16,434 | 21,478 | 26,540 | 31,449 | 36,348 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 12,724 | 17,788 | 16,638 | 21,703 | 26,783 | 31,625 | 36,570 |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 967 | 1,002 | 1,019 | 989 | 961 | 910 | 846 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 119,289 | 112,870 | 106,796 | 101,054 | 95,614 | 90,473 | 85,610 |
| Mining | | 66 | 39 | 19 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Total Brazos Basin Demand | | 120,450 | 114,043 | 107,970 | 102,193 | 96,724 | 91,532 | 86,609 |
| **Colorado** | | | | | | | | |
| Municipal | | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,083 | 1,025 | 970 | 918 | 868 | 822 | 777 |
| Mining | | 15 | 9 | 4 | 2 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Total Colorado Basin Demand | | 1,115 | 1,052 | 992 | 938 | 887 | 841 | 797 |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 1,253 | 1,288 | 1,223 | 1,214 | 1,204 | 1,086 | 1,068 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 131,690 | 130,922 | 123,738 | 122,996 | 122,562 | 122,328 | 122,360 |
| Mining | | 66 | 39 | 19 | 11 | 5 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 128 | 132 | 136 | 139 | 144 | 149 | 153 |
| Total Brazos Basin Supply | | 133,137 | 132,381 | 125,116 | 124,360 | 123,915 | 123,563 | 123,581 |
| **Colorado** | | | | | | | | |
| Municipal | | 6 | 7 | 7 | 6 | 6 | 6 | 6 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,120 | 475 | 462 | 454 | 460 | 416 | 375 |
| Mining | | 15 | 9 | 4 | 2 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 11 | 11 | 11 | 12 | 12 | 13 | 14 |
| Total Colorado Basin Supply | | 1,153 | 503 | 484 | 474 | 480 | 435 | 394 |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 286 | 286 | 204 | 225 | 243 | 176 | 222 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,401 | 18,052 | 16,942 | 21,942 | 26,948 | 31,855 | 36,750 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | 12,687 | 18,338 | 17,146 | 22,167 | 27,191 | 32,031 | 36,972 |

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### *Table 4-16 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage (Cont.)** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 37 | -550 | -508 | -464 | -408 | -406 | -402 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 37 | -550 | -508 | -464 | -408 | -406 | -402 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in oder to use its full supply from CRMWA.

[5] The quantity is that experienced in 2003, and is 96 percent of the premitted value for the project, with plans to discontinue use of reclaimed water for irrigation by 2020.

[6] Value is the sum of reclaimed water from the City of Wilson, City of Tahoka, and City of O'Donnell. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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***Table 4-17.***
***Projected Water Demands, Supplies, and Needs***
***Motley County***
***Llano Estacado Region***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 355,295 | 282,644 | 231,003 | 180,893 | 132,340 | 85,257 | 39,482 |
| | Quantity Pumped[2] | Ogallala | 10,200 | 5,717 | 5,565 | 5,411 | 5,254 | 5,115 | 4,991 |
| | Supply | (Ogallala)[3] | 10,200 | 5,717 | 5,565 | 5,411 | 5,254 | 5,115 | 4,991 |
| | Seymour Aquifer | | 18,817 | 18,817 | 18,817 | 13,507 | 13,507 | 13,507 | 13,507 |
| | Other Aquifer | | 239 | 234 | 224 | 207 | 187 | 174 | 166 |
| | Local Surface | Stock Tanks and Windmills | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 29,881 | 25,404 | 25,253 | 19,784 | 19,619 | 19,480 | 19,362 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Matador | | | 239 | 234 | 224 | 207 | 187 | 174 | 166 |
| Rural | | | 148 | 143 | 136 | 123 | 108 | 98 | 93 |
| | Subtotal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Total Municipal Demand | | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Matador | | Other Aquifer | 239 | 234 | 224 | 207 | 187 | 174 | 166 |
| Rural | | Ogallala | 148 | 143 | 136 | 123 | 108 | 98 | 93 |
| | Subtotal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Total Municipal Existing Supply | | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Matador | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Matador | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Municipal New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Total Industrial Demand | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Total Industrial Existing Supply | | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-17 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Red Basin | | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| Total Irrigation Demand | | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| **Irrigation Supply** | | | | | | | | |
| Red Basin | Ogallala | 10,032 | 5,559 | 5,419 | 5,279 | 5,139 | 5,011 | 4,892 |
| | Seymour | 2,065 | 2,003 | 1,943 | 1,885 | 1,828 | 1,774 | 1,724 |
| Total Irrigation Supply | | 12,097 | 7,562 | 7,362 | 7,164 | 6,967 | 6,785 | 6,616 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Red Basin | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |
| Total Irrigation Surplus/Shortage | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |
| **Mining Demand** | | | | | | | | |
| Red Basin | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Total Mining Demand | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Red Basin | Ogallala | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Total Mining Supply | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total Range & All Other Livestock Demand | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total Range & All Other Livestock Supply | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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***Table 4-17 Concluded***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Demand** | | | | | | | | |
| Municipal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| Mining | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total County Demand | | 10,200 | 9,922 | 9,645 | 9,370 | 9,094 | 8,839 | 8,604 |
| | | | | | | | | |
| **Total Supply** | Unallocated | 16,752 | 16,814 | 16,874 | 11,622 | 11,679 | 11,733 | 11,783 |
| Municipal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,097 | 7,562 | 7,362 | 7,164 | 6,967 | 6,785 | 6,616 |
| Mining | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total County Supply | | 29,881 | 25,404 | 25,253 | 19,784 | 19,619 | 19,480 | 19,362 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| Mining | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total Red Basin Demand | | 10,200 | 9,922 | 9,645 | 9,370 | 9,094 | 8,839 | 8,604 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | Unallocated | 16,752 | 16,814 | 16,874 | 11,622 | 11,679 | 11,733 | 11,783 |
| Municipal | | 387 | 377 | 360 | 330 | 295 | 272 | 259 |
| Industrial | | 5 | 6 | 6 | 6 | 6 | 6 | 6 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,097 | 7,562 | 7,362 | 7,164 | 6,967 | 6,785 | 6,616 |
| Mining | | 15 | 9 | 4 | 3 | 1 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 625 | 636 | 647 | 659 | 671 | 684 | 698 |
| Total Red Basin Supply | | 13,129 | 8,590 | 8,379 | 8,162 | 7,940 | 7,747 | 7,579 |
| | | | | | | | | |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | 2,929 | -1,332 | -1,266 | -1,208 | -1,154 | -1,092 | -1,025 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

## Table 4-18.
## Projected Water Demands, Supplies, and Needs
## Parmer County
## Llano Estacado Region

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 655,566 | 490,328 | 370,958 | 328,543 | 297,091 | 281,282 | 268,726 |
| | Quantity Pumped[2] | Ogallala | 135,705 | 76,545 | 26,066 | 19,901 | 36,235 | 37,658 | 35,109 |
| | Supply | (Ogallala)[3] | 135,705 | 76,545 | 26,066 | 19,901 | 36,235 | 37,658 | 35,109 |
| | Local Surface | Stock Tanks and Windmills | 273 | 286 | 298 | 309 | 324 | 341 | 356 |
| | Reclaimed Water[4] | | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 |
| | Total Supply | | 138,464 | 79,316 | 28,850 | 22,697 | 39,045 | 40,485 | 37,951 |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 1,120,024 | 738,596 | 361,646 | 184,032 | 139,200 | 135,555 | 132,695 |
| | Quantity Pumped[2] | Ogallala | 289,384 | 182,317 | 60,373 | 31,879 | 15,545 | 14,122 | 16,671 |
| | Supply | (Ogallala)[3] | 289,384 | 182,317 | 60,373 | 31,879 | 15,545 | 14,122 | 16,671 |
| | Local Surface | Stock Tanks and Windmills | 530 | 551 | 575 | 601 | 626 | 651 | 680 |
| | Reclaimed Water[4] | | 401 | 401 | 401 | 401 | 401 | 401 | 401 |
| | Total Supply | | 290,315 | 183,269 | 61,349 | 32,881 | 16,572 | 15,174 | 17,752 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 1,775,591 | 1,228,925 | 732,604 | 512,575 | 436,291 | 416,838 | 401,421 |
| | Quantity Pumped[2] | Ogallala | 425,089 | 258,862 | 86,439 | 51,780 | 51,780 | 51,780 | 51,780 |
| | Supply | (Ogallala)[3] | 425,089 | 258,862 | 86,439 | 51,780 | 51,780 | 51,780 | 51,780 |
| | Local Surface | Stock Tanks and Windmills | 803 | 837 | 873 | 910 | 950 | 992 | 1,036 |
| | Reclaimed Water[4] | | 2,887 | 2,887 | 2,887 | 2,887 | 2,887 | 2,887 | 2,887 |
| | Total Supply | | 428,779 | 262,586 | 90,199 | 55,577 | 55,617 | 55,659 | 55,703 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Friona | | | 803 | 835 | 872 | 879 | 870 | 838 | 791 |
| Rural | | | 106 | 110 | 113 | 112 | 110 | 106 | 100 |
| | Subtotal | | 909 | 945 | 985 | 991 | 980 | 944 | 891 |
| Brazos Basin | | | | | | | | | |
| Bovina | | | 309 | 321 | 334 | 335 | 330 | 317 | 300 |
| Farwell | | | 370 | 388 | 405 | 410 | 408 | 393 | 371 |
| Rural | | | 287 | 297 | 305 | 304 | 298 | 286 | 270 |
| | Subtotal | | 966 | 1,006 | 1,044 | 1,049 | 1,036 | 996 | 941 |
| Total Municipal Demand | | | 1,875 | 1,951 | 2,029 | 2,040 | 2,016 | 1,940 | 1,832 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Friona | | Ogallala | 803 | 956 | 1,421 | 495 | 445 | 401 | 360 |
| Rural | | Ogallala | 106 | 110 | 113 | 112 | 110 | 106 | 100 |
| | Subtotal | | 909 | 1,066 | 1,534 | 607 | 555 | 507 | 460 |
| Brazos Basin | | | | | | | | | |
| Bovina | | Ogallala | 309 | 321 | 334 | 335 | 330 | 317 | 300 |
| Farwell | | Ogallala | 370 | 388 | 404 | 364 | 328 | 294 | 265 |
| Rural | | Ogallala | 287 | 297 | 305 | 304 | 298 | 286 | 270 |
| | Subtotal | | 966 | 1,006 | 1,043 | 1,003 | 956 | 897 | 835 |
| Total Municipal Existing Supply | | | 1,875 | 2,072 | 2,577 | 1,610 | 1,511 | 1,404 | 1,295 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Friona | | | 0 | 121 | 549 | -384 | -425 | -437 | -431 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 121 | 549 | -384 | -425 | -437 | -431 |
| Brazos Basin | | | | | | | | | |
| Bovina | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farwell | | | 0 | 0 | -1 | -46 | -80 | -99 | -106 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | -1 | -46 | -80 | -99 | -106 |
| Total Municipal Surplus/Shortage | | | 0 | 121 | 548 | -430 | -505 | -536 | -537 |

Continued on next page

### *Table 4-18 Continued*

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Friona | | | 0 | 0 | 0 | 384 | 425 | 437 | 431 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 384 | 425 | 437 | 431 |
| Brazos Basin | | | | | | | | | |
| Bovina | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Farwell | | | 0 | 0 | 1 | 46 | 80 | 99 | 106 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 1 | 46 | 80 | 99 | 106 |
| Total Municipal New Supply Need | | | 0 | 0 | 1 | 430 | 505 | 536 | 537 |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Red Basin | | | 120,480 | 119,201 | 117,935 | 116,683 | 115,444 | 114,219 | 113,006 |
| Brazos Basin | | | 294,969 | 291,836 | 288,738 | 285,673 | 282,640 | 279,639 | 276,670 |
| Total Irrigation Demand | | | 415,449 | 411,037 | 406,673 | 402,356 | 398,084 | 393,858 | 389,676 |
| **Irrigation Supply** | | | | | | | | | |
| Red Basin | | Ogallala | 130,669 | 69,993 | 18,426 | 12,367 | 28,007 | 29,144 | 26,195 |
| | | Reclaimed Water | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 | 2,486 |
| Red Basin Subtotal | | | 133,155 | 72,479 | 20,912 | 14,853 | 30,493 | 31,630 | 28,681 |
| Brazos Basin | | Ogallala | 285,582 | 176,775 | 54,130 | 25,479 | 10,150 | 10,362 | 13,894 |
| | | Reclaimed Water | 401 | 401 | 401 | 401 | 401 | 401 | 401 |
| Brazos Basin Subtotal | | | 285,983 | 177,176 | 54,531 | 25,880 | 10,551 | 10,763 | 14,295 |
| Total Irrigation Supply | | | 419,138 | 249,655 | 75,443 | 40,733 | 41,044 | 42,393 | 42,976 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 12,675 | -46,722 | -97,023 | -101,830 | -84,951 | -82,589 | -84,325 |
| Brazos Basin | | | -8,986 | -114,660 | -234,207 | -259,793 | -272,089 | -268,876 | -262,375 |
| Total Irrigation Surplus/Shortage | | | 3,689 | -161,382 | -331,230 | -361,623 | -357,040 | -351,465 | -346,700 |

Continued on next page

***Table 4-18 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 2,046 | 2,494 | 2,797 | 2,968 | 3,153 | 3,347 | 3,553 |
| Brazos Basin | | 2,817 | 3,434 | 3,849 | 4,087 | 4,338 | 4,606 | 4,890 |
| Total Beef Feedlot Livestock Demand | | 4,863 | 5,928 | 6,646 | 7,056 | 7,491 | 7,953 | 8,443 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | Ogallala | 2,046 | 2,494 | 2,797 | 2,968 | 3,153 | 3,347 | 3,553 |
| Brazos Basin | Ogallala | 2,817 | 3,434 | 3,849 | 4,087 | 3,589 | 2,220 | 1,513 |
| Total Beef Feedlot Livestock Supply | | 4,863 | 5,928 | 6,646 | 7,056 | 6,742 | 5,567 | 5,066 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | -749 | -2,386 | -3,377 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | -749 | -2,386 | -3,377 |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 10 | 566 | 694 | 768 | 847 | 933 | 1,031 |
| Brazos Basin | | 20 | 1,101 | 1,349 | 1,489 | 1,646 | 1,821 | 2,011 |
| Total Dairies Demand | | 30 | 1,667 | 2,043 | 2,257 | 2,493 | 2,754 | 3,042 |
| **Dairies Supply** | | | | | | | | |
| Red Basin | Ogallala | 10 | 566 | 694 | 768 | 847 | 933 | 1,031 |
| Brazos Basin | Ogallala | 20 | 1,101 | 1,349 | 1,309 | 849 | 495 | 296 |
| Total Dairies Supply | | 30 | 1,667 | 2,043 | 2,077 | 1,696 | 1,428 | 1,327 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | -180 | -797 | -1,326 | -1,715 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | -180 | -797 | -1,326 | -1,715 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 273 | 285 | 296 | 308 | 324 | 340 | 356 |
| Brazos Basin | | 530 | 550 | 573 | 600 | 626 | 649 | 678 |
| Total Range & All Other Livestock Demand | | 803 | 835 | 869 | 908 | 950 | 989 | 1,034 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 273 | 285 | 296 | 308 | 324 | 340 | 356 |
| Brazos Basin | Local | 530 | 550 | 573 | 600 | 626 | 649 | 678 |
| Total Range & All Other Livestock Supply | | 803 | 835 | 869 | 908 | 950 | 989 | 1,034 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,875 | 1,951 | 2,029 | 2,040 | 2,016 | 1,940 | 1,832 |
| Industrial | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 415,449 | 411,037 | 406,673 | 402,356 | 398,084 | 393,858 | 389,676 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 4,863 | 5,928 | 6,646 | 7,056 | 7,491 | 7,953 | 8,443 |
| Dairies | | 30 | 1,667 | 2,043 | 2,257 | 2,493 | 2,754 | 3,042 |
| Range & All Other Livestock | | 803 | 835 | 869 | 908 | 950 | 989 | 1,034 |
| Total County Demand | | 425,090 | 423,845 | 420,877 | 417,389 | 413,954 | 410,544 | 407,287 |

Continued on next page

***Table 4-18 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 1,875 | 2,072 | 2,577 | 1,610 | 1,511 | 1,404 | 1,295 |
| Industrial | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 419,138 | 249,655 | 75,443 | 40,733 | 41,044 | 42,393 | 42,976 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 4,863 | 5,928 | 6,646 | 7,056 | 6,742 | 5,567 | 5,066 |
| Dairies | | 30 | 1,667 | 2,043 | 2,077 | 1,696 | 1,428 | 1,327 |
| Range & All Other Livestock | | 803 | 835 | 869 | 908 | 950 | 989 | 1,034 |
| Total County Supply | | 428,779 | 262,584 | 90,195 | 55,156 | 54,863 | 54,831 | 54,958 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 121 | 548 | -430 | -505 | -536 | -537 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 3,689 | -161,382 | -331,230 | -361,623 | -357,040 | -351,465 | -346,700 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | -749 | -2,386 | -3,377 |
| Dairies | | 0 | 0 | 0 | -180 | -797 | -1,326 | -1,715 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 3,689 | -161,261 | -330,682 | -362,233 | -359,091 | -355,713 | -352,329 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 909 | 945 | 985 | 991 | 980 | 944 | 891 |
| Industrial | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 120,480 | 119,201 | 117,935 | 116,683 | 115,444 | 114,219 | 113,006 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,046 | 2,494 | 2,797 | 2,968 | 3,153 | 3,347 | 3,553 |
| Dairies | | 10 | 566 | 694 | 768 | 847 | 933 | 1,031 |
| Range & All Other Livestock | | 273 | 285 | 296 | 308 | 324 | 340 | 356 |
| Total Red Basin Demand | | 125,788 | 125,918 | 125,324 | 124,490 | 123,668 | 122,833 | 122,097 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 966 | 1,006 | 1,044 | 1,049 | 1,036 | 996 | 941 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 294,969 | 291,836 | 288,738 | 285,673 | 282,640 | 279,639 | 276,670 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,817 | 3,434 | 3,849 | 4,087 | 4,338 | 4,606 | 4,890 |
| Dairies | | 20 | 1,101 | 1,349 | 1,489 | 1,646 | 1,821 | 2,011 |
| Range & All Other Livestock | | 530 | 550 | 573 | 600 | 626 | 649 | 678 |
| Total Brazos Basin Demand | | 299,302 | 297,927 | 295,553 | 292,898 | 290,286 | 287,711 | 285,190 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | Unallocated | 459 | 6 | 306 | 308 | 306 | 304 | 308 |
| Municipal | | 909 | 1,066 | 1,534 | 607 | 555 | 507 | 460 |
| Industrial | | 2,070 | 2,427 | 2,617 | 2,772 | 2,921 | 3,051 | 3,261 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 133,155 | 72,479 | 20,912 | 14,853 | 30,493 | 31,630 | 28,681 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,046 | 2,494 | 2,797 | 2,968 | 3,153 | 3,347 | 3,553 |
| Dairies | | 10 | 566 | 694 | 768 | 847 | 933 | 1,031 |
| Range & All Other Livestock | | 273 | 285 | 296 | 308 | 324 | 340 | 356 |
| Total Red Basin Supply | | 138,464 | 79,317 | 28,850 | 22,276 | 38,292 | 39,807 | 37,341 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 966 | 1,006 | 1,043 | 1,003 | 956 | 897 | 835 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 285,983 | 177,176 | 54,531 | 25,880 | 10,551 | 10,763 | 14,295 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,817 | 3,434 | 3,849 | 4,087 | 3,589 | 2,220 | 1,513 |
| Dairies | | 20 | 1,101 | 1,349 | 1,309 | 849 | 495 | 296 |
| Range & All Other Livestock | | 530 | 550 | 573 | 600 | 626 | 649 | 678 |
| Total Brazos Basin Supply | | 290,315 | 183,267 | 61,345 | 32,879 | 16,571 | 15,024 | 17,617 |

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### *Table 4-18 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | 121 | 549 | -384 | -425 | -437 | -431 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 12,675 | -46,722 | -97,023 | -101,830 | -84,951 | -82,589 | -84,325 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | 12,675 | -46,601 | -96,474 | -102,214 | -85,376 | -83,026 | -84,756 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 0 | -1 | -46 | -80 | -99 | -106 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -8,986 | -114,660 | -234,207 | -259,793 | -272,089 | -268,876 | -262,375 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | -749 | -2,386 | -3,377 |
| Dairies | | 0 | 0 | 0 | -180 | -797 | -1,326 | -1,715 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | -8,986 | -114,660 | -234,208 | -260,019 | -273,715 | -272,687 | -267,573 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from Excel Corp., City of Friona, City of Farwell, City of Bovina, and Lazabuddie Utility & Water Supply. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value was held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

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### *Table 4-19. Projected Water Demands, Supplies, and Needs Swisher County Llano Estacado Region*

| Basin | | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **WATER SUPPLIES** | | | | | | | | | |
| | **Red Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 6,819,588 | 6,377,657 | 5,725,090 | 5,127,016 | 4,605,948 | 4,378,512 | 4,174,484 |
| | Quantity Pumped[2] | Ogallala | 109,814 | 93,170 | 84,809 | 75,784 | 66,827 | 64,355 | 63,614 |
| | Supply | (Ogallala)[3] | 109,814 | 93,170 | 84,809 | 75,784 | 66,827 | 64,355 | 63,614 |
| | Dockum Aquifer (Santa Rosa Formation) | | 846 | 846 | 846 | 846 | 846 | 846 | 846 |
| | Local Surface | Stock Tanks and Windmills | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| | Other Surface | Lake Mackenzie | 417 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 111,498 | 94,451 | 86,131 | 77,123 | 68,184 | 65,732 | 65,011 |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 749,269 | 438,658 | 111,975 | 29,204 | 16,981 | 13,621 | 9,933 |
| | Quantity Pumped[2] | Ogallala | 66,489 | 59,724 | 23,582 | 2,488 | 1,098 | 533 | 531 |
| | Supply | (Ogallala)[3] | 66,489 | 59,724 | 23,582 | 2,488 | 1,098 | 533 | 531 |
| | Local Surface | Stock Tanks and Windmills | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 66,657 | 59,891 | 23,723 | 2,626 | 1,234 | 666 | 662 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 7,568,857 | 6,816,315 | 5,837,065 | 5,156,220 | 4,622,929 | 4,392,133 | 4,184,417 |
| | Quantity Pumped[2] | Ogallala | 176,303 | 152,893 | 108,391 | 78,271 | 67,924 | 64,888 | 64,145 |
| | Supply | (Ogallala)[3] | 176,303 | 152,893 | 108,391 | 78,271 | 67,924 | 64,888 | 64,145 |
| | Dockum Aquifer (Santo Rosa Formation) | | 846 | 846 | 846 | 846 | 846 | 846 | 846 |
| | Local Surface | Stock Tanks and Windmills | 589 | 603 | 617 | 632 | 648 | 664 | 682 |
| | Other Surface | Lake Mackenzie | 417 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 178,155 | 154,342 | 109,854 | 79,749 | 69,418 | 66,398 | 65,673 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Red Basin | HAPPY in Region A | | 6 | 11 | 17 | 22 | 27 | 33 | 38 |
| Happy | | | 107 | 109 | 110 | 111 | 110 | 108 | 103 |
| Kress (Part) | | | 80 | 82 | 82 | 83 | 81 | 79 | 76 |
| Tulia | | | 1,020 | 1,050 | 1,065 | 1,072 | 1,064 | 1,038 | 993 |
| Rural | | | 207 | 211 | 211 | 211 | 207 | 202 | 193 |
| | Subtotal | | 1,414 | 1,452 | 1,468 | 1,477 | 1,462 | 1,427 | 1,365 |
| Brazos Basin | | | | | | | | | |
| Kress (Part) | New listing | | 21 | 22 | 22 | 22 | 22 | 21 | 20 |
| Rural | | | 41 | 41 | 42 | 41 | 41 | 40 | 38 |
| | Subtotal | | 62 | 63 | 64 | 63 | 63 | 61 | 58 |
| Total Municipal Demand | | | 1,476 | 1,515 | 1,532 | 1,540 | 1,525 | 1,488 | 1,423 |
| **Municipal Existing Supply** | | | | | | | | | |
| Red Basin | HAPPY in Region A | Ogallala | 6 | 11 | 17 | 22 | 27 | 33 | 38 |
| Happy | | Ogallala | 107 | 109 | 110 | 111 | 110 | 108 | 103 |
| Kress (Part) | | Ogallala | 80 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tulia[4] | | Ogallala | 302 | 317 | 324 | 328 | 324 | 311 | 288 |
| | | Dockum (Santa Rosa Formation) | 302 | 316 | 324 | 328 | 324 | 311 | 288 |
| | | Lake Mackenzie | 417 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tulia Subtotal | | | 1,020 | 633 | 648 | 655 | 647 | 621 | 576 |
| Rural | | Ogallala | 207 | 211 | 211 | 211 | 207 | 202 | 193 |
| | Subtotal | | 1,414 | 953 | 969 | 977 | 964 | 931 | 872 |
| Brazos Basin | | | | | | | | | |
| Kress (Part) | New listing | Ogallala | 21 | 204 | 184 | 165 | 149 | 134 | 120 |
| Rural | | Ogallala | 41 | 41 | 42 | 41 | 41 | 40 | 38 |
| | Subtotal | | 62 | 245 | 226 | 206 | 190 | 174 | 158 |
| Total Municipal Existing Supply | | | 1,476 | 1,198 | 1,195 | 1,183 | 1,154 | 1,105 | 1,030 |

Continued on next page

***Table 4-19 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Happy | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kress | | | 0 | -82 | -82 | -83 | -81 | -79 | -76 |
| Tulia | | | 0 | -417 | -417 | -417 | -417 | -417 | -417 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | -499 | -499 | -500 | -498 | -496 | -493 |
| Brazos Basin | | | | | | | | | |
| Kress (Part) | New listing | New supply (wells in Brazos Basin) | 0 | 182 | 162 | 143 | 127 | 113 | 100 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 182 | 162 | 143 | 127 | 113 | 100 |
| | | | | | | | | | |
| Total Municipal Surplus/Shortage | | | 0 | -317 | -337 | -357 | -371 | -383 | -393 |
| | | | | | | | | | |
| **Municipal New Supply Need** | | | | | | | | | |
| Red Basin | | | | | | | | | |
| Happy | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kress | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tulia | | | 0 | 417 | 417 | 417 | 417 | 417 | 417 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 417 | 417 | 417 | 417 | 417 | 417 |
| Brazos Basin | | Kress Surplus | | 100 | 80 | 60 | 46 | 34 | 24 |
| Kress (Part) | New listing | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| Total Municipal New Supply Need | | | 0 | 417 | 417 | 417 | 417 | 417 | 417 |
| | | | | | | | | | |
| **Industrial Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Industrial New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Demand** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Red Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-19 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Demand** | | | | | | | | |
| Red Basin | | 97,872 | 97,313 | 93,233 | 96,205 | 95,655 | 95,108 | 94,565 |
| Brazos Basin | | 73,834 | 73,412 | 70,333 | 72,575 | 72,161 | 71,749 | 71,338 |
| Total Irrigation Demand | | 171,706 | 170,725 | 163,566 | 168,780 | 167,816 | 166,857 | 165,903 |
| | | | | | | | | |
| **Irrigation Supply** | | | | | | | | |
| Red Basin | Ogallala | 106,610 | 88,698 | 79,952 | 70,789 | 61,688 | 59,061 | 58,162 |
| Brazos Basin | Ogallala | 66,397 | 59,381 | 23,191 | 2,116 | 743 | 194 | 208 |
| Total Irrigation Supply | | 173,007 | 148,079 | 103,143 | 72,905 | 62,431 | 59,255 | 58,370 |
| | | | | | | | | |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Red Basin | | 8,738 | -8,615 | -13,281 | -25,416 | -33,967 | -36,047 | -36,403 |
| Brazos Basin | | -7,437 | -14,031 | -47,142 | -70,459 | -71,418 | -71,555 | -71,130 |
| Total Irrigation Surplus/Shortage | | 1,301 | -22,646 | -60,423 | -95,875 | -105,385 | -107,602 | -107,533 |
| | | | | | | | | |
| **Mining Demand** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Mining Supply** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Mining Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Red Basin | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| | | | | | | | | |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Red Basin | Ogallala | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| | | | | | | | | |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Dairies Demand** | | | | | | | | |
| Red Basin | | 3 | 11 | 18 | 18 | 18 | 18 | 18 |
| Brazos Basin | | 29 | 97 | 165 | 165 | 165 | 165 | 165 |
| Total Dairies Demand | | 33 | 108 | 183 | 183 | 183 | 183 | 183 |
| | | | | | | | | |
| **Dairies Supply** | | | | | | | | |
| Red Basin | Ogallala | 3 | 11 | 18 | 18 | 18 | 18 | 18 |
| Brazos Basin | Ogallala | 29 | 97 | 165 | 165 | 165 | 165 | 165 |
| Total Dairies Supply | | 33 | 108 | 183 | 183 | 183 | 183 | 183 |
| | | | | | | | | |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Red Basin | | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Brazos Basin | | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Total Range & All Other Livestock Demand | | 589 | 603 | 617 | 632 | 648 | 664 | 682 |
| | | | | | | | | |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Red Basin | Local | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Brazos Basin | Local | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Total Range & All Other Livestock Supply | | 589 | 603 | 617 | 632 | 648 | 664 | 682 |
| | | | | | | | | |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Red Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brazos Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4-19 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Demand** | | | | | | | | |
| Municipal | | 1,476 | 1,515 | 1,532 | 1,540 | 1,525 | 1,488 | 1,423 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 171,706 | 170,725 | 163,566 | 168,780 | 167,816 | 166,857 | 165,903 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Dairies | | 33 | 108 | 183 | 183 | 183 | 183 | 183 |
| Range & All Other Livestock | | 589 | 603 | 617 | 632 | 648 | 664 | 682 |
| Total County Demand | | 176,303 | 175,997 | 169,314 | 174,762 | 174,022 | 173,280 | 172,531 |
| | | | | | | | | |
| **Total Supply** | Unallocated | 545 | 680 | 522 | 518 | 523 | 536 | 558 |
| Municipal | | 1,476 | 1,198 | 1,195 | 1,183 | 1,154 | 1,105 | 1,030 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 173,007 | 148,079 | 103,143 | 72,905 | 62,431 | 59,255 | 58,370 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Dairies | | 33 | 108 | 183 | 183 | 183 | 183 | 183 |
| Range & All Other Livestock | | 589 | 603 | 617 | 632 | 648 | 664 | 682 |
| Total County Supply | | 178,149 | 153,714 | 109,076 | 79,048 | 68,788 | 65,830 | 65,162 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | -317 | -337 | -357 | -371 | -383 | -393 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 1,301 | -22,646 | -60,423 | -95,875 | -105,385 | -107,602 | -107,533 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 1,301 | -22,963 | -60,760 | -96,232 | -105,756 | -107,985 | -107,926 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 1,414 | 1,452 | 1,468 | 1,477 | 1,462 | 1,427 | 1,365 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 97,872 | 97,313 | 93,233 | 96,205 | 95,655 | 95,108 | 94,565 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Dairies | | 3 | 11 | 18 | 18 | 18 | 18 | 18 |
| Range & All Other Livestock | | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Total Red Basin Demand | | 102,209 | 102,258 | 98,610 | 101,820 | 101,497 | 101,172 | 100,838 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 62 | 63 | 64 | 63 | 63 | 61 | 58 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 73,834 | 73,412 | 70,333 | 72,575 | 72,161 | 71,749 | 71,338 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 29 | 97 | 165 | 165 | 165 | 165 | 165 |
| Range & All Other Livestock | | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Total Brazos Basin Demand | | 74,094 | 73,740 | 70,704 | 72,942 | 72,525 | 72,109 | 71,693 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Red** | Unallocated | 545 | 680 | 522 | 518 | 523 | 536 | 558 |
| Municipal | | 1,414 | 953 | 969 | 977 | 964 | 931 | 872 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 106,610 | 88,698 | 79,952 | 70,789 | 61,688 | 59,061 | 58,162 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 2,499 | 3,047 | 3,416 | 3,626 | 3,850 | 4,087 | 4,339 |
| Dairies | | 3 | 11 | 18 | 18 | 18 | 18 | 18 |
| Range & All Other Livestock | | 421 | 435 | 475 | 493 | 512 | 531 | 551 |
| Total Red Basin Supply | | 111,492 | 93,823 | 85,352 | 76,422 | 67,554 | 65,164 | 64,500 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 62 | 245 | 226 | 206 | 190 | 174 | 158 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 66,397 | 59,381 | 23,191 | 2,116 | 743 | 194 | 208 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 29 | 97 | 165 | 165 | 165 | 165 | 165 |
| Range & All Other Livestock | | 168 | 167 | 141 | 139 | 136 | 133 | 132 |
| Total Brazos Basin Supply | | 66,657 | 59,891 | 23,723 | 2,626 | 1,233 | 666 | 662 |

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### *Table 4-19 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Red** | | | | | | | | |
| Municipal | | 0 | -499 | -499 | -500 | -498 | -496 | -493 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 8,738 | -8,615 | -13,281 | -25,416 | -33,967 | -36,047 | -36,403 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Red Basin Surplus/Shortage | | 8,738 | -9,114 | -13,780 | -25,916 | -34,465 | -36,543 | -36,896 |
| | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 182 | 162 | 143 | 127 | 113 | 100 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -7,437 | -14,031 | -47,142 | -70,459 | -71,418 | -71,555 | -71,130 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | -7,437 | -13,849 | -46,981 | -70,316 | -71,292 | -71,443 | -71,031 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Tulia is obtaining a part of its municipal water from the Santa Rosa formation. The information available indicates that the aquifer can supply the quantities shown here for the projection period.

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## *Table 4-20. Projected Water Demands, Supplies, and Needs Terry County Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Brazos Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 447,345 | 424,035 | 403,426 | 383,304 | 435,139 | 400,547 | 374,030 |
| | Quantity Pumped[2] | Ogallala | 8,237 | 6,069 | 5,756 | 5,461 | 4,704 | 4,713 | 4,719 |
| | Supply | (Ogallala)[3] | 8,237 | 6,069 | 5,756 | 5,461 | 4,704 | 4,713 | 4,719 |
| | Local Surface | Stock Tanks and Windmills | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 8,241 | 6,075 | 5,766 | 5,469 | 4,717 | 4,723 | 4,725 |
| | | Ogallala | | | | | | | |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 4,129,436 | 3,737,389 | 3,397,878 | 3,179,834 | 2,993,744 | 3,120,368 | 3,245,025 |
| | Quantity Pumped[2] | Ogallala | 158,282 | 113,165 | 86,251 | 67,983 | 54,595 | 54,570 | 54,553 |
| | Supply | (Ogallala)[3] | 158,282 | 113,165 | 86,251 | 67,983 | 54,595 | 54,570 | 54,553 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 879 | 1,699 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| | Local Surface | Stock Tanks and Windmills | 115 | 115 | 114 | 119 | 118 | 124 | 130 |
| | Other Surface | Lake Meredith (CRMWA) | 1,670 | 850 | 1,071 | 1,071 | 1,071 | 1,071 | 1,071 |
| | Total Supply | | 160,946 | 115,829 | 88,915 | 70,652 | 57,262 | 57,243 | 57,232 |
| | **County Total** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 4,576,781 | 4,161,424 | 3,801,304 | 3,563,138 | 3,428,883 | 3,520,915 | 3,619,055 |
| | Quantity Pumped[2] | Ogallala | 166,519 | 119,234 | 92,007 | 73,445 | 59,299 | 59,283 | 59,271 |
| | Supply | (Ogallala)[3] | 166,519 | 119,234 | 92,007 | 73,445 | 59,299 | 59,283 | 59,271 |
| | Other Ground | Ogallala (CRMWA - Roberts Co.) | 879 | 1,699 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| | Local Surface | Stock Tanks and Windmills | 119 | 121 | 124 | 127 | 130 | 134 | 137 |
| | Other Surface | Lake Meredith (CRMWA) | 1,670 | 850 | 1,071 | 1,071 | 1,071 | 1,071 | 1,071 |
| | Total Supply | | 169,187 | 121,904 | 94,681 | 76,121 | 61,979 | 61,966 | 61,958 |
| Data LERWPG | | Ogallala | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| | Subtotal | | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Colorado Basin | | | | | | | | | |
| Brownfield | | | 2,593 | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| Meadow | | | 70 | 73 | 75 | 78 | 80 | 79 | 79 |
| Rural | | | 362 | 376 | 393 | 407 | 419 | 418 | 415 |
| | Subtotal | | 3,025 | 3,196 | 3,373 | 3,532 | 3,680 | 3,682 | 3,661 |
| Total Municipal | | | 3,038 | 3,210 | 3,387 | 3,547 | 3,696 | 3,697 | 3,676 |
| **Municipal Existing Supply** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | Ogallala | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| | Subtotal | | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Colorado Basin | | | | | | | | | |
| Brownfield | | Ogallala | 295 | 267 | 241 | 218 | 197 | 178 | 161 |
| | | Lake Meredith (CRMWA)[4] | 1,670 | 850 | 1,071 | 1,071 | 1,071 | 1,071 | 1,071 |
| | | Ogallala (CRMWA - Roberts Co.)[4] | 879 | 1,699 | 1,478 | 1,478 | 1,478 | 1,478 | 1,478 |
| Brownfield Subtotal | | | 2,844 | 2,816 | 2,790 | 2,767 | 2,746 | 2,727 | 2,710 |
| Meadow | | Ogallala | 70 | 73 | 75 | 78 | 80 | 79 | 79 |
| Rural | | Ogallala | 362 | 376 | 393 | 407 | 419 | 418 | 415 |
| | Subtotal | | 3,276 | 3,265 | 3,258 | 3,252 | 3,245 | 3,224 | 3,204 |
| Total Municipal | Existing Supply | | 3,289 | 3,279 | 3,272 | 3,267 | 3,261 | 3,239 | 3,219 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | | | | | | | |
| Brownfield | | | 251 | 69 | -115 | -280 | -435 | -458 | -457 |
| Meadow | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 251 | 69 | -115 | -280 | -435 | -458 | -457 |
| Total Municipal | Surplus/Shortage | | 251 | 69 | -115 | -280 | -435 | -458 | -457 |

Continued on next page

***Table 4-20 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Municipal New Supply Need** | | | | | | | | | |
| Brazos Basin | | | | | | | | | |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | | | | | | | |
| Brownfield | | | 0 | 0 | 115 | 280 | 435 | 458 | 457 |
| Meadow | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 115 | 280 | 435 | 458 | 457 |
| Total Municipal | New Supply Need | | 0 | 0 | 115 | 280 | 435 | 458 | 457 |
| **Industrial Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Industrial | Demand | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Industrial Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | Ogallala | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total Industrial | Existing Supply | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial | Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial | New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric | Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Existing Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric | Existing Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric | Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric | New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | | |
| Brazos Basin | | | 10,157 | 9,636 | 9,142 | 8,674 | 8,229 | 7,807 | 7,407 |
| Colorado Basin | | | 192,984 | 183,089 | 173,702 | 164,797 | 156,348 | 148,332 | 140,726 |
| Total Irrigation | Demand | | 203,141 | 192,725 | 182,844 | 173,471 | 164,577 | 156,139 | 148,133 |
| **Irrigation Supply** | | | | | | | | | |
| Brazos Basin | | Ogallala | 8,224 | 6,055 | 5,742 | 5,446 | 4,688 | 4,698 | 4,704 |
| Colorado Basin | | Ogallala | 156,624 | 111,782 | 85,125 | 66,958 | 53,649 | 53,692 | 53,674 |
| Total Irrigation | Supply | | 164,848 | 117,837 | 90,867 | 72,404 | 58,337 | 58,390 | 58,378 |
| **Irrigation Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | -1,933 | -3,581 | -3,400 | -3,228 | -3,541 | -3,109 | -2,703 |
| Colorado Basin | | | -36,360 | -71,307 | -88,577 | -97,839 | -102,699 | -94,640 | -87,052 |
| Total Irrigation | Surplus/Shortage | | -38,293 | -74,888 | -91,977 | -101,067 | -106,240 | -97,749 | -89,755 |

Continued on next page

***Table 4-20 Continued***

| Basin | | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Mining Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Total Mining | Demand | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| **Mining Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | Ogallala | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Total Mining | Supply | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot | Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot | Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot | Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Total Dairies | Demand | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| **Dairies Supply** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | Ogallala | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Total Dairies | Supply | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| **Dairies Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies | Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | | |
| Brazos Basin | | | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Colorado Basin | | | 115 | 115 | 114 | 118 | 118 | 125 | 130 |
| Total Range & All | Other Livestock Demand | | 119 | 121 | 124 | 126 | 130 | 135 | 137 |
| **Range & All Other Livestock Supply** | | | | | | | | | |
| Brazos Basin | | Local | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Colorado Basin | | Local | 115 | 115 | 114 | 118 | 118 | 125 | 130 |
| Total Range & All | Other Livestock Supply | | 119 | 121 | 124 | 126 | 130 | 135 | 137 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | | |
| Brazos Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All | Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Demand** | | | | | | | | | |
| Municipal | | | 3,038 | 3,210 | 3,387 | 3,547 | 3,696 | 3,697 | 3,676 |
| Industrial | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 203,141 | 192,725 | 182,844 | 173,471 | 164,577 | 156,139 | 148,133 |
| Mining | | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Range & All Other Livestock | | | 119 | 121 | 124 | 126 | 130 | 135 | 137 |
| Total County Demand | | | 207,229 | 196,724 | 186,772 | 177,466 | 168,653 | 160,173 | 152,170 |

Continued on next page

***Table 4-20 Continued***

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Supply** | | | | | | | | |
| Municipal | | 3,289 | 3,279 | 3,272 | 3,267 | 3,261 | 3,239 | 3,219 |
| Industrial | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 164,848 | 117,837 | 90,867 | 72,404 | 58,337 | 58,390 | 58,378 |
| Mining | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Range & All Other Livestock | | 119 | 121 | 124 | 126 | 130 | 135 | 137 |
| Total County Supply | | 169,187 | 121,904 | 94,681 | 76,119 | 61,979 | 61,967 | 61,958 |
| | | | | | | | | |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 251 | 69 | -115 | -280 | -435 | -458 | -457 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -38,293 | -74,888 | -91,977 | -101,067 | -106,240 | -97,749 | -89,755 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | -38,042 | -74,820 | -92,092 | -101,346 | -106,675 | -98,206 | -90,212 |
| | | | | | | | | |
| **Total Basin Demand** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 10,157 | 9,636 | 9,142 | 8,674 | 8,229 | 7,807 | 7,407 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Total Brazos Basin Demand | | 10,174 | 9,657 | 9,166 | 8,697 | 8,257 | 7,832 | 7,429 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 3,025 | 3,196 | 3,373 | 3,532 | 3,680 | 3,682 | 3,661 |
| Industrial | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 192,984 | 183,089 | 173,702 | 164,797 | 156,348 | 148,332 | 140,726 |
| Mining | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Range & All Other Livestock | | 115 | 115 | 114 | 118 | 118 | 125 | 130 |
| Total Colorado Basin Demand | | 197,055 | 187,067 | 177,606 | 168,769 | 160,396 | 152,342 | 144,741 |
| | | | | | | | | |
| **Total Basin Supply** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 13 | 14 | 14 | 15 | 16 | 15 | 15 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 8,224 | 6,055 | 5,742 | 5,446 | 4,688 | 4,698 | 4,704 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 4 | 7 | 10 | 8 | 12 | 10 | 7 |
| Total Brazos Basin Supply | | 8,241 | 6,075 | 5,766 | 5,469 | 4,717 | 4,723 | 4,725 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 3,276 | 3,265 | 3,258 | 3,252 | 3,245 | 3,224 | 3,204 |
| Industrial | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 156,624 | 111,782 | 85,125 | 66,958 | 53,649 | 53,692 | 53,674 |
| Mining | | 930 | 554 | 266 | 155 | 66 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| Range & All Other Livestock | | 115 | 115 | 114 | 118 | 118 | 125 | 130 |
| Total Colorado Basin Supply | | 160,946 | 115,829 | 88,915 | 70,650 | 57,262 | 57,244 | 57,233 |

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### *Table 4-20 Concluded*

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Brazos** | | | | | | | | |
| Municipal | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -1,933 | -3,581 | -3,400 | -3,228 | -3,541 | -3,109 | -2,703 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Brazos Basin Surplus/Shortage | | -1,933 | -3,581 | -3,400 | -3,228 | -3,541 | -3,109 | -2,703 |
| | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 251 | 69 | -115 | -280 | -435 | -458 | -457 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | -36,360 | -71,307 | -88,577 | -97,839 | -102,699 | -94,640 | -87,052 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | -36,109 | -71,238 | -88,692 | -98,119 | -103,134 | -95,098 | -87,509 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

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## *Table 4-21.*
## *Projected Water Demands, Supplies, and Needs*
## *Yoakum County*
## *Llano Estacado Region*

| Demand Updated 6-4-09 | | and 6/8/2009 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | Source | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **WATER SUPPLIES** | | | | | | | | | |
| | **Colorado Basin** | | | | | | | | |
| | Quantity in Storage[1] | Ogallala | 4,381,613 | 3,620,371 | 3,017,014 | 2,457,580 | 1,939,772 | 1,457,384 | 1,005,116 |
| | Quantity Pumped[2] | Ogallala | 133,881 | 103,958 | 99,734 | 95,204 | 91,342 | 88,062 | 85,269 |
| | Supply | (Ogallala)[3] | 133,881 | 103,958 | 99,734 | 95,204 | 91,342 | 88,062 | 85,269 |
| | Local Surface | Stock Tanks and Windmills | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| | Other Surface | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Supply | | 134,095 | 104,176 | 100,007 | 95,482 | 91,624 | 88,350 | 85,562 |
| Data LERWPG | | | | | | | | | |
| Oct. 28, 04 | | | | | | | | | |
| **WATER DEMANDS** | | | | | | | | | |
| **Municipal Demand** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Denver City | | | 955 | 1,043 | 1,126 | 1,172 | 1,220 | 1,181 | 1,141 |
| Plains | | | 378 | 416 | 448 | 468 | 488 | 473 | 457 |
| Rural | | | 264 | 286 | 305 | 314 | 323 | 312 | 302 |
| | Subtotal | | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| Total Municipal Demand | | | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| **Municipal Existing Supply** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Denver City | | Ogallala | 955 | 1,043 | 1,126 | 193 | 174 | 157 | 141 |
| Plains | | Ogallala | 378 | 416 | 0 | 0 | 0 | 0 | 0 |
| Rural | | Ogallala | 264 | 286 | 305 | 314 | 323 | 312 | 302 |
| | Subtotal | | 1,597 | 1,745 | 1,431 | 507 | 497 | 469 | 443 |
| Total Municipal Existing Supply | | | 1,597 | 1,745 | 1,431 | 507 | 497 | 469 | 443 |
| **Municipal Surplus/Shortage** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Denver City | | | 0 | 0 | 0 | -979 | -1,046 | -1,024 | -1,000 |
| Plains | | | 0 | 0 | -448 | -468 | -488 | -473 | -457 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | -448 | -1,447 | -1,534 | -1,497 | -1,457 |
| Total Municipal Surplus/Shortage | | | 0 | 0 | -448 | -1,447 | -1,534 | -1,497 | -1,457 |
| **Municipal New Supply Need** | | | | | | | | | |
| Colorado Basin | | | | | | | | | |
| Denver City | | | 0 | 0 | 0 | 979 | 1,046 | 1,024 | 1,000 |
| Plains | | | 0 | 0 | 448 | 468 | 488 | 473 | 457 |
| Rural | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Subtotal | | 0 | 0 | 448 | 1,447 | 1,534 | 1,497 | 1,457 |
| Total Municipal New Supply Need | | | 0 | 0 | 448 | 1,447 | 1,534 | 1,497 | 1,457 |
| **Industrial Demand** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Demand | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Existing Supply** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Existing Supply | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Industrial Surplus/Shortage** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial Surplus/Shortage | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| **Industrial New Supply Need** | | | | | | | | | |
| Colorado Basin | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Industrial New Supply Need | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric Demand** | | | | | | | | | |
| Colorado Basin | | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Total Steam-Electric Demand | | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |

Continued on next page

***Table 4-21 Continued***

| Basin | Source | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Steam-Electric Existing Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Total Steam-Electric Existing Supply | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| **Steam-Electric Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Steam-Electric New Supply Need** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Steam-Electric New Supply Need | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Irrigation Demand** | | | | | | | | |
| Colorado Basin | | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| Total Irrigation Demand | | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| **Irrigation Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 127,273 | 97,200 | 92,443 | 87,806 | 83,873 | 79,851 | 76,166 |
| Total Irrigation Supply | | 127,273 | 97,200 | 92,443 | 87,806 | 83,873 | 79,851 | 76,166 |
| **Irrigation Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 214 | -23,779 | -22,744 | -21,868 | -20,553 | -19,576 | -18,502 |
| Total Irrigation Surplus/Shortage | | 214 | -23,779 | -22,744 | -21,868 | -20,553 | -19,576 | -18,502 |
| **Mining Demand** | | | | | | | | |
| Colorado Basin | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Total Mining Demand | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| **Mining Supply** | | | | | | | | |
| Colorado Basin | Ogallala | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Total Mining Supply | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| **Mining Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Mining Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Demand** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Supply** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Beef Feedlot Livestock Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Beef Feedlot Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Demand** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Demand | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Supply** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Supply | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dairies Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Dairies Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Range & All Other Livestock Demand** | | | | | | | | |
| Colorado Basin | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total Range & All Other Livestock Demand | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| **Range & All Other Livestock Supply** | | | | | | | | |
| Colorado Basin | Local | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total Range & All Other Livestock Supply | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| **Range & All Other Livestock Surplus/Shortage** | | | | | | | | |
| Colorado Basin | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Range & All Other Livestock Surplus/Shortage | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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### *Table 4-21 Concluded*

| Basin | Source | Total in 2000 (acft) | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| | | | Projections | | | | | |
| **Total Demand** | | | | | | | | |
| Municipal | | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| Mining | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total County Demand | | 133,881 | 127,955 | 122,581 | 116,958 | 112,056 | 107,784 | 104,047 |
| **Total Supply** | | | | | | | | |
| Municipal | | 1,597 | 1,745 | 1,431 | 507 | 497 | 469 | 443 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | 127,273 | 97,200 | 92,443 | 87,806 | 83,873 | 79,851 | 76,166 |
| Mining | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total County Supply | | 134,095 | 104,176 | 99,389 | 93,643 | 89,969 | 86,711 | 84,088 |
| **Total Surplus/Shortage** | | | | | | | | |
| Municipal | | 0 | 0 | -448 | -1,447 | -1,534 | -1,497 | -1,457 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 214 | -23,779 | -22,744 | -21,868 | -20,553 | -19,576 | -18,502 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total County Surplus/Shortage | | 214 | -23,779 | -23,192 | -23,315 | -22,087 | -21,073 | -19,959 |
| **Total Basin Demand** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 1,597 | 1,745 | 1,879 | 1,954 | 2,031 | 1,966 | 1,900 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| Mining | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total Colorado Basin Demand | | 133,881 | 127,955 | 122,581 | 116,958 | 112,056 | 107,784 | 104,047 |
| **Total Basin Supply** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 1,597 | 1,745 | 1,431 | 507 | 497 | 469 | 443 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | 127,273 | 97,200 | 92,443 | 87,806 | 83,873 | 79,851 | 76,166 |
| Mining | | 3,159 | 2,416 | 1,524 | 706 | 204 | 56 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 214 | 218 | 273 | 278 | 282 | 288 | 293 |
| Total Colorado Basin Supply | | 134,095 | 104,176 | 99,389 | 93,643 | 89,969 | 86,711 | 84,088 |
| **Total Basin Surplus/Shortage** | | | | | | | | |
| **Colorado** | | | | | | | | |
| Municipal | | 0 | 0 | -448 | -1,447 | -1,534 | -1,497 | -1,457 |
| Industrial | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | 214 | -23,779 | -22,744 | -21,868 | -20,553 | -19,576 | -18,502 |
| Mining | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Range & All Other Livestock | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Colorado Basin Surplus/Shortage | | 214 | -23,779 | -23,192 | -23,315 | -22,087 | -21,073 | -19,959 |

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

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## Table 4-22.
## Projected Water Demands, Supplies, and Needs
## River Basin and Llano Estacado Region Summaries
## Llano Estacado Region

| Updated 8/13/2009 | and 12/31/2009 | Total in | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basin | | 1990 | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Canadian Basin Demand** | | | | | | | | | |
| Municipal | | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock | | | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| **Total Canadian Basin Demand** | | | 73 | 90 | 100 | 101 | 103 | 104 | 109 |
| | | | | | | | | | |
| **Canadian Basin Supply** | | | | | | | | | |
| Municipal | | | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock | | | 73 | 89 | 99 | 100 | 102 | 103 | 108 |
| **Total Canadian Basin Supply** | | | 73 | 90 | 100 | 101 | 103 | 104 | 109 |
| | | | | | | | | | |
| **Canadian Basin Surplus/Shortage [1]** | | | | | | | | | |
| Municipal | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Canadian Basin Surplus/Shortage [1]** | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | |
| **Red Basin Demand** | | | | | | | | | |
| Municipal | | | 7,548 | 7,875 | 8,177 | 8,378 | 8,474 | 8,417 | 8,301 |
| Industrial | | | 3,404 | 6,239 | 6,578 | 6,856 | 7,124 | 7,356 | 7,714 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 909,585 | 883,748 | 855,251 | 834,628 | 811,278 | 788,702 | 766,868 |
| Mining | | | 85 | 50 | 24 | 14 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | | 14,731 | 17,958 | 20,134 | 21,374 | 22,693 | 24,091 | 25,576 |
| Dairies | | | 164 | 2,884 | 3,524 | 3,880 | 4,270 | 4,698 | 5,176 |
| All Other Livestock | | | 5,246 | 5,419 | 5,658 | 5,869 | 6,096 | 6,336 | 6,580 |
| **Total Red Basin Demand** | | | 940,764 | 924,174 | 899,346 | 880,999 | 859,940 | 839,600 | 820,215 |
| | | | | | | | | | |
| **Red Basin Supply** | Unallocated | | 25,349 | 25,240 | 25,429 | 17,452 | 17,514 | 17,577 | 17,649 |
| Municipal | | | 8,128 | 8,045 | 8,683 | 11,406 | 11,502 | 11,444 | 11,318 |
| Industrial | | | 3,404 | 6,239 | 6,578 | 6,856 | 7,124 | 7,356 | 7,714 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 932,270 | 550,845 | 389,469 | 291,061 | 231,676 | 221,809 | 207,907 |
| Mining | | | 85 | 50 | 24 | 14 | 6 | 0 | 0 |
| Beef Feedlot Livestock | | | 14,731 | 17,958 | 20,134 | 21,374 | 21,324 | 22,336 | 23,713 |
| Dairies | | | 164 | 2,884 | 3,524 | 3,880 | 4,270 | 4,698 | 5,176 |
| All Other Livestock | | | 5,246 | 5,419 | 5,658 | 5,869 | 6,096 | 6,336 | 6,580 |
| **Total Red Basin Supply** | | | 989,377 | 616,680 | 459,499 | 357,911 | 299,511 | 291,556 | 280,056 |

Continued on next page

***Table 4-22 Continued***

| | | Total in | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Basin** | | **1990** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Red Basin Surplus/Shortage [1]** | | | | | | | | | |
| Municipal | | | 580 | 170 | 506 | 3,028 | 3,028 | 3,027 | 3,017 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 22,685 | -332,903 | -465,782 | -543,567 | -579,602 | -566,893 | -558,961 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | -1,369 | -1,755 | -1,864 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Red Basin Surplus/Shortage [1]** | | | 23,265 | -332,733 | -465,276 | -540,539 | -577,943 | -565,621 | -557,808 |
| | | | | | | | | | |
| **Brazos Basin Demand** | | | | | | | | | |
| Municipal | | | 68,459 | 79,566 | 82,674 | 84,038 | 84,196 | 84,289 | 84,774 |
| Industrial | | | 6,558 | 9,339 | 9,961 | 10,466 | 10,947 | 11,358 | 12,042 |
| Steam-Electric | | | 23,766 | 23,048 | 22,103 | 25,842 | 30,398 | 35,953 | 42,724 |
| Irrigation | | | 2,497,120 | 2,409,240 | 2,322,320 | 2,244,092 | 2,166,425 | 2,091,863 | 2,020,262 |
| Mining | | | 5,630 | 3,681 | 2,141 | 1,351 | 530 | 23 | 2 |
| Beef Feedlot Livestock | | | 10,983 | 13,388 | 15,009 | 15,936 | 16,917 | 17,960 | 19,067 |
| Dairies | | | 1,020 | 5,688 | 6,989 | 7,678 | 8,443 | 9,289 | 10,218 |
| All Other Livestock | | | 4,088 | 4,208 | 4,445 | 4,576 | 4,717 | 4,852 | 5,003 |
| **Total Brazos Basin Demand** | | | 2,617,625 | 2,548,159 | 2,465,643 | 2,393,978 | 2,322,572 | 2,255,588 | 2,194,093 |
| | | | | | | | | | |
| **Brazos Basin Supply** | Unallocated | | 4,807 | 4,654 | 4,654 | 3,166 | 3,164 | 3,162 | 3,166 |
| Municipal | | | 97,556 | 86,348 | 86,784 | 81,456 | 77,102 | 70,560 | 67,969 |
| Industrial | | | 6,558 | 9,339 | 9,961 | 10,466 | 10,947 | 11,358 | 12,042 |
| Steam-Electric | | | 23,766 | 23,048 | 22,103 | 25,842 | 30,398 | 35,953 | 42,724 |
| Irrigation | | | 2,569,206 | 1,768,692 | 1,396,325 | 1,080,544 | 801,184 | 700,041 | 656,739 |
| Mining | | | 5,630 | 3,681 | 2,141 | 1,351 | 530 | 23 | 2 |
| Beef Feedlot Livestock | | | 10,983 | 13,388 | 14,250 | 13,510 | 11,109 | 8,639 | 8,040 |
| Dairies | | | 1,019 | 5,688 | 6,989 | 6,914 | 6,115 | 5,658 | 5,535 |
| All Other Livestock | | | 4,088 | 4,208 | 4,445 | 4,576 | 4,717 | 4,852 | 5,003 |
| **Total Brazos Basin Supply** | | | 2,723,614 | 1,919,046 | 1,547,652 | 1,227,824 | 945,265 | 840,246 | 801,219 |
| | | | | | | | | | |
| **Brazos Basin Surplus/Shortage [1]** | | | | | | | | | |
| Municipal | | | 29,097 | 6,782 | 4,110 | -2,582 | -7,094 | -13,729 | -16,805 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 72,086 | -640,548 | -925,995 | -1,163,548 | -1,365,241 | -1,391,822 | -1,363,523 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | -759 | -2,426 | -5,808 | -9,321 | -11,027 |
| Dairies | | | 0 | 0 | 0 | -764 | -2,328 | -3,631 | -4,684 |
| All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Brazos Basin Surplus/Shortage [1]** | | | 101,182 | -633,767 | -922,644 | -1,169,320 | -1,380,471 | -1,418,504 | -1,396,039 |
| | | | | | | | | | |
| **Colorado Basin Demand** | | | | | | | | | |
| Municipal | | | 11,315 | 11,995 | 12,621 | 13,058 | 13,371 | 13,145 | 12,864 |
| Industrial | | | 102 | 120 | 130 | 138 | 145 | 151 | 163 |
| Steam-Electric | | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | | 941,172 | 893,030 | 847,371 | 804,060 | 762,975 | 724,003 | 687,033 |
| Mining | | | 15,721 | 12,593 | 8,115 | 4,994 | 2,316 | 705 | 256 |
| Beef Feedlot Livestock | | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| All Other Livestock | | | 918 | 936 | 1,045 | 1,067 | 1,086 | 1,114 | 1,144 |
| **Total Colorado Basin Demand** | | | 971,580 | 921,992 | 873,833 | 828,553 | 785,959 | 746,184 | 709,737 |
| | | | | | | | | | |
| **Colorado Basin Supply** | | | | | | | | | |
| Municipal | | | 12,294 | 12,847 | 12,513 | 11,604 | 11,552 | 11,130 | 10,915 |
| Industrial | | | 102 | 120 | 130 | 138 | 145 | 151 | 163 |
| Steam-Electric | | | 1,852 | 2,597 | 3,718 | 4,346 | 5,113 | 6,047 | 7,186 |
| Irrigation | | | 910,511 | 621,156 | 520,689 | 464,048 | 417,178 | 365,478 | 339,707 |
| Mining | | | 15,721 | 12,593 | 8,115 | 4,994 | 2,316 | 705 | 256 |
| Beef Feedlot Livestock | | | 500 | 609 | 683 | 725 | 770 | 817 | 868 |
| Dairies | | | 0 | 112 | 150 | 166 | 183 | 202 | 223 |
| All Other Livestock | | | 918 | 936 | 1,045 | 1,067 | 1,086 | 1,114 | 1,144 |
| **Total Colorado Basin Supply** | | | 941,899 | 650,970 | 547,044 | 487,087 | 438,343 | 385,644 | 360,462 |

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***Table 4-22 Concluded***

| Basin | | Total in 1990 (acft) | Total in 2000 (acft) | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|---|
| **Colorado Basin Surplus/Shortage [1]** | | | | | | | | | |
| Municipal | | | 979 | 852 | -108 | -1,454 | -1,819 | -2,015 | -1,949 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | -30,661 | -271,874 | -326,682 | -340,012 | -345,797 | -358,525 | -347,326 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dairies | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Colorado Basin Surplus/Shortage [1]** | | | -29,682 | -271,022 | -326,789 | -341,466 | -347,616 | -360,540 | -349,275 |
| **Llano Estacado Region Demand** | | | | | | | | | |
| Municipal | | | 87,322 | 99,437 | 103,473 | 105,475 | 106,042 | 105,852 | 105,940 |
| Industrial | | | 10,064 | 15,698 | 16,669 | 17,460 | 18,216 | 18,865 | 19,919 |
| Steam-Electric | | | 25,618 | 25,645 | 25,821 | 30,188 | 35,511 | 42,000 | 49,910 |
| Irrigation | | | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |
| Mining | | | 21,436 | 16,324 | 10,280 | 6,359 | 2,852 | 728 | 258 |
| Beef Feedlot Livestock | | | 26,215 | 31,955 | 35,826 | 38,035 | 40,380 | 42,869 | 45,512 |
| Dairies | | | 1,184 | 8,685 | 10,663 | 11,723 | 12,896 | 14,188 | 15,617 |
| All Other Livestock | | | 10,326 | 10,652 | 11,247 | 11,612 | 12,000 | 12,405 | 12,834 |
| **Total Llano Estacado Region Demand** | | | 4,530,042 | 4,394,415 | 4,238,922 | 4,103,632 | 3,968,574 | 3,841,476 | 3,724,153 |
| **Llano Estacado Region Supply** | | | | | | | | | |
| | Unallocated | | 30,156 | 29,894 | 30,083 | 20,617 | 20,677 | 20,739 | 20,815 |
| Municipal | | | 117,978 | 107,241 | 107,981 | 104,467 | 100,158 | 93,135 | 90,204 |
| Industrial | | | 10,064 | 15,698 | 16,669 | 17,460 | 18,216 | 18,865 | 19,919 |
| Steam-Electric | | | 25,618 | 25,645 | 25,821 | 30,188 | 35,511 | 42,000 | 49,910 |
| Irrigation | | | 4,411,987 | 2,940,692 | 2,306,484 | 1,835,653 | 1,450,037 | 1,287,327 | 1,204,352 |
| Mining | | | 21,436 | 16,324 | 10,280 | 6,359 | 2,852 | 728 | 258 |
| Beef Feedlot Livestock | | | 26,214 | 31,955 | 35,067 | 35,609 | 33,203 | 31,793 | 32,621 |
| Dairies | | | 1,184 | 8,685 | 10,663 | 10,959 | 10,568 | 10,557 | 10,934 |
| All Other Livestock | | | 10,326 | 10,652 | 11,247 | 11,612 | 12,000 | 12,405 | 12,834 |
| **Total Llano Estacado Region Supply** | | | 4,654,963 | 3,186,786 | 2,554,295 | 2,072,924 | 1,683,221 | 1,517,550 | 1,441,846 |
| **Llano Estacado Region Surplus/Shortage [1]** | | | | | | | | | |
| Municipal | | | 30,656 | 7,804 | 4,508 | -1,008 | -5,884 | -12,717 | -15,736 |
| Industrial | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Steam-Electric | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irrigation | | | 64,110 | -1,245,326 | -1,718,458 | -2,047,127 | -2,290,641 | -2,317,241 | -2,269,811 |
| Mining | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beef Feedlot Livestock | | | 0 | 0 | -759 | -2,426 | -7,177 | -11,076 | -12,891 |
| Dairies | | | 0 | 0 | 0 | -764 | -2,328 | -3,631 | -4,683 |
| All Other Livestock | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Llano Estacado Region Surplus/Shortage** | | | 94,766 | -1,237,522 | -1,714,710 | -2,051,326 | -2,306,030 | -2,344,665 | -2,303,122 |

Notes:

[1] The values listed in this section of the table are not necessarily additive due to the fact that demands and supplies are not necessarily located in close proximity to each other.

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It is important to note that the computations of supply and demand have been based upon county level data, and therefore show the county balance of shortage or surplus. This method of analysis may show a county or a user group within the county as having a surplus of water when individuals of user groups have shortages (i.e., the surplus water is neither in a location nor an ownership such that it can be obtained by users who need it). This condition most likely applies to each user group of each county, and cannot be addressed unless plans are developed for each individual water user.

A review of results of comparisons of projected demands, supplies, and quantities or water remaining in storage, as shown in Tables 4-1 through 4-21, results in questions regarding calculated water shortages for certain water user groups, particularly irrigation. For example, the results for 10 of the counties of the region (Bailey, Castro, Cochran, Deaf Smith, Gaines, Hale, Lamb, Motley, Parmer, and Yoakum) show that greater than 60 percent of estimated quantities of water in storage in year 2000 are projected to have been used by 2060. The results for 7 counties (Briscoe, Crosby, Dickens, Floyd, Hockley, Lubbock, Swisher, and Terry) show that between 18 percent and about 44 percent of estimated quantities of water in storage in year 2000 are projected to have been used by 2060. The results for these 17 counties appear to be consistent with expectations of supplies, demands and shortages in view of the nature of declining supplies from the Ogallala aquifer. However, the results for 4 counties (Dawson, Garza, and Lynn) show that less than 5 percent of estimated quantities of water in storage in year 2000 are projected to have been used by 2060, and in the case of Dawson County, the quantity of water projected to be available for use is 45,213 acft/yr in 2010 declining to 31,212 acft/yr in 2060, however quantity of water in storage remains constant at 7,202,322 acft, while projected shortages for irrigation decrease from 95,526 acft/yr in 2010 to 72,967 acft/yr in 2060 (Table 4-6). A similar result is shown for Garza County, with projected quantity of water in storage remaining constant at 643,700 acft, while shortages are projected for irrigation in the 3,000 to 4,700 acft/yr range (Table 4-11), and in the case of Lynn County, projected quantities of water in storage remain in the range of 3,645,979 acft/yr to 3,655,103 acft/yr, quantity of water available is shown at 120,916 acft/yr for 2010 declining to 120,805 acft/yr in 2060, and irrigation surpluses are shown at 17,502 acft/yr in 2010 increasing to 36,474 acft/yr in 2060 (Table 4-16). It appears that the calculations of quantities of water available and quantity remaining in storage for Dawson, Garza, and Lynn Counties, as provided by the Southern Ogallala GAM model may result from a poor matching of the location of irrigated acreages in relation to the locations of land having water in storage, and should be checked before the model is used in the future for developing water supply information for regional water planning purposes.

## *4.2 Water Needs Projections for Wholesale Water Providers*

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections are tabulated for each Wholesale Water Provider of the Llano Estacado Water Planning (Table 4-23 and Appendix F). For each Wholesale Water Provider the water demands were brought forward from Section 2, Population and Water Demand Projections (Table 2-22), and water supplies were brought forward from Section 3, Water Supply Projections for the Planning Region. Of the four Wholesale Water Providers of the region, all four are projected to have a water shortage during the planning period (Table 4-23). More detailed information on projected demands, supplies, and needs for each WWP is provided in Appendix G.

### *Table 4-23. Projected Water Demands, Supplies and Needs for Wholesale Water Providers Llano Estacado Water Planning Region*

| Lubbock updated 7/10/2009; CRMWA updated 12/28/09 | Total in | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| **Wholesale Providers** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Canadian River Municipal Water Authority** | | | | | | | |
| CRMWA Customer Demands | | 103,855 | 104,269 | 104,434 | 104,391 | 103,924 | 103,388 |
| Supplies to Region O | | 43,685 | 59,722 | 59,722 | 59,722 | 59,722 | 59,722 |
| Supplies to Region A | | 43,163 | 50,260 | 50,169 | 50,045 | 49,858 | 49,676 |
| **Surplus/Shortages (Needs)** | | -17,007 | 5,713 | 5,457 | 5,376 | 5,656 | 6,010 |
| **City of Lubbock** | | | | | | | |
| CRMWA Supply (Lubbock and CRMWA data) | 42,535 | 32,000 | 34,000 | 34,000 | 34,000 | 32,000 | 32,000 |
| Bailey County Supply | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 | 3,000 | 3,000 |
| Lake Alan Henry Supply | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Supply | 54,535 | 42,000 | 42,000 | 40,000 | 38,000 | 35,000 | 35,000 |
| Projected Demands (Lubbock and Customers) | 41,917 | 51,442 | 53,359 | 54,327 | 54,632 | 55,208 | 56,516 |
| **Surplus/Shortages (Needs)** | 12,618 | -9,442 | -11,359 | -14,327 | -16,632 | -20,208 | -21,516 |
| **Mackenzie Municipal Water Authority (MMWA)** | | | | | | | |
| Lake Mackenzie supply | 864 | 0 | 0 | 0 | 0 | 0 | 0 |
| Projected Demands | 2,046 | 2,100 | 2,133 | 2,128 | 2,098 | 2,030 | 1,936 |
| **Surplus/Shortages (Needs)** | -1,182 | -2,100 | -2,133 | -2,128 | -2,098 | -2,030 | -1,936 |
| **White River Municipal Water District (WRMWD)** | | | | | | | |
| White River Lake Supply | 2,003 | 1,999 | 1,947 | 1,463 | 979 | 495 | 8 |
| Groundwater Supply | | | | | | | |
| Total Supply | 2,003 | 1,999 | 1,947 | 1,463 | 979 | 495 | 8 |
| Projected Municipal Demands | 3,164 | 2,545 | 2,080 | 1,872 | 1,689 | 1,537 | 1,489 |
| Projected Mining and Industrial Demands | 1,625 | 970 | 470 | 277 | 123 | 8 | 8 |
| Total Demands | 4,789 | 3,515 | 2,550 | 2,149 | 1,812 | 1,545 | 1,497 |
| **Surplus/Shortages (Needs)** | -2,786 | -1,516 | -603 | -686 | -833 | -1,050 | -1,489 |
| | | | | | | | |
| **CRMWA Supplies to REGION A** | Information from Region A Technical Consultant | | | | | | |
| SOUTHWESTERN PUBLIC SERVICE | | 683 | 0 | 0 | 0 | 0 | 0 |
| AMARILLO | 42,964 | 36,215 | 42,987 | 42,987 | 42,987 | 42,987 | 42,987 |
| BORGER | 700 | 3,433 | 4,000 | 4,000 | 4,000 | 4,000 | 4,000 |
| PAMPA | 3,499 | 2,832 | 3,273 | 3,182 | 3,058 | 2,871 | 2,689 |
| **REGION A CRMWA Supply TOTALS** | 47,163 | 43,163 | 50,260 | 50,169 | 50,045 | 49,858 | 49,676 |
| | | | | | | | |
| **CRMWA Supplies to REGION O** | Information from CRMWA | | | | | | |
| BROWNFIELD | 1,571 | 1,758 | 2,616 | 2,616 | 2,616 | 2,616 | 2,616 |
| LAMESA | 1,744 | 2,594 | 2,594 | 2,594 | 2,594 | 2,594 | 2,594 |
| LEVELLAND | 2,232 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 | 3,320 |
| LUBBOCK | 37,182 | 29,646 | 44,099 | 44,099 | 44,099 | 44,099 | 44,099 |
| O'DONNELL DAWSON & LYNN Cos | 20 | 166 | 278 | 278 | 278 | 278 | 278 |
| O'DONNELL LYNN CO | 145 | | | | | | |
| PLAINVIEW | 2,953 | 4,393 | 4,393 | 4,393 | 4,393 | 4,393 | 4,393 |
| SLATON | 914 | 1,261 | 1,875 | 1,875 | 1,875 | 1,875 | 1,875 |
| TAHOKA | 368 | 547 | 547 | 547 | 547 | 547 | 547 |
| **REGION O CRMWA SUPPLY TOTALS** | 47,129 | 43,685 | 59,722 | 59,722 | 59,722 | 59,722 | 59,722 |
| Meredith Estimated Quantity Available | 69,750 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 |
| Groundwater | 40,000 | 69,000 | 69,000 | 69,000 | 69,000 | 69,000 | 69,000 |
| CRMWA Total (Determined by CRMWA) | 109,750 | 119,000 | 119,000 | 119,000 | 119,000 | 119,000 | 119,000 |
| | | | | | | | <><><> |

### *4.3 Socioeconomic Impacts of Not Meeting Projected Water Needs*

Section 357.7(a)(4) of the rules for the development of regional water plans requires that the social and economic impacts of not meeting regional water supply needs be evaluated by the Regional Water Planning Groups (RWPGs). The TWDB is required to provide technical assistance, upon request, to complete the evaluations. The LERWPG requested technical assistance of the TWDB to perform the required analyses. TWDB conducted the required analysis of the impacts of the identified needs for the Llano Estacado Region using the same methodology that was used for all other regions. The results of this analysis are presented for information purposes. These results give an indication of the significance of having an adequate water supply, and should be viewed by individuals and public policymakers in that light. The results of the social and economic impact analyses have not been used in any other way in the development of this water plan, since the TWDB Regional Water Planning Rules specified that the RWPG was to develop a water plan to meet the projected needs (shortages) of each water user group unless it was determined that it was not feasible to meet one or more of the projected needs.

The projected total water demands for the Llano Estacado Region decrease from 4.39 million acft in 2010 to 4.10 million acft in 2030, and 3.72 million acft in 2060 (Table 2-19). Under historic drought of record water supply conditions, and with no water management strategies in place, water needs (shortages) are projected to be 1.26 million acft/yr in 2010, increasing to 2.08 million acft/yr in 2030 and to 2.34 million acft/yr by 2060 (Table 4-24).

The projected water needs (shortages) of the region amount to about 28 percent of the projected demand in 2010, increasing to 50 percent of demand in 2030, and 62.7 percent in and 2060 (Table 4-24). This means that by 2030 the region would be able to supply only about 50 percent of the projected water demands unless supply development or other water management strategies are implemented.

The LERWPG identified 59 individual water user groups which showed an unmet need during drought-of-record supply conditions for each decade from 2010 to 2060(Table 4-24). Of the 21 counties of the Llano Estacado Region, 20 have irrigation water user groups with projected water needs (shortages), there are 30 municipal WUGs (29 cities and one water supply district) with projected needs (shortages), and five counties with projected confined animal

**Table 4-24.**
**Projected Water Needs (Shortages) and**
**Socioeconomic Impacts of Failing to Meet Projected Water Needs (Shortages)**
**Llano Estacado Water Panning Region (Region O)**

| County/WUG | Basin | Use | Projections 2010 (acft/yr) | 2020 (acft/yr) | 2030 (acft/yr) | 2040 (acft/yr) | 2050 (acft/yr) | 2060 (acft/yr) |
|---|---|---|---|---|---|---|---|---|
| **Region Total Water Shortages** | | | | | | | | |
| | | Mun | 9,461 | 13,243 | 18,997 | 22,532 | 27,124 | 29,047 |
| | | Irrig | 1,253,776 | 1,722,690 | 2,053,846 | 2,301,752 | 2,332,340 | 2,290,511 |
| | | Beef Fdlt | 0 | 759 | 2,426 | 7,177 | 11,076 | 12,891 |
| | | Dairies | 0 | 0 | 764 | 2,328 | 3,631 | 12,891 |
| **Total Shortage** | | | 1,263,237 | 1,736,692 | 2,076,033 | 2,333,789 | 2,374,171 | 2,345,340 |
| | | | | | | | | |
| **Region** | **Units** | | Years | | | | | |
| | | | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Socioeconomic Impacts of Shortages | | | | | | | | |
| Irrigated Agriculture | | | | | | | | |
| Lost Income (GSP) | $ million | per year | 353.29 | 687.56 | 895.63 | 1,085.94 | 1,124.63 | 1,101.93 |
| Lost Taxes (State & Local) | $ million | per year | 17.26 | 35.80 | 47.81 | 57.75 | 59.92 | 59.03 |
| Lost Jobs | Number | | 5,465 | 10,158 | 1,314 | 15,631 | 16,114 | 15,824 |
| | | | | | | | | |
| Beef Feedlots & Dairies | | | | | | | | |
| Lost Income (GSP) | $ million | per year | 0.00 | 3.68 | 15.46 | 78.30 | 236.21 | 274.40 |
| Lost Taxes (State & Local) | $ million | per year | 0.00 | 0.27 | 1.13 | 7.34 | 17.30 | 20.10 |
| Lost Jobs | Number | | 0 | 92 | 386 | 2,303 | 5,892 | 6,117 |
| | | | | | | | | |
| Municipal WUGS | | | | | | | | |
| Lost Utility Revenues | $ million | per year | 16.63 | 23.28 | 34.13 | 40.61 | 48.98 | 52.19 |
| Lost Income (Bus & Com) | $ million | per year | 2.81 | 22.91 | 37.94 | 49.98 | 53.81 | 60.51 |
| Lost Taxes (State & Local) | $ million | per year | 0.32 | 2.03 | 4.36 | 5.69 | 6.26 | 7.18 |
| Lost Jobs | Number | | 81 | 593 | 1,240 | 1,598 | 1,755 | 2,052 |
| | | | | | | | | |
| Region Totals | | | | | | | | |
| Lost Income (GSP) | $ million | per year | 356.10 | 714.15 | 949.03 | 1,214.22 | 1,414.65 | 1,436.84 |
| Lost Taxes (State & Local) | $ million | per year | 17.58 | 38.10 | 53.30 | 70.78 | 83.48 | 86.31 |
| Lost Jobs | Number | | 5,546 | 10,843 | 2,940 | 19,532 | 23,761 | 23,993 |
| | | | | | | | | |
| Social Impacts | | | | | | | | |
| Population Losses | Number | | 7,160 | 13,910 | 18,670 | 24,590 | 29,830 | 30,030 |
| School Enrollment Declines | Number | | 1,380 | 3,270 | 4,380 | 5,770 | 7,000 | 7,040 |
| | | | | | | | | |
| | | | | | | | | <><><> |

feeding (beef feedlots and dairies) WUGS with projected needs (shortages)(Table 4-24). The projected needs (shortages) for each county are summarized in Appendix C: Table C-01. For example, the projected municipal needs for cities of Castro County are 744 acft/yr in 2030, 805 acft/yr in 2040, 832 acft/yr in 2050, and 844 acft/yr in 2060 (Appendix C: Table C-01). The projected needs for irrigation in Bailey County are 81,561 acft/yr in 2010, 84,647 acft/yr in 2030, and 83,220 acft/yr in 2060 (Appendix C: Table C-01).

The results of the social and economic analyses of not meeting the projected water needs (shortages) are summarized in Table 4-24, and are shown in detail in Appendix C. Estimates are presented for effects upon regional income, taxes, jobs lost, and population and school enrollment effects of not meeting projected water needs. It is estimated that due to projected water shortages, regional income losses in irrigated agriculture, business and commercial establishments, are $356.10 million/yr in 2010, $949.03 million/yr in 2030, and $1,436.84 million/yr in 2060 (Table 4-24). Losses in tax payments to local and state governments are estimated at $17.58 million/yr in 2010, $53.30 million/yr in 2030, and $86.31 million in 2060 (Table 4-24). (Note: the socioeconomic impact analyses were calculated for projected unmet needs (quantities of projected shortages) for municipal, irrigation, and beef feedlot and dairies without taking into account the effects of voluntary transfers of quantities of irrigation sufficient to meet the projected needs of municipal water user groups. Therefore the shortages shown in Table 4-24 are different from the projected shortages shown elsewhere in the plan that take ino account the quantities of irrigation water that will need to be transferred to the municipal water user group to meet municipal projected needs.)

The estimated effects of unmet water shortages upon the population of the region are 7,160 in 2010, 18,670 in 2030, and 30,030 in 2060 (Table 4-24). School enrollment is projected to be 1,680 less in 2010, 4,380 less in 2030, and 7,040 less in 2060 (Table 4-24).

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## *4.4 Water Management Strategies for the Llano Estacado Region*

### *4.4.1 Water Conservation*

A significant water planning option is to increase water conservation and thereby reduce freshwater use within the planning area. The general methods to accomplish this objective are to: (1) reduce per capita water use in the municipal water use category; (2) recycle and reuse industrial water and substitute reclaimed water (treated municipal and industrial wastewater) for use in some industries, steam-electric power generation, and irrigation; and (3) improve irrigation efficiencies to reduce the quantity of water use in agriculture per acre irrigated. BMPs for water conservation, as identified by the Water Conservation Implementation Task Force, will be used in the water conservation water management strategy.[1] In addition, estimates will be made of the water conservation potentials and associated costs of water conservation.

#### *4.4.1.1 Municipal Water Conservation*

For regional water planning purposes, municipal water use is defined as residential and commercial water use. Municipal water is primarily for drinking, sanitation, cleaning, cooling, fire protection, and landscape watering for residential, commercial, and institutional establishments. Such water is supplied by both public and private utilities, and in areas not served by water utilities, is supplied by individual households. A key parameter of municipal water use within a typical city or water service area is the number of gallons used per person per day (per capita water use). The objective of municipal water conservation programs is to reduce the per capita water use parameter without adversely affecting the quality of life of the people involved. This can be achieved through:

- Use of low flow plumbing fixtures (e.g., toilets, shower heads, and faucets that are designed for low quantities of flow per unit of use);
- The selection and use of more efficient water-using appliances (e.g., clothes washers and dishwashers);
- Modifying and/or installing lawn and landscaping systems to use grass and plants that require less water;
- Repair of plumbing and water-using appliances to reduce leaks; and
- Modification of personal behavior that controls the use of plumbing fixtures, appliances, and lawn watering methods.

[1]Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board (TWDB), Special Report, Austin, Texas, November 2004.

In 1991, the Texas Legislature enacted Senate Bill 587, which established minimum standards for plumbing fixtures sold within Texas.[2] The bill became effective on January 1, 1992, and allowed for wholesalers and retailers to clear existing inventories of pre-standards plumbing fixtures by January 1, 1993. The standards for new plumbing fixtures, as specified by Senate Bill 587, are shown in Table 4.4-1. The TCEQ has promulgated rules requiring the labeling of both plumbing fixtures and water-using appliances sold in Texas. The labels must specify the rates of flow for plumbing fixtures and lawn sprinklers, and the amounts of water used per cycle for clothes washers and dishwashers.[3]

***Table 4.4-1.***
***Standards for Plumbing Fixtures***

| *Fixture* | *Standard* |
|---|---|
| Wall-mounted Flushometer Toilets | 2.00 gallons per flush |
| All Other Toilets | 1.60 gallons per flush |
| Shower Heads | 2.75 gallons per minute at 80 psi |
| Urinals | 1.00 gallons per flush |
| Faucet Aerators | 2.20 gallons per minute at 80 psi |
| Drinking Water Fountains | Shall be self-closing |

The TWDB has estimated that the effect of the new plumbing fixtures in dwellings, offices, and public places will be a reduction in per capita water use of 18 gpcd, in comparison to what would have occurred with previous generations of plumbing fixtures (Table 4.4-2).[4]

In 2001, amendments to the Texas Water Code by the Texas Legislature established the Water Conservation Implementation Task Force and included requirements that Regional Water Planning Groups consider water conservation and drought management measures for each water user group with a projected need (water shortage). The legislation directed that the Water Conservation Implementation Task Force identify and describe Water Conservation BMPs and provide a BMP Guide for use by Regional Water Planning Groups in the development of the

[2] Senate Bill 587, Texas Legislature, Regular Session, 1991, Austin, Texas.
[3] Chapter 290, 30 TAC Sections 290.251, 290.253 - 290.256, 290.260, 290.265, 290.266, Water Hygiene, Texas Register, Page 9935, December 24, 1993.
[4] "Water Conservation Impacts on Per Capita Water Use," Water Planning Information, TWDB, Austin, Texas, 1992.

***Table 4.4-2.***
***Water Conservation Potentials of Low-Flow Plumbing Fixtures***[1]

| ***Plumbing Fixture*** | ***Water Savings (gpcd)*** |
|---|---|
| Toilets – 1.6 gallons per flush | 11.5 |
| Shower Heads – 2.75 gallons per minute | 4.0 |
| Faucet Aerators – 2.2 gallons per minute | 2.0 |
| Urinals – 1.0 gallons per minute | 0.3 |
| Drinking Fountains (self-closing) | 0.1 |
| Total | 17.9 (18 gpcd) |

[1] Texas Water Development Board, 1992.

2006 Regional Water Plans.[5] The list of BMPs for municipal water users is as follows:

System Water Audit and Water Loss;
Water Conservation Pricing;
Prohibition on Wasting Water;
Showerhead, Aerator, and Toilet Flapper Retrofit;
Residential Ultra-Low-Flow Toilet Replacement Programs;
Residential Clothes Washer Incentive Program;
School Education;
Water Survey for Single-Family and Multi-Family Customers;
Landscape Irrigation Conservation and Incentives;
Water-Wise Landscape Design and Conversion Programs;
Athletic Field Conservation;
Golf Course Conservation;
Metering of all New Connections and Retrofitting of Existing Connections;
Wholesale Agency Assistance Programs;
Conservation Coordinator;
Reuse of Reclaimed Water;
Public Information;
Rainwater Harvesting and Condensate Reuse;
New Construction Graywater;
Park Conservation; and
Conservation Programs for Industrial, Commercial, and Institutional Accounts.

[5] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November, 2004.

In addition to the list of BMPs, the Water Conservation Implementation Task Force recommended that a standardized methodology be used for determining per capita per day (gpcd) municipal water use in order to allow consistent evaluations of effectiveness of water conservation measures among cities that are located in the different climates and parts of Texas. The Task Force further recommended gpcd targets and goals that should be considered by retail public water suppliers when developing water conservation plans required by the state, as follows:

- All public water suppliers that are required to prepare and submit water conservation plans should establish targets for water conservation, including specific goals for per capita water use and for water loss programs using appropriate water conservation BMPs; and
- Municipal Water Conservation Plans required by the state shall include per capita water use goals, with targets and goals established by an entity giving consideration to a minimum annual reduction of 1 percent in total per capita water, based upon a 5-year moving average, until such time as the entity achieves a total per capita water use of 140 gpcd or less.

For purposes of developing the 2006 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000. The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Llano Estacado Water Planning Region average municipal water use of 172 gpcd. (The Llano Estacado Region total municipal water use in 2000 was 87,322 acft; total population in 2000 was 453,997, giving a calculated regional average municipal water use in 2000 of 172 gpcd (87,322/453,997)).[6] For purposes of developing the 2011 Llano Estacado Regional Water Plan the municipal water conservation goal, as adopted for the 2006 Plan, has been continued, with revisions and updates of municipal water conservation costs.

The 72 municipal WUGs of Region O are listed in Table 4.4-3 in the order of low to high per capita water use in 2000, together with projected per capita water use with expected effects of low flow plumbing fixtures upon per capita water use in 2010, 2020, 2030, 2040, 2050, and 2060 (i.e., the projected water conservation effects of low flow plumbing fixtures). It is important to note that the per capita water use, as shown in Table 4.4-3, was used in making the

[6] Texas per capita water use in year 2000 was 173 gpcd.

municipal water demand projections, thereby including the potential water conservation or water demand reduction potentials of low flow plumbing fixtures in the projected water demands for the municipal WUGs of the Region. The projected municipal water needs (shortages) were calculated for each WUG by subtracting projected municipal water demands from existing municipal water supplies, with the low flow plumbing fixtures water conservation taken into account. For the Region, there are 26 municipal WUGs that are projected to have water needs (shortages) during the projection period. For WUGs with projected need (shortages) the projected date of need is shown in the right-hand column of the table (Table 4.4-3).

The projected per capita water use for municipal WUGS of Region O for the water conservation goal of reducing per capita water use by 1 percent per year from the year 2000 level until the year 2000 region average of 172 gpcd is reached is shown in Table 4.4-4 in comparison to the projected per capita water use with low flow plumbing fixtures (Table 4.4-4). This comparison shows that the low flow plumbing fixtures water conservation effects are greater than the effects of the goal to reduce per capita water use by 1 percent per year for municipal WUGs numbered 1 through 45 (Table 4.4-4). That is to say that for those WUGs having per capita water use in the year 2000 of 176 gpcd or less, low flow plumbing fixtures are capable of meeting or exceeding the goal of reducing per capita municipal water use by 1 percent per year until the year 2000 Region average of 172 gpcd is reached. Therefore, additional water conservation for the first 45 WUGs listed in Table 4.4-4 is not given further consideration. However, water conservation in addition to that expected from low flow plumbing fixtures must be considered for WUGs 46 through 72 of Table 4.4-5 that have projected needs. The quantity of additional water conservation needed to reach the Region O goal, in gallons per person per day ranges from 3 gpcd for Tulia in 2010 to 118 gpcd for Seminole in 2060 (Table 4.4-5). A part of the additional water needed to meet the goal can be reached through plumbing fixtures and clothes washers retrofit (Table 4.4-5). For example, all of the additional conservation needed for numbers 46 through 55 (Tulia through Sundown) can be met through plumbing fixtures and clothes washers retrofit, and a part of that needed for the remaining WUGs of the list can be met through plumbing fixtures retrofit (Table 4.4-5). However, the remaining conservation needed will have to be obtained in other ways. For purposes of the regional water plan, lawn and

**Table 4.4-3.**
**Municipal Water User Groups**
**Projected Per Capita Water Use with Low Flow Plumbing Fixtures**
**Llano Estacado Water Planning Region**

| | Water User Group* | County ** | Per Capita Water Use With Low Flow Plumbing Fixtures | | | | | | | Year of Projected Need |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2000 gpcd | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd | |
| 1 | MEADOW | TERRY | 95 | 92 | 88 | 86 | 83 | 82 | 82 | |
| 2 | COUNTY-OTHER | GAINES | 101 | 97 | 94 | 91 | 89 | 88 | 88 | |
| 3 | LOCKNEY | FLOYD | 103 | 100 | 96 | 93 | 90 | 89 | 89 | 2030 |
| 4 | WILSON | LYNN | 109 | 106 | 102 | 99 | 96 | 95 | 95 | 2010 |
| 5 | COUNTY-OTHER | LUBBOCK | 110 | 106 | 104 | 101 | 99 | 98 | 98 | |
| 6 | KRESS | SWISHER | 110 | 107 | 104 | 102 | 99 | 98 | 98 | |
| 7 | COUNTY-OTHER | DAWSON | 113 | 110 | 107 | 105 | 102 | 101 | 101 | |
| 8 | COUNTY-OTHER | CROSBY | 115 | 110 | 107 | 104 | 101 | 100 | 100 | |
| 9 | COUNTY-OTHER | HALE | 115 | 110 | 107 | 104 | 101 | 100 | 100 | |
| 10 | RALLS | CROSBY | 115 | 111 | 108 | 106 | 103 | 102 | 102 | 2030 |
| 11 | COUNTY-OTHER | GARZA | 118 | 115 | 111 | 109 | 106 | 104 | 104 | |
| 12 | IDALOU | LUBBOCK | 119 | 116 | 113 | 109 | 106 | 105 | 105 | 2040 |
| 13 | COUNTY-OTHER | LYNN | 120 | 116 | 112 | 109 | 106 | 105 | 105 | |
| 14 | COUNTY-OTHER | PARMER | 120 | 117 | 113 | 110 | 107 | 106 | 106 | |
| 15 | COUNTY-OTHER | SWISHER | 121 | 118 | 114 | 111 | 108 | 107 | 107 | |
| 16 | COUNTY-OTHER | FLOYD | 123 | 120 | 116 | 113 | 110 | 109 | 109 | |
| 17 | COUNTY-OTHER | HOCKLEY | 124 | 119 | 116 | 113 | 110 | 109 | 109 | |
| 18 | COUNTY-OTHER | YOAKUM | 125 | 121 | 118 | 115 | 112 | 111 | 111 | |
| 19 | SMYER | HOCKLEY | 125 | 119 | 116 | 113 | 110 | 109 | 109 | 2050 |
| 20 | COUNTY-OTHER | TERRY | 128 | 123 | 120 | 117 | 114 | 113 | 113 | |
| 21 | COUNTY-OTHER | DEAFSMITH | 129 | 122 | 118 | 116 | 115 | 114 | 114 | |
| 22 | SHALLOWATER | LUBBOCK | 133 | 128 | 125 | 123 | 120 | 119 | 119 | 2010 |
| 23 | SLATON | LUBBOCK | 136 | 132 | 129 | 126 | 123 | 121 | 121 | |
| 24 | O'DONNELL | DAWSON | 138 | 134 | 130 | 127 | 124 | 123 | 123 | |
| 25 | COUNTY-OTHER | BAILEY | 143 | 138 | 135 | 132 | 129 | 128 | 128 | |
| 26 | WOLFFORTH | LUBBOCK | 144 | 140 | 137 | 135 | 133 | 132 | 132 | 2050 |
| 27 | TAHOKA | LYNN | 145 | 142 | 139 | 136 | 133 | 132 | 132 | |
| 28 | SILVERTON | BRISCOE | 146 | 143 | 140 | 137 | 134 | 132 | 132 | 2010 |
| 29 | ROPESVILLE | HOCKLEY | 147 | 143 | 140 | 137 | 134 | 133 | 133 | 2020 |
| 30 | BOVINA | PARMER | 147 | 144 | 141 | 138 | 135 | 134 | 134 | |
| 31 | COUNTY-OTHER | DICKENS | 149 | 147 | 144 | 142 | 140 | 138 | 138 | |
| 32 | COUNTY-OTHER | CASTRO | 150 | 146 | 143 | 140 | 137 | 136 | 136 | |
| 33 | POST | GARZA | 150 | 146 | 143 | 140 | 137 | 136 | 136 | 2030 |
| 34 | LEVELLAND | HOCKLEY | 154 | 149 | 146 | 143 | 140 | 139 | 139 | |
| 35 | HAPPY | SWISHER | 156 | 152 | 148 | 146 | 143 | 142 | 142 | |
| 36 | COUNTY-OTHER | BRISCOE | 158 | 154 | 151 | 148 | 145 | 143 | 143 | |
| 37 | COUNTY-OTHER | COCHRAN | 159 | 155 | 152 | 149 | 146 | 145 | 145 | |

Continued on next page

***Table 4.4-3 Concluded***

| | Water User Group* | County ** | Per Capita Water Use With Low Flow Plumbing Fixtures | | | | | | | Year of Projected Need |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2000 gpcd | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd | |
| 38 | SEAGRAVES | GAINES | 159 | 154 | 151 | 148 | 145 | 144 | 144 | |
| 39 | NEW DEAL | LUBBOCK | 159 | 154 | 152 | 150 | 148 | 147 | 147 | 2020 |
| 40 | FLOYDADA | FLOYD | 161 | 157 | 153 | 150 | 147 | 146 | 146 | |
| 41 | PLAINVIEW | HALE | 163 | 159 | 156 | 153 | 150 | 149 | 149 | |
| 42 | HART | CASTRO | 166 | 162 | 159 | 156 | 153 | 152 | 152 | 2040 |
| 43 | CROSBYTON | CROSBY | 167 | 162 | 159 | 156 | 153 | 152 | 152 | 2040 |
| 44 | LORENZO | CROSBY | 169 | 165 | 162 | 160 | 157 | 156 | 156 | 2030 |
| 45 | HALE CENTER | HALE | 176 | 172 | 169 | 167 | 164 | 163 | 163 | |
| 46 | TULIA | SWISHER | 178 | 175 | 171 | 168 | 165 | 164 | 164 | 2010 |
| 47 | AMHERST | LAMB | 184 | 180 | 177 | 174 | 171 | 170 | 170 | 2020 |
| 48 | OLTON | LAMB | 185 | 182 | 178 | 176 | 173 | 172 | 172 | |
| 49 | ANTON | HOCKLEY | 186 | 182 | 179 | 176 | 173 | 172 | 172 | 2010 |
| 50 | FRIONA | PARMER | 186 | 182 | 179 | 176 | 173 | 172 | 172 | 2030 |
| 51 | SUDAN | LAMB | 187 | 184 | 181 | 178 | 175 | 174 | 174 | |
| 52 | COUNTY-OTHER | MOTLEY | 193 | 189 | 186 | 183 | 180 | 178 | 178 | |
| 53 | MULESHOE | BAILEY | 193 | 189 | 186 | 183 | 180 | 179 | 179 | |
| 54 | ABERNATHY | HALE | 193 | 189 | 185 | 183 | 180 | 179 | 179 | 2010 |
| 55 | SUNDOWN | HOCKLEY | 193 | 188 | 185 | 182 | 179 | 178 | 178 | 2010 |
| 56 | PETERSBURG | HALE | 195 | 190 | 187 | 184 | 181 | 180 | 180 | 2050 |
| 57 | MORTON | COCHRAN | 198 | 194 | 191 | 188 | 185 | 184 | 184 | 2010 |
| 58 | DIMMITT | CASTRO | 199 | 194 | 191 | 188 | 185 | 184 | 184 | 2020 |
| 59 | EARTH | LAMB | 200 | 196 | 192 | 189 | 186 | 185 | 185 | 2030 |
| 60 | LITTLEFIELD | LAMB | 203 | 199 | 196 | 193 | 190 | 189 | 189 | |
| 61 | LUBBOCK | LUBBOCK | 209 | 205 | 202 | 199 | 196 | 195 | 195 | 2010 |
| 62 | DENVER CITY | YOAKUM | 214 | 209 | 206 | 203 | 200 | 199 | 199 | 2020 |
| 63 | HEREFORD | DEAFSMITH | 218 | 215 | 211 | 208 | 205 | 204 | 204 | |
| 64 | LAMESA | DAWSON | 223 | 220 | 216 | 213 | 210 | 209 | 209 | |
| 65 | SPUR | DICKENS | 226 | 222 | 219 | 216 | 213 | 211 | 211 | 2040 |
| 66 | COUNTY-OTHER | LAMB | 230 | 226 | 222 | 219 | 216 | 215 | 215 | |
| 67 | PLAINS | YOAKUM | 233 | 229 | 225 | 223 | 220 | 219 | 219 | 2010 |
| 68 | FARWELL | PARMER | 242 | 239 | 235 | 232 | 229 | 228 | 228 | 2050 |
| 69 | BROWNFIELD | TERRY | 244 | 239 | 236 | 233 | 230 | 229 | 229 | 2010 |
| 70 | RANSOM CANYON | LUBBOCK | 274 | 269 | 266 | 264 | 262 | 261 | 261 | |
| 71 | MATADOR | MOTLEY | 288 | 285 | 282 | 279 | 276 | 274 | 274 | |
| 72 | SEMINOLE | GAINES | 305 | 300 | 297 | 294 | 291 | 290 | 290 | |
| | LAH WSD | Garza | New entity to provide water to Lake Alan Henry area. | | | | | | | 2010 |

* Listed in order of low to high per capita water use. If no date shown in right column, WUG has no projected need.

** Some water user groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is listed in the table.

**Table 4.4-4.**
**Municipal Water User Groups -- Llano Estacado Water Planning Region**
**Projected Per Capita Water Use with Goal to Reduce Per Capita Water Use by One Percent Per Year ***

| | Water User Group** | County ** | Water Use With Goal to Reduce by 1% Per Year* | | | | | | | Year of Projected Need |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2000 gpcd | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd | |
| 1 | MEADOW | TERRY | 95 | 95 | 95 | 95 | 95 | 95 | 95 | |
| 2 | COUNTY-OTHER | GAINES | 101 | 101 | 101 | 101 | 101 | 101 | 101 | |
| 3 | LOCKNEY | FLOYD | 103 | 103 | 103 | 103 | 103 | 103 | 103 | 2030 |
| 4 | WILSON | LYNN | 109 | 109 | 109 | 109 | 109 | 109 | 109 | 2010 |
| 5 | COUNTY-OTHER | LUBBOCK | 110 | 110 | 110 | 110 | 110 | 110 | 110 | |
| 6 | KRESS | SWISHER | 110 | 110 | 110 | 110 | 110 | 110 | 110 | |
| 7 | COUNTY-OTHER | DAWSON | 113 | 113 | 113 | 113 | 113 | 110 | 110 | |
| 8 | COUNTY-OTHER | CROSBY | 115 | 115 | 115 | 115 | 115 | 113 | 113 | |
| 9 | COUNTY-OTHER | HALE | 115 | 115 | 115 | 115 | 115 | 115 | 115 | |
| 10 | RALLS | CROSBY | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 2030 |
| 11 | COUNTY-OTHER | GARZA | 118 | 118 | 118 | 118 | 118 | 115 | 115 | |
| 12 | IDALOU | LUBBOCK | 119 | 119 | 119 | 119 | 119 | 118 | 118 | 2040 |
| 13 | COUNTY-OTHER | LYNN | 120 | 120 | 120 | 120 | 120 | 119 | 119 | |
| 14 | COUNTY-OTHER | PARMER | 120 | 120 | 120 | 120 | 120 | 120 | 120 | |
| 15 | COUNTY-OTHER | SWISHER | 121 | 121 | 121 | 121 | 121 | 120 | 120 | |
| 16 | COUNTY-OTHER | FLOYD | 123 | 123 | 123 | 123 | 123 | 121 | 121 | |
| 17 | COUNTY-OTHER | HOCKLEY | 124 | 124 | 124 | 124 | 124 | 123 | 123 | |
| 18 | COUNTY-OTHER | YOAKUM | 125 | 125 | 125 | 125 | 125 | 124 | 124 | |
| 19 | SMYER | HOCKLEY | 125 | 125 | 125 | 125 | 125 | 125 | 125 | 2050 |
| 20 | COUNTY-OTHER | TERRY | 128 | 128 | 128 | 128 | 128 | 125 | 125 | |
| 21 | COUNTY-OTHER | DEAFSMITH | 129 | 129 | 129 | 129 | 129 | 128 | 128 | |
| 22 | SHALLOWATER | LUBBOCK | 133 | 133 | 133 | 133 | 133 | 129 | 129 | 2010 |
| 23 | SLATON | LUBBOCK | 136 | 136 | 136 | 136 | 136 | 136 | 136 | |
| 24 | O'DONNELL | DAWSON | 138 | 138 | 138 | 138 | 138 | 138 | 138 | |
| 25 | COUNTY-OTHER | BAILEY | 143 | 143 | 143 | 143 | 143 | 143 | 143 | |
| 26 | WOLFFORTH | LUBBOCK | 144 | 144 | 144 | 144 | 144 | 144 | 144 | 2050 |
| 27 | TAHOKA | LYNN | 145 | 145 | 145 | 145 | 145 | 145 | 145 | |
| 28 | SILVERTON | BRISCOE | 146 | 146 | 146 | 146 | 146 | 146 | 146 | 2010 |
| 29 | ROPESVILLE | HOCKLEY | 147 | 147 | 147 | 147 | 147 | 147 | 147 | 2020 |
| 30 | BOVINA | PARMER | 147 | 147 | 147 | 147 | 147 | 147 | 147 | |
| 31 | COUNTY-OTHER | DICKENS | 149 | 149 | 149 | 149 | 149 | 149 | 149 | |
| 32 | COUNTY-OTHER | CASTRO | 150 | 150 | 150 | 150 | 150 | 150 | 150 | |
| 33 | POST | GARZA | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 2030 |
| 34 | LEVELLAND | HOCKLEY | 154 | 154 | 154 | 154 | 154 | 154 | 154 | |
| 35 | HAPPY | SWISHER | 156 | 156 | 156 | 156 | 156 | 156 | 156 | |
| 36 | COUNTY-OTHER | BRISCOE | 158 | 158 | 158 | 158 | 158 | 158 | 158 | 2010 |
| 37 | COUNTY-OTHER | COCHRAN | 159 | 159 | 159 | 159 | 159 | 159 | 159 | |

Continued on next page

*Table 4.4-4 Concluded*

| | Water User Group** | County ** | Water Use With Goal to Reduce by 1% Per Year* | | | | | | | Year of Projected Need |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2000 gpcd | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd | |
| 38 | SEAGRAVES | GAINES | 159 | 159 | 159 | 159 | 159 | 159 | 159 | |
| 39 | NEW DEAL | LUBBOCK | 159 | 159 | 159 | 159 | 159 | 159 | 159 | 2020 |
| 40 | FLOYDADA | FLOYD | 161 | 161 | 161 | 161 | 161 | 161 | 161 | |
| 41 | PLAINVIEW | HALE | 163 | 163 | 163 | 163 | 163 | 163 | 163 | |
| 42 | HART | CASTRO | 166 | 166 | 166 | 166 | 166 | 166 | 166 | 2040 |
| 43 | CROSBYTON | CROSBY | 167 | 167 | 167 | 167 | 167 | 167 | 167 | 2040 |
| 44 | LORENZO | CROSBY | 169 | 169 | 169 | 169 | 169 | 169 | 169 | 2030 |
| 45 | HALE CENTER | HALE | 176 | 172 | 172 | 172 | 172 | 172 | 172 | |
| 46 | TULIA | SWISHER | 178 | 172 | 172 | 172 | 172 | 172 | 172 | |
| 47 | AMHERST | LAMB | 184 | 172 | 172 | 172 | 172 | 172 | 172 | 2020 |
| 48 | OLTON | LAMB | 185 | 172 | 172 | 172 | 172 | 172 | 172 | |
| 49 | ANTON | HOCKLEY | 186 | 172 | 172 | 172 | 172 | 172 | 172 | 2010 |
| 50 | FRIONA | PARMER | 186 | 172 | 172 | 172 | 172 | 172 | 172 | 2030 |
| 51 | SUDAN | LAMB | 187 | 172 | 172 | 172 | 172 | 172 | 172 | |
| 52 | COUNTY-OTHER | MOTLEY | 193 | 172 | 172 | 172 | 172 | 172 | 172 | |
| 53 | MULESHOE | BAILEY | 193 | 175 | 172 | 172 | 172 | 172 | 172 | |
| 54 | ABERNATHY | HALE | 193 | 175 | 172 | 172 | 172 | 172 | 172 | 2010 |
| 55 | SUNDOWN | HOCKLEY | 193 | 175 | 172 | 172 | 172 | 172 | 172 | 2010 |
| 56 | PETERSBURG | HALE | 195 | 176 | 172 | 172 | 172 | 172 | 172 | 2050 |
| 57 | MORTON | COCHRAN | 198 | 179 | 172 | 172 | 172 | 172 | 172 | 2010 |
| 58 | DIMMITT | CASTRO | 199 | 180 | 172 | 172 | 172 | 172 | 172 | |
| 59 | EARTH | LAMB | 200 | 181 | 172 | 172 | 172 | 172 | 172 | 2030 |
| 60 | LITTLEFIELD | LAMB | 203 | 184 | 172 | 172 | 172 | 172 | 172 | |
| 61 | LUBBOCK | LUBBOCK | 209 | 188 | 172 | 172 | 172 | 172 | 172 | 2010 |
| 62 | DENVER CITY | YOAKUM | 214 | 194 | 175 | 172 | 172 | 172 | 172 | 2020 |
| 63 | HEREFORD | DEAFSMITH | 218 | 197 | 178 | 172 | 172 | 172 | 172 | |
| 64 | LAMESA | DAWSON | 223 | 202 | 182 | 172 | 172 | 172 | 172 | |
| 65 | SPUR | DICKENS | 226 | 204 | 185 | 172 | 172 | 172 | 172 | 2040 |
| 66 | COUNTY-OTHER | LAMB | 230 | 208 | 188 | 172 | 172 | 172 | 172 | |
| 67 | PLAINS | YOAKUM | 233 | 211 | 191 | 172 | 172 | 172 | 172 | 2010 |
| 68 | FARWELL | PARMER | 242 | 219 | 196 | 179 | 172 | 172 | 172 | 2050 |
| 69 | BROWNFIELD | TERRY | 244 | 221 | 200 | 180 | 172 | 172 | 172 | 2010 |
| 70 | RANSOM CANYON | LUBBOCK | 274 | 248 | 224 | 200 | 183 | 172 | 172 | |
| 71 | MATADOR | MOTLEY | 288 | 260 | 236 | 213 | 193 | 174 | 172 | |
| 72 | SEMINOLE | GAINES | 305 | 278 | 249 | 226 | 204 | 185 | 172 | |
| | LAH WSD | Garza | New entity to provide water to Lake Alan Henry area. | | | | | | | 2010 |

* Goal is to reduce per capita water use for WUGs with gpcd greater than regional average of 172 gpcd to year 2000 regional average of 172 gpcd. For WUGs with per capita water use less than 172 gpcd, no reduction is projected.

* Listed in order of low to high per capita water use. If no date shown in right column, WUG has no projected need.

** Some water user groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is listed in the table.

***Table 4.4-5.***
***Additional Municipal Water Conservation Needed to Meet Goals of Reducing Per Capita Water Use to Year 2000 Regional Average of 172 gpcd***
***Llano Estacado Water Planning Region***

| | Water User Group | County | Year 2000 gpcd | Plumbing Fixtures Potential (gpcd) | Additional Conservation Needed to Meet Region O Goals | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd |
| 1 | MEADOW | TERRY | 95 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | COUNTY-OTHER | GAINES | 101 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | LOCKNEY | FLOYD | 103 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | WILSON | LYNN | 109 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | COUNTY-OTHER | LUBBOCK | 110 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | KRESS | SWISHER | 110 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | COUNTY-OTHER | DAWSON | 113 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | COUNTY-OTHER | CROSBY | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | COUNTY-OTHER | HALE | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | RALLS | CROSBY | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | COUNTY-OTHER | GARZA | 118 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | IDALOU | LUBBOCK | 119 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | COUNTY-OTHER | LYNN | 120 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | COUNTY-OTHER | PARMER | 120 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | COUNTY-OTHER | SWISHER | 121 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | COUNTY-OTHER | FLOYD | 123 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | COUNTY-OTHER | HOCKLEY | 124 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | COUNTY-OTHER | YOAKUM | 125 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | SMYER | HOCKLEY | 125 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | COUNTY-OTHER | TERRY | 128 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | COUNTY-OTHER | DEAFSMITH | 129 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | SHALLOWATER | LUBBOCK | 133 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | SLATON | LUBBOCK | 136 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | O'DONNELL | DAWSON | 138 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | COUNTY-OTHER | BAILEY | 143 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | WOLFFORTH | LUBBOCK | 144 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | TAHOKA | LYNN | 145 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | SILVERTON | BRISCOE | 146 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | ROPESVILLE | HOCKLEY | 147 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | BOVINA | PARMER | 147 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | COUNTY-OTHER | DICKENS | 149 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | COUNTY-OTHER | CASTRO | 150 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | POST | GARZA | 150 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | LEVELLAND | HOCKLEY | 154 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | HAPPY | SWISHER | 156 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | COUNTY-OTHER | BRISCOE | 158 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | COUNTY-OTHER | COCHRAN | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4.4-5 Concluded***

| | Water User Group | County | Year 2000 gpcd | Plumbing Fixtures Potential (gpcd) | Additional Conservation Needed to Meet Region O Goals | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd |
| 38 | SEAGRAVES | GAINES | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | NEW DEAL | LUBBOCK | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | FLOYDADA | FLOYD | 161 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | PLAINVIEW | HALE | 163 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | HART | CASTRO | 166 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | CROSBYTON | CROSBY | 167 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | LORENZO | CROSBY | 169 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | HALE CENTER | HALE | 176 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | TULIA | SWISHER | 178 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 47 | AMHERST | LAMB | 184 | 18 | 8 | 5 | 2 | 0 | 0 | 0 |
| 48 | OLTON | LAMB | 185 | 18 | 10 | 6 | 4 | 1 | 0 | 0 |
| 49 | ANTON | HOCKLEY | 186 | 18 | 10 | 7 | 4 | 1 | 0 | 0 |
| 50 | FRIONA | PARMER | 186 | 18 | 10 | 7 | 4 | 1 | 0 | 0 |
| 51 | SUDAN | LAMB | 187 | 18 | 12 | 9 | 6 | 3 | 2 | 2 |
| 52 | COUNTY-OTHER | MOTLEY | 193 | 18 | 14 | 14 | 11 | 8 | 6 | 6 |
| 53 | MULESHOE | BAILEY | 193 | 18 | 14 | 14 | 11 | 8 | 7 | 7 |
| 54 | ABERNATHY | HALE | 193 | 18 | 14 | 13 | 11 | 8 | 7 | 7 |
| 55 | SUNDOWN | HOCKLEY | 193 | 18 | 13 | 13 | 10 | 7 | 6 | 6 |
| 56 | PETERSBURG | HALE | 195 | 18 | 14 | 15 | 12 | 9 | 8 | 8 |
| 57 | MORTON | COCHRAN | 198 | 18 | 15 | 19 | 16 | 13 | 12 | 12 |
| 58 | DIMMITT | CASTRO | 199 | 18 | 14 | 19 | 16 | 13 | 12 | 12 |
| 59 | EARTH | LAMB | 200 | 18 | 15 | 20 | 17 | 14 | 13 | 13 |
| 60 | LITTLEFIELD | LAMB | 203 | 18 | 15 | 24 | 21 | 18 | 17 | 17 |
| 61 | LUBBOCK | LUBBOCK | 209 | 18 | 15 | 30 | 27 | 24 | 23 | 23 |
| 62 | DENVER CITY | YOAKUM | 214 | 18 | 15 | 31 | 21 | 28 | 27 | 27 |
| 63 | HEREFORD | DEAFSMITH | 218 | 18 | 18 | 33 | 36 | 33 | 32 | 32 |
| 64 | LAMESA | DAWSON | 223 | 18 | 18 | 34 | 41 | 38 | 37 | 37 |
| 65 | SPUR | DICKENS | 226 | 18 | 18 | 34 | 44 | 41 | 39 | 39 |
| 66 | COUNTY-OTHER | LAMB | 230 | 18 | 18 | 34 | 47 | 44 | 43 | 43 |
| 67 | PLAINS | YOAKUM | 233 | 18 | 18 | 34 | 51 | 48 | 47 | 47 |
| 68 | FARWELL | PARMER | 242 | 18 | 20 | 37 | 53 | 57 | 56 | 56 |
| 69 | BROWNFIELD | TERRY | 244 | 18 | 18 | 36 | 53 | 58 | 57 | 57 |
| 70 | RANSOM CANYON | LUBBOCK | 274 | 18 | 21 | 42 | 61 | 79 | 89 | 89 |
| 71 | MATADOR | MOTLEY | 288 | 18 | 25 | 48 | 66 | 83 | 100 | 102 |
| 72 | SEMINOLE | GAINES | 305 | 18 | 24 | 48 | 68 | 87 | 105 | 118 |

**Table 4.4-6.**
**Additional Municipal Water Conservation Potentials of Plumbing Fixture Retrofit**
**Llano Estacado Water Planning Region**

| | Water User Group | County | Year 2000 gpcd | Plumbing Fixtures Potential (gpcd) | Additional Conservation Potentials of Plumbing Fixture Retrofit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd |
| 1 | MEADOW | TERRY | 95 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | COUNTY-OTHER | GAINES | 101 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | LOCKNEY | FLOYD | 103 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | WILSON | LYNN | 109 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | COUNTY-OTHER | LUBBOCK | 110 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | KRESS | SWISHER | 110 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | COUNTY-OTHER | DAWSON | 113 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | COUNTY-OTHER | CROSBY | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | COUNTY-OTHER | HALE | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | RALLS | CROSBY | 115 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | COUNTY-OTHER | GARZA | 118 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | IDALOU | LUBBOCK | 119 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | COUNTY-OTHER | LYNN | 120 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | COUNTY-OTHER | PARMER | 120 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | COUNTY-OTHER | SWISHER | 121 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | COUNTY-OTHER | FLOYD | 123 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | COUNTY-OTHER | HOCKLEY | 124 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | COUNTY-OTHER | YOAKUM | 125 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | SMYER | HOCKLEY | 125 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | COUNTY-OTHER | TERRY | 128 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | COUNTY-OTHER | DEAFSMITH | 129 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | SHALLOWATER | LUBBOCK | 133 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | SLATON | LUBBOCK | 136 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | O'DONNELL | DAWSON | 138 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | COUNTY-OTHER | BAILEY | 143 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | WOLFFORTH | LUBBOCK | 144 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | TAHOKA | LYNN | 145 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | SILVERTON | BRISCOE | 146 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | ROPESVILLE | HOCKLEY | 147 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | BOVINA | PARMER | 147 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | COUNTY-OTHER | DICKENS | 149 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | COUNTY-OTHER | CASTRO | 150 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | POST | GARZA | 150 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | LEVELLAND | HOCKLEY | 154 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | HAPPY | SWISHER | 156 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | COUNTY-OTHER | BRISCOE | 158 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | COUNTY-OTHER | COCHRAN | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4.4-6 Concluded***

| | Water User Group | County | Year 2000 gpcd | Plumbing Fixtures Potential (gpcd) | Additional Conservation Potentials of Plumbing Fixture Retrofit | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2010 gpcd | 2020 gpcd | 2030 gpcd | 2040 gpcd | 2050 gpcd | 2060 gpcd |
| 38 | SEAGRAVES | GAINES | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | NEW DEAL | LUBBOCK | 159 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | FLOYDADA | FLOYD | 161 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | PLAINVIEW | HALE | 163 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | HART | CASTRO | 166 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | CROSBYTON | CROSBY | 167 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | LORENZO | CROSBY | 169 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | HALE CENTER | HALE | 176 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | TULIA | SWISHER | 178 | 18 | 3 | 0 | 0 | 0 | 0 | 0 |
| 47 | AMHERST | LAMB | 184 | 18 | 8 | 5 | 2 | 0 | 0 | 0 |
| 48 | OLTON | LAMB | 185 | 18 | 10 | 6 | 4 | 1 | 0 | 0 |
| 49 | ANTON | HOCKLEY | 186 | 18 | 10 | 7 | 4 | 1 | 0 | 0 |
| 50 | FRIONA | PARMER | 186 | 18 | 10 | 7 | 4 | 1 | 0 | 0 |
| 51 | SUDAN | LAMB | 187 | 18 | 12 | 9 | 3 | 3 | 3 | 2 |
| 52 | COUNTY-OTHER | MOTLEY | 193 | 18 | 14 | 11 | 8 | 5 | 3 | 3 |
| 53 | MULESHOE | BAILEY | 193 | 18 | 14 | 11 | 8 | 5 | 4 | 4 |
| 54 | ABERNATHY | HALE | 193 | 18 | 14 | 10 | 8 | 5 | 4 | 4 |
| 55 | SUNDOWN | HOCKLEY | 193 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |
| 56 | PETERSBURG | HALE | 195 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |
| 57 | MORTON | COCHRAN | 198 | 18 | 14 | 11 | 8 | 5 | 4 | 4 |
| 58 | DIMMITT | CASTRO | 199 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |
| 59 | EARTH | LAMB | 200 | 18 | 14 | 10 | 7 | 4 | 3 | 3 |
| 60 | LITTLEFIELD | LAMB | 203 | 18 | 14 | 11 | 8 | 5 | 4 | 4 |
| 61 | LUBBOCK | LUBBOCK | 209 | 18 | 14 | 11 | 8 | 5 | 4 | 4 |
| 62 | DENVER CITY | YOAKUM | 214 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |
| 63 | HEREFORD | DEAFSMITH | 218 | 18 | 15 | 11 | 8 | 5 | 4 | 4 |
| 64 | LAMESA | DAWSON | 223 | 18 | 15 | 11 | 8 | 4 | 4 | 4 |
| 65 | SPUR | DICKENS | 226 | 18 | 14 | 11 | 8 | 5 | 3 | 3 |
| 66 | COUNTY-OTHER | LAMB | 230 | 18 | 14 | 10 | 7 | 4 | 3 | 3 |
| 67 | PLAINS | YOAKUM | 233 | 18 | 14 | 10 | 8 | 5 | 4 | 4 |
| 68 | FARWELL | PARMER | 242 | 18 | 15 | 11 | 8 | 5 | 4 | 4 |
| 69 | BROWNFIELD | TERRY | 244 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |
| 70 | RANSOM CANYON | LUBBOCK | 274 | 18 | 13 | 10 | 8 | 6 | 5 | 5 |
| 71 | MATADOR | MOTLEY | 288 | 18 | 15 | 12 | 9 | 6 | 4 | 4 |
| 72 | SEMINOLE | GAINES | 305 | 18 | 13 | 10 | 7 | 4 | 3 | 3 |

landscape irrigation conservation is included to accomplish the remainder of the conservation needed to meet the goals.

The water conservation water management strategy for municipal WUGs numbered 46 through 72 of Table 4.4-5 is based upon plumbing fixtures and clothes washers retrofit, and lawn and landscape irrigation water conservation (BMPs numbered 5, 6, and 9 listed above), and costs of water conservation measures, as reported in, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas," TWDB, GDS Associates, Austin, Texas, July 2003. The underlying methods and assumptions are as follows:

Indoor plumbing fixtures and clothes washer water conservation potentials are 18 gpcd. (Note: a part of the plumbing fixtures potential was included in the per capita water use projections (municipal water demand projections) shown in Table 4.4-3; the computations presented below apply only to the additional potential not included in the water demand projections.);

Outdoor (lawn and landscape) water conservation potentials are used to accomplish additional conservation needed to meet the regional goals; and

Cost of municipal water conservation is as follows:

Plumbing fixture and clothes washer retrofit[7]

Rural areas ..................................................................... $737.72 per acft

Suburban areas .............................................................. $712.73 per acft

Urban areas .................................................................... $683.80 per acft

Lawn watering and landscape water conservation.............. $526.00 per acft

The calculated water demand reduction (municipal water conservation) from plumbing and clothes washer retrofit and lawn and landscape irrigation for Tulia is 18 acft/yr in 2010, and zero thereafter, since by 2010 the goal of reducing per capita water use to the region average of 172 gpcd is projected to have been reached (Table 4.4-7). For Seminole, the projected reduction in demand through the water conservation water management strategy is 178 acft/yr in 2010, 384 acft/yr in 2020, 588 acft/yr in 2030, and 1,035 acft/yr in 2060 (Table 4.4-7). Values for each of the WUGs can be viewed in Table 4.4-6, and will not be repeated here.

The municipal water conservation water management strategy is estimated to meet 5,809 acft/yr of municipal water needs in Region O in 2010, 10,583 acft/yr in 2020, 10,729 acft/yr in 2030, and 10,424 acft/yr in 2060 (Table 4.4-7). The values for each WUG having a projected need will be used as a water management strategy to meet a part of the

[7] GDS Associates, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas; Appendix VI, Region L," TWDB, Austin, Texas, July 2003. Costs were adjusted from September 2008 to September 2008. The cost index for this adjustment is 8557/6508, or 1.315.

**Table 4.4-7.**
**Water Conservation Potentials of**
**Plumbing Retrofit, Clothes Washer Retrofit, and Lawn Watering**
**Llano Estacado Water Planning Region**

| | | | Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Water User Group | County | 2010 (acft/yr) | 2020 (acft/yr) | 2030 (acft/yr) | 2040 (acft/yr) | 2050 (acft/yr) | 2060 (acft/yr) |
| 1 | Meadow | Terry | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | County-Other | Gaines | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Lockney | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Wilson | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | County-Other | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Kress | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | County-Other | Dawson | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | County-Other | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | County-Other | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Ralls | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | County-Other | Garza | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Idalou | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | County-Other | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | County-Other | Parmer | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | County-Other | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | County-Other | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | County-Other | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | County-Other | Yoakum | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Smyer | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | County-Other | Terry | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | County-Other | Deaf Smith | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Shallowater | Libbpck | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | Slaton | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | O'Donnell | Dawson | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | County-Other | Bailey | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Wolfforth | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | Tahoka | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | Silverton | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | Ropesvile | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Bovina | Parmer | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | County-Other | Dickens | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | County-Other | Castro | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4.4-7 Concluded***

| Water User Group | | County | Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 (acft/yr) | 2020 (acft/yr) | 2030 (acft/yr) | 2040 (acft/yr) | 2050 (acft/yr) | 2060 (acft/yr) |
| 33 | Post | Garza | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | Levelland | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | Happy | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | County-Other | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | County-Other | Cochran | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | Seagraves | Gaines | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | New Deal | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | Floydada | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | Plainview | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | Hart | Castro | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | Crosbyton | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | Lorenzo | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | Hale Center | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | Tulia | Swisher | 18 | 0 | 0 | 0 | 0 | 0 |
| 47 | Amherst | Lamb | 7 | 5 | 2 | 0 | 0 | 0 |
| 48 | Olton | Lamb | 27 | 17 | 12 | 3 | 0 | 0 |
| 49 | Anton | Hockley | 14 | 11 | 6 | 2 | 0 | 0 |
| 50 | Friona | Parmer | 46 | 34 | 20 | 5 | 0 | 0 |
| 51 | Sudan | Lamb | 15 | 12 | 8 | 4 | 3 | 3 |
| 52 | County-Other | Motley | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | Muleshoe | Bailey | 79 | 81 | 67 | 51 | 44 | 44 |
| 54 | Abernathy | Hale | 50 | 48 | 43 | 32 | 28 | 27 |
| 55 | Sundown | Hockley | 24 | 25 | 19 | 14 | 11 | 11 |
| 56 | Petersburg | Hale | 21 | 24 | 20 | 16 | 14 | 14 |
| 57 | Morton | Cochran | 41 | 56 | 48 | 38 | 34 | 32 |
| 58 | Dimmitt | Castro | 75 | 110 | 97 | 81 | 75 | 74 |
| 59 | Earth | Lamb | 20 | 28 | 25 | 21 | 20 | 17 |
| 60 | Littlefield | Lamb | 118 | 196 | 181 | 161 | 151 | 149 |
| 61 | Lubbock | Lubbock | 4,132 | 7,662 | 7,112 | 6,441 | 6,256 | 6,405 |
| 62 | Denver City | Yoakum | 77 | 169 | 179 | 171 | 160 | 155 |
| 63 | Hereford | Deaf Smith | 302 | 572 | 649 | 610 | 596 | 598 |
| 64 | Lamesa | Dawson | 212 | 400 | 501 | 471 | 448 | 431 |
| 65 | Spur | Dickens | 21 | 42 | 54 | 50 | 48 | 48 |
| 66 | County-Other | Lamb | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | Plains | Yoakum | 33 | 68 | 106 | 107 | 102 | 98 |
| 68 | Farwell | Parmer | 33 | 64 | 94 | 101 | 97 | 91 |
| 69 | Brownfield | Terry | 211 | 448 | 687 | 802 | 793 | 788 |
| 70 | Ransom Canyon | Lubbock | 35 | 90 | 162 | 248 | 325 | 342 |
| 71 | Matador | Motley | 20 | 37 | 49 | 57 | 63 | 62 |
| 72 | Seminole | Gaines | 178 | 384 | 588 | 778 | 938 | 1,035 |
| **Total** | | | **5,809** | **10,583** | **10,729** | **10,264** | **10,206** | **10,424** |

**Table 4.4-8.**
**Costs of Plumbing Fixture and Clothes Washer Retrofit and Lawn Watering Water Conservation**
**Llano Estacado Water Planning Region**

| Water User Group | | County | Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 (dollars) | 2020 (dollars) | 2030 (dollars) | 2040 (dollars) | 2050 (dollars) | 2060 (dollars) |
| 1 | Meadow | Terry | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | County-Other | Gaines | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | Lockney | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | Wilson | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | County-Other | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | Kress | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | County-Other | Dawson | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | County-Other | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | County-Other | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Ralls | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | County-Other | Garza | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Idalou | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | County-Other | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | County-Other | Parmer | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | County-Other | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | County-Other | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | County-Other | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | County-Other | Yoakum | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Smyer | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | County-Other | Terry | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | County-Other | Deaf Smith | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | Shallowater | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | Slaton | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | O'Donnell | Dawson | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | County-Other | Bailey | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | Wolfforth | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | Tahoka | Lynn | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | Silverton | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | Ropesville | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | Bovina | Parmer | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | County-Other | Dickens | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | County-Other | Castro | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | Post | Garza | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | Levelland | Hockley | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | Happy | Swisher | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4.4-8 Concluded***

| Water User Group | | County | Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 (dollars) | 2020 (dollars) | 2030 (dollars) | 2040 (dollars) | 2050 (dollars) | 2060 (dollars) |
| 36 | County-Other | Briscoe | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | County-Other | Cochran | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | Seagraves | Gaines | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | New Deal | Lubbock | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | Floydada | Floyd | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | Plainview | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | Hart | Castro | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | Crosbyton | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | Lorenzo | Crosby | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | Hale Center | Hale | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | Tulia | Swisher | 13,283 | 0 | 0 | 0 | 0 | 0 |
| 47 | Amherst | Lamb | 5,513 | 3,665 | 1,542 | 0 | 0 | 0 |
| 48 | Olton | Lamb | 19,940 | 12,727 | 8,925 | 2,313 | 0 | 0 |
| 49 | Anton | Hockley | 10,668 | 7,792 | 4,561 | 1,141 | 0 | 0 |
| 50 | Friona | Parmer | 33,831 | 25,156 | 14,735 | 3,709 | 0 | 0 |
| 51 | Sudan | Lamb | 10,868 | 8,672 | 5,206 | 3,151 | 2,389 | 2,063 |
| 52 | County-Other | Motley | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | Muleshoe | Bailey | 57,930 | 56,372 | 45,327 | 33,260 | 28,708 | 28,180 |
| 54 | Abernathy | Hale | 35,831 | 32,462 | 28,378 | 20,469 | 17,686 | 17,334 |
| 55 | Sundown | Hockley | 18,000 | 16,942 | 13,065 | 8,786 | 7,071 | 6,722 |
| 56 | Petersburg | Hale | 15,127 | 16,276 | 13,253 | 9,746 | 8,403 | 8,241 |
| 57 | Morton | Cochran | 29,859 | 36,110 | 30,383 | 23,334 | 20,272 | 19,286 |
| 58 | Dimmitt | Castro | 54,358 | 69,934 | 59,860 | 48,128 | 43,422 | 42,660 |
| 59 | Earth | Lamb | 14,310 | 17,609 | 15,273 | 12,481 | 11,301 | 11,150 |
| 60 | Littlefield | Lamb | 85,113 | 122,254 | 109,568 | 93,870 | 8,6831 | 85,702 |
| 61 | Lubbock | Lubbock | 2,710,211 | 4,473,330 | 4,073,369 | 3,599,732 | 3,462,415 | 3,544,986 |
| 62 | Denver City | Yoakum | 54,309 | 100,614 | 102,694 | 95011 | 88,085 | 85,093 |
| 63 | Hereford | Deaf Smith | 212,336 | 341,834 | 372,020 | 340,279 | 329,440 | 330,411 |
| 64 | Lamesa | Dawson | 147,965 | 238,281 | 284,147 | 260,930 | 245,779 | 236,474 |
| 65 | Spur | Dickens | 14,901 | 24,732 | 30,270 | 27,573 | 25,775 | 25,775 |
| 66 | County-Other | Lamb | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | Plains | Yoakum | 22,840 | 40,237 | 59,512 | 58,404 | 55,219 | 53,358 |
| 68 | Farwell | Parmer | 22,349 | 37,626 | 52,264 | 55,249 | 52,239 | 49,354 |
| 69 | Brownfield | Terry | 142,485 | 261,914 | 380,644 | 433,686 | 425,849 | 423,482 |
| 70 | Ransom Canyon | Lubbock | 22,221 | 51,167 | 89,255 | 133,876 | 174,412 | 183,611 |
| 71 | Matador | Motley | 13,187 | 21,388 | 27,143 | 30,618 | 33,864 | 33,087 |
| 72 | Seminole | Gaines | 114,121 | 166,714 | 321,760 | 417,028 | 499,012 | 550,022 |
| **Total** | | | **3,881,554** | **6,183,808** | **6,143,154** | **5,712,775** | **5,618,172** | **5,736,991** |

WUG's projected water needs (shortages) in the Regional Water Plan, with the associated cost for the water conservation water management strategy as shown in Table 4.4-8.

Estimated annual cost of the water conservation water management strategy for the Region is $3,881,554 in 2010, and increases to $5,736,991 in 2060 (Table 4.4-8). Given that water conservation in 2010 is 5,809 acft, cost per acft in year 2010 is approximately $668 ($3,881,554/5,809= $668), and for conservation of 10,424 acft in 2060 is approximately $550 ($5,736,991/10,424=$550)..

#### *4.4.1.2 Irrigation Water Conservation*

**Background**: Of the approximately 7.3 million acres of cropland in production in the Llano Estacado Water Planning Region, approximately 60 percent are farmed without irrigation and 40 percent are irrigated. For the most part, the irrigated acreages are those that have saturated sections of the Ogallala Formation underlying them that are thick enough to provide an adequate quantity of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Dryland and irrigation farmers in the area attempt to maximize the use of the precipitation they receive on their farms. Precipitation will support selected crops (dryland cotton, dryland grain sorghum, and dryland wheat) resulting in yields adequate to return a profit in about six of ten years. With increased precipitation or supplemental irrigation, yields of these crops can be increased by 30 percent to more than 300 percent and other crops can be produced, i.e., cotton requires about 5 inches of water to grow the plant, then for each additional inch of water the cotton plants will produce from 30 to 50 pounds of lint per acre depending on soil fertility and the timing of the receipt of additional water. Grain sorghum and wheat also require a similar amount of water to grow the plant, and the yields produced have a direct relationship to the total amount of water available during the growing season. The water supply can be a combination of stored soil moisture and precipitation or irrigation water received during the growing season.

**Projected Irrigation Water Demand, Irrigation Water Supply, and Irrigation Water Needs (Shortages)**: The projected irrigation water demands from Section 2, projected supplies of water available for irrigation use from Section 3, and projected irrigation water needs (shortages) from Section 4 for the counties of the Llano Estacado Region are summarized in

***Table 4.4-9.***
***Projected Irrigation Water Demands, Irrigation Water Supplies, and Irrigation Water Needs (Shortages)***

| County | Use in 2000 (acft) | Projections in Acre-Feet | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Bailey | | | | | | | |
| Demand | 182,865 | 178,478 | 174,197 | 170,018 | 165,939 | 161,958 | 158,071 |
| Supply | | 96,917 | 88,476 | 85,371 | 81,710 | 78,311 | 74,851 |
| Shortages | | 81,561 | 85,721 | 84,647 | 84,229 | 83,647 | 83,220 |
| Briscoe | | | | | | | |
| Demand | 26,329 | 25,373 | 24,453 | 23,566 | 22,710 | 21,886 | 21,091 |
| Supply | | 26,702 | 19,769 | 11,537 | 9,133 | 7,065 | 6,568 |
| Shortages | | 0 | 4,684 | 12,029 | 13,577 | 14,821 | 14,523 |
| Castro | | | | | | | |
| Demand | 503,792 | 484,475 | 465,902 | 448,039 | 430,861 | 414,342 | 398,457 |
| Supply | | 337,780 | 274,112 | 184,190 | 79,568 | 62,338 | 52,291 |
| Shortages | | 146,695 | 191,790 | 263,849 | 351,293 | 352,004 | 346,166 |
| Cochran | | | | | | | |
| Demand | 119,985 | 115,352 | 110,903 | 106,623 | 102,506 | 98,549 | 94,744 |
| Supply | | 75,443 | 72,307 | 69,617 | 67,001 | 21,904 | 22,100 |
| Shortages | | 39,909 | 38,596 | 37,006 | 35,505 | 76,645 | 72,644 |
| Crosby | | | | | | | |
| Demand | 112,135 | 107,617 | 103,281 | 99,120 | 95,126 | 91,295 | 87,618 |
| Supply | | 90,587 | 86,708 | 82,793 | 79,256 | 76,801 | 73,516 |
| Shortages | | 17,030 | 16,573 | 16,327 | 15,870 | 14,494 | 14,102 |
| Dawson | | | | | | | |
| Demand | 146,039 | 137,803 | 130,036 | 122,705 | 115,786 | 109,260 | 103,102 |
| Supply | | 42,175 | 35,379 | 32,781 | 29,808 | 30,031 | 30,034 |
| Shortages | | 95,628 | 94,657 | 89,924 | 85,978 | 79,229 | 73,068 |
| Deaf Smith | | | | | | | |
| Demand | 372,827 | 361,015 | 349,580 | 338,504 | 327,780 | 317,396 | 307,341 |
| Supply | | 189,534 | 153,759 | 113,503 | 73,026 | 70,086 | 64,536 |
| Shortages | | 171,481 | 195,821 | 225,001 | 254,754 | 247,310 | 242,805 |
| Dickens | | | | | | | |
| Demand | 9,486 | 9,203 | 8,928 | 8,663 | 8,405 | 8,153 | 7,908 |
| Supply | | 5,882 | 5,743 | 5,610 | 5,484 | 5,361 | 5,245 |
| Shortages | | 3,321 | 3,185 | 3,053 | 2,921 | 2,792 | 2,663 |

Continued on next page

***Table 4.4-9 Continued***

| *County* | *Water Use in 2000* (acft) | *Projections* *2010* (acft) | *2020* (acft) | *2030* (acft) | *2040* (acft) | *2050* (acft) | *2060* (acft) |
|---|---|---|---|---|---|---|---|
| Floyd | | | | | | | |
| Demand | 237,020 | 227,579 | 218,516 | 209,812 | 201,454 | 193,431 | 185,727 |
| **Supply** | | 136,848 | 112,125 | 100,845 | 92,488 | 88,283 | 85,654 |
| Shortages | | 90,731 | 106,391 | 108,967 | 108,966 | 105,148 | 100,073 |
| Gaines | | | | | | | |
| Demand | 414,772 | 393,170 | 372,693 | 353,283 | 334,884 | 317,442 | 300,908 |
| Supply | | 325,885 | 267,246 | 233,832 | 207,271 | 183,157 | 160,927 |
| Shortages | | 67,285 | 105,447 | 119,451 | 127,613 | 134,285 | 139,981 |
| Garza | | | | | | | |
| Demand | 12,165 | 11,451 | 10,783 | 10,148 | 9,556 | 8,997 | 8,471 |
| Supply | | 6,739 | 6,482 | 6,153 | 5,835 | 5,542 | 5,259 |
| Shortages | | 4,712 | 4,301 | 3,995 | 3,721 | 3,455 | 3,212 |
| Hale | | | | | | | |
| Demand | 367,700 | 355,516 | 343,737 | 332,349 | 321,337 | 310,690 | 300,396 |
| Supply | | 333,299 | 288,425 | 193,720 | 115,043 | 87,819 | 79,346 |
| Shortages | | 22,217 | 55,312 | 138,629 | 206,294 | 222,871 | 221,050 |
| Hockley | | | | | | | |
| Demand | 174,996 | 168,151 | 161,578 | 155,261 | 149,188 | 143,354 | 137,749 |
| Supply | | 104,469 | 85,903 | 72,402 | 61,357 | 59,517 | 56,105 |
| Shortages | | 63,682 | 75,675 | 82,859 | 87,831 | 83,837 | 81,644 |
| Lamb | | | | | | | |
| Demand | 377,893 | 363,313 | 349,294 | 335,816 | 322,858 | 310,401 | 298,425 |
| Supply | | 248,481 | 190,849 | 134,163 | 84,304 | 62,026 | 47,780 |
| Shortages | | 114,832 | 158,445 | 201,653 | 238,554 | 248,375 | 250,645 |
| Lubbock | | | | | | | |
| Demand | 242,978 | 229,267 | 216,397 | 204,248 | 192,782 | 181,961 | 171,747 |
| Supply | | 168,222 | 125,744 | 104,673 | 83,079 | 79,668 | 74,901 |
| Shortages | | 61,046 | 90,653 | 99,575 | 109,703 | 102,293 | 96,846 |
| Lynn | | | | | | | |
| Demand | 120,372 | 113,895 | 107,766 | 101,972 | 96,482 | 91,295 | 86,387 |
| Supply | | 131,397 | 124,200 | 123,450 | 123,022 | 122,744 | 122,735 |
| Shortages* | SURPLUS | -17,502 | -16,434 | -21,475 | -26,540 | -31,449 | -36,348 |
| Shortage | Colo Basin | 550 | 508 | 464 | 409 | 406 | 401 |

*Negative values in shortage row means surpluses for irrigation.

Concluded on next page

***Table 4.4-9 Concluded***

| County | Water Use in 2000 (acft) | Projections | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| Motley | | | | | | | |
| Demand | 9,168 | 8,894 | 8,628 | 8,372 | 8,121 | 7,877 | 7,641 |
| Supply | | 7,562 | 7,362 | 7,164 | 6,967 | 6,785 | 6,616 |
| Shortages | | 1,332 | 1,266 | 1,208 | 1,154 | 1,092 | 1,025 |
| Parmer | | | | | | | |
| Demand | 415,449 | 411,037 | 406,673 | 402,356 | 398,084 | 393,858 | 389,676 |
| Supply | | 249,655 | 75,443 | 40,733 | 41,044 | 43,393 | 42,976 |
| Shortages | | 161,382 | 331,230 | 361,623 | 357,040 | 351,465 | 346,700 |
| Swisher | | | | | | | |
| Demand | 171,706 | 170,725 | 163,566 | 168,780 | 167,816 | 166,857 | 165,903 |
| Supply | | 148,079 | 103,143 | 72,905 | 62,431 | 59,255 | 58,370 |
| Shortages | | 22,646 | 60,423 | 95,875 | 105,385 | 107,602 | 107,533 |
| Terry | | | | | | | |
| Demand | 203,141 | 192,725 | 182,844 | 173,471 | 164,577 | 156,139 | 148,133 |
| Supply | | 117,837 | 90,867 | 72,404 | 58,337 | 58,390 | 58,378 |
| Shortages | | 74,888 | 91,977 | 101,067 | 106,240 | 97,749 | 89,755 |
| Yoakum | | | | | | | |
| Demand | 127,059 | 120,979 | 115,187 | 109,674 | 104,426 | 99,427 | 94,668 |
| Supply | | 97,200 | 92,443 | 87,806 | 83,873 | 79,851 | 76,166 |
| Shortages | | 23,779 | 22,744 | 21,868 | 20,553 | 19,576 | 18,502 |
| Region Total | | | | | | | |
| Demand | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |
| Supply | | 2,940,692 | 2,306,484 | 1,835,653 | 1,450,037 | 1,287,327 | 1,204,352 |
| Shortages * | | 1,264,707 | 1,735,400 | 2,069,069 | 2,317,590 | 2,3349,096 | 2,306,560 |

- *Sum of shortages for counties, excluding Lynn County, in Brazos Basin which has a projected surplus.

Table 4.4-9. The TWDB irrigation water demand projections for the Llano Estacado Water Planning Region show a decline from the estimated level of use in year 2000 of 4,347,877 acft/yr to 4,024,942 acft/yr in 2020, and 3,474,163 acft/yr in 2060 (Table 4.4-9). Projected irrigation water supplies available decline from 2,940,692 acft/yr in year 2010 to 1,835,653 acft/yr in 2030, and 1,204,352 acft/yr in 2060 (Table 4.4-9), resulting in a projected irrigation water shortage of 1,264,707 acft/yr in 2010, and 2,306,560 acft/yr in 2060 (Table 4.4-9 and Figure 4.4-1). For each of the counties of the Region except Briscoe and Lynn, irrigation water shortages are projected to begin immediately and continue to 2060. In the case of Briscoe County, shortages are projected to begin by 2020 and continue until 2060. However, Lynn County has a projected irrigation water supply that is greater than projected irrigation water demand in the quantity of about 17,502 acft/yr in 2010, and increases to about 36,478 acft/yr in 2060 (Table 4.4-9).

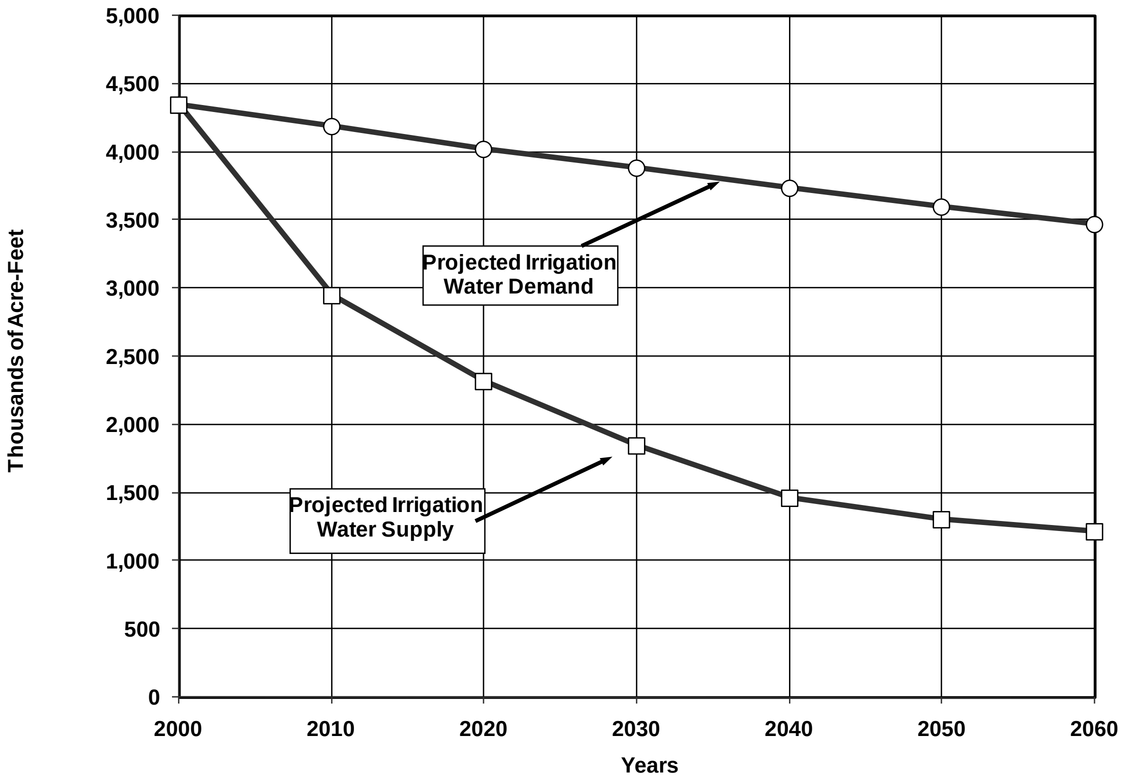



***Figure 4.4-1. Projected Irrigation Water Demand and Supply — Region O***

TWDB Rules for regional water planning require Regional Water Planning Groups to consider water conservation and drought management measures for each water user group with a need (projected water shortage). In addition, the Rules direct that water conservation BMPs, as identified by the Water Conservation Implementation Task Force, be considered in the development of the water conservation water management strategy. Since 20 of the 21 counties of the Region are projected to have irrigation needs (shortages), the LERWPG is required to consider irrigation water conservation as a water management strategy for the regional water plan.

**Irrigation Water Conservation Best Management Practices**: The Water Conservation Implementation Task Force list of BMPs for irrigation is as follows:

Irrigation Scheduling;
Volumetric Measurement of Irrigation Water Use;
Crop Residue Management and Conservation Tillage;
On-farm Irrigation Audit;
Furrow Dikes;
Land Leveling;
Contour Farming;
Conversion of Supplemental Irrigated Farmland to Dry-Land Farmland;
Brush Control/Management;
Lining of On-Farm Irrigation Ditches;
Replacement of On-/farm Irrigation Ditches with Pipelines;
Low Pressure Center Pivot Sprinkler Irrigation Systems;
Drip/Micro-Irrigation System;
Gated and Flexible Pipe for Field Water Distribution Systems;
Surge Flow Irrigation for Field Water Distribution Systems;
Linear Move Sprinkler Irrigation Systems;
Lining of District Irrigation Canals;
Replacement of District Irrigation Canals and Lateral Canals with Pipelines;
Tailwater Recovery and Use System; and
Nursery Production Systems.

**Irrigation Farming Practices in the Llano Estacado Water Planning Region**: In the interests of improving irrigation water use efficiency which works to assist in maintaining levels of agricultural production on individual farms as well as the regional totals, and in the interests of irrigation farming survival, many irrigation farmers of Region O have implemented the most efficient, practical irrigation application methods and farming practices available, while some have not.[8] For example, many of the BMPs listed above, were developed and/or implemented on a widespread basis over the past 50 years by researchers and farmers located in Region O, including:

1. Contour Farming;
2. Tailwater Recovery and Use;
3. Replacement of On-farm Irrigation Ditches with Pipelines;
4. Gated and Flexible Pipe for Field Water Distribution;
5. Low Pressure Center Pivot Sprinkler Irrigation Systems (LEPA and LESA);
6. Surge Flow Irrigation for Field Water Distribution Systems;

[8] It is important to note that farming operations are carried out within existing Federal Government Farm Programs that have specifications and conditions that require farmers to maintain consistency of farming practices in order to qualify for program benefits. For example, the objectives of the Environmental Quality Incentives Program (EQIP) include increasing the efficiency of irrigation water use.

7. Furrow Dikes, Chiseling, and Deep Ripping;
8. Crop Residue Management and Conservation Tillage;
9. Linear Move Sprinkler Irrigation Systems;
10. Drip/Micro-Irrigation Systems; and
11. Volumetric Measuring.

Some of the BMPs identified by the Water Conservation Implementation Task Force are not applicable for use in Region O; e.g.; brush management, irrigation district canal lining or replacement, and nursery production systems. Principal methods of irrigation water conservation on irrigation farms of Region O are: (1) low elevation spray application systems; (2) low-energy precision application systems (LEPA); (3) surge irrigation; (4) furrow diking, chiseling, and deep ripping; (5) soil moisture monitoring, (6) drip irrigation, (7) irrigation scheduling; and (8) crop residue management and conservation tillage. In comparison to the irrigation method (furrow or flood irrigation) of releasing the water into the furrows at the ends of the rows and allowing it to flow across the fields until each furrow has been saturated throughout its entire length, the use of sprinklers, LEPA, surge valves, furrow diking, and irrigation scheduling improves application efficiency within the irrigated fields and thereby reduces the total quantity of water needed to produce an irrigated crop. The major irrigation water conservation techniques that are in use at the present time by irrigation farmers in the Llano Estacado Region are described briefly below.

**Low Elevation Spray Application Sprinklers:** Center pivot and lateral-move low elevation/pressure sprinklers (LESA) spray water downward above the crops as the sprinkler systems move across the fields. Low-pressure sprinklers improve irrigation application efficiency in comparison to furrow irrigation by reducing water requirements per acre in the 10 to 15 percent range, while LEPA combined with furrow diking can reduce water requirements per acre by 30 to 40 percent. Use of LESA and LEPA, together with furrow dikes allow irrigation farmers to produce equivalent yields per acre at lower energy and labor costs of irrigation (i.e., it has been demonstrated that LESA and LEPA systems improve production and profitability of irrigation farming.

**Low Energy Precision Application Systems:** LEPA systems involve a sprinkler system that has been modified to discharge water directly into furrows at low pressure, thus reducing evaporation losses. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water behind small mounds of earth within the furrows, LEPA systems can accomplish the irrigation objective with less water than is required for the furrow irrigation and pressurized sprinkler methods. (Note: Furrow dikes are described below)

**Surge Irrigation:** Surge irrigation is an irrigation method in which water is released from pipes located at the head of the furrows as in the furrow irrigation method. The difference between furrow irrigation and surge irrigation is that surge valves allow the flow into the furrows for a period of time (usually 30 minutes to an hour) and then switch the water stream into the adjoining furrows for a period of time. This allows the water to soak into the furrow length that has just been wetted while the neighboring furrow is being watered. On the next cycle, the water stream is switched back to the original furrow where it is discharged into the previously wetted furrow section. On the second, third, and subsequent cycles, the water stream flows over the previously wetted sections much faster and with less deep percolation than if the stream of water had been continuously discharged into the furrow until the entire length had been wetted. In short, the alternation between rows reduces soil intake rates and increases advance rate across the fields, thereby reducing deep percolation. Although surge valves and furrow dikes cannot be used within the same row or furrow, furrow dikes and surge valves are sometimes used in alternate furrows

**Furrow Dikes, Chiseling and Deep Ripping:** Furrow dikes are small mounds of soil mechanically installed a few feet apart in the furrow. Furrow dikes are constructed by towing the furrow diking implement behind chisels, planters or cultivators when these operations are performed. These mounds of soil create small reservoirs that capture precipitation and hold it until it soaks into the soil instead of running down the furrow and out the end of the field. This practice can conserve (capture) as much as 100 percent of rainfall runoff, and furrow dikes are used to prevent irrigation runoff under sprinkler systems. This maintains high irrigation uniformity and increases irrigation application efficiencies. Capturing and holding precipitation that would have drained from the fields replaces required irrigation water on irrigated fields; and on dryland cropland it maximizes the benefits of precipitation for use by dryland crops. In addition, furrow diking may help increase recharge to the Ogallala Aquifer during periods when rainfall is in excess of the plant root zone soil water holding capacity. Furrow diking requires special tillage equipment and costs $3.00 to $5.00 per acre to install.

**Drip Irrigation**: Drip or subsurface irrigation delivers small but frequent and/or steady flows of moisture to plants by means of buried small-diameter, plastic tubes with small orifices or holes spaced to allow the release of water near the plant roots. This method results in a reduction in loss of water through evaporation or deep percolation into the ground. Yields have been increased from 500 to 1,500 pounds of lint cotton per acre on some drip irrigation tracts.

**Crop Residue Management and Conservation Tillage:** Crop residue management and conservation tillage practices are being used by both irrigation and dryland farmers in Region O in an effort to control costs and, to the extent possible to improve efficiency of both precipitation and applied irrigation water. Conservation tillage includes systems of planting and tillage that cover 30 percent or more of the soil surface, or leaves 1,000 pounds per acre of flat small grain residue equivalent, with crop residue, after planting, to reduce soil and wind erosion. No-till and strip till, where the soil is left undisturbed from harvest to planting, except for strips up to one-third of the row width; ridge-till, where the soil is left undisturbed from harvest to planting, except for strips up to one-third of the row width, with planting completed on the ridge, and residue is left on the surface between the ridges; and mulch-till, where full-width tillage trips, which disturbs all of the soil surface, and is done prior to and/or during planting, are among the leading types of conservation tillage practices. These tillage practices appear to be lowering overall costs of crop production by reducing the number of seedbed preparation and cultivation trips required across the fields, but it is not clear that they are reducing the quantities of irrigation water that need to be applied. It is thought, however, that these tillage practices will increase water use efficiency by increasing yields per acre, other things equal, including seeding, fertilizer, and irrigation water application rates.

In addition to the practices listed and described above, soil moisture monitoring and irrigation scheduling are used by individual producers. Soil moisture monitoring is the periodic measurement of soil moisture content. Its purpose is to indicate when and how much irrigation water needs to be applied to meet crop needs. Irrigation scheduling is the practice of applying irrigation water to crops in quantities that the crop can efficiently use, when the crop needs it, and in amounts that are not in excess of the soil water holding capacity.

**Irrigation Water Conservation Water Management Strategy for the Llano Estacado Regional Water Plan**: The Irrigation Water Conservation Water Management Strategy for the Llano Estacado Regional Water Plan is the recommendation that irrigation producers of crops install and use Center Pivots (LEPA or LESA as described above) for the application of irrigation water. The development and evaluation of this Irrigation Water Conservation Water

Management Strategy for regional water planning purposes requires information about the quantity of acreages being irrigated with irrigation practices which can be modified and/or replaced with more efficient methods (Center Pivots) which would result in less water use per acre; i.e.; acreages being irrigated with furrow methods that result in high evaporation and deep percolation of irrigation water that could be irrigated with center pivots with less water required per acre. Therefore, in order to prepare an Irrigation Water Conservation Water Management Strategy for the Llano Estacado Water Planning Region, it is necessary to obtain information about (1) total acres irrigated, (2) the number of acres already being irrigated with efficient application methods (Center Pivots), and therefore not candidates for irrigation water conservation, (3) the costs of irrigation water conservation equipment and practices (Center Pivots), and (4) the potential water savings per acre for the water conservation practice. In the following discussion, the data and procedures used in developing and evaluating the Irrigation Water Conservation Water Management Strategy are presented. Irrigation water use data available from the Texas Water Development Board show that irrigation application rates were in the range of about 1.0 to 1.45 acft per acre per year during the 1990s, with the lowest rate being 0.80 acft/acre in 1992, and the highest being 1.45 acft/acre in 1998, a very dry year (Table 4.4-10).

The Natural Resource Conservation Service (NRCS) reported that in 2004, there were 3.23 million irrigated acres in the Llano Estacado Water Planning Region.[9] Using year 2004 infrared orthographic imagery and ESRI ArcView 9.0, the High Plains Underground Water Conservation District No. 1, showed that in the Llano Estacado Region in 2004, there were 17,482 center pivots irrigating approximately 2.32 million acres, or 71.88 percent of irrigated acres in the region in 2004 (Table 4.4-11).[10] In 2004, five counties (Dawson, Gaines, Motley, Terry, and Yoakum) had center pivot systems and/or drip irrigation on nearly 100 percent of the irrigated acreage of the counties (Table 4.4-11). However, 908,851 irrigated acres in the region were not being irrigated using efficient center pivot or drip systems, and numerous farmers were not using other available water conservation practices, as identified and recommended by the Water Conservation Implementation Task Force and the Llano Estacado Regional Water Planning Group (Table 4.4-11).

[9] "Resource Data and Concerns, Zone 1," NRCS, U. S. Department of Agriculture, January 2005.
[10] Center Pivot Inventory, High Plains Underground Water Conservation District No. 1. October 2005.

**Table 4.4-10**
**Irrigated Acreages and Irrigation Water Use – 1990 to 2000**
**Llano Estacado Region**

| Years | Acres Irrigated | Irrigation Water Use (acft/yr) | Irrigation Water Use acft/acre/yr | Irrigation Water Use Acre Inches/acre/yr | Growing Season Rainfall (inches) | Irrigation plus Rainfall (inches) |
|---|---|---|---|---|---|---|
| 1990 | 2,876,792 | 3,657,740 | 1.27 | 15.26 | 9.87 | 25.13 |
| 1991 | 3,049,177 | 3,031,115 | 0.99 | 11.93 | 16.45 | 28.38 |
| 1992 | 3,540,785 | 2,825,480 | 0.80 | 9.58 | 17.04 | 26.61 |
| 1993 | 3,027,835 | 4,132,229 | 1.36 | 16.38 | 10.68 | 27.05 |
| 1994 | 3,144,604 | 4,001,063 | 1.27 | 15.27 | 12.34 | 27.61 |
| 1995 | 3,240,764 | 4,193,017 | 1.29 | 15.53 | 16.30 | 31.82 |
| 1996 | 3,228,610 | 4,376,814 | 1.36 | 16.27 | 15.16 | 31.43 |
| 1997 | 3,162,448 | 4,118,124 | 1.30 | 15.63 | 18.75 | 34.38 |
| 1998 | 3,107,166 | 4,504,575 | 1.45 | 17.40 | 5.74 | 23.14 |
| 1999 | 3,292,624 | 3,711,833 | 1.13 | 13.53 | 17.58 | 31.11 |
| 2000 | 3,292,722 | 4,347,877 | 1.32 | 15.85 | 10.09 | 25.94 |

In 2009, the High Plains Underground Water Conservation District No. 1, performed a similar survey to that of 2004 of counties of the Llano Estacado Water Planning Region using infrared orthographic imagery and ESRI ArcView, which showed that in 2008, there were 18,581 center pivots irrigating approximately 2.49 million acres, or 76.14 percent of irrigated acres in the region in 2008 (Table 4.4-11).[11] Between 2004 and 2008, the number of center pivots increased from 17,482 to 18,581 (1,099 or 6.3 percent), with an increase in acres irrigated with center pivots from 2,356,287 acres to 2,493,373 acres, an increase of 137,086, or 5.8 percent (Table 4.4-11). However, a comparison of the 2004 and 2008 total irrigated acreage and acreage being irrigated with center pivots, shows considerable differences between these two points in time for several of the counties, with major differences in reported total acres irrigated in about half of the counties; i.e.; Bailey, Deaf Smith, Floyd, Gaines, Lamb, Lubbock, Swisher, and Yoakum (Table 4.4-11). Given that weather conditions and markets affect both the total acres irrigated and the acres irrigated using center pivots from year to year, for purposes of this regional water plan, baseline acreage has been established for both total acres irrigated and acres

[11] Ibid.

irrigated using center pivots. The baseline is the larger of the acreage reported and/or estimated for 2004 and 2008, based upon the assumption that the larger or higher acreage datum is indicative that such acreage is available for use and could be used if and when market conditions justify irrigation production efforts. Thus, for purposes of developing this irrigation water conservation strategy, it has been assumed that the larger of the reported total irrigated acreages in 2004 and 2008, and the larger number of acres irrigated using center pivots are the baseline acreages for use in calculating the potential irrigation water conservation for the irrigation water conservation water management strategy (Table 4.4-11). However, it is estimated that center pivots could or would be installed on only about 80 percent of the "baseline" irrigated acreage that is not now being irrigated using center pivots.

The LERWPG recommends that efforts be continued to educate, inform, and assist producers to implement all practical, site-specific water conservation practices and strategies. And further recommends the continued use of the BMPs described above. In addition, the LERWPG recommends voluntary implementation of volumetric measurement of irrigation water used, drip/micro-irrigation systems, remote sensing and irrigation scheduling; and variable rate irrigation application, other newly developed water conservation methods that are demonstrated to be practical and profitable, and improvements to existing strategies that may be made.

In addition, it is the recommendation of the LERWPG, that irrigation water conservation strategies currently being practiced in much of the region be extended and applied to additional irrigated acreages not now receiving the most efficient irrigation practices, and that irrigation farmers of the Llano Estacado Water Planning Region practice irrigation water conservation farming to the extent feasible, on a site specific basis. However, in order to accomplish the maximum estimated potential irrigation conservation, in many instances, it will be necessary to install efficient irrigation application equipment, such as LEPA and/or LESA systems on acreages that have not yet been equipped with such systems. When used in conjunction with furrow dikes and deep chiseling, which hold both precipitation and sprinkler applied water within the furrows, this water management strategy has the potential to meet a part of the projected irrigation shortages in the region, and are included as water conservation water management strategies for the regional water plan (Table 4.4-12). For example, an analysis of 86 loans by the High Plains Underground Water Conservation District No. 1, Lubbock, Texas that financed the installation of LEPA on 10,320 acres showed that average water savings were

***Table 4.4-11***
***Total Acres Irrigated, Acres Irrigated Using Center Pivots, and Potential Acres to Which Center Pivots can be Added***
***Llano Estacado Region***

| County | Total Acres Irrigated | | Baseline Irrigated Acreage (Greater Acres of 2004/2008) | Number of Center Pivots | | Acres Irrigated Using Center Pivots | | Baseline Irrigated Acres Using Pivots (Greater Acres of 2004/2008) |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2008 | (2004/2008) | 2004 | 2008 | 2004 | 2008 | |
| (A) | (B) | (C) | (D) | (E) | (F) | (G) | (H) | (I) |
| Bailey [1] | 130,786 | 110,287 | 130,786 | 768 | 739 | 92,598 | 88,786 | 92,598 |
| Briscoe [2] | 29,725 | 31,855 | 31,855 | 110 | 163 | 13,216 | 18,422 | 18,422 |
| Castro [1] | 312,014 | 293,604 | 312,014 | 1,378 | 1,459 | 218,174 | 225,398 | 225,398 |
| Cochran [1] | 108,561 | 127,517 | 127,517 | 615 | 666 | 81,849 | 86,093 | 86,093 |
| Crosby [1] | 134,000 | 125,577 | 134,000 | 551 | 588 | 74,712 | 79,942 | 79,942 |
| Dawson [3] | 74,487 | 88,003 | 88,003 | 595 | 647 | 72,250 | 75,543 | 75,543 |
| Deaf Smith [1] | 229,120 | 164,171 | 229,120 | 845 | 896 | 134,741 | 142,549 | 142,549 |
| Dickens [2] | 8,364 | 6,516 | 8,364 | 44 | 47 | 4,166 | 4,670 | 4,670 |
| Floyd [1] | 191,835 | 156,655 | 191,835 | 541 | 705 | 79,587 | 100,308 | 100,308 |
| Gaines [1] | 291,700 | 351,963 | 351,963 | 2,101 | 2,179 | 324,545 | 330,425 | 330,425 |
| Garza [2] | 13,531 | 9,690 | 13,531 | 35 | 27 | 4,457 | 3,311 | 4,457 |
| Hale [1] | 310,765 | 328,909 | 328,909 | 1,631 | 1,823 | 221,739 | 242,062 | 242,062 |
| Hockley [1] | 158,306 | 166,925 | 166,925 | 931 | 906 | 109,440 | 105,949 | 109,440 |
| Lamb [1] | 233,824 | 275,089 | 275,089 | 1,737 | 1,835 | 207,064 | 216,776 | 216,776 |
| Lubbock [1] | 181,600 | 202,616 | 202,616 | 743 | 830 | 94,691 | 102,392 | 102,392 |
| Lynn [1] | 91,896 | 93,376 | 93,376 | 497 | 572 | 61,053 | 69,482 | 69,482 |
| Motley [2] | 5,500 | 8,792 | 8,792 | 53 | 61 | 5,500 | 6,974 | 6,974 |
| Parmer [1] | 256,935 | 245,792 | 256,935 | 1,788 | 1,792 | 217,754 | 216,213 | 217,754 |
| Swisher [1] | 190,961 | 142,685 | 190,961 | 371 | 467 | 65,626 | 83,343 | 83,343 |
| Terry [3] | 171,000 | 196,351 | 196,351 | 1,409 | 1,392 | 171,193 | 167,678 | 167,678 |
| Yoakum [3] | 107,385 | 148,383 | 148,383 | 739 | 825 | 105,625 | 127,057 | 127,057 |
| Total | 3,232,295 | 3,274,756 | 3,487,325 | 17,482 | 18,619 | 2,359,982 | 2,494,823 | 2,471,152 |

1 Source: "Resource Data and Concerns, Zone 1," Natural Resource Conservation Service, U.S. Department of Agriculture, January, 2007.
2 Source: Center Pivot Survey, HPUWCD, 2008.
3 Source: Mesa, South Plains, and Sandy Land UWCDs, respectively, November 2009.
4 Source: "2009 Center Pivot Inventory," High Plains Underground Water Conservation District, Lubbock, Texas, August 2009.

0.61 acre-feet per acre. If the 786,008 acres of the region that are now being irrigated without this type of equipment were to be equipped with center pivots, it is estimated that the potential water conservation is 479,466 acft/yr in 2010 (Table 4.4-13A). The projected potential irrigation water conservation for the region is 388,366 acft/yr in 2030, and declines to 283,118 acft/yr in 2060 due to projected declining well yields as the saturate thickness of the aquifer declines. The estimated potential quantities of water from this irrigation water conservation strategy for Bailey County are 18,636 acft/yr in 2010, 15,095 acft/yr in 2030, and 11,004 acft/yr in 2060 (Table 4.4-13B). This irrigation water conservation water management strategy could reduce the Bailey County irrigation water shortage in 2010 from 81,561 acft/yr to 62,926 acft/yr, and in 2030 from 84,647 acft/yr to 69,553 acft/yr (Table 4.4-13C). The projected irrigation shortages (needs), potential irrigation water conservation, and projected shortages after irrigation conservation quantities are taken into account are shown in Table 4.4-13C for each county.

Estimated capital cost to install LEPA and/or LESA types of center pivots on the presently unequipped 786,008 irrigated acres of the region is approximately $345.82 million (Table 4.4-13A). The annual repayment cost of such an investment, amortized over 20 years (expected life of pivot systems), at 6% is approximately $30.15 million (Table 4.4-13A), with capital cost per acre-foot of water saved increasing from $63 in 2010 to $78 in 2030, and $106/acft in 2060 (Table 4.4-13B). With the more efficient irrigation application methods of this irrigation water conservation strategy, less water would be pumped per acre irrigated, thereby reducing farm production costs by at least the value of the energy that would have been needed to pump the water saved. Although this is a significant benefit to the irrigation water conservation strategy, data are not available with which to estimate its value. However, it is recognized and acknowledged as one of the major sources of income with which to make the payments to meet the capital costs of the irrigation water conservation strategy.

The irrigation water conservation strategy could potentially reduce the regional irrigation water shortage from 1,264,707 acft/yr in 2010, to 862,291 acft/yr, a reduction of approximately 32 percent, and in 2060 by 283,118 acft/yr from 2,306,560 acft/yr to 2,031,400 acft/yr (Table 4.4-13C). The estimated potential quantities of irrigation water conservation for the region are shown in Table 4.4-13C and Figure 4.4-2.

***Table 4.4-12.***
***Baseline Irrigated Acreage, Acres Irrigated Using Center Pivots, and Estimated Potential Number of Acres to Which Center Pivots could be Installed***
***Llano Estacado Region***

| *County* | *Baseline Irrigated Acreage (Greater Acres of 2004 & 2008)* | *Number of Center Pivots* (2008) | *Baseline Irrigated Acres Using* Pivots (Greater Acres of 2004/2008) | *Percent of Acres Irrigated Using Center Pivots* | Number of Acres Irrigated Without Pivots | *Potential Number of Acres to Which Center Pivots Might be Applied (80% of Col (E)* |
|---|---|---|---|---|---|---|
| | (A) | *(B)* | *(C)* | *(D)* | *(E)* | *(F)* |
| Bailey | 130,786 | 739 | 92,598 | 70.80 | 38,188 | 30,550 |
| Briscoe | 31,855 | 163 | 18,422 | 57.83 | 13,433 | 10,746 |
| Castro | 312,014 | 1,459 | 225,398 | 72.24 | 86,616 | 69,293 |
| Cochran | 127,517 | 666 | 86,093 | 67.52 | 41,424 | 33,139 |
| Crosby | 134,000 | 588 | 79,942 | 59.66 | 54,058 | 43,246 |
| Dawson | 88,003 | 647 | 75,543 | 85.84 | 12,460 | 9,968 |
| Deaf Smith | 229,120 | 896 | 142,549 | 62.22 | 86,571 | 69,257 |
| Dickens | 8,364 | 47 | 4,670 | 55.83 | 3,694 | 2,955 |
| Floyd | 191,835 | 705 | 100,308 | 52.29 | 91,527 | 73,222 |
| Gaines | 351,963 | 2,179 | 330,425 | 93.88 | 21,538 | 17,230 |
| Garza | 13,531 | 27 | 4,457 | 32.94 | 9,074 | 7,259 |
| Hale | 328,909 | 1,823 | 242,062 | 73.60 | 86,847 | 69,478 |
| Hockley | 166,925 | 906 | 109,440 | 65.56 | 57,485 | 45,988 |
| Lamb | 275,089 | 1,835 | 216,776 | 78.80 | 58,313 | 46,650 |
| Lubbock | 202,616 | 830 | 102,392 | 50.53 | 100,224 | 80,180 |
| Lynn | 93,376 | 572 | 69,482 | 74.41 | 23,894 | 19,115 |
| Motley | 8,792 | 61 | 6,974 | 79.33 | 1,817 | 1,454 |
| Parmer | 256,935 | 1,792 | 217,754 | 84.75 | 39,181 | 31,345 |
| Swisher | 190,961 | 467 | 83,343 | 43.64 | 107,618 | 86,094 |
| Terry | 196,351 | 1,392 | 169,128 | 86.13 | 27,223 | 21,778 |
| Yoakum | 148,383 | 825 | 127,057 | 85.63 | 21,326 | 17,061 |
| Total | 3,487,324 | 18,619 | 2,504,813 | 71.78 | 982,511 | 786,008 |

1 Average water savings per acre, as calculated from 86 water conservation equipment loans administered by the High Plains Underground Water Conservation District No. 1, Lubbock, Texas, 2005
2 Estimated at $440 per acre.

**_Table 4.4-13A._**
**Estimates of Irrigation Water Conservation Potentials and Costs**
***Llano Estacado Region***

| *County* | *Applicable Acreage* | *Conservation Potential Per Acre[1] (acft)* | *Estimated Conservation in Year 2010 (acft/yr)* | *Total Cost to Install LEPA[2] (million dollars)* | *Annual Costs Amortized 20 Years @6% (million dollars)* |
|---|---|---|---|---|---|
| Bailey | 30,550 | 0.61 | 18,636 | 13.44 | 1.17 |
| Briscoe | 10,746 | 0.61 | 6,555 | 4.73 | 0.41 |
| Castro | 69,293 | 0.61 | 42,268 | 30.49 | 2.66 |
| Cochran | 33,139 | 0.61 | 20,215 | 14.58 | 1.27 |
| Crosby | 43,246 | 0.61 | 26,380 | 19.03 | 1.66 |
| Dawson | 9,968 | 0.61 | 6,080 | 4.38 | 0.38 |
| Deaf Smith | 69,257 | 0.61 | 42,246 | 30.47 | 2.66 |
| Dickens | 2,955 | 0.61 | 1,803 | 1.30 | 0.11 |
| Floyd | 73,222 | 0.61 | 44,665 | 32.22 | 2.81 |
| Gaines | 17,230 | 0.61 | 10,515 | 7.58 | 0.66 |
| Garza | 7,259 | 0.61 | 4,428 | 3.19 | 0.28 |
| Hale | 69,478 | 0.61 | 42,381 | 30.57 | 2.67 |
| Hockley | 45,988 | 0.61 | 28,053 | 20.23 | 1.76 |
| Lamb | 46,650 | 0.61 | 28,457 | 20.52 | 1.79 |
| Lubbock | 80,180 | 0.61 | 48,909 | 35.28 | 3.08 |
| Lynn | 19,115 | 0.61 | 11,660 | 8.41 | 0.73 |
| Motley | 1,454 | 0.61 | 886 | 0.64 | 0.06 |
| Parmer | 31,345 | 0.61 | 19,120 | 13.79 | 1.20 |
| Swisher | 86,094 | 0.61 | 52,517 | 37.88 | 3.30 |
| Terry | 21,778 | 0.61 | 13,285 | 9.58 | 0.84 |
| Yoakum | 17,061 | 0.61 | 10,407 | 7.51 | 0.65 |
| Total | 786,008 | 0.61 | 479,466 | 345.82 | 30.15 |

1 Average water savings per acre, as calculated from 86 water conservation equipment loans administered by the High Plains Underground Water Conservation District No. 1, Lubbock, Texas, 2005
2 Estimated at $440 per acre.

### *Table 4.4-13B.*
### *Estimates of Projected Irrigation Water Conservation Potentials[1]*
### *and Cost per Acre-Foot*
### *Llano Estacado Region*

| County | 2010 acft/yr | 2020 acft/yr | 2030 acft/yr | 2040 acft/yr | 2050 acft/yr | 2060 acft/yr |
|---|---|---|---|---|---|---|
| Bailey | 18,636 | 16,772 | 15,095 | 13,585 | 12,227 | 11,004 |
| Briscoe | 6,555 | 5,900 | 5,310 | 4,779 | 4,301 | 3,871 |
| Castro | 42,268 | 38,041 | 34,237 | 30,813 | 27,732 | 24,959 |
| Cochran | 20,215 | 18,193 | 16,374 | 14,737 | 13,263 | 11,937 |
| Crosby | 26,380 | 23,742 | 21,368 | 19,231 | 17,308 | 15,577 |
| Dawson | 6,080 | 5,472 | 4,925 | 4,432 | 3,989 | 3,590 |
| Deaf Smith | 42,246 | 38,022 | 34,219 | 30,797 | 27,718 | 24,946 |
| Dickens | 1,803 | 1,622 | 1,460 | 1,314 | 1,183 | 1,064 |
| Floyd | 44,665 | 40,198 | 36,178 | 32,561 | 29,305 | 26,374 |
| Gaines | 10,515 | 9,463 | 8,517 | 7,665 | 6,898 | 6,209 |
| Garza | 4,428 | 3,985 | 3,587 | 3,228 | 2,905 | 2,615 |
| Hale | 42,381 | 38,143 | 34,329 | 30,896 | 27,806 | 25,026 |
| Hockley | 28,053 | 25,247 | 22,723 | 20,450 | 18,405 | 16,565 |
| Lamb | 28,457 | 25,611 | 23,050 | 20,745 | 18,670 | 16,803 |
| Lubbock | 48,909 | 44,018 | 39,616 | 35,655 | 32,089 | 28,880 |
| Lynn | 11,660 | 10,494 | 9,445 | 8,500 | 7,650 | 6,885 |
| Motley | 886 | 798 | 718 | 646 | 582 | 523 |
| Parmer | 19,120 | 17,208 | 15,487 | 13,938 | 12,545 | 11,290 |
| Swisher | 52,517 | 47,266 | 42,539 | 38,285 | 34,457 | 31,011 |
| Terry | 13,285 | 11,956 | 10,760 | 9,684 | 8,716 | 7,844 |
| Yoakum | 10,407 | 9,366 | 8,429 | 7,587 | 6,828 | 6,145 |
| Total | 479,466 | 431,517 | 388,366 | 349,528 | 314,577 | 283,118 |
| **Cost Per Acre-Foot[1]** | **$ 63** | **$ 70** | **$ 78** | **$ 86** | **$ 96** | **$ 106** |

[1] Projections are based upon estimates that well yields will decline one percent per year. Since water conservation potentials are 0.61 acre-feet per acre, and the well yield decline of one percent per year projection is applied throughout the region, the cost per acre-foot estimate is the same for each county, and increases at each projected decade because annual costs per year remain the same while the quantity of water saved each year declines.

**Table 4.4-13C.**
**Projected Irrigation Water Needs (Shortages) with Irrigation Water Conservation**
**Llano Estacado Region**

| County | Projections | | | | | |
|---|---|---|---|---|---|---|
| | 2010 (acft/yr) | 2020 (acft/yr) | 2030 (acft/yr) | 2040 (acft/yr) | 2050 (acft/yr) | 2060 (acft/yr) |
| **Bailey County** | | | | | | |
| Projected Irrigation Need (Shortage) | 81,561 | 85,721 | 84,647 | 84,229 | 83,647 | 83,220 |
| Irrigation Conservation Potentials * | 18,636 | 16,772 | 15,095 | 13,585 | 12,227 | 11,004 |
| Projected Shortage with Irrigation Conservation | 62,926 | 68,949 | 69,553 | 70,644 | 71,420 | 72,216 |
| **Briscoe County** | | | | | | |
| Projected Irrigation Need (Shortage) | 0 | 4,684 | 12,029 | 13,577 | 14,821 | 14,523 |
| Irrigation Conservation Potentials * | 6,555 | 5,900 | 5,310 | 4,779 | 4,301 | 3,871 |
| Projected Shortage with Irrigation Conservation | 0 | 0 | 6,719 | 8,798 | 10,520 | 10,652 |
| **Castro County** | | | | | | |
| Projected Irrigation Need (Shortage) | 146,695 | 191,790 | 263,849 | 351,293 | 352,004 | 346,166 |
| Irrigation Conservation Potentials * | 42,268 | 38,041 | 34,237 | 30,813 | 27,732 | 24,959 |
| Projected Shortage with Irrigation Conservation | 104,427 | 153,749 | 229,612 | 320,480 | 324,272 | 321,207 |
| **Cochran County** | | | | | | |
| Projected Irrigation Need (Shortage) | 39,909 | 38,596 | 37,006 | 35,505 | 76,645 | 72,644 |
| Irrigation Conservation Potentials * | 20,215 | 18,193 | 16,374 | 14,737 | 13,263 | 11,937 |
| Projected Shortage with Irrigation Conservation | 19,694 | 20,403 | 20,632 | 20,768 | 63,382 | 60,707 |
| **Crosby County** | | | | | | |
| Projected Irrigation Need (Shortage) | 17,030 | 16,573 | 16,327 | 15,870 | 14,494 | 14,102 |
| Irrigation Conservation Potentials * | 26,380 | 23,742 | 21,368 | 19,231 | 17,308 | 15,577 |
| Projected Shortage with Irrigation Conservation | 0 | 0 | 0 | 0 | 0 | 0 |
| **Dawson County** | | | | | | |
| Projected Irrigation Need (Shortage) | 95,628 | 94,657 | 89,924 | 85,978 | 79,229 | 73,068 |
| Irrigation Conservation Potentials * | 6,080 | 5,472 | 4,925 | 4,432 | 3,989 | 3,590 |
| Projected Shortage with Irrigation Conservation | 89,548 | 89,185 | 84,999 | 81,546 | 75,240 | 69,478 |
| **Deaf Smith County** | | | | | | |
| Projected Irrigation Need (Shortage) | 171,481 | 195,821 | 225,001 | 254,754 | 247,310 | 242,805 |
| Irrigation Conservation Potentials * | 42,246 | 38,022 | 34,219 | 30,797 | 27,718 | 24,946 |
| Projected Shortage with Irrigation Conservation | 129,235 | 157,799 | 190,782 | 223,957 | 219,592 | 217,859 |
| **Dickens County** | | | | | | |
| Projected Irrigation Need (Shortage) | 3,321 | 3,185 | 3,053 | 2,921 | 2,792 | 2,663 |
| Irrigation Conservation Potentials * | 1,803 | 1,622 | 1,460 | 1,314 | 1,183 | 1,064 |
| Projected Shortage with Irrigation Conservation | 1,518 | 1,563 | 1,593 | 1,607 | 1,609 | 1,599 |

Continued on next page

***Table 4.4-13C (continued)***

| County | Projections | | | | | |
|---|---|---|---|---|---|---|
| | **2010 (acft/yr)** | **2020 (acft/yr)** | **2030 (acft/yr)** | **2040 (acft/yr)** | **2050 (acft/yr)** | **2060 (acft/yr)** |
| **Floyd County** | | | | | | |
| Projected Irrigation Need (Shortage) | 90,731 | 106,391 | 108,967 | 108,966 | 105,148 | 100,073 |
| Irrigation Conservation Potentials * | 44,665 | 40,198 | 36,178 | 32,561 | 29,305 | 26,374 |
| Projected Shortage with Irrigation Conservation | 46,066 | 66,193 | 72,789 | 76,405 | 75,843 | 73,699 |
| **Gaines County** | | | | | | |
| Projected Irrigation Need (Shortage) | 67,285 | 105,447 | 119,451 | 127,613 | 134,285 | 139,981 |
| Irrigation Conservation Potentials * | 10,515 | 9,463 | 8,517 | 7,665 | 6,898 | 6,209 |
| Projected Shortage with Irrigation Conservation | 56,770 | 95,984 | 110,934 | 119,948 | 127,387 | 133,772 |
| **Garza County** | | | | | | |
| Projected Irrigation Need (Shortage) | 4,712 | 4,301 | 3,995 | 3,721 | 3,455 | 3,212 |
| Irrigation Conservation Potentials * | 4,428 | 3,985 | 3,587 | 3,228 | 2,905 | 2,615 |
| Projected Shortage with Irrigation Conservation | 284 | 316 | 408 | 493 | 550 | 597 |
| **Hale County** | | | | | | |
| Projected Irrigation Need (Shortage) | 22,217 | 55,312 | 138,629 | 206,294 | 222,871 | 221,050 |
| Irrigation Conservation Potentials * | 42,381 | 38,143 | 34,329 | 30,896 | 27,806 | 25,026 |
| Projected Shortage with Irrigation Conservation | 0 | 17,169 | 104,300 | 175,398 | 195,065 | 196,024 |
| **Hockley County** | | | | | | |
| Projected Irrigation Need (Shortage) | 63,682 | 75,675 | 82,859 | 87,831 | 83,837 | 81,644 |
| Irrigation Conservation Potentials * | 28,053 | 25,247 | 22,723 | 20,450 | 18,405 | 16,565 |
| Projected Shortage with Irrigation Conservation | 35,629 | 50,428 | 60,136 | 67,381 | 65,432 | 65,079 |
| **Lamb County** | | | | | | |
| Projected Irrigation Need (Shortage) | 114,832 | 158,445 | 201,653 | 238,554 | 248,375 | 250,645 |
| Irrigation Conservation Potentials * | 28,457 | 25,611 | 23,050 | 20,745 | 18,670 | 16,803 |
| Projected Shortage with Irrigation Conservation | 86,375 | 132,834 | 178,603 | 217,809 | 229,705 | 233,842 |
| **Lubbock County** | | | | | | |
| Projected Irrigation Need (Shortage) | 61,046 | 90,653 | 99,575 | 109,703 | 102,293 | 96,846 |
| Irrigation Conservation Potentials * | 48,909 | 44,018 | 39,616 | 35,655 | 32,089 | 28,880 |
| Projected Shortage with Irrigation Conservation | 12,137 | 46,635 | 59,959 | 74,048 | 70,204 | 67,966 |
| **Lynn County** | | | | | | |
| Projected Irrigation Need (Shortage) | 550 | 508 | 464 | 408 | 406 | 402 |
| Irrigation Conservation Potentials * | 11,660 | 10,494 | 9,445 | 8,500 | 7,650 | 6,885 |
| Projected Shortage with Irrigation Conservation | 0 | 0 | 0 | 0 | 0 | 0 |

Continued on next page

***Table 4.4-13C (continued)***

| County | Projections | | | | | |
|---|---|---|---|---|---|---|
| | **2010 (acft/yr)** | **2020 (acft/yr)** | **2030 (acft/yr)** | **2040 (acft/yr)** | **2050 (acft/yr)** | **2060 (acft/yr)** |
| **Motley County** | | | | | | |
| Projected Irrigation Need (Shortage) | 1,332 | 1,266 | 1,208 | 1,154 | 1,092 | 1,025 |
| Irrigation Conservation Potentials * | 886 | 798 | 718 | 646 | 582 | 523 |
| Projected Shortage with Irrigation Conservation | 446 | 468 | 490 | 508 | 510 | 502 |
| **Parmer County** | | | | | | |
| Projected Irrigation Need (Shortage) | 161,382 | 331,230 | 361,623 | 357,040 | 351,465 | 346,700 |
| Irrigation Conservation Potentials * | 19,120 | 17,208 | 15,487 | 13,938 | 12,545 | 11,290 |
| Projected Shortage with Irrigation Conservation | 142,262 | 314,022 | 346,136 | 343,102 | 338,920 | 335,410 |
| **Swisher County** | | | | | | |
| Projected Irrigation Need (Shortage) | 22,646 | 60,423 | 95,875 | 105,385 | 107,602 | 107,533 |
| Irrigation Conservation Potentials * | 52,517 | 47,266 | 42,539 | 38,285 | 34,457 | 31,011 |
| Projected Shortage with Irrigation Conservation | 0 | 13,157 | 53,336 | 67,100 | 73,145 | 76,522 |
| **Terry County** | | | | | | |
| Projected Irrigation Need (Shortage) | 74,888 | 91,977 | 101,067 | 106,240 | 97,749 | 89,755 |
| Irrigation Conservation Potentials * | 13,285 | 11,956 | 10,760 | 9,684 | 8,716 | 7,844 |
| Projected Shortage with Irrigation Conservation | 61,603 | 80,021 | 90,307 | 96,556 | 89,033 | 81,911 |
| **Yoakum County** | | | | | | |
| Projected Irrigation Need (Shortage) | 23,779 | 22,744 | 21,868 | 20,553 | 19,576 | 18,502 |
| Irrigation Conservation Potentials * | 10,407 | 9,366 | 8,429 | 7,587 | 6,828 | 6,145 |
| Projected Shortage with Irrigation Conservation | 13,372 | 13,378 | 13,439 | 12,966 | 12,748 | 12,357 |
| **Llano Estacado Region**** | | | | | | |
| Projected Irrigation Need (Shortage) | 1,264,707 | 1,735,400 | 2,069,069 | 2,317,590 | 2,349,096 | 2,306,560 |
| Irrigation Conservation Potentials * | 479,465 | 431,517 | 388,365 | 349,529 | 314,576 | 283,118 |
| Projected Shortage with Irrigation Conservation ** | 862,291 | 1,322,253 | 1,694,725 | 1,979,6514 | 2,044,577 | 2,031,400 |

* Potential conservation is estimated to be reduced by 1 percent per year due to reduced well yields because of thinning of the saturated thicknesses within the aquifer. This is the same estimate used in the water supply computations.

**Sum of the County Rows for the Llano Estacado Region that have calculate shortages (Is not Projected Shortage minus Conservation Potential).

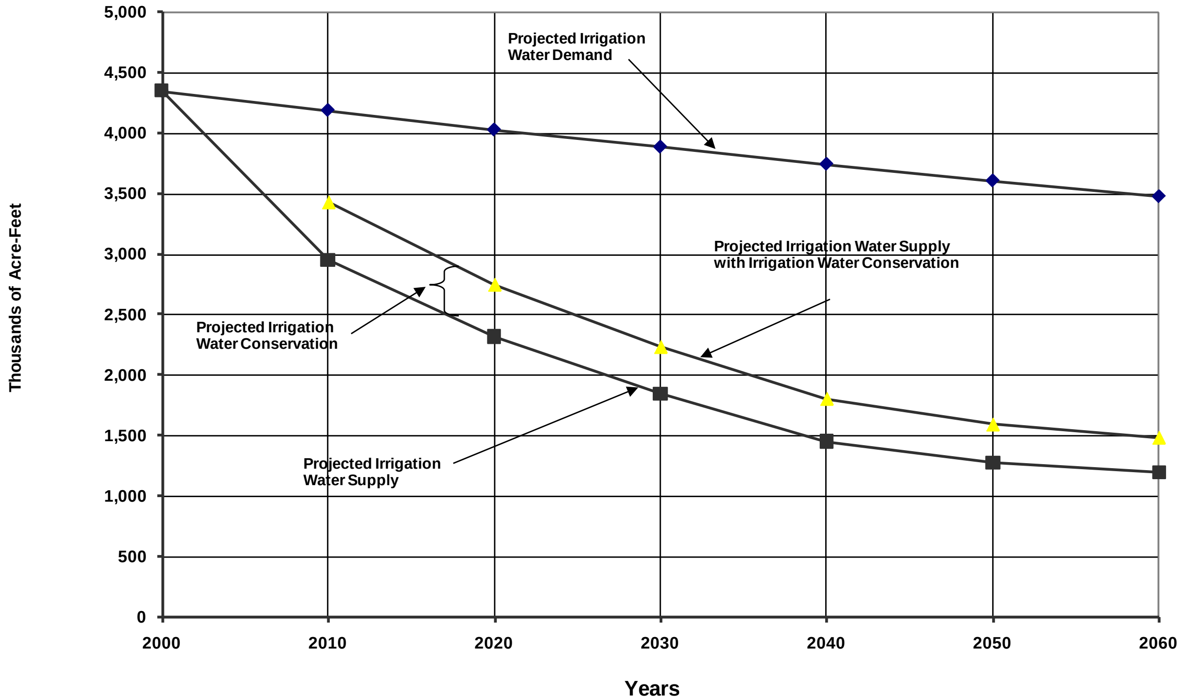



***Figure 4.4-2. Projected Irrigation Water Demand, Water Supply and Water Supply with Irrigation Water Conservation***

The Llano Estacado Regional Water Plan includes the recommendation that Llano Estacado Region irrigation farmers continue to use irrigation water conservation BMPs, and further recommends that all irrigation farmers of the Region adopt the previously described BMPs and consider and adopt, where practical, new irrigation water conservation methods that become available in the future. The LERWPG especially recommends the adoption of any successful management strategies that result from the Texas Alliance for Water Conservation Demonstration Project located in Floyd and Hale Counties. The Texas Alliance for Water Conservation Demonstration Project is an 8-year study to identify and quantify the best agricultural projection practices and technologies to reduce groundwater pumpage from the Ogallala Aquifer, while maintaining agricultural production and economic opportunities. The use of irrigation BMPs in the past has increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region, and the longevity of the aquifer. Such contributions are, in effect, operating to offset a part of the irrigation water shortages that have occurred in the past, and are projected to occur in the future as the Ogallala aquifer water levels decline.

The Region O Water Planning Group recognizes that the High Plains Ogallala aquifer with any appreciable pumping, is not sustainable, however with the implementation of water conservation strategies, the longevity of the Ogallala can be appreciably extended. Ground water is an exceedingly valuable asset to all of the Region O landowners and water rights holders, whether agricultural, municipal or industrial, and justifies implementation of all currently available water conservation strategies and technologies, including refinements thereto, and all strategies which may be developed in the future. The Llano Estacado Regional Water Planning Group believes that water in the ground is like money in a bank and such should be spent wisely.

### *4.4.2 Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply*

#### *4.4.2.1 Description of Option*

Most municipal water systems in the Llano Estacado Region obtain water from the Ogallala Aquifer for all or part of their supply. This source is strongly preferred since it is readily available at a comparatively reasonable cost, in most cases it is the only available local supply, and it is suitable as a public supply with minimal treatment (disinfection only). The water management strategy identified as one way to meet the needs of cities of the Llano Estacado Region that overlie the Ogallala Aquifer is to obtain additional supplies from the aquifer beneath the area surrounding or near to the city. This option is evaluated as to the approximate distance to additional water supplies; the dates at which additional supplies are projected to be needed; and the costs of land, wells, and conveyance facilities to obtain the needed supplies. The results are presented in Section 4.4.2.2.

#### *4.4.2.2 Available Supply from the Ogallala Aquifer to Meet Projected Needs of Cities*

During 1999, staff members of the High Plains UWCD No. 1 made an analysis of the existing saturated thickness of the water-bearing formation of each city’s well field(s) and the saturated thickness of the aquifer in areas surrounding each city. The volumes of groundwater in storage in each city’s well field(s) in 1995 were calculated from saturated thickness maps. Of the 51 cities in the Llano Estacado Region for which the TWDB has made water use projections, and that are projected to obtain all or part of their supply from the Ogallala Aquifer, 29 were projected to need additional supplies during the planning period (Lake Alan Henry Water Supply

District also needs water)(Section 4.1 and Figure 4.4-3). Of the 29 cities with projected needs, Brownfield has indicated that additional supply is to be obtained from CRMWA. In addition, Plainview, located in Hale County, although not projected to need additional water supplies, is included in this option due to the City's plan to drill additional wells in the near future. The City of Lubbock has also indicated an interest in participating in the development of additional groundwater supplies from the Ogallala aquifer including the augmentation of water supplies through linear well fields along existing water transmission lines.

For those cities obtaining water from both groundwater and surface water sources, the projected surface water supplies were estimated from water use data supplied by the respective surface water suppliers, and groundwater was used for the remaining supply to meet the total projected demand. As was determined in the analyses, in all but three cases adequate saturated formation exists within a 2- to 5-mile radius of each city, respectively, to locate new well fields. For the other three, the distances are between 6 and 14 miles. The method of estimating costs and the data and assumptions used in evaluation of this water management strategy are presented in Section 4.2.2.4. The new wells would be sized to meet the peak day demands of the city. As was done elsewhere in this study, calculations were based upon the assumption that the yields of new wells will decline 1 percent per year as the saturated thickness of the aquifer declines due to pumping. New wells would be located as close to the city as feasible.

#### *4.4.2.3 Environmental Issues*

The implementation of this option to supply cities with water to meet future needs is not expected to have significant, if any, adverse environmental effects. Wells will likely be located on property that has previously been altered by agriculture, and pipelines will be located in county and state road rights-of-way. In cases where these conditions are not met, field inspection of potential well sites and pipeline rights-of-way can be done, and well sites and pipeline routes can be selected to avoid sensitive wildlife habitat, plant communities, and/or cultural resources.

#### *4.4.2.4 Engineering and Costing*

A representative set of costs for wells, pipelines, and land was developed (Table 4.4-15). For cost estimating purposes, it was assumed that pumps would be sized to provide the needed pressure to move the water from the well to the distribution system without additional storage at

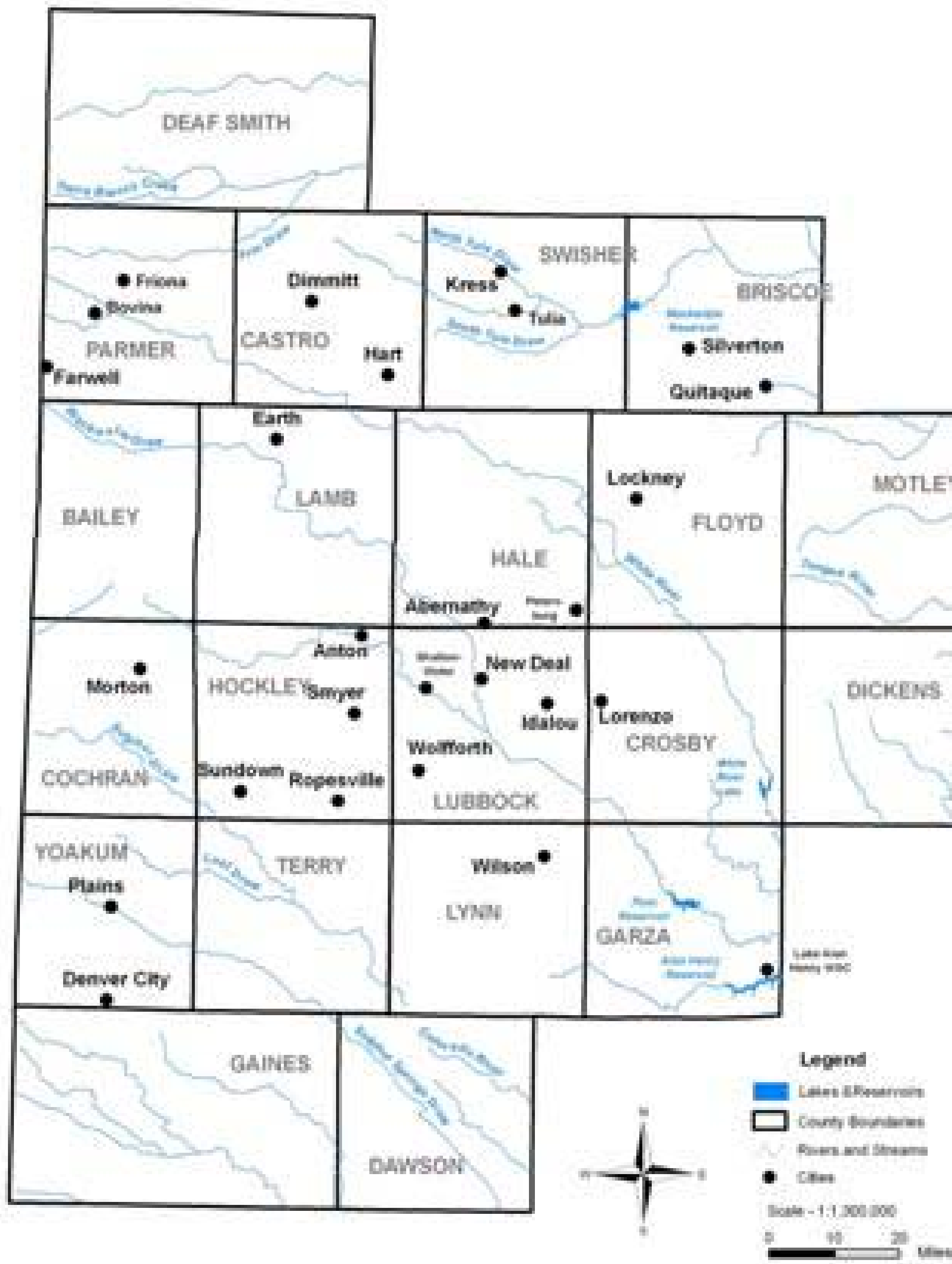



*Figure 4.4-3. Cities Projected to Need Additional Water Supply*

**Table 4.4-14.**
**Representative Costs — Llano Estacado Region**

| Item | Cost[1] |
|---|---|
| 4-inch well and related equipment (Ogallala) | $71,000 |
| 6-inch well and related equipment (Ogallala) | $106,500 |
| 4-inch PVC pipe | $17 per foot |
| 6-inch PVC pipe | $25 per foot |
| 8-inch PVC pipe | $34 per foot |
| 10-inch PVC pipe | $42 per foot |
| 12-inch PVC pipe | $51 per foot |
| 14-inch PVC pipe | $57 per foot |
| 16-inch PVC pipe | $64 per foot |
| 18-inch PVC pipe | $72 per foot |
| Land[2] | $1,650 per acre |

[1] All costs are in September 2008 prices.
[2] Assumed 40 acres purchased per well needed.

the well site and without the need for booster pumps along the pipelines. It was estimated that the city would need to purchase 40 acres of land per well needed. In calculating pipeline costs, it was assumed that a single pipeline sized to carry all of the projected additional supply would be used to transport water from the well field to the city's distribution system, with smaller pipelines connecting individual wells to the main transmission pipeline, and that transmission pipelines would be located in existing rights-of-way along county roads, eliminating the costs of purchasing land for new rights-of-way. It was further assumed that interest during construction would not be needed, since construction periods would be of short duration; i.e.; a few months.

Using the data and cost assumptions shown in Table 4.4-14, 10 percent of the total capital costs for engineering and contingencies, and 1 percent of pipeline and 1.5 percent of well capital costs for operation and maintenance, financing wells and transmission pipelines for 30 years at 6 percent annual interest, and power costs of $0.06 per kWh, costs were computed for this water management strategy (Tables 4.4-15 through 4.4-38). A summary sheet is presented for each city that is estimated to need additional water supplies. The summary shows the approximate date at which new wells will be needed, the distance to potentially available supply, the capacity needed, and the costs for land, wells and equipment, and pipelines. The costs are expressed as total capital costs, annual debt service, annual operation and maintenance, including power costs, cost per acft, and cost per 1,000 gallons of water (Tables 4.4-15 through 4.4-38). The individual city plans are provided on the following tables.

**Table 4.4-15**

7/6/2009
7/8/2010

**City of Abernathy Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hale and Lubbock Counties**

| Projected Water Needs (acft/yr) | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Municipal Need[1] | | | 0 | 0 | 304 | 366 | 403 | 433 | 446 |

| New Water Supplies (acft/yr)[2] | | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| Implemented | Well #1 | 2011 | 2002 | | - | - | - | - | - | - |
| | Well #2 | 2015 | | | | 428 | 385 | 346 | 312 | 280 |
| | Well #3 | 2015 | | | | 202 | 182 | 164 | 147 | 132 |
| | Well #4 | 2025 | | | | | 202 | 182 | 164 | 147 |
| | Well #5 | 2042 | | | | | | | 196 | 176 |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | Total New Supplies | | | 0 | 0 | 629 | 768 | 691 | 818 | 736 |
| | Total Surplus / Deficit | | | 0 | 0 | 325 | 402 | 288 | 385 | 290 |

| Well #[6] | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #3 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #4 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #5 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Well #1.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.
6 Gray highlighted row(s) signify wells included in the 2006 LERWP that have been implemented. Therefore, well information and costs have not been included for these wells.

**Table 4.4-16**

**City of Anton Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hockley County**

**Projected Water Needs (acft/yr)**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | 0 | 263 | 270 | 272 | 268 | 256 | 243 |

**New Water Supplies (acft/yr)[2]**

| | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2006 | | | 204 | 184 | 165 | 149 | 134 | 120 |
| Well #2 | 2006 | | | 204 | 184 | 165 | 149 | 134 | 120 |
| Well #3 | 2015 | | | | 202 | 182 | 164 | 147 | 132 |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 408 | 569 | 512 | 461 | 415 | 373 |
| Total Surplus / Deficit | | | 0 | 145 | 299 | 240 | 193 | 159 | 130 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 4 | 8 | $66,000 | $71,000 | $722,007 | $859,007 | $85,901 | $82,377 | $19,138 | $239 | $0.73 |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #3 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-17**

**City of Bovina Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Parmer County**

| Projected Water Needs (acft/yr) | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| **Total Municipal Need**[1] | 0 | 0 | 334 | 335 | 330 | 317 | 300 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2015 | | | | 202 | 182 | 164 | 147 | 132 |
| Well #2 | 2015 | | | | 202 | 182 | 164 | 147 | 132 |
| Well #3 | 2025 | | | | | 202 | 182 | 164 | 147 |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 0 | 404 | 565 | 509 | 458 | 412 |
| **Total Surplus / Deficit** | | | 0 | 0 | 70 | 230 | 179 | 141 | 112 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 3 | 8 | $66,000 | $71,000 | $541,505 | $678,505 | $67,851 | $65,067 | $17,333 | $194 | $0.60 |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #3 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-18**

**City of Denver City Projected Water Needs and Water Management Strategy (Includes adjoining subdivision)**
**Llano Estacado Region - Yoakum County**

| | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Projected Water Needs (acft/yr)** | | | | | | | | | | |
| | **Total Municipal Need**[1] | | | 0 | 0 | 0 | 979 | 1,046 | 1,024 | 1,000 |
| **New Water Supplies (acft/yr)**[2] | | **Year Needed** | **Year Added** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Implemented | Well #1 | 2021 | 2004 | | - | - | - | - | - | - |
| | Well #2 | 2023 | | | | | 419 | 377 | 339 | 305 |
| | Well #3 | 2025 | | | | | 428 | 385 | 346 | 312 |
| | Well #4 | 2027 | | | | | 437 | 393 | 354 | 318 |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | **Total New Supplies** | | | 0 | 0 | 0 | 1,283 | 1,154 | 1,039 | 935 |
| | **Total Surplus / Deficit** | | | 0 | 0 | 0 | 304 | 108 | 15 | -65 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #3 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #4 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Well #1.
2 Includes additional municipal need for adjoining subdivision served by the City of Denver City.
3 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-19**

**City of Dimmitt Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Castro County**

| Projected Water Needs (acft/yr) | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Municipal Need[1] | | | 0 | 0 | 0 | 744 | 805 | 832 | 844 |

| New Water Supplies (acft/yr)[2] | | | Year Needed | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| Implemented | Well #1 | 2017 | 2005 | | - | - | - | - | - | - |
| | Well #2 | 2019 | | | | 446 | 401 | 361 | 325 | 292 |
| | Well #3 | 2021 | | | | | 410 | 369 | 332 | 299 |
| | Well #4 | 2042 | | | | | | | 414 | 373 |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | Total New Supplies | | | 0 | 0 | 446 | 810 | 729 | 1,070 | 963 |
| | Total Surplus / Deficit | | | 0 | 0 | 446 | 66 | -76 | 238 | 119 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #3 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #4 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Well #1.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-20**

**City of Earth Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lamb County**

| Projected Water Needs (acft/yr) | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | 0 | 0 | 0 | 0 | 283 | 280 | 276 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2031 | | | | | | 193 | 174 | 157 |
| Well #2 | 2034 | | | | | | 200 | 180 | 162 |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 0 | 0 | 0 | 393 | 354 | 318 |
| **Total Surplus / Deficit** | | | 0 | 0 | 0 | 0 | 110 | 74 | 42 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 3 | 6 | $66,000 | $71,000 | $395,715 | $532,715 | $53,272 | $51,086 | $15,875 | $158 | $0.48 |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-21**

**City of Farwell Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Parmer County**

| Projected Water Needs (acft/yr) | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Total Municipal Need[1]** | | | 0 | 0 | 1 | 46 | 80 | 99 | 106 |

| New Water Supplies (acft/yr)[2] | | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| Implemented | Well #1 | 2015 | 2002 | | - | - | - | - | - | - |
| Implemented | Well #2 | 2015 | 2002 | | | - | - | - | - | - |
| | Well #3 | 2020 | | | | 147 | 132 | 119 | 107 | 107 |
| | Well #4 | | | | | | | | | |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | **Total New Supplies** | | | 0 | 0 | 147 | 132 | 119 | 107 | 107 |
| | **Total Surplus / Deficit** | | | 0 | 0 | 146 | 86 | 39 | 8 | 1 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #3 | 200 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $149 | $0.46 |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Wells #1 and #2.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-22**

**City of Friona Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Parmer County**

| Projected Water Needs (acft/yr) | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total Municipal Need[1] | | | 0 | 0 | 0 | 384 | 425 | 437 | 431 |

| New Water Supplies (acft/yr)[2] | | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| Implemented | Well #1 | 2010 | 2001 | - | - | - | - | - | - | - |
| Implemented | Well #2 | 2018 | 2004 | - | - | - | - | - | - | - |
| | Well #3 | 2023 | | | | | 419 | 377 | 339 | 305 |
| | Well #4 | 2023 | | | | | 419 | 377 | 339 | 305 |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | Total New Supplies | | | 0 | 0 | 0 | 837 | 753 | 678 | 610 |
| | Total Surplus / Deficit | | | 0 | 0 | 0 | 453 | 328 | 241 | 179 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4,6] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #3 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #4 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Wells #1 and #2.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.
6 Costs for the 241 acft/yr capacity well were provided by the City of Friona.

**Table 4.4-23**

**City of Hart Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Castro County**

**Projected Water Needs (acft/yr)**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| **Total Municipal Need**[1] | 0 | 0 | 0 | 0 | 0 | 67 | 82 |

**New Water Supplies (acft/yr)**[2]

| | | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| Implemented | Well #1 | 2041 | 2002 | - | - | - | - | - | - | - |
| | Well #2 | 2043 | | | | | | | 198 | 178 |
| | Well #3 | | | | | | | | | |
| | Well #4 | | | | | | | | | |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | **Total New Supplies** | | | 0 | 0 | 0 | 0 | 0 | 198 | 178 |
| | **Total Surplus / Deficit** | | | 0 | 0 | 0 | 0 | 0 | 131 | 96 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $329,100 | $67,860 | $462,960 | $46,296 | $44,397 | $19,049 | $149 | $0.46 |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation and implementation of Well #1.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-24**

**City of Idalou Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lubbock County**

| **Projected Water Needs (acft/yr)** | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| **Total Municipal Need[1]** | | 0 | 0 | 0 | 0 | 274 | 273 | 272 |

| **New Water Supplies (acft/yr)[2]** | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2031 | | | | | | 410 | 369 | 332 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 0 | 0 | 0 | 410 | 369 | 332 |
| **Total Surplus / Deficit** | | | 0 | 0 | 0 | 0 | 136 | 96 | 60 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 4 | 6 | $66,000 | $106,500 | $527,620 | $700,120 | $70,012 | $67,140 | $29,374 | $107 | $0.33 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-25**

**City of Lockney Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Floyd County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 0 | 240 | 234 | 224 | 212 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2021 | | | | | 410 | 369 | 332 | 299 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 0 | 410 | 369 | 332 | 299 |
| Total Surplus / Deficit | | | 0 | 0 | 0 | 170 | 135 | 108 | 87 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 2 | 4 | $66,000 | $106,500 | $180,502 | $353,002 | $35,300 | $33,852 | $25,903 | $66 | $0.20 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-26**

**City of Lorenzo Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Crosby County**

| Projected Water Needs (acft/yr) | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | 0 | 0 | 0 | 37 | 69 | 92 | 108 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2021 | | | | | 206 | 185 | 167 | 150 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 0 | 206 | 185 | 167 | 150 |
| Total Surplus / Deficit | | | 0 | 0 | 0 | 169 | 116 | 75 | 42 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 2 | 4 | $66,000 | $71,000 | $180,502 | $317,502 | $31,750 | $30,448 | $13,723 | $104 | $0.32 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-27**

**City of Morton Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Cochran County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 560 | 565 | 547 | 521 | 496 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2015 | | | | 428 | 385 | 346 | 312 | 280 |
| Well #2 | 2015 | | | | 428 | 385 | 346 | 312 | 280 |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 855 | 770 | 693 | 623 | 561 |
| Total Surplus / Deficit | | | 0 | 0 | 295 | 205 | 146 | 102 | 65 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 3 | 10 | $66,000 | $106,500 | $666,468 | $838,968 | $83,897 | $80,455 | $30,762 | $124 | $0.38 |
| Well #2 | 900 | 0.5 | 6 | $66,000 | $106,500 | $65,953 | $238,453 | $23,845 | $22,867 | $24,757 | $53 | $0.16 |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-28**

**City of New Deal Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lubbock County**

| Projected Water Needs (acft/yr) | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| **Total Municipal Need[1]** | 0 | 0 | 12 | 20 | 20 | 20 | 20 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2011 | | | | 193 | 174 | 157 | 141 | 127 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 0 | 193 | 174 | 157 | 141 | 127 |
| **Total Surplus / Deficit** | | | 0 | 0 | 181 | 154 | 137 | 121 | 107 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 4 | 4 | $66,000 | $71,000 | $361,003 | $498,003 | $49,800 | $47,758 | $15,528 | $149 | $0.46 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-29**

**City of Petersburg Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hale County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 0 | 0 | 0 | 312 | 306 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2041 | | | | | | | 410 | 369 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 0 | 0 | 0 | 410 | 369 |
| Total Surplus / Deficit | | | 0 | 0 | 0 | 0 | 0 | 98 | 63 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 1 | 6 | $66,000 | $106,500 | $131,905 | $304,405 | $30,441 | $29,192 | $25,417 | $61 | $0.19 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-30**

**City of Plains Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Yoakum County**

| Projected Water Needs (acft/yr) | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | 0 | 0 | 448 | 468 | 488 | 473 | 457 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2012 | | | | 414 | 373 | 335 | 302 | 272 |
| Well #2 | 2016 | | | | 204 | 184 | 165 | 149 | 134 |
| Well #3 | 2045 | | | | | | | 149 | 134 |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 618 | 556 | 501 | 600 | 539 |
| Total Surplus / Deficit | | | 0 | 0 | 170 | 88 | 13 | 127 | 82 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 3 | 8 | $66,000 | $106,500 | $541,505 | $714,005 | $71,401 | $68,472 | $29,513 | $109 | $0.33 |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #3 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-31**

**City of Silverton Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Briscoe County**

**Projected Water Needs (acft/yr)**

| | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| **Total Municipal Need**[1] | 0 | 128 | 126 | 123 | 115 | 111 | 108 |

**New Water Supplies (acft/yr)**[2]

| | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Wells #1,2,&3 | 2012 | | | 217 | 195 | 176 | 158 | 142 | 128 |
| | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 217 | 195 | 176 | 158 | 142 | 128 |
| **Total Surplus / Deficit** | | | 0 | 89 | 69 | 53 | 43 | 31 | 20 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wells #1,2,&3 | 425 | 12 | 12 | $1,056,000 | $675,000 | $2,950,000 | $4,681,000 | $1,490,850 | $538,062 | $56,518 | $1,399 | $4.29 |
| | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 30% of pipeline costs and 35% of other costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-32**

**City of Ropesville Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hockley County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 0 | 91 | 89 | 85 | 81 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2021 | | | | | 193 | 174 | 157 | 141 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 0 | 193 | 174 | 157 | 141 |
| Total Surplus / Deficit | | | 0 | 0 | 0 | 102 | 85 | 72 | 60 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 2 | 4 | $66,000 | $71,000 | $180,502 | $317,502 | $31,750 | $30,448 | $13,723 | $104 | $0.32 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-33**

**City of Shallowater Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lubbock County**

| Projected Water Needs (acft/yr) | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | 0 | 157 | 180 | 190 | 184 | 192 | 184 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2006 | | | 432 | 389 | 350 | 315 | 283 | 255 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 432 | 389 | 350 | 315 | 283 | 255 |
| Total Surplus / Deficit | | | 0 | 275 | 209 | 160 | 131 | 91 | 71 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 2 | 6 | $66,000 | $106,500 | $263,810 | $436,310 | $43,631 | $41,841 | $26,736 | $76 | $0.23 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-34**

**City of Smyer Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hockley County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 0 | 0 | 0 | 0 | 62 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2051 | 2051 | | | | | | | 193 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 0 | 0 | 0 | 0 | 193 |
| Total Surplus / Deficit | | | 0 | 0 | 0 | 0 | 0 | 0 | 131 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 1 | 4 | $66,000 | $71,000 | $90,251 | $227,251 | $22,725 | $21,793 | $12,821 | $81 | $0.25 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-35**

**City of Sundown Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Hockley County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 350 | 353 | 347 | 332 | 316 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2016 | | | | 204 | 184 | 165 | 149 | 134 |
| Well #2 | 2018 | | | | 208 | 187 | 169 | 152 | 137 |
| Well #3 | 2023 | | | | | 198 | 178 | 160 | 144 |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 412 | 569 | 512 | 461 | 415 |
| Total Surplus / Deficit | | | 0 | 0 | 62 | 216 | 165 | 129 | 99 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 2 | 8 | $66,000 | $71,000 | $361,003 | $498,003 | $49,800 | $47,758 | $15,528 | $149 | $0.46 |
| Well #2 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #3 | 425 | 0.5 | 4 | $66,000 | $71,000 | $45,125 | $182,125 | $18,213 | $17,465 | $12,369 | $70 | $0.22 |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-36**

**City of Tulia Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Swisher County**

| Projected Water Needs (acft/yr) | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | 0 | 417 | 417 | 417 | 417 | 417 | 417 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2006 | | | 432 | 389 | 350 | 315 | 283 | 255 |
| Well #2 | 2006 | | | 432 | 389 | 350 | 315 | 283 | 255 |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| **Total New Supplies** | | | 0 | 864 | 778 | 700 | 630 | 567 | 510 |
| **Total Surplus / Deficit** | | | 0 | 447 | 361 | 283 | 213 | 150 | 93 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 900 | 4 | 10 | $66,000 | $106,500 | $888,624 | $1,061,124 | $106,112 | $101,760 | $32,984 | $150 | $0.46 |
| Well #2 | 900 | 0.5 | 4 | $66,000 | $106,500 | $45,125 | $217,625 | $21,763 | $20,870 | $24,549 | $50 | $0.15 |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**
1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-37**

**City of Wilson Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lynn County**

| Projected Water Needs (acft/yr) | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Total Municipal Need[1] | | | 0 | 0 | 68 | 65 | 63 | 60 | 55 |

| New Water Supplies (acft/yr)[2] | Year Needed | Year Added | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 2011 | | | | 193 | 174 | 157 | 141 | 127 |
| Well #2 | | | | | | | | | |
| Well #3 | | | | | | | | | |
| Well #4 | | | | | | | | | |
| Well #5 | | | | | | | | | |
| Well #6 | | | | | | | | | |
| Well #7 | | | | | | | | | |
| Well #8 | | | | | | | | | |
| Well #9 | | | | | | | | | |
| Well #10 | | | | | | | | | |
| Total New Supplies | | | 0 | 0 | 193 | 174 | 157 | 141 | 127 |
| Total Surplus / Deficit | | | 0 | 0 | 125 | 109 | 94 | 81 | 72 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 | 425 | 2 | 4 | $66,000 | $71,000 | $180,502 | $317,502 | $31,750 | $30,448 | $13,723 | $104 | $0.32 |
| Well #2 | | | | | | | | | | | | |
| Well #3 | | | | | | | | | | | | |
| Well #4 | | | | | | | | | | | | |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.

**Table 4.4-38**

**City of Wolfforth Projected Water Needs and Water Management Strategy**
**Llano Estacado Region - Lubbock County**

| | | | | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Projected Water Needs (acft/yr)** | | | | | | | | | | |
| | **Total Municipal Need[1]** | | | 0 | 0 | 0 | 0 | 0 | 165 | 388 |
| **New Water Supplies (acft/yr)[2]** | | **Year Needed** | **Year Added** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Implemented | Well #1 (6) | 2007 | 2007 | - | - | - | - | - | - | - |
| Implemented | Well #2 | 2011 | 2007 | - | - | - | - | - | - | - |
| Implemented | Well #3 (7) | 2019 | 2007 | - | - | - | - | - | - | - |
| | Well #4 | 2047 | | | | | | | 437 | 393 |
| | Well #5 | | | | | | | | | |
| | Well #6 | | | | | | | | | |
| | Well #7 | | | | | | | | | |
| | Well #8 | | | | | | | | | |
| | Well #9 | | | | | | | | | |
| | Well #10 | | | | | | | | | |
| | **Total New Supplies** | | | 0 | 0 | 0 | 0 | 0 | 437 | 393 |
| | **Total Surplus / Deficit** | | | 0 | 0 | 0 | 0 | 0 | 272 | 5 |

| Well # | Capacity (acft/yr) | Pipeline Length (miles)[3] | Pipeline Diameter (inches)[3] | Land Costs[4] | Well Costs[4] | Pipeline Costs[4] | Total Capital Costs[4] | Engineering & Contingency Costs[4] | Annual Debt Service[5] | Annual O&M Costs[4] | Annual Cost of Water ($/acft)[4] | Annual Cost of Water ($/1,000 gal)[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well #1 (6) | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #2 | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #3 (7) | - | - | - | - | - | - | - | - | - | - | - | - |
| Well #4 | 900 | 0.5 | 6 | $60,000 | $106,500 | $65,953 | $232,453 | $23,245 | $22,292 | $24,757 | $52 | $0.16 |
| Well #5 | | | | | | | | | | | | |
| Well #6 | | | | | | | | | | | | |
| Well #7 | | | | | | | | | | | | |
| Well #8 | | | | | | | | | | | | |
| Well #9 | | | | | | | | | | | | |
| Well #10 | | | | | | | | | | | | |

**Notes:**

1 Value represents total municipal need after low flow plumbing fixture water conservation, with implementation of Wells #1, #2, and #3.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1% per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in September 2008 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 20 years.
6 Represents 6 wells converted from irrigation use to municipal use. Costs associated with this development have been provided by the city.
7 Represents 4 wells developed on a recently purchased property. Costs associated with this development have been provided by the city.

### *4.4.3 Water Supply from Lake Alan Henry, Groundwater Sources, and Reclaimed Water*

Lake Alan Henry, (TCEQ Permit 4146) located in the southeastern corner of Garza County, on the Double Mountain Fork of the Brazos River, owned by the City of Lubbock, is a potential water management strategy for the Lake Alan Henry Water District and the City of Lubbock.[12] Each water management strategy is described and evaluated below.

#### *4.4.3.1 Lake Alan Henry Water District Water Management Strategy*

##### *4.4.3.1.1 Description of Option*

This water management strategy includes construction of the following water supply facilities at Lake Alan Henry (Figure 4.4-4):

Raw water intake on the north side of Lake Alan Henry near the dam on property to be acquired by the project sponsor(s) for that purpose;[13]

Raw water pipeline from the water intake to a water treatment plant located on the north side of Lake Alan Henry;

Water treatment plant on the north side of Lake Alan Henry in Garza County;

Treated water ground storage tank at the water treatment plant;

Treated water pipeline from the treated water storage tank to serve the following developments on the north side of Lake Alan Henry:

a. Community of Justiceburg;
b. Justiceburg Recreation Vehicle Park;
c. Grubs Recreation Vehicle Park;
d. North Ridge Recreation Vehicle Park;
e. North Ridge Development; and
f. Other areas within the Lake Alan Henry Water District; and

Treated water pipeline from the treated water ground storage tank across the Brazos River downstream of the dam, and extended to supply treated water to the following developments located near Lake Alan Henry in Garza and Kent Counties:

a. Rio Brazos Development;
b. West Rio Brazos Development;
c. Rio Brazos Recreation Vehicle Park;

[12] Raw Water Lease between The City of Lubbock and The Lake Alan Henry Water District, May 2008.

[13] Lease with Lubbock allows use of connection to Lubbock's LAH pipeline instead of an intake, however, the lease specifies that, "…there shall be times or events wherein water delivery to Lessee (Lake Alan Henry Water District) shall not be available and that the Lessor (City of Lubbock) is under no obligation to guarantee that water will be available if construction or operations by or on behalf of Lessor require that water delivery to Lessee be temporarily suspended." Therefore, the cost of an intake and pump station to serve the Water Treatment Plant has been included in this Water Management Strategy.

d. Community of Polar; and
e. Other Areas within the Lake Alan Henry Water District.

The quantity of water needed and the size of the facilities are based upon information about potential numbers of connections, people per connection, and daily water use rates shown in Table 4.4-39. (Note: Only the Community of Justiceburg has resident population that is

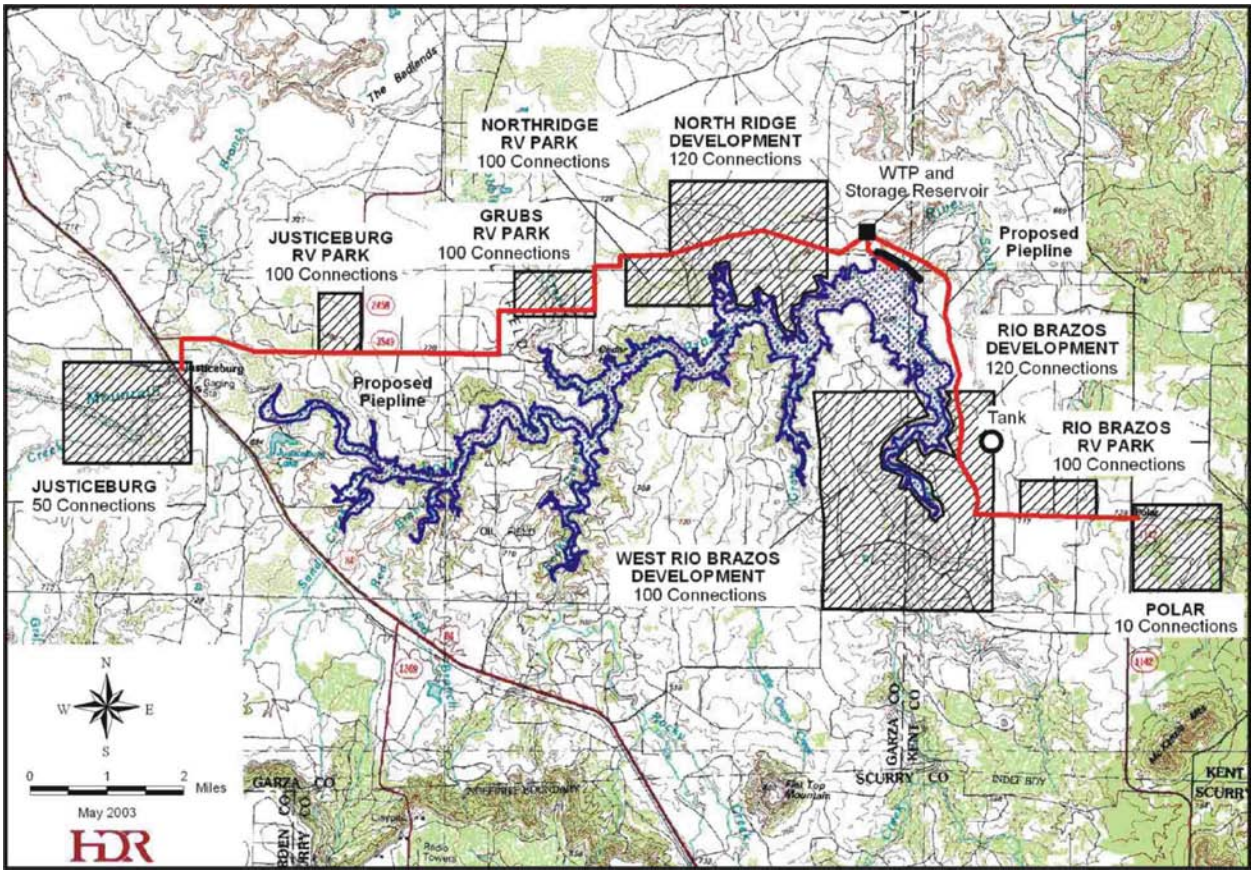



***Figure 4.4-4. Lake Alan Henry Water District Project***

included in the regional population and water demand projections. The remaining service areas have mostly transient populations and therefore need water only when people are present. However, this water management strategy is sized to meet the projected needs at full developed occupancy of communities and developments listed in Table 4.4-39.)

#### *4.4.3.1.2 Quantity of Water Available*

The quantity needed for this option is 270 acft/yr, of the 520 acft/yr specified in the raw water lease between the District and Lubbock, and would be obtained from Lake Alan Henry via a water supply lease between Lubbock and the Lake Alan Henry Water District. Lake Alan Henry has an estimated firm yield of 22,500 acft/yr, of which the quantity needed to supply this water management strategy is presently available, and will be available for the 50-year planning horizon (see Section 3.2.4).

**Table 4.4-39.**
**Potential Population and Water Demand**
**Lake Alan Henry Water District System[1]**

| Name of Development | Maximum Number of Connections | Population with Maximum Number of Connections | GPCD[2] Use Rate | Water Demand (acft/yr) |
|---|---|---|---|---|
| **North Side of Lake** | | | | |
| Justiceburg Community | 50 | 150 | 118 | 19.83 |
| Justiceburg RV Park | 100 | 300 | 45 | 15.12 |
| Grubs RV Park | 100 | 300 | 45 | 15.12 |
| North Ridge RV Park | 120 | 360 | 45 | 18.15 |
| North Ridge Development | 100 | 300 | 118 | 39.65 |
| **Subtotal** | **470** | **1,410** | **—** | **107.87** |
| **South Side of Lake** | | | | |
| Rio Brazos Development | 200 | 600 | 118 | 79.31 |
| West Rio Brazos Development | 120 | 360 | 118 | 47.58 |
| Rio Brazos RV Park | 200 | 600 | 45 | 30.24 |
| Polar Community | 10 | 30 | 118 | 3.97 |
| **Subtotal** | **530** | **1,590** | **—** | **161.10** |
| **Total** | | **3,000** | **—** | **268.97** |
| Quantity of Water (Million Gallons per Day) Average Use | | | | 0.25 |
| Peaking Factor of 2.0; Peak Day Demand (Million Gallons per Day) | | | | 0.50 |

[1] It is intended that other areas within the Lake Alan Henry Water Supply District can be served, as needed.
[2] GPCD is gallons per person per day.

### *4.4.3.1.3 Environmental Issues*

Water is to be obtained from Lake Alan Henry (TCEQ Permit 4146). The environmental issues associated with this option are for pipeline rights-of-way and sites for the water treatment plant and storage facilities. Since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

#### *4.4.3.1.4 Engineering and Costing*

Costs for this option include costs of:

- Land and rights-of-way;
- Raw water intake facilities (intake, pumps, and pipeline to water treatment plant);
- Surface water treatment plant;
- Treated water ground storage tank;
- Treated water pipelines, pumps and pump stations;
- Raw water;
- Engineering;
- Environmental and archeological studies,
- Permitting, and mitigation, if any; and
- Interest during construction.

The following assumptions and conditions were used in the costing of this option.

- The 270 acft of water can be obtained from Lake Alan Henry, which has an adequate yield to meet this demand.
- The cost for raw water from Lake Alan Henry is $590/acft.
- Cost of land for water treatment plant, pump stations, and storage tank is $275/acre.
- Cost of land for pipeline easements is $275/acre.
- The surface water treatment plant would have a capacity of 0.5 MGD and is sized to meet peak daily demands of the water users at build-out of all areas listed in Table 4-1.
- The pipelines are sized to meet peak daily water demands of the water users at build-out of all areas listed in Table 4.4-39.
- The costs given are for treated water delivered to the end users' respective locations, but do not include costs of distributing the treated water within the respective communities and subdivisions.
- Engineering, legal costs, and contingencies are calculated as 30 percent of the construction costs for the pipelines and 35 percent for all other facilities.
- Environmental and archeological studies, mitigation, and permitting costs are calculated as 100 percent of the land cost.
- Interest during construction is calculated at an annual rate of 6 percent with a 4 percent annual rate of return on funds balances during construction, which is estimated to be for a period of 2 (two) years.

The total project construction cost for this option was estimated at $7,334,502 (Table 4.4-40). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $532,485 for debt service (Table 4.4-40). Annual operation and maintenance (O&M) costs total $208,950 (Table 4.4-40). The total annual cost, including debt service, raw water cost, O&M cost, and power cost, is $904,135 (Table 4.4-40). For an annual delivery of 270 acft of treated water at the treated water storage tanks ready for distribution to end users the calculated cost per acft is $3,349 or $10.30 per thousand gallons (Table 4.4-40).

***Table 4.4-40.***
***Cost Estimate for***
***Lake Alan Henry Water District Project***
***Llano Estacado and Brazos G Regions***
***September 2008 Prices***

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs** | |
| Intake, Pump, and Pump Station (0.5 MGD) | $ 513,280 |
| Water Treatment Plant (0.5 MGD modular upflow clarifier) | 1,050,620 |
| Transmission Pump, and Pump Station (0.5 MGD) | 375,970 |
| Treated Water Storage Tank (1 MGD) | 951,060 |
| Transmission Pipelines (6 inch diameter; 7.1 miles) | 952,370 |
| Transmission Pipelines (4 inch diameter; 7.3 miles) | 789,930 |
| Transmission Pipelines (2 inch diameter; 3.5 miles) | 293,440 |
| Highway and Stream Crossings (4 minor and 1 major streams, and 1 road crossing) | 158,510 |
| **Total Capital Cost** | **$5,085,180** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other) | $1,678,026 |
| Environmental Studies and Permitting (100% 0f land costs) | 14,000 |
| Land and Surveying for Pipelines (43 acres @ $275 per acre) | 12,900 |
| Land for Treatment Plant, Pump Stations, and Storage Tank (4 acres @ $275/acre) | 1,100 |
| Interest During Construction (2 years @ 4%) | 543,296 |
| **Total Project Cost** | **$7,334,502** |
| Annual Costs | |
| Debt Service (6 percent for 30 years) | $532,485 |
| Intake, Pipeline, and Pump Station Operation and Maintenance | 51,660 |
| Water Treatment Plant Operation and Maintenance | 157,290 |
| Cost of Raw Water (270 acft/yr @ $590 per acft)[1] | 159,300 |
| Pumping Energy Costs (56,350 kWh @ $0.06/kWh) | 3,400 |
| **Total Annual Cost[1]** | **$904,135** |
| **Quantity of Water (acft/yr)** | **270** |
| **Annual Cost of Water ($ per acft)[2]** | **3,349** |
| **Annual Cost of Water ($ per 1,000 gallons)[2]** | **10.30** |

1 Cost of raw water at Lake Alan Henry is $590 per acft.
2 Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

### *4.4.3.1.5 Implementation Issues*

Implementation of this option will require financing, rights-of-way and sites for facilities, state and federal permits for the raw water intake, stream crossings, environmental and cultural resources studies, and mitigation for any environmental and cultural resources that might be affected.

#### *4.4.3.2 Lake Alan Henry Supply to City of Lubbock*

##### *4.4.3.2.1 Description of Option*

This water management strategy includes the construction of a pipeline from Lake Alan Henry to the City of Lubbock, plus construction of a new 24-MGD surface water treatment plant located near the southeast corner of Lubbock (Figure 4.4-5). The treated water would be an additional source for the City and its wholesale customers within the Lubbock service area.

##### *4.4.3.2.2 Quantity of Water Available*

The ultimate quantity available from this option is 48,049 acft/yr, comprised of supply originating from three primary sources:

1. 21,880 acft/yr, which is the portion of the 22,500 acft/yr yield of Lake Alan Henry after subtracting the 620 acft/yr obligated to local water users, including that for the Lake Alan Henry Water District;
2. 17,445 acft/yr contributed by diverting reclaimed wastewater through the North Fork Diversion Project (Section 4.4.3.4) to the intake side of the pipeline pump station; and
3. 8,725 acft/yr of additional yield contributed by diverting storm flows through the North Fork Diversion Project (Section 4.4.3.4) directly into Lake Alan Henry.

Utilization of reclaimed wastewater and stormwater supplies made available by the North Fork Diversion Project will allow the City of Lubbock to conserve existing resources such as the Bailey County Wellfield, and more efficiently utilize the yield of Lake Alan Henry by extending its supply in consideration of a drought worse than the drought of record.

The additional supply available from reclaimed wastewater diverted from the North Fork will not be available until the City's wastewater flows increase to an equivalent volume. Accordingly, the pump stations and treatment plant are currently sized to supply 21,880 acft/yr. The pipeline is sized to accommodate up to 34 MGD (38,112 acft/yr) if the pump station and treatment capacities are increased in the future. Capacity to accommodate supply in excess of 38,112 acft/yr would require additional pump station capacity and possibly an additional parallel pipeline to minimize high velocity flows and reduce pumping energy costs.

#### *4.4.3.2.3 Environmental Issues*

Water is to be obtained from Lake Alan Henry (TCEQ Permit 4146). The environmental issues associated with this option are for pipeline rights-of-way and sites for water treatment plant and storage facilities. Since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

#### *4.4.3.2.4 Costing*

Costs of this water management strategy include costs of the raw water transmission pipeline, surface water treatment plant, engineering, land acquisition, environmental studies and mitigation, if needed, and interest during construction. The following assumptions and conditions were used in the costing of this option.

- The project would be sized to use 21,880 acft/yr of Lake Alan Henry's 22,500 acft/yr firm yield.
- The new surface water treatment plant would have a capacity of 24 MGD.
- Cost of land for pipeline easements is $8,712 per acre. Cost of land for pump stations, intake structures, and storage tanks is $450 per acre. Cost of land for a water treatment plant is $3,000 per acre.
- The cost calculations are for treated water delivered to the City of Lubbock distribution system.
- Costs of raw water from Lake Alan Henry reservoir are included in the estimate as annual reservoir debt service and reservoir operating and maintenance costs.
- Capital costs for the pipeline, pump stations, and water treatment plant were based upon a 2008 cost estimate of this water transmission and treatment project by the City of Lubbock.
- Engineering, legal costs, and contingencies are calculated as 30 percent of the construction costs for pipelines and 35 percent for all other facilities unless otherwise noted in the City of Lubbock cost estimate.
- Environmental and archeological studies, mitigation, and permitting costs are calculated as 100 percent of the land cost unless otherwise noted in the City of Lubbock cost estimate.
- Interest during construction is calculated with a 6 percent interest rate and a 4 percent annual rate of return for a period of 2 years.

The total project cost for this option was estimated at $294,329,000 (Table 4.4-41). The total annual cost, including debt service, operation and maintenance, and power cost, is estimated

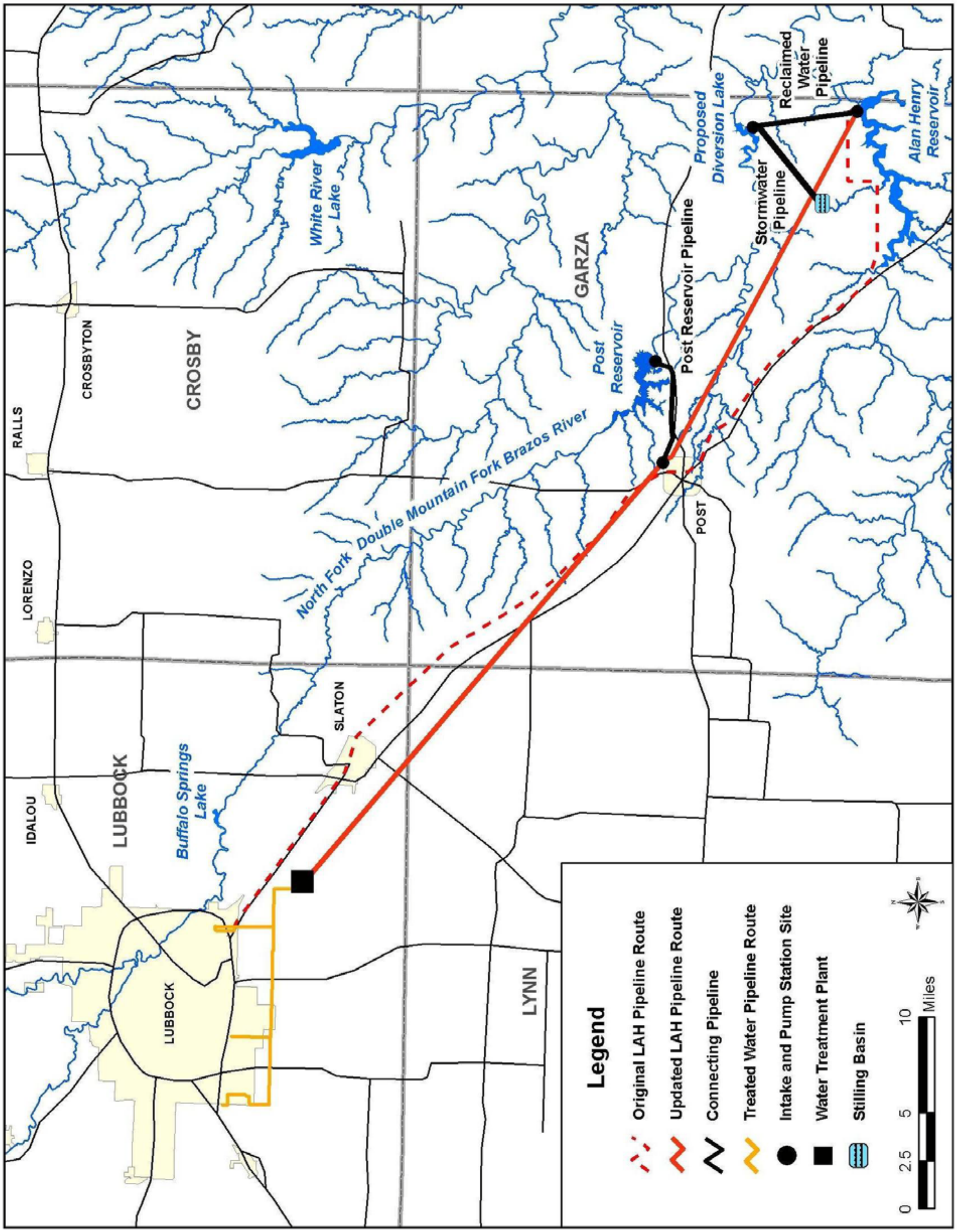



***Figure 4.4-5. Lake Alan Henry to Lubbock Pipeline***

***Table 4.4-41.***
***Cost Estimate Summary for***
***Lake Alan Henry Pipeline***
***Llano Estacado Region***
***September 2008 Prices***

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs** | |
| Terminal Storage Reservoir | $15,628,000 |
| Intake and Pump Stations | 28,297,000 |
| Transmission Pipeline (42 in & 48 in dia., 49 miles) | 108,357,000 |
| Water Treatment Plant (24 MGD) | 19,049,000 |
| Treated Water Transmission Pipeline s(42 in & 48 in dia., 22 miles) | 31,003,000 |
| **Total Capital Cost** | **$202,334,000** |
| Engineering, Legal Costs and Contingencies (pipelines 30% & other facilities 35%) | $63,849,000 |
| Environmental Studies and Permitting | 1,058,000 |
| Land Acquisition and Surveying (439 acres) | 5,284,000 |
| Interest During Construction (2 years) | 21,804,000 |
| **Total Project Cost** | **$294,329,000** |
| **Annual Costs** | |
| Debt Service (6 percent for 30 years) | $19,727,000 |
| Reservoir Debt Service (6 percent, 40 years) (Lake Alan Henry) | 1,514,0000 |
| Intake, Pipeline, and Pump Station Operation and Maintenance | 2,101,000 |
| Water Treatment Plant Operation and Maintenance | 1,733,000 |
| Dam and Reservoir Operation and Maintenance (Lake Alan Henry) | 234,000 |
| Pumping Energy Costs (37,181,000 kWh @ $0.09/kWh) | 3,346,000 |
| **Total Annual Cost** | **$28,655,000** |
| **Available Project Yield (acft/yr)** | **21,880** |
| **Annual Cost of Water ($ per acft)[1]** | **$1,310** |
| **Annual Cost of Water ($ per 1,000 gallons)[1]** | **$4.01** |

- [1] Calculated Annual Cost of Water is for treated water delivered to the City's distribution system and does not include costs associated with distribution within the municipal system.

to be $28,655,000 (Table 4.4-41). For an annual delivery of 21,880 acft/yr, the resulting cost of treated water at the water treatment plant is $1,310 per acft or $4.01 per 1,000 gallons (Table 4.4-41).

***Table 4.4-42.***
***Comparison of Lake Alan Henry Supply to City of Lubbock to Plan Development Criteria***
***Llano Estacado Water Planning Region***

| *Impact Category* | *Comment(s)* |
|---|---|
| A. Water Supply<br>1. Quantity<br>2. Reliability<br>3. Cost | <br>1. Sufficient to meet needs<br>2. High reliability<br>3. Reasonable |
| B. Environmental factors<br>1. Environmental Water Needs<br>2. Habitat<br>3. Cultural Resources<br>4. Bays and Estuaries<br>5. Threatened and Endangered Species<br>6. Wetlands | <br>1. Low impact<br>2. Low impact<br>3. Low impact<br>4. Low impact<br>5. Low impact<br>6. Low impact |
| C. Impact on Other State Water Resources | • No apparent negative impacts on state water resources; no effect on navigation |
| D. Threats to Agriculture and Natural Resources | • No threats identified |
| E. Equitable Comparison of Strategies Deemed Feasible | • Option is considered to meet municipal and industrial shortages |
| F. Requirements for Interbasin Transfers | • Not applicable |
| G. Third Party Social and Economic Impacts from Voluntary Redistribution | • None |

#### *4.4.3.2.5 Implementation Issues*

This water management strategy has been compared to the plan development criteria, and meets each criterion (Table 4.4-42).

Implementation of this option will require the development of a regional water supply system, including customers and terms and conditions between customers and the regional supplier. The regional supplier will need to arrange financing, obtain rights-of-way and sites for facilities, secure state and federal permits for stream crossings, perform environmental and cultural resources studies, and provide mitigation for any environmental and cultural resources that might be affected.

### *4.4.3.3 Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7*

#### *4.4.3.3.1 Description of Option*[14]

This water management strategy would allow use of Lubbock's "developed water resources," including storm water collected within the City of Lubbock and transferred and discharged into the Yellowhouse Canyon, groundwater from the Lubbock Land Application Site, and treated wastewater (source of treated wastewater is groundwater and water from CRMWA) discharged into Yellowhouse Canyon. To achieve this, Lake 7 from the Canyon Lakes System (now called the Jim Bertram Lake System) would be built to impound and store water (Figure 4.4-6). This water would be treated at a new water treatment facility located southeast of Lubbock. The City of Lubbock is currently developing a pipeline and treatment plant to utilize water from Lake Alan Henry. The Lake Alan Henry treatment plant would be expanded to accommodate supply developed by Lake 7. Costs include a pump station and pipeline sized to deliver up to 89 MGD, which would include capacity for Lubbock municipal supply, as well as reserve capacity for additional industrial and irrigation uses. The treatment plant expansion is sized to 21 MGD for Lubbock municipal supply. This water would be transported to the south and southwest areas of Lubbock's service area. Key components of this system are:

- Lake 7: Storage Capacity: 20,700 AF
  Pump station & pipeline capacity: 40 MGD
  Pipeline length: 20,800 feet
  Pipeline diameter: 48 inches
- Water Treatment Plant: Capacity: 21 MGD expansion

#### *4.4.3.3.2 Quantity of Water Available*

Water potentially available for impoundment in the proposed Lake 7 was estimated using Run 3 of the Brazos River Basin Water Availability Model (Brazos WAM) developed by the Texas Commission on Environmental Quality (TCEQ)[15]. The model utilizes a timeframe from January 1940 through December 1997 hydrologic period of record to estimate water available to existing and potential water rights. The model assumes that existing perpetual water rights are fully

[14] "Lubbock, Texas; Feasibility Report on the Canyon Lakes Project," Freese, Nichols and Endress, Fort Worth, Texas, 1969.
[15] HDR Engineering, Inc., "Water Availability in the Brazos River Basin and San Jacinto-Brazos Coastal Basin," Texas Natural Resource Conservation Commission (now TCEQ), December 1991.

utilized, reservoir storage capacity is as originally permitted, and wastewater treatment plant effluent is fully reused (zero return flows). The City of Lubbock has estimated that 8 million gallons per day (MGD) of effluent will be available in the future that can be dedicated to developing water supply from the reservoir. The 8 MGD (8,968 acft/yr) of return flows were input into the Brazos WAM and used in conjunction with available unappropriated flows to develop firm yield estimates for Lake 7. Interruptible developed flows from the playa lake system were also included in the analysis to contribute to the development of the estimated Lake 7 firm yield supply.

Available unappropriated streamflows were determined by the Brazos WAM without causing increased shortages to existing downstream rights. Firm yield was computed subject to the reservoir having to pass natural inflows to meet Consensus Criteria for Environmental Flow Needs (CCEFN) instream flow requirements. The streamflow statistics used to determine the Consensus Criteria pass-through requirements for the reservoirs are shown in Table 4.4-43. Only natural unappropriated flows were subjected to the CCEFN requirements; the return flows were not.

The firm yield of Lake 7 is estimated to be 17,650 acft/yr. Figure 4.4-7 illustrates the simulated Lake 7 storage levels for the 1940 to 1997 historical period, with annual diversions of 17,650 acft/yr. Figure 4.4-8 illustrates the changes in streamflows of the North Fork Double Mountain Fork of the Brazos River caused by impounding the unappropriated waters of the Brazos River.

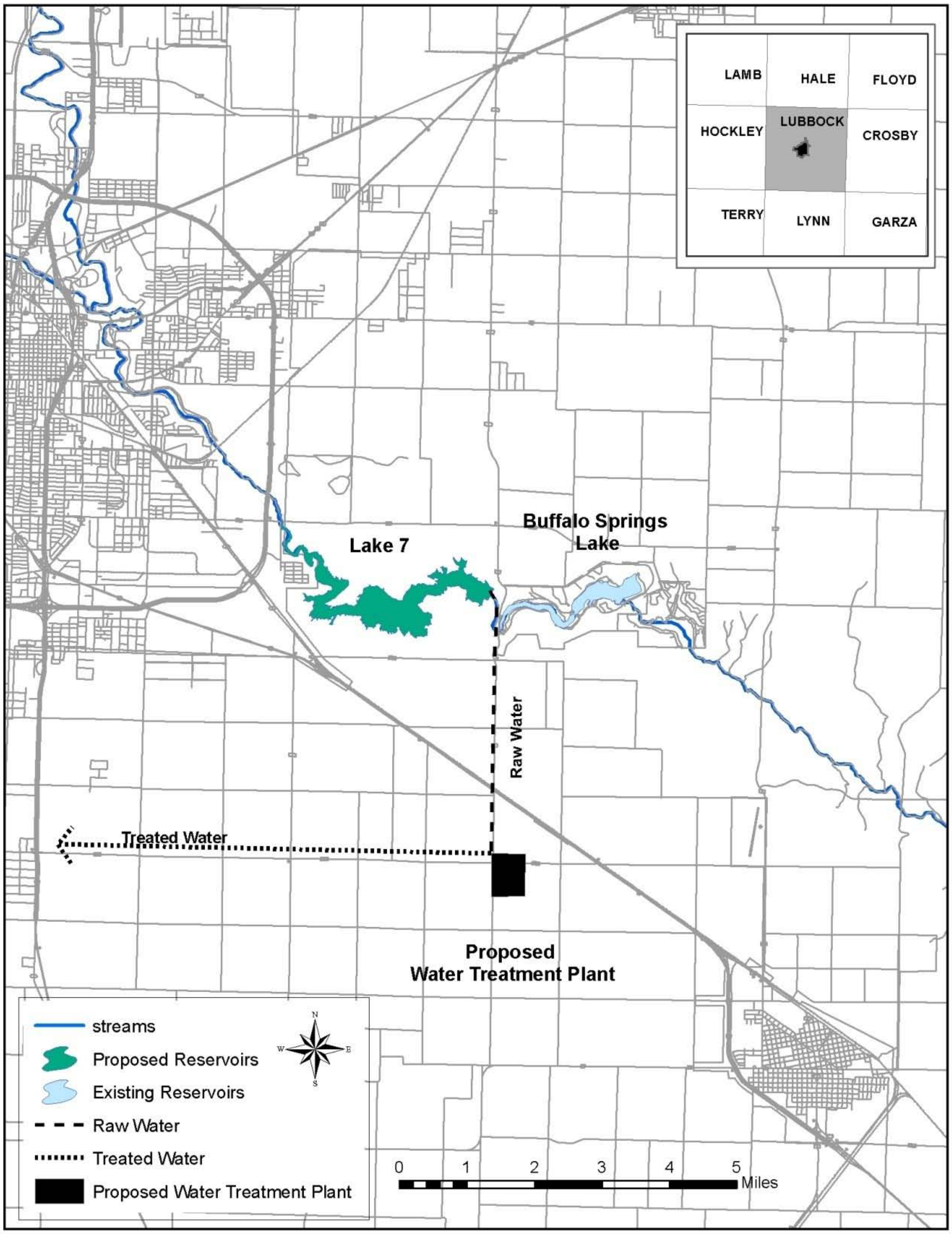
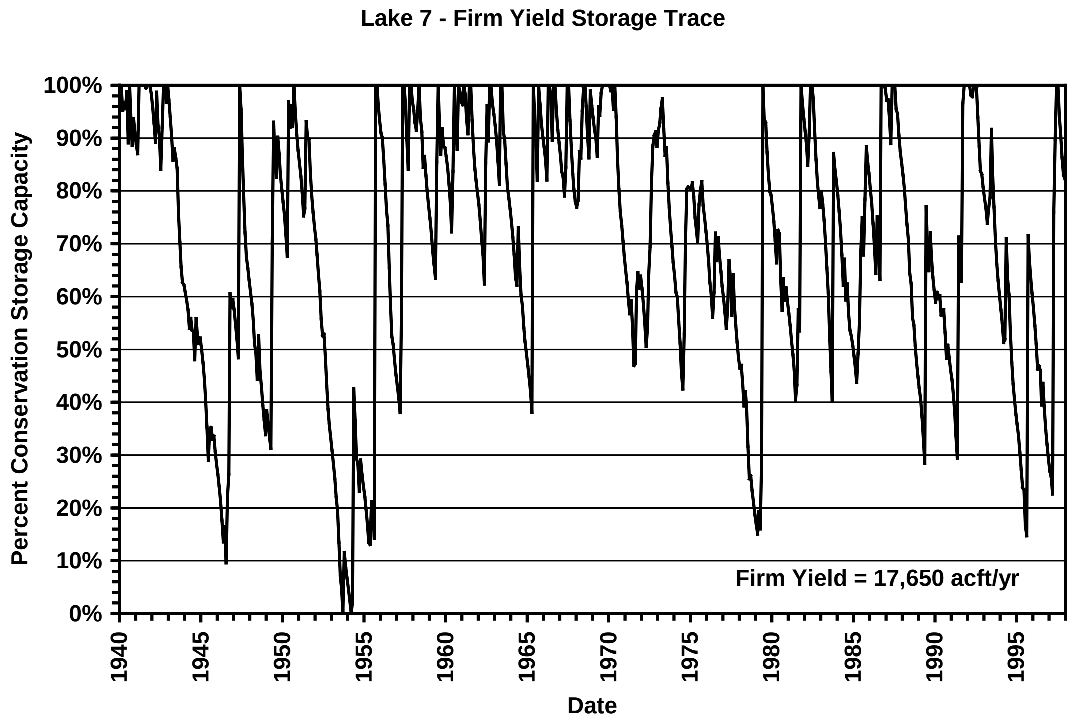



***Figure 4.4-6. Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7***

***Table 4.4-43.***
***Daily Natural Streamflow Statistics***
***Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7***
***Llano Estacado Water Planning Region***

| ***Month*** | ***Median Flows – Zone 1 Pass-Through Requirements (cfs)*** | ***25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)*** |
|---|---|---|
| | ***Lake 7*** | |
| January | 0.2 | 0.0 |
| February | 0.2 | 0.0 |
| March | 0.1 | 0.0 |
| April | 0.2 | 0.0 |
| May | 3.4 | 0.1 |
| June | 5.1 | 0.5 |
| July | 1.5 | 0.0 |
| August | 0.6 | 0.0 |
| September | 1.3 | 0.0 |
| October | 0.9 | 0.0 |
| November | 0.6 | 0.0 |
| December | 0.4 | 0.0 |
| **Zone 3 (7Q2) Pass-Through Requirement (cfs):** | | 0 |



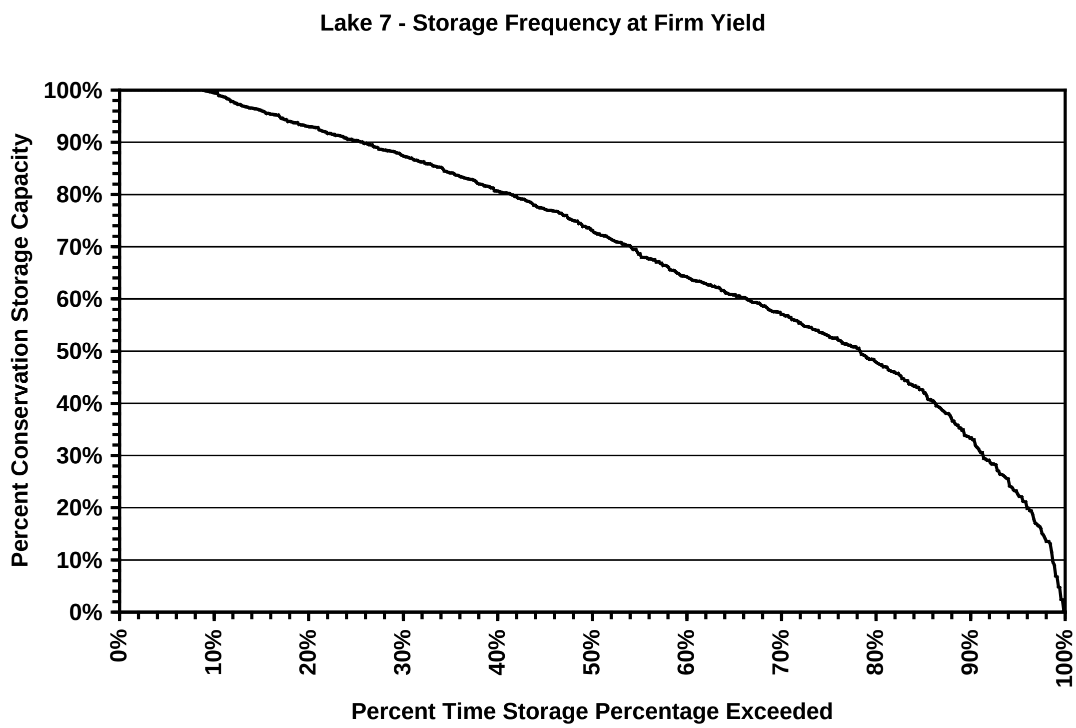
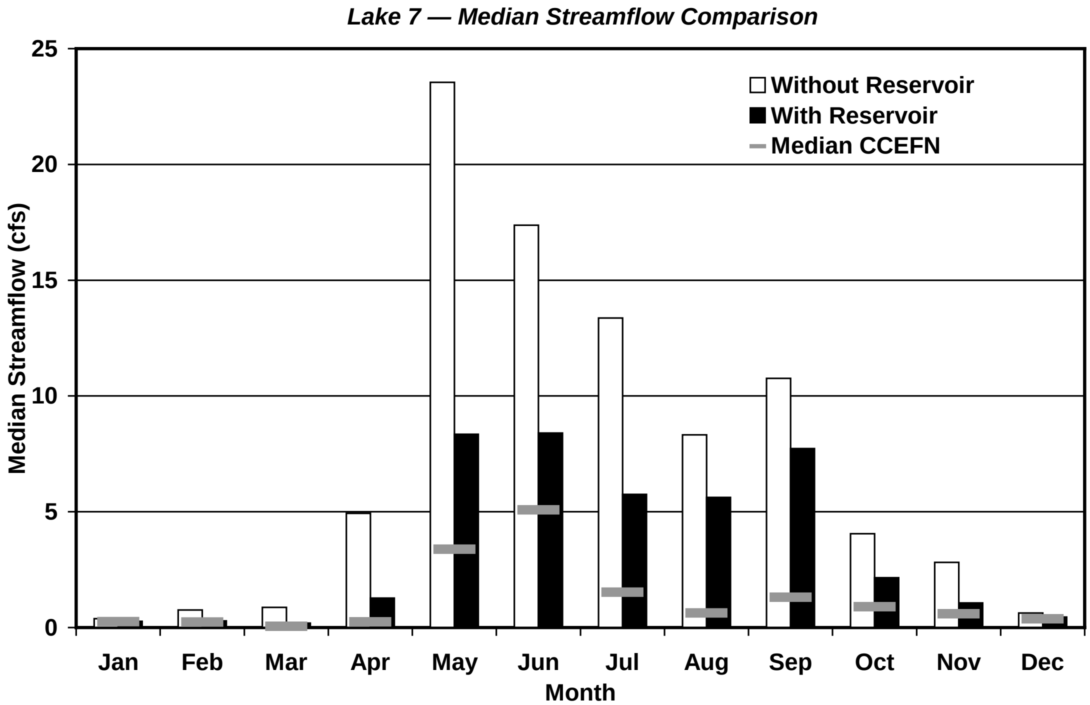




***Figure 4.4-7. Jim Bertram Lake System (JBLS) Expansion Reservoir Storage Considerations – Lake 7***



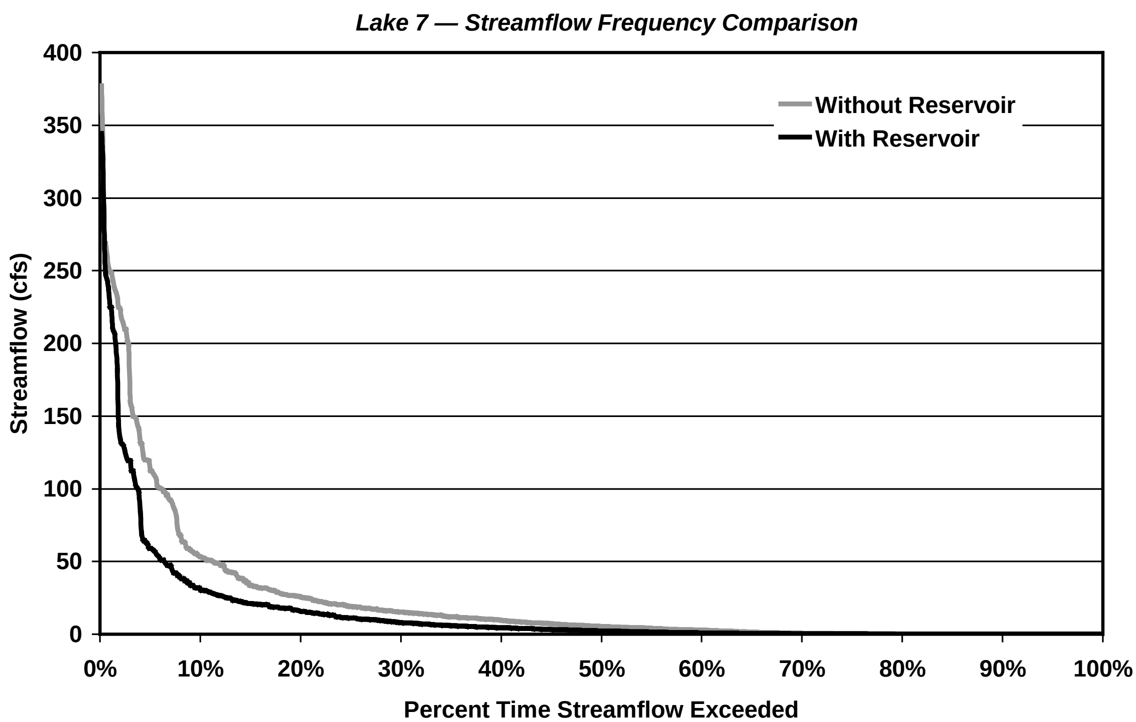




***Figure 4.4-8. Jim Bertram Lake System (JBLS) Expansion Streamflow Comparisons – Below Lake 7***

#### *4.4.3.3.3 Environmental and Cultural Resource Issues*

The City of Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7 involves the construction of Lake 7 along an approximately 5-mile reach of the North Double Mountain Fork of the Brazos River, a raw water intake structure and an associated water transmission line. The proposed lake site is located in Lubbock County southeast of the City of Lubbock within the Western High Plains ecoregion,[16] in the High Plains vegetational area of Texas,[17] and in the Kansan biotic province.[18] The High Plains Region is a nearly level treeless plain with a relatively even surface. It is dominated by native grasses, the major species including buffalo grass (*Buchloe dactyloides)*, blue grama (*Bouteloua gracilis*), and sideoats grama (*Bouteloua curtipendula*). Annual and perennial forbs, legumes and woody species such as beargrass and cholla cactus occasionally invade this grassland region. In zones with loamy soils, honey mesquite (*Prosopis glandulosa)* and yucca have invaded large areas. The prevalent land use within the proposed Lake 7 project area is mixed rangeland (52%)[19], with additional areas of nonforested wetlands (19%), gravel pits (15%), confined feeding operations (10%), and minor amounts of cropland or pasture. It is unlikely that the area designated as nonforested wetlands has a large amount of wetland area; however the presence and location of actual wetland areas potentially affected by reservoir construction would have to be determined by a site survey. In addition, a small portion of this proposed lake area is currently an existing reservoir (5%).

Within the proposed lake site, the General Soil Map for Lubbock County shows Potter-Berda-Bippus soils. These soils, found on bottomlands and uplands, can be very shallow, shallow, or deep, and are located on nearly level to steep slopes. Two of these soil types are found on gently sloping to steep slopes, and include Potter soils which are found on uplands and Berda soils which are generally found on foot slopes. Slopes of areas containing these soils are generally found to be 1 to 45 percent. Bippus soils are found on nearly level areas on frequently flooded bottom lands. These soils areas have very little slope, generally less than one percent. The surface layer for all of these soils is composed of a friable, alkaline loam which differs in depth within each soil type from 5 to 30 inches. Rangeland is the most common landuse

[16] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1), pp. 118-125, 1986.
[17] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas, 1962.
[18] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.
[19] U. S. Geological Survey, 1990. Reston, Virginia

occurring within areas of Bippus soils. Cultivated crops are not generally grown in this area due to the steep slopes, and the potential for water erosion and flooding.

There are six existing, smaller impoundments along the North Double Mountain Fork of the Brazos River in the upper reaches of the canyon above the proposed Lake 7 location. The North Double Mountain Fork of the Brazos River (Segment 1241A) is considered perennial from its confluence with the Double Mountain Fork to the dam impounding Lake Ransom Canyon. The water is typically high in dissolved solids, with segment standards for chloride and sulfate of 2500 mg/L and 2400 mg/L, respectively. This segment is on the Draft 2004 303(d) list for excessive bacterial concentrations, and is listed in the Statewide Water Quality Inventory (305b list) for concerns over algal growth and nitrogen concentrations. Although the current data listing on the Brazos River Authority web site indicates that the segment meets the average screening criterion for Fecal Coliforms of 200 MPN/100 ml, 23% of the samples collected exceeded the single grab criterion of 400 MPN/100 ml. Additional study will be required to confirm this result before a TMDL is scheduled. There are no Ecologically Significant River and Stream Segments within the project area.[20]

The major sources for this water body include streamflow from natural rainfall, which is generally infrequent and irregular in this area, future return flows, releases of cooling water from a municipal power plant, springs associated with the irrigation of adjoining farm lands by effluent from the main Lubbock Sewer Treatment Plant, and runoff from the portion of the city's storm sewer system that drains playa lakes. The principal function of the proposed Lake 7 will be to store and reuse reclaimed water and storm water, and to provide additional recreation opportunities. The upper six small impoundments presently form the core of a municipal park which stretches for approximately 8 miles through the southeast quadrant of the city.

Health concerns for the proposed lake include bacteria from discharged water and pollution from storm runoff. Storm runoff, particularly from urban areas, will likely be a source of coliform bacteria, oxygen demanding materials, nutrients and other materials (e.g., oil and grease, metals, household chemicals) potentially affecting water quality. However, this condition is common in streams and their impoundments receiving urban runoff, and has proved a serious problem in limited cases. Water quality and aquatic life conditions in the existing reservoir system are the best predictors of conditions most likely to develop in the proposed Lake 7.

[20] Texas Parks and Wildlife, Water Resources Branch, 2005.

Plant and animal species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Lubbock County are listed in Table 4.4-44. There are two species listed as endangered by the State of Texas found within Lubbock County, the Whooping Crane (*Gus Americana*), and Black-footed Ferret (*Mustela nigripes*). In addition there are three threatened species which are state-listed within the county, the Arctic Peregrine Falcon (*Falco peregrinus tundrius*), Bald Eagle (*Haliaeetus leucocephalus*), and Texas horned lizard (*Phrynosoma cornutum*).

The Whooping Crane, Arctic Peregrine Falcon and Bald Eagle are potential migrants to Lubbock County which may use habitats in the area during migration. A survey of the lake site may be required to determine whether populations of or potential habitats used by listed species occur in the area to be affected. The Black-footed Ferret is generally found in areas occupied by prairie dogs, usually dry, flat short grasslands including land overgrazed by cattle and the Texas Horned Lizard generally prefers open, arid areas with sparse vegetation. Either of these two species might be found within the mixed rangeland areas of the project.

There are two fish species found in the Brazos River Basin which are candidates for Federal Listing, the sharpnose shiner (*Notropis oxyrhynchus*), and the smalleye shiner (*Notropis buccula*). Both of these species require fairly shallow water in broad, open sandy channels with moderate current. Neither of these shiner species is listed as occurring within Lubbock County.

The primary impacts that would result from construction and operation of the proposed lake would include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. Figure 4.4-7A (Lake 7 Storage) shows that operation of the proposed Lake 7 near its 50% capacity elevation more than 75% of the time will result in the permanent inundation of

### *Table 4.4-44.*
### *Potentially Occurring Species that are Rare or Federal-and State-Listed at the Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7*
### *Llano Estacado Water Planning Region*

| ***Birds*** | ***Federal Status*** | ***State Status*** |
|---|---|---|
| **Arctic Peregrine Falcon (*Falco peregrinus tundrius*)** - potential migrant | DL | T |
| **Baird's Sparrow (Ammodramus bairdii)** – shortgrass prairie with scattered low bushes and matted vegetation. | | |
| **Bald Eagle (*Haliaeetus leucocephalus*)** - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds. | LT-PDL | T |
| **Ferruginous Hawk (Buteo regalis)** – open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers. | | |
| **Lesser Prairie Chicken (Tympanuchus pallidicinctus)** – arid grasslands, generally interspersed with shrubs and dwarf trees; nests in a scrape lined with grasses. | C1 | |
| **Mountain Plover (*Charadrius montanus*)** – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous | | |
| **Snowy Plover (Charadrius alexandrinus)** – formerly an uncommon breeder in the Panhandle; potential migrant | | |
| **Western Burrowing Owl (*Athene cunicularia hypugaea*)** - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culvert. | | |
| **Whooping Crane *(Grus americana*)** - potential migrant; winters in and around Aransas National Wildlife Refuge and migrates to Canada for breeding; only remaining natural breeding population of this species. | LE | E |
| ***Mammals*** | | |
| **Black-footed Ferret (Mustela nigripes)** – considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area. | LE | E |
| **Black-tailed Prairie Dog (Cynomys ludovicianus)** – dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups. | | |
| **Cave Myotis Bat (Myotis velifer)** – roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonots)* nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore. | | |
| **Plains Spotted Skunk (Spilogale putorius interrupta)** – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie. | | |
| **Swift Fox (Vulpes velox)** – restricted to current and historic shortgrass prairie; western and northern portions of Panhandle. | | |
| ***Reptiles*** | | |
| **Texas Horned Lizard (Phrynosoma cornutum)** – open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September. | | T |
| Status Key: DL-De-Listed, PDL-Proposed De-Listed, LE, LT-Federally Listed Endangered/Threatened, PE, PT-Federally Proposed Endangered/Threatened, E/SA, T/SA-Federally Listed Endangered/Threatened by Similarity of Appearance, C1-Federal Candidate for Listing, E,T-State Listed Endangered/Threatened, "blank"-Rare, but with no regulatory listing status. | | |
| *June 2005, Annotated County Lists of Rare Species maintained by TPWD, Austin, Texas.* | | |

514 acres of brush – invaded grassland habitat and its conversion to a lacustrine environment in which an aquatic community will develop. On-site surveys will be required to document existing habitat values and determine the necessity and scope of mitigation for significant losses.

Operation of the reservoir will result in a decrease in the volume and constancy of streamflow in the North Fork reach between the Lake 7 dam and the Buffalo Springs Lake backwater (Figure 4.4-8A).

Federal and state laws such as Section 106 of the National Historic Preservation Act and the Antiquities Code of Texas require that impacts to cultural resources be considered. To address impacts these laws outline a consultation process that may involve the State Historic Preservation Officer (SHPO), Native American Tribes, the Advisory Council on Historic Preservation, and other interested parties. The consultation process is usually initiated by gathering information regarding cultural resources located within project area and presenting it to the SHPO for an effect determination. Based on the information available the SHPO makes a determination as to whether the properties affected are eligible for listing on the National Register of Historic Places (NRHP) or for formal designation as a State Archeological Landmark (SAL). If the SHPO feels that more information is needed in order to evaluate eligibility, they may request additional information such as archival research, or archeological field investigations. If the SHPO determines that there is "no effect" to properties eligible for listing on the NRHP or for formal designation as an SAL, the consultation process ends and project activities may proceed. On the other hand, if it is determined that eligible properties will be affected, then mitigation of the effects will likely be required. Mitigation may include additional archeological investigations, archival research, or avoidance and protection.

Available information regarding know cultural resources was gathered from the Texas Archeological Research Laboratory in Austin. Examination of their map files identified 14 recorded archeological sites within the footprint and park boundary of Lake 7 (see Table 4.4-45).

Sites 41LU9 through 41LU23 have no eligibility recommendations. However sites 41LU132 and 41LU48 were recommended for listing on the NRHP. Site 41LU49 was not recommended for the NRHP.

As there is no evidence of any systematic archeological investigations being conducted for the lake area, it is likely that the Texas Historical Commission and the U.S. Army Corps of Engineers will require an intensive archeological survey of the dam site, the maximum flood pool area, and the proposed park area adjacent to the lake. This information will be required in order to begin the Section 106 and Antiquities Code consultation with these agencies.

**Table 4.4-45.**
**Archeological Sites on Record for Lake 7**

| Lake 7 | Site Description |
|---|---|
| 41LU9 | Prehistoric camp |
| 41LU10 | Prehistoric camp |
| 41LU11 | Prehistoric camp |
| 41LU12 | Prehistoric camp |
| 41LU13 | Prehistoric camp |
| 41LU14 | Prehistoric camp |
| 41LU15 | Prehistoric camp |
| 41LU16 | Prehistoric camp |
| 41LU17 | Prehistoric camp |
| 41LU18 | Prehistoric camp |
| 41LU19 | Prehistoric camp |
| 41LU132 | Prehistoric camp |
| 41LU48 | Stone wall |
| 41LU49 | Prehistoric lithic scatter |

#### *4.4.3.3.4 Engineering and Costing*

Costs for this option include the following:

- Land and right-of-way for Lake 7 and pipeline;
- Construction of dam for Lake 7;
- Pump station and pipeline;
- Expansion of the future Lake Alan Henry water treatment plant;
- Environmental impact assessments and archeological studies and recovery, and mitigation, if needed;
- State and federal permit acquisition;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated at $68,288,400 (Table 4.4-46). Annual operation and maintenance costs, including energy, are estimated at $2,453,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $7,956,000 (Table 4.4-46). For an annual quantity of 17,650 acft/yr of treated water ready for delivery to customers, the cost is $451 per acft, or $1.38 per 1,000 gallons (Table 4.4-46). To the extent that interruptible water and other firm developed water are available, the unit costs of water would differ from those presented here.

#### *4.4.3.3.5 Implementation Issues*

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-47, and the option meets each criterion.

The implementation of this option to supply additional water to the City of Lubbock depends upon acquisition of the necessary permits, including water rights and those required for construction, as well as other issues as summarized below:

*Potential Regulatory Requirements:*

- Texas Commission on Environmental Quality Water Right and Storage permits;
- U.S. Army Corps of Engineers Permits will be required for discharges of dredge or fill into wetlands and waters of the U.S. for dam construction, and other activities (Section 404 of the Clean Water Act);
- Texas Commission on Environmental Quality administered Texas Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- General Land Office Easement if State-owned land or water is involved; and
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit if state-owned streambed is involved.

*State and Federal Permits may require the following studies and plans:*

- Environmental impact or assessment studies;
- Wildlife habitat mitigation plan that may require acquisition and management of additional land;
- Flow releases downstream to maintain aquatic ecosystems;
- Assessment of impacts on Federal- and State-listed endangered and threatened species; and
- Cultural resources studies to determine resources impacts and appropriate mitigation plan that may include cultural resource recovery and cataloging; requires coordination with the Texas Historical Commission.

*Land Acquisition Issues:*

- Land acquired for reservoir and/or mitigation plans could include market transactions and/or eminent domain;
- Additional acquisition of rights-of-way and/or easements may be required; and
- Possible relocations or removal of residences, utilities, roads, or other structures.

***Table 4.4-46.***
***Cost Estimate Summary for***
***Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7***
***Llano Estacado Water Planning Region***
***September 2008 Prices***

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs** | |
| Construction of Dam and Reservoir (Lake 7) | $ 8,401,000 |
| Intake and Pump Station (40 MGD) | 4,101,000 |
| Transmission Pipelines (20,800 ft , 48 in) | 4,519,000 |
| Water Treatment Plant Expansion (21 MGD) | 28,924,000 |
| **Total Capital Cost** | **$ 45,945,000** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies) | $15,766,400 |
| Environmental and Archeological Studies and Mitigation | 744,000 |
| Land Acquisition and Surveying (1,127 acres) | 734,000 |
| Interest During Construction (7 years, 4 percent) | 5,099,000 |
| **Total Project Cost** | **$ 68,288,400** |
| **Annual Costs** | |
| Debt Service (Pipeline, Pump Station, & Treatment Plant expansion) (6 percent for 30 years) | $ 4,558,000 |
| Debt Service (Reservoir) (6 percent for 40 years) | 891,000 |
| Operation and Maintenance | |
| Intake, Pipeline, and Pump Station | 145,000 |
| Dams and Reservoirs | 126,000 |
| Water Treatment Plant | 2,071,000 |
| Pumping Energy Costs (1,840,010 kWh @ $0.06/kWh) | 165,000 |
| **Total Annual Cost** | **$ 7,956,000** |
| **Quantity of Water (acft/yr) Firm Yield** | **17,650** |
| **Annual Cost of Water ($ per acft) Firm Yield[1]** | **$ 451** |
| **Annual Cost of Water ($ per 1,000 gallons)[1]** | **$ 1.38** |

[1] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with transmission of treated water to or within municipal distribution systems. To the extent that interruptible water is available, unit cost would be lower.

***Table 4.4-47.***
***Comparison of Lubbock Jim Bertram Lake System (JBLS) Expansion – Lake 7 to Plan Development Criteria***
***Llano Estacado Water Planning Region***

| *Impact Category* | *Comment(s)* |
|---|---|
| A. Water Supply | |
| 1. Quantity | 1. Sufficient to meet needs |
| 2. Reliability | 2. High reliability |
| 3. Cost | 3. Reasonable to High |
| B. Environmental factors | |
| 1. Environmental Water Needs | 1. Low impact |
| 2. Habitat | 2. Low impact |
| 3. Cultural Resources | 3. Moderate impact |
| 4. Bays and Estuaries | 4. Negligible impact |
| 5. Threatened and Endangered Species | 5. Possible Low impact |
| 6. Wetlands | 6. Low impact |
| C. Impact on Other State Water Resources | • No apparent negative impacts on state water resources; no effect on navigation |
| D. Threats to Agriculture and Natural Resources | • Potential impact on bottomland farms and habitat in reservoir area |
| E. Equitable Comparison of Strategies Deemed Feasible | • Option is considered to meet municipal and industrial shortages |
| F. Requirements for Interbasin Transfers | • Not applicable |
| G. Third Party Social and Economic Impacts from Voluntary Redistribution | • None |

#### *4.4.3.4 Lubbock North Fork Diversion Operation*

##### *4.4.3.4.1 Description of Option*

This water supply strategy would involve the diversion of storm water flows (interruptible source) and reclaimed wastewater from the North Fork of the Double Mountain Fork of the Brazos River (the North Fork) to Lake Alan Henry to supplement its firm annual yield (Figure 4.4-9). The map shown in Figure 4.4-9 indicates a location of the diversion dam and lake in Garza County, but is only intended to serve as a general conceptual location. When this option is implemented, the specific location will be selected based upon the topography, geology, land availability, permitting, and perhaps other factors. Key components of the proposed system are:

- Diversion dam: Capacity: 1,000 acre-feet;
- Diversion rate: Annual: 30,000 acft/yr;
- Maximum flow: 250 cfs;
- Pump station & pipeline capacity: 250 cfs;
- Stormwater Pipeline diameter: 96 inches;
- Stilling Basin at Gobbler Creek 250 cfs capacity;
- Reclaimed Wastewater Pipeline diameter 27 inches;
- Stormwater Pipeline length 27,600 feet;
- Reclaimed Wastewater Pipeline length: 27,668 feet; and
- Expansion of LAH pump stations 23.3 MGD.

Storm water would be pumped from the diversion lake during storm events and discharged into Gobbler Creek, which would then flow to Lake Alan Henry. Reclaimed wastewater would be pumped continually and blended with water in the Lake Alan Henry pipeline (Section 4.4.3.2).

##### *4.4.3.4.2 Quantity of Water Available*

Storm Water

Storm water potentially available for diversion from the North Fork into Lake Alan Henry was estimated using Run 3 of the Brazos River Basin Water Availability Model (Brazos WAM) developed by the Texas Commission on Environmental Quality (TCEQ)[21]. The model utilizes a January 1940 through December 1997 hydrologic period of record to estimate water

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[21] HDR Engineering, Inc., "Water Availability in the Brazos River Basin and San Jacinto-Brazos Coastal Basin," Texas Natural Resource Conservation Commission (now TCEQ), December 2001.

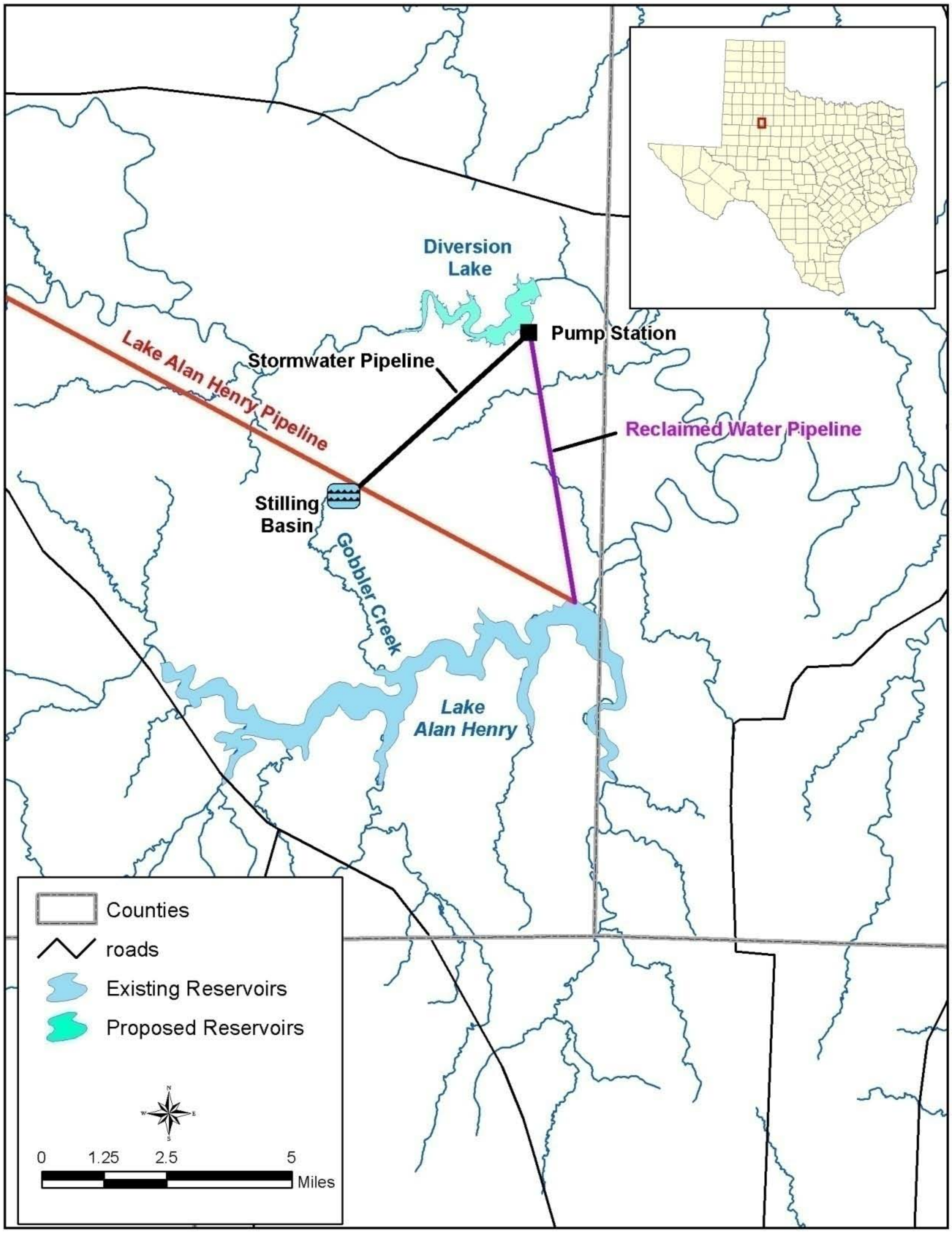



***Figure 4.4-9. Lubbock North Fork Diversion Operation***

available to existing and potential water rights. The model assumes that existing perpetual water rights are fully utilized, reservoir storage capacity is as originally permitted, and wastewater treatment plant effluent is fully reused (zero return flows).

Available unappropriated natural streamflows were determined by the Brazos WAM without causing increased shortages to existing downstream rights. Added to available natural streamflows were discharges from the City's playa lake stormwater system, which are not considered natural streamflows. The firm yield of Lake Alan Henry was computed subject to the storm water diversion having to pass natural inflows to meet Consensus Criteria for Environmental Flow Needs (CCEFN) instream flow requirements. The streamflow statistics used to determine the CCEFN pass-through requirements for the North Fork storm water diversion are shown in Table 4.4-48.

***Table 4.4-48.***
***Daily Natural Streamflow Statistics***
***Lubbock North Fork Diversion Operation***
***Llano Estacado Water Planning Region***

| ***Month*** | ***Median Flows – Zone 1 Pass-Through Requirements (cfs)*** | ***25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)*** |
|---|---|---|
| January | 2 | 0 |
| February | 3 | 0 |
| March | 1 | 0 |
| April | 1 | 0 |
| May | 8 | 0 |
| June | 13 | 2 |
| July | 4 | 0 |
| August | 2 | 0 |
| September | 5 | 0 |
| October | 4 | 0 |
| November | 3 | 0 |
| December | 3 | 0 |
| **Zone 3 (7Q2) Pass-Through Requirement (cfs):** | | 0.0 |

Under the above assumptions, the stormwater diversion would increase the firm yield of Lake Alan Henry by 8,725 acft/yr.

Reclaimed Wastewater

The City of Lubbock has estimated that future wastewater discharges will equal 25,664 acft/yr. For purposes of these analyses, it was assumed that 8,962 acft/yr would be discharged upstream of the proposed Lake 7 site, with the remaining 16,702 acft/yr discharged to the North Fork downstream of Lake Ransom Canyon. Considering channel losses as included in the Brazos WAM, up to 17,444 acft/yr would be available for diversion to the Lake Alan Henry system.

Total Supply Considering Firm Yield, Storm Water and Reclaimed Water

An estimate of the firm yield for Lake Alan Henry of 22,500 acft/yr was provided by the City of Lubbock to the Llano Estacado Regional Water Planning Group. This estimate accounts for a subordination agreement with the Brazos River Authority regarding Possum Kingdom Reservoir. The firm yield of Lake Alan Henry as computed by the Brazos WAM (accounting similarly for the subordination agreement) is 20,225 acft/yr, which is somewhat less than the yield estimate provided by the City of Lubbock. The yield analysis developed for the City of Lubbock is more detailed and in-depth than that computed by the Brazos WAM and is likely somewhat more accurate. With the North Fork Diversion Operation, the supply from the Lake Alan Henry system could be increased by 26,169 acft/yr to 48,669 acft/yr, considering that the diversion of storm water into Lake Alan Henry would increase the reservoir firm yield by 8,725 acft/yr and up to 17,444 acft/yr would be available from expected increases in wastewater discharges from the City of Lubbock. This potential supply exceeds the planned initial and ultimate capacity of the Lake Alan Henry Supply Project pipeline (38,112 acft/yr), and would require additional pump station capacity and possibly a parallel pipeline to eliminate excessive pipeline velocities and reduce pumping energy costs.

Figure 4.4-10 illustrates the simulated Lake Alan Henry storage levels for the 1940 to 1997 historical simulation period, subject to the enhanced firm yield. The reclaimed wastewater discharges would likely be considered as owned by the City of Lubbock and diversion of those flows would not be subject to instream flow requirements. However, the storm water flows, being natural flows, would be subject to instream flow requirements. Diversions of storm flows from the North Fork into the reservoir would change North Fork natural streamflows, as presented in Table 4.4-49 and illustrated in Figure 4.4-11. Monthly median natural streamflows at the diversion location on the North Fork would decrease, with the largest decline being about

20 cfs in June. However, inspection of the streamflow frequency graph indicates that little change in high or low natural streamflows would result from the diversion, with streamflows downstream of Lake Alan Henry being changed minimally. Streamflows in Gobbler Creek would increase by an average of about 3,095 acft/yr, with a maximum of 18,438 acft/yr, due to discharge of the North Fork flows. The instantaneous increase in streamflow in Gobbler Creek would be equal to the maximum diversion capacity of 250 cfs. However, as discussed above, this is the stand alone supply that would be provided by the North Fork Diversion to the Lake Alan Henry system, assuming that this project is built and operated independently of Post Reservoir and Lake 7. If Post Reservoir and Lake 7 are developed and operated in conjunction with the North Fork Diversion Operation, the supplies that could be developed by the three projects as follows: (a) Post Reservoir – 22,270 acft/yr, (b) North Fork Diversion Operation – 3,675 acft/yr, and (c) Jim Bertram Lake system Expansion – Lake 7—17,650 acft/yr.

***Table 4.4-49.***
***Median Monthly Streamflow***
***Lubbock North Fork Diversion Operation***
***Llano Estacado Water Planning Region***

| Month | Monthly Median Streamflow (cfs) | | | Percent Reduction |
|---|---|---|---|---|
| | Without Project | With Project | Decrease | |
| Jan | 2.9 | 1.4 | 1.5 | 50% |
| Feb | 3.8 | 1.8 | 2.0 | 54% |
| Mar | 2.8 | 1.1 | 1.7 | 63% |
| Apr | 6.7 | 2.2 | 4.5 | 67% |
| May | 28.3 | 14.9 | 13.4 | 47% |
| Jun | 37.3 | 16.7 | 20.6 | 55% |
| Jul | 12.9 | 10.1 | 2.8 | 22% |
| Aug | 15.0 | 11.3 | 3.7 | 25% |
| Sep | 29.0 | 16.2 | 12.8 | 44% |
| Oct | 8.0 | 5.0 | 3.0 | 37% |
| Nov | 5.2 | 1.6 | 3.6 | 68% |
| Dec | 3.4 | 1.8 | 1.6 | 48% |

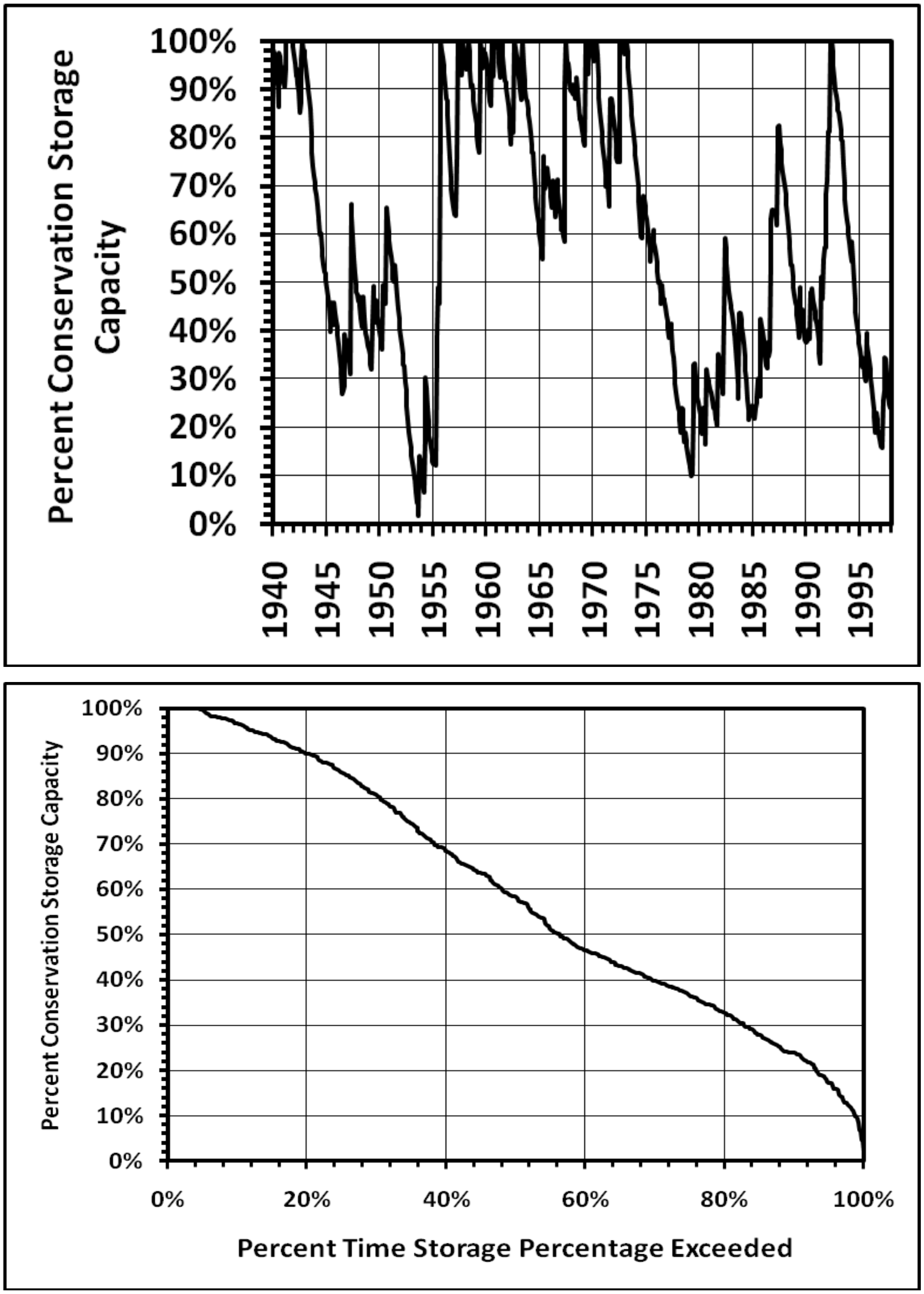
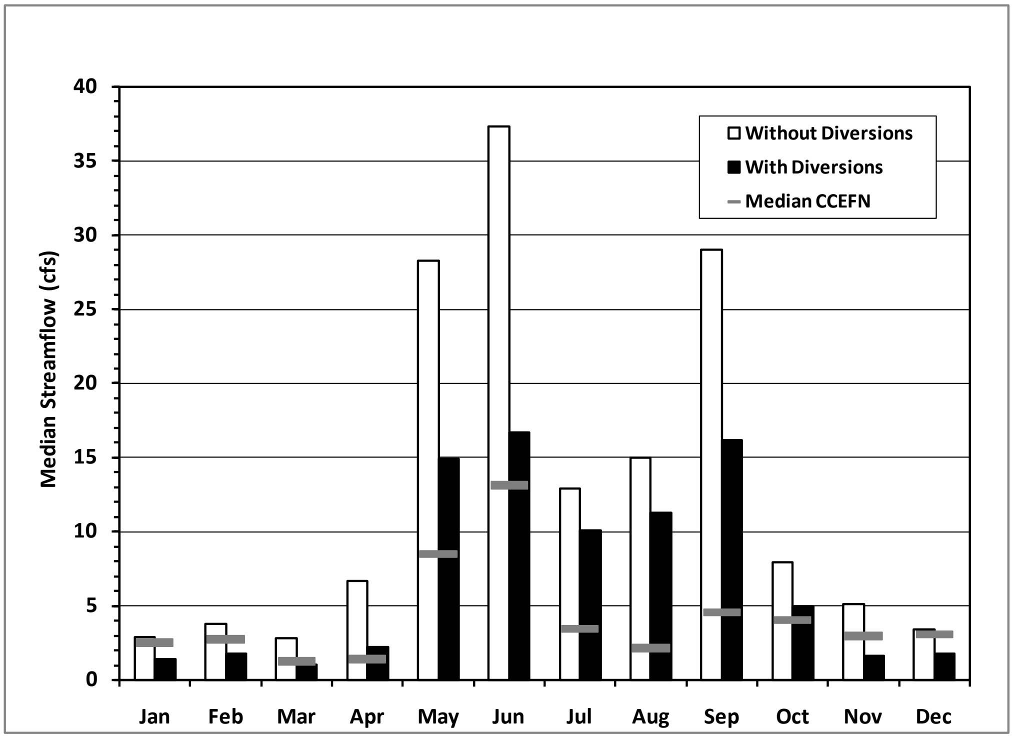



***Figure 4.4-10. Lubbock North Fork Diversion Operation Storage Considerations***



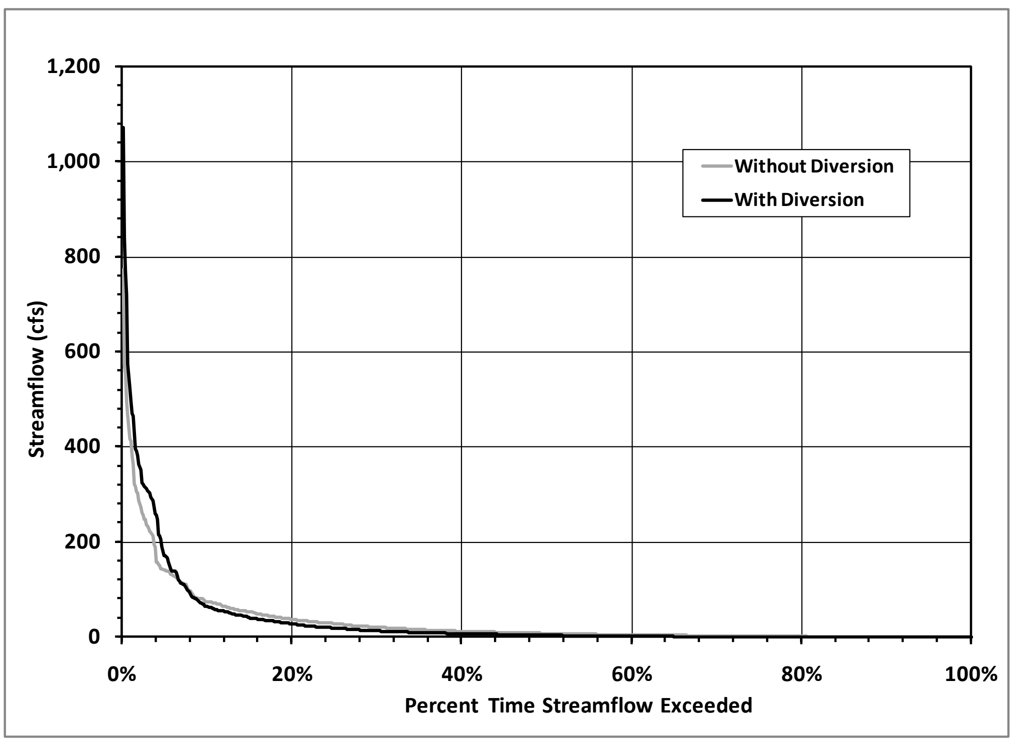




***Figure 4.4-11. Lubbock North Fork Diversion Operation Streamflow Comparisons***

#### *4.4.3.4.3 Environmental Issues*

The North Fork Diversion Operation to supplement the yield of Lake Alan Henry involves the construction of a diversion lake on the North Fork of the Double Mountain Fork of the Brazos River approximately 18 miles southeast of Post, Texas, a raw water intake structure and associated water transmission lines. The approximately six-mile storm water pipeline would deliver diverted water to a point on Gobbler Creek, from which it would flow an additional five miles through the existing stream channel to Lake Alan Henry on the Double Mountain Fork Brazos River. The proposed diversion lake site and Lake Alan Henry are both located in Garza County within the Southwestern Tablelands ecoregion,[22] in the Rolling Plains vegetational area of Texas,[23] and in the Kansan biotic province.[24]

The Llano Estacado Regional Water Planning Group acknowledges concerns that discharging water from the North Fork into Lake Alan Henry might encourage the growth of golden alga *(Prymnesium parvum*), an organism that has proven toxic to fish under certain conditions, and is known to occur in lakes along the North Fork. Prior to any project being constructed to discharge water from the North Fork into the South Fork, studies should be pursued to assess the risk of introducing golden alga to the South Fork.

The study area is located in the Rolling Plains Ecological Region as designated by the Texas Parks and Wildlife Department (TPWD 2005). This region is characterized gently rolling hills, used primarily as rangeland, that are dissected by streams and rivers that flow from west to east. This area is bordered on the south by the Edwards Plateau Ecological Region and on the west by the High Plains Ecological Region. Vegetation in this area is generally classified as mesquite-buffalo grass. The predominant vegetation form is medium-tall grassland with a sparse shrub cover. Little bluestem (*Schizachyrium scoparium* var. *frequens*), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), Indiangrass (*Sorghastrum nutans*), and sand bluestem (*Andropogon gerardii* var. *paucipilus*) are included in the list of native grasses in this area. Invasion of the rangeland areas in this region by annual and perennial forbs, legumes, and

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[22] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1), pp. 118-125, 1986.
[23] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas, 1962.
[24] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

woody species has been facilitated by historic livestock grazing practices and a lack of naturally occurring fire in the area. Dominant woody species include redberry juniper (*Juniperus pinchotii*), yucca, mesquite (*Prosopis glandulosa*), lotebush (*Zizyphus obtusifolia* var. *obtusifolia*), hackberry (*Celtis* sp.), bumelia, pricklypear (*Opuntia* sp.), skunkbush sumac (*Rhus aromatica* var. *flabelliformis*), ephedra, plum (*Prunus* sp.), western soapberry (*Sapindus saponaria*), little leaf sumac (*Rhus microphylla*), shin oak (*Quercus sinuata* var. *breviloba*), tasajillo (*Opuntia leptocaulis*), agarito (*Berberis trifoliolata*), catclaw acacia (*Acacia* greggii var. *greggii*), lime pricklyash (*Zanthoxylum fagara*), sand sage, and others. Bottomland areas found along larger streams contain American elm (*Ulmus Americana)*, button willow (*Cephalanthus occidentalis)*, pecan (*Carya illinoensis)* and cottonwood (*Populus* sp.). The limestone ridges and steep terrains of this area produce a greater diversity of woody plants and wildlife habitat than would normally be expected from a plains region.

Faunal species include those suited to a semi-arid environment. Riparian zones along the Brazos River and streams and their tributaries contain important wildlife habitat for the region and support populations of white-tailed deer (*Odocoileus virginianus)* and Rio Grande turkeys (*Meleagris gallopavo intermedia)*. Bobwhites (*Colinus virginianus)*, scaled quail (*Callipepla squamata*), mourning dove (*Zenaida macroura*), and a variety of song birds, small mammals, waterfowl, shorebirds, reptiles, and amphibians are found in this region. Large to medium-size mammals include the coyote (*Canis latrans)*, ringtail (*Bassariscus astusus)*, ocelot (*Felis pardalis*), and collared peccary (*Tayassu tajacu)*. Typical smaller herbivores include desert cottontail (*Sylvilagus auduboni*), hispid pocket mouse (*Perognathus hispidis)*, Texas kangaroo rat (*Dipodomys elator)*, Texas mouse (*Peromyscus attwateri*), desert shrew (*Notiosorex crawfordi)*, and rock squirrel (*Spermophilus variegates)*, Bison (*Bos bison)*, and black-footed ferret (*Mustela nigripes)* are historically associated with this area.

Within the proposed diversion lake area, the General Soil Map for Garza County shows Vernon-Rough broken land associations found close to the Brazos River, and Miles associations on the upland areas on either side of the river. Vernon soils are moderately deep clay loams, with slopes ranging from gentle to steep. Rough broken land is found in areas along escarpments and in areas that are generally sloping to steep in grade. The Miles series are generally found on uplands, and are composed of deep, moderately permeable deep fine sandy soils. These soils are well-drained and have a high available water capacity.

Federal and State listed Threatened and Endangered species for Garza County are summarized in Table 4.4-50. The Texas Natural Diversity Database lists two species considered Endangered or Threatened by the US Fish and Wildlife Service in Garza County; the Whooping Crane (*Gus Americana*), Black-footed Ferret (*Mustela nigripes*) and bald eagle (*Haliaeetus leucocephalus*). In addition there are four state-listed species within the county, the Arctic Peregrine Falcon (*Falco peregrinus tundrius*), Palo Duro Mouse (*Peromyscus truei Comanche*), and Texas horned lizard (*Phrynosoma cornutum*).

The Whooping Crane, Arctic Peregrine Falcon and Bald Eagle are potential migrants to Garza County which may use habitats in the area during migration. A survey of the diversion lake site may be required to determine whether populations of or potential habitats used by listed species occur in the area to be affected. The Palo Duro Mouse prefers juniper and mesquite covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado. The Black-footed Ferret is generally found in areas occupied by prairie dogs, usually dry, flat short grasslands including land overgrazed by cattle, and the Texas Horned Lizard generally prefers open, arid areas with sparse vegetation. Either of these two species might be found within the area of the proposed project.

There are two fish species found in the Brazos River Basin which are candidates for Federal Listing, the sharpnose shiner (*Notropis oxyrhynchus*), and the smalleye shiner (*Notropis buccula*). Both of these species require fairly shallow water in broad, open sandy channels with moderate current. Both species are listed as occurring within Garza County. There are no Ecologically Significant River and Stream Segments within the project area.[25]

The primary impacts potentially resulting from construction and operation of the proposed diversion lake and pipelines would include the temporary disturbance during construction of the dam and pipelines. Little difference is anticipated in habitat value between the existing, prevalent grasslands and the permanent pipeline rights-of-way that will be maintained free of woody vegetation. Within the proposed diversion site, the extent of habitat impact will depend on the frequency and duration of inundation events. Although the reach downstream of the diversion dam is intermittent, aquatic life in the North Fork Double Mountain Fork Brazos River may be affected to the extent that flows, or perennial pools, now persist for sufficient annual periods to provide some aquatic habitat. Changes in the size and configuration

[25] Texas Parks and Wildlife. Water Resources Branch TPWD 2005.

### *Table 4.4-50.*
### *Potentially Occurring Species that are Rare or Federal-and state-Listed in Garza County near the Lubbock North Fork Diversion Operation Llano Estacado Water Planning Region*

| *Birds* | *Federal Status* | *State Status* |
|---|---|---|
| **Arctic Peregrine Falcon (*Falco peregrinus tundrius*)** - potential migrant | DL | T |
| **Baird's Sparrow (Ammodramus bairdii)** – shortgrass prairie with scattered low bushes and matted vegetation. | | |
| **Bald Eagle (*Haliaeetus leucocephalus*)** - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds. | LT-PDL | T |
| **Ferruginous Hawk (Buteo regalis)** – open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers. | | |
| **Mountain Plover (*Charadrius montanus*)** – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous | | |
| **Snowy Plover (Charadrius alexandrinus)** – formerly an uncommon breeder in the Panhandle; potential migrant | | |
| **Western Burrowing Owl (*Athene cunicularia hypugaea*)** - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culverts. | | |
| **Whooping Crane *(Grus americana*)** - potential migrant; winters in and around Aransas National Wildlife Refuge and migrates to Canada for breeding; only remaining natural breeding population of this species. | LE | E |
| ***Fishes*** | | |
| **Sharpnose Shiner (Notropis oxyrhynchus)** – endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud. | C1 | |
| **Smalleye Shiner (Notropis buccula) -** endemic to upper two-thirds of Brazos River system and its tributaries; apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumably eats small aquatic invertebrates. | C1 | |
| ***Mammals*** | | |
| **Black-footed Ferret (Mustela nigripes)** – considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area. | LE | E |
| **Black-tailed Prairie Dog (Cynomys ludovicianus)** – dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups. | | |
| **Cave Myotis Bat (Myotis velifer)** – roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonots)* nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore. | | |
| **Palo Duro Mouse (Peromyscus truei Comanche)** – rocky, juniper-mesquite-covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado; juniper woodlands in canyon country of the panhandle; primarily nocturnal. | | T |
| **Plains Spotted Skunk (Spilogale putorius interrupta)** – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie. | | |
| **Swift Fox (Vulpes velox)** – restricted to current and historic shortgrass prairie; western and northern portions of Panhandle. | | |
| ***Reptiles*** | | |
| **Texas Horned Lizard (Phrynosoma cornutum)** – open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September. | | T |
| Status Key: DL-De-Listed, PDL-Proposed De-Listed, LE, LT-Federally Listed Endangered/Threatened, PE, PT-Federally Proposed Endangered/Threatened, E/SA, T/SA-Federally Listed Endangered/Threatened by Similarity of Appearance, C1-Federal Candidate for Listing, E,T-State Listed Endangered/Threatened, "blank"-Rare, but with no regulatory listing status | | |

of the Gobbler Creek channel may result from the increased frequency and magnitude of peak streamflows during diversion events.

The Texas Archeological Research Laboratory does not indicate any recorded sites within the flood pool of the diversion lake, as located herein. Although there are no recorded sites that occur within the floodpool of the lake there is at least one site located approximately 1/4 mile downstream of the proposed dam site. These findings indicate that there has been no systematic effort to record sites in the vicinity of the project.

#### *4.4.3.4.4 Engineering and Costing*

Costs for this option include the following:

- Land and right-of-way for diversion dam and pipelines;
- Construction of diversion dam;
- Pump stations and pipelines;
- Environmental impact assessments and archeological studies and recovery, and mitigation, if needed;
- State and federal permit acquisition;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated at $153,040,000 (Table 4.4-51). The total annual cost, including debt service, operation and maintenance, and power cost, is estimated to be $23,298,000. Power cost is based upon the additional energy needed to deliver the yield increase through the Lake Alan Henry pipeline system (26,169 acft/yr) in excess of that required to deliver only the current planned pipeline capacity of 21,880 acft/yr. For an annual yield increase of Lake Alan Henry of 26,169 acft/yr, the cost is $890 per acft, or $2.73 per 1,000 gallons (Table 4.4-51).

#### *4.4.3.4.5 Implementation Issues*

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-52, and the option meets each criterion.

The implementation of this option to supply additional water to the City of Lubbock depends upon acquisition of the necessary permits, including water rights and those required for construction, as well as other issues as summarized below:

*Potential Regulatory Requirements:*

- Texas Commission on Environmental Quality Water Right and Storage permits;
- U.S. Army Corps of Engineers Permits will be required for discharges of dredge or fill into wetlands and waters of the U.S. for dam construction, and other activities (Section 404 of the Clean Water Act);
- Texas Commission on Environmental Quality administered Texas Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- General Land Office Easement if State-owned land or water is involved; and
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit if state-owned streambed is involved.

*State and Federal Permits may require the following studies and plans:*

- Environmental impact or assessment studies;
- Wildlife habitat mitigation plan that may require acquisition and management of additional land;
- Flow releases downstream to maintain aquatic ecosystems;
- Assessment of impacts on Federal- and State-listed endangered and threatened species; and
- Cultural resources studies to determine resources impacts and appropriate mitigation plan that may include cultural resource recovery and cataloging; requires coordination with the Texas Historical Commission.

*Land Acquisition Issues:*

- Land acquired for reservoir and/or mitigation plans could include market transactions and/or eminent domain;
- Additional acquisition of rights-of-way and/or easements may be required; and
- Possible relocations or removal of residences, utilities, roads, or other structures.

***Table 4.4-51.***
***Cost Estimate Summary for***
***Lubbock North Fork Diversion Operation***
***Llano Estacado Water Planning Region***
***September 2008 Prices***

| ***Item*** | ***Estimated Cost*** |
|---|---|
| **Capital Costs** | |
| Dam and Reservoir (Conservation Pool: 1,000 acft; 650 acres; 2,000 ft. msl) | $2,315,000 |
| Stormwater Intake and Pump Station at Diversion Dam (171 MGD) | 25,037,000 |
| Stormwater Transmission Pipeline ( 5 miles; 96 in. diameter) | 15,555,000 |
| Stormwater Stilling Basin (250 cfs capacity) | 994,000 |
| Reclaimed Water Intake and Pump Station (12 MGD) | 3,128,000 |
| Reclaimed Water Transmission Pipeline ( 5 miles; 27 in. diameter) | 2,658,000 |
| Expansions of LAH Pipeline Pump Stations (23.3 MGD) | 24,541,000 |
| Water Treatment Plant Expansion (21 MGD) | 29,030,000 |
| **Total Capital Cost** | **$103,258,000** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies) | $35,230,000 |
| Environmental & Archeological Studies and Mitigation | 263,000 |
| Land Acquisition and Surveying (696 acres) | 460,000 |
| Interest During Construction (3 years @ 4 percent) | 13,829,000 |
| **Total Project Cost** | **$153,040,000** |
| **Annual Costs** | |
| Debt Service (Intake, Pipelines, and Pump Stations) (6 percent for 30 years) | $10,762,000 |
| Reservoir Debt Service (6 percent, 40 years) | 326,000 |
| Operation and Maintenance | |
| Intake, Pipelines, and Pump Stations | 1,500,000 |
| Dam and Reservoir | 50,000 |
| Water Treatment Plant | 2,602,000 |
| Stormwater Pumping Energy Costs ( 5,599,000 kWh @ $0.09/kWh) | 504,000 |
| Reclaimed Water Pumping Energy Costs ( 4,431,000 kWh @ $0.09/kWh) | 399,000 |
| LAH Pipeline Expansion Pumping Energy Costs (79,503,000 kWh @ $0.09/kWh) | 7,155,000 |
| **Total Annual Cost** | **$23,298,000** |
| **Stand Alone Operation** | |
| **Quantity of Water (acft/yr)** | **26,169** |
| **Annual Cost of Water ($ per acft)[1]** | **$890** |
| **Annual Cost of Water ($ per 1,000 gallons)[1]** | **$2.73** |
| **Conjunctive Operation with Post Reservoir and Lake 7** | |
| **Ouantity of Water (acft/yr)** | **3,675** |
| **Annual Cost of Water ($ per acft)[1]** | **$6,340** |
| **Annual Cost of Water ($ per 1,000 gallons)[1]** | **$19.45** |

[1] Annual Cost of Water is for the additional supply to be transmitted to the Lake Alan Henry Pipeline and treated at the expanded treatment facility. Costs do not included transport through the Lake Alan Henry pipeline nor costs associated with the Lake Alan Henry pipeline.

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***Table 4.4-52.***
***Comparison of Lubbock North Fork Diversion Operation***
***to Plan Development Criteria***
***Llano Estacado Water Planning Region***

| ***Impact Category*** | ***Comment(s)*** |
|---|---|
| A. Water Supply<br>1. Quantity<br>2. Reliability<br>3. Cost | <br>1. Sufficient to meet needs<br>2. High reliability<br>3. Reasonable to High |
| B. Environmental factors<br>1. Environmental Water Needs<br>2. Habitat<br>3. Cultural Resources<br>4. Bays and Estuaries<br>5. Threatened and Endangered Species<br>6. Wetlands | <br>1. Low impact<br>2. Low impact<br>3. Low impact<br>4. Negligible impact<br>5. Possible Low impact<br>6. Low impact |
| C. Impact on Other State Water Resources | • No apparent negative impacts on state water resources; no effect on navigation |
| D. Threats to Agriculture and Natural Resources | • Potential impact on habitat in diversion dam area |
| E. Equitable Comparison of Strategies Deemed Feasible | • Option is considered to meet municipal and industrial shortages |
| F. Requirements for Interbasin Transfers | • Not applicable |

### 4.4.3.5 Post Reservoir—Delivered to Lake Alan Henry Pipeline

#### *4.4.3.5.1 Description of Option*

The White River Municipal Water District holds TCEQ Certificate of Adjudication Number C3711 for Post Dam and Reservoir, which authorizes impoundment of 57,420 acre-feet; and diversion of 5,600 acft/yr for municipal purposes; 1,000 acft/yr for industrial purposes; and 4,000 acft/yr for mining purposes, with the priority date of January 20, 1970. The proposed Post Reservoir Project is located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas in Garza County (Figure 4.4-12). Water would be transported to the Lake Alan Henry Water Treatment Plant by way of the proposed Post Reservoir Pipeline connecting to the proposed Lake Alan Henry Pipeline. This supply would require expansion of the proposed Lake Alan Henry Water Treatment Plant, and expansion of the Lake Alan Henry Pipeline booster pump station located at Post.

Preliminary data pertinent to the project were obtained from the September 1968 report titled "Feasibility Report on Post Reservoir Site."[26] The proposed project includes a 5,800-ft rolled embankment dam with a 2,000-ft emergency spillway for passing the probable maximum flood (PMF). The project also includes a morning glory type service spillway to pass storm flows up to the 100-year return period.

#### *4.4.3.5.2 Available Supply of Water*

The conservation pool would provide approximately 56,000 acft of storage (neglecting sedimentation) and 37,000 acft (including sediment reserve) with a surface area of 2,280 acres. Recent analyses using the TCEQ WAM Run 3 indicate that the firm yield from the project would be 25,720 acft/yr considering availability of up to 22.9 MGD of effluent discharged by Lubbock into the North Fork and developed playa lake stormwater discharges from Lubbock. This yield assumes: (1) Lake 7 is not constructed upstream; (2) Re-allocation of the 19,000 acft of sediment reserve to conservation storage; and (3) Natural, unappropriated flows are subject to instream flow requirements equivalent to Consensus Criteria for Environmental Flow Needs (CCEFN), as shown in Table 4.4-53. For these conditions, the safe yield supply would be 18,525 acft/yr. A

[26] Freese, Nichols and Endress, 1968, "Feasibility Report on Post Reservoir Site," prepared for White River Municipal Water District, September. The 1968 cost estimate was $2.2 million.

safe yield analysis leaves a volume remaining in storage during the critical month of the drought of record equivalent to a one-year supply. However, for purposes of this analysis, the full firm yield supply of 25,720 acft/yr is assumed.

***Table 4.4-53.***
***Daily Natural Streamflow Statistics***
***Post Reservoir***
***Llano Estacado Water Planning Region***

| *Month* | *Median Flows – Zone 1 Pass-Through Requirements (cfs)* | *25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)* |
|---|---|---|
| January | 2 | 0 |
| February | 2 | 0 |
| March | 1 | 0 |
| April | 1 | 0 |
| May | 7 | 0 |
| June | 10 | 1 |
| July | 3 | 0 |
| August | 2 | 0 |
| September | 3 | 0 |
| October | 3 | 0 |
| November | 2 | 0 |
| December | 2 | 0 |
| **Zone 3 (7Q2) Pass-Through Requirement (cfs):** | | 0.0 |

Figure 4.4-13 illustrates the simulated Post Reservoir storage levels for the 1940 to 1997 historical period under firm yield operations of 25,720 acft/yr. Figure 4.4-14 illustrates changes in streamflows of the North Fork caused by construction and operation of the reservoir. As the model utilizes a monthly time step, all streamflow statistics shown are computed monthly values in acre-feet (acft) converted to equivalent cubic feet per second (cfs) flow rates. The stand alone yield of Post Reservoir, assuming that this project is built and operated independently of the North Fork Diversion to the Lake Alan Henry system and Lake 7. If the North Fork Diversion to the Lake Alan Henry system and Lake 7 are also developed and operated in conjunction with Post Reservoir, then supplies would be developed by the three projects as follows: (a) Post Reservoir – 22,270 acft/yr, (b) North Fork Diversion Operation – 3,675 acft/yr, and (c) Jim Bertram Lake System Expansion - Lake 7 – 17,650 acft/yr.

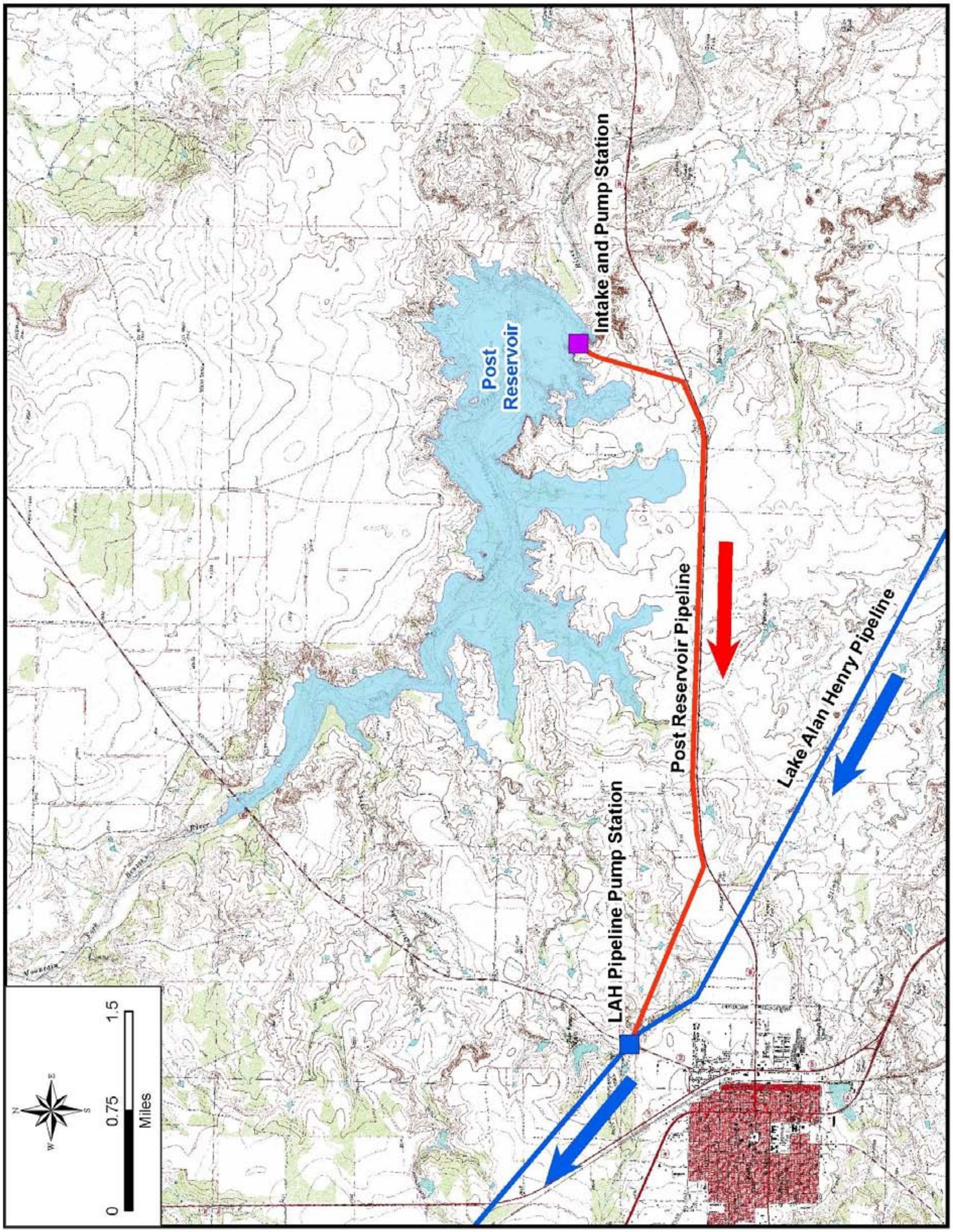



***Figure 4.4-12. Post Reservoir and Pipeline***

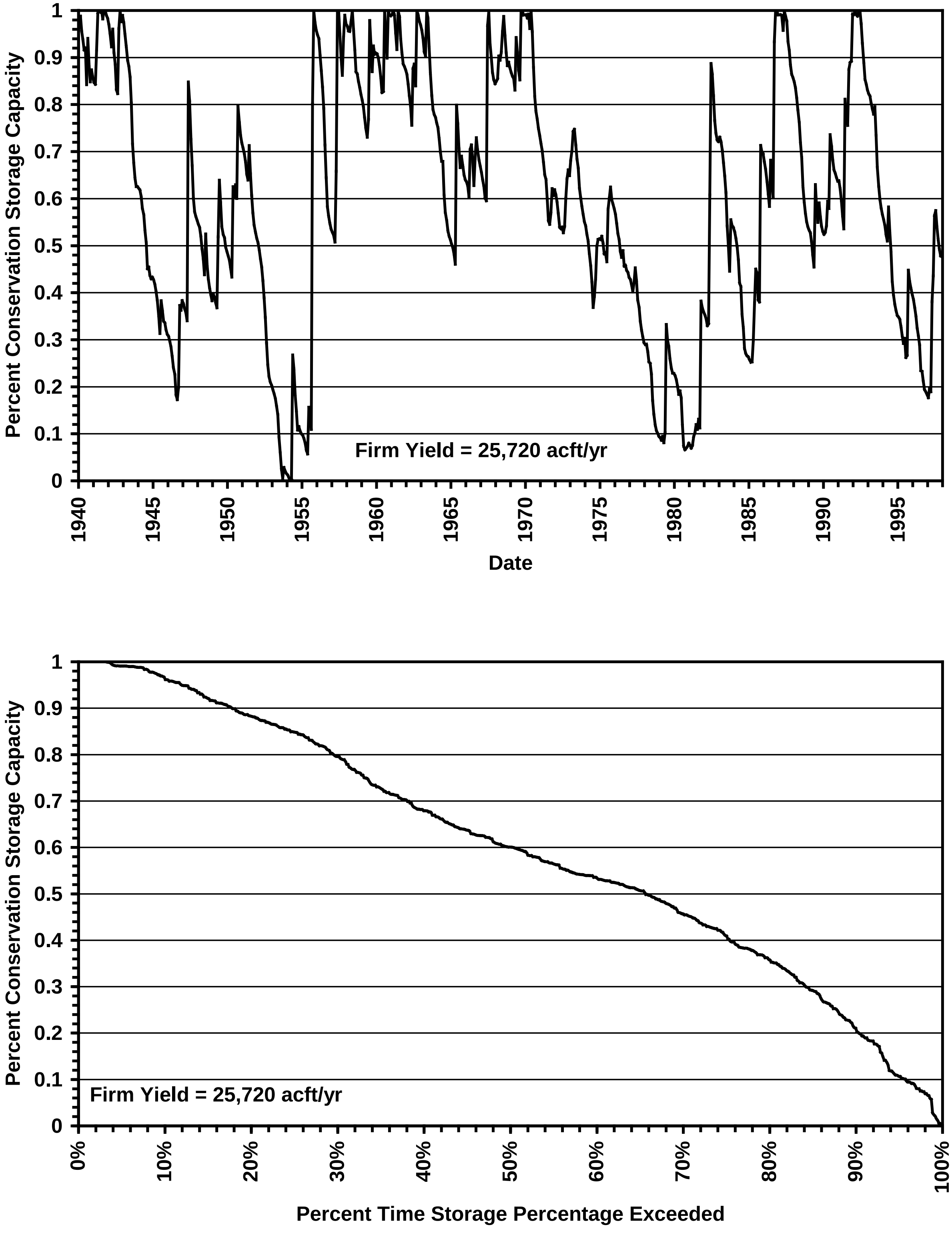
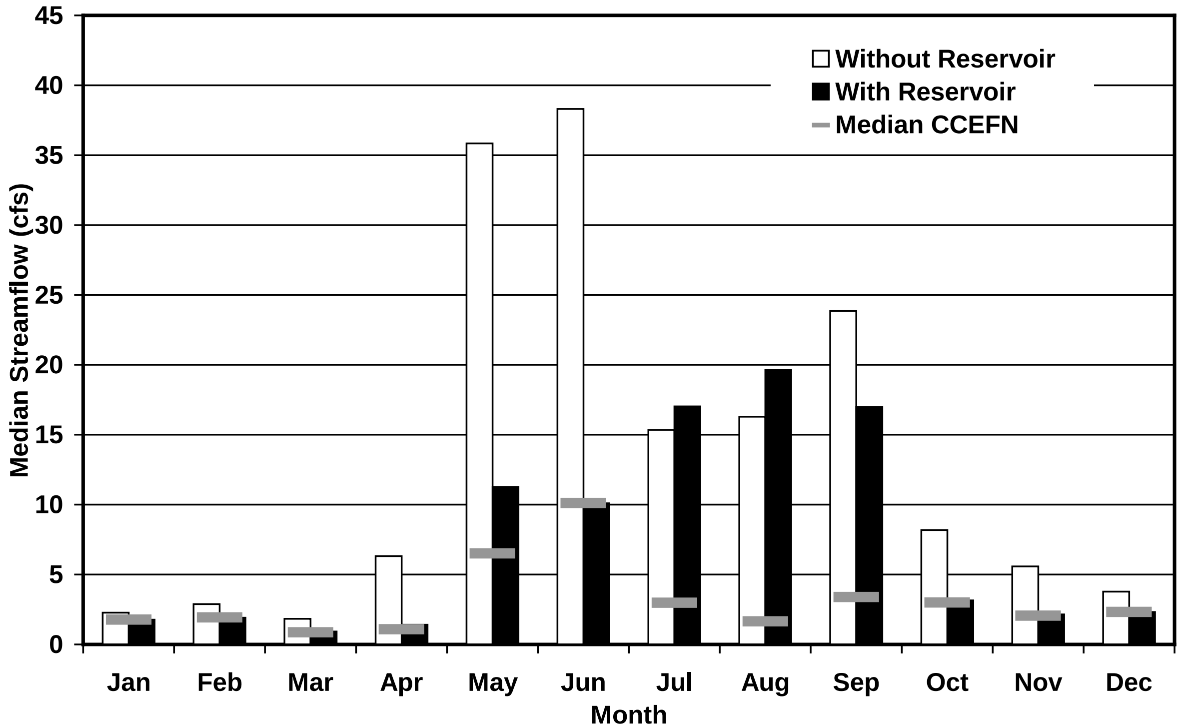



***Figure 4.4-13. Post Reservoir Storage Considerations***



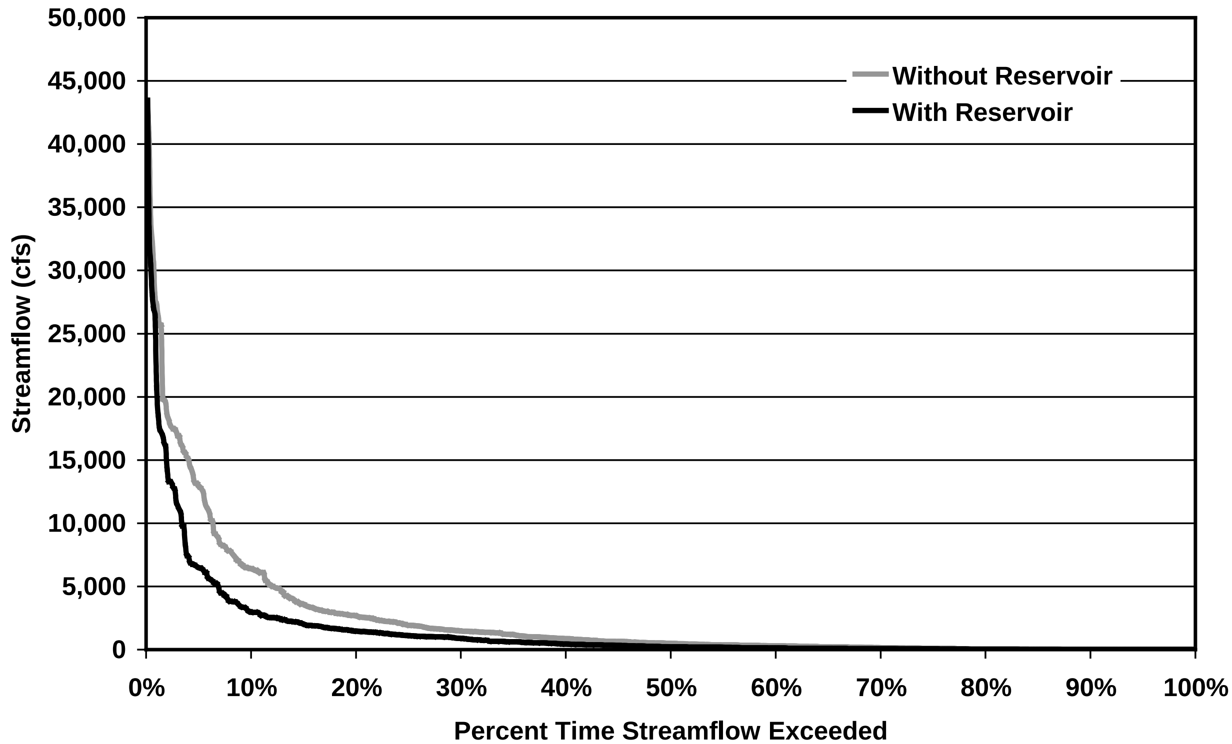




***Figure 4.4-14. Post Reservoir Streamflow Comparisons – Below Post Reservoir***

#### *4.4.3.5.3 Environmental Issues*

The primary environmental issue related to Post Reservoir is the change in landuse of an estimated 3,320 acres from ranching to a reservoir site and the resulting inundation of 2,280 acres including existing riparian habitat. The potential environmental effects resulting from the construction of the reservoir will also include the alteration of the existing aquatic environment of the North Fork of the Double Mountain Fork of the Brazos River both within the reservoir area, and above and below the dam site.

The study area is located in the Southwestern Tablelands Ecological Region as designated by the Texas Parks and Wildlife Department (TPWD).[27] This region is characterized by canyons, mesas, badlands, and dissected river breaks. Little cropland occurs within this area, with much of the region consisting of sub-humid grassland and semiarid rangeland. Vegetation within this area is characterized by grama-buffalograss with some mesquite-buffalograss in the southeast portion of the Region, juniper-scrub oak-midgrass savannah on escarpment bluffs, and midgrass prairie with low oak brush along portions of some rivers. This region is bordered on the south by the Edwards Plateau Ecological Region and on the west by the High Plains Ecological Region. The project area has an annual average precipitation of 18 to 24 inches, and an average temperature range of 57$^{o}$ F to 64$^{o}$ F. The growing season in this area lasts from 185 to 230 days. The prevalent wind direction is south to southwesterly and can be quite robust at times.

The project area is located within the Rolling Plains Vegetational Area as delineated by Gould.[28] This area is a nearly level to rolling plain with moderately rapid surface drainage. Upland soils of this area are generally pale to reddish brown sandy loams, clay loams and clays. Saline soils are common within this area, as are shallow and stony soils which may contain pockets of deep sand. Bottomland areas generally include only minor areas of loamy to clayey, calcareous alluvial soils.

The original prairie vegetation found within the Rolling Plains Vegetational Area included medium-tall grassland with a sparse shrub cover. The dominant vegetation currently found includes native grasses such as little bluestem (*Schizachyrium scoparium* var. *frequens*), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), Indiangrass (*Sorghastrum nutans*), sand bluestem (*Andropogon gerardii* var. *paucipilus)*, and various forbs.

[27] TPWD. 2005.
[28] Gould, F.W., G.O. Hoffman, and C.A. Rechenthin. 1960. Vegetational Areas of Texas. TX Agri. Ext. Serv. L-492.

Within areas of sandier soils with broad rolling relief you will find shin oak (*Quercus sinuata* var. *breviloba*) grasslands, with additional groups of various oaks occurring in the mixed grass prairie. In areas containing clay and clay loam soils the predominant vegetation is the mesquite savannah grasslands. These usually occur on flat to gently rolling lands and are characterized by an open canopy of larger mesquite trees, a midstory composed of shrubs such as lotebush (*Zizyphus obtusifolia*), succulents including prickly pears (*Opuntia* spp.) and ephedra (*Ephedra* spp.), and an understory of grasses and forbs.

Historically these natural communities were maintained by a combination of severe weather events, drought and fire. Invasion of the rangeland areas in this region by annual and perennial forbs, legumes, and woody species has been facilitated by historic livestock grazing practices and a lack of naturally occurring fire in the area.

The natural region of the proposed project area, as described by TPWD in the *Vegetation Types of Texas,*[29] is classified as Mesquite-Lotebush Brush and Shrub. In general this area includes a mosaic of brushy rangelands, grasslands, and pastures. Common or characteristic tree and shrub species found in this vegetation type include mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*) skunkbush sumac (*Rhus aromatica*), juniper (*Juniperus* spp.), and agarita (*Mahonia trifoliolata*) among others. Some of the grasses found occurring in rangelands, pastures, and clearings within the shrub areas include cane bluestem (*Bothriochloa barbinodis* var. *perforata*), purple three-awn (*Aristida purpurea*), Texas grama (*Bouteloua rigidiseta*), hairy grama (*B. hirsuta*), and Texas wintergrass (*Nassella leucotricha*). The majority of land found near the project area is currently used as rangeland with limited areas of dryland and irrigated crops and pastures.

Faunal species found within the area include those suited to a semi-arid environment. Riparian zones located along the Brazos River, and streams and their tributaries contain important wildlife habitat for the region and support populations of white-tailed deer (*Odocoileus virginianus)* and Rio Grande turkeys (*Meleagris gallopavo intermedia)*. Bobwhites (*Colinus virginianus)*, scaled quail (*Callipepla squamata*), mourning dove (*Zenaida macroura*), and a variety of song birds, small mammals, waterfowl, shorebirds, reptiles, and amphibians are found in this region. Mammals which occur principally in the plains area of Texas include the Texas kangaroo rat (*Dipodomys elator)*, Texas mouse (*Peromyscus attwateri*), prairie vole (*Microtus*

[29] The Vegetation Types of Texas. 1984. Texas Parks and Wildlife Department. Austin

*ochrogaster*), and plains pocket mouse (*Perognatus flavescents*).[30] Larger mammals found in the region include the coyote (*Canis latrans)* and ringtail (*Bassariscus astusus).* Bison (*Bos bison),* and black-footed ferrets (*Mustela nigripes*) are historically associated with this area.

#### *4.4.3.5.3.1 Threatened and Endangered Species*

Current databases of sensitive species maintained by the United States Fish and Wildlife Service (USFWS) and TPWD were reviewed to determine state and/or federally listed threatened or endangered species that occur or have historically occurred in Garza County. Table 4.4-54 contains a total of eight state-protected species, three federally listed endangered species, and one federal candidate species which are potentially known to occur in Garza County. Some of the listed species are migrants or wintering residents only, or considered extirpated.

The federal Endangered Species Act (ESA) of 1973, as amended, prohibits the "take" of any threatened or endangered species. The term "take" under the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." The term "harm" was further defined to include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." Additional federal protection is extended to migratory birds, and bald and golden eagles under the Migratory Bird Treaty Act, as amended, and the Bald and Golden Eagle Protection Act, respectively. Protection is also afforded to Texas state-listed species. The TPWD enforces the state regulations.

Review of the TPWD Texas Natural Diversity Database (TXNDD) system files and map data requested for the project area in March 2009 reveals that there are no documented occurrences of any endangered or threatened species within 1.5 miles of the proposed reservoir site. While the geographic range of some listed species encompasses the project area, the actual likelihood that they occur on the site or that suitable habitat for them is present varies depending on the biological requirements of each individual species.

The presence or absence of potential habitat does not confirm the presence or absence of a listed species. Surveys for protected species should be conducted within the proposed project area where preliminary evidence indicates their existence. No species specific surveys were conducted in the project area for this report. The following paragraphs present distributional data

[30] Davis, W. B. and D. J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

concerning each federally listed or state-listed species, along with a brief evaluation of the potential for the species to occur within the project area.

Three species listed in Table 4.4-54 are considered endangered by both the USFWS and TPWD. These are the Whooping Crane (*Grus Americana*), Gray wolf (*Canis lupus*), and black-footed ferret (*Mustela nigripes*). Portions of north Texas including the panhandle lie within the migratory corridor the whooping cranes follow in route to and from their nesting grounds in Wood Buffalo National Park in northwestern Canada. This species is known to stop during migration at locations in Oklahoma, Kansas, and Nebraska. There have been only a few scattered confirmed ground sightings of whooping cranes within Texas with the exception of their salt marsh wintering grounds along the Texas Coastal Bend. Although these birds might occur as possible vagrants during migration periods, the likelihood of incidence within the project area is remote.

The gray wolf and black-footed ferret are considered extirpated in Texas. Originally found within the western two thirds of the state, the last sighting of a gray wolf occurred in 1970 near Brewster County. The decline of the black-footed ferret is generally associated with the decline of available shortgrass prairie habitat and the subsequent reduction in the black-tailed prairie dog (*Cynomys ludovicianus*) population, a species that the ferret is heavily dependent on for survival. Although their historic range included the High Plains, Rolling Plains and Trans-Pecos regions of North America, the last reported Texas sightings of the black-footed ferret were on the western edge of the Texas panhandle in Dallam County in 1953 and Bailey County in 1963.[31]

[31] Davis, W. B. and D. J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

**Table 4.4-54.**
**Rare, Threatened, and Endangered Species**
**of Potential Occurrence in Garza County, Texas**

| Common Name | Scientific Name | Summary of Habitat Preference | Listing Entity | | Potential Occurrence in County |
|---|---|---|---|---|---|
| | | | USFWS | TPWD | |
| Baird's sparrow | *Ammodramus bairdii* | Shortgrass prairie with scattered low bushes and matted vegetation | -- | -- | Potential Migrant |
| Bald eagle | *Haliaeetus leucoephalus* | Primarily found near large rivers, nests in tall trees or cliffs | DL | T | Potential Migrant |
| Ferruginous hawk | *Buteo regalis* | Open country, primarily prairies, nests in tall trees or cliffs near water | -- | -- | Resident |
| Mountain plover | *Charadrius montanus* | Nests on shortgrass plains and fields | -- | -- | Nesting/ Migrant |
| Peregrine falcon | *Falco peregrinus anatum (American)* | Open county; cliffs. | DL | E | Nesting/ Migrant |
| | *Falco peregrinus tundrius (Arctic)* | | DL | T | |
| Snowy plover | *Charadrius alexandrinus* | Uncommon breeder in panhandle, winters along coast | -- | -- | Potential Migrant |
| Western burrowing owl | *Athene cunicularia hypugaea* | Open grasslands, especially prairie, plains and savanna | -- | -- | Resident |
| Western snowy plover | *Charadrius alexandrinus nivosus* | Uncommon breeder in panhandle, winters along coast | -- | -- | Potential Migrant |
| Whooping crane | *Grus americana* | Potential migrant | LE | E | Potential Migrant |
| Big free-tailed bat | *Nyctinomops macrotis* | Prefers to roost in crevices and cracks in high canyon walls | -- | -- | Resident |
| Black-footed ferret* | *Mustela nigripes* | Extirpated | LE | E | Historic resident |
| Black-tailed prairie dog | *Cynomys ludovicianus* | Dry short grasslands with sparse vegetation | -- | -- | Resident |
| Cave myotis bat | *Myotis velifer* | Colonial and cave-dwelling | -- | -- | Resident |

| ***Common Name*** | ***Scientific Name*** | ***Summary of Habitat Preference*** | ***Listing Entity*** | | ***Potential Occurrence in County*** |
|---|---|---|---|---|---|
| | | | ***USFWS*** | ***TPWD*** | |
| Gray wolf* | *Canis lupus* | Extirpated, forests, brushlands or grasslands | LE | E | Historic resident |
| Pale Townsend's big-eared bat | *Corynorhinus townsendii pallescens* | Roosts in caves and old buildings | -- | -- | Resident |
| Palo Duro mouse | *Peromyscus truei comanche* | Rocky slopes of canyons and juniper woodlands | -- | T | Possible Resident |
| Plains Spotted Skunk | *Spilogale putorius interrupta* | Prefers wooded, brushy areas. | -- | -- | Resident |
| Swift fox | *Vulpes velox* | Shortgrass prairie | -- | -- | Resident |
| Smalleye shiner | *Notropis buccula* | Endemic to Brazos River System | C | -- | Resident |
| Texas Horned Lizard | *Phrynosoma cornutum* | Varied, sparsely vegetated uplands. | | T | Resident |

LE/LT=Federally Listed Endangered/Threatened
DL, PDL=Federally Delisted/Proposed for Delisting
E, T=State Listed Endangered/Threatened
C=Candidate species
Blank = Rare, but no regulatory listing status
* Considered extinct in Texas
Source: Texas Parks & Wildlife Dept., Annotated County Lists of Rare Species, Revised 08/08/2007.

The Peregrine Falcon has been removed by USFWS from the Federal protection list but remains protected by TPWD in Texas. Two subspecies, the American Peregrine Falcon (*Falco peregrinus anatum*) and the Arctic Peregrine Falcon (*Falco peregrinus tundrius*) occur as migrants in Texas. Peregrine falcons are found in a variety of habitats throughout North America, including plains, tundra, forests, coastal regions and mountains. They are swift raptors which feed almost exclusively on birds ranging in size from that of small songbirds to ducks, and utilize almost any area with trees. The American Peregrine Falcon was removed from federal protection in 1999 but still is considered endangered by TPWD. The Arctic Peregrine Falcon, federally delisted in 1994, remains on the TPWD state-protected list as threatened. The project area does contain certain nesting and foraging habitat such as high steep cliffs and open undisturbed grasslands and meadows that could be occupied briefly by migrating individuals of this species.

Additional species listed as threatened by the TPWD include the Bald Eagle (*Haliaeetus leucoephalus*), Palo Duro mouse (*Peromyscus truei comanche*) and Texas horned lizard (*Phrynosoma cornutum*). The Bald Eagle (*Haliaeetus leucocephalus*) is found year-round within Texas as spring and fall migrants, breeders, or winter residents. However, according to TPWD information, the project area is not located within the known wintering or nesting range for this species. Bald eagles are generally found in coastal areas, near large inland reservoirs and along river systems. Because the Bald Eagle is primarily a fish eater, waters of sufficient size and clarity are necessary to provide their dietary requirements. It is possible that wintering populations occasionally pass through the project area, finding some suitable feeding habitat along the upper Brazos River Basin, although it is unlikely that this species would nest within this area.

The Palo Duro mouse is a secretive and nocturnal burrowing rodent that typically is restricted to steep, rocky canyon walls covered with a few juniper/mesquite trees and sparse grass cover. This species is found only in Randall, Armstrong, Briscoe and Culberson Counties of Texas, primarily in the Palo Duro Canyon along the eastern edge of the Llano Estacado. Thus, its presence within the project area is highly unlikely.

The Texas horned lizard may be found within the project area in habitat which contains open arid and semiarid regions with sparse plant cover including grass, cactus, scattered brush or scrubby trees. Because of their need to dig for hibernation, nesting and insulation, they are frequently found in loose sand or loamy soils. Although the Texas horned lizard may occur within the project area, no impact to this species is anticipated due to the abundance of similar habit near the project area and the species' ability to relocate to those areas if necessary.

Federal category 1 candidate (C1) species are those for which substantial information is available to support the biological appropriateness of proposing to list them as endangered or threatened. The smalleye shiner (*Notropis buccula*) is a C1 species of occurrence in the project area. This shiner has been sampled within the project area from the North Fork of the Double Mountain Fork of the Brazos River at its intersection with Highway 380. Historically, the smalleye shiner was found throughout the Brazos River Watershed and several of its major tributaries. This species is considered at this time to be stable in the upper Brazos River Basin, but its numbers have declined in the middle and lower reaches of the Basin. The most serious issues threatening this species are the effects of impoundments such as the proposed reservoir, and the degradation of water quality. Current information indicates that the shiner population within the Upper Brazos drainage upstream of Possum Kingdom Reservoir is apparently stable, whereas the population within the Lower Brazos River Basins may only exist in remnant areas of suitable habitat, or may be completely extirpated. This cyprinid species evolved to prosper in the saline and turbid conditions naturally occurring in the Brazos River Basin.

The remaining species in Table 4.4-57 have been designated by TPWD as rare but with no regulatory status. This status level includes species not presently threatened with extinction but which occur in such small numbers throughout their range that survival is a possible concern. These species include the black-tailed prairie dog (*Cynomys ludovicianus*), Mountain plover (*Charadrius montanus*), Ferruginous hawk (*Buteo regalis*), Western burrowing owl (*Athene curicularia hypugaea*), Western snowy plover (*Charadrius alexandrinus nivosus*), Snowy plover (*Charadrius alexandrinus*), Baird's sparrow (*Ammodramus bairdii*), big free-tailed bat (*Nyctinomops macrotis*), cave myotis bat (*Myotis velifer*), pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*), plains spotted skunk (*Spilogale putorius interrupta*), and swift fox (*Vulpes velox*).

The black-tailed prairie dog is an important prairie grassland species whose burrowing activity, foraging and feeding practices provide habitat and food sources for a variety of other species. Reduction of their preferred grassland habitat as a consequence of its conversion to cropland and urban areas has resulted in a dramatic decrease in their population numbers, as has hunting, poisoning and trapping. Important species observed on or near prairie dog colonies include mountain plovers and the endangered black-footed ferret.

The Mountain Plover is an upland migratory shorebird native to the shortgrass prairies of the Great Plains and arid rangelands of North America. Their current breeding range is northeastern New Mexico, western Oklahoma and northwestern Texas. This species is adapted to the sparsely vegetated and bare ground areas associated with various disturbances including heavy grazing, fire, and prairie dog towns. With the elimination of a great number of prairie dog towns throughout their range, mountain plover habitat has also been severely restricted.

The Ferruginous hawk prefers open county, primarily prairies, plains, and badlands. It nests in tall trees along streams or on steep slopes, cliff ledges, hillsides and power line towers. This species is a year-round resident in the northwestern high plains, but winters throughout the western two thirds of Texas.

The western burrowing owl nests and roosts in abandoned animal burrows. It prefers to inhabit open grasslands, especially prairie, plains and savanna, but sometimes utilizes other open areas such as vacant lots.

The western snowy plover is an uncommon breeder within the Panhandle of Texas. This species is a potential migrant within the project area, wintering along the Texas coast.

An inhabitant of flat, open coastal beaches and sand dunes, the Snowy Plover is a migrant along the lower Texas coast. This small shorebird species has suffered declines in population due to human disturbance, habitat loss and habitat degradation. Its occurrence in the project area is unlikely other than as a potential rare migrant.

Baird's Sparrow is dependant upon short and mixed grass upland prairie habitat with small, scattered shrub cover and matted vegetation. This species has suffered population declines attributed to habitat loss mainly from the conversion of native prairie and grasslands to agriculture.

The big-free-tailed bat is a species with sparse habitat data. Records indicate that this bat prefers to roost in crevices and cracks in high canyon walls, but will also utilize buildings. Thought to hibernate in the Trans-Pecos area, this species is an opportunistic herbivore.

The cave myotis bat is a colonial cave-dwelling species that is known to occur over much of western Texas including Garza County. This species may also roost in rock crevices, old buildings, carports, and under bridges. Colonies of this species can sometimes number in the thousands of individuals.

Roosting in caves, abandoned mine tunnels and occasionally old buildings, the pale Townsend's big-eared bat hibernates in groups during the winter. Males and females of this species separate into solitary roosts and maternity colonies until their offspring are born in May or June.

The historic range of the plains spotted skunk includes the plain states of the United States from Minnesota south to Texas and from Missouri west to parts of Wyoming and Kansas. The plains spotted skunk is commonly found in open prairie grasslands, wooded, brushy areas and cultivated lands. A decline in population of this species coincides with the conversion of their habitat to urban and agricultural uses.

The swift fox is found in the northern and western portions of the Texas panhandle. Although this species prefers to live in the open desert or sparsely vegetated prairie grasslands, they have adapted to inhabit cultivated areas and ranchlands. This species has faced habitat losses due to the conversion of native prairie grasslands to farmland over much of its former geographic range, and a reduction of its food sources with the associated decrease in the number of prairie dogs and ground squirrels.

#### *4.4.3.5.4 Costing*

The following assumptions and conditions were applied in the updating of the costs of this water management strategy:

- Capital costs are updated from 1968 to September 2008 using the Engineering News Record Construction Cost Index (CCI).
- The original cost estimate from 1968 does not include an outlet works structure that would be used to satisfy downstream instream flow requirements. A cost for an outlet works system is added to this cost update.
- Costs for embankment materials are increased from the 1968 report to include excavation and transport of the embankment materials.
- Engineering, legal costs, and contingencies are calculated as 35 percent of the total capital costs associated with construction of the dam. Environmental studies, mitigation and permitting costs are calculated as 100 percent of the land acquisition cost.
- Land acquisition costs are based on the inundated conservation pool area plus additional flood easements. Land costs are assumed as $750/acre for 2,280 acres of conservation pool area and $150/acre for 1,040 acres of flood easements.
- Interest during construction is calculated considering a 6 percent interest rate, with a 4 percent return on investments over a 4-year construction period.
- The annual cost for debt service is based on a 6 percent interest rate over a 40-year period.
- O&M costs are calculated as 1.5 percent of the estimated construction costs for the dam and reservoir.

Costs for this option include construction costs and other project costs, which include engineering costs, land acquisition for the reservoir and dam site, and interest during construction. The total project cost for this option was estimated to be $110,307,000 (Table 4.4-55). Financing the reservoir project for 40 years at 6 percent annual interest results in an annual debt service expense of $2,359,000 (Table 4.4-55). All non-reservoir components of the project are financed for 30 years at 6 percent annual interest and result in an annual debt service expense of $5,435,000. Annual operating and maintenance costs total $3,362,000 (Table 4.4-55). Annual pumping energy costs for the Post Reservoir Pipeline and transmission of water through the Lake Alan Henry Pipeline are estimated to be $726,000 and $3,904,000, respectively. Pumping energy cost for transmission through the Lake Alan Henry Pipeline is calculated as the additional energy cost required to deliver the additional 25,720 acft/yr while also delivering the initial planned capacity of the Lake Alan Henry Pipeline of 21,880 acft/yr. The total annual cost, including debt service and O&M cost, totals $15,786,000 (Table 4.4-55). With an annual firm yield of 25,720 acft/yr, the resulting cost of treated water at is $614 per acft, or $1.88 per 1,000 gallons, which does not include transmission pipeline costs from the treatment plant to the distribution system or distribution system costs. These unit costs are subject to the computed firm yield of 25,720 acft/yr, which is dependent upon the availability of upstream discharges of treated effluent and interruptible discharges of developed playa lake stormwater. If Post Reservoir were developed and operated in conjunction with the North Fork Diversion Operation and Lake 7, the supply developed by the project would decrease to 22,270 acft/yr, and unit costs would increase to $695 per acft, or $2.13 per 1,000 gallons (Table 4.4-55).

#### *4.4.3.5.5 Implementation Issues*

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-56, and the option meets each criterion.

The development of the Post Reservoir will require that the local sponsor, the White River Municipal Water Authority, either proceed with development or make arrangements for another entity to proceed, and customers willing to purchase water at prices adequate to retire the debt and pay operating costs, including water treatment and conveyance to locations of use. Implementation will require the following permits and studies.

1. Permits
   a. USCOE Sections 10 and 404 dredge and fill permits for reservoirs and pipelines impacting wetlands or navigable waters of the U. S.
   b. TPWD Sand, Gravel, and Marl permit for construction in state owned streambeds.
   c. NPDES Storm Water Pollution Prevention Plan.
   d. GLO easement for use of the state-owned streambed; and
   e. Section 404 certification from the TCEQ required by the clean water act.

***Table 4.4-55.***
***Cost Estimate Summary for Post Reservoir – Delivered through LAH Pipeline***
***Llano Estacado Region***
***September 2008 Prices***

| *Item* | *Estimated Cost for Facilities* |
|---|---|
| **Capital Costs** | |
| Dam and Reservoir (Conservation Pool of 38,421 acft, 2,283 acres, 2,430 ft msl) | |
| Preparation of Site | $230,000 |
| Core Trench Excavation (74,300 cubic yards) | 196,000 |
| Wetted and Rolled Embankment (2,317,400 cubic yards) | 12,189,000 |
| Riprap (62,400 cubic yards) | 2,872,000 |
| Blanket (25,900 cubic yards) | 1,191,000 |
| Service Spillway and Outlet | 2,958,000 |
| Mulching (22 acres=$116,000 and Irrigation of Downstream Slope=$131,000) | 247,000 |
| Relocation (Bridge at FM 651--raised, widened, or relocated.) | 657,000 |
| Intake, Pump Station, and LAH Pipeline Pump Station Expansion | 16,518,000 |
| Post Reservoir Transmission Pipeline (36 in dia., 6 miles) | 4,932,000 |
| Water Treatment Plant Expansion (21 MGD) | 29,030,000 |
| **Total Capital Cost** | **$71,020,000** |
| Engineering, Legal Costs and Contingencies (35% of Total Capital Cost) | $24,611,000 |
| Environmental & Archaeology Studies, Mitigation, and Permitting | 2,010,000 |
| Land Acquisition and Surveying (3,355 acres) | 2,227,000 |
| Pipeline Interest During Construction (2 years) | 5,542,000 |
| Reservoir Interest During Construction (4 years) | 4,897,000 |
| **Total Project Cost** | **$110,307,000** |
| **Annual Costs** | |
| Non-Reservoir Debt Service (6 percent, 30 years) | $5,435,000 |
| Reservoir Debt Service (6 percent, 40 years) | 2,359,000 |
| Operation and Maintenance | |
| Intake, Pipeline, Pump Station | 462,000 |
| Dam and Reservoir | 298,000 |
| Water Treatment Plant | 2,602,000 |
| Post Pipeline Pumping Energy Costs (10,065,096 kW-hr @ 0.09 $/kW-hr) | 726,000 |
| LAH Pipeline Pumping Energy Costs (43,378,000 kW-hr @ 0.09 $/kW-hr) | 3,904,000 |
| **Total Annual Cost** | **$15,786,000** |
| **Stand Alone Operation** | |
| **Available Project Firm Yield (acft/yr)** | **25,720** |
| **Annual Cost of Water ($ per acft)** | **$614** |
| **Annual Cost of Water ($ per 1,000 gallons)** | **$1.88** |
| **Conjunctive Operation with North Fork Diversion and Lake 7** | |
| **Available Project Firm Yield (acft/yr)** | **22,720** |
| **Annual Cost of Water ($ per acft)** | **$695** |
| **Annual Cost of Water ($ per 1,000 gallons)** | **$2.13** |

2. Studies to Support Permit Applications for permits 1.b through 1.f above:
   a. Assessment of changes in stream flows.
   b. Habitat mitigation plan.
   c. Environmental surveys.
   d. Cultural resources surveys, studies, and mitigation.
3. Land will have to be acquired either by negotiation or condemnation.

***Table 4.4-56.***
***Comparison of Post Reservoir – Delivered through LAH Pipeline to Plan Development Criteria Llano Estacado Water Planning Region***

| *Impact Category* | *Comment(s)* |
|---|---|
| A. Water Supply<br>1. Quantity<br>2. Reliability<br>3. Cost | <br>1. Sufficient to meet needs<br>2. High reliability<br>3. Reasonable to high |
| B. Environmental factors<br>1. Environmental Water Needs<br>2. Habitat<br>3. Cultural Resources<br>4. Bays and Estuaries<br>5. Threatened and Endangered Species<br>6. Wetlands | <br>1. Low to moderate impact<br>2. High impact<br>3. Low to moderate impact<br>4. Negligible impact<br>5. Possible Low impact<br>6. Low impact |
| C. Impact on Other State Water Resources | • No apparent negative impacts on state water resources; no effect on navigation |
| D. Threats to Agriculture and Natural Resources | • Potential impact on bottomland farms and habitat in reservoir area |
| E. Equitable Comparison of Strategies Deemed Feasible | • Option is considered to meet municipal and industrial shortages |
| F. Requirements for Interbasin Transfers | • Not applicable |
| G. Third Party Social and Economic Impacts from Voluntary Redistribution | • None |

### *4.4.3.6 Lubbock Brackish Groundwater Desalination*

#### *4.4.3.6.1 Description of Option*

This water management strategy would develop wells in the Trinity and Dockum Group of aquifers for subsequent treatment and use as drinking water. Wells would be developed in Bailey and Lubbock Counties. The proposed system would be developed in groups of four wells to produce an estimated 4 million gallons per day (MGD) of groundwater. Each well group would have an associated well collection, treatment and reject water disposal system. Each 4-well group is estimated to produce about 3,360 acre-feet per year (acft/yr) of potable water. It is intended that well groups with treatment and disposal systems will be brought on line, as the water is needed.

#### *4.4.3.6.2 Quantity of Water Available*

Evaluations by the City of Lubbock indicate that this water management strategy of 4 wells will yield a dependable, reliable during drought of record conditions supply of 3,360 acft of water per year for each of the projection dates.

#### *4.4.3.6.3 Environmental Issues*

The environmental issues associated with this water management strategy are for pipeline rights-of-way and sites for pumping plants. Since the project is located within an existing well field or city property, there are no known wildlife habitat or cultural resources that would be affected. Brine concentrate disposal will be through deep well injection.

#### *4.4.3.6.4 Engineering and Costing*

Costs for this option (4 well group) include the following:

- 4 wells at approximately 1,040 gpm per well;
- Collection pipelines;
- Reverse osmosis water treatment plant(s);
- Brine concentrate injection wells;
- Brine concentrate transmission pipelines;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

***Table 4.4-57.***
***Cost Estimate Summary for***
***Lubbock Brackish Groundwater Desalination***
***Llano Estacado Water Planning Region***
***September 2008 Prices***

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs**[1] | |
| Supply Wells (4 wells; 1,040 gpm) | $3,144,000 |
| Collection Pipeline(s) (10,560 ft; 12 in diameter) | 415,000 |
| Water Treatment Plant (Reverse Osmosis) | 2,096,000 |
| Building and Support Facilities | 1,179,000 |
| Sitework | 33,000 |
| Concentrate Injection Wells (2; 0.5 MGD) | 917,000 |
| Concentrate Transmission Pipelines ((2,640 ft; 8 in diameter) | 69,000 |
| **Total Construction Cost**[1] | **$7,853,000** |
| Feasibility Studies | 393,000 |
| Pilot Studies | 786,000 |
| **Total Capital Cost**[1] | **$9,032,000** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies) | $2,724,000 |
| Interest During Construction (3 years @ 4 percent) | 1,411,000 |
| **Total Project Cost** | **$13,167,000** |
| **Annual Costs** | |
| Debt Service (6 percent for 30 years) | 956,000 |
| Pipeline and Well Operation and Maintenance (1% of capital cost for pipelines; 1.5% for wells and Water Treatment Plant) | 159,000 |
| Membrane Replacement and Disinfection | 84,000 |
| Pumping Energy Costs (13,064,664 kWh @ $0.06/kWh) | 1,027,000 |
| **Total Annual Cost** | **$2,226,000** |
| **Quantity of Water (acft/yr)** | **3,360** |
| **Annual Cost of Water ($ per acft)**[2] | **663** |
| **Annual Cost of Water ($ per 1,000 gallons)**[2] | **2.03** |

1 Cost data provided by the City of Lubbock on 10/10/2005 were adjusted to September 2008 price level.
2 Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

The total project cost for this option was estimated at $9,032,000 (Table 4.4-57). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $956,00 for debt service. Annual operation and maintenance costs, including energy totals $1,270,000, with the annual cost, including debt service, operation and maintenance, and power cost, totaling $2,226,00. For an annual quantity of 3,360 acft/yr of treated water ready for delivery to customers, the cost is $663 per acft, or $2.03 per 1,000 gallons (Table 4.4-57).

#### *4.4.3.6.5 Implementation Issues*

The implementation of this option to supply additional water to the City of Lubbock is not expected to have significant, if any, adverse environmental effects. Wells will be located on property that has previously been altered by existing well fields or urban development.

This water management strategy uses brackish ground water from an aquifer which has not been used in this local area in the past. Information available indicates that use of brackish water from this source will have no effect upon water resources of the state, nor other water management strategies of the Region O Plan.

#### *4.4.3.7 White River Municipal Water District – Reclaimed Water*

##### *4.4.3.7.1 Description of Option*

This water management strategy would augment the WRMWD's water supply from White River Lake with reclaimed water. For this alternative, a reverse osmosis (RO) water treatment plant (WTP) would be located at the City of Lubbock's wastewater treatment plant (WWTP), and secondary effluent would be obtained from the City of Lubbock WTP and treated with RO on an as-needed basis to remove Total Dissolved Solids (TDS) such that historical levels of TDS are maintained in the reservoir. Following RO treatment, the effluent will be piped approximately 41 miles directly to a proposed constructed wetlands, located on a tributary to the lake. The wetlands would provide treatment for removal of nutrients and constituents, and provide "polishing" prior to discharge into the lake. Following discharge to the wetlands system, the water would flow into the reservoir, mix with the ambient waters, and eventually be withdrawn at the District's intake for treatment at the existing water treatment plant prior to distribution to District customers.[32]

##### *4.4.3.7.2 Quantity of Water Available*

Subject to agreement between the City of Lubbock and the WRMWD, the quantity of water available would be 2 MGD, or 2,240 acft/yr.

##### *4.4.3.7.3 Environmental Issues*

The environmental issues associated with this water management strategy involve the health implications of utilizing reclaimed water as a supplementary potable water supply, pipeline rights-of-way and sites for pumping plants and storage facilities, the proposed constructed wetlands, and White River Lake, into which the reclaimed water would be placed. Each of these issues is discussed briefly below.

In the case of health implications, a review of available studies indicates,

> "that to date, there are no known documented adverse health impacts associated with use of reclaimed water as a supplementary potable water source. However, there are still many constituents within the wastewater which have not been

[32] Alan Plummer Associates, Inc., "Water Reuse and Conservation Study, Augmentation of Water Supply Using Reclaimed Water," White River Municipal Water District and Texas Water Development Board, Austin Texas, October 2004.

> identified or about which little or no information is available as to the effectiveness of existing treatment technologies in removing them from the potable water supply. In addition, no detailed studies have been performed which address potential long-term health impacts of using reclaimed water to supplement potable water supplies. Consequently, systems using reclaimed water to supplement their potable water supplies assume some level of risk. Most systems have addressed this risk by adopting a conservative "multiple barrier" approach to the treatment and use of reclaimed water. This approach typically includes a combination of providing ample detention time and dilution between the discharge and intake points and providing various degrees of advanced treatment at the wastewater treatment plant and/or the water treatment plant."[33]

In the case of White River Lake, water quality evaluations of reclaimed water alternatives were made, the results of which are summarized below:

- In order to maintain percent blends and detention times within the range recommended as guidance of average percent blend less than 30 percent, and average detention time greater than 1 year, the maximum amount of wastewater that can be diverted to the proposed wetlands/reservoir system is approximately 4 MGD, and
- In order to maintain TDS levels within the range of historically observed values in White River Reservoir, RO treatment must be provided for the wastewater effluent.

It is important to note that the proposed project is sized at 2 MGD, reverse osmosis and constructed wetlands treatments are included.

In the case of rights-of way for pipeline and facilities, since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

#### *4.4.3.7.4 Engineering and Costing*

Costs for this option include the following:

- Reverse Osmosis Water Treatment Plant
- Conveyance Pump Station and Pumps
- Pipeline and Valves (16-inch)
- Constructed Wetland
- Land and Easements
- Wastewater Effluent
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return (applied to Capital plus 70 percent of engineering, legal, and contingency costs) (Table 4.4-58).

[33] Ibid.

***Table 4.4-58.***
***Cost Estimate Summary for***
***White River Municipal Water District—Reclaimed Water ****
***Llano Estacado Water Planning Region***
***September 2008 Prices***

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs[1]** | |
| Wastewater Effluent | |
| Reverse Osmosis Water Treatment Plant & Pretreatment Facilities (2 MGD) | $ 6,762,220 |
| Pump Station, Pumps, Electrical & Equipment Setting (2 pumps @ 1400 gpm each) | 2,447,080 |
| Pipeline and Valves (16 in, 41 miles) to Wetlands | 15,234,907 |
| Wetlands Construction (40 acres @ $13,350/acre) | 534,000 |
| Land (40 acres @ $2,000/acre) and Easements (492 acres @ $2,000/acre) | 1,064,242 |
| **Total Capital Cost[1]** | **$26,042,449** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other) | $ 8,230,758 |
| Interest During Construction (3 years @ 4 percent)(Capital+70% of Engr/ Legal/Contg) | 3,816,477 |
| **Total Project Cost** | **$38,089,684** |
| Annual Costs | |
| Debt Service (6 percent for 30 years) | $ 2,765,311 |
| Operation and Maintenance | 683,472 |
| Pumping Energy Costs (1,978,551 kWh @ $0.06/kWh) | 118,713 |
| **Total Annual Cost** | **$3,567,496** |
| **Quantity of Water (acft/yr)** | **2,240** |
| **Annual Cost of Water ($ per acft)[2]** | **$1,593** |
| **Annual Cost of Water ($ per 1,000 gallons)[3]** | **$4.89** |

[1] Alan Plummer Associates, Inc.," Water District Water Reuse and Conservation Study," White River Municipal Water District and Texas Water Development Board, Austin Texas, October 2004.

[2] Annual Cost of Water is for reclaimed water at White River Lake and does not include costs associated with water treatment and distribution to members' municipal systems.

The total project cost for this option was estimated at $26,042,449 (Table 4.4-58). The total annual cost, including debt service, operation and maintenance, and power cost, is estimated to be $3,567,496. With an annual yield of 2,240 acft/yr, the cost is $1,593 per acft, or $4.89 per 1,000 gallons (Table 4.4-58).

#### *4.4.3.7.5 Implementation Issues*

In order to implement this water management strategy, the White River Municipal Water district will need to enter into an agreement with the City of Lubbock to obtain the necessary wastewater effluent. In addition, it will be necessary to obtain permits from the TCEQ, the USCOE, and other agencies, as follows:

1. Permits and/or Permit Amendments

a. TCEQ Certificate of Adjudication 12-3693 has been awarded to the White River Municipal Water District to impound not to exceed 44,897 acft per annum of water, and to divert up to 6,000 acft per annum of said water (2,000 acft per annum for mining purposes and 4,000 acft per annum for municipal purposes) at a maximum rate of 4,100 gpm. The District will need to obtain authorization pursuant to Water Code Section 11.042 to convey water through the Lake, and Water Code Section 11.122 to increase the annual amount diverted pursuant to Certificate of Adjudication No. 12-3693. Additionally, the District will need to obtain authorization pursuant to Water Code Section 11.046 to recognize the indirect reuse of groundwater and developed water-based effluent discharged to the headwaters of the reservoir. Each of these authorizations can be pursued through an amendment to Certificate of Adjudication No. 12-3693.

b. Authorization from TCEQ pursuant to the Clean Water Act and Chapter 26 of the Water Code. This water management strategy contemplates a new outfall from the Lubbock's wastewater treatment facility into the headwaters of White River Lake. As such, TPDES Permit No. 10353-002, granted to the City of Lubbock would need to be amended to authorize this discharge. The transfer of water between the North Fork and the Lake would require a discharge permit pursuant to Chapter 26 of the Water Code, since these are two "distinct sources" of water. In addition the District will need to obtain approval for the design of any water or wastewater treatment facilities contemplated by these options.

c. USCOE Sections 10 and 404 dredge and fill permits for pipelines impacting wetlands or navigable waters of the U. S.

d. Texas Parks and Wildlife Department (TPWD) Sand, Gravel, and Marl permit for construction in state owned streambeds.

e. National Pollution Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan.

f. General Land Office (GLO) easement for use of the state-owned streambed; and

g. Section 404 certification from the TCEQ required by the clean water act.

2. Studies to Support Permit Applications:

   a. Assessment of changes in stream flows.

   b. Habitat mitigation plan.

   c. Environmental surveys.

   d. Cultural resources surveys, studies, and mitigation.

3. Land will have to be acquired either by negotiation or condemnation.

#### *4.4.3.8 White River Municipal Water District – Local Groundwater*

##### *4.4.3.8.1 Description of Option*

This water management strategy would augment the WRMWD's water supply by drilling up to eight wells within Crosby or Dickens Counties on property owned or leased by the district or one of its member cities, and the connection of the eight wells to WRMWD's existing wholesale supply system via 1,000 linear feet of 6-inch diameter pipeline.

##### *4.4.3.8.2 Quantity of Water Available*

The quantity of water available would be 7,742 acft/yr.

##### *4.4.3.8.3 Environmental Issues*

There are no known environmental issues associated with this water management strategy.

##### *4.4.3.8.4 Engineering and Costing*

Costs of this option include:

- Drilling and equipping eight (8), 600-gpm wells; and
- Construction of 1,000 feet of 6-inch water line (Table 4.4-59).
- The total project cost for this option was estimated at $1,063,625 (Table 4.4-59). The total annual cost, including debt service, operation and maintenance, and power cost, is estimated to be $345,308. With an annual yield of 7,742 acft/yr, the cost is $45 per acft, or $0.14 per 1,000 gallons (Table 4.4-59).

##### *4.4.3.8.5 Implementation Issues*

There are no known implementation issues associated with this water management strategy.

**Table 4.4-59.**
**Cost Estimate Summary for**
**White River Municipal Water District—Local Groundwater**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| *Item* | *Estimated Cost* |
|---|---|
| **Capital Costs** | |
| Water Supply Wells (8) (600 gpm) | $ 733,600 |
| Transmission Pipeline (6 in., 1,000 feet) | 24,890 |
| **Total Capital Cost[1]** | **$758,490** |
| Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other) | $ 264,227 |
| Interest During Construction (1 year @ 4 percent) | 40,908 |
| **Total Project Cost** | **$1,063,625** |
| Annual Costs | |
| Debt Service (6 percent for 20 years) | $ 92,748 |
| Operation and Maintenance | 7,560 |
| Pumping Energy Costs (4,083,912 kWh @ $0.06/kWh) | 245,000 |
| **Total Annual Cost** | **$345,308** |
| **Quantity of Water (acft/yr)** | **7,742** |
| **Annual Cost of Water ($ per acft)[1]** | **$45** |
| **Annual Cost of Water ($ per 1,000 gallons)[1]** | **$0.14** |

[1] Annual Cost of Water is for raw water at the well field and does not include costs associated with water treatment and distribution to members' municipal systems.

### *4.4.3.9 Confined Animal Feeding Operations (CAFOs) Water Management Strategy*

The purpose of this water management strategy for confined animal feeding operations (CAFO) is to address projected potential water shortages for dairies and beef feedyards located in Bailey, Castro, Deaf Smith, Hale, Lamb and Parmer Counties of the Llano Estacado Water Planning region (Region O).

#### *4.4.3.9.1 Description of Option*

The development of the CAFO water management strategy consisted of identifying those CAFOs that are projected to experience a water need (shortage) during the 2010 through 2060 planning period and developing a potential water management plan to obtain water to meet the projected need using groundwater from the Ogallala Aquifer within the county where the shortage is projected to occur. In the six-county area, water demand for feedyards is projected to increase from 25,305 acft/yr in 2010 to 36,040 acft/yr in 2060, and from 8,175 acft/yr in 2010 to 14,703 acft/yr in 2060 for dairies (Table 4.4-60).[34] Calculations (Appendix K) were made of dates at which water and aquifer storage levels would decline to points at which shortages would be expected to occur for each CAFO. Of the total number of 78 feedyards in the six-county area, the projected numbers with water needs (shortages) is 3 in 2020, 8 in 2030, 22 in 2040, 28 in 2050, and 30 in 2060. However, there are no projected shortages in Bailey County. Of the 55 dairies located in the 6 county area, 4 are projected to have needs (shortages) in 2030, 12 in 2040, 17 in 2050, and 20 in 2060.

[34] The water demands for beef feedlots are presented in Section 2, Table 2-9, and for dairies in Section 2, Table 2-11.

**Table 4.4-60.**
**Projected Water Demands for Feedyards and Dairies**

| County | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|
| | | | **Feedyards** | | | |
| **Bailey** | 1,184 | 1,327 | 1,409 | 1,496 | 1,588 | 1,686 |
| **Castro** | 6,546 | 7,339 | 7,791 | 8,272 | 8,782 | 9,323 |
| **Deaf Smith** | 8,583 | 9,623 | 10,216 | 10,846 | 11,514 | 12,224 |
| **Hale** | 1,445 | 1,620 | 1,720 | 1,826 | 1,939 | 2,058 |
| **Lamb** | 1,619 | 1,815 | 1,927 | 2,046 | 2,172 | 2,306 |
| **Parmer** | 5,928 | 6,646 | 7,056 | 7,491 | 7,953 | 8,443 |
| **Total** | 25,305 | 28,370 | 30,119 | 31,977 | 33,948 | 36,040 |
| | | | | | | |
| | | | **Dairies** | | | |
| **Bailey** | 1,328 | 1,727 | 1,908 | 2,107 | 2,328 | 2,571 |
| **Castro** | 1,476 | 1,919 | 2,120 | 2,342 | 2,587 | 2,858 |
| **Deaf Smith** | 1,559 | 1,828 | 2,019 | 2,231 | 2,464 | 2,722 |
| **Hale** | 855 | 960 | 1,060 | 1,171 | 1,294 | 1,429 |
| **Lamb** | 1,290 | 1,398 | 1,544 | 1,706 | 1,884 | 2,081 |
| **Parmer** | 1,667 | 2,043 | 2,257 | 2,493 | 2,754 | 3,042 |
| **Total** | 8,175 | 9,875 | 10,908 | 12,050 | 13,311 | 14,703 |
| **Source: Section 2: Table 2-9 and Table 2-11.** | | | | | | |

**Table 4.4-61.**
**Projected Water Needs (Shortages) for Feedyards and Dairies**

| County | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|
| | | | **Feedyards** | | | |
| **Bailey** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Castro** | 0 | 759 | 1,612 | 4,279 | 4,846 | 5,144 |
| **Deaf Smith** | 0 | 0 | 0 | 517 | 548 | 582 |
| **Hale** | 0 | 0 | 573 | 609 | 1,939 | 2,058 |
| **Lamb** | 0 | 0 | 241 | 1,023 | 1,358 | 1,730 |
| **Parmer** | 0 | 0 | 0 | 749 | 2,386 | 3,377 |
| **TOTAL** | 0 | 759 | 2,426 | 7,176 | 11,077 | 12,891 |
| | | | | | | |
| | | | **Dairies** | | | |
| **Bailey** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Castro** | 0 | 0 | 450 | 749 | 1,107 | 1,228 |
| **Deaf Smith** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Hale** | 0 | 0 | 0 | 187 | 208 | 460 |
| **Lamb** | 0 | 0 | 134 | 595 | 990 | 1,280 |
| **Parmer** | 0 | 0 | 180 | 797 | 1,326 | 1,715 |
| **TOTAL** | 0 | 0 | 764 | 2,328 | 3,631 | 4,683 |

#### *4.4.3.9.2 Quantity of Water Needed (Shortages)*

The projected water shortage of the beef feedyards and dairies was calculated by: (1) determining the number of feedyards and dairies that are expected to have a shortage by decade, (2) estimating the average number of cattle in each CAFO in each county by decade since 2010 by using (a) county water demands of feedyards and dairies, (b) total water demand of feedyards and dairies within Region O, (c) total number of feeders and dairy animals within Region O, and (d) the number of inventoried feedyards and dairies within the study area, (3) assuming the water demand for a feeder is 15 gal/hd/d, and for a dairy animal of 48 gal/head/d, (4) multiplying the number of feedyards with shortages times the number of head in the feedlot and dairy times the unit water consumption of an animal.

The projected total water needs (shortages) are presented at the county level as is done for other water user groups in order to avoid disclosure of individual entity information (Table 4.4-61). The analysis shows that there is sufficient local groundwater in 2010 for all the feedyards and dairies in the six counties, with projected needs (shortages) in 2020 of 759 acft/yr for feedyards, shortages in 2040 of 7,176 acft/yr for feedyards and 2,328 acft/yr for dairies, and shortages in 2060 of 12,891 acft/yr for feedyards and 4,683 acft/yr for dairies (Table 4.4-61). The greatest shortage for beef feedyards and dairies occurs in Castro and Parmer Counties, respectively.

#### *4.4.3.9.3 Environmental Issues*

The implementation of this water management strategy to supply confined animal feeding (CAFOS) operations with water to meet future needs is not expected to have significant, if any, adverse environmental effects. Wells and pipelines will likely be located on property that has previously been altered by agriculture. In cases where these conditions are not met, field inspection of potential well sites and pipeline rights-of-way can be done, and well sites and pipeline routes can be selected to avoid sensitive wildlife habitat, plant communities, and/or cultural resources.

#### *4.4.3.9.4 Costing*

The general approach in the costing for CAFOs is to formulate several generalized or generic water supply facilities that could potentially meet the projected needs of one or more CAFOs (beef feedyards or dairies) with replacement supply wells at a range of distances from the CAFOs. This approach was selected because: (1) the CAFOs are individually owned, (2) needs (shortages) are projected to develop at various times during the planning period, (3) individual owners need to be able to assess their needs and the local groundwater supplies on an individual basis, and (4) flexibility is needed for the owners to select a preliminary design that most closely approximates their respective situations.

The selected sizes (shortages) for the preliminary designs are 300, 900 and 1,500 acft/yr. These needs (shortages) are generally representative of the annual water demands of 1, 3 and 5 CAFOs, respectively. Costs are calculated for these three sizes of water management strategies located at distances of 5 and 10 miles from the CAFOs having projected needs (shortages). These plans are considered to be approximate for conditions and settings in the six county study area and can provide a guide to the CAFO water users of the approximate cost of replacement water supplies. They also give an indication of the benefit of several or more CAFO owners working together to implement one or more water management strategies to meet their combined needs (shortages).

The design is based on the estimate that wells will yield about 150 gpm and the CAFOs have a peak demands in the summer of 1.5 times the annual average demands. It also assumes that the wells will be spaced one quarter mile apart and the CAFOs will be located one-half mile apart. In order to avoid disclosure of information that might compromise individual ownership interests in the purchase and sale of land and water involved the specific locations of well fields and pipeline routes are not identified. In addition, it is assumed that acquisition of land, water and rights-of-way will be on a voluntary and willing basis.

The cost estimates for well fields include a contingency of one backup well to meet peak demands during the summer. For the well field that is 5 miles from the CAFOs, the well pumps are designed to have sufficient power and capacity to delivery the water to the CAFOs. For the well field that is 10 miles from the CAFOs, the preliminary design utilizes a small pump station to deliver the water from the well field to the delivery points and a storage tank at the terminal end to balance the water deliveries and provide a supply of water for the pump station.

The water management facilities consist of the pipelines, pump stations (if needed), wells and power connections. The project costs include the capital cost, engineering, legal, contingencies, environment, land acquisition (which assumes a purchase of 40 acres for each well site), and surveying costs, and interest during construction. The annual cost is based on a debt service of the project cost over a 20-year period. Other elements of the annual cost include operation and maintenance and power, with the unit costs calculated on the basis of the annual cost and the quantity of water for the given need (shortage).

The estimated costs of water for a water management strategy to supply approximately 300 to 1,500 acft/yr of water from well fields located at a distance of 5 to 10 miles from the CAFO users show a decreasing cost with an increase in the size of the project and a shorter distance to the water management strategy well field. For example, the lowest cost project is estimated to deliver 1,500 acft/yr of water from a well field located 5 miles from the CAFO. In this case, the unit water cost is $490/acft during the period when the debt must be paid. The highest cost project is estimated to deliver 300 acft/yr of water, with the nearest well field located 10 miles from the CAFO. In this case, the estimated cost of water for this water management strategy is $1,650/acft. Cost estimates for various components of the six combinations of projects are provided in Table 4.4-62 and Table 4.4-63.

**Table 4.4-62.**
**Cost Estimates--Water Management Strategy Located Five Miles From Feedyards and Dairies (CAFOs) with Needs (Shortages)**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| **Distance to Well Field: 5 miles** | | | |
|---|---|---|---|
| ***Item*** | ***300 acft/yr*** | ***900 acft/yr*** | ***1,500 acft/yr*** |
| **Capital Costs** | | | |
| Water Transmission and Distribution Facilities (Pipelines) | $1,161,900 | $1,521,765 | $1,780,485 |
| Well Field and Collector Pipelines (150 gpm wells, 400 ft deep) | $440,000 | $1,170,000 | $1,816,000 |
| **Total Capital Cost** | **$1,601,900** | **$2,691,765** | **$3,596,485** |
| Engineering, Legal Costs and Contingencies | $503,000 | $866,000 | $1,170,000 |
| Environmental & Archaeology Studies and Mitigation | $635,000 | $650,000 | $957,000 |
| Land Acquisition (62 acres) and Surveying | $739,000 | $743,000 | $1,077,000 |
| Interest During Construction (1 years) | $140,000 | $199,000 | $273,000 |
| **Total Project Cost** | **$3,618,900** | **$5,149,765** | **$7,073,485** |
| **Annual Costs** | | | |
| Debt Service (6 percent, 20 years) | $316,000 | $449,000 | $617,000 |
| Operation and Maintenance | | | |
| Pipeline and Pump Station | $16,000 | $27,000 | $36,000 |
| Pumping Energy Costs | $12,000 | $48,000 | $82,000 |
| Purchase Groundwater | $0 | $0 | $0 |
| **Total Annual Cost** | **$344,000** | **$524,000** | **$735,000** |
| **Available Project Yield (acft/yr)** | 300 | 900 | 1,500 |
| **Annual Cost of Water ($ per acft)** | $1,147 | $582 | $490 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $3.52 | $1.79 | $1.50 |

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**Table 4.4-63.**
**Cost Estimates--Water Management Strategy Located Ten Miles From Feedyards and Dairies (CAFOs) with Needs (Shortages)**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| **Distance to Well Field: 10 miles** | | | |
|---|---|---|---|
| **Item** | **300 acft/yr** | **900 acft/yr** | **1,500 acft/yr** |
| **Capital Costs** | | | |
| Water Transmission and Distribution Facilities (Pipelines) | $2,106,000 | $2,969,000 | $4,136,000 |
| Well Field and Collector Pipelines (150 gpm wells, 400 ft deep) | $440,000 | $1,170,000 | $1,816,000 |
| **Total Capital Cost** | **$2,546,000** | **$4,139,000** | **$5,952,000** |
| | | | |
| Engineering, Legal Costs and Contingencies | $791,000 | $1,330,000 | $1,931,000 |
| Environmental & Archaeology Studies and Mitigation | $760,000 | $775,000 | $1,082,000 |
| Land Acquisition (62 acres) and Surveying | $913,000 | $918,000 | $1,252,000 |
| Interest During Construction (1 years) | $201,000 | $287,000 | $409,000 |
| **Total Proiect Cost** | **$5,211,000** | **$7,449,000** | **$10,626,000** |
| | | | |
| **Annual Costs** | | | |
| Debt Service (6 percent, 20 years) | $454,000 | $649,000 | $926,000 |
| Operation and Maintenance | | | |
| Pipeline and Pump Station | $27,000 | $50,000 | $74,000 |
| Pumping Energy Costs | $14,000 | $62,000 | $106,000 |
| Purchase Groundwater | $0 | $0 | $0 |
| **Total Annual Cost** | **$495,000** | **$761,000** | **$1,106,000** |
| | | | |
| **Available Proiect Yield (acft/yr)** | 300 | 900 | 1,500 |
| **Annual Cost of Water ($ per acft)** | $1,650 | $846 | $737 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $5.06 | $2.59 | $2.26 |

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### *4.4.3.9.5 Implementation*

Implementation will require permits from the High Plains Underground Water Conservation District No. 1 to drill wells, unless existing wells are used, and permits. In addition, it may be necessary to obtain rights-of-way across private property and for crossing of county roads and perhaps state highways for pipeline crossings. In some cases, it may be desirable to form cooperative association(s), consortium(s) or public entities to formulate and implement plans to construct projects and operate the necessary facilities.

### *4.4.3.10 Canadian River Municipal Water Authority Water Management Strategy*

This water management strategy addresses projected potential water supplies for 7 of the Canadian River Municipal Water Authority (CRMWA) member cities of the Llano Estacado Water Planning Region (Region O) served by the CRMWA pipeline, including Plainview, Brownfield, Lamesa, Levelland, O'Donnell, Slaton, and Tahoka, plus a part of the supplies provided by Lubbock to three of its customers (New Deal, Ransom Canyon, and Shallowater) (Figure 4.4-15).

#### 4.4.3.10.1 Description of Option

The development of the CRMWA Water Management Strategy consisted of identifying and evaluating a potential water management strategy using groundwater from the Ogallala aquifer located in Region O for CRMWA-member cities of Region O mentioned above that are

**Table 4.4-64.**
**Selected Canadian River Municipal Water Authority Members**
**Llano Estacado Water Planning Region**

| Member City | 2000 | Water Demand Projections | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| Levelland | 2,219 | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| Slaton | 931 | 907 | 889 | 870 | 849 | 837 | 836 |
| Tahoka | 473 | 492 | 504 | 490 | 478 | 453 | 421 |
| Brownfield | 2,593 | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| Lamesa | 2,486 | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| O'Donnell | 156 | 161 | 163 | 159 | 155 | 147 | 137 |
| Lubbock Customers | | | | | | | |
| New Deal | 126 | 149 | 165 | 173 | 173 | 173 | 173 |
| Ransom Canyon | 310 | 440 | 569 | 698 | 825 | 953 | 1,004 |
| Shallowater | 311 | 344 | 367 | 377 | 371 | 379 | 371 |
| Subtotal | 9,605 | 10,090 | 10,497 | 10,785 | 10,957 | 10,872 | 10,649 |
| | | | | | | | |
| Plainview* | 4,078 | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |

* Plainview is shown separately, due to its location apart from the members located more closely together south of Lubbock.

presently being supplied from the CRMWA pipeline sources (Lake Meredith and Roberts County groundwater). The projected water demands of the member cities for which this water management strategy is a potential supply source are approximately 4,700 acft/yr for Plainview north of Lubbock and approximately 11,000 acft/yr for the remaining members located west of Lubbock, and south of Lubbock (Table 4.4-64).

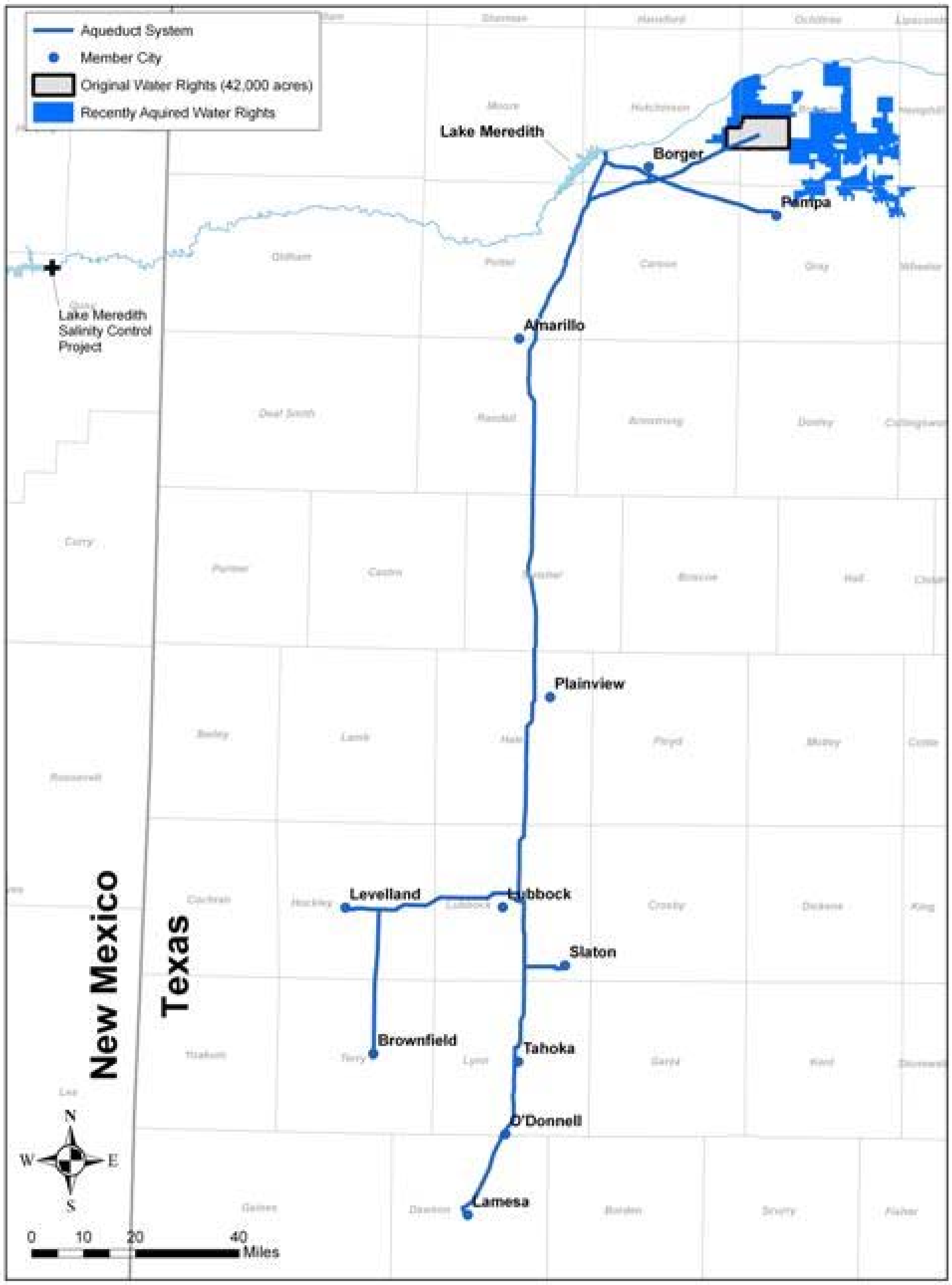


**Figure 4.4-15: CRMWA Member Cities and Pipeline**
**(Source: CRMWA web site: http://www.crmwa.com/).**

A study of groundwater level hydrographs for the long-term monitoring wells in the six-county area for the period 1998 to 2009 provides estimates of the recent trend in groundwater levels (Appendix L). Three well field sites located in close proximity to the existing CRMWA pipeline and in areas where the Ogallala has sufficient projected saturated thickness to meet the projected water demands of CRMWA cities of Region O were identified and evaluated. However, the specific locations of well fields and pipeline routes are not identified in order to avoid compromising private owner rights. Water from either or all of these sites could be routed to the existing CRMWA pipeline and become available for distribution to the CRMWA-member cities of Region O. The well fields are described briefly below.

Well Field Site Number 1 is located approximately seven miles east of Plainview and would be implemented at the size of 4,700 acft/yr to supply Plainview. Aquifer saturated thickness for Well Field Site Number 1 is approximately 160 ft.

Well Field Site Number 2 is located about 25 miles northeast of Lubbock and would supply Brownfield, Lamesa, Levelland, O'Donnell, Slaton, and Tahoka, plus provide enough water for Lubbock's customers (New Deal, Ransom Canyon, and Shallowater), and is evaluated at 2 sizes of 11,000 acft/yr and 4,500 acft/yr. At the 11,000 acft/yr size, Well Field Number 2 would meet the total needs of Brownfield, Lamesa, Levelland, O'Donnell, Slaton, and Tahoka, plus provide enough water for Lubbock's customers (New Deal, Ransom Canyon, and Shallowater). Aquifer saturated thickness for Well Field Site Number 2 is approximately 220 ft.

At the 4,500 acft/yr size, Well Field Number 2 would be used with Well Field Number 3, which is located in central Lynn County. Aquifer saturated thickness for Well Field Site Number 3 is approximately 150 ft. The smaller sized well field Number 2 would supply Shallowater, New Deal, and Ransom Canyon, whose demands are projected at approximately 4,500 acft/yr. In this scenario, Well Field Number 3 supply Brownfield, Lamesa, Levelland, O'Donnell, Slaton, and Tahoka. The demands of these southern cities server by the CRMWA pipeline are projected at approximately 6,500 acft/yr. The analysis shows that there is sufficient groundwater at the three well fields identified to meet the projected demands, as follows: (a) Plainview demand to be met by Well Field 1 is 4,635 acft/yr in 2040, and declining to 4,488 acft/yr in 2060; and (b) Brownfield, Lamesa, Levelland, O'donnell, Tahoka, and Shallowater combined demands could be met by Well Field 2 at 10,957 acft/yr in 2040, declining to 10,649 acft/yr in 2060.

#### *4.4.3.10.3 Environmental Issues*

The implementation of this water management strategy to supply CRMWA-member cities within Region O with water to meet future needs is not expected to have significant, if any, adverse environmental effects. Wells and pipelines will likely be located on property that has previously been altered by agriculture. In cases where these conditions are not met, field inspection of potential well sites and pipeline rights-of-way can be done, and well sites and pipeline routes can be selected to avoid sensitive wildlife habitat, plant communities, and/or cultural resources.

#### *4.4.3.10.4 Costing*

It is reiterated that the locations of the three well field sites that would be needed to meet the projected demands of CRMWA cities of Region O listed above are in close proximity to the existing CRMWA pipeline and in areas where the Ogallala has sufficient projected saturated thickness to meet the projected water demands. However, the specific locations of well fields and pipeline routes are not identified in order to avoid compromising private owner rights. The sizes of the collector system and CMWA connecting pipelines and the possible need of a pump station were designed based on the demands to be met at each well field.

The cost estimates are for well yields at 400 gpm and include a contingency of one backup well. The capital costs consist of the land, wells, pipelines, pump stations, and power connections. The project costs include land acquisition, surveying, well drilling and equipment, collection and transmission pipe and pipeline installation, pumps and pump station installation, engineering, legal, contingencies, environment, and interest during construction. The annual cost is based on a debt service of projects cost over a 20-year period. Other elements of the annual cost include operation and maintenance and power, with the unit costs calculated on the basis of the annual cost and the projected quantity of water demands of the cities.

The estimated costs for water delivered to Plainview from Well Field Number 1 are $461 per acft or $1.41 per 1,000 gallons (Table 4.4-65). Costs for delivery to the CRMWA pipeline from Well Field Number 2 at the 11,000 acft/yr size are $332 per acft ($1.02 per 1,000 gallons), and at the 4,500 acft/yr size are $421 per acf ($1.29 per 1,000 gallons) and for Well Field Number 3 are $241 per acft ($0.74 per 1,000 gallons) (Tables 4.4-66 through 4.4-68).

**Table 4.4-65.**
**Estimated Cost for Well Field Number 1**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| ***Item*** | ***Estimated Costs for Facilities*** |
|---|---|
| **Capital Costs** | |
| Well Fields and Collector Pipeline (10 wells and 1 mile of 12 in dia.) | $5,712,000 |
| Transmission Pipeline (20 in dia., 12 miles) | $6,456,000 |
| Pump Station | $2,070,000 |
| **Total Capital Cost** | **$14,238,000** |
| | |
| Engineering, Legal Costs and Contingencies | $4,707,000 |
| Environmental & Archaeology Studies and Mitigation | $1,077,000 |
| Land (Acquisition and Surveying) (444 acres @ $2,549/acre) | $1,132,000 |
| Interest During Construction (1 years) | $852,000 |
| **Total Project Cost** | **$22,006,000** |
| | |
| **Annual Costs** | |
| Debt Service (6 percent, 20 years) | $1,930,000 |
| Operation and Maintenance | |
| Intake, Pipeline, Pump Station | $175,000 |
| Pumping Energy Costs (683,236 kW-hr @ 0.09 $/kW-hr) | $61,000 |
| **Total Annual Cost** | **$2,166,000** |
| | |
| **Available Project Yield (acft/yr)** | 4,700 |
| **Annual Cost of Water ($ per acft)** | $461 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $1.41 |

**Table 4.4-66.**
**Estimated Cost for Well Field Number 2 (11,000 acft/yr)**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| ***Item*** | ***Estimated Costs for Facilities*** |
|---|---|
| **Capital Costs** | |
| Well Fields and Collector Pipeline (22 wells and 2 miles of 12 in dia.) | $12,448,000 |
| Transmission Pipeline (36 in dia., 13 miles) | $9,960,000 |
| Pump Station | $2,070,000 |
| **Total Capital Cost** | **$24,478,000** |
| | |
| Engineering, Legal Costs and Contingencies | $8,116,000 |
| Environmental & Archaeology Studies and Mitigation | $1,775,000 |
| Land (Acquisition and Surveying) (769 acres @ $2,287/acre) | $1,758,000 |
| Interest During Construction (1 years) | $1,451,000 |
| **Total Project Cost** | **$37,578,000** |
| | |
| **Annual Costs** | |
| Debt Service (6 percent, 20 years) | $3,288,000 |
| Operation and Maintenance | |
| Intake, Pipeline, Pump Station | $277,000 |
| Pumping Energy Costs (966,547 kW-hr @ 0.09 $/kW-hr) | $87,000 |
| **Total Annual Cost** | **$3,652,000** |
| | |
| **Available Project Yield (acft/yr)** | 11,000 |
| **Annual Cost of Water ($ per acft)** | $332 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $1.02 |

**Table 4.4-67.**
**Estimated Cost for Well Field Number 2A (4,500 acft/yr)**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| ***Item*** | ***Estimated Costs for Facilities*** |
|---|---|
| **Capital Costs** | |
| Well Fields and Collector Pipeline (7 wells and 1 mile of 12 in dia.) | $3,992,000 |
| Transmission Pipeline (20 in dia., 13 miles) | $6,304,000 |
| Pump Station | $2,070,000 |
| **Total Capital Cost** | **$12,366,000** |
| | |
| Engineering, Legal Costs and Contingencies | $4,060,000 |
| Environmental & Archaeology Studies and Mitigation | $874,000 |
| Land (Acquisition and Surveying) (329 acres @ $2,919/acre) | $960,000 |
| Interest During Construction (1 years) | $736,000 |
| **Total Project Cost** | **$18,996,000** |
| | |
| **Annual Costs** | |
| Debt Service (6 percent, 20 years) | $1,668,000 |
| Operation and Maintenance | |
| Intake, Pipeline, Pump Station | $156,000 |
| Pumping Energy Costs (795,900 kW-hr @ 0.09 $/kW-hr) | $72,000 |
| **Total Annual Cost** | **$1,896,000** |
| | |
| **Available Project Yield (acft/yr)** | 4,500 |
| **Annual Cost of Water ($ per acft)** | $421 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $1.29 |

**Table 4.4-68.**
**Estimated Cost for Well Field Number 3**
**Llano Estacado Water Planning Region**
**September 2008 Prices**

| *Item* | *Estimated Costs for Facilities* |
|---|---|
| **Capital Costs** | |
| Well Fields and Collector Pipeline (11 wells and 1 mile of 12 in dia.) | $6,357,000 |
| Transmission Pipeline (24 in dia., 2 miles) | $1,416,000 |
| Pump Station | $2,070,000 |
| **Total Capital Cost** | **$9,843,000** |
| | |
| Engineering, Legal Costs and Contingencies | $3,421,000 |
| Environmental & Archaeology Studies and Mitigation | $904,000 |
| Land (Acquisition and Surveying) (449 acres @ $1,941/acre) | $872,000 |
| Interest During Construction (1 years) | $607,000 |
| **Total Project Cost** | **$15,647,000** |
| | |
| **Annual Costs** | |
| Debt Service (6 percent, 20 years) | $1,376,000 |
| Operation and Maintenance | |
| Intake, Pipeline, Pump Station | $131,000 |
| Pumping Energy Costs (688,341716 kW-hr @ 0.09 $/kW-hr) | $62,000 |
| **Total Annual Cost** | **$1,569,000** |
| | |
| **Available Project Yield (acft/yr)** | 6,500 |
| **Annual Cost of Water ($ per acft)** | $241 |
| **Annual Cost of Water ($ per 1,000 gallons)** | $0.74 |

#### *4.4.3.10.5 Implementation*

Implementation will require permits from the High Plains Underground Water Conservation District No. 1 to drill wells. In addition, it will be necessary to obtain rights-of way across private property and for crossing of county roads and perhaps state highways for pipeline crossings.

#### *4.4.4 Region-Wide Water Management Strategies*

There are several water management strategies that have widespread significance and importance to the region, and if pursued could increase regional water supplies and/or improve efficiency of water use. These water management strategies are described and evaluated below.

##### *4.4.4.1 Precipitation Enhancement*

###### *4.4.4.1.1 Description of Weather Modification to Enhance Precipitation*

Weather modification, as it has been applied in Texas over the past 25 to 30 years, involves cloud seeding to either attempt to create rain when none would have occurred or to attempt to increase rain above what would have naturally occurred. The result of cloud seeding is referred to as precipitation enhancement. The concept of how this is thought to occur is described below.

In natural rainfall, droplets are created from the presence of ice particles (crystals) in the cloud. These crystals are formed when freezing water contacts particles of dust, salt, or sand. The ice crystals form a nucleus around which water droplets attach to make the size of the droplet increase. When the size of a droplet increases sufficiently, it becomes a raindrop and falls from the cloud. Cloud seeding is thought to increase the number of "nuclei" available to take advantage of the moisture in the cloud to form raindrops that would not have otherwise formed. To be effective, seeding must be done at the correct time and in the correct manner.

As a cloud grows taller, the air temperature in the cloud cools and falls below the freezing point of water. This cooling effect means that the cloud droplets, which are much too small to fall as rain, are also cooled to a point where they respond to crystallization when contacted by an ice particle. Consequently, when there are fewer crystals to act as nuclei for raindrops, there will be less rain than would have been if more crystals were present. Although crude experiments to enhance rainfall were attempted in the United States as early as the mid-1800s, modern weather modification was begun in 1946 when it was found that silver iodide (AgI) almost exactly matches the chemical structure of ice crystals.[35] The other seeding chemical used when the cloud temperature is too warm for forming ice is sodium chloride (NaCl).

[35] Jensen, Ric, "Does Weather Modification Really Work?" Texas Water Resources, Summer 1994.

When silver iodide is introduced into a cloud, the number of ice crystals increases and the crystals contact water vapor, causing it to freeze to the crystal. Considerable heat is released to the atmosphere during the freezing and crystal formation phase. The released heat causes the cloud to grow taller and its vertical wind velocity (updraft) to increase. This results in the cloud being able to pull in more moist air and, thus, create more raindrops. However, not all clouds are potential rainmakers. Generally, cloud seeding is performed with a meteorologist working in tandem with pilots utilizing cloud seeding aircraft so that, with direction from the meteorologist, the pilots can target the most promising cloud(s).[36] The criterion used in Texas to find promising clouds is to locate "feeder" cells near developing cloud formations which have temperatures below 23 degrees Fahrenheit. The target cloud must also have sufficient moisture and airflow to be a candidate. About 20 or 30 minutes prior to the desired rainfall event, the candidate cloud is seeded when the airplane releases silver iodide particles in a plume, typically at the base of the cloud so the updraft can draw the particles upward and make more contact with water in the cloud. Seeding is believed to have another effect on large, potentially dangerous thunderstorms capable of causing hail. Seeding tends to mitigate the extreme freezing that results in forming large particles of ice (hail) and makes the moisture more likely to fall as rain.

The criteria for cloud seeding based on experience in Texas since the early 1970s are the following:

- The cloud must be "convective," meaning that it displays instability in the atmosphere;
- Temperature at the top of the cloud must be $23^{o}$ F or less; and
- The base of the cloud must be lower than 12,000 feet elevation.

Clouds having the characteristics listed above exhibit a warm base, a strong updraft, and sufficient heat to carry water vapor to the cloud top.

A summary of recent cloud seeding experiments in Texas, Florida, Cuba, and Southeast Asia has been presented by the TCEQ in a public information document.[37] The TCEQ concludes the following:

- Cloud seeding with AgI increases rain generated by these clouds by extending the life of the clouds, by allowing the clouds to enlarge laterally so that they cover more area, and by slightly increasing the height of the clouds.
- Rain production of seeded clouds is more efficient than for non-seeded clouds.

[36] Clouds may also be seeded using ground-based silver iodide dispensers. However, in this discussion, only the aircraft method is considered.

[37] Bomar, George, "Some Facts about Cloud Seeding from Recent Research on Rain Enhancement in Texas," Texas Commission on Environmental Quality (TCEQ, formerly TNRCC), 1999.

- The timing of seeding and the selection of clouds are fundamental. These are such critical factors that "…seeding at the wrong time and in the wrong place(s) may actually decrease the rainfall."[38]

In order to engage in weather modification activities, an individual or organization must possess a weather modification license and a weather modification permit issued by the TCEQ (Texas Water Code: Section 18). The purpose of the weather modification license is to demonstrate competence in the field of meteorology necessary to engage in weather modification activities. The weather modification permit specifies the area to which the weather modification activity may be applied and any limitations or conditions to be observed. In the Llano Estacado Water Planning Region, the Southern Ogallala Aquifer Rainfall Enhancement (SOAR) program was in operation in 2005. The SOAR target area includes approximately 2.3 million acres in Gaines, Terry and Yoakum Counties. Each of these counties are within the boundaries of an underground water conservation district, including the Llano Estacado UWCD (Gaines County), South Plains UWCD (Terry and part of Hockley Counties), and Sandy Land UWCD (Yoakum County). The program is administered by the Sandy Land UWCD, with aircraft and radar located at the Plains, TX airport. The Districts maintain a network of 106 rain gauges that are read monthly during the program.

#### *4.4.4.1.2 Summary of Results of Weather Modification Projects of the Past and Potential Quantities of Water Supply from Weather Modification in Llano Estacado Water Planning Region*

The reported findings of seven Texas cloud seeding projects are summarized below, in order to gain an indication of the potentials of weather modification to increase water supplies in the Llano Estacado Water Planning Region. The projects are listed in the order in which they were conducted, as follows: Colorado River Municipal Water District Program, Southwest Cooperative Program, Texas Experiment in Augmenting Rainfall through Cloud-Seeding Program, High Plains UWCD Program, Edwards Aquifer Authority Program, North Plains GWCD Program, and Panhandle GWCD Program. Each of these programs is described below, together with the results that are reported for their respective programs.

**Colorado River Municipal Water District Program*:*** Having been started in 1971, the Colorado River MWD Program is the longest-running operational weather modification program

[38] Ibid.

in Texas. The target area is roughly the Upper Colorado River Basin upstream of Spence Reservoir, comprising some 3,600 square miles. The goals for the program are/were to increase water supplies to Lake J.B. Thomas and Spence Reservoir and to increase rainfall to agricultural areas. The reported long-term results are that a 34 percent increase (above normal historic precipitation) in the seeded areas and a 13 percent increase in non-seeded areas occurred.[39,40]

**Southwest Cooperative Program (SWCP):** The Southwest Cooperative Program (SWCP) was begun in 1986 as a cooperative effort between Oklahoma and Texas "…to develop a scientifically sound, environmentally sensitive, and socially acceptable applied weather modification technology for increasing water supplies…in the southern High Plains."[41] The area involved in Texas was 5,000 square miles located between Midland-Odessa and Lubbock. Random cloud seeding experiments were conducted in 1986, 1987, 1989, 1990, and 1994.

During the period 1987 through 1990, 183 experiments were made (93 seeded, 90 non-seeded). The criteria for selection were the following:

- Liquid water content had to be at least 0.5 $gm/m^3$ and updrafts had to be at least 1,000 ft/min.
- The target had to be a multiple-cell convective unit.
- No cloud or cell height could exceed 10 km (above ground level).
- Some of the tops had to have temperatures -10$^o$ C or colder.

The results confirmed increased rainfall. Compared to the non-seeded cells, the seeded cells displayed an increase in maximum height of 7 percent, an increase in the coverage of the rainfall event of 43 percent, an increase in the storm duration of 36 percent, and an increase in rain volumes of 130 percent.[42]

**Texas Experiment in Augmenting Rainfall through Cloud Seeding:** The State of Texas implemented the Texas Experiment in Augmenting Rainfall through Cloud Seeding (TEXARC) Program in 1994 and 1995 to investigate physical processes within large storms in the Big Spring-San Angelo area. This research was focused on understanding the best ways of seeding clouds to make them more efficient producers of water, rather than quantifying the

[39] Jones, R., "A Summary of the 1988 Rainfall Enhancement Program and a Review of the Area Rainfall and Primary Crop Yield," Report 88-1 of the Colorado River Municipal Water District, 75 pages, 1988.
[40] Jones, R., "A Summary of the 1997 Rainfall Enhancement Program and a Review of the Area Rainfall and Primary Crop Yield," Report 97-1 of the Colorado River Municipal Water District, 54 pages, 1997.
[41] Bomar, George, William L. Woodley, and Dale L. Bates, "The Texas Weather Modification Program: Objectives, Approach, and Progress," Journal of Weather Modification, Volume 31, April 1999.
[42] Rosenfeld, D. and W. L. Woodley, "Effects of Cloud Seeding in West Texas: Additional Results and New Insights," Journal of Applied Meteorology, Volume 32, pp. 1848-1866, 1993.

results. The results showed that seeding must be within the super-cooled updraft region of the cloud to increase rainfall. From this research it was shown that the seeding agent must be carefully placed either directly in the top of the updraft or at the entrance to the updraft at the base of the cloud.

**High Plains Underground Water Conservation District No. 1 Program:** The High Plains UWCD No. 1 conducted a cloud seeding program between 1997 and 2002. The High Plains Water District’s board of directors terminated the program on October 1, 2002, due to negative feedback about the program from constituents.

**Edwards Aquifer Authority (EAA) Program:** *(Substantial portions of this program description were reproduced from the EAA web page, edwardsaquifer.org, and are presented here unedited)* “The Edwards Aquifer Authority board of directors voted in the Fall of 1997 to obtain a permit to conduct precipitation enhancement, or cloud seeding, from the TNRCC. The Authority contracted with Weather Modification, Inc. to complete and submit the permit application on the Authority's behalf and work with the TNRCC. The permit was granted by TNRCC in October 1998 and was valid for four years from January 1999 through December 2002. The permit allowed the Authority to conduct precipitation enhancement any time during the year, including the traditional period of April through September. The Authority provided $500,000 for the 1999 program, with half the expenses reimbursed by the TNRCC.”

“The target area of the program covered over 6.37 million acres in all or part of Bandera, Bexar, Blanco, Caldwell, Comal, Guadalupe, Hays, Kendall, Kerr, Medina, Real, and Uvalde Counties, at a total cost to the Authority and the State of Texas of 8 to 9 cents an acre.” The Authority use WMI to perform weather modification services in the 12-county area from 1999 through 2001. A TWDB sponsored study of the 1999-2001 EAA precipitation enhancement program reported that the program resulted in approximately 60,000 acft/yr of additional rainfall to the area.

In 2002 and 2003, the EAA contracted with South Texas Weather Modification Association to perform cloud seeding in Bandera, Bexar, and Medina Counties, and at the same time contracted with Southwest Texas Rain Enhancement Association to perform cloud seeding in Uvalde County. An assessment of this effort indicated that in 2003, an additional 85,745 acft of rainfall was created for Bandera, Bexar, and Medina Counties, and 36,733 acft of rainfall was created for Uvalde County.

**North Plains Groundwater Conservation District:** The North Plains Groundwater Conservation District (GWCD) weather modification program was started in May 2000. The target area included Sherman, Hansford, Ochiltree, Lipscomb, and parts of Dallam, Hartley, Moore, and Hutchinson Counties. The goal for the program is to increase rainfall in the target area by 15 to 20 percent.

**Panhandle Groundwater Conservation District:** The Panhandle Groundwater Conservation District (GWCD) weather modification program was started in May 2000. The target area included Armstrong, Donley, Carson, Gray, Wheeler, Roberts, Carson, and parts of Potter and Hutchinson Counties. The goals of this program are to increase recharge to the Ogallala Aquifer in selected areas and to reduce irrigation water requirements from the Ogallala Aquifer.

**Estimated Potential Quantities of Water Supply Resulting from Weather Modification in the Llano Estacado Regional Water Planning Region:** Performance data from cloud seeding programs typically focus on the rainfall event and parameters such as storm duration, cloud height, storm coverage (cloud area), and rainfall amount, rather than water supply parameters like increased stream flows and increased reservoir storage. Where water supply parameters have been measured in cloud seeding programs, the results appear to be positive. For example, Colorado River MWD reservoir storage increased from 14,000 acft to 20,000 acft in Lake Spence and from 26,000 acft to 30,000 acft in Lake Thomas since the inception of cloud seeding in the Big Spring and Snyder areas.[43] Also, the Twin Buttes and Fisher Reservoirs increased from a combined 40,000 acft to a combined 230,000 acft during a cloud seeding program sponsored by the City of San Angelo between 1985 and 1989.[44]

Annual precipitation in the area seeded by the High Plains UWCD project was estimated to have been 1.47 and 1.97 inches more in 1997 and 1999, respectively, than the 1945 through 1997 long-term average of 18.29 inches (Figure 4.4-16). Data collected to date indicate that cloud seeding could materially contribute to the Llano Estacado Region’s water supplies. For example, for the 20,294 square mile (12,988,160 acres) Llano Estacado Planning Region, an annual increase in precipitation of one and one-half inches would result in an increase of about 1,623,520 acft of water per year to the land surface. At a cost of 7.2 cents per acre, the cost per

[43] Jensen, Ric, Op. Cit., 1994.
[44] Jensen, Ric, Op. Cit., 1994.

acft of water is $0.57. Additional precipitation during the growing season, which is the period during which cloud seeding projects are usually operated, would directly and immediately benefit both dryland and irrigated agriculture. Crop and grazing yields would be increased, irrigation water pumped from the Ogallala Aquifer could be reduced, and lawn irrigation could be reduced. The latter effect would contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additional water would be available for surface water reservoirs that are used for public water supplies, and runoff into playa basins may be increased, some of which would recharge the aquifer as well as provide water for wildlife. In summary, the benefits resulting from cloud seeding in the Llano Estacado Regional Water Planning Area may include improvements in environmental and economic conditions. Potential improvements include increased crop production, increased livestock grazing, and increased ground and surface water supplies.

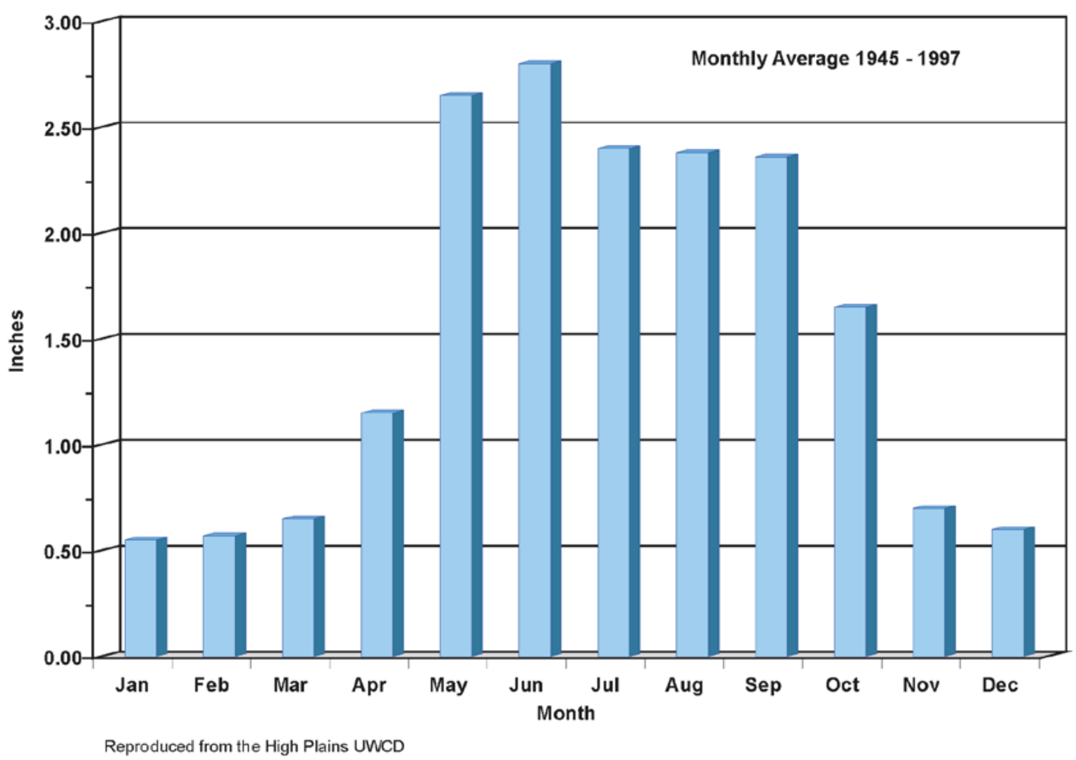


***Figure 4.4-16. Rainfall Distribution***

#### *4.4.4.1.3 Potential Environmental Effects of Weather Modification*

Although cloud seeding for weather modification is not a new technique, the effectiveness of weather modification has not been conclusively documented and efforts to quantify the effects continue. Since Texas established a permit procedure, administered by TCEQ, data have been collected for a scientific evaluation of cloud seeding effectiveness and management. Originally conceived as a means to end droughts, experience shows that cloud seeding may work best during periods of normal rainfall. Weather modification is now considered a long-term water augmentation strategy for freshwater supplies.[45]

The amount of silver iodide and sodium chloride used during a seeding event is believed to be negligible and too widely dispersed to have a measurable effect on the environment. Safe handling and storage of these materials prior to dispersal are a larger concern. Both are normally used in industrial applications and printing. Therefore, procedures for handling and storing silver iodide are well documented. There are no known environmental problems associated with this option.

#### *4.4.4.1.4 Estimated Costs of Weather Modification*

The cloud seeding program run by Sandy Land UWCD covers 2,300,000 acres at a total cost of about $109,200 per year, or 4.2 cents per acre per year.

#### *4.4.4.1.5 Weather Modification Implementation Issues*

In terms of a measurable and dependable regional water supply option, weather modification in the form of cloud seeding appears to be a beneficial, but somewhat uncertain, source of usable water. Although available data are not adequate to provide estimates of firm yield that can be depended upon during a drought, there are several potential benefits that could perhaps be realized. One important potential benefit of cloud seeding is that a part of the agricultural (irrigated and dryland crops, and rangelands) and municipal water needs could be met. For example, higher rainfall would lower the quantities of irrigation water that has to be withdrawn from the aquifers of the Llano Estacado Regional Water Planning Area for irrigation purposes, dryland production would benefit from increased rainfall, and municipal lawn irrigation could be reduced. Thus, for a relatively low cost, cloud seeding could perhaps meet a

[45] Bomar, George, TNRCC Senior Meteorologist, Austin, Texas.

part of the agricultural and municipal needs, as well as make significant contributions to aquifer recharge and streamflows of the region, some of which may be collected in surface water reservoirs that are used to meet municipal and industrial water needs. A potential goal of this program is to increase rainfall in the target area an average of 2 inches annually over a 10-year period.

#### *4.4.4.2 Brush Control*

##### *4.4.4.2.1 Description of Brush Control for Increasing Water Supplies*

The interest in brush control as a means to increase water supply has its roots in 1) the belief that Texas rangelands changed after settlement and use by Europeans from predominantly open grasslands to increasing domination of brush and 2) the significantly greater interception of water by brush than grasses. These views suggest the possibility of increasing aquifer recharge and streamflow by controlling and limiting growth of brush and trees in areas where grasslands would have naturally dominated. For this water management option, brush control methods will be described and estimates of cost and potential water supply effects will be presented.

Documentation by early European settlers[46] described Texas rangelands as grasslands. Prior to settlement by Europeans with its associated grazing, significant brush growth was inhibited due to several natural conditions. Tree seeds commonly die following germination in grass cover because they cannot compete with grasses for sunlight and moisture. Also, surviving seedlings are destroyed typically in periodic wildfires that occur in natural grasslands. Heavy grazing lessens the competitiveness of grass relative to brush and removes fuel (grass) for rangeland wildfires. The result of heavy grazing is the increased dominance of trees and brush in grasslands, with a resulting decrease in surface runoff and/or recharge to aquifers.[47]

Of the approximately 12.5 million acres of the Llano Estacado Region, about 30 percent is rangeland (3.8 million acres) (Table 4.4-69). The Natural Resources Conservation Service (NRCS) estimates that nearly 1.9 million acres of rangeland in the region have moderate-to-heavy canopy cover.[48] The most abundant species is mesquite (1.17 million acres), with shinnery oak next most abundant at 487,000 acres. Thus, nearly 87 percent of the moderate-to-heavy

[46] Smiens, F., S. Fuhlendorf, and C. Tayor, Jr., “Environmental and Land Use Changes: A Long-Term Perspective,” Juniper Symposium Proceedings, Texas A & M Agricultural Experiment Station, Sonora, Texas, 1997.
[47] Thurow, T. L., “Assessment of Brush Management as a Strategy for Enhancing Water Yield,” Proceedings of the 25th Water for Texas Conference, Texas Water Resources Institute, Texas A & M University, 1998.
[48] Bell, J.R. Natural Resources Conservation Service – Amarillo. December 6, 1999 letter to NRCS Lubbock.

brush coverage is mesquite and shinnery oak. Other brush species in the region include sand sage, yucca, snake weed, juniper, and salt cedar.

**Table 4.4-69.**
**Approximate Range and Brush-Covered Areas**
**Llano Estacado Region**

| County | Range (acres) | Mesquite (acres) | Shinnery Oak (acres) | Sand Sage (acres) | Yucca (acres) | Snake Weed (acres) | Juniper (acres) | Salt Cedar (acres) |
|---|---|---|---|---|---|---|---|---|
| Bailey | 108,300 | 42,000 | 52,000 | 10,000 | | | | |
| Briscoe | 370,000 | 64,000 | | | | | 64,000 | |
| Castro | 106,000 | | | | 8,700 | 20,000 | | |
| Crosby | 221,500 | 65,000 | 20,000 | 2,000 | 2,000 | | | 500 |
| Cochran | 190,000 | 46,000 | 129,500 | 9,000 | | | | |
| Dawson | 87,000 | 58,000 | 5,500 | | | | | 500 |
| Deaf Smith | 312,000 | 37,000 | | | | 16,000 | | |
| Dickens | 385,000 | 238,000 | 55,000 | | | | | 500 |
| Floyd | 117,000 | 35,000 | | | | | 5,000 | |
| Gaines | 162,000 | 40,000 | 85,000 | | | | | |
| Garza | 450,000 | 150,000 | 35,000 | | | | 16,000 | 400 |
| Hale | 30,000 | 200 | | | 2,000 | 2,000 | | |
| Hockley | 77,000 | 45,000 | 5,000 | | | | | 1,500 |
| Lamb | 100,000 | | | 18,000 | 1,500 | | | |
| Lubbock | 17,000 | 7,500 | | | | | | |
| Lynn | 107,000 | 58,000 | 1,700 | | | | | |
| Motley | 500,000 | 230,000 | 25,000 | 5,000 | | | 8,000 | 500 |
| Parmer | 66,000 | | | | 700 | 14,000 | | |
| Swisher | 104,000 | 3,500 | | | 2,000 | | | |
| Terry | 71,000 | 30,000 | 20,000 | 5,000 | | | | 2,000 |
| Yoakum | 197,000 | 20,000 | 50,000 | 5,000 | | | | |
| **Totals** | **3,787,800** | **1,169,000** | **487,000** | **54,000** | **16,900** | **52,000** | **93,000** | **5,900** |

Source: J. R. Bell, Natural Resources Conservation Service Amarillo, December 8, 1999.

Brush is important as food and cover for wildlife in the Llano Estacado Region. Rodents, small mammals, songbirds, and quail use the ripe Mesquite seeds. Deer utilize the leaves and twigs; brush also provides important nesting sites for larger birds such as hawks, ravens, and songbirds. Therefore, for brush control to be implemented while still providing food and cover for wildlife, certain guidelines need to be observed, as follows:

1. Brush Control should achieve the desired plant community of both herbaceous and woody species.
2. Brush Control should apply to target species and protect desired species.
3. Scheduled follow-up treatment is mandatory when desired control is not achieved.
4. Mechanical methods that destroy all ground cover should be followed with revegetation of desired species.
5. An approved plan (patterns, strips, or motts) should be developed to assure that the proper percentage of brush is removed. All essential areas such as draws should be protected.
6. Timing of treatment to minimize harm during wildlife nesting or breeding seasons is important.

Brush control should include protection of present and future land use values. The land value for aesthetics, recreation and wildlife uses is generally greater with some brush than with only herbaceous vegetation.

#### *4.4.4.2.2 Potential Water Yield from Brush Control on Rangelands*

In terms of water supply, for purposes of this water planning effort, yield is defined as the quantity of water available in a year for municipal, industrial, agricultural, and other uses, and is expressed as acft per year. Firm yield is the quantity of water available during a critical drought. However, increasing the quantity of water that is not intercepted by brush on rangelands does not necessarily increase yield as defined above for water supply; e.g., there may be other factors that prevent this water from being available. For example, the water could enter the soil as deep percolation, or it could be captured in a rangeland impoundment, each of which would be beneficial to the region.

The water balance stated below can be used to estimate the runoff and/or deep percolation from rangeland.[49]

$$Runoff + Deep\ Percolation = Precipitation - Evapotranspiration$$

and its variables are defined as follows:

[49] Thurow, T.L., Op. Cit., 1998.

Runoff is water that leaves the watershed through surface flow;

Deep Percolation is water that leaves the watershed by percolating through soil absent of roots (or below the rooting zone); and

Evapotranspiration is water vapor entering the atmosphere through both leaf tissue (transpiration) and the drying of wet soil or ponded water (evaporation).

According to the water balance, runoff and/or deep percolation can be increased by decreasing evapotranspiration, which can be accomplished by managing vegetation. There are large differences in interception loss (water in the canopy that can be evaporated) among the common brush (mesquite and juniper) and grasses. Interception losses in Texas range from 14 percent for grass to 73 percent for juniper.[50] Thus, a strategy of limiting brush cover and increasing grass cover would presumably increase runoff and/or deep percolation. There is anecdotal and other information concerning the rangelands of Texas that supports the contention than coverage of brush decreases soil percolation, runoff, and streamflow. For example, historical data on stream flow (USGS Station No. 08134000 at Carlsbad, Texas) and rainfall at the San Angelo weather station for the period from 1925 to 1996 show a reduction in average annual discharge from 38,617 acft to 8,358 acft between the periods 1925 to 1959 and 1960 to 1996, respectively. The declining recorded stream flow coincides with the increasing coverage of mesquite, juniper and other brush that occurred in the North Concho watershed between about 1900 and the 1950s, when coverage was essentially complete.[51]

In the Llano Estacado Region, about 60 percent of the area is cropland. Thus, row-crop cultivation in the region prevented the brush coverage that has occurred on the rangeland of the area. The areas of the region where significant concentrations of brush occur, and where brush management or control has potential to contribute to the region's water supplies, are in the east "caprock counties" and in the western counties. Information and discussion about the costs and potentials for contributions of brush control to the region's water supply are presented below.

The seasonal water use differences among trees, brush, and grasses common to the Llano Estacado Region are demonstrated in Table 4.4-70. The average unit water consumption for mesquite and Ashe Juniper is more than twice the average of the common grasses in the region.

[50] Thurow, T. L. and Hester, J. W., "How an Increase in Juniper Cover Alters Rangeland Hydrology," Proceedings Juniper Symposium, Texas A & M Agricultural Experiment Station Technical Report 97-1, 1997.
[51] Taylor, Charles, A. and Fred E. Smiens, "A History of Land Use of the Edwards Plateau and Its Effect on the Native Vegetation," 1994 Juniper Symposium, Texas A&M University Research Station at Sonora, 1994.

Thus, a reduction in brush species should result in more water for grass and increased quantities for stream flow and aquifer recharge.

***Table 4.4-70.***
***Densities and Seasonal Water Use for Common Plant Species***
***Llano Estacado Region***

| *Species* | *Density* | *Seasonal Water Use[1] (acft)* |
|---|---|---|
| Mesquite[2] | 307 plants/acre | 0.93 |
| Juniper (no grazing) | 309 plants/acre | 1.12 |
| Juniper (goat grazing) | 114 plants/acre | 0.28 |
| Sideoats grama grass[2] | 890 pounds/acre | 0.20 |
| Kleingrass | 1,525 pounds/acre | 0.59 |
| Buffalograss | 1,340 pounds/acre | 0.53 |

[1] The growing season of April through September.
[2] Common in Llano Estacado Region.

Source: Owens, M.K. and R.W. Knight, "Water Use on Rangelands," Water for South Texas, The Texas Agricultural Experiment Stations, pp. 1-13, October 1992.

#### *4.4.4.2.3 Areas in Llano Estacado Region Where Potential Yield Increase Exists*

The areas of the region where significant concentrations of brush occur are in the east "caprock counties" and in the western counties. In addition, in the Llano Estacado Water Planning Region, there are approximately one million acres of land in the U.S. Department of Agriculture's (USDA) Conservation Reserve Program (CRP) on which perennial grass vegetation has been established.[52] This program was established to convert cropland to native or adapted vegetation, thereby reducing crop production in an effort to increase crop prices paid for the remaining crops marketed. As the current contracts with the USDA expire on these CRP areas and as the USDA programs change, some of the land may be returned to cultivated row crops; however, some acres are expected to remain in grass. If these grassland acres are not managed to prevent brush infestation, these areas could become brush covered, further contributing to the brush problem of the region.

Soil moisture management is critical to rangeland and pastureland production and is therefore very important to the potentials of brush management to increase water supplies of the

[52] USDA Economics and Statistics System; Conservation Reserve File summary (96004). http\\usda.mannlib.cornell.edu/usda/

region. Research and field trials have shown that as much as 60 percent of the precipitation runs off from poorly managed range and pastures.[53] Maximum opportunity time for infiltration into the soil cannot be achieved if ranges and pastures are grazed short. One trial in Oldham County, just north of the Llano Estacado Region, showed that with 1,350 pounds of grass cover per acre, runoff from rainfall was 35 percent. With 400 pounds of cover, runoff increased to 72 percent. The Llano Estacado Planning Region has three major soil types, which together with management practices determine the water production potentials of brush management. The soil types are (1) Sandy Soils of the south; (2) Sandy Loams and Loam Textured Soils of the central portion of the region; and (3) Clay Loam and Silty Clay Loam Soils of the north. The vegetation of each soil type is described below.

The sandier textured soils of the southwestern part of the region (Dawson, Gaines, Yoakum, Terry, and Lynn Counties, and parts of Cochran County) support taller grasses such as sand bluestem, little bluestem, sideoats grama, and dropseeds. The main woody plants present are mesquite, shinoak, and sand sagebrush. These brush species are present in moderate amounts on most of the rangeland of the region.[54] Their removal appears to offer significant potential for enhancement of water supplies and grazing.

The sandy loam and loam texture soils generally found in the central portion of the region (Bailey, Lamb, Hockley, Lubbock, and Crosby Counties) support sideoats grama, blue grama, hairy grama, and sand dropseed and would best be described as a midgrass/shortgrass grassland. As overgrazing occurred, the percentage of these grasses decreased over time and now includes a higher percentage of lower quality grasses and woody species.[55] Mesquite is the most prevalent woody plant and is present on a majority of rangeland of the sandy loam and loam textured soils (Table 4.4-40). This part of the region offers promise for the brush control water management strategy.

The clay loam and silty clay loam texture soils found in the northern part of the region (Hale, Parmer, Castro, and Swisher Counties) support short grasses, mainly blue grama, and buffalograss, with some occasional western wheatgrass along draws and drainages. As overgrazing occurred, the percentage of these grasses decreased over time and now includes a

[53] Ibid.
[54] High Plains Underground Water Conservation District No. 1. Background material prepared for the Llano Estacado Regional Water Planning Group. December 10, 1999. Unpublished.
[55] Ibid.

higher percentage of lower quality grasses and woody species. In this part of the Region, brush is less of a problem, although there is some presence of cholla, yucca, mesquite, and prickly pear; and brush control could perhaps make a contribution to local water supplies.[56]

In Crosby County, the watershed that drains into the White River Reservoir has a significant amount of brush. The NRCS performed a study to compare runoff under existing conditions to two hypothetical conditions. The existing condition is light brush coverage over about 70 percent of the 86,000-acre watershed. The hypothetical conditions are for 100 percent brush control in the watershed and no brush control (0 percent) in the watershed. The NRCS study suggested that considerably more runoff could be captured in the reservoir in either the existing condition (light brush on 70 percent of the watershed) or the 100-percent condition (brush control on 100 percent of the watershed), as compared to the condition where no brush control is practiced (Table 4.4-70). For example, for a 2-year frequency, 24-hour rainfall event (relatively often event), under existing brush conditions (70 percent of watershed covered), runoff to the reservoir is estimated at 5,054 acft. With no brush control, runoff is estimated at 2,816 acft, while with 100 percent brush control, runoff is estimated at 6,498 acft, or 2.3 times that for no brush control (Table 4.4-71). For larger, or more intense, but less frequent storms (10-year frequency, 24-hour event), the estimated runoff into the reservoir is 2.6 to 3.4 times that for the 2-year, 24-hour event, depending upon level of brush control (Table 4.4-71).

**_Table 4.4-71._**
**_Comparison of Water That Could be Collected in White River Reservoir for Varying Degrees of Brush Control_**
**_Llano Estacado Region_**

| Rainfall Event | Runoff Volume Retained in White River Reservoir for Varying Percentages of Watershed with Brush Control | | |
|---|---|---|---|
| | 70% existing[1] (acft) | 100% brush control[2] (acft) | 0% brush control[2] (acft) |
| 2-year frequency, 24-hour duration | 5,054 | 6,498 | 2,816 |
| 5-year frequency, 24-hour duration | 9,098 | 10,978 | 5,848 |
| 10-year frequency, 24-hour duration | 13,935 | 16,246 | 9,748 |

[1] Approximates the existing condition in the watershed.
[2] Hypothetical brush control coverage in watershed, percent of total watershed.

Source: Natural Resources Conservation Service

[56] Ibid.

The methods of brush control are described and costs of the leading methods used in the western parts of Texas are presented below.

#### *4.4.4.2.4 Best Management Practices for Brush Control*

The USDA Natural Resources Conservation Service (NRCS) has a conservation practice standard for brush control.[57] The standard includes biological, chemical, mechanical, and burning methods. The biological method describes the use of goats for specific vegetation goats eat. The method involves defoliation of brush systematically. Another standard is for the use of herbicides for brush control. A review of Texas Agricultural Extension Service on-line Expert System for Brush and Weed Control Technology Selection, Version 1.09 (Excel)[58] provided information on chemical agents for control of brush (Table 4.4-72).

***Table 4.4-72.***
***Chemical Agents for Control of Brush***

| Brush | Chemical Agent | Control Level[1] |
|---|---|---|
| Ashe Juniper | Velpar L (hexazinone) | Very high control level |
| | Tordon 22K (picloram) | Very high control level |
| Blackjack Oak | Velpar L | Very high control level |
| | Spike 20P (tebuthiron) | Very high control level |
| | Crossbow | High control level |
| Live Oak | None recommended | |
| Mesquite | Remedy (triclopyr) | Very high control level |
| | Reclaim (clopyralid) | Very high control level |
| | Tordon 22K | Very high control level |
| | Velpar L | High control level |
| Post Oak | Velpar L | Very high control level |
| | Spike 20P | Very high control level |
| | Crossbow | High control level |

[1] Very high means 76 to 100 percent of plants killed. High means 56 to 75 percent killed.

The mechanical standard prescribes plowing, grubbing, chaining, and dozing as primary brush control methods. In most cases the NRCS recommends burning to control sprouts. For control of mesquite and shinoak, the recommended methods include root plowing, power grubbing, and hand grubbing. Control of these types of brush requires uprooting the plants. Because of the higher degree of ground disturbance with these methods, replanting grass is

[57] Natural Resources Conservation Service, Conservation Practice Standard, Brush Management (Acre) Code 314.
[58] http://cnrit.tamu.edu/rsg/exsel/work/exsel.cgi

recommended. Replanting grass is done at the next applicable time following clearing. For example, if planting grass is planned for spring, brush clearing should be performed in early winter.[59]

In 1985, the Texas Legislature authorized a brush control program for the state and placed planning and administration of the program with the Texas State Soil and Water Conservation Board (TSSWCB). The purpose of the program is to provide "selective control, removal, or reduction of noxious brush such as mesquite, salt cedar, or other brush species that consume water to a degree detrimental to water conservation." The Draft State Plan delineates a critical area in Texas for brush control. The counties in the area are those having 16 to 36 inches of precipitation per year. Cost of brush control in the draft plan is shared between landowners and the state. Local soil and water conservation districts determine the maximum and average costs for different control methods and the cost share rates. The methods of brush control that the TSSWCB can approve are those which:

1. Are proven effective and efficient for brush control,
2. Are cost effective,
3. Have beneficial impact on wildlife habitat,
4. Will maintain topsoil to prevent erosion or siltation, and
5. Will allow for revegetation of the area with plants that are beneficial to livestock and wildlife.[60]

Since the Texas brush control program is on a cost-sharing basis with the ranchers, an objective of the program is to equate rancher costs with rancher benefits. The benefit to ranchers would be the increases in income from cattle, sheep, and wildlife that result from brush control. Once the total cost of brush control is determined, then the difference between the total cost and the benefit to the rancher would be the cost that might be attributed to the additional water yield. Presumably, if the rancher receives no benefits, then the rancher would not be interested in engaging in the practices. In this case, brush control costs would have to be borne by the state or the water authority that would benefit from the increased water supply resulting from the practice. In the discussion below, estimates are presented of brush control costs.

[59] NRCS Conservation Practice Standard Code 314 (http://okecs.ok.nrcs.usda.gov/stds/std314.htm)
[60] Texas State Soil and Water Conservation Board, "Draft State Brush Control Plan," April 1, 1999.

#### *4.4.4.2.5 Environmental Issues*

Removal of woody species that compete with grasses for water and nutrients have been shown to increase runoff from treated areas. However, there are concerns that the techniques used to remove brush can adversely affect wildlife habitat, and if chemicals are used, concerns extend to their potential effects upon water quality.

A range management plan to protect species should be designed for this strategy. Chaining, cabling, disking, and other mechanical brush removal methods remove some wildlife habitat and expose soil surfaces to wind and water erosion. Therefore, low impact, hand techniques, or well controlled, selective mechanical methods that clear brush in a patchwork or strip fashion, leaving brush berms to control erosion and provide protection for wildlife are preferred.

The chemicals used to remove unwanted vegetation may be detected in surface water sources or may affect air quality, since they are sprayed from the air onto the brush covered areas to be treated. The chemical method of controlling brush can be implemented only after a very thorough evaluation is made, and plans are selected that will avoid chemical runoff into streams or percolation into aquifers.

#### *4.4.4.2.6 Cost of Brush Control*

The costs of brush control are estimated using information from brush control studies that have been done to determine brush control costs for rangelands in Texas.[61,62,63] Costs are presented on a present worth, uniform annual basis because brush control requires an initial (year ”1”) investment, plus a periodic future outlay to maintain control (Table 4.4-73). The initial year, or front end, costs per acre for brush control range from $10.65 per acre for chemical applications to light mesquite, to $99.40 per acre to doze and burn heavy cedar (Table 4.4-73). The costs per acre, computed using 30 years as the project horizon, 6 percent interest, and the initial and periodic costs in Table 4.4-73, range from $1.54 per year for light mesquite to $6.93 per year for heavy mesquite, and $7.47 per year for heavy cedar (Table 4.4-74). Costs in

[61] Walker, J.W., F. B. Dugas, F. Baird, S. Bednarz, R. Muttiah, and R. Hicks, “Site Selection for Publicly Funded Brush Control to Enhance Water Yield,” Proceedings, Water for Texas Conference, Austin, Texas, December 1998.
[62] Bach, Joel P. and J. Richard Connor, “Economic Analysis of Brush Control Practices for Increased Water Yield: The North Concho River Example,” Proceedings, Water for Texas Conference, Austin, Texas, December 1998.
[63] Ethridge, D., B. Dahl, and R. Sosebee. Economic Evaluation of Chemical Mesquite Control Using 2,4,5-T. J. Range Management 37:152-156. 1984.

Table 4.4-72 compare to costs reported from $9.61 to $31.90 per acre for chemical control of mesquite using 2,4,5-T in 1984.[64]

**Table 4.4-73.**
**Initial and Interim Costs for Various Brush Control Methods**

| Brush Condition (method) | One Time Costs | | Recurring Costs | |
|---|---|---|---|---|
| | Year 1 ($/acre) | Year 2 or 3 ($/acre) | Periodic Cost[1] ($/acre) | Frequency of Control (years) |
| Heavy mesquite (power grubber) | 51.15 | 21.06 | 12.23 | 7 |
| Heavy cedar (doze and burn) | 99.40 | 0 | 12.23 | 6 |
| Heavy cedar (2-way chain) | 21.30 | 9.30 | 12.23 | 7 |
| Moderate mesquite (chemical then prescribed burn) | 21.30 | 0 | 12.23 | 6 |
| Moderate cedar (chemical then prescribed burn) | 28.40 | 0 | 12.23 | 6 |
| Light mesquite (chemical then prescribed burn) | 10.65 | 0 | 12.23 | 6 |
| Light cedar (chemical then prescribed burn) | 14.20 | 0 | 12.23 | 6 |
| [1] Costs at intervals shown in column to the right (e.g.; heavy mesquite $12.23 per acre every 7 years). | | | | |

Source: Bach, Joel P. and J. Richard Connor, "Economic Analysis of Brush Control Practices for Increased Water Yield: The North Concho River Example," Proceedings, Water for Texas Conference, Austin, Texas, December 1998.

**Table 4.4-74.**
**Present Worth and Uniform Annual Costs for**
**30-Year Brush Control Projects under Varying Brush Conditions**

| Brush Condition | Present Worth Per Acre (Second Quarter 2008 Costs) | Uniform Annual Cost (per acre)[1] |
|---|---|---|
| Heavy mesquite | $103.36 | $6.93 |
| Heavy cedar | $111.60 | $7.47 |
| Moderate mesquite | $33.52 | $2.25 |
| Moderate cedar | $40.62 | $2.72 |
| Light mesquite | $22.87 | $1.54 |
| Light cedar | $26.40 | $1.78 |
| [1] Amortized over 30 years at 6 percent interest. | | |

The following assumptions have been made to simplify the estimation of brush control cost in the Llano Estacado Region:

1. According to the NRCS, about 50 percent of the rangeland in the region has moderate to heavy brush.

[64] Ibid.

2. The two most abundant species are mesquite and shinnery oak.
3. Based upon the conditions stated in No. 1 and 2 above, an estimated unit cost for brush control would be an average of the values in Table 4.4-74 for heavy mesquite and moderate mesquite. These unit values (per acre) would be $68.44 (rounded to $68) and $4.52 (rounded to $4.50) respectively, for present worth and annual cost.
4. All other brush listed in Table 4.4-74 would be assumed to require a cost comparable to light cedar, or $26.40 and $1.78, respectively for present worth and annual cost.
5. Brush control would only be applied to mesquite and shinnery oak in counties of the region having a combined total of 50,000 or more acres of these two species (Table 4.4-69). The reason for setting this acreage condition for the present cost estimation effort is that in counties having fewer than 50,000 acres of these brush species, the brush infested acreages are likely to be too widely dispersed to allow efficient brush control operations. However, this condition is not intended to be a limitation to a brush control effort by anyone who desires to conduct brush control projects.
6. Brush control would or could be applied to only 50 percent of the mesquite and shinnery oak acres of each county that meets the conditions specified in number 5 above. This condition is intended to give adequate latitude for selection of only the most appropriate acreages to which to apply brush control methods from both the wildlife habitat standpoints, and the water producing potentials.

Of the 21 counties of the Llano Estacado Region, 13 counties meet the condition of having 50,000 or more acres of mesquite and shinnery oak combined (Table 4.4-75). The counties located in the southwest corner of the region, and east, below the caprock, have the highest acreages of mesquite and shinnery oak and would be the places to apply brush control practices to increase water supplies for those parts of the region. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. If brush control works to increase water supplies from reservoirs, then brush control projects on the watersheds of these two reservoirs could result in increased firm yields of both projects and contribute to the region’s water supply.

Based upon the assumptions and costs listed above, the capital outlay to implement brush control upon 50 percent of the mesquite-and shinnery oak-infested acres in counties having 50,000 acres of these two species of brush is estimated at $53.33 million, with an annual cost of $3.53 million (Table 4.4-75). For example, if brush control on the Alan Henry Reservoir contributing watershed at an annual cost of $420,875 were to increase the yield of the reservoir by 10 percent, or 2,250 acft/yr, the cost per acft of raw water yield at the reservoir would be $187, or $0.57 per 1,000 gallons.

**Table 4.4-75.**
**Estimated Cost of Brush Control**
**Llano Estacado Region**
**September 2008 Prices**

| County | Mesquite (acres) | Shinnery Oak (acres) | Mesquite plus Shinnery Oak (acres) | Estimated Brush Control (acres)[1] | Initial Brush Control Capital Cost (dollars)[2] | Annual Brush Control Cost (dollars)[3] |
|---|---|---|---|---|---|---|
| Bailey | 42,000 | 52,000 | 94,000 | 47,000 | 3,196,000 | 211,500 |
| Briscoe | 64,000 | | 64,000 | 32,000 | 2,176,000 | 144,000 |
| Castro | | | | | | |
| Crosby | 65,000 | 20,000 | 85,000 | 42,500 | 2,890,000 | 191,250 |
| Cochran | 46,000 | 129,000 | 175,000 | 87,500 | 5,950,000 | 393,750 |
| Dawson | 58,000 | 5,500 | 63,500 | 31,750 | 2,159,000 | 142,875 |
| Deaf Smith | 37,000 | | 37,000 | | | |
| Dickens | 238,000 | 55,000 | 293,000 | 146,500 | 9,962,000 | 659,250 |
| Floyd | 35,000 | | 35,000 | | | |
| Gaines | 40,000 | 85,000 | 125,000 | 62,500 | 4,250,000 | 281,250 |
| Garza | 150,000 | 35,000 | 185,000 | 92,500 | 6,290000 | 416250 |
| Hale | 200 | | 200 | | | |
| Hockley | 45,000 | 5,000 | 50,000 | 25,000 | 1,700,000 | 112,500 |
| Lamb | | | | | | |
| Lubbock | 7,500 | | 7,500 | | | |
| Lynn | 58,000 | 1,700 | 59,700 | 29,500 | 2,006,000 | 132,750 |
| Motley | 230,000 | 25,000 | 255,000 | 127,500 | 8,670,000 | 573750 |
| Parmer | | | | | | |
| Swisher | 3,500 | | 3,500 | | | |
| Terry | 30,000 | 20,000 | 50,000 | 25,000 | 1,700,000 | 112,500 |
| Yoakum | 20,000 | 50,000 | 70,000 | 35,000 | 2,380,000 | 157,500 |
| Totals | 1,169,000 | 487,000 | 1,656,000 | 784,250 | 53,329,000 | 3,529,125 |

[1] Estimated at 50 percent of total mesquite and shinnery oak acres.
[2] Calculated at $68 per acre.
[3] Calculated at $4.50 per acre.

#### *4.4.4.2.7 Implementation Issues*

Several implementation issues pertain to this potential water supply option. *In situ* brush control studies are only available for catchment-level examples comprising an area 1,000 acres or less. A large-scale brush control program would require the cooperation of many landowners having different interests in their property. In a specific target watershed, there may be property owners who are not dependent on grazing income and therefore have limited interest in brush control. To ensure cooperation of ranch owners, additional incentives or other considerations may be required which could alter the cost estimates for brush control. Another issue is that most of the assumptions and results presented above are based on computer modeling rather than *in situ* examples that have the benefit of several years of performance to demonstrate results. It is recommended that results of current studies at specific sites be evaluated before public funds are invested in major projects in the LERWPA.

One critical implementation issue is how the increase in runoff and/or recharge resulting from brush control would be related to usable water supply. Key questions that need answers are:

- How are the increased runoff and/or recharge verified?
- How much of the increased runoff and/or recharge results in yields of affected aquifers? and
- How is the increased yield of the affected aquifers verified?

See Table 4.4-76 for evaluation of this water management strategy.

***Table 4.4-76.***
***Evaluations of Brush Control to***
***Enhance Water Supply Yield***

| *Impact Category* | *Comment(s)* |
|---|---|
| a. Quantity, reliability, and cost of treated water | • Indeterminate to low reliable quantity<br>• Low cost |
| b. Environmental factors | • Brush control techniques may adversely affect existing wildlife populations, however, for Llano Estacado region, programs would be designed to enhance wildlife habitat<br>• Chemical brush control methods may result in residual chemicals in aquifers and streams |
| c. State water resources | • No apparent negative impacts on other water resources<br>• Potential benefit to Ogallala Aquifer water resources due to increased water for recharge and increased water for direct use, which would reduce need to withdraw water from aquifer |
| d. Threats to agriculture and natural resources in region | • Potential threats to habitat due to removal of brush, unless carefully designed to enhance wildlife habitat |
| e. Recreational | • Potentials to enhance hunting and other outdoor activities |
| f. Comparison and consistency equities | • Cost model for brush control is based on values reported in the literature; values appear to be comparable to those of other options<br>• No estimate made for cost of water supply yield because data not adequate to estimate yields |
| g. Interbasin transfers | • Not applicable |
| h. Third party social and economic impacts from voluntary redistribution of water | • Not applicable |
| i. Efficient use of existing water supplies and regional opportunities | • Improvement over current conditions |
| j. Effect on navigation | • None |

### *4.4.4.3 Desalt Brackish Groundwater*

#### *4.4.4.3.1 Description of Option*

The purpose of this option is to present estimates of the costs of desalination of brackish groundwater, the potential source of which is the Santa Rosa Aquifer of the Dockum Formation. The Dockum Formation underlies the entire area of the Llano Estacado Region and crops out along the eastern edge of the caprock escarpment (Figure 4.4-17).[65] The primary water-bearing zone in the Dockum is commonly called the "Santa Rosa." The Santa Rosa section consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale. Water is under artesian conditions. Recharge is from rainfall on the outcrop, with the long-term average being estimated at less than 50,000 acft/yr (Figure 4.4-17). Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment, with the exception of parts of Deaf Smith, Swisher, Briscoe, Floyd, Crosby, Garza, Motley, and Dickens Counties, where the quality of water obtained from the Santa Rosa is adequate for some uses. Concentrations of TDS of this water range from less than 1,000 mg/L in the outcrop and downdip portion, to over 20,000 mg/L in the deeper parts of the formation near the center of the planning region (Figure 4.4-17). High salinity levels pose a hazard for irrigation. Mixing Santa Rosa and Ogallala water reduces the salinity concentrations and is being done by some irrigators. Several municipalities are using water from the Santa Rosa, even though the water contains chlorides, sulfate, and dissolved solids that are near or in excess of safe drinking water standards.

In a part of the planning region where oil has been discovered, water from the Santa Rosa is being used for water flooding to recover oil. However, water from the Santa Rosa must be treated to make it compatible for use in water flooding, since the minerals of the Santa Rosa water are reported to cause flocculation to occur when injected into oil bearing formations that have water of a different mineral content.

[65] Bureau of Economic Geology, The University of Texas at Austin, 1967.

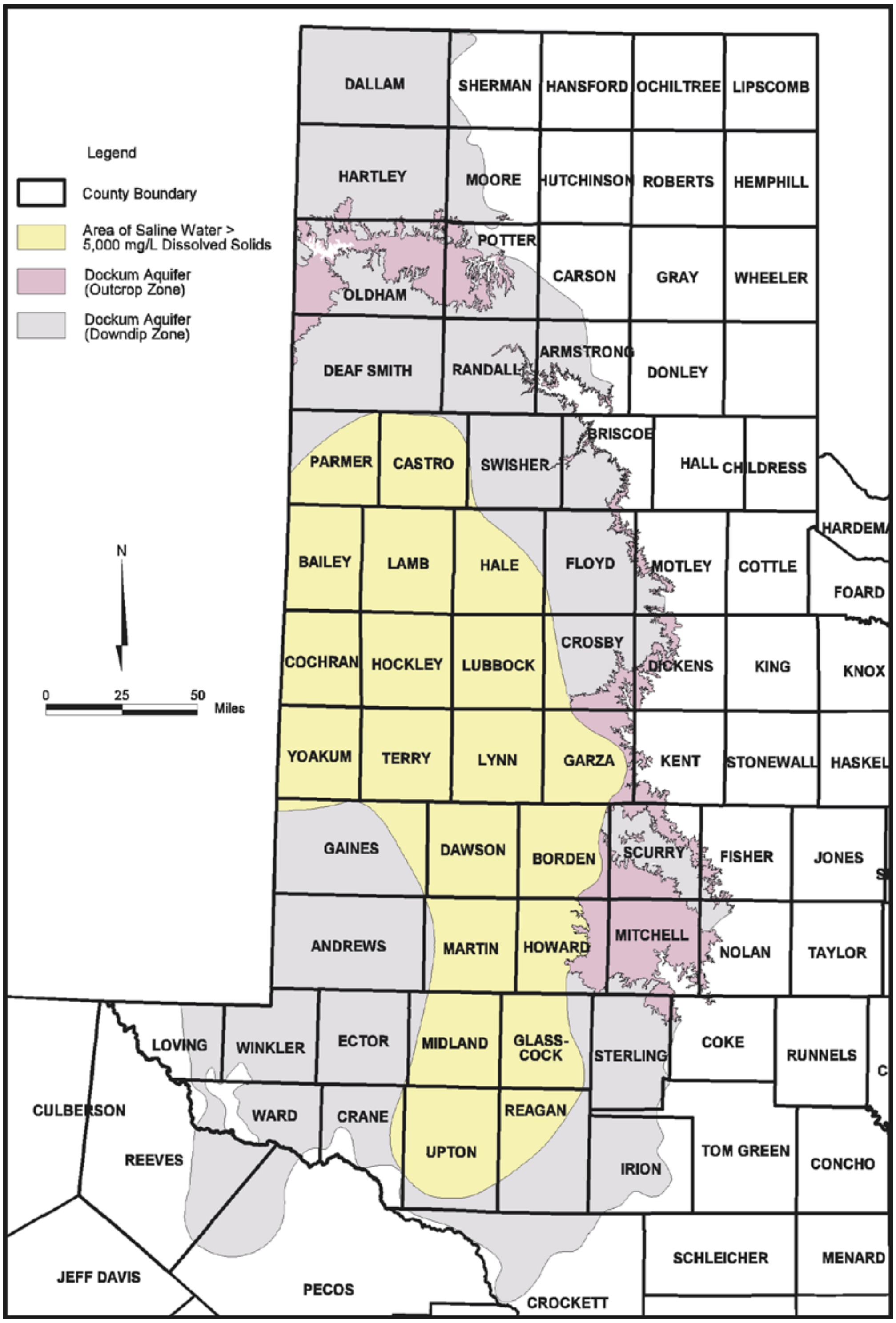


***Figure 4.4-17. Santa Rosa Formation of the Dockum Aquifer***

#### *4.4.4.3.2 General Desalination Background*[66]

Desalination of saline (seawater and brackish groundwater) water involves the removal of dissolved solids from the feedwater, and the disposal of the resulting waste concentrate stream. The commercially available processes that are currently used to desalt seawater and brackish groundwater to produce potable water are:

- Distillation (thermal) Processes; and
- Membrane (non-thermal) Processes.
- The available methods for concentrate disposal include:
- Surface water discharge;
- Solar evaporation ponds;
- Deep well injection;
- Land application (spray irrigation);
- Disposal to sewers (wastewater treatment plant processing); and
- Zero liquid discharge (mechanical evaporation).

Each of the desalination processes and solar evaporation and deep well injection concentrate disposal methods are described below.

**Distillation (Thermal) Processes**: Distillation processes produce purified water by vaporizing a portion of the saline feedstock to form steam. Since the salts dissolved in the feedstock are nonvolatile, they remain unvaporized and the steam formed is captured as a pure condensate. Distillation processes are normally very energy-intensive, quite expensive, and are generally used for large-scale desalination of seawater. Heat is usually supplied by steam produced by boilers or from a turbine power cycle used for electric power generation. Distillation plants are commonly dual-purpose facilities that produce purified water and electricity.

In general, for a specific plant capacity the equipment in distillation plants tends to be much larger than membrane desalination equipment. However, distillation plants do not have the stringent feedwater quality requirements of membrane plants. Due to the relatively high temperatures required to evaporate water, distillation plants have high energy requirements, making energy a large factor in the cost of water.

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[66] "Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan, Phase I Report, (1) Estimates of Population and Water Demands for New Ethanol Industries and Expanding Dairies; (2) Evaluation of water supplies and Desalination costs of Dockum Aquifer Water; and (3) video conferencing Facilities Available for Coordination Between Regions A and O," Llano Estacado Regional Water Planning Group, and Texas Water Development Board, April 30, 2009, Austin, Texas.

The three main distillation processes in use today are Multistage Flash Evaporation (MSF), Multiple Effect Distillation (MED), and Vapor Compression (VC). All three of these processes utilize an evaporator vessel that vaporizes and condenses the feedstock. The three processes differ in the design of the heat exchangers in the vessels and in the method of heat introduction into the process. Since seawater is not available in the Llano Estacado Region, distillation is not appropriate and will not be considered here. However, there are membrane desalination operations in Texas, from which information relevant to the Llano Estacado Region can be obtained. The following discussion and analyses present this information.

**Membrane (Non-thermal) Processes:** The two types of membrane processes use either pressure, as in reverse osmosis, or electrical charge, as in electrodialysis reversal, to reduce the mineral content of water. Both processes use semi-permeable membranes that allow selected ions to pass through while other ions are blocked. Electrodialysis reversal (EDR) uses direct electrical current applied across a vessel to attract the dissolved salt ions to their opposite electrical charges. EDR can desalt brackish water with TDS up to several thousand mg/L.

Reverse Osmosis (RO) utilizes a semi-permeable membrane that limits the passage of salts from the saltwater side to the freshwater side of the membrane. Electric motor driven pumps or steam turbines (in dual-purpose installations) provide the 800- to 1,200-psi pressure to overcome the osmotic pressure and drive the freshwater through the membrane, leaving a waste stream of brine/concentrate. The basic components of an RO plant include pre-treatment, high-pressure pumps, membrane assemblies, and post-treatment. Pre-treatment is essential because feedwater must pass through very narrow membrane passages during the process and suspended materials, biological growth, and some minerals can foul the membrane. As a result, virtually all suspended solids must be removed and the feedwater must be pre-treated so precipitation of minerals or growth of microorganisms does not occur on the membranes. Various levels of filtration and the addition of various chemical additives and inhibitors normally accomplish this. Post-treatment of product water is usually required prior to distribution to reduce its corrosivity and to improve its aesthetic qualities. Specific treatment is dependent on product water composition.

Depending upon TDS levels of the feedwater, a “single-pass/stage” RO plant can produce water with a TDS of 300 to 500 mg/L, most of which is sodium and chloride. The product water will be corrosive, but this may be acceptable if a source of blending water is available. If not, and if post-treatment is required, the various post-treatment additives may cause the product water to exceed the desired TDS levels. In such cases, or when better water quality is desired, a "two-pass/stage" RO system is used to produce water typically in the 200 mg/L TDS range. In a two-pass RO system, the product water from the first RO pass/stage is further desalted in a second RO pass/stage, and the water from the second pass is blended with water from the first pass.

Recovery rates up to 45 percent are common for a two-pass/stage RO facility. RO plants, which comprise about 31 percent of the world's desalting capacity, range from a few gallons per day (gpd) to 15 million gallons per day (MGD). The largest RO seawater plant in the United States is the 25 MGD plant in Tampa Bay, Florida. The largest RO plant in operation in Texas is a groundwater desalt plant at El Paso with a capacity of 27.5 MGD. The current domestic and worldwide trend seems to be for the adoption of RO when a single purpose seawater desalting plant is to be constructed. RO membranes have been improved significantly over the past two decades (i.e., the membranes have been improved with respect to efficiency, longer life, and lower prices).

**Concentrate Disposal:** Conditions in the Llano Estacado Water Planning Region do not justify the consideration of all the aforementioned concentrate disposal candidates. The two least complex methods, surface water discharge and sewer disposal, are not viable alternatives because adequate receiving waters and wastewater treatment facilities do not exist in the area. Land application via spray irrigation is not an advantageous solution due to the potential for environmental degradation resulting from the inevitable accumulation of salts in the receiving soil. Zero liquid discharge utilizing mechanical evaporation is feasible from a constructability perspective, but due to high capital and operations cost it would be prohibitive from an economic perspective. Environmental conditions including geological and meteorological considerations do warrant evaluation of solar evaporation and deep well injection strategies. Solar evaporation ponds and deep well injection disposal methods are described below.

**Solar Evaporation:** Solar ponds function by separating dissolved salts from the concentrate liquid through evaporation. These beds are relatively simple to construct, maintain, and clean and require no mechanical equipment other than pumps to transfer the concentrate to the ponds. Impervious liners (clay or synthetic membranes) are required to prevent leakage and the contamination of underlying groundwater. Predictably, this technique is most appropriate for small concentrate flows in arid regions with high evaporation rates and low land costs, since low evaporation rates and/or high concentrate disposal rates significantly increase the requisite evaporation area, thereby significantly increasing the cost of this disposal alternative.

Sizing of evaporation ponds primarily depends on climatic conditions, the concentrate discharge rate and concentration, and regulatory requirements. Ponds must have the capacity to accommodate concentrate disposal surges, precipitated salts, rainfall, and wave action. The evaporation and precipitation rates for the Llano Estacado Water Planning Region were estimated by evaluating 40 years of data collected at Lake Meredith, near Amarillo, Texas. A net evaporation rate of approximately 30 inches per year was determined after applying correction factors to account for the reduced evaporation potential of large bodies of high salinity water.

**Deep Well Injection:** Deep well injection is a specialized disposal technique whereby liquid wastes (e.g., municipal wastes, hazardous wastes, and produced waters from oil field operations) are pumped into the deep subsurface. Injection wells have been used to dispose of wastes for many years in Gulf Coast states such as Florida, Louisiana, and Texas. These wells, called Class I wells, commonly extend 1,000 to 8,000 feet into the subsurface to isolate the wastes from the environment and prevent contamination of potable groundwater sources. It is crucial, therefore, that the contiguous geologic formations prevent the migration of wastes out of the injection zone.

Selection of a suitable injection site depends primarily on geologic and hydrogeologic conditions. The well must be located and completed in a porous subsurface formation that is beneath the lowermost source of fresh water and separated from that source by a layer of impermeable strata. Findings of a study performed for the Texas Water Development Board conclude that the geologic formations in the Llano Estacado Water Planning Region are amenable to concentrate injection.[67] Furthermore, the cited study indicates that opportunities may exist to dispose of the concentrate in existing oil and gas wells (Class II wells). Current TCEQ guidance allows desalination concentrate to be injected into existing Class II wells if the desalination concentrate is being injected for the active recovery of oil and/or gas from a producing well field. Therefore, use of an existing Class II well for desalination concentrate disposal may not be a dependable long-term disposal option because it is dependant on the

[67] Bureau of Economic Geology, 2004. Please Pass the Salt: Using Oil Fields for the Disposal of Concentrate from Desalination Plants. Prepared for Texas Water Development Board.

continued use of the well for oil and/or gas production. Alternatively, it may be possible to convert a Class II well to a Class I disposal well. However, the permitting process to convert a Class II well to a Class I disposal well can be a hindrance to small desalination facilities due to the requirements of the application process. Underground Injection Control regulations of the U.S. Environmental Protection Agency require an Area of Review (AOR) study be performed in the conversion of Class II wells, but a variance of AOR request can be granted by demonstrating any of the following evidence:

- Reservoir pressure is insufficient to raise injection fluids to groundwater;
- Geological conditions preclude upward movement of fluids;
- Aquifers with water of good quality (less than 10,000 mg/L TDS) are absent in the injection area;
- Lack of intersection (i.e., no adjacent well is drilled to the depth of the injection zone); and
- Mitigating geological factors (e.g., 100 ft of continuous impervious strata).

Design and construction of a deep injection well requires knowledge of the concentrate flow rate and site-specific conditions. New injection wells are constructed in successive stages of drilling, casing, and cementing to the target well depth. The concentrate injection tube is commonly oversized to accommodate potential future increases in concentrate flow, however, details related to installation strategies and techniques vary widely depending on site-specific geological conditions and, therefore, cannot be specified until specific sites are selected. Therefore, cost estimates presented below are for more or less “generic” sites, and may be different if individual sites have specific needs or problems.

**Example of Relevant Existing Desalt Projects:** In 1996, Seadrift, Texas (population 1,890) was dependent upon the Gulf Coast Aquifer for its water supply. Total dissolved solids and chlorides had reached unacceptable levels of 1,592 mg/L and 844 mg/L, respectively. These values exceeded the primary drinking water standard for TDS (1,000 mg/L) and the secondary drinking water standard for chlorides (300 mg/L). Since the community was not located near an adequate quantity of freshwater or a wholesaler of drinking water, the decision was made to install RO to treat this slightly brackish groundwater. The city installed pressure filters, two RO units, antiscalent chemical feed equipment, and a chlorinator. The capital cost for the system was

***Table 4.4-77.***
***Municipal Use Desalt Plants in Texas – 2005****

| *Location* | *Source* | *Total Capacity (MGD)* | *Desalt Capacity (MGD)* | *Membrane Type*[1] |
|---|---|---|---|---|
| Abilene, City of | Surface Water | 8 | 8 | RO |
| Bardwell, City of | Groundwater | 0.25 | 0.036 | RO |
| Bayside, City of | Groundwater | 0.15 | 0.15 | RO |
| Beckville, City of | Groundwater | 0.19 | 0.14 | RO |
| Brady, City of | Groundwater | 3 | 1.5 | RO |
| Dell City, City of | Groundwater | 0.11 | 0.11 | EDR |
| DS Water of America (Katy) | Groundwater | 0.1 | 0.09 | RO |
| El Paso, City of | Groundwater | 27.5 | 27.5 | RO |
| Electra, City of | Groundwater | 0.5 | 0.5 | RO |
| Esperanza FWS (Pecos) | Groundwater | -- | 0.02 | RO |
| Ft. Stockton, City of | Groundwater | 7 | 6 | RO |
| Granbury, City of | Surface Water | 0.55 | 0.35 | EDR |
| Haciendas Del Norte (El Paso) | Groundwater | 0.23 | 0.05 | RO |
| Holiday Beach (Fulton) | Groundwater | 0.2 | 0.15 | RO |
| Horizon Regional MUD (Horizon ) | Groundwater | 4 | 2.2 | RO |
| Kenedy, City of | Groundwater | 2.86 | 0.72 | RO |
| Lake Granbury | Surface Water | 10 | 6 | RO |
| Laredo Santa Isabel , City of | Groundwater | -- | 0.1 | RO |
| North Cameron/Hidalgo WA | Groundwater | 2 | -- | RO |
| Robinson, City of | River | 2 | 2 | RO |
| Oak Trail Shores | Surface Water | 1.85 | 0.79 | EDR |
| Primera, City of | Groundwater | 2.5 | 2 | RO |
| Ramondville, City of | Groundwater | -- | 1 | RO |
| River Oaks Ranch (Hays Co) | Groundwater | -- | 0.14 | RO |
| Robinson, City of | Surface Water | 2.3 | 1.8 | RO |
| Seadrift, City of | Groundwater | 0.6 | 0.52 | RO |
| Seymour, City of | Groundwater | 3 | 0.5 | RO |
| Sherman, City of | Surface Water | 10 | 7.5 | EDR |

**Continued next page**

**Table 4.4-77 Continued**

| Location | Source | Total Capacity (MGD) | Desalt Capacity (MGD) | Membrane Type[1] |
|---|---|---|---|---|
| Southmost Regional WA | Groundwater | 7.5 | 6.75 | RO |
| Sportsmans World MUD | Surface Water | 0.1 | 0.1 | RO |
| Study Butte Trelingua WS | Groundwater | -- | 0.14 | RO |
| Tatum, City of | Groundwater | 0.32 | 0.28 | RO |
| The Cliffs (Graford) | Surface Water | -- | 0.2 | RO |
| Valley MUD # 2 (Olimito) | Groundwater | 1 | 0.75 | RO |
| Windermere Water System (WS) | Groundwater | 2.9 | 1 | RO |

RO = Reverse Osmosis EDR = Electrodialysis Reversal

*Source: Texas Water Development Board, Desalination Database; prepared by Bureau of Economic Geology, Austin, Texas, 2005.

$1.2 million ($1.82 million in September 2008 prices), with an annual O&M cost of $56,000 ($81,708 in September 2008 prices), resulting in a total debt service plus O&M cost of about $0.88 ($1.29 in September 2008 prices) per 1,000 gallons treated by RO. The capital cost included the cost of facilities in addition to the RO units and their appurtenant equipment. Product water from the RO units is blended with groundwater to meet an acceptable quality level. About 60 percent of the total is from the desalt units. The list of desalt plants in operation in Texas in 2005 is shown in Table 4.4-77.

#### *4.4.4.3.3 Quantity of Supply Available*

One way to evaluate the Santa Rosa is to compare it with the Ogallala. The first consideration is the physical location of the respective aquifers. The Ogallala lies near the land surface; the Santa Rosa lies below the Ogallala and is several hundred feet below land surface in most of the planning area. The greater the depth of the formation, the greater the cost to drill, complete, equip, and operate wells to obtain water. A well completed in the Santa Rosa in Deaf Smith County is estimated to cost approximately $142,000 in 2008 prices, while wells drilled and completed in the Ogallala in the same area, producing comparable yields, cost between $27,500 and $42,400.

The coefficient of storage in the Ogallala is about 0.15, or about 15 percent. The coefficient of storage of the Santa Rosa is about 0.0001. This indicates that at least 100 times more water can be recovered from 100 feet of saturated Ogallala material than could be recovered from 100 feet of decline in the artesian head (water level) of the Santa Rosa. The permeability of the Ogallala is about 400 gallons per day per square foot (gpd/sf), as compared to the 250 gpd/sf for the Santa Rosa.[68]

Using an analytical well field model, the calculated decline, in feet, of the static water level when a well located in the center of a grid of nine wells evenly spaced 440 yards apart, is pumped at a rate of 600 gpm from the Ogallala Aquifer, with a permeability of 400 gpd/sf, a coefficient of storage of 0.15 percent, and a saturated thickness of 100 feet, would be about 31 feet after 15 days of continuous pumping, 41 feet after 30 days of continuous pumping, 58 feet after 60 days of continuous pumping, and 73 feet after 90 days of continuous pumping. This example assumes that all nine wells are being pumped for the time periods stated. An example is given below of the results of comparable pumping for the Santa Rosa Formation. The calculated decline in feet from the static water level when a well is pumped that is located in the center of a grid of nine wells evenly spaced 440 yards apart, pumping 600 gpm from the Santa Rosa Aquifer, with a transmissibility of 22,000 gpd/f, and a coefficient of storage of 0.0001, would be about 215 feet after 15 days of continuous pumping, 234 feet after 30 days of continuous pumping, 254 feet after 60 days of continuous pumping, and 265 feet after 90 days of continuous pumping. This example assumes that all nine wells are being pumped for the time periods stated. Recommended spacing for Santa Rosa wells is one mile.

In summary, the quantity of useable quality water (less than 5,000 mg/L of TDS) in storage in the Santa Rosa Aquifer in the planning region in 2000 is estimated to be about 3.2 million acft. Due to the poor quality of water in the Santa Rosa Aquifer in a large part of the Llano Estacado Planning Region, demineralization would be necessary for municipal and industrial uses. Therefore, estimates of costs of desalination are presented, since such estimates may be useful to local communities that need additional municipal water supply (e.g., may need supply that can be blended with existing sources or supply that can be used directly).

#### *4.4.4.3.4 Environmental Issues*

As freshwater is extracted from brackish water, a more concentrated brackish water is produced as a waste product. Concentrated brackish water created from the desalination process is about triple the level of TDS of the brackish aquifer water and must be disposed of properly.

[68] Bradley, R.G. and Sanjeev Kalaswad, "The Groundwater Resources of the Dockum Aquifer in Texas, Texas Water Development Board," Report 359, Austin, Texas, December 2003.

For this option, it has been assumed that the brine concentrate will be discharged into the city(s)'s wastewater collection and treatment system.

#### *4.4.4.3.5 Cost Estimates*

The cost of desalting brackish groundwater depends upon the concentration levels of minerals in the feedwater to be treated (Table 4.4-78). For purposes of this analysis, cost estimates are presented for two levels of feedwater salinity—3,000 mg/L and 5,000 mg/L, and three water treatment plant sizes—0.2 MGD, 1.0 MGD, and 3.0 MGD, and include costs of obtaining untreated (raw) brackish groundwater for the desalination plants, and costs of concentrate disposal using the evaporation pond concentrate disposal method for desalting brackish groundwater for all cases except desalination of brackish groundwater of 5,000 mg/L TDS by a 3.0 MGD sized desalination plant. For example, the estimated cost of concentrate disposal using the evaporation pond method is the lowest for all cases considered except desalination of 5,000 mg/L by a 3.0 MGD size plant.[69]

**Table 4.4-78.**
**Engineering Assumptions for Brackish Groundwater Desalination**

| Parameter | Assumption | Description |
|---|---|---|
| Raw water salinity | 3,000 mg/L & 5,000 mg/L | Range from 1,200 to 1,500 mg/L |
| Finished water chlorides | Less than 500 mg/L | |
| RO Feedwater Pressure | 300 psi & 400 psi | 300 psi for 3,000 mg/L and 400 psi for 5,000 mg/L |
| Treatment capacity | Varies | |
| WTP storage | 0 | Use existing tanks |
| Booster pumps | 0 | Use existing tanks |
| Land for plant | 0 | Use existing city property |
| Pipeline friction factor | C = 140 | C-900 PVC pipe |

The cost per acft for a 0.2 MGD plant to desalt 3,000 mg/L water is estimated at $1,047/acft, or $3.21 per 1,000 gallons (Table 4.4-83), with total cost including raw water desalination, and concentrate disposal of $2,412/acft, or $7.40 per 1,000 gallons (Table 4.4-83). The cost for the same size plant to desalt 5,000 mg/L water is estimated at $1,232/acft, or $3.78

[69] op. cit.

per 1,000 gallons (Table 4.4-84), with a total cost of water, including raw water, desalination, and concentrate disposal of $2,597/acft, or $7.97 per 1,000 gallons (Table 4.4-84).

At larger sized water treatment plants, the costs are lower. For example, for a 1.0 MGD plant the cost to desalt 3,000 mg/L water is estimated at $630/acft, or $1.93 per 1,000 gallons; the cost to desalt 5,000 mg/L water is estimated at $714/acft, or $2.19 per 1,000 gallons (Tables 4.4-83 and 4.4-84, respectively). A 3.0 MGD size plant is estimated to have a desalt cost of $473/acft, or $1.45 per 1,000 gallons for water with 3,000 mg/L of salts, and for water with 5,000 mg/L of salts, the cost is $546/acft, or $1.68 per 1,000 gallons (Tables 4.4-83 and 4.4-84, respectively). Total cost of desalted water, including raw water, desalination, and concentrate disposal for a 1.0 MGD size facility to desalt 3,000 mg/L water is $1,825/acft ($5.60 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,909/acft ($5.86 per 1,000 gallons) Tables 4.4-83 and 4.4-84, respectively). Total cost of desalted water, including raw water, desalination, and concentrate disposal for a 3.0 MGD size facility to desalt 3,000 mg/L water is $1,601/acft ($3.85 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,618/acft ($4.96 per 1,000 gallons) Tables 4.4-83 and 4.4-84, respectively).

***Table 4.4-79.***
***Estimated Costs for Brackish Wells (Raw Water Production)***
***Parmer-Castro-Lamb County Area***
**Llano Estacado Water Planning Region[70]**
**September 2008 Prices**

| Components and Sizes | 0.2 MGD | 1 MGD | 3 MGD |
|---|---|---|---|
| **Capital Costs** | | | |
| Wells | $506,000 | $2,887,500 | $7,161,000 |
| Pipelines | $198,000 | $938,300 | $2,951,300 |
| Ground Storage | $133,100 | $453,200 | $1,305,700 |
| Power Connections | $11,000 | $55,000 | $154,000 |
| **Total Capital Costs** | **$848,100** | **$4,334,000** | **$11,572,000** |
| **Other Costs** | | | |
| Engineering, Legal Costs and Contingencies | $294,800 | $1,510,300 | $4,027,100 |
| Env. & Arch. Studies and Mitigation | $25,000 | $120,000 | $356,000 |
| Interest During Construction | $94,600 | $480,700 | $1,283,700 |
| **Total Project Costs** | **$1,262,500** | **$6,445,000** | **$17,238,800** |
| **Annual Costs** | | | |
| Debt Service | $92,400 | $470,800 | $1,258,400 |
| Operation & Maintenance | $8,800 | $42,900 | $115,500 |
| Power | $11,000 | $58,300 | $256,300 |
| **Total Annual Cost** | **$112,200** | **$572,000** | **$1,630,200** |
| Available Yield (acft/yr) | 224 | 1,120 | 3,336 |
| Annual Cost of Water ($ per acft) | 501 | 511 | 485 |

[70] op. cit.

**Table 4.4-80.**
**Estimated Costs for Evaporation Pond Concentrate Disposal from RO Desalination of Brackish Groundwater of 3,000 mg/L of TDS for 0.2 MGD, 1 MGD, and 3 MGD Sized Desalination Plants[71]**
**September 2008 Prices**

| | Desalination Plant Size | | |
|---|---|---|---|
| **Item** | **0.2 MGD** | **1 MGD** | **3 MGD** |
| Required Land (acres) | | | |
| Evaporation Area | 20 | 97 | 291 |
| Total Land | 28 | 120 | 344 |
| | | | |
| Capital Costs | | | |
| Evaporation Pond for Concentrate | $1,106,600 | $4,774,000 | $13,673,000 |
| **Total Capital Cost** | **$1,106,600** | **$4,774,000** | **$13,673,000** |
| | | | |
| Engineering, Legal, and Contingencies | $387,200 | $1,670,900 | $4,786,100 |
| Environmental & Archaeology Studies and Mitigation | $200,000 | $200,000 | $300,000 |
| Land Acquisition and Surveying | $16,000 | $99,000 | $283,000 |
| Interest During Construction (2 years) | $139,700 | $545,600 | $1,537,800 |
| **Total Project Cost** | **$1,849,500** | **$7,289,500** | **$20,579,900** |
| | | | |
| Annual Costs | | | |
| Debt Service (6 percent, 30 years) | $136,400 | $531,300 | $1,499,300 |
| Evaporation Pond Concentrate Disposal (O&M) | $16,500 | $72,600 | $205,700 |
| **Total Annual Costs** | **$152,900** | **$549,000** | **$1,705,000** |
| | | | |
| Available Project Yield (acft/yr) | 177 | 883 | 2,651 |
| Annual Cost ($ per acft of Desalted Water) | 864 | 684 | 643 |
| Annual cost ($ per 1,000 gals of Desalted Water) | 2.65 | 2.10 | 1.97 |

[71] Ibid.

**Table 4.4-81.**
**Estimated Costs for Evaporation Pond Concentrate Disposal from RO Desalination of Brackish Groundwater of 5,000 mg/L of TDS for 0.2 MGD, 1 MGD, and 3 MGD Sized Desalination Plants[72]**
**September 2008 Prices**

| Item | Desalination Plant Size | | |
|---|---|---|---|
| | **0.2 MGD** | **1 MGD** | **3 MGD** |
| Required Land (acres) | | | |
| Evaporation Area | 25 | 124 | 366 |
| Total Land | 34 | 153 | 433 |
| | | | |
| Capital Costs | | | |
| Evaporation Pond for Concentrate | $1,386,000 | $6,105,000 | $17,198,500 |
| **Total Capital Cost** | **$1,386,000** | **$6,105,000** | **$17,198,500** |
| | | | |
| Engineering, Legal, and Contingencies | $485,100 | $2,136,200 | $6,020,300 |
| Environmental & Archaeology Studies and Mitigation | $200,000 | $255,000 | $377,000 |
| Land Acquisition and Surveying (120 acres) | $21,000 | $126,000 | $355,000 |
| Interest During Construction (2 years) | $170,500 | $697,400 | $1,933,800 |
| **Total Project Cost** | **$2,262,600** | **$9,319,600** | **$25,884,600** |
| | | | |
| Annual Costs | | | |
| Debt Service (6 percent, 30 years) | $166,100 | $678,700 | $1,885,400 |
| Evaporation Pond Concentrate Disposal (O&M) | $20,900 | $92,400 | $258,500 |
| **Total Annual Costs** | **$187,000** | **$771,100** | **$2,143,900** |
| | | | |
| Available Project Yield (acft/yr) | 164 | 818 | 2,446 |
| Annual Cost ($ per acft of Desalted Water) | 1,140 | 944 | 876 |
| Annual cost ($ per 1,000 gals of Desalted Water) | 3.50 | 2.90 | 2.69 |

[72] Ibid.

**Table 4.4-82.**
**Estimated Costs for Deep Well Injection of Concentrate from RO Desalination of Brackish Groundwater of 3,000 mg/L and 5,000 mg/L of TDS for 3 MGD Size Desalination Plant[73]**
**September 2008 Prices**

| **Items** | **Desalt Plant Size** | |
|---|---|---|
| | **3 MGD** | **3 MGD** |
| **Brackish Groundwater to be Desalted** | **3,000 mg/L** | **5,000 mg/L** |
| | | |
| Number of Injection Wells | 1 | 2 |
| Hydraulic Conditions | | |
| Tubing Diameter (inches) | 6 | 4 |
| Injection Velocity (feet/second) | 5 | 7.2 |
| | | |
| Capital Costs | | |
| Deep Wells for Concentrate Injection | $6,113,800 | $11,407,000 |
| **Total Capital Costs** | **$6,113,800** | **$11,407,000** |
| | | |
| Engineering, Legal, and Contingencies | $2,139,500 | $3,993,000 |
| Environmental & Archaeology Studies and Mitigation | $510,000 | $620,000 |
| Land Acquisition and Surveying (0 acres) | $10,000 | $20,000 |
| Interest During Construction (2 years) | $706,200 | $1,289,200 |
| **Total Project Cost** | **$9,479,500** | **$17,329,200** |
| | | |
| Annual Costs | | |
| Debt Service (6 percent, 30 years) | $693,000 | $1,263,900 |
| (O&M) | $92,400 | $171,600 |
| **Total Annual Costs** | **$785,400** | **$1,435,500** |
| | | |
| Available Project Yield (acft/yr) | 2,651 | 2,446 |
| Annual Cost ($ per acft of Desalted Water) | 296 | 587 |
| Annual cost ($ per 1,000 gals of Desalted Water) | $0.91 | $1.80 |

***** Estimated costs for concentrate disposal are lower for solar evaporation ponds at desalination plant size reaches below 3 MGD for desalination of brackish groundwater of 3,000 mg/L and 5,000 mg/L. At plant sizes of 3 MGD and larger, deep well injection has the lower concentrate disposal costs, and is presented in Table 4.4-80 for use in estimating costs of desalination water management strategies for the 2011 Llano Estacado Regional Water Plan.

[73] Ibid.

***Table 4.4-83.***
***Cost Estimate for***
***Brackish Groundwater Desalination (3,000 mg/L TDS)***
***September 2008 Prices[74]***

| *Item* | *0.2 MGD* | *1 MGD* | *3 MGD* |
|---|---|---|---|
| **Capital Costs** | | | |
| Ground Storage Tank | $181,000 | $643,000 | $1,494,000 |
| Desalination Water Treatment Plant | $825,000 | $2,162,000 | $4,433,000 |
| **Total Capital Cost** | **$1,006,000** | **$2,805,000** | **$5,927,000** |
| | | | |
| Engineering, Legal Costs and Contingencies | $352,000 | $982,000 | $2,075,000 |
| Environmental & Archaeology Studies and Mitigation | $5,000 | $7,000 | $10,000 |
| Land Acquisition and Surveying (6 acres) | $6,000 | $8,000 | $11,000 |
| Interest During Construction (2 years) | $110,000 | $305,000 | $643,000 |
| **Total Project Cost** | **$1,478,000** | **$4,108,000** | **$8,665,000** |
| | | | |
| **Annual Costs** | | | |
| Debt Service (6 percent, 30 years) | $108,000 | $299,000 | $629,000 |
| Operation and Maintenance | | | |
| Ground Storage Tank | $2,220 | $6,660 | $14,430 |
| Water Treatment Plants | $75,480 | $251,000 | $610,500 |
| **Total Annual Cost** | **$185,370** | **$556,000** | **$1,254,000** |
| **Available Project Yield (acft/yr)** | 177 | 883 | 2,651 |
| **Annual Desalination Cost ($ per acft)** | $1,047 | $630 | $473 |
| **Annual Desalination Cost ($ per 1,000 gal.)** | $3.21 | $1.93 | $1.45 |
| **Annual Cost of Water ($ per acft)** | | | |
| **Raw Water (Table 4.4-77)** | 501 | 511 | 485 |
| **Desalted Water (Table 4.4-81)** | 1,047 | 630 | 473 |
| **Concentrate Disposal (Table 4.4-78 & 4.4-80)** | 864 | 684 | 296 |
| **Total Cost of Desalted Water ($ per acft)** | 2,412 | 1,825 | 1,601 |
| **Annual Cost of Water ($ per 1,000 gallons)** | | | |
| **Raw Water** | $1.54 | $1.57 | $1.49 |
| **Desalted Water (Table 4.4-81)** | $3.21 | $1.93 | $1.45 |
| **Concentrate Disposal (Table 4.4-78)** | $2.65 | $2.10 | $0.91 |
| **Total Cost of Desalted Water ($ per 1,000 gal.)** | $7.40 | $5.60 | $3.85 |

[74] Ibid.

**Table 4.4-84.**
**Cost Estimate for**
**Brackish Groundwater Desalination (5,000 mg/L TDS)**
**September 2008 Prices[75]**

| Item | 0.2 MGD | 1 MGD | 3 MGD |
|---|---|---|---|
| **Capital Costs** | | | |
| Ground Storage Tank | $172,000 | $606,000 | $1,406,000 |
| Desalination Water Treatment Plant | $932,000 | $2,288,000 | $4,677,000 |
| **Total Capital Cost** | **$1,104,000** | **$2,894,000** | **$6,084,000** |
| | | | |
| Engineering, Legal Costs and Contingencies | $386,000 | $1,012,000 | $2,129,000 |
| Environmental & Archaeology Studies and Mitigation | $5,000 | $7,000 | $10,000 |
| Land Acquisition and Surveying (6 acres) | $6,000 | $8,000 | $11,000 |
| Interest During Construction (2 years) | $121,000 | $314,000 | $659,000 |
| **Total Project Cost** | **$1,623,000** | **$4,235,000** | **$8,893,000** |
| | | | |
| **Annual Costs** | | | |
| Debt Service (6 percent, 30 years) | $117,660 | $307,470 | $646,000 |
| Operation and Maintenance | | | |
| Ground Storage Tank | $2,220 | $5,550 | $14,430 |
| Water Treatment Plants | $82,140 | $270,840 | $673,770 |
| **Total Annual Cost** | **$202,020** | **$583,860** | **$1,334,220** |
| **Available Project Yield (acft/yr)** | 164 | 818 | 2,446 |
| **Annual Desalination Cost ($ per acft)** | 1,232 | $714 | $546 |
| **Annual Desalination Cost ($ per 1,000 gal.)** | 3.78 | $2.19 | $1.68 |
| **Annual Cost of Water ($ per acft)** | | | |
| **Raw Water (Table 4.4-77)** | $501 | $511 | $485 |
| **Desalted Water (Table 4.4-82)** | $1,232 | $714 | $546 |
| **Concentrate Disposal (Tables 4.4-78 & 4.4-80)** | $864 | $684 | $587 |
| **Total Cost of Desalted Water ($ per acft)** | $2,597 | $1,909 | $1,618 |
| **Annual Cost of Water ($ per 1,000 gallons)** | | | |
| **Raw Water** | $1.54 | $1.57 | $1.49 |
| **Desalted Water (Table 4.4-81)** | $3.78 | $2.19 | $1.68 |
| **Concentrate Disposal (Table 4.4-78)** | $2.65 | $2.10 | $1.80 |
| **Total Cost of Desalted Water ($ per 1,000 gal.)** | $7.97 | $5.86 | $4.96 |

[75] Ibid.

#### *4.4.4.3.6 Implementation Issues*

Implementation of small community water supply from brackish groundwater sources includes financial and technological issues. For a municipal water demand of about 500,000 gpd, desalination could improve the quality of a backup supply or could perhaps replace a more vulnerable freshwater supply as the primary source. However, the estimated cost, while comparable to conventional treatment, is much higher than communities experience when they do not have to treat their groundwater, except to disinfect. Therefore, the best applications may be for small, remotely located systems where freshwater supplies are readily available nearby. Then desalination may compete economically with projects transporting fresh raw water or treated water over a distance of several miles.

There are two technological issues confronting a small utility that might consider desalination. The first is how to make the more centralized desalt plant compatible with a distribution system that is likely constructed to be compatible with two or more wells. Normally, this would be resolved in the design engineering process.

The second technological issue is the relative complexity of desalination compared to the relative simplicity of a fresh groundwater supply, requiring only extraction from the ground, storage, disinfection and distribution. Desalt plants encounter scaling, corrosion, and chemical challenges that require relatively highly trained and experienced treatment staff. Therefore, the smaller communities might consider contract operations rather than developing in-house expertise to operate desalt plants.

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-85.

***Table 4.4-85.***
***Evaluation of Brackish Groundwater Desalination***

| *Impact Category* | *Comment(s)* |
|---|---|
| a. Quantity, reliability, and cost of treated water | • Unknowns regarding extent and yields of brackish aquifer<br>• Moderately high treatment cost |
| b. Environmental factors | • Disposal of concentrated brine created from process<br>• Typically in low recharge rate aquifers or confined aquifers; use could lead to the depletion of aquifers<br>• Extracted brackish water possibly replaced by freshwater from a higher strata aquifer, thereby removing and contaminating accessible freshwater |
| c. State water resources | • In case of brackish aquifer, improves state water resources<br>• For freshwater aquifer having brackish lower zone, potentially contaminates fresh groundwater |
| d. Threats to agriculture and natural resources in region | • None |
| e. Recreational | • None |
| f. Comparison and consistency equities | • Same cost model used to estimate total costs |
| g. Interbasin transfers | • Not applicable |
| h. Third party social and economic impacts from voluntary redistribution of water | • Not applicable |
| i. Efficient use of existing water supplies and regional opportunities | • Increases |
| j. Effect on navigation | • Not applicable |

### *4.4.4.4 Research and Development of Drought-Tolerant Crops and New Technology*

This is a region-wide or regional water management strategy, since it is applicable to individual irrigation and dryland farmers and ranchers. The strategy is described but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

#### *4.4.4.4.1 Description of Option*

Both public and private agricultural research organizations are presently engaged in plant crop breeding, plant nutrition, and cultural practices to improve the productivity, quality, and other characteristics of crops that can be produced in the Llano Estacado and other regions of Texas, the United States, and other countries of the world. In addition, in the Llano Estacado Region, the TWDB has funded a demonstration initiative whose purposes are "… to expedite transfer of available technology to the farms and to develop comprehensive data, utilizing large scale demonstration sites, to assess the cost effectiveness of selected technologies, evaluate and determine the impact of implementation on crop productivity, impacts on reductions of irrigation water use, and impacts on available water supplies."

The LERWPG recommends that funding be continued in adequate levels for research and development of new and improved technology in the fields of drought tolerant strains of crops, new or alternative crops for arid and semiarid regions, plant nutrition, irrigation application methods, brush control, weather modification, aquifer recharge, and development of better information about the aquifers and other water resources of the region.

##### *4.4.4.4.2 Quantity of Water*

Not possible to make evaluation.

##### *4.4.4.4.3 Environmental Issues*

Not possible to make evaluation.

##### *4.4.4.4.4 Costing*

Not possible to make evaluation.

##### *4.4.4.4.5 Implementation*

Not possible to make evaluation.

#### *4.4.4.5 Reuse of Municipal Effluent*

This is a water management strategy which may have potentials for the industrial, municipal, steam-electric power generation, and irrigation water user groups. The strategy is described, but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

##### *4.4.4.5.1 Description of Option*

Of the total quantities of water used for municipal purposes, approximately 45 percent to 65 percent are returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Water Planning Region, a large percentage of this treated effluent, or reclaimed water, is used for irrigation of open spaces, golf courses, and neighboring farmland. However, the quantity is between 45 and 65 percent of the quantity of municipal use and could perhaps be a significant source of supply for some water users, including perhaps municipal supply in the future if treatment levels can be increased to the extent that the use of such water does not pose a health risk. For example, this water is already at or very near the point of potential municipal use and would not have to be transported to the city, as other sources would have to be. In addition, this water exists, whereas equivalent quantities may not be readily available, if available at all.

##### *4.4.4.5.2 Quantity of Water*

Not possible to make evaluation.

##### *4.4.4.5.3 Environmental Issues*

Must be studied and treatment technology improved enough to be acceptable by the public and regulatory agencies.

##### *4.4.4.5.4 Costing*

Not possible to make evaluation.

##### *4.4.4.5.5 Implementation*

Requires further research.

#### *4.4.4.6 Stormwater Capture and Use*

This is a water management strategy which may have potentials for the industrial, municipal, steam-electric power generation, and irrigation water user groups. The strategy is described, but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

##### *4.4.4.6.1 Description of Option*

In some cities of the Llano Estacado Region disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, as appropriate and needed, and use this water as a source of supply for non-potable as well as perhaps potable uses. Although it is expected that water treatment technology, such as membranes, can handle the treatment requirements, evaluations are needed of ways to successfully integrate flood protection, storage of this stormwater, and treatment of this water for useful purposes.

##### *4.4.4.6.2 Quantity of Water*

Not possible to make evaluation.

##### *4.4.4.6.3 Environmental Issues*

Must be studied and treatment technology demonstrated to be acceptable by the public and regulatory agencies.

##### *4.4.4.6.4 Costing*

Not possible to make evaluation.

##### *4.4.4.6.5 Implementation*

Requires further research.

### *4.5 Llano Estacado Regional Water Plan*

In Section 1, the Llano Estacado Region is described. In Section 2 projections of population and water demand are presented. In Section 3, existing water supplies are tabulated. In Section 4, the projected water demands of Section 2 are compared with the existing water supplies of Section 3 and needs (shortages) for additional supplies are calculated. In Section 4.4, water management strategies are identified, described, and evaluated. The information from Sections 1, 2, 3, and 4 is used in the development of the following water plan for the region.

For purposes of developing the 2011 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000 of 172 gallons per person per day (gpcd). The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Region average municipal water use of 172 gpcd.

Water management strategies included in the plan to meet the needs of specific water user groups include municipal water conservation and local groundwater development for municipalities, and irrigation BMPs and an irrigation water conservation water management strategy for irrigators, while strategies that are not specific to a particular water user group, but instead are region-wide strategies include weather modification and brush management. The plan does not propose any changes to existing water contracts or option agreements. Further, the plan was created in close cooperation with each wholesale water provider in the region, and no strategy contained in the plan would adversely affect any existing water contracts, option agreements, or special water resources.

For each city with a projected need and a per capita water use of 172 gpcd or greater, municipal water conservation is included as a water management strategy until the goal of 172 gpcd is reached. Municipal water conservation beyond that which is estimated to be accomplished through low flow plumbing fixtures and the municipal water conservation strategy is not included, since municipal water conservation is estimated to cost more than the next available source of water; e.g. in the range of $627 per acft to $689 per acft compared to costs of local groundwater in the range of approximately $49 per acft to approximately $283 per acft.

Additional water supply to meet needs above those that can potentially be met through municipal water conservation is the expansion or replacement of existing wells or well fields with new wells. If the new wells or well fields are located on private property, the city will need to purchase that property or purchase water rights.

The proposed plan encourages the continued and expanded use of irrigation BMPs and an irrigation water conservation strategy to meet as much as possible of the projected irrigation needs of the region. Individual irrigators who have not already adopted irrigation BMPs and installed available efficient irrigation application equipment, such as Low Energy Precision Application (LEPA), Low Pressure Sprinkler Systems (LESA), and subsurface or drip irrigation will need to do so as soon as possible to conserve their current water supplies.

Non-specific strategies would contribute to increasing the region’s water supplies on a widespread scale for all water user groups, as opposed to being specifically applicable to an individual user group. These include weather modification and brush control. Both weather modification and brush control have been and should continue to be carried out by underground water conservation districts, soil and water conservation districts, and private groups, as desired and supported by the citizens of local areas affected. The local choice is particularly appropriate for precipitation enhancement and brush control strategies.

The water management strategies are intended to assist in meeting the water needs of the region during all types of weather, but are especially directed at meeting needs during drought. In addition, these strategies were selected to contribute to sustainability of present supplies of groundwater. The detailed plans for each of the 21 counties of the Llano Estacado Planning Region are presented in alphabetic order below. In each county plan, each water user group of the county is listed, and if the user group has a projected need (shortage) during the planning horizon, a water management strategy to meet the need is included, except in the case of irrigated agriculture, for which it has been determined that it is not economically feasible to meet all of the projected needs at this time. The strategies selected are those that are estimated to be the lowest cost by virtue of the fact that they are the strategies located nearest to the location of need.

Drought Management is not a recommended water management strategy to meet projected water needs in Region O, in part because it cannot be demonstrated to be an economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Region O shows income losses due to unmet irrigation, confined animal feeding, business, and commercial water needs (shortages) of approximately $282 per acft/yr in 2010 increasing to approximately $457 per acft/yr in 2030, and to approximately $615 per acft/yr in 2060 (calculated from data in Table 4-24). The Water Conservation water management strategies recommended in the 2011 Regional Water Plan, together with the other water management strategies appear to the LERWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration. The uncertainty and the cost associated therewith is not acceptable to the LERWPG, thus Drought Management is not included as a recommended water management strategy. **However, the LERWPG recognizes the individual cities "Demand Management and Drought Contingency Plans" that are on file with the TCEQ. The surface water supplies of this plan are included only at the firm yield quantities and the groundwater supplies are included at the quantities estimated to be available through existing facilities and aquifer capabilities. Therefore, the LERWPG depends upon water users to follow their respective drought management plans and to implement any additional water conservation needed during droughts that may affect existing and planned water management strategies.**

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### *4.5.1 Bailey County Water Supply Plan*

Table 4.5-1 lists each water user group in Bailey County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-1.***
***Bailey County Surplus/Shortage****

| *Water User Group* | *Surplus/Shortage*[1] | | *Comment* |
|---|---|---|---|
| | *2030 (acft/yr)* | *2060 (acft/yr)* | |
| City of Muleshoe | 0 | 0 | No projected surplus/shortage |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -84,647 | -83,220 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-1, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.1.1 The City of Muleshoe*

##### *4.5.1.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

##### *4.5.1.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Muleshoe.

- Municipal water conservation.

#### *4.5.1.1.3 Costs*

Costs of the recommended plan for the City of Muleshoe are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-8
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-2 for a cost summary of this option.

***Table 4.5-2.***
***Recommended Plan Costs by Decade for the City of Muleshoe***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 79 | 81 | 67 | 51 | 44 | 44 |
| Annual Cost ($/yr) | $57,930 | $56,372 | $45,327 | $33,260 | $28,708 | $28,180 |
| Unit Cost ($/acft) | $733 | $696 | $676 | $652 | $652 | $640 |

### *4.5.1.2 Irrigation*

#### *4.5.1.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 96,917 acft/yr in 2010 declining to 74,851 acft/yr in 2060.

#### *4.5.1.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Bailey County has increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Bailey County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.1.2.3 Costs*

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $13,440,000

- Annual Cost: $1,040,000; including debt service at 20 yrs useful life of systems (Table 4.5-3).

***Table 4.5-3.***
***Recommended Plan Costs by Decade for Irrigation – Bailey County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 81,561 | 85,721 | 84,647 | 84,229 | 83,647 | 83,220 |
| Irrigation Conservation Quantity (acft/yr) | 18,636 | 16,772 | 15,095 | 13,585 | 12,227 | 11,004 |
| Annual Cost (million dollars/ year)(Table 4.4-13A) | $1.17 | $1.17 | $1.17 | $1.17 | $1.17 | $1.17 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.2 Briscoe County Water Supply Plan*

Table 4.5-4 lists each water user group in Briscoe County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-4.***
***Briscoe County Surplus/Shortage****

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Silverton | -123 | -108 | To replace quantity from Lake Mackenzie |
| County Other (Quitague) | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -12,029 | -14,523 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-2, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.2.1 The City of Silverton*

##### 4.5.2.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Additional supplies needed due to lack of dependability of quantities from Lake Mackenzie and poor water quality of existing wells.

##### 4.5.2.1.2 Water Supply Plan

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Silverton through 2060.

- Local groundwater development beginning in 2012 needed to supply 126 acft/yr in 2020, and 108 acfr/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 12 miles from the City of Silverton into which new water supply wells can be located.

**4.5.2.1.3 Costs**

Costs of the recommended plan for the City of Silverton to meet projected needs shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-31
   - Date to be Implemented: 2012
   - Total Project Cost: $6,171,850
   - Annual Cost: See Table 4.5-5A for a cost summary of this option.

**Table 4.5-5A.**
Recommended Plan Costs by Decade for the City of Silverton

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 128 | 126 | 123 | 115 | 111 | 108 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 126 | 123 | 115 | 111 | 108 |
| Annual Cost ($/yr) | — | $594,580 | $594,580 | $594,580 | $56,518 | $56,518 |
| Unit Cost ($/acft) | — | $1,399 | $1,399 | $1,399 | $509 | $523 |

### *4.5.2.2 Irrigation*

#### *4.5.2.2.1 Description of Supply*

- **Source:** Ogallala, Dockum, and Seymour Aquifers
- **Current Supply:** 26,635 acft/yr in 2010 declining to 6,481 acft/yr in 2060.

#### *4.5.2.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Briscoe County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Briscoe

County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.2.2.3 Costs*

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2010
- Total Cost: $4,730,000
- Annual Cost: $410,000; including debt service at 20 yrs useful life of systems (Table 4.5-5).

***Table 4.5-5.***
***Recommended Plan Costs by Decade for Irrigation – Briscoe County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 0 | 4,684 | 12,029 | 13,577 | 14,821 | 14,523 |
| Irrigation Conservation Quantity (acft/yr) | 6,555 | 5,900 | 5,310 | 4,779 | 4,301 | 3,871 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.41 | $0.41 | $0.41 | $0.41 | $0.41 | $0.41 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.3 Castro County Water Supply Plan*

Table 4.5-6 lists each water user group in Castro County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-6.***
***Castro County Surplus/Shortage****

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Dimmitt | -744 | -844 | Projected shortage – see plan below |
| City of Hart | 0 | -82 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -263,849 | -346,166 | Projected shortage – see plan below |
| Beef Feedlot Livestock | -1,612 | -5,144 | Projected shortage – see plan below |
| Dairies | -450 | -1,228 | Projected shortage – see plan below |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-3, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.3.1 The City of Dimmitt*

##### *4.5.3.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2024, at which time additional supplies will be needed

##### *4.5.3.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Dimmitt through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2019 needed to supply an additional 844 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 11 miles from the City of Dimmitt into which the city could locate new municipal water supply wells.

#### *4.5.3.1.3 Costs*

Costs of the recommended plan for the City of Dimmitt to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-7 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-19
   - Date to be Implemented: 2019
   - Total Project Cost: $786,894
   - Annual Cost: See Table 4.5-7 for a cost summary of this option.

***Table 4.5-7.***
***Recommended Plan Costs by Decade for the City of Dimmitt***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 744 | 805 | 832 | 844 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 75 | 110 | 97 | 81 | 75 | 74 |
| Annual Cost ($/yr) | $54,358 | $69,934 | $59,860 | $48,128 | $43,422 | $42,660 |
| Unit Cost ($/acft) | $725 | $636 | $617 | $594 | $579 | $576 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 446 | 810 | 729 | 1,070 | 963 |
| Annual Cost ($/yr) | — | $47,624 | $95,248 | $95,248 | $142,872 | $142,872 |
| Unit Cost ($/acft) | — | $107 | $118 | $131 | $134 | $148 |

### *4.5.3.2 The City of Hart*

#### *4.5.3.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed

#### *4.5.3.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Hart through 2060.

- Local groundwater development beginning in 2045 needed to supply an additional 82 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Hart into which the city could locate new municipal water supply wells.

#### *4.5.3.2.3 Costs*

Costs of the recommended plan for the City of Hart to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-23
   - Date to be Implemented: 2045
   - Total Project Cost: $509,256
   - Annual Cost: See Table 4.5-8 for a cost summary of this option.

***Table 4.5-8.***
***Recommended Plan Costs by Decade for the City of Hart***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 67 | 82 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | — | — | 198 | 178 |
| Annual Cost ($/yr) | — | — | — | — | $63,446 | $63,446 |
| Unit Cost ($/acft) | — | — | — | — | $320 | $356 |

### *4.5.3.3 Irrigation*

#### *4.5.3.3.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 337,973 acft/yr in 2010 declining to 47,060 acft/yr in 2060.

#### *4.5.3.3.2 Water Supply Plan*

The use of irrigation BMPs in the past in Castro County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Castro County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.3.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2010
   - Total Cost: $30,490,000
   - Annual Cost: $2,660,000; including debt service at 20 yrs useful life of systems (Table 4.5-9).

### *4.5.3.4 Confined Animal Feeding Operations (CAFOs) Beef Feedyards and Dairies*

#### *4.5.3.4.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 8,022 acft/yr in 2010 declining to 5,808 acft/yr in 2060.

- Working within the planning criteria established by the LERWPG and TWDB, it is not feasible to meet the CAFO (Beef Feedyards and Dairies) needs (shortages) at this time, for the following reasons: (1) the CAFOs are owned by private individuals and are located several miles apart, (2) needs (shortages) of individual CAFOs are projected to develop at different times during the planning period, such that demands for quantities of water from water management strategies (WMSs) will not arise such that the WMSs can be successfully implemented from the financial standpoints, and (3) cost estimates of water management strategies evaluated appear to be in excess of affordability for CAFOs (Section 4.4.3.9). In addition, at the present time, it does not appear that there are organizations available to the CAFOs that have authority to implement water management strategies to deliver the needed water.

***Table 4.5-9.***
***Recommended Plan Costs by Decade for Irrigation and CAFOs – Castro County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 146,695 | 191,770 | 263,849 | 351,293 | 352,004 | 346,166 |
| Irrigation Conservation Quantity (acft/yr) | 42,268 | 38,041 | 34,237 | 30,813 | 27,732 | 24,959 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $2.66 | $2.66 | $2.66 | $2.66 | $2.66 | $2.66 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |
| | | | | | | |
| Projected CAFO Need (Shortage) (acft/yr) | --- | 759 | 2,062 | 5,028 | 5,953 | 6,372 |

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### *4.5.4 Cochran County Water Supply Plan*

Table 4.5-10 lists each water user group in Cochran County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-10. Cochran County Surplus/Shortage****

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Morton | -565 | -496 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -37,006 | -72,644 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-4, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.4.1 City of Morton*

##### *4.5.4.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

##### *4.5.4.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Morton through 2060.

- Municipal water conservation, and

- Local groundwater development beginning in 2015 needed to supply an additional 496 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Morton into which the city could locate new municipal water supply wells.

#### *4.5.4.1.3 Costs*

Costs of the recommended plan for the City of Morton to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-11 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-31
   - Date to be Implemented: 2015
   - Total Project Cost: $1,185,162
   - Annual Cost: See Table 4.5-13 for a cost summary of this option.

***Table 4.5-11.***
***Recommended Plan Costs by Decade for the City of Morton***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 560 | 565 | 547 | 521 | 496 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 41 | 56 | 48 | 38 | 34 | 32 |
| Annual Cost ($/yr) | $29,859 | $36,110 | $30,383 | $23,334 | $20,272 | $19,286 |
| Unit Cost ($/acft) | $728 | $645 | $633 | $614 | $596 | $603 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 855 | 770 | 693 | 623 | 561 |
| Annual Cost ($/yr) | — | $158,842 | $158,842 | $158,842 | $55,519 | $55,519 |
| Unit Cost ($/acft) | — | $186 | $206 | $292 | $89 | $99 |

### *4.5.4.2 Irrigation*

#### *4.5.4.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water

- **Current Supply:** 75,443 acft/yr in 2010 declining to 22,661 acft/yr in 2060.

#### *4.5.4.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Cochran County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Cochran County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.4.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2010
   - Total Cost: $14,580,000
   - Annual Cost: $1,270,000; including debt service at 20 yrs useful life of systems (Table 4.5-12).

***Table 4.5-12.***
***Recommended Plan Costs by Decade for Irrigation – Cochran County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 39,909 | 38,596 | 37,006 | 35,505 | 76,645 | 72,644 |
| Irrigation Conservation Quantity (acft/yr) | 20,215 | 18,193 | 16,374 | 14,737 | 13,263 | 11,937 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $1.27 | $1.27 | $1.27 | $1.27 | $1.27 | $1.27 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### 4.5.5 Crosby County Water Supply Plan

Table 4.5-13 lists each water user group in Crosby County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

**Table 4.5-13.**
**Crosby County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Crosbyton | 0 | -336 | Projected shortage – see plan below |
| City of Lorenzo | -37 | -108 | Projected shortage – see plan below |
| City of Ralls | -4 | -318 | Projected shortage – see plan below |
| County Other | 100 | 100 | Projected surplus |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -16,327 | -14,102 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-5, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### 4.5.5.1 The City of Crosbyton

##### 4.5.5.1.1 Description of Supply

- **Source:** Ogallala Aquifer and White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

##### 4.5.5.1.2 Water Supply Plan

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Crosbyton through 2060.

- Local groundwater development in partnership with the White River MWD needed to supply an additional 336 acft/yr in 2060.

#### *4.5.5.1.3 Costs*

Costs of the recommended plan for the City of Crosbyton to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
   - Cost Source: Section 4.4.3.8, Table 4.4-59
   - Date to be Implemented: 2015
   - Annual Cost: See Table 4.5-14 for a cost summary of this option.

***Table 4.5-14.***
***Recommended Plan Costs by Decade for the City of Crosbyton***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 336 |
| **Local Groundwater Development (with the White River MWD)** | | | | | | |
| Quantity Available (acft/yr) | 0 | 400 | 400 | 400 | 400 | 400 |
| Annual Cost ($/yr) | 0 | $18,200 | $18,200 | $18,200 | $18,200 | $18,200 |
| Unit Cost ($/acft) | -- | $45 | $45 | $45 | $45 | $45 |

### *4.5.5.2 The City of Lorenzo*

#### *4.5.5.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

#### *4.5.5.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Lorenzo through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 108 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Lorenzo into which the city could locate new municipal water supply wells.

#### *4.5.5.2.3 Costs*

Costs of the recommended plan for the City of Lorenzo to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-26
   - Date to be Implemented: 2021
   - Total Project Cost: $349,250
   - Annual Cost: See Table 4.5-15 for a cost summary of this option.

***Table 4.5-15.***
***Recommended Plan Costs by Decade for the City of Lorenzo***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 37 | 69 | 92 | 108 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | 206 | 185 | 167 | 150 |
| Annual Cost ($/yr) | — | — | $44,171 | $44,171 | $13,723 | $13,723 |
| Unit Cost ($/acft) | — | — | $214 | $239 | $82 | $91 |

### *4.5.5.3 The City of Ralls*

#### *4.5.5.3.1 Description of Supply*

- **Source:** White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

#### *4.5.5.3.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Ralls through 2060.

- Local groundwater development in partnership with the White River MWD needed to supply an additional 318 acft/yr in 2060.

#### *4.5.5.3.3 Costs*

Costs of the recommended plan for the City of Ralls to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
- Cost Source: Section 4.4.3.8, Table 4.4-59
- Date to be Implemented: 2015
- Annual Cost: See Table 4.5-16 for a cost summary of this option.

***Table 4.5-16.***
***Recommended Plan Costs by Decade for the City of Ralls***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 4 | 7 | 323 | 318 |
| **Local Groundwater Development (with the White River MWD)** | | | | | | |
| Quantity Available (acft/yr) | 0 | 400 | 400 | 400 | 400 | 400 |
| Annual Cost ($/yr) | -- | $18,200 | $18,200 | $18,200 | $18,200 | $18,200 |
| Unit Cost ($/acft) | -- | $45 | $45 | $45 | $45 | $45 |

### *4.5.5.4 Irrigation*

#### *4.5.5.4.1 Description of Supply*

- **Source:** Ogallala and Seymour Aquifers, and Reclaimed Water
- **Current Supply:** 98,329 acft/yr in 2010 declining to 81,408 acft/yr in 2060.

#### *4.5.5.4.2 Water Supply Plan*

The use of irrigation BMPs in the past in Crosby County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Crosby County irrigation farmers (Section 4.4.1.2).

#### *4.5.5.3.3 Costs*

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $19,030,000

- Annual Cost: $1,660,000; including debt service at 20 yrs useful life of systems (Table 4.5-17).

**_Table 4.5-17._**
**_Recommended Plan Costs by Decade for Irrigation – Crosby County_**

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 17,030 | 16,573 | 16,327 | 15,870 | 14,494 | 14,102 |
| Irrigation Conservation Quantity (acft/yr) | 26,380 | 23,742 | 21,368 | 19,231 | 17,308 | 15,577 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $1.66 | $1.66 | $1.66 | $1.66 | $1.66 | $1.66 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.6 Dawson County Water Supply Plan*

Table 4.5-18 lists each water user group in Dawson County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-18.***
***Dawson County Surplus/Shortage****

| *Water User Group* | *Surplus/Shortage*[1] | | *Comment* |
|---|---|---|---|
| | *2030 (acft/yr)* | *2060 (acft/yr)* | |
| City of Lamesa | 383 | 228 | Projected surplus |
| City of O'Donnell (part) | 41 | 42 | Projected surplus |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -89,824 | -73,068 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-6, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.6.1 The City of Lamesa*

##### *4.5.6.1.1 Description of Supply*

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2060.

##### *4.5.6.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Lamesa.

- Municipal water conservation.

#### *4.5.6.1.3 Costs*

Costs of the recommended plan for the City of Lamesa are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-8
- Date to be Implemented: Prior to 2012
- Annual Cost: See Table 4.5-19 for a cost summary of this option.

***Table 4.5-19.***
***Recommended Plan Costs by Decade for the City of Lamesa***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 212 | 400 | 501 | 471 | 448 | 431 |
| Annual Cost ($/yr) | $147,965 | $238,281 | $284,147 | $260,930 | $245,779 | $236,474 |
| Unit Cost ($/acft) | $698 | $596 | $567 | $554 | $549 | $549 |

### *4.5.6.2 Irrigation*

#### *4.5.6.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 42,277 acft/yr in 2010 declining to 30,135 acft/yr in 2060.

#### *4.5.6.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Dawson County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Dawson County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.6.3.3 Costs*

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $4,380,000

- Annual Cost: $380,000; including debt service at 20 yrs useful life of systems (Table 4.5-20).

***Table 4.5-20.***
***Recommended Plan Costs by Decade for Irrigation – Dawson County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 95,628 | 94,657 | 89,924 | 85,978 | 79,229 | 73,068 |
| Irrigation Conservation Quantity (acft/yr) | 6,080 | 5,472 | 4,925 | 4,432 | 3,989 | 3,590 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.38 | $0.38 | $0.38 | $0.38 | $0.38 | $0.38 |
| Unit Cost ($/acft) (Table 4.4-13B) | $36 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.7 Deaf Smith County Water Supply Plan*

Table 4.5-21 lists each water user group in Deaf Smith County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-21.***
***Deaf Smith County Surplus/Shortage****

| *Water User Group* | *Surplus/Shortage[1]* | | *Comment* |
|---|---|---|---|
| | *2030 (acft/yr)* | *2060 (acft/yr)* | |
| City of Hereford | 3,751 | 3,789 | Projected surplus |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -225,001 | -242,805 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | -582 | Projected shortage |
| Dairies | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-7, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.7.1 The City of Hereford*

##### *4.5.7.1.1 Description of Supply*

- **Source:** Ogallala Aquifer and Dockum Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

##### *4.5.7.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Hereford.

- Municipal water conservation.

#### *4.5.7.1.3 Costs*

Costs of the recommended plan for the City of Hereford are:

a. Municipal water conservation:

- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2012
- Annual Cost: See Table 4.5-22 for a cost summary of this option.

***Table 4.5-22.***
***Recommended Plan Costs by Decade for the City of Hereford***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 302 | 572 | 649 | 610 | 596 | 598 |
| Annual Cost ($/yr) | $212,336 | $341,834 | $372,020 | $340,279 | $329,440 | $330,411 |
| Unit Cost ($/acft) | $703 | $598 | $573 | $558 | $553 | $553 |

### *4.5.7.2 Irrigation*

#### *4.5.7.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 189,659 acft/yr in 2010 declining to 63,968 acft/yr in 2060.

#### *4.5.7.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Deaf Smith County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Deaf Smith County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.7.3.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $30,470,000

- Annual Cost: $2,660,000; including debt service at 20 yrs useful life of systems (Table 4.5-23).

***Table 4.5-23.***
***Recommended Plan Costs by Decade for Irrigation and CAFOs – Deaf Smith County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 171,481 | 195,821 | 225,001 | 254,754 | 247,310 | 242,805 |
| Irrigation Conservation Quantity (acft/yr) | 42,246 | 38,022 | 34,219 | 30,797 | 27,718 | 24,946 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $2.66 | $2.66 | $2.66 | $2.66 | $2.66 | $2.66 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |
| | | | | | | |
| Projected CAFO Need (Shortage) (acft/yr) | --- | --- | --- | 517 | 548 | 582 |

### *4.5.7.3 Confined Animal Feeding Operations (CAFOs) Beef Feedyards and Dairies*

#### *4.5.7.3.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 10,142 acft/yr in 2010, increasing to 14,364 acft/yr in 2060, with demand increasing by a greater quantity of 582 acft/yr in 2060.
- Working within the planning criteria established by the LERWPG and TWDB, is not feasible to meet the CAFO (Beef Feedyards and Dairies) needs (shortages) at this time, for the following reasons: (1) the CAFOs are owned by private individuals and are located several miles apart, (2) needs (shortages) of individual CAFOs are projected to develop at different times during the planning period, such that demands for quantities of water from water management strategies (WMSs) will not arise such that the WMSs can be successfully implemented from the financial standpoints, and (3) cost estimates of water management strategies evaluated appear to be in excess of affordability for CAFOs (Section 4.4.3.9). In addition, at the present time, it does not appear that there are organizations available to the CAFOs that have authority to implement water management strategies to deliver the needed water.

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### *4.5.8 Dickens County Water Supply Plan*

Table 4.5-24 lists each water user group in Dickens County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-24.***
***Dickens County Surplus/Shortage****

| *Water User Group* | *Surplus/Shortage[1]* 2030 (acft/yr) | *Surplus/Shortage[1]* 2060 (acft/yr) | *Comment* |
|---|---|---|---|
| City of Spur | 0 | -257 | Projected shortage – see plan below |
| County Other | 80 | 74 | Projected surplus |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -3,053 | -2,663 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

1 From Table 4-8, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.8.1 The City of Spur*

##### *4.5.8.1.1 Description of Supply*

- **Source:** White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

##### *4.5.8.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Spur.

- Municipal water conservation; and
- Local groundwater development in partnership with the White River MWD needed to supply an additional 257 acft/yr in 2060.

#### *4.5.8.1.3 Costs*

Costs of the recommended plan for the City of Spur are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-8
- Date to be Implemented: Prior to 2012
- Annual Cost: See Table 4.5-25 for a cost summary of this option.

b. Local groundwater development in partnership with the White River MWD:
- Cost Source: Section 4.4.3.8, Table 4.4-59
- Date to be Implemented: 2015
- Annual Cost: See Table 4.5-25 for a cost summary of this option.

***Table 4.5-25.***
***Recommended Plan Costs by Decade for the City of Spur***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 151 | 257 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 21 | 42 | 54 | 50 | 48 | 48 |
| Annual Cost ($/yr) | $14,901 | $24,732 | $30,270 | $27,573 | $25,775 | $25,775 |
| Unit Cost ($/acft) | $710 | $589 | $561 | $551 | $537 | $537 |
| **Local Groundwater Development (with the White River MWD)** | | | | | | |
| Quantity Available (acft/yr) | 400 | 400 | 400 | 400 | 400 | 400 |
| Annual Cost ($/yr) | $18,200 | $18,200 | $18,200 | $18,200 | $18,200 | $18,200 |
| Unit Cost ($/acft) | $45 | $45 | $45 | $45 | $45 | $45 |

### *4.5.8.2 Irrigation*

#### *4.5.8.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 5,796 acft/yr in 2010 declining to 5,171 acft/yr in 2060.

#### *4.5.8.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Dickens County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region.

The Irrigation Water Conservation Water Management Strategy is recommended for Dickens County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.8.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $1,300,000
   - Annual Cost: $110,000; including debt service at 20 yrs useful life of systems (Table 4.5-26).

***Table 4.5-26.***
***Recommended Plan Costs by Decade for Irrigation – Dickens County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 3,321 | 3,185 | 3,053 | 2,921 | 2,792 | 2,663 |
| Irrigation Conservation Quantity (acft/yr) | 1,803 | 1,622 | 1,460 | 1,314 | 1,183 | 1,064 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 | $0.11 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### 4.5.9 Floyd County Water Supply Plan

Table 4.5-27 lists each water user group in Floyd County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

**Table 4.5-27.**
**Floyd County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Floydada | 0 | 0 | No projected surplus/shortage |
| City of Lockney | -240 | -212 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -108,967 | -100,073 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-9, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### 4.5.9.1 The City of Lockney

##### 4.5.9.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Mackenzie
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

##### 4.5.9.1.2 Water Supply Plan

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Lockney through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 212 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Lockney into which the city could locate new municipal water supply wells.

#### *4.5.9.1.3 Costs*

Costs of the recommended plan for the City of Lockney to meet 2030 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-25
   - Date to be Implemented: 2021
   - Total Project Cost: $388,302
   - Annual Cost: See Table 4.5-28 for a cost summary of this option.

***Table 4.5-28.***
***Recommended Plan Costs by Decade for the City of Lockney***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 240 | 234 | 224 | 212 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | 410 | 369 | 332 | 299 |
| Annual Cost ($/yr) | — | — | $59,755 | $59,755 | $59,755 | $25,903 |
| Unit Cost ($/acft) | — | — | $146 | $162 | $180 | $87 |

### *4.5.9.2 Irrigation*

#### *4.5.9.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 136,848 acft/yr in 2010 declining to 85,954 acft/yr in 2060.

#### *4.5.9.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Floyd County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Floyd County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.9.3.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $32,220,000
- Annual Cost: $2,810,000; including debt service at 20 yrs useful life of systems (Table 4.5-29).

***Table 4.5-29.***
***Recommended Plan Costs by Decade for Irrigation – Floyd County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 90,731 | 106,391 | 108,967 | 108,966 | 105,148 | 100,073 |
| Irrigation Conservation Quantity (acft/yr) | 44,665 | 40,198 | 36,178 | 32,561 | 29,305 | 26,374 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $2.81 | $2.81 | $2.81 | $2.81 | $2.81 | $2.81 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.10 Gaines County Water Supply Plan*

Table 4.5-30 lists each water user group in Gaines County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

**Table 4.5-30.**
**Gaines County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Seagraves | 0 | 0 | No projected surplus/shortage |
| City of Seminole | 0 | 0 | No projected surplus/shortage |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -119,451 | -139,981 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-10, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.10.1 Irrigation*

##### *4.5.10.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 325,949 acft/yr in 2010 declining to 160,991 acft/yr in 2060.

##### *4.5.10.1.2 Water Supply Plan*

The use of irrigation BMPs in the past in Gaines County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Gaines

County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.10.1.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $ 7,580,000
- Annual Cost: $ 660,000; including debt service at 20 yrs useful life of systems (Table 4.5-31).

***Table 4.5-31.***
***Recommended Plan Costs by Decade for Irrigation – Gaines County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 67,285 | 105,447 | 119,451 | 127,613 | 134,285 | 139,981 |
| Irrigation Conservation Quantity (acft/yr) | 10,515 | 9,463 | 8,517 | 7,665 | 6,898 | 6,209 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 | $0.66 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

### *4.5.11 Garza County Water Supply Plan*

Table 4.5-32 lists each water user group in Garza County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-32.***
***Garza County Surplus/Shortage****

| *Water User Group* | *Surplus/Shortage*[1] *2030 (acft/yr)* | *2060 (acft/yr)* | *Comment* |
|---|---|---|---|
| City of Post | 183 | -206 | Projected shortage – see plan below |
| Lake Alan Henry WSD | -270 | -270 | New service area – see plan below |
| County Other | 14 | 14 | Projected surplus |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -3,995 | -3,212 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-11, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.11.1 The City of Post*

##### *4.5.11.1.1 Description of Supply*

- **Source:** Lake Meredith (CRMWA via Slaton) and White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2035, at which time additional supplies will be needed

##### *4.5.11.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Post through 2060.

- Local groundwater development in partnership with the White River MWD needed to supply an additional 206 acft/yr in 2060.

#### *4.5.11.1.3 Costs*

Costs of the recommended plan for the City of Post to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
   - Cost Source: Section 4.4.3.10, Table 4.4-59
   - Date to be Implemented: 2012
   - Annual Cost: See Table 4.5-33 for a cost summary of this option.

***Table 4.5-33.***
***Recommended Plan Costs by Decade for the City of Post***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 261 | 243 | 206 |
| **Local Groundwater Development (with the White River MWD)** | | | | | | |
| Quantity Available (acft/yr) | 0 | 400 | 400 | 400 | 400 | 400 |
| Annual Cost ($/yr) | -- | $18,200 | $18,200 | $18,200 | $18,200 | $18,200 |
| Unit Cost ($/acft) | -- | $45 | $45 | $45 | $45 | $45 |

### *4.5.11.2 Lake Alan Henry WSD*

#### *4.5.11.2.1 Description of Supply*

- **Source:** Lake Alan Henry via contract with Lubbock.
- **Current Supply:** The new Lake Alan Henry Water Supply District is projected to need supplies prior to 2012.

#### *4.5.11.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the Lake Alan Henry WSD through 2060.

- Supply from Lake Alan Henry beginning prior to 2012.

#### *4.5.11.2.3 Costs*

Costs of the recommended plan for the Lake Alan Henry Water Supply District to meet 2060 shortages are:

a. Supply from Lake Alan Henry (See Section 4.4.3.1):
- Cost Source: Section 4.4.3.1, Table 4.4-40
- Date to be Implemented: 2012
- Total Project Cost: $7,334,502
- Annual Cost: See Table 4.5-34 for a cost summary of this option.

***Table 4.5-34.***
***Recommended Plan Costs by Decade for the Lake Alan Henry WSD***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 270 | 270 | 270 | 270 | 270 | 270 |
| **Supply from Lake Alan Henry** | | | | | | |
| Quantity Available (acft/yr) | 0 | 270 | 270 | 270 | 270 | 270 |
| Annual Cost ($/yr) | -- | $904,135 | $904,135 | $904,135 | $904,135 | $904,135 |
| Unit Cost ($/acft) | -- | $3,349 | $3,349 | $3,349 | $3,349 | $3,349 |

### *4.5.11.3 Irrigation*

#### *4.5.11.3.1 Description of Supply*

- **Source:** Ogallala and Dockum Aquifers
- **Current Supply:** 6,739 acft/yr in 2010 declining to 5,259 acft/yr in 2060.

#### *4.5.11.3.2 Water Supply Plan*

The use of irrigation BMPs in the past in Garza County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Garza County irrigation farmers (Section 4.4.1.2). The strategy is projected to meet the irrigation water needs of Garza County.

#### *4.5.11.3.3 Costs*

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-13A

- Date to be Implemented: Prior to 2012
- Total Cost: $3,190,000
- Annual Cost: $280,000; including debt service at 20 yrs useful life of systems (Table 4.5-35).

***Table 4.5-35.***
***Recommended Plan Costs by Decade for Irrigation – Garza County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 4,712 | 4,301 | 3,995 | 3,721 | 3,455 | 3,212 |
| Irrigation Conservation Quantity (acft/yr) | 4,428 | 3,985 | 3,587 | 3,228 | 2,905 | 2,615 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.28 | $0.28 | $0.28 | $0.28 | $0.28 | $0.28 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

### *4.5.12 Hale County Water Supply Plan*

Table 4.5-36 lists each water user group in Hale County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

**Table 4.5-36.**
**Hale County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Abernathy[2] | -366 | -446 | Projected shortage – see plan below |
| City of Hale Center | 0 | 0 | No Projected surplus/shortage |
| City of Petersburg | 0 | -306 | Projected shortage – see plan below |
| City of Plainview | 9,255 | 6,469 | Projected surplus – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -138,629 | -221,050 | Projected shortage – see plan below |
| Beef Feedlot Livestock | -573 | -2,058 | Projected shortage |
| Dairies | 0 | -460 | Projected shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-12, Section 4.1 – Water Needs Projections by Water User Group.
[2] A portion of the City of Abernathy is located in Lubbock County. However, the city's total projected shortage is shown here.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.12.1 The City of Abernathy*

##### *4.5.12.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

#### *4.5.12.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Abernathy through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2015 needed to supply an additional 446 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 10 miles from the City of Abernathy into which the city could locate new municipal water supply wells.

#### *4.5.12.1.3 Costs*

Costs of the recommended plan for the City of Abernathy to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-37 for a cost summary of this option.

***Table 4.5-37.***
***Recommended Plan Costs by Decade for the City of Abernathy***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 304 | 366 | 403 | 433 | 446 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 50 | 48 | 43 | 32 | 28 | 27 |
| Annual Cost ($/yr) | $35,831 | $32,462 | $28,378 | $20,469 | $17,686 | $17,334 |
| Unit Cost ($/acft) | $717 | $676 | $660 | $640 | $632 | $642 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 428 | 385 | 510 | 459 | 439 |
| Annual Cost ($/yr) | — | $47,624 | $47,624 | $77,459 | $77,459 | $77,459 |
| Unit Cost ($/acft) | — | $111 | $124 | $152 | $169 | $176 |

Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-15
   - Date to be Implemented: 2011
   - Total Project Cost: $699,732

- Annual Cost: See Table 4.5-37 for a cost summary of this option.

### *4.5.12.2 The City of Petersburg*

#### *4.5.12.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed.

#### *4.5.12.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Petersburg through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2041 needed to supply an additional 306 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately one mile from the City of Petersburg into which the city could locate new municipal water supply wells.

#### *4.5.12.2.3 Costs*

Costs of the recommended plan for the City of Petersburg to meet 2060 shortages are:

a. Municipal water conservation:
    - Cost Source: Section 4.4.1, Table 4.4-7
    - Date to be Implemented: Prior to 2012
    - Annual Cost: See Table 4.5-38 for a cost summary of this option.
b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
    - Cost Source: Section 4.4.2, Table 4.4-29
    - Date to be Implemented: 2041
    - Total Project Cost: $334,846
    - Annual Cost: See Table 4.5-38 for a cost summary of this option.

***Table 4.5-38.***
***Recommended Plan Costs by Decade for the City of Petersburg***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 312 | 306 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 21 | 24 | 20 | 16 | 14 | 14 |
| Annual Cost ($/yr) | $15,127 | $16,276 | $13,253 | $9,746 | $8,403 | $8,241 |
| Unit Cost ($/acft) | $720 | $678 | $663 | $609 | $600 | $589 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | — | — | 410 | 369 |
| Annual Cost ($/yr) | — | — | — | — | $54,608 | $54,608 |
| Unit Cost ($/acft) | — | — | — | — | $133 | $148 |

### *4.5.12.3 Irrigation*

#### *4.5.12.3.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 335,702 acft/yr in 2010 declining to 78,926 acft/yr in 2060.

#### *4.5.12.3.2 Water Supply Plan*

The use of irrigation BMPs in the past in Hale County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Hale County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.12.3.3 Costs*

a. Irrigation water conservation:
    - Cost Source: Section 4.4.1.2, Table 4.4-13A
    - Date to be Implemented: Prior to 2010
    - Total Cost: $30,570,000
    - Annual Cost: $2,670,000; including debt service at 20 yrs useful life of systems (Table 4.5-39).

***Table 4.5-39.***
***Recommended Plan Costs by Decade for Irrigation and CAFOs– Hale County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 22,217 | 55,312 | 138,629 | 206,294 | 222,871 | 221,050 |
| Irrigation Conservation Quantity (acft/yr) | 42,381 | 38,143 | 34,329 | 30,896 | 27,806 | 25,026 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $2.67 | $2.67 | $2.67 | $2.67 | $2.67 | $2.67 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |
| | | | | | | |
| Projected CAFO Need (Shortage) (acft/yr) | --- | --- | 573 | 796 | 2,147 | 2,518 |

### *4.5.12.4 Confined Animal Feeding Operations (CAFOs) Beef Feedyards and Dairies*

#### *4.5.7.4.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 2,300 acft/yr in 2010, decreasing 969 to acft/yr in 2060.
- Working within the planning criteria established by the LERWPG and TWDB, is not feasible to meet the CAFO (Beef Feedyards and Dairies) needs (shortages) at this time, for the following reasons: (1) the CAFOs are owned by private individuals and are located several miles apart, (2) needs (shortages) of individual CAFOs are projected to develop at different times during the planning period, such that demands for quantities of water from water management strategies (WMSs) will not arise such that the WMSs can be successfully implemented from the financial standpoints, and (3) cost estimates of water management strategies evaluated appear to be in excess of affordability for CAFOs (Section 4.4.3.9). In addition, at the present time, it does not appear that there are organizations available to the CAFOs that have authority to implement water management strategies to deliver the needed water.

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### *4.5.13 Hockley County Water Supply Plan*

Table 4.5-40 lists each water user group in Hockley County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-40. Hockley County Surplus/Shortage****

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Anton | -272 | -243 | Projected shortage – see plan below |
| City of Levelland | 867 | 701 | Projected surplus |
| City of Ropesville | -91 | -81 | Projected shortage – see plan below |
| City of Smyer | 0 | -62 | Projected shortage – see plan below |
| City of Sundown | -353 | -316 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -82,859 | -81,644 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-13, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.13.1 The City of Anton*

##### *4.5.13.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2010, at which time additional supplies will be needed

#### *4.5.13.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Anton through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2010 needed to supply an additional 243 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Anton into which the city could locate new municipal water supply wells.

#### *4.5.13.1.3 Costs*

Costs of the recommended plan for the City of Anton to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-41 for a cost summary of this option.

***Table 4.5-41.***
***Recommended Plan Costs by Decade for the City of Anton***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 263 | 270 | 272 | 268 | 256 | 243 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 14 | 11 | 6 | 2 | 0 | 0 |
| Annual Cost ($/yr) | $10,668 | $7,792 | $4,561 | $1,141 | 0 | 0 |
| Unit Cost ($/acft) | $762 | $708 | $760 | $571 | — | — |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | 408 | 367 | 330 | 297 | 268 | 243 |
| Annual Cost ($/yr) | $131,350 | $131,350 | $131,350 | $131,350 | $31,507 | $31,507 |
| Unit Cost ($/acft) | $322 | $358 | $398 | $442 | $76 | $84 |

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-16
   - Date to be Implemented: 2011
   - Total Project Cost: $1,145,246

- Annual Cost: See Table 4.5-41 for a cost summary of this option.

### *4.5.13.2 The City of Ropesville*

#### *4.5.13.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed.

#### *4.5.13.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Ropesville through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 81 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Ropesville into which the city could locate new municipal water supply wells.

#### *4.5.13.2.3 Costs*

Costs of the recommended plan for the City of Ropesville to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-32
   - Date to be Implemented: 2021
   - Total Project Cost: $349,252
   - Annual Cost: See Table 4.5-42 for a cost summary of this option.

***Table 4.5-42.***
***Recommended Plan Costs by Decade for the City of Ropesville***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 91 | 89 | 85 | 81 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | 193 | 174 | 157 | 141 |
| Annual Cost ($/yr) | — | — | $44,171 | $44,171 | $44,171 | $13,723 |
| Unit Cost ($/acft) | — | — | $229 | $254 | $281 | $97 |

### *4.5.13.3 The City of Smyer*

#### *4.5.13.3.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2055, at which time additional supplies will be needed

#### *4.5.13.3.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Smyer through 2060.

- Local groundwater development beginning in 2051 needed to supply an additional 62 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately one mile from the City of Smyer into which the city could locate new municipal water supply wells.

#### *4.5.13.3.3. Costs*

Costs of the recommended plan for the City of Smyer to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-42
   - Date to be Implemented: 2051
   - Total Project Cost: $249,976
   - Annual Cost: See Table 4.5-43 for a cost summary of this option.

***Table 4.5-43.***
***Recommended Plan Costs by Decade for the City of Smyer***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 62 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | — | — | — | 193 |
| Annual Cost ($/yr) | — | — | — | — | — | $34,613 |
| Unit Cost ($/acft) | — | — | — | — | — | $179 |

### *4.5.13.4 The City of Sundown*

#### *4.5.13.4.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

#### *4.5.13.4.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Sundown through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2016 needed to supply an additional 316 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Sundown into which the city could locate new municipal water supply wells.

#### *4.5.13.4.3 Costs*

Costs of the recommended plan for the City of Sundown to meet 2060 shortages are:

a. Municipal water conservation:
    - Cost Source: Section 4.4.1, Table 4.4-8
    - Date to be Implemented: Prior to 2012
    - Annual Cost: See Table 4.5-44 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
    - Cost Source: Section 4.4.2, Table 4.4-35
    - Date to be Implemented: 2016
    - Total Project Cost: $948,479
    - Annual Cost: See Table 4.5-44 for a cost summary of this option.

***Table 4.5-44.***
***Recommended Plan Costs by Decade for the City of Sundown***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 350 | 353 | 347 | 332 | 316 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 24 | 25 | 19 | 14 | 11 | 11 |
| Annual Cost ($/yr) | $18,000 | $16,942 | $13,065 | $8,786 | $7,071 | $6,722 |
| Unit Cost ($/acft) | $750 | $678 | $688 | $628 | $643 | $611 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 412 | 569 | 512 | 461 | 415 |
| Annual Cost ($/yr) | — | $93,120 | $122,955 | $122,955 | $40,267 | $40,267 |
| Unit Cost ($/acft) | — | $226 | $216 | $240 | $87 | $97 |

### *4.5.13.5 Irrigation*

#### *4.5.13.5.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 105,038 acft/yr in 2010 declining to 57,167 acft/yr in 2060.

#### *4.5.13.5.2 Water Supply Plan*

The use of irrigation BMPs in the past in Hockley County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Hockley County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.13.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $20,230,000
   - Annual Cost: $1,760,000; including debt service at 20 yrs useful life of systems (Table 4.5-45).

***Table 4.5-45.***
***Recommended Plan Costs by Decade for Irrigation – Hockley County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 63,682 | 75,675 | 82,859 | 87,831 | 83,837 | 81,644 |
| Irrigation Conservation Quantity (acft/yr) | 28,053 | 25,247 | 22,723 | 20,450 | 18,405 | 16,565 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $1.76 | $1.76 | $1.76 | $1.76 | $1.76 | $1.76 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.14 Lamb County Water Supply Plan*

Table 4.5-46 lists each water user group in Lamb County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-46. Lamb County Surplus/Shortage****

| Water User Group | Surplus/(Shortage)[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Amherst | 0 | 0 | No projected surplus/shortage |
| City of Earth | 0 | -276 | Projected shortage – see plan below |
| City of Littlefield | 0 | 0 | No projected surplus/shortage |
| City of Olton | 0 | 0 | No projected surplus/shortage |
| City of Sudan | 0 | 0 | No projected surplus/shortage |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected surplus/shortage |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -201,653 | -250,645 | Projected shortage – see plan below |
| Beef Feedlot Livestock | -241 | -1,730 | Projected shortage |
| Dairies | -134 | -1,280 | Projected shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-14, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.14.1 The City of Earth*

##### *4.5.14.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2035, at which time additional supplies will be needed

#### *4.5.14.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Earth through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2031 needed to supply an additional 276 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Earth into which the city could locate new municipal water supply wells.

#### *4.5.14.1.3. Costs*

Costs of the recommended plan for the City of Earth to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-47 for a cost summary of this option.

***Table 4.5-47.***
***Recommended Plan Costs by Decade for the City of Earth***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 283 | 280 | 276 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 20 | 28 | 25 | 21 | 20 | 17 |
| Annual Cost ($/yr) | $14,310 | $17,609 | $15,273 | $12,481 | $11,301 | $11,150 |
| Unit Cost ($/acft) | $716 | $629 | $611 | $594 | $565 | $656 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | — | 393 | 354 | 318 |
| Annual Cost ($/yr) | — | — | — | $96,796 | $96,796 | $96,796 |
| Unit Cost ($/acft) | — | — | — | $246 | $273 | $304 |

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-20
   - Date to be Implemented: 2031
   - Total Project Cost: $786,325

- Annual Cost: See Table 4.5-47 for a cost summary of this option.

### *4.5.14.2 Irrigation*

#### *4.5.14.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 248,481 acft/yr in 2010 declining to 45,217 acft/yr in 2060.

#### *4.5.14.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Lamb County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lamb County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.14.2.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $20,520,000
   - Annual Cost: $1,790,000; including debt service at 20 yrs useful life of systems (Table 4.5-48).

**Table 4.5-48.**
**Recommended Plan Costs by Decade for Irrigation and CAFOs – Lamb County**

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 114,832 | 158,445 | 201,653 | 238,554 | 248,375 | 250,645 |
| Irrigation Conservation Quantity (acft/yr) | 28,457 | 25,611 | 23,050 | 20,745 | 18,670 | 16,803 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $1.79 | $1.79 | $1.79 | $1.79 | $1.79 | $1.79 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |
| | | | | | | |
| Projected CAFO Need (Shortage) (acft/yr) | --- | --- | 375 | 1,618 | 2,347 | 3,009 |

### *4.5.14.3 Confined Animal Feeding Operations (CAFOs) Beef Feedyards and Dairies*

#### *4.5.14.3.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 2,909 acft/yr in 2010, decreasing1,377 acft/yr in 2060.

- Working within the planning criteria established by the LERWPG and TWDB, is not feasible to meet the CAFO (Beef Feedyards and Dairies) needs (shortages) at this time, for the following reasons: (1) the CAFOs are owned by private individuals and are located several miles apart, (2) needs (shortages) of individual CAFOs are projected to develop at different times during the planning period, such that demands for quantities of water from water management strategies (WMSs) will not arise such that the WMSs can be successfully implemented from the financial standpoints, and (3) cost estimates of water management strategies evaluated appear to be in excess of affordability for CAFOs (Section 4.4.3.9). In addition, at the present time, it does not appear that there are organizations available to the CAFOs that have authority to implement water management strategies to deliver the needed water.

### *4.5.15 Lubbock County Water Supply Plan*

Table 4.5-49 lists each water user group in Lubbock County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-49.***
***Lubbock County Surplus/Shortage***

| *Water User Group* | *Surplus/Shortage*[1] | | *Comment* |
|---|---|---|---|
| | *2030 (acft/yr)* | *2060 (acft/yr)* | |
| City of Abernathy | -- | -- | See Hale County (Included in Hale County) |
| City of Idalou | 0 | -272 | Projected shortage – see plan below |
| City of Lubbock | -13,454 | -20,649 | Projected shortage – see plan below |
| City of New Deal | -20 | -20 | Projected shortage – see plan below |
| City of Ransom Canyon | 0 | 0 | Projected surplus |
| City of Shallowater | -190 | -184 | Projected shortage – see plan below |
| City of Slaton | 193 | 227 | Projected surplus |
| City of Wolfforth | 397 | -388 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected surplus/shortage |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -99,575 | -96,846 | Projected shortage –see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-15, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.15.1 The City of Abernathy (See Hale County)*

#### *4.5.15.2 The City of Idalou*

##### *4.5.15.2.1 Description of Supply*

- **Source:** Ogallala Aquifer

- **Current Supply:** Adequate to meet demands until approximately 2035, at which time additional supplies will be needed

#### *4.5.15.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Idalou through 2060.

- Local groundwater development beginning in 2031 needed to supply an additional 272 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Idalou into which the city could locate new municipal water supply wells.

#### *4.5.15.2.3 Costs*

Costs of the recommended plan for the City of Idalou to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-24
   - Date to be Implemented: 2031
   - Total Project Cost: $770,132
   - Annual Cost: See Table 4.5-50 for a cost summary of this option.

***Table 4.5-50.***
***Recommended Plan Costs by Decade for the City of Idalou***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 274 | 273 | 272 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | — | 410 | 369 | 332 |
| Annual Cost ($/yr) | — | — | — | $96,514 | $96,514 | $96,514 |
| Unit Cost ($/acft) | — | — | — | $235 | $261 | $291 |

### *4.5.15.3 The City of Lubbock*

#### *4.5.15.3.1 Description of Supply*

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2015.

#### *4.5.15.3.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation,
- Lake Alan Henry Supply to Lubbock,
- Jim Bertram Lake System Expansion - Lake 7,
- Post Reservoir,
- Lubbock North Fork Diversion Operation, and
- Lubbock Brackish Groundwater Desalination.

#### *4.5.15.3.3 Costs*

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-51 for a cost summary of this option.

b. Lake Alan Henry Supply to Lubbock:
   - Cost Source: Section 4.4.3.2, Table 4.4-41
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $294,329,000
   - Annual Cost: See Table 4.5-41 for a cost summary of this option.

c. Lubbock Jim Bertram Lake System Expansion – Lake 7
   - Cost Source: Section 4.4.3.3. Table 4.4-46
   - Date to be Implemented: 2020
   - Total Project Cost: $68,288,000
   - Annual Cost: See Table 4.5-51 for a cost summary of this option.

d. Post Reservoir
   - Cost Source: Section 4.4.3.5
   - Date to be Implemented: 2030
   - Total Project Cost: $110,307,000
   - Annual Cost: See Table 4.4-55 for a cost summary of this option.

e. Lubbock North Fork Diversion Operation
   - Cost Source: Section 4.4.3.4. Table 4.4-51
   - Date to be Implemented: 2045
   - Total Project Cost: $153,040,000
   - Annual Cost: See Table 4.5-51 for a cost summary of this option.

**Table 4.5-51.**
**Estimated Plan Costs by Decade for the City of Lubbock**

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 8,602 | 10,496 | 13,454 | 15,765 | 19,333 | 20,649 |
| **Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)** | | | | | | |
| Quantity Available (acft/yr) | 4,132 | 7,662 | 7,112 | 6,441 | 6,256 | 6,405 |
| Annual Cost ($/yr) (millions) | $2.710 | $4.473 | $4.073 | $3.599 | $3.462 | $3.545 |
| Unit Cost ($/acft) | $656 | $583 | $572 | $559 | $553 | $554 |
| **Lake Alan Henry Supply to Lubbock** | | | | | | |
| Quantity Available (acft/yr) | 0 | 21,880 | 21,880 | 21,880 | 21,880 | 21,880 |
| Annual Cost ($/yr) (millions) | — | $28.655 | $28.655 | $28.655 | $28.655 | $28.655 |
| Unit Cost ($/acft) | — | $1,310 | $1,310 | $1,310 | $1,310 | $1,310 |
| **Lubbock Jim Bertram Lake System Expansion - Lake 7** | | | | | | |
| Quantity Available (acft/yr) | 0 | 17,650 | 17,650 | 17,650 | 17,650 | 17,650 |
| Annual Cost ($/yr) (millions) | — | $7.956 | $7.956 | $7.956 | $7.956 | $7.956 |
| Unit Cost ($/acft) | — | $451 | $451 | $451 | $451 | $451 |
| **Post Reservoir** | | | | | | |
| Quantity Available (acft/yr) | 0 | 0 | 22,270 | 22,270 | 22,270 | 22,270 |
| Annual Cost ($/yr) (millions) | — | — | $15,786 | $15,786 | $15,786 | $15,786 |
| Unit Cost ($/acft) | — | — | $695 | $695 | $695 | $695 |
| **Lubbock North Fork Diversion Operation** | | | | | | |
| Quantity Available (acft/yr) | 0 | 0 | 0 | 0 | 3,675 | 3,675 |
| Annual Cost ($/yr) (millions) | — | — | — | — | $23.298 | $23.298 |
| Unit Cost ($/acft) | — | — | — | — | $6,340 | $6,340 |
| **Lubbock Brackish Groundwater Desalination** | | | | | | |
| Quantity Available (acft/yr) | 0 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 |
| Annual Cost ($/yr) (millions) | — | $2.418 | $2.418 | $2.418 | $2.418 | $2.418 |
| Unit Cost ($/acft) | — | $720 | $720 | $720 | $720 | $720 |

c. Lubbock Brackish Groundwater Desalination
  d. Cost Source: Section 4.4.3.6, Table 4.4-57
  e. Date to be Implemented: 2020
  f. Total Project Cost: $13,167,230
  g. Annual Cost: See Table 4.4-57 for a cost summary of this option.

### *4.5.15.4 The City of New Deal*

#### *4.5.15.4.1 Description of Supply*

- **Source:** City of Slaton (CRMWA)
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

#### *4.5.15.4.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of New Deal through 2060.

- Local groundwater development beginning in 2011 needed to supply an additional 12 acft/yr in 2020, increasing to 20 acft/yr from 2030 to 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of New Deal into which the city could locate new municipal water supply wells.

#### *4.5.15.4.3 Costs*

Costs of the recommended plan for the City of New Deal to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-28
   - Date to be Implemented: 2012
   - Total Project Cost: $547,803
   - Annual Cost: See Table 4.5-52 for a cost summary of this option.

***Table 4.5-52.***
***Recommended Plan Costs by Decade for the City of New Deal***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 12 | 20 | 20 | 20 | 20 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 193 | 174 | 157 | 141 | 127 |
| Annual Cost ($/yr) | — | $63,286 | $63,286 | $63,286 | $15,528 | $15,528 |
| Unit Cost ($/acft) | — | $328 | $363 | $403 | $110 | $122 |

### *4.5.15.5 The City of Ransom Canyon*

#### *4.5.15.5.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

#### *4.5.15.5.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Ransom Canyon.

- Municipal water conservation.

#### *4.5.15.5.3 Costs*

Costs of the recommended plan for the City of Ransom Canyon are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-53 for a cost summary of this option.

***Table 4.5-53.***
***Recommended Plan Costs by Decade for the City of Ransom Canyon***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 35 | 90 | 162 | 248 | 325 | 342 |
| Annual Cost ($/yr) | $22,221 | $51,167 | $89,255 | $133,876 | $174,412 | $183,611 |
| Unit Cost ($/acft) | $635 | $569 | $551 | $540 | $537 | $537 |

### *4.5.15.6 The City of Shallowater*

#### *4.5.15.6.1 Description of Supply*

- **Source:** Ogallala Aquifer and City of Lubbock (CRMWA)
- **Current Supply:** Adequate to meet demands until approximately 2010, at which time additional supplies will be needed

#### *4.5.15.6.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Shallowater through 2060.

- Local groundwater development beginning in 2010 needed to supply an additional 184 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Shallowater into which the city could locate new municipal water supply wells.

#### *4.5.15.6.3 Costs*

Costs of the recommended plan for the City of Shallowater to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-33
   - Date to be Implemented: 2012
   - Total Project Cost: $479,941
   - Annual Cost: See Table 4.5-54 for a cost summary of this option.

**_Table 4.5-54._**
**_Recommended Plan Costs by Decade for the City of Shallowater_**

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 157 | 180 | 190 | 184 | 192 | 184 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | 432 | 389 | 350 | 315 | 283 | 255 |
| Annual Cost ($/yr) | $68,577 | $68,577 | $68,577 | $26,736 | $26,736 | $26,736 |
| Unit Cost ($/acft) | $159 | $176 | $196 | $85 | $94 | $105 |

### *4.5.15.7 The City of Wolfforth*

#### *4.5.15.7.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed

#### *4.5.15.7.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Wolfforth through 2060.

- Local groundwater development beginning in 2045 needed to supply an additional 388 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Wolfforth into which the city could locate new municipal water supply wells.

#### *4.5.15.7.3 Costs*

Costs of the recommended plan for the City of Wolfforth to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-38
   - Date to be Implemented: 2045
   - Total Project Cost: $255,698
   - Annual Cost: See Table 4.5-55 for a cost summary of this option.

***Table 4.5-55.***
***Recommended Plan Costs by Decade for the City of Wolfforth***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 165 | 388 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | 0 | 0 | 0 | 0 | 437 | 393 |
| Annual Cost ($/yr) | 0 | 0 | 0 | 0 | $47,049 | $47,049 |
| Unit Cost ($/acft) | 0 | 0 | 0 | 0 | $108 | $120 |

### *4.5.15.8 Irrigation*

#### *4.5.15 8.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 168,610 acft/yr in 2010 declining to 76,161 acft/yr in 2060.

#### *4.5.15 8.2 Water Supply Plan*

The use of irrigation BMPs in the past in Lubbock County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lubbock County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.15.3.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2012
- Total Cost: $35,280,000
- Annual Cost: $3,080,000; including debt service at 20 yrs useful life of systems (Table 4.5-56).

***Table 4.5-56.***
***Recommended Plan Costs by Decade for Irrigation – Lubbock County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 61,046 | 90,653 | 99,575 | 109,703 | 102,293 | 96,846 |
| Irrigation Conservation Quantity (acft/yr) | 48,909 | 44,018 | 39,616 | 35,655 | 32,089 | 28,880 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $3.08 | $3.08 | $3.08 | $3.08 | $3.08 | $3.08 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.16 Lynn County Water Supply Plan*

Table 4.5-57 lists each water user group in Lynn County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-57.***
***Lynn County Surplus/Shortage***

| *Water User Group* | *Surplus/Shortage*[1] *2030 (acft/yr)* | *Surplus/Shortage*[1] *2060 (acft/yr)* | *Comment* |
|---|---|---|---|
| City of O'Donnell (part) | 122 | 113 | Projected surplus |
| City of Tahoka | 44 | 39 | Projected surplus |
| City of Wilson | -65 | -55 | Projected shortage – see plan below |
| County Other | 100 | 100 | Projected surplus |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | 21,651 | 36,474 | Projected surplus – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-16, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.16.1 The City of Wilson*

##### *4.5.16.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

##### *4.5.16.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Wilson through 2060.

- Local groundwater development beginning in 2011 needed to supply an additional 55 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Wilson into which the city could locate new municipal water supply wells, and

- Purchase water from the City of Lubbock.

##### 4.5.16.1.3 Costs

Costs of the recommended plan for the City of Wilson to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-37
   - Date to be Implemented: 2012
   - Total Project Cost: $349,252
   - Annual Cost: See Table 4.5-58 for a cost summary of this option.

**Table 4.5-58.**
**Recommended Plan Costs by Decade for the City of Wilson**

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 68 | 65 | 63 | 60 | 55 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 193 | 174 | 157 | 141 | 127 |
| Annual Cost ($/yr) | — | $44,171 | $44,171 | $44,171 | $13,723 | $13,723 |
| Unit Cost ($/acft) | — | $229 | $254 | $281 | $97 | $108 |

#### 4.5.16.2 Irrigation

##### 4.5.16.2.1 Description of Supply

- **Source:** Ogallala and Edwards-Trinity Aquifers, and Reclaimed Water
- **Current Supply:** 131,397 acft/yr in 2010 declining to 122,861 acft/yr in 2060.

##### 4.5.16.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Lynn County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lynn

County irrigation farmers (Section 4.4.1.2) even though there is no projected need (shortage) during the planning period. Irrigation water conservation will contribute to extending the future life of the aquifer in the county.

#### *4.5.16.3.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2010
- Total Cost: $8,410,000
- Annual Cost: $730,000; including debt service at 20 yrs useful life of systems (Table 4.5-59).

***Table 4.5-59.***
***Recommended Plan Costs by Decade for Irrigation – Lynn County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 550 | 508 | 464 | 408 | 406 | 402 |
| Irrigation Conservation Quantity (acft/yr) | 11,660 | 10,494 | 9,445 | 8,500 | 7,650 | 6,885 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.73 | $0.73 | $0.73 | $0.73 | $0.73 | $0.73 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.17 Motley County Water Supply Plan*

Table 4.5-60 lists each water user group in Motley County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-60.***
***Motley County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Matador | 0 | 0 | No projected surplus/shortage |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -1,266 | -1,025 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-17, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

### *4.5.17.1 The City of Matador*

#### *4.5.17.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

#### *4.5.17.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Matador.

- Municipal water conservation.

#### *4.5.17.1.3 Costs*

Costs of the recommended plan for the City of Matador are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-8
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-61 for a cost summary of this option.

***Table 4.5-61.***
***Recommended Plan Costs by Decade for the City of Matador***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 20 | 37 | 49 | 57 | 63 | 62 |
| Annual Cost ($/yr) | $13,187 | $21,388 | $27,143 | $30,618 | $33,864 | $33,087 |
| Unit Cost ($/acft) | $659 | $578 | $554 | $537 | $538 | $534 |

### *4.5.17.2 Irrigation*

#### *4.5.17.2.1 Description of Supply*

- **Source:** Ogallala and Seymour Aquifers
- **Current Supply:** 7,562 acft/yr in 2010 declining to 6,616 acft/yr in 2060.

#### *4.5.17.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Motley County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Motley County irrigation farmers (Section 4.4.1.2). however, information available indicates that practically all of the presently irrigated acreages are equipped with efficient application systems. Irrigation water conservation will contribute to extending the future life of the aquifer in the county.

#### *4.5.17.3.3 Costs*

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-13A
- Date to be Implemented: Prior to 2010
- Total Cost: $640,000
- Annual Cost: $60,000; including debt service at 20 yrs useful life of systems (Table 4.5-62).

***Table 4.5-62.***
***Recommended Plan Costs by Decade for Irrigation – Motley County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 1,332 | 1,266 | 1,208 | 1,154 | 1,092 | 1,025 |
| Irrigation Conservation Quantity (acft/yr) | 886 | 798 | 718 | 646 | 582 | 523 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 | $0.06 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### 4.5.18 Parmer County Water Supply Plan

Table 4.5-63 lists each water user group in Parmer County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

**Table 4.5-63.**
**Parmer County Surplus/Shortage**

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Bovina | 0 | 0 | No projected surplus/shortage |
| City of Farwell | -46 | -106 | Projected shortage – see plan below |
| City of Friona | -384 | -431 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -361,623 | -346,700 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | -3,377 | Projected shortage |
| Dairies | -180 | -1,715 | Projected shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-18, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### 4.5.18.1 The City of Farwell

##### 4.5.18.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed

#### *4.5.18.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Farwell through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2045 needed to supply an additional 106 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Farwell into which the city could locate new municipal water supply wells.

#### *4.5.18.1.3 Costs*

Costs of the recommended plan for the City of Farwell to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-64 for a cost summary of this option.

***Table 4.5-64.***
***Recommended Plan Costs by Decade for the City of Farwell***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 1 | 46 | 80 | 99 | 106 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 33 | 64 | 94 | 101 | 97 | 91 |
| Annual Cost ($/yr) | $22,349 | $37,626 | $52,264 | $55,249 | $52,239 | $49,354 |
| Unit Cost ($/acft) | $677 | $588 | $556 | $547 | $539 | $542 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 147 | 132 | 119 | 107 | 107 |
| Annual Cost ($/yr) | — | $29,835 | $29,835 | $12,369 | $12,369 | $12,369 |
| Unit Cost ($/acft) | — | $203 | $226 | $104 | $115 | $115 |

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-21
   - Date to be Implemented: 2020

- Total Project Cost: $163,152
- Annual Cost: See Table 4.5-64 for a cost summary of this option.

### *4.5.18.2 The City of Friona*

#### *4.5.18.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

#### *4.5.18.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Friona through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2010 needed to supply an additional 431 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 4 miles from the City of Friona into which the city could locate new municipal water supply wells.

#### *4.5.18.2.3 Costs*

Costs of the recommended plan for the City of Friona to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-65 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-22
   - Date to be Implemented: 2012
   - Total Project Cost: $524,596
   - Annual Cost: See Table 4.5-65 for a cost summary of this option.

***Table 4.5-65.***
***Recommended Plan Costs by Decade for the City of Friona***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 384 | 425 | 437 | 431 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 46 | 34 | 20 | 5 | 0 | 0 |
| Annual Cost ($/yr) | $33,831 | $25,156 | $14,735 | $3,709 | - | - |
| Unit Cost ($/acft) | $735 | $740 | $737 | $742 | - | - |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | -- | -- | 419 | 753 | 678 | 610 |
| Annual Cost ($/yr) | -- | -- | $47,624 | $95,248 | $95,248 | $49,514 |
| Unit Cost ($/acft) | -- | -- | $114 | $126 | $140 | $81 |

### *4.5.18.3 Irrigation*

#### *4.5.18.4.1 Description of Supply*

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 249,653 acft/yr in 2010 declining to 38,624 acft/yr in 2060.

#### *4.5.18.4.2 Water Supply Plan*

The use of irrigation BMPs in the past in Parmer County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Parmer County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.18.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2010
   - Total Cost: $13,790,000
   - Annual Cost: $1,200,000; including debt service at 20 yrs useful life of systems (Table 4.5-66).

***Table 4.5-66.***
***Recommended Plan Costs by Decade for Irrigation and CAFOs– Parmer County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 161,382 | 331,230 | 361,623 | 357,040 | 351,465 | 346,700 |
| Irrigation Conservation Quantity (acft/yr) | 19,120 | 17,208 | 15,487 | 13,938 | 12,545 | 11,290 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $1.20 | $1.20 | $1.20 | $1.20 | $1.20 | $1.20 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |
| | | | | | | |
| Projected CAFO Need (Shortage) (acft/yr) | --- | --- | 180 | 1,546 | 3,712 | 5,092 |

### *4.5.18.4 Confined Animal Feeding Operations (CAFOs) Beef Feedyards and Dairies*

#### *4.5.18.4.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 7,595 acft/yr in 2010, increasing to 8,107 acft/yr in 2060, but with demand increasing to 5,092 more than supply available in 2060.
- Working within the planning criteria established by the LERWPG and TWDB, is not feasible to meet the CAFO (Beef Feedyards and Dairies) needs (shortages) at this time, for the following reasons: (1) the CAFOs are owned by private individuals and are located several miles apart, (2) needs (shortages) of individual CAFOs are projected to develop at different times during the planning period, such that demands for quantities of water from water management strategies (WMSs) will not arise such that the WMSs can be successfully implemented from the financial standpoints, and (3) cost estimates of water management strategies evaluated appear to be in excess of affordability for CAFOs (Section 4.4.3.9). In addition, at the present time, it does not appear that there are organizations available to the CAFOs that have authority to implement water management strategies to deliver the needed water.

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### *4.5.19 Swisher County Water Supply Plan*

Table 4.5-67 lists each water user group in Swisher County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-67.***
***Swisher County Surplus/Shortage***

| *Water User Group* | *Surplus/Shortage*[1] 2030 (acft/yr) | 2060 (acft/yr) | *Comment* |
|---|---|---|---|
| City of Happy | 0 | 0 | No projected surplus/shortage |
| City of Kress | 60 | 24 | No projected shortage |
| City of Tulia | -417 | -417 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected demand |
| Irrigation | -95,875 | -107,533 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected surplus/shortage |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-19, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.19.1 The City of Tulia*

##### *4.5.19.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

##### *4.5.19.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Tulia through 2060.

- Municipal water conservation; and
- Local groundwater development beginning in 2011 needed to supply an additional 417 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Tulia into which the city could locate new municipal water supply wells.

#### *4.5.19.1.3 Costs*

Costs of the recommended plan for the City of Tulia are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-68 for a cost summary of this option.

***Table 4.5-68.***
***Recommended Plan Costs by Decade for the City of Tulia***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 417 | 417 | 417 | 417 | 417 | 417 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 18 | 0 | 0 | 0 | 0 | 0 |
| Annual Cost ($/yr) | $13,283 | — | — | — | — | — |
| Unit Cost ($/acft) | $738 | — | — | — | — | — |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | 432 | 778 | 700 | 630 | 567 | 510 |
| Annual Cost ($/yr) | $134,743 | $180,162 | $180,162 | $57,533 | $57,533 | $57,533 |
| Unit Cost ($/acft) | $312 | $232 | $257 | $91 | $101 | $113 |

Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):

- Cost Source: Section 4.4.2, Table 4.4-36
- Date to be Implemented: 2012
- Total Project Cost: $1,406,624
- Annual Cost: See Table 4.5-68 for a cost summary of this option.

### *4.5.19.2 Irrigation*

#### *4.5.19.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 148,846 acft/yr in 2010 declining to 58,842 acft/yr in 2060.

#### *4.5.19.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Swisher County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Swisher County irrigation farmers (Section 4.4.1.2), which is projected to meet the irrigation needs through 2020. However, it is not economically feasible to meet all of the irrigation needs (shortages) beyond 2020, at this time.

#### *4.5.19.2.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $37,880,000
   - Annual Cost: $3,300,000; including debt service at 20 yrs useful life of systems (Table 4.5-69).

***Table 4.5-69.***
***Recommended Plan Costs by Decade for Irrigation – Swisher County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 22,646 | 60,423 | 95,875 | 105,385 | 107,602 | 107,533 |
| Irrigation Conservation Quantity (acft/yr) | 52,517 | 47,266 | 42,539 | 38,285 | 34,457 | 31,011 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $3.30 | $3.30 | $3.30 | $3.30 | $3.30 | $3.30 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.20 Terry County Water Supply Plan*

Table 4.5-70 lists each water user group in Terry County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-70.***
***Terry County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| City of Brownfield | -280 | -457 | Projected shortage – see plan below |
| City of Meadow | 0 | 0 | No projected surplus/shortage |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected surplus/shortage |
| Steam Electric | 0 | 0 | No projected demand |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -101,067 | -89,755 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-20, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

### *4.5.20.1 The City of Brownfield*

#### *4.5.20.1.1 Description of Supply*

- **Source:** Ogallala Aquifer and Canadian River Municipal Water Authority
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

#### *4.5.20.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Brownfield through 2060.

- Municipal water conservation,
- Expand supplies from CRMWA.

#### *4.5.20.1.3 Costs*

Costs of the recommended plan for the City of Brownfield to meet 2060 shortages are:

a. Municipal water conservation:
  - Cost Source: Section 4.4.1, Table 4.4-8
  - Date to be Implemented: Prior to 2012
  - Annual Cost: See Table 4.5-71 for a cost summary of this option.

b. Expand Supplies from CRMWA:
  - Cost Source: Section 4.4.3.5, Table 4.4-53.
  - Date to be Implemented: Prior to 2012
  - Total Project Cost: Purchase at per acre-foot cost from CRMWA (Based on calculation of Brownfield share of CRMWA supply at 1.56 percent, or 494 acft/yr)
  - Annual Cost: See Table 4.5-71 for a cost summary of this option.

***Table 4.5-71.***
***Recommended Plan Costs by Decade for the City of Brownfield***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 115 | 280 | 435 | 458 | 457 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 211 | 448 | 687 | 802 | 793 | 788 |
| Annual Cost ($/yr) | $142,485 | $261,914 | $380,644 | $433,686 | $425,849 | $423,482 |
| Unit Cost ($/acft) | $675 | $585 | $554 | $541 | $537 | $537 |
| **Expand Supplies from CRMWA *** | | | | | | |
| Quantity Available (acft/yr)* | 494 | 494 | 494 | 494 | 494 | 494 |
| Annual Cost ($/yr)* | % of total | % | % | % | % | % of total |
| Unit Cost ($/acft)* | $282 | $282 | $282 | $282 | $282 | $282 |
| * See 4.5.20.1.3 c, above. Adjusted to September 2008 prices is $282 per acft. | | | | | | |

### *4.5.20.2 Irrigation*

#### *4.5.20.2.1 Description of Supply*

- **Source:** Ogallala Aquifer

- **Current Supply:** 117,837 acft/yr in 2010 declining to 58,377 acft/yr in 2060.

#### *4.5.20.2.2 Water Supply Plan*

The use of irrigation BMPs in the past in Terry County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Terry County irrigation farmers (Section 4.4.1.2), however, information available indicates that nearly all of presently irrigated acres are equipped with efficient application systems, thus, there is very little potential for additional irrigation conservation through use of this water management strategy. As is the case elsewhere in Region O, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.20.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $9,580,000
   - Annual Cost: $840,000; including debt service at 20 yrs useful life of systems (Table 4.5-72).

***Table 4.5-72.***
***Recommended Plan Costs by Decade for Irrigation – Terry County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 74,888 | 91,977 | 101,067 | 106,240 | 97,749 | 89,755 |
| Irrigation Conservation Quantity (acft/yr) | 13,285 | 11,956 | 10,760 | 9,684 | 8,716 | 7,844 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.84 | $0.84 | $0.84 | $0.84 | $0.84 | $0.84 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

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### *4.5.21 Yoakum County Water Supply Plan*

Table 4.5-73 lists each water user group in Yoakum County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

***Table 4.5-73.***
***Yoakum County Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] 2030 (acft/yr) | Surplus/Shortage[1] 2060 (acft/yr) | Comment |
|---|---|---|---|
| City of Denver City | -979 | -1,000 | Projected shortage – see plan below |
| City of Plains | -468 | -457 | Projected shortage – see plan below |
| County Other | 0 | 0 | No projected surplus/shortage |
| Industrial | 0 | 0 | No projected demand |
| Steam Electric | 0 | 0 | No projected surplus/shortage |
| Mining | 0 | 0 | No projected surplus/shortage |
| Irrigation | -21,868 | -18,502 | Projected shortage – see plan below |
| Beef Feedlot Livestock | 0 | 0 | No projected demand |
| Range & All Other Livestock | 0 | 0 | No projected surplus/shortage |

[1] From Table 4-21, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

#### *4.5.21.1 The City of Denver City*

##### *4.5.21.1.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

##### *4.5.21.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Denver City through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2021 needed to supply an additional 1,000 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 14 miles from the City of Denver City into which the city could locate new municipal water supply wells.

#### *4.5.21.1.3 Costs*

Costs of the recommended plan for the City of Denver City to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-74 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-18
   - Date to be Implemented: 2021
   - Total Project Cost: $786,894
   - Annual Cost: See Table 4.5-74 for a cost summary of this option.

***Table 4.5-74.***
***Recommended Plan Costs by Decade for the City of Denver City***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 979 | 1,046 | 1,024 | 1,000 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 77 | 169 | 179 | 171 | 160 | 155 |
| Annual Cost ($/yr) | $54,309 | $100,614 | $102,694 | $95,011 | $88,085 | $85,093 |
| Unit Cost ($/acft) | $705 | $595 | $574 | $556 | $551 | $549 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | — | 1,283 | 1,154 | 1,039 | 935 |
| Annual Cost ($/yr) | — | — | $142,872 | $142,872 | $142,872 | $74,271 |
| Unit Cost ($/acft) | — | — | $111 | $124 | $138 | $79 |

### *4.5.21.2 The City of Plains*

#### *4.5.21.2.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

#### *4.5.21.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Plains through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2012 needed to supply an additional 457 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Plains into which the city could locate new municipal water supply wells.

#### *4.5.21.2.3 Costs*

Costs of the recommended plan for the City of Plains to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-8
   - Date to be Implemented: Prior to 2012
   - Annual Cost: See Table 4.5-75 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-30
   - Date to be Implemented: 2012
   - Total Project Cost: $1,186,082
   - Annual Cost: See Table 4.5-75 for a cost summary of this option.

***Table 4.5-75.***
***Recommended Plan Costs by Decade for the City of Plains***

| ***Plan Element*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 448 | 468 | 488 | 473 | 457 |
| **Municipal Water Conservation** | | | | | | |
| Quantity Available (acft/yr) | 33 | 68 | 106 | 107 | 102 | 98 |
| Annual Cost ($/yr) | $22,840 | $40,237 | $59,512 | $58,404 | $55,219 | $53,358 |
| Unit Cost ($/acft) | $692 | $592 | $561 | $546 | $541 | $544 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 618 | 556 | 501 | 600 | 539 |
| Annual Cost ($/yr) | — | $127,819 | $127,819 | $127,819 | $71,716 | $71,716 |
| Unit Cost ($/acft) | — | $207 | $230 | $255 | $120 | $133 |

### *4.5.21.3 Irrigation*

#### *4.5.21.3.1 Description of Supply*

- **Source:** Ogallala Aquifer
- **Current Supply:** 97,200 acft/yr in 2010 declining to 76,640 acft/yr in 2060.

#### *4.5.21.3.2 Water Supply Plan*

The use of irrigation BMPs in the past in Yoakum County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Yoakum County irrigation farmers (Section 4.4.1.2), however, information available indicates that nearly all of presently irrigated acres are equipped with efficient application systems, thus, there is very little potential for additional irrigation conservation through use of this water management strategy. As is the case elsewhere in Region O, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

#### *4.5.21.3.3 Costs*

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-13A
   - Date to be Implemented: Prior to 2012
   - Total Cost: $7,510,000

- Annual Cost: $65,000; including debt service at 20 yrs useful life of systems (Table 4.5-76).

***Table 4.5-76.***
***Recommended Plan Costs by Decade for Irrigation – Yoakum County***

| Plan Element | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|
| Projected Irrigation Need (Shortage) (acft/yr) | 23,779 | 22,744 | 21,868 | 20,553 | 19,576 | 18,502 |
| Irrigation Conservation Quantity (acft/yr) | 10,407 | 9,366 | 8,429 | 7,587 | 6,828 | 6,145 |
| Annual Cost (million dollars/yr) (Table 4.4-13A) | $0.65 | $0.65 | $0.65 | $0.65 | $0.65 | $0.65 |
| Unit Cost ($/acft) (Table 4.4-13B) | $63 | $70 | $78 | $86 | $96 | $106 |

### *4.5.22 Water Supply Plans for Wholesale Water Providers*

Table 4.5-77 lists each Wholesale Water Provider identified by the LERWPG and their corresponding surplus or shortage in years 2030 and 2060. Water supply plans that have been developed for CRMWA, City of Lubbock, and WRMWD are described below. Mackenzie Municipal Water Authority is also projected to have a shortage during the planning period; however no plan has been developed for this entity. Instead, a plan to develop locally available groundwater has been developed for each of the MMWA customers with a projected need.

***Table 4.5-77. Wholesale Water Provider Surplus/Shortage***

| Water User Group | Surplus/Shortage[1] | | Comment |
|---|---|---|---|
| | 2030 (acft/yr) | 2060 (acft/yr) | |
| Canadian River Municipal Water Authority (CRMWA) | | | Projected shortage of main pipeline capacity at southern customer locations |
| City of Lubbock | 13,454 | 20,649 | Projected shortage – see plan below. |
| Mackenzie Municipal Water Authority (MMWA) | -2,128 | -1,936 | Projected shortage – see comment above. |
| White River Municipal Water District (WRMWD) | -686 | -1,489 | Projected shortage – see plan below. |

[1] From Table 4-23, Section 4.2 – Water Needs Projections by Major Water Provider.

#### *4.5.22.1 Canadian River Municipal Water Authority (CRMWA)(See Section 4.4.3.10)*

##### *4.5.22.1.1 Description of Supply*

- **Source:** Ogallala Aquifer and Lake Meredith.
- **Current Supply:** Adequate to meet demands, but subject to pipeline capacity limitations in southernmost reaches of delivery system.

##### *4.5.22.1.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the CRMWA System.

- Add Capacity of Groundwater Supply to meet needs of 7 southernmost located CRMWA customers in Region O.

#### *4.5.22.1.3 Costs*

Costs of the recommended plan for CRMWA are:

- Cost Source: Section 4.4.3.10 Table 4.4-69 and Table 4.4-70.
- Date to be Implemented: Prior to 2030.
- Total Project Cost: $56,574,000. (Well Fields 2 and 2A)
- Annual Cost: See Table 4.5-78 for a cost summary of this option.

***Table 4.5-78.***
***Recommended Plan Costs by Decade for the Canadian River Municipal Water Authority***

| *Plan Element* | *2010* | *2020* | *2030* | *2040* | *2050* | *2060* |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | -- | -- | -- | -- | -- | -- |
| **CRMWA Expand Groundwater Supply** | | | | | | |
| Quantity Available (acft/yr) | -- | -- | 15,700 | 14,130 | 12,717 | 11,445 |
| Annual Cost ($/yr) (millions) | -- | -- | $5.8 | $5.8 | $5.8 | $5.8 |
| Unit Cost ($/acft) | -- | -- | $370 | $412 | $456 | $507 |

### *4.5.22.2 The City of Lubbock (See Sections 4.4.3 and 4.5.15.3)*

#### *4.5.22.2.1 Description of Supply*

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2015.

#### *4.5.22.2.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation,
- Lake Alan Henry Supply to Lubbock,
- Jim Bertram Lake System Expansion - Lake 7,
- Lubbock North Fork Diversion Operation,
- Post Reservoir, and
- Lubbock Brackish Groundwater Desalination.

#### *4.5.22.2.3 Costs*

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:

- Cost Source: Section 4.4.1, Table 4.4-8
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-51 for a cost summary of this option.

b. Lake Alan Henry Supply to Lubbock:
- Cost Source: Section 4.4.3.2, Table 4.4-41.
- Date to be Implemented: Prior to 2020.
- Total Project Cost: $294,329,000.
- Annual Cost: See Table 4.5-41 for a cost summary of this option.

c. Lubbock Jim Bertram Lake System Expansion – Lake 7
- Cost Source: Section 4.4.3.3. Table 4.4-46
- Date to be Implemented:  2020.
- Total Project Cost: $68,288,000
- Annual Cost: See Table 4.5-79 for a cost summary of this option.

d. Post Reservoir
- Cost Source: Section 4.4.3.5
- Date to be Implemented:  2030
- Total Project Cost: $110,307,000
- Annual Cost: See Table 4.5-79 for a cost summary of this option.

e. Lubbock North Fork Diversion Operation
- Cost Source: Section 4.4.3.4. Table 4.4-51
- Date to be Implemented:  2045
- Total Project Cost: $153,040,000
- Annual Cost: See Table 4.5-79 for a cost summary of this option.

f. Lubbock Brackish Groundwater Desalination
- Cost Source: Section 4.4.3.6, Table 4.4-57
- Date to be Implemented:  2020
- Total Project Cost: $13,167,230
- Annual Cost: See Table 4.5-79 for a cost summary of this option.

***Table 4.5-79.***
***Estimated Plan Costs by Decade for the City of Lubbock***

| ***Plan Element*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 8,602 | 10,496 | 13,454 | 15,765 | 19,333 | 20,649 |
| **Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)** | | | | | | |
| Quantity Available (acft/yr) | 4,132 | 7,662 | 7,112 | 6,441 | 6,256 | 6,405 |
| Annual Cost ($/yr) (millions) | $2.710 | $4.473 | $4.073 | $3.599 | $3.462 | $3.545 |
| Unit Cost ($/acft) | $656 | $583 | $572 | $559 | $553 | $554 |
| **Lake Alan Henry Supply to Lubbock** | | | | | | |
| Quantity Available (acft/yr) | 0 | 21,880 | 21,880 | 21,880 | 21,880 | 21,880 |
| Annual Cost ($/yr) (millions) | — | $28.655 | $28.655 | $28.655 | $28.655 | $28.655 |
| Unit Cost ($/acft) | — | $1,310 | $1,310 | $1,310 | $1,310 | $1,310 |
| **Lubbock Jim Bertram Lake System Expansion - Lake 7** | | | | | | |
| Quantity Available (acft/yr) | 0 | 17,650 | 17,650 | 17,650 | 17,650 | 17,650 |
| Annual Cost ($/yr) (millions) | — | $7.956 | $7.956 | $7.956 | $7.956 | $7.956 |
| Unit Cost ($/acft) | __ | $451 | $451 | $451 | $451 | $451 |
| **Post Reservoir** | | | | | | |
| Quantity Available (acft/yr) | 0 | 0 | 22,270 | 22,270 | 22,270 | 22,270 |
| Annual Cost ($/yr) (millions) | — | — | $15,786 | $15,786 | $15,786 | $15,786 |
| Unit Cost ($/acft) | __ | __ | $695 | $695 | $695 | $695 |
| **Lubbock North Fork Diversion Operation** | | | | | | |
| Quantity Available (acft/yr) | 0 | 0 | 0 | 0 | 3,675 | 3,675 |
| Annual Cost ($/yr) (millions) | — | — | — | — | $23.298 | $23.298 |
| Unit Cost ($/acft) | __ | __ | __ | __ | $6,340 | $6,340 |
| **Lubbock Brackish Groundwater Desalination** | | | | | | |
| Quantity Available (acft/yr) | 0 | 3,360 | 3,360 | 3,360 | 3,360 | 3,360 |
| Annual Cost ($/yr) (millions) | — | $2.418 | $2.418 | $2.418 | $2.418 | $2.418 |
| Unit Cost ($/acft) | — | $720 | $720 | $720 | $720 | $720 |

### *4.5.22.3 White River Municipal Water District (See Section 4.4.3.7)*

#### *4.5.22.3.1 Description of Supply*

- **Source:** White River Lake
- **Current Supply:** Adequate to meet demands through 2010.

#### *4.5.22.3.2 Water Supply Plan*

Working within the planning criteria established by the LERWPG and TWDB, the following water supply plan is recommended for the White River Municipal Water District.

- Municipal water conservation, and
- Reclaimed Water, and
- Local groundwater development by 2012 on land owned by the District in Crosby County.

#### *4.5.22.3.3 Costs*

Costs of the recommended plan for the White River Municipal Water District are:

a. Reclaimed Water:

- Cost Source: Section 4.4.3.7, table 4.4-58
- Date to be Implemented: Prior to 2020
- Total Project Cost: $38,089,684
- Annual Cost: See Table 4.5-80 for a cost summary of this option.

b. Local groundwater development (see Section 4.4.3.8 for a cost summary of this option).

- Cost Source: Section 4.4.3.8, Table 4.4-59
- Date to be Implemented: 2012
- Total Project Cost: $1,063,625
- Annual Cost: See Table 4.5-80 for a cost summary of this option.

***Table 4.5-80.***
***Recommended Plan Costs by Decade for the White River Municipal Water District****

| ***Plan Element*** | ***2010*** | ***2020*** | ***2030*** | ***2040*** | ***2050*** | ***2060*** |
|---|---|---|---|---|---|---|
| Projected Shortage (acft/yr) | 0 | 0 | 0 | 0 | 0 | 0 |
| **Municipal Water Conservation (By Member Cities)** | | | | | | |
| Quantity Available (acft/yr) | 21 | 42 | 54 | 50 | 48 | 48 |
| Annual Cost ($/yr) | $14,847 | $24,654 | $30,132 | $27,450 | $25,680 | $25,680 |
| Unit Cost ($/acft) | $707 | $587 | $558 | $549 | $535 | $535 |
| **Reclaimed Water*** | | | | | | |
| Quantity Available (acft/yr) | — | 2,240 | 2,240 | 2,240 | 2,240 | 2,240 |
| Annual Cost ($/yr) (millions) | — | $3.567 | $3.567 | $3.567 | $3.567 | $3.567 |
| Unit Cost ($/acft) | — | $1,593 | $1,593 | $1,593 | $1,593 | $1,593 |
| **Local Groundwater Development** | | | | | | |
| Quantity Available (acft/yr) | — | 7,742 | 7,742 | 7,742 | 7,742 | 7,742 |
| Annual Cost ($/yr) | — | $345,308 | $345,308 | $345,308 | $345,308 | $345,308 |
| Unit Cost ($/acft) | — | $45 | $45 | $45 | $45 | $45 |

* This water management strategy augments the quantity of water that can be obtained from White River Lake for diversion to the District's existing water treatment plant located at the lake. The purpose of the WMS is to maintain the District's capability to supply water to its member cities.

### *4.5.23 Region-Wide Water Management Strategies Included in the Llano Estacado Water Plan*

#### *4.5.23.1 Precipitation Enhancement (See Section 4.4.4.1 for a description of this option)*

Weather modification is included in the Llano Estacado Regional Water Plan. Weather modification, or precipitation enhancement, has the potential to increase the quantity of water that would be available to all water user groups in the Llano Estacado Region, as well as reduce pumpage requirements from the Ogallala Aquifer. Several cloud seeding operations are being carried out in Texas, including the Southern Ogallala Rainfall Enhancement (SOAR) program, which includes 2.3 million acres in Gaines, Terry, and Yoakum Counties at an annual cost of $109,200, or 4.7 cents per acre per year.

Although available data and cloud seeding experience are not adequate to give reliable estimates of long-term increases in precipitation, the present information indicates that precipitation can be increased by cloud seeding. For the 3,593 square mile (2,300,000-acre)

SOAR area, an increase in precipitation of one and one-half inches would result in an increase of about 287,500 acft of water per year to the land surface. At a cost of 4.7 cents per acre, the cost per acft of water is $0.38.

Additional precipitation during the growing season, which is the period during which present cloud seeding projects are operated, would directly and immediately benefit dryland and irrigated agriculture. Crop and grazing yields will be increased, irrigation water pumped from the Ogallala Aquifer can be reduced, and lawn irrigation can be reduced. The latter effect will contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additionally, increased runoff could increase the water supply in public water supply reservoirs. An increase of water supply in playa lakes would increase natural recharge and provide water for wildlife.

#### *4.5.23.2 Brush Control (See Section 4.4.4.2 for a description of this option)*

Brush control is included in the Llano Estacado Regional Water Plan. Brush control could increase water supply in the Llano Estacado Region by increasing the runoff into lakes and reservoirs. The areas of the region where significant concentrations of brush occur are in the east "caprock counties" and in the western counties. In addition, there are approximately one million acres in the U.S. Department of Agriculture's (USDA) Conservation Reserve Program (CRP) located within the region. As the current contracts with USDA expire on these CRP areas and as the USDA programs change, some of the land may be returned to cultivated row crops; however, some of the land is expected to remain in grass. If these grassland acres are not managed to prevent brush infestation, these areas could become brush covered and thereby further contribute to the brush problem of the region.

Of the 21 counties in the region, 13 counties meet the condition of having 50,000 or more acres of mesquite and shinnery oak combined. The counties located in the southwest corner of the region and along the caprock have the highest acreages of mesquite and shinnery oak and would primarily be the locations where brush control can be applied to increase water supplies. As has been demonstrated in Crosby County on the White River Reservoir watershed, brush control can contribute to increased inflows to a reservoir. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. Brush control projects on the watersheds of these two reservoirs could result in increased firm yields and thereby contribute to the region's water supply.

The capital outlay to implement brush control upon 50 percent of the mesquite and shinnery oak infested acres in counties having more than 50,000 acres of these two species of brush is estimated at $53.33 million, with an annual cost of $3.53 million (see Section 4.4.4.2 for a discussion of costing assumptions and procedures). For example, if brush control were to be implemented on the Alan Henry Reservoir contributing watershed, the annual cost would be approximately $425,324. If the yield of the reservoir were increased by 10 percent, or 2,250 acft/yr, the cost per acft of raw water yield at the reservoir would be $189, or $0.57 per thousand gallons. The owners of the Alan Henry Reservoir and the proposed Post Reservoir should cooperate with the landowners of the watersheds and the Texas State Soil and Water Conservation Board to implement brush control on these watersheds.

#### *4.5.23.3 Desalt Brackish Groundwater (See Section 4.4.4.3 for a description of this option)*

Desalting brackish groundwater is included in the Llano Estacado Regional Water Plan. The potential source of water for this option is the Santa Rosa Aquifer of the Dockum Formation, which underlies the entire area of the Llano Estacado Water Planning Region. Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment, including most municipal and irrigation uses. Cost estimates are presented for two levels of feedwater salinity—3,000 mg/L and 5,000 mg/L, and three water treatment plant sizes—0.2 MGD, 1.0 MGD, and 3.0 MGD, and include costs of obtaining untreated (raw) brackish groundwater for the desalination plants, and costs of concentrate disposal. The cost per acft for a 0.2 MGD plant to desalt 3,000 mg/L water is estimated at $1,047 per acft, or $3.21 per 1,000 gallons (Table 4.4-81), with total cost including raw water desalination, and concentrate disposal of $2,412 per acft, or $7.40 per 1,000 gallons (Table 4.4-81). The cost for a 0.2 MGD plant to desalt 5,000 mg/L water is estimated at $1,232 per acft, or $3.78 per 1,000 gallons (Table 4.4-82), with a total cost of water, including raw water, desalination, and concentrate disposal of $2,597 per acft, or $7.97 per 1,000 gallons (Table 4.4-82).

At larger sized water treatment plants, the costs are lower. For a 1.0 MGD plant the cost to desalt 3,000 mg/L water is estimated at $630 per acft, or $1.93 per 1,000 gallons; the cost to desalt 5,000 mg/L water is estimated at $714 per acft, or $2.19 per 1,000 gallons (Tables 4.4-81 and 4.4-82, respectively). A 3.0 MGD size plant is estimated to have a desalt cost of $473 per acft, or $1.45 per 1,000 gallons for water with 3,000 mg/L of salts, and for water with 5,000 mg/L of salts, the cost is $546 per acft, or $1.68 per 1,000 gallons (Tables 4.4-81 and 4.4-82, respectively).

Total cost of desalted water, including raw water, desalination, and concentrate disposal for a 1.0 MGD size facility to desalt 3,000 mg/L water is $1,825 per acft ($5.60 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,909 per acft ($5.86 per 1,000 gallons) Tables 4.4-81 and 4.4-82, respectively). Total cost of desalted water, including raw water, desalination, and concentrate disposal for a 3.0 MGD size facility to desalt 3,000 mg/L water is $1,601 per acft ($3.85 per 1,000 gallons), and to desalt 5,000 mg/L water is $1,618 per acft ($4.96 per 1,000 gallons) (Tables 4.4-81 and 4.4-82, respectively).

#### *4.5.23.4 Research and Development of Drought Tolerant Crops and New Technology (See Section 4.4.4.5 for a description of this option)*

Research and development of drought tolerant crops, new technology, and demonstration initiatives to expedite transfer of available technology to are included in the Llano Estacado Regional Water Plan. In addition, the Llano Estacado Regional Water Planning Group recommends that funding be continued at adequate levels to accomplish these objectives.

#### *4.5.23.5 Reuse of Municipal Effluent (See Section 4.4.4.6 for a description of this option)*

Of the total quantities of water used for municipal purposes, approximately 45 percent to 65 percent is returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Water Planning Region a large percentage of this treated effluent or reclaimed water is used for irrigation of open spaces, golf courses, and neighboring farmland. The quantity is between 45 percent and 65 percent of the quantity of municipal use and could be a significant source of water in the future for a number of uses, including perhaps municipal use, if treatment levels can be increased to the extent that the use of such water does not pose a health risk. The Llano Estacado Regional Water Planning Group recommends that funding be made available to universities, water districts, and the cities to further study the quantity of water available from this option and to study treatment technologies to make this option feasible for a larger number of uses.

#### *4.5.23.6 Stormwater Capture and Use (See Section 4.4.4.7 for a description of this option)*

In some cities of the Llano Estacado Water Planning Region, disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, as appropriate and needed, and use this water as a source of supply for non-potable, as well as potable uses. The Llano Estacado Regional Water Planning Group recommends that funding be made available to the cities and water districts to further study the quantity of water available from this option and to study ways to successfully integrate flood protection, storage, and treatment, as needed, of this stormwater for useful purposes.

#### *4.5.23.7 Agricultural Water Conservation Practices on Farms (See Section 4.4.1.2 for a description of this option)*

Agricultural water conservation practices on farms are included in the Llano Estacado Regional Water Plan in order to sustain the present water supplies, enhance agricultural profitability, and enhance playa basins for wildlife habitat and aquifer recharge. In the Llano Estacado Region, both irrigation and non-irrigated, or dryland farming is projected. For the most part, the irrigated acreages are those acres lying above saturated sections of the Ogallala Formation that have sufficient quantities of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Irrigated and dryland farming attempt to maximize the efficiency of use of irrigation water and precipitation in the area. This is done through the use of Low Energy Precision Application (LEPA) and Low Elevation Sprinkler (LESA) irrigation systems, furrow diking, plant residue management, bench leveling, and terracing.

### *4.5.24 Public Education*

Underground water conservation districts, cities, universities, the Texas Agricultural Extension Service and other water agencies will continue existing education and information dissemination programs. In addition, Llano Estacado Region water suppliers and agencies will build a strong cooperative relationship with formal and informal educators including the region's Educational Service Centers and Independent School Districts.

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### *4.5.25 Drought and Drought Response*

Water supplies are included in Section 3 of the Llano Estacado Regional Water Plan as firm yields during drought of record for surface water sources, and dependable supplies during drought of record for groundwater sources, i.e., drought of record conditions underlie the calculations of water supply available from each source, included in Section 3 for each water user group. Therefore, each source of supply is for drought conditions. In addition, in accordance with requirements of SB 1, TCEQ has required retail water suppliers to prepare drought contingency plans. However, Texas Water Code Section 16.053(e)(3)(A) and 31 TAC 357.5(e)(7) require that for each source of water supply in the regional water planning area designated in accordance with 31 TAC 357.7(a)(1), the regional water plan shall identify: (A) factors specific to each source of water supply to be considered in determining whether to initiate a drought response, and (B) actions to be taken as part of the response.

Given that the major source of water for all uses in the Llano Estacado Region is the Ogallala Aquifer, with surface water from the Canadian River Municipal Water Authority, White River Municipal Water District, and Mackenzie Municipal Water Authority, for some municipal and industrial uses, the effects of drought are through increased demands upon the water supply facilities to provide larger quantities of water from each water supply source. For example, in the region, demands increase during droughts, placing ever-greater demands upon wells, pumps, motors, storage facilities, and the aquifer and surface water reservoirs. Therefore, the primary factor specific to each water supply is atmosphere conditions affecting precipitation, evaporation, and evapotranspiration. Thus, when atmospheric conditions result in: (1) reduced precipitation and (2) increased evaporation and evapotranspiration, the Llano Estacado Regional Water Plan recommendation is that drought response be initiated as described below.

Drought Trigger Conditions will be based on local atmospheric conditions using the currently available potential evaporation-transpiration (PET) stations. For the purposes of this planning cycle, it is recommended that local precipitation be factored into the consideration of implementing a drought trigger. Recommended drought triggers are presented as follows.

#### *4.5.25.1 Drought Triggers*

**Alert Stage of Drought**: Precipitation at less than 50 percent of the 30-year average for the month and 55 percent of the 30-year average of the preceding twelve months.

**Warning Stage of Drought**: Precipitation at less than 25 percent of the 30 year average for the month and 45 percent of the 30 year average of the preceding twelve months.

The Llano Estacado Water Planning Area will be divided into geographical areas based on location of existing PET stations for drought trigger and response purposes. The current locations of a PET stations within Region O are Dimmitt, Earth, Farwell, Halfway, Lamesa, Lubbock, and Seminole.

The drought trigger and response zones in the Llano Estacado Water Planning Area are shown in Table 4.5-81.

***Table 4.5-81.***
***Drought Trigger and Response Zones***
***in the Llano Estacado Water Planning Area***

| *PET Stations* | *Counties* |
|---|---|
| Dimmitt | Castro, Deaf Smith, and Swisher |
| Earth | Cochran and Lamb |
| Farwell | Bailey and Parmer |
| Halfway | Briscoe, Floyd, Hale, and Motley |
| Lamesa | Dawson, Garza, and Lynn |
| Lubbock | Crosby, Dickens, Hockley, and Lubbock |
| Seminole | Gaines, Terry, and Yoakum |

### *4.5.25.2 Drought Response*

As the LERWPG is a planning body only, with no implementation authority, it is emphasized that these drought triggers and responses are recommendations only. Since local public water suppliers and water districts are all required to have adopted a Drought Contingency Plan that contains drought responses unique to each specific entity, these entities are the only ones who have the authority to manage their particular water supply or area of authority. Therefore, the LERWPG recommends that these entities carry out their respective plans based upon the triggers listed above.

For example:

1. When the Alert Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the

relevant geographical area. Those entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

2. When the Warning Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. These entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

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# Section 5
# Impacts of Water Management Strategies on Key Parameters of Water Quality [31 TAC §357.7(a)(12)] and Impacts of Moving Water from Rural and Agricultural Areas [31 TAC §357.7(a)(8)(G)]

## 5.1 Impacts of Water Management Strategies on Key Parameters of Water Quality

In accordance with Regional Water Planning Guidelines 357.7(a)(12), at its November 20, 2003, meeting, the LERWPG identified the following list of key parameters of water quality as important to the use of the water resource:

- Chlorides;
- Sulfates;
- Nitrates;
- Fluoride;
- Arsenic;
- Total Dissolved Solids (TDS);
- Dissolved Oxygen (DO);
- pH Range;
- Indicator Bacteria; and
- Temperature.

The uses of the water resources in the Llano Estacado Region were identified as follows:

- Recreation;
- Aquatic Life;
- Domestic Water Supply;
- Agriculture – Crop Irrigation ;
- Agriculture – Livestock Water; and
- Agribusiness.

The water management strategies included in the Regional Water Plan are:

- Municipal Water Conservation;
- Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply;
- Water Supply from Lake Alan Henry and Groundwater Sources;
- Precipitation Enhancement;
- Brush Control;
- Desalt Brackish Groundwater;
- Post Reservoir-Raw Water at the Reservoir;
- Research and Development of Drought Tolerant Crops and New Technology;
- Reuse of Municipal Effluent for Potable Water Supply; and
- Stormwater Capture, Treatment, and Use.

**Municipal Water Conservation:** The municipal water conservation water management strategy is projected to have the potential to meet approximately 10,583 acft/yr of municipal water demand in 2020, 10,264 acft/yr in 2040, and 10,424 acft/yr in 2060 (Table 4.4-7). This water management strategy would not affect the key water quality parameters listed above.

**Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply:** This water management strategy involves the addition of water wells and/or well fields by 24 municipalities of the region. In most cases, this strategy is the expansion of municipal supplies from existing sources available to each respective city (Section 4.4.2). However, in some cases it will be necessary for the individual municipality to obtain locations for additional well fields in nearby locations. As was determined in the analyses, in all but three cases adequate saturated formation exists within a 2- to 5-mile radius of each city, respectively, to locate new well fields. For the other three, the distances are between 6 and 14 miles. In effect, this water management strategy is a continuation of existing practices which have shown no indication of affecting the water quality parameters listed above. In addition, the quality of the water available is suitable for the intended municipal use.

**Water Supply from Lake Alan Henry and Groundwater Sources**: The use of Lake Alan Henry water may have the potential to result in slight increases in chlorides, sulfates, and TDS in the downstream reaches of the stream on which it is located. The expansion of groundwater uses from wells in Lubbock's Bailey County well field, and groundwater sources being obtained by CRMWA from locations in Region A would not be expected to affect the water quality parameters identified above.

**Precipitation Enhancement:** This strategy is an attempt to increase precipitation within parts of the Llano Estacado Region, and as such is not expected to affect the water quality parameters identified above.

**Brush Control**: This strategy is an attempt to reduce the undesirable use of both ground and surface water by a range of woody species, and thereby increase the quantities of water available for all other uses. This strategy is not expected to affect the water quality parameters identified above.

**Desalt Brackish Groundwater**: This strategy relies upon the use of source water for municipal uses which is lower in quality than other source waters now being used and/or included in other water management strategies. The return flows of municipal effluent from the use of this water management strategy may be higher in chlorides, sulfates, and TDS, than return flows from other source waters now being used and/or included in other water management strategies, depending upon the level of demineralization of the brackish groundwater.

**Post Reservoir–Raw Water at the Reservoir**: This strategy would result in a new source of surface water, which is not expected to affect the water quality parameters listed above.

**Research and Development of Drought-Tolerant Crops and New Technology**: This strategy involves the invention of new water using or water using related technology and as such cannot be evaluated as to potential effects upon the water quality parameters listed above until the specified techniques are known.

**Reuse of Municipal Effluent for Potable Water Supply**: This strategy proposes to reuse municipal effluent whose quality is lower than the original source water. Therefore, the water will have to be demineralized before it can be used for potable purposes, and depending upon the degree of demineralization, would be expected to have higher concentrations of water quality constituents than presently used sources. The resulting return flows would also be higher in many of the water quality parameters listed above, including chlorides, sulfates, nitrates, and TDS.

**Stormwater Capture, Treatment, and Use**: As is the case with municipal effluent, this strategy proposes to capture, treat and make available for use stormwater for municipal uses within the region. The quality of stormwater depends upon the drainage areas from which it is captured. In the case of lakes and reservoirs such as Alan Henry and Post, the quality is usually high and is the type of water for which there is extensive, successful experience with treatment and use. In the case of stormwater runoff from urban areas, the quality may be poor due to transport of urban pollutants such as oil, grease, pesticides, insecticides, and bacteria. Treatment of such water will be required, and the quality of the resulting water and its return flows depends directly upon the degree of treatment given.

## *5.2 Impacts of Moving Water from Rural and Agricultural Areas*

Total water use in the Llano Estacado Region in year 2000 was reported at 4.530 million acft, with projected demands of 3.704 million acft in 2060. Of the total projected demands, irrigated agriculture and livestock uses are more than 95 percent; with municipal use in the 2 to 2.5 percent range over the planning period. Supplies available are projected to decline from 3.20 million acft in 2010 to 1.46 million acft in 2060. Recommended water management strategies for municipal uses would result in the development of approximately 8,300 acft/yr from local groundwater sources or about 0.26 percent of total supply available on an annual basis in 2010, and 0.56 percent of total supply available in 2060. Of this total, about 50 percent (4,150 acft/yr) would be from existing well fields that were obtained many years ago by municipalities for municipal uses, and about 50 percent (4,150 acft/yr) would be transferred from rural and agricultural areas to municipal areas through the acquisition of additional sites for well fields in approximately 12 to 15 widely dispersed locations near to the municipalities that acquire them. The impacts of these transfers are not considered to be significant to the local areas, however, to the extent that such transfers reduce water supplies available to irrigated agriculture and/or livestock or dairies, the economic impacts would result in lower levels of farm production and farm incomes, and would reduce business to agricultural input suppliers and agricultural marketing establishments; i.e.; the adverse results would extend throughout the local economy including third party agricultural service, finance, and marketing sectors of the local region.

## 5.3 Impacts of Limited Water Quantity Upon Irrigated Agriculture[1]

The water supply projections of Section 3.0 show that the total quantity of water available for use in the region from the Ogallala aquifer was 4,501,390 acft/yr in year 2000, declining to 3,054,897 (68% of quantity in 2000) acft/yr in year 2010, 1,960,641 (43% of level in 2000) acft/yr in year 2030, and to 1,328,057 (30% of quantity in 2000) acft/yr in 2060 (Table 5-1). The analyses also show that the Ogallala aquifer is the major source of water supply available to the region, supplying 96 percent of the total in year 2000, 95 percent in 2010, 93 percent in 2030, and 89 percent in 2060.

The water demand and supply analyses in Section 4.0 for the water user groups of the region show that the quantity of water available from the Ogallala aquifer for irrigated agriculture was 4,411,987 (98% of the total) acft/yr in year 2000, 2,951,555 acft/yr (96% of the total) in year 2010, 1,851,051 acft/yr (93.6% of the total) in year 2030, and 1,219,946 acft/yr (90.68% of the total) in year 2060. This projection of the declining trend of supply available to irrigated agriculture from year 2000 of 33 percent by year 2010, 58 percent by year 2030, and 70 percent by year 2060 indicates that the irrigated agriculture water using sector of the region faces

[1]This Subsection has been added in response to TWDB Comments on Initially Prepared 2011 Region O Regional Water Plan, "Pages 1-66 through 1-69, Section 1.8; pages 5-1 through 5-3, Section 5.1: Please clarify in the plan whether any existing threats of limited water quantity with respect to irrigated agriculture were considered (page 1-66) and whether such a threat would be addressed or affected by the recommended water management strategies (page 5-1). *[Title 31 Texas Administrative Code (TAC) §357.7 (a)(1)(L) and (a)(8)(C)]*

a steady decline in supply of irrigation water. The comparisons of projected irrigation water demand and supply showed needs (shortages) of irrigation water in 2010 of 1,264,707 acft/yr (30% of projected demand) in 2010, 2,069,096 acft/yr (53.29% of projected demand) in 2030, and 2,306,561 acft/yr (66.39% of projected demand) in 2060. The socioeconomic impact analysis of not meeting irrigation water needs, shows lost income and taxes in 2010 of $370.55 million, $943.44 million annually in 2030, and $1.102 billion annually in 2060.

**Table 5-1**
**Projected Irrigation Water Demands and Supplies**
**Llano Estacado Region**

| | Projections | | | | | | |
|---|---|---|---|---|---|---|---|
| **Region** | **2000** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Total Ogallala Supply** | 4,501,390 | 3,054,897 | 2,436,556 | 1,960,641 | 1,569,152 | 1,405,760 | 1,328,057 |
| **Irrigation Supply from Ogallala** | 4,411,987 | 2,940,692 | 2,306,484 | 1,835,653 | 1,450,037 | 1,287,327 | 1,204,352 |
| **Irrigation Water Demand** | 4,347,877 | 4,186,018 | 4,024,942 | 3,882,780 | 3,740,678 | 3,604,568 | 3,474,163 |
| **Supply As Percent of Demand** | 101.47% | 70.25% | 57.30% | 47.28% | 38.76% | 35.71% | 34.67% |
| **Irrigation Water Need (Shortage)** | NA | 1,264,707 | 1,735,400 | 2,069,069 | 2,317,589 | 2,349,096 | 2,306,561 |
| **Shortage as Percent of Demand** | | 30.21% | 43.12% | 53.29% | 61.96% | 65.17% | 66.39% |
| **Irrigation Water Conservation** | NA | 479,465 | 431,517 | 388,365 | 349,529 | 314,576 | 283,118 |
| **Irrigation Water Conservation as Percent of Need** | NA | 37.91% | 24.87% | 18.77% | 15.08% | 13.39% | 12.27% |
| **Supply with Water Conservation** | Na | 3,420,157 | 2,738,001 | 2,224,018 | 1,799,566 | 1,601,903 | 1,487,470 |
| **Supply with Water Conservation as Percent of Demand** | NA | 81.70% | 68.03% | 57.28% | 48.11% | 44.44% | 42.82% |

During the development of the 2011 Llano Estacado Regional Water Plan, irrigation water conservation was identified as a water management strategy, and is included in the plan. The irrigation water conservation water management strategy has the potential to offset 479,466 acft/yr, or 37.91 percent of the projected need in year 2010, 388,366 acft/yr, or 18.77 percent of the projected need in 2030, and 283,118 acft/yr, or 12.27 percent of the projected need in 2060 (Table 5-1).

The results of declining water supplies available to irrigated agriculture will be reduced numbers of acres irrigated, reduced levels of irrigation water applied per acre, or a combination of reduced irrigated acreages and application rates, both of which will adversely affect the local, regional, state, and national economies.

The Region O Water Planning Group recognizes that the quantity of water available from the High Plains Ogallala aquifer is declining, however with the implementation of water conservation strategies; the longevity of the Ogallala can be appreciably extended. Ground water is an exceedingly valuable asset to all of the Region O landowners and water rights holders, whether agricultural, municipal or industrial, and justifies implementation of all currently available water conservation strategies and technologies, including refinements thereto, and all strategies which may be developed in the future.

# *Section 6*
# *Consolidated Water Conservation and Drought Management Recommendations for the Regional Water Plan*
# *[31 TAC §357.7(a)(11)]*

## *6.1 Municipal Water Conservation (See Section 4.4.1.1)*

### 6.1.1 Municipal Water Conservation Water Management Strategy

Municipal water conservation is included in the Llano Estacado Regional Water Plan. The objective of the municipal water conservation option is to reduce per capita water use at a rate of 1 percent per year for those municipalities with projected needs (shortages) until the municipality's per capita water use is at year 2000 region-wide average per capita water use of 172 gpcd. The potentials for municipal water conservation in addition to that expected from the continued use of low flow plumbing fixtures in the Llano Estacado Region are about 10,424 acft/yr in 2060, or about 9.8 percent of the projected 2060 municipal demand. Although the potential is modest, it is very important that municipal water conservation continue to be emphasized through active public information and education programs in the public schools, through the media, and at the individual water utility levels. With respect to the latter, it is suggested that each water utility of the region measure its water distribution system leaks and unaccounted for water and set goals to bring this parameter into the 12 to 15 percent range. In addition, during droughts municipalities are expected to follow their respective Demand Management and Drought Contingency Plans and to practice additional water conservation, if needed.

### 6.1.2 Survey of Implementation of Municipal Water Conservation Water Management Strategies in Llano Estacado Water Planning region

The LERWPG included the municipal water conservation survey presented below in order to obtain information about the extent of the implementation of municipal and irrigation water conservation water management strategies included in the 2006 Llano Estacado Regional Water Plan. During the summer of 2009, a mail survey of the 51 municipalities of the Llano Estacado Water Planning Region was conducted to obtain information about the extent and success of municipal water conservation programs that are being implemented in the region. The survey form contained the following list of questions:

(1) When was your current water conservation plan initiated?
(2) What water conservation program(s) are currently being implemented by your organization?
(3) What is the percent reduction in water consumption attributed to your water conservation program, as measured by either average or peak gallons per person (or connection) per day consumption?
(5) What is the primary objective of your water conservation program?
(6) Is your organization already implementing any of the voluntary BMPs (list provided)?
(7) Of those not being currently implemented, is your organization interested in pursuing any of the 13 BMPs listed?
(8) If so, which ones?
(9) If not, please describe why (please check all that apply)?
(10) Would you like a follow-up phone call to discuss specific best management practices, or water conservation assistance programs?

The TWDB Municipal Water Conservation Best Management Practices (BMPs) list of November 2004 was included with the survey form, as follows:

1. System Water Audit and Water Loss;
2. Water Conservation Pricing;
3. Prohibition on Wasting Water;
4. Showerhead, Aerator, and Toilet Flapper Retrofit;
5. Residential Toilet Replacement Programs;
6. School Education ;
7. Water Survey for Single- Family and Multi-Family Customers;
8. Landscape Irrigation Conservation and Incentives and Water Wise Landscape Design and Conservation Programs;
9. Metering of All New Connections and Retrofit of Existing Connections
10. Public Information;
11. Rainwater Harvesting and Condensate Reuse; and
12. New Construction Graywater (or Retrofit of Existing Households); and
13. Conservation Programs for Industrial, Commercial, and Institutional Accounts.

Of the 51 municipal water users to which the survey was sent, 43 responded, for a response rate of 84 percent. Of those responding, one reported that it has a drought contingency plan and one indicated that it does not have a water conservation plan.

**Dates Water Conservation Plans Implemented**: The dates of implementation of water conservation plans, as reported in the survey, ranged from one (1) in 1989, the earliest, to 4 between 1990 and 2000, 6 in 2000, 5 during 2001 to 2003, 7 between 2004 and 2006, 6 during 2007 and 2008, 5 in 2009, and 7 did not provide a date of plan implementation (see List A below).

**List A: Date Water Conservation Plan Implemented**

| Date Plan Implemented | Number |
|---|---|
| Before 1990 | 1 |
| 1990 to 1999 | 4 |
| 2000 | 6 |
| 2001 to 2003 | 5 |
| 2004 to 2006 | 7 |
| 2007 to 2008 | 6 |
| 2009 | 5 |
| No Date Given | 7 |
| No Plan | 2 |
| Total | 43 |

**Water Conservation Practices Used**: The survey response to water conservation practices and programs being used indicates that public information, leak detection, repair, and monitoring, and meter testing, repair, and replacement are the main water conservation practices in use within the region, with plumbing retrofit being used by only one respondent (see listing below). Meter testing, repair, and replacement was used by 81 percent of the respondents, Leak detection, repair, and monitoring was used by 67 percent of respondents, and 65 percent used public information (see list B below). Of the total respondents, 21 or 49 percent reported that the following three water conservation practices (Public Information, Leak Detection, Repair, and Monitoring, and Meter Testing, Repair, and Replacement) were being used.

**List B: Water Conservation Practices Being Used**

| Water Conservation Practices Used | Number of Users |
|---|---|
| Public Information | 28 |
| Showerhead/Aerator/Toilet Flapper Retrofit | 1 |
| Leak Detection, Repair, Monitoring | 29 |
| Meter Testing/Repair/Replacement | 35 |
| Landscape Irrigation Conservation | 6 |
| Other (please specify) (water audit, line upgrades, school education, and tiered rates | 5 |

**Water Conservation Budget**: To the question, "What is the current budget for water conservation programs, or what is water conservation budget as prevent of total water budget?" 11 (25 percent) of the 43 municipalities surveyed did not provide a response, 10 (23 percent) responded that the budget for water conservation was zero, 4 (9 percent) responded that the water conservation budget was less than 1 percent of the water budget, 13 (30 percent) indicated that the budget for water conservation ranged between 1 percent and 10 percent of the water budget, and 4 (9 percent) responded that the water conservation budget was greater than 10 percent of the water budget.

**Reduction in Water Use Through Water Conservation**: The survey response to the question pertaining to reduction in water use due to water conservation programs ranged from a response that no reduction had been accomplished (39) percent of respondents, to 15 to 20 percent reduction by one respondent (see List C below). Three respondents indicated that the effects of water conservation programs has been a reduction in leaks of as much as 20 percent, one respondent indicated that water conservation is being practiced to control water rates, and one respondent indicated that water conservation is being used for something other than reduction of water use, but did not indicate what the "other purpose" is.

**List C: Reduction in Water Use**

| **Percent Reduction in Water Use** | **Number of Users** |
|---|---|
| Zero (0) | 17 (39%) |
| 1 to 5 | 15 (35%) |
| 5 to 10 | 4 (9) |
| 15 to 20 | 1 (2.3%) |
| Other Results | 3 (6.9%) |
| No Plan/No Response | 3 (6.9%) |
| Total | 43 |

**Primary Objectives of Water Conservation:** The response to the question of primary purpose of water conservation programs indicated that 67 percent of respondents are using water conservation programs to reduce unaccounted for water, about 41 percent are attempting to reduce per capita water use, 39 percent are attempting to reduce peak demands, and 41 percent have more than one of the objectives listed (see List D below).

**List D: Primary Objectives of Water Conservation**

| **Objectives of Water Conservation** | **Number of Users** |
|---|---|
| Reduce Peak Demands | 17 (39%) |
| Reduce Per Capita Water Use | 18 (41%) |
| Reduce Unaccounted for Water | 29 (67%) |
| Other | 0 |
| More than one objective | 18 (41%) |

**Implementation of Best Management Water Conservation Practices (BMPs):** With respect to questions about use or implementation of the TWDB Water Conservation Best Management Practices (BMPs) listed in the survey, 21 (49 percent) indicated that the BMPs are being implemented, 10 (23 percent) responded that the BMPs were not being implemented, and 12 did not respond to the question. With regard to "interest in implementing BMPs," 14 (32 percent) responded that they are interested, 14 (32 percent) responded that they are not interested in implementing BMPs, 14 (32 percent) responded "maybe," and one did not respond to the question. The respondents indicated that the BMPs of most interest are (10) Public Information, (11) Rainwater Harvesting and Condensate Use, (12) Graywater in New Construction, (9) Metering of all New Connections, and (6) School Education. Five respondents indicated an interest in BMP Number 2, Water Conservation Pricing, and two expressed interest in Number 5, Residential Toilet Replacement.

**Reasons for Lack of Interest in Best Management Practices (BMPs):** Of the responses to this question, 22 (51 percent) indicated that cost was the reason for lack of interest, 20 (46 percent) indicated that lack of staff was the reason, 9 (21 percent) indicated that impact to revenues was the reason, 3 (7 percent) indicated that water supply is not susceptible to drought, and 4 (9 percent) indicated that existing water conservation program is effective.

**Summary of Results of Water Conservation Survey:** The response rate to the municipal water conservation survey was 84 percent (43 of 51). Of the 43 respondents, 5 (12 percent) have water conservation plans that were implemented before year 2000, 5 (12 percent) were implemented in 2009, 18 (42 percent) were implemented between 2001 and 2008, 2 (4 percent) have no water conservation plan, and 7 (16 percent) did not give did not indicated the date of plan implementation.

The principal water conservation practices used by the survey respondents are Public Information, Leak Detection, Repair, and Monitoring, and Meter Testing, Repair, and

Replacement. Approximately 40 percent of respondents indicated that water conservation is not reducing water use, 35 percent of respondents indicate water use reductions of 1-5 percent, and one respondent reported reductions of 15 to 20 percent.

The reported principle objectives of water conservation are to Reduce Peak Reduce Unaccounted for Water (67 percent), Reduce Per Capita Water Use (41 percent) and Reduce Peak Demands (39 percent). Twenty-one (49 percent) of respondents indicated that the BMPs are being implemented, According to the survey, the BMPs of most interest are (10) Public Information, (11) Rainwater Harvesting and Condensate Use, (12) Graywater in New Construction, (9) Metering of all New Connections, and (6) School Education. Five respondents indicated an interest in BMP Number 2, Water Conservation Pricing, and two expressed interest in Number 5, Residential toilet Replacement. Reasons given for lack of interest in BMPs were cost (51 percent of respondents), lack of staff (49 percent of respondents), and impact to revenues (21 percent of respondents).

## *6.2 Irrigation Water Conservation (See Section 4.4.1.2)*

### 6.2.1 Irrigation Water Conservation Water Management Strategy

The use of agricultural water conservation BMPs on farms, and an irrigation water conservation water management strategy are included in the Llano Estacado Regional Water Plan in order to sustain the present water supplies, enhance agricultural profitability, and enhance playa basins for wildlife habitat and aquifer recharge. In the Llano Estacado Region, both irrigation and non-irrigated (dryland farming) is practiced. For the most part, the irrigated acreages are those acres lying above saturated sections of the Ogallala aquifer that have sufficient quantities of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Irrigated and dryland farming attempts to maximize the efficiency of use of irrigation water and precipitation in the area. This is done through the use of Irrigation BMPs, including LEPA and LESA irrigation systems, in conjunction with furrow diking and plant residue management. The Irrigation Water Conservation Water Management Strategy included in the 2006 Llano Estacado Regional Water Plan was that irrigation producers of crops install and use Center Pivots (LEPA or LISA) for the application of irrigation water. LEPA (Low Energy

Precision Application Systems) is a center pivot application system that discharges water directly into furrows at low pressure, thus reducing evaporation losses. LESAs (Low Elevation Spray Application Sprinklers) are center pivot and lateral move low elevation/pressure sprinklers that spray water downward above the crops as the sprinkler systems move across the fields. When LEPA and LESA systems are used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water behind small mounds of earth within the furrows, these systems can accomplish the irrigation objective with less water than is required for the furrow irrigation and pressurized sprinkler methods.

### 6.2.2 Extent of Implementation of Irrigation Water Conservation Water Management Strategies in Llano Estacado Water Planning Region

Using year 2004 infrared orthographic imagery and ESRI ArcView 9.0, the High Plains Underground Water Conservation District No. 1, showed that in the Llano Estacado Region in 2004, there were 17,482 center pivots irrigating approximately 2.36 million acres, or 71.88 percent of irrigated acres in the region in 2004.[1] However, approximately 982,511 irrigated acres in the region were not being irrigated using efficient center pivot or drip systems, and some farmers were not using other available water conservation practices, as identified and recommended by the Water Conservation Implementation Task Force and the Llano Estacado Regional Water Planning Group.

In 2009, the High Plains Underground Water Conservation District No. 1, performed a similar survey to that of 2004 of counties of the Llano Estacado Water Planning Region using infrared orthographic imagery and ESRI ArcView, which showed that in 2008, there were 18,619 center pivots irrigating approximately 2.49 million acres (Table 6-1).[2] Between 2004 and 2008, the number of center pivots increased from 17,482 to 18,619 (1,137 or 6.5 percent), with an increase in acres irrigated with center pivots from 2,359,980 acres to 2,494,823 acres, an increase of 134,843 acres, or 5.7 percent (Table 6-1). Although the number of center pivots and acreages irrigated using center pivots increased between 2004 and 2008, there were decreases in 4 counties (Bailey, Garza, Hockley, and Terry). The decrease in Terry County is reported to be conversion to dryland production.

[1] Center Pivot Inventory, High Plains Underground Water Conservation District No. 1. October 2005.
[2] Ibid.

**Table 6-1**
**Number of Center Pivots and Acreages Irrigated Using Center Pivots**
**Llano Estacado Region**

| | *Number of Center Pivots* | | | *Acres Irrigated with Center Pivots* | | |
|---|---|---|---|---|---|---|
| ***County*** | ***2004*** | ***2008*** | ***Change*** | ***2004*** | ***2008*** | ***Change*** |
| ***(A)*** | ***(B)*** | ***(C)*** | ***2004/2008*** | ***(D)*** | ***(E)*** | ***2004/2008*** |
| Bailey | 768 | 739 | -29 | 92,598 | 88,786 | -3,812 |
| Briscoe | 110 | 163 | 53 | 13,216 | 18,422 | 5,206 |
| Castro | 1,378 | 1,459 | 81 | 218,174 | 225,398 | 7,224 |
| Cochran | 615 | 666 | 51 | 81,849 | 86,093 | 4,244 |
| Crosby | 551 | 588 | 37 | 74,712 | 79,942 | 5,230 |
| Dawson | 595 | 647 | 52 | 72,250 | 75,543 | 3,293 |
| Deaf Smith | 845 | 896 | 51 | 134,741 | 142,549 | 7,808 |
| Dickens | 44 | 47 | 3 | 4,166 | 4,670 | 504 |
| Floyd | 541 | 705 | 164 | 79,587 | 100,308 | 20,721 |
| Gaines | 2,101 | 2,179 | 78 | 324,545 | 330,425 | 5,880 |
| Garza | 35 | 27 | -8 | 4,457 | 3,311 | -1,146 |
| Hale | 1,631 | 1,823 | 192 | 221,739 | 242,062 | 20,323 |
| Hockley | 931 | 906 | -25 | 109,440 | 105,949 | -3,491 |
| Lamb | 1,737 | 1,835 | 98 | 207,064 | 216,776 | 9,712 |
| Lubbock | 743 | 830 | 87 | 94,691 | 102,392 | 7,701 |
| Lynn | 497 | 572 | 75 | 61,053 | 69,482 | 8,429 |
| Motley | 53 | 61 | 8 | 5,500 | 6,974 | 1,474 |
| Parmer | 1,788 | 1,792 | 4 | 217,754 | 216,213 | -1,541 |
| Swisher | 371 | 467 | 96 | 65,626 | 83,343 | 19,717 |
| Terry | 1,409 | 1,392 | -17 | 171,193 | 169,128 | -2,065 |
| Yoakum | 739 | 825 | 86 | 105,625 | 127,057 | 21,432 |
| Total | 17,482 | 18,619 | 1,137 | 2,359,980 | 2,494,823 | 134,843 |

Based upon the results of the survey using infrared orthographic imagery and ESRI ArcView of number of center pivots, as described above and as shown in Table 6-1, it appears that the recommended irrigation water conservation management strategy is being implemented in the Llano Estacado Water Planning Region, with the resulting water conserved being a contribution toward somewhat reducing the projected water shortages for the irrigation water user group.

### *6.3 Drought and Drought Response*

Water supplies are included in Section 3 of the Llano Estacado Regional Water Plan as firm yields during drought of record for surface water sources, and dependable supplies during drought of record for groundwater sources (i.e., drought of record conditions underlie the calculations of water supply available from each source included in Section 3 for each water user group). Therefore, each source of supply is for drought conditions. In addition, in accordance with requirements of Senate Bill 2, TCEQ has required retail water suppliers to prepare drought contingency plans.

Given that the major source of water for all uses in the Llano Estacado Region is the Ogallala Aquifer, with surface water from the Canadian River Municipal Water Authority, White River Municipal Water District, and Mackenzie Municipal Water Authority for some municipal and industrial uses, the effects of drought are through reduced flows of surface water into existing water supply lakes and increased demands upon the water supply facilities to provide larger quantities of water from each water supply source. For example, in the region, demands increase during droughts, placing ever-greater demands upon wells, pumps, motors, storage facilities, and the aquifer and surface water reservoirs. Therefore, the primary factor specific to each water supply is atmosphere conditions affecting precipitation, evaporation, and evapotranspiration. Thus, when atmospheric conditions result in: (1) reduced precipitation and (2) increased evaporation and evapotranspiration, the Llano Estacado Regional Water Plan recommendation is that drought response be initiated as described below.

Drought Trigger Conditions will be based on local atmospheric conditions using the currently available PET stations. For the purposes of this planning cycle, it is recommended that local precipitation be factored into the consideration of implementing a drought trigger. Recommended drought triggers are presented as follows.

- **Alert Stage of Drought**: Precipitation at less than 50 percent of the 30-year average for the month and 55 percent of the 30-year average of the preceding 12 months.
- **Warning Stage of Drought**: Precipitation at less than 25 percent of the 30-year average for the month and 45 percent of the 30-year average of the preceding 12 months.

The Llano Estacado Water Planning Area is divided into geographical areas based upon location of existing PET stations for drought trigger and response purposes. The current locations of PET stations within Region O are Dimmitt, Earth, Farwell, Halfway, Lamesa, Lubbock, and

Seminole. The drought trigger and response zones in the Llano Estacado Water Planning Area are shown in Table 6-2.

***Table 6-2.***
***Drought Trigger and Response Zones***
***in the Llano Estacado Water Planning Area***

| ***PET Stations*** | ***Counties*** |
|---|---|
| Dimmitt | Castro, Deaf Smith, and Swisher |
| Earth | Cochran and Lamb |
| Farwell | Bailey and Parmer |
| Halfway | Briscoe, Floyd, Hale, and Motley |
| Lamesa | Dawson, Garza, and Lynn |
| Lubbock | Crosby, Dickens, Hockley, and Lubbock |
| Seminole | Gaines, Terry, and Yoakum |

## *6.4 Drought Response*

As the LERWPG is a planning body only, with no implementation authority, it is emphasized that these drought triggers and responses are recommendations only. Since local public water suppliers and water districts are all required to have adopted a Drought Contingency Plan that contains drought responses unique to each specific entity, these entities are the only ones who have the authority to manage their particular water supply or area of authority. Therefore, the LERWPG recommends that these entities carry out their respective plans based upon the triggers listed above. For Example:

When the Alert Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. Those entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

When the Warning Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. It is recommended that these entities exercise their respective authority(ies) to implement their own Drought Contingency Plans, as they deem necessary.

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# Section 7
# Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources [31 TAC §357.7(a)(13) and §357.14(2)(C)]

The 2011 Llano Estacado Regional Water Plan (2011 Plan) is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources and is developed based on guidance principles outlined in the Texas Administrative Code Chapter 358-State Water Planning Guidelines. The 2011 Plan was produced with an understanding of the importance of orderly development, management, and conservation of water resources and is consistent with laws applicable to water use for the state and regional water planning areas. In the case of groundwater, the 2011 Plan recognizes principles for groundwater use in Texas and the programs of groundwater conservation districts within the Llano Estacado Region. The rules of groundwater conservation districts in the region and the programs of water conservation districts were followed when determining groundwater availability.

The 2011 Plan identifies actions and policies necessary to meet the Region's projected municipal, industrial, steam-electric power, mining, and livestock needs, by developing and recommending water management strategies to meet their needs with reasonable cost, and good water quality. However, even with an irrigation water conservation water management strategy, it was not possible to meet all of the projected needs of irrigated agriculture. A socioeconomic impact analysis was performed to estimate the economic loss associated with not meeting these needs (Appendix C).

The 2011 Plan considered environmental information resulting from site-specific studies and ongoing water development projects when evaluating water management strategies. A list of endangered and threatened species in the Llano Estacado Region for each county was obtained from the U.S. Fish and Wildlife Service and these possible habitats were considered for each water management strategy (Appendix A).

The 2011 Plan consists of water conservation initiatives, and initiatives to respond to drought conditions by the municipal water user group, and the use of water conservation best BMPs in the irrigation water use group was described in terms of how these BMPs have resulted in high water use efficiency by this WUG.

The LERWPG conducted several meetings during the 2011 planning cycle, with meetings open to the public, and the LERWPG's decisions were based upon the best available information. The Region coordinated water planning and management activities with local, regional, state, and federal agencies and cooperated with Region A (Panhandle Region) to identify common needs. The LERWPG considered recommendations of stream segments with unique ecological value by Texas Parks and Wildlife. At this time, the LERWPG recommends that no stream segments or reservoir sites with unique ecological value be designated. The Planning Group developed policy recommendations for the 2011 Plan including improved water demand and water supply data, continued support for the Rule of Capture as modified by the Rules and Regulations of existing underground water conservation districts, continued funding for regional water planning, and especially that the Legislature provide adequate funding for the implementation of water management strategies of the plan.

# Section 8
# Unique Stream Segments/Reservoir Sites/ Legislative Recommendations
# [31 TAC §357.7(a)(8-9); 31 TAC §357.8; and 31 TAC §357.9]

## 8.1 Identification of Unique Ecological Stream Segments and Reservoir Sites

The Llano Estacado Regional Water Planning Group (LERWPG) does not recommend any stream segments within the planning area for designation as stream segments of unique ecological value. In 2001, with the passage of HB 3096, the 77th Texas Legislature designated the Post Reservoir Site as a unique reservoir site.[1] The LERWPG continues to support this designation with the inclusion of Post Reservoir as a component of the Strategies to meet water supply needs for the City of Lubbock and White River Municipal Water District.

## 8.2 Legislative and Administrative Recommendations

1. Since the completion of the 2001 Llano Estacado Regional Water Plan, it has been clear both within this region and statewide that if the regional water plans are going to be implemented within the needed timeframe, some level of state financial assistance will be required. The LERWPG strongly supports the funding provided by the 80th and 81st Texas Legislatures in 2007 and 2009 for funding projects in the 2007 State Water Plan. Furthermore, the LERWPG recommends that the Texas Legislature identify a dedicated source of revenue for funding projects in the regional and state water plans so that future generations of Texans will have reliable, affordable, and sufficient water supplies. The funds could include low interest loans, direct grants, or cost-sharing arrangements. High priority items include public water supply, watershed management, water conservation, and development of drought-tolerant crops and more efficient irrigation strategies.

2. The 2011 Llano Estacado Regional Water Plan completes the third round of regional water planning. After three rounds of planning, we have reached a point of diminishing benefits in the recognition that the 2011 Llano Estacado Regional Water Plan is primarily an update of the 2006 plan. We believe the planning process needs to be expanded to allow for the evaluation of additional region-specific planning options. This change will allow planning groups to

participate more directly in the development of the most likely future supply and demand projections for the region. The current procedure requires the planning groups to focus on closing hypothetical gaps between projected water demands and supplies at various points in time, but when the group does not agree with the projections provided by the TWDB, the experiences of the past planning cycles have greatly improved the ability of the LERWPG to participate in the discussion of realistic forecast scenarios.

3. The next round of water planning must incorporate the desired future conditions (DFCs) that are adopted for the Groundwater Management Areas (GMAs). After the Managed Available Groundwater (MAG) amounts are set, the GMA policies will establish the distribution of that supply over the DFC time period. That distribution of supply will replace the current projections of groundwater supply in the 2011 plan. Obviously, any changes in the planning process need to be identified early in the planning cycle to allow the RWPGs the maximum time to consider the options that best fit their regional needs. Since changes to the planning process do not require legislative action, we recommend that this review proceed now with a goal of having a revised planning process defined by the end of 2010.

4. The LERWPG recommends that the planning process be reviewed by a representative stakeholder group made up of planning group members from across the state, and then revised to better capture region-specific characteristics throughout the planning process. Possible revisions may include more alternative scenario analysis on both the demand and supply side of the process. Changed conditions resulting from the potential impact of climate change and policy changes such as those made through the 2008 Farm Bill may have dramatic affects on the Llano Estacado Planning Region, and as such, should be a more fundamental component of the planning process than currently allowed.

5. The LERWPG recommends that the Texas Legislature continue to support the regional water planning effort and to provide funding for the following.

a. The implementation of water management strategies and water conservation incentives for water user groups in the plan, including loans for public water supplies, precipitation enhancement, brush management, water conservation, and research/development of drought tolerant species and more efficient technology.

b. Increased public awareness and education regarding water supply issues including water conservation.

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[1] Kretzschmar, Gilbert E, P.E,, Samuel Vaugh, P.E., Robert Perkins, P.E., Robert Brandes, Ph.D.,P.E.,Richard D. Purkeypile, P.E., Thomas C. Gooch, P.E., Simone f. Kiel, P.E., and Barney Austin, "Reservoir Site Protection Study," (Report 370) Texas Water Development Board, Austin, Texas, July 2008.

c. Continued funding and support of basic water data collection, processing, and analysis of basic data needed to continually update and improve our understanding of surface water and groundwater resources.

d. Continued funding and support of the ongoing development and improvements to the TWDB's Groundwater Availability Models for the major and minor aquifers of Texas. We fully appreciate and recognize the importance of systematic review, integration of new data and affects of changed conditions, re-calibration and re-verification of these models, and feel it imperative that funding for this effort is sustained.

e. Implementation of a statewide public awareness program for water conservation achievements.

f. Continuation and funding of the Water Conservation Advisory Council.

6. The LERWPG supports the Water Conservation Advisory Council efforts to develop standardized methodologies, definitions, and data for characterizing and computing per capita daily water use and other water use metrics.

7. The LERWPG continues to support the following recommendations from the 2006 Llano Estacado Regional Water Plan.

a. Support the Rule of Capture as modified by the rules and regulations of existing underground water conservation districts.

b. Support the state's policy that groundwater conservation districts are the preferred method of managing groundwater and support the creation and operation of groundwater conservation districts that are organized and function under Chapter 36 of the Texas Water Code.

c. Urge the Texas Legislature <u>**not**</u> to empower the regional water planning groups with any water management or regulatory authority.

d. Support the continued funding by the Texas Legislature of studies to achieve a better understanding of the recharge mechanisms of the Ogallala Aquifer.

8. The LERWPG supports and encourages the development and voluntary use of Best Management Practices (BMPs) to improve recharge and to protect playa basins from siltation, including creation and preservation of native grass buffers on land surrounding playas to maintain their water holding capacity. The Texas Water Development Board's BMP guide (Report 362, 2004) should be updated and new BMPs added to provide a valuable resource for those developing water management plans and practicing water conservation.

9. The LERWPG supports controlling aquatic vegetation as a water conservation practice, and particularly supports and encourages the Canadian River Municipal Water Authority's efforts of controlling salt cedar along the Canadian River drainage above Lake Meredith as a means to increase water flow to the reservoir for water supply and environmental purposes. Further, we encourage similar controls be applied to other watersheds regionally, including those of Lake MacKenzie, White River Lake, and Lake Alan Henry.

10. Finally, the LERWPG supports voluntary protection of springs and seeps as they exist and encourages landowners to use best management practices to maintain remnant springs and seeps in the region.

# Section 9
# Report to the Legislature on
# Water Infrastructure Funding Recommendations
# [31 TAC §357.7(a)(14)]

## 9.1 Introduction

Senate Bill 2 (77th Texas Legislature) requires that an Infrastructure Financing Report (IFR) be incorporated into the regional water planning process. In order to meet this requirement, each regional water planning group (RWPG) is required to examine the funding needed to implement the water management strategies and projects identified and recommended in the region's January 2006 regional water plan.

## 9.2 Objectives of the Infrastructure Financing Report

The primary objectives of the Infrastructure Financing Report are as follows:

- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

## 9.3 Methods and Procedures

For the Llano Estacado Water Planning Area, all municipal water user groups having water needs and recommended water management strategies in the regional plan with an associated capital cost were surveyed using the questionnaire provided by the TWDB (Appendix H). For individual cities the survey was mailed to either the mayor or the city manager.

The surveys were mailed via first class U.S. Mail, along with supporting documentation that summarized the water management strategies included in the regional plan for that entity. One follow-up telephone contact was made with each municipal water user surveyed that did not respond by the due date. In all cases, copies of the survey information and forms were e-mailed to those contacted via telephone.

## 9.4 Survey Responses

The Llano Estacado RWPG mailed survey packages to 32 municipal water user groups and received 17 responses, a 53 percent response rate. The list of respondents is included in Table 9-

1, and copies of the completed surveys and related documentation are included in Appendix I. As shown in Table 9-1, the estimated cost of water management strategies of the 17 survey respondents is $690.96 million, which is about 90.70 percent of the estimated $761.54 million of capital costs for water management strategies included in the Regional Water Plan for municipal water user groups. The respondents indicated that $117.54 million is needed from the TWDB funding programs, with $74.56 million needed for planning, design, and permitting, $34.95 million needed for acquisition and construction, $0.06 million needed from the excess capacity fund, $1.18 million needed for Rural categories, and $6.79 million needed from the "disadvantaged" fund (Table 9-1).

The list of non-respondents, in alphabetical order, is as follows:

| | | | |
|---|---|---|---|
| Amherst | Anton | Friona | Hale Center |
| Kress | Littlefield | Lockney | Petersburg |
| Plainview | Seagraves | Shallowater | Sudan |
| Sundown | Tulia | Wolfforth. | |

The Canadian River Municipal Water Authority (CRMWA) responded to the IFR Survey in Region A.

**Table 9-1**
**Summary of Infrastructure Financing Survey Responses ***
**Llano Estacado Region**

| Name of Political Subdvisions | Recommended Water Management Strategy | Date Needed | Cost (Dollars) | Funding Needed From TWDB Programs: Planning Design & Permitting (Dollars) | Acquisition and Construction (Dollars) | Excess Capacity (Dollars) | Rural (Dollars) | Disadv-antaged (Dollars) | Total (Dollars) |
|---|---|---|---|---|---|---|---|---|---|
| City of Lubbock | Lake Alan Henry Pipeline | 2010 | 294,329,000 | 33,491,000 | | | | | 33,491,000 |
| City of Lubbock | Post Reservoir to LAH Pipeline | 2010 | 110,307,000 | 8,000,000 | | | | | 8,000,000 |
| City of Lubbock | Brackish Groundwater Desalt | 2012 | 13,167,000 | 1,000,000 | | | | | 1,000,000 |
| City of Lubbock | Jim Bertram Lake 7 | 2011 | 68,288,400 | 8,000,000 | | | | | 8,000,000 |
| City of Lubbock | North Fork Diversion | 2013 | 153,040,000 | 15,000,000 | | | | | 15,000,000 |
| Abernathy | Local Groundwater | 2013 | 699,732 | 69,973 | 629,759 | | | | 699,732 |
| Ropesville | Local Groundwater | 2012 | 349,252 | 34,925 | 314,327 | | | | 349,252 |
| Idalou | Local Groundwater | 2015 | 770,132 | 77,013 | 693,119 | | | | 770,132 |
| Farwell | Local Groundwater | 2011 | 163,152 | 16,315 | 146,837 | | | | 163,152 |
| Silverton | Local Groundwater | 2011 | 6,171,850 | | | | | 6,171,850 | 6,171,850 |
| White River MWD | Local Groundwater | 2011 | 1,063,625 | 264,227 | 799,398 | | | | 1,063,625 |
| White River MWD | Reclaimed Water | 2030 | 38,089,684 | 8,230,758 | 29,858,926 | | | | 38,089,684 |
| Lorenzo | Local Groundwater | 2015 | 276,408 | | 491,458 | | | | 491,458 |
| Earth | Local Groundwater | 2031 | 619,608 | 78,632 | 540,976 | | | | 619,608 |
| Morton | Local Groundwater | 2010 | 1,185,162 | 118,516 | 1,066,646 | | | | 1,185,162 |
| Denver City | Local Groundwater | 2012 | 786,894 | | | | 786,894 | | 786,894 |
| Hart | Local Groundwater | 2050 | 509,256 | | | | | 509,256 | 509,256 |
| Wilson | Local Groundwater | 2015 | 349,252 | 34,925 | 64,327 | | 250,000 | | 349,252 |
| New Deal | Local Groundwater | 2030 | 547,803 | 116,426 | 117,087 | 63,490 | 140,400 | 110,400 | 547,803 |
| Smyer | Local Groundwater | 2012 | 249,976 | 24,997 | 224,979 | | | | 249,996 |
| Total | | | 690,963,186 | 74,557,707 | 34,947,839 | 63,490 | 1,177,294 | 6,791,506 | 117,537,856 |
| * Dimmitt | Local Groundwater | NA | 786,894 | Already implemented, and further funding not needed at present time. | | | | | |
| Plains | Local Groundwater | | 1,186,082 | Commented that currently seeking land for future supply, but have no cost now. | | | | | |
| | | | | | | | | | <><><><><> |

# Section 10
# Adoption of Plan
# [31 TAC §357.11-12]

## 10.1 Public Involvement Program

Public involvement was begun at the start of the Llano Estacado regional water planning process to allow ample opportunity for public input into the process of developing the regional water plan, as well as opportunity to review and comment upon the Initially Prepared Plan.

Since the adoption of the 2006 Plan, the High Plains Underground Water Conservation District No. 1 continues to provide public information about the regional water planning process during the current 5-year planning cycle (2006-2011). The public information activities are described and listed below.

The LERWPG's website (www.llanoplan.org) is and continues to be the primary method of distributing information to the public. The site contains the LERWPG mission statement; a list and map of the counties within the region; agendas for all meetings from 2002-2010; minutes of all meetings from 2002-2010; a list of the planning group members, their respective e-mail addresses, and the water user groups they represent; a list of LERWPG committees; the 2006 approved regional water management plan; 2006 suggested water management strategies; other related information, such as websites for other regional water planning groups in Texas; a request form for publications, such as *Soils of the Llano Estacado Region* and *Conservation Tillage Within The LERWPG*; and an online form to provide feedback to the webmaster.

This regularly updated site received a major makeover in December 2009/January 2010. New interactive features include the ability to "bookmark and share" information from the site using social media such as Facebook and Twitter. In addition, members may now sign up for periodic LERWPG newsletters delivered to them via e-mail.

The High Plains Underground Water Conservation District No. 1 website (www.hpwd.com) is another online source for information relating to the LERWPG. Meeting notices and news releases about the LERWPG are also posted to the HPWD site. This regularly updated site has received more than 277,000 visits since 1997.

LERWPG representatives and High Plains Water District staff have given numerous presentations to civic clubs and professional groups about the regional water planning process and the updated plan. District staff members have also spent many hours answering public inquiries about the plan since the first 5-year planning cycle.

The public involvement program has included duly noticed public meetings, information on both the LERWPG and HPWD web sites, articles in *The Cross Section* (High Plains Water District monthly newsletter), and presentations at public meetings. In addition, a public hearing on the scope of work was held August 31, 2006 at the High Plains Underground Water Conservation District No. 1 office, 2930 Avenue Q, in Lubbock.

A reporter from the *Lubbock Avalanche-Journal* was assigned to cover the regional water planning group, which has resulted in several news stories appearing in the newspaper.

The following articles about the Llano Estacado Regional Water Management Plan were published in *The Cross Section*, a monthly publication of the High Plains Underground Water Conservation District No. 1, from 2006 to 2010:

| Date | Activity |
|---|---|
| June 2006 | RWPG begins third 5-year planning cycle. |
| August 2006 | LERWPG Meeting Notice. |
| 2007 | No articles appeared – The first two years of this third round of regional water planning focused on local and region specific water supply-related issues (2006-2008). |
| February 2008 | LERWPG Meeting Notice |
| May 2009<br>May 2009 | LERWPG Meeting Notice.<br>LERWPG to receive public comments regarding the City of Lubbock's proposed amendments to 2006 plan. |
| June 2009<br><br>August 2009<br>September 2009<br>September 2009<br>November 2009 | LERWPG establishes comment period on the City of Lubbock proposed amendments.<br>LERWPG to consider City of Lubbock proposed amendments.<br>LERWPG Meeting Notice.<br>2006 plan amended to include City of Lubbock amendments.<br>LERWPG Meeting Notice. |
| March 2010 | Public comment period begins for Initially Prepared Llano Estacado regional Water Plan. |

Either LERWPG members or High Plains Underground Water Conservation District No. 1 employees gave the following interviews and presentations about the Llano Estacado Regional Water Management Plan from 2006 to 2010:

| Date | Location | Association or Organization |
|---|---|---|
| 2006 | Hereford | Hereford Rotary Club |
| 2006 | Lubbock | Texas Cotton Ginners Show |
| 2006 | Wolfforth | Wolfforth Lions Club |
| 2006 | Lubbock | League of Women Voters |
| 2006 | Lubbock | ICASALS Conference |
| 2006 | Lubbock | Southwest Rotary Club |
| 2006 | Lubbock | Chamber of Comm., Agri. Committee Monthly Meeting |
| 2006 | Lubbock | Chamber of Comm., Water Cons. Council Mo. Meeting |
| 2006 | Lubbock | Texas DoT Regional Director's Meeting |
| 2006 | Lubbock | Chris Winn, Fox Talk 950 |
| 2006 | Lubbock | Jim Stewart, KRFE-AM |
| 2006 | Lubbock | Emily Leonard, KLBK-TV |
| 2006 | Lubbock | MBA Class at Texas Tech University |
| 2006 | Lubbock | Texas Section AWWA Meeting |
| 2006 | Amarillo | Amarillo Farm and Ranch Show |
| 2006 | Lubbock | Air and Waste Management Meeting |
| 2007 | Lubbock | High Plains Public Radio Network |
| 2007 | Lubbock | Home and Garden Show |
| 2007 | Lubbock | Chamber of Comm., Agri. Committee Monthly Meeting |
| 2007 | Lubbock | Chamber of Comm., Water Cons, Council Mo. Meeting |
| 2007 | Lubbock | Texas Tech University Student Publications |
| 2007 | Lubbock | St. John's United Methodist Church |
| 2007 | Lubbock | Texas Cotton Ginner's Show |
| 2007 | Amarillo | Panhandle Grain and Feed Association Convention |
| 2007 | Levelland | Levelland Evening Lion's Club |
| 2007 | Lubbock | Jim Stewart, KRFE-AM |
| 2007 | Canyon | Randall County Advisory Committee Meeting |
| 2007 | Lubbock | Southwest Rotary Club |
| 2007 | Muleshoe | Muleshoe Rotary Club |
| 2007 | Littlefield | Littlefield Rotary Club |
| 2007 | Lubbock | Texas Farm Bureau Ag Lead Class |
| 2007 | Amarillo | Amarillo Farm and Ranch Show |
| 2008 | Lubbock | Chamber of Comm., Agri. Committee Monthly Meeting |
| 2008 | Lubbock | Chamber of Comm., Water Cons, Council Mo. Meeting |
| 2008 | Lubbock | Impact of Water in Environment, Lubbock Arboretum |
| 2008 | Lubbock | HPWD Co. Advisory Committee Meeting, Texas Tech |
| 2008 | Lockney | Lockney rotary Club |
| 2008 | Lubbock | Second Baptist Church Study Group |

| | | |
|---|---|---|
| 2008 | Lubbock | Texas Cotton Ginners Show |
| 2008 | Floydada | Daughters of American Revolution |
| 2008 | Lubbock | Eddie Griffis, Ag Talk Show |
| 2008 | Slaton | Slaton Lion's Club |
| 2008 | Muleshoe | Muleshoe Rotary Club |
| 2008 | Lubbock | KOHM-FM, James Stewart |
| 2008 | Lubbock | Farmhouse Fraternity Conclave |
| 2008 | Lubbock | Farm Bureau Tour Group |
| 2008 | Lubbock | Texas Ag Industries Meeting (Regional Meeting) |
| 2008 | Lubbock | West Texas Ag Chemical Conference (Regional Meeting) |
| 2008 | Lubbock | House Ag and Livestock Committee Meeting |
| 2008 | Lubbock | Banker's Conference |
| 2008 | Amarillo | Amarillo Farm and Ranch Show |
| 2009 | Lubbock | Lubbock Master Gardeners |
| 2009 | Lubbock | Chamber of Comm., Agri. Committee Monthly Meeting |
| 2009 | Lubbock | Chamber of Comm., Water Cons, Council Mo. Meeting |
| 2009 | Lubbock | Eddie Griffis, Ag Talk Show |
| 2009 | Lubbock | Jim Stewart, KRFE-AM |
| 2009 | Dimmitt | Castro County Corn Conference |
| 2009 | Lubbock | South Plains Ag, Wind, & Wildlife Conference |
| 2009 | Lubbock | Lubbock Lion's Club |
| 2009 | Lubbock | Texas Cotton Ginner's Show |
| 2009 | Canyon | American West History Class at West Texas A&M |
| 2009 | Lubbock | Amando Gonzales/Randy Sanders Interview KEJS-FM |
| 2009 | Littlefield | Littlefield Lion's Club |
| 2009 | Canyon | CRP Information Meeting |
| 2009 | Amarillo | Amarillo Farm and Ranch Show |

### *10.2 Data Gathering and Coordination with Water Supply and Water Conservation Entities*

During March through August of 2009, the High Plains Underground Water Conservation District No. 1, Mesa Underground Water Conservation District, Sandy Land Underground Water Conservation District, South Plains Underground Water Conservation District, Garza County Underground and Fresh Water Conservation District, Llano Estacado Underground Water Conservation District, White River Municipal Water District, Canadian River Municipal Water Authority, Brazos River Authority, and Red River Authority were contacted and requested to provide up-to-date information about their respective programs and plans. Each entity responded with updated information, which was used to update the respective entity's information in Sections 1, 3, and 4 of the Regional Water Plan.

### *10.3 Informational Mailouts to Water User Groups and Supply Entities*

During March of 2009, the LERWPG wrote a letter to Mayors, City Managers and/or Administrators, Municipal Water Utility Directors, County Judges, and wholesale Water Providers, in which it was announced and explained that: (1) the Llano Estacado Regional Water Planning Group (LERWPG) had begun the process to develop the 2011 Llano Estacado Regional Water Plan, as required by 31 Texas Administrative Code 355 and 357; (2) provided information about the process; and, (3) presented the schedule to complete this work. In addition, it was explained that the 2011 Plan is to take into account changed conditions within the region, such as the emergence of the ethanol industry and the rapid increase in the number of dairies in several counties of the region. The Mayors, City Managers and/or Administrators, Municipal Water Utility Directors, and County Judges were requested to provide information of any changed conditions that needed to be considered in the development of the 2011 Regional Water Plan. It was further explained that a requirement of the Regional Water Planning Process is for the LERWPG to take into consideration water supply plans of local public water suppliers (cities and water supply districts). In its letter, the LERWPG requested each public water supplier to communicate to the HPUWCD and the Technical Consultant any existing water supply plans, and in addition to communicate any changes needed to the plan that was included in the 2006 Regional Water Plan for their respective water utilities. A copy of the 2006 Plan, in which their individual plans are found, was attached to the letter. One municipality responded to the inquiry, with information that it was in the process of applying to the TWDB for a loan to implement parts of its water supply plan.

### *10.4 Llano Estacado Regional Water Planning Group Meetings*

The Llano Estacado Regional Water Planning Group conducted regular meetings on the dates listed below. Notices of all public meetings were duly posted at the Lubbock County Courthouse, the administrative office of the High Plains Underground Water Conservation District No. 1, and on the LERWPG and HPWD websites.

| Date | Meeting |
|---|---|
| June 20, 2006 | Joint Meeting with Region A. |
| July 7, 2006 | Regional Water Planning Group Committees. |
| September 20, 2007 | Regular Meeting. |
| February 21, 2008 | Regular Meeting. |
| May 1, 2008 | Regular Meeting. |
| October 23, 2008 | Regular Meeting. |
| April 23, 2009 | Regular Meeting. |
| June 18, 2009 | Public Hearing Regarding City of Lubbock Amendments to 2006 Regional Water Plan. |
| August 27, 2009 | Regular Meeting. |
| October 15, 2009 | Regular Meeting. |
| December 10, 2009 | Regular Meeting. |
| February 18, 2010 | Regular Meeting. |
| April 15, 2010 | Public Hearing on Initially Prepared Plan. |
| August 12, 2010 | Regular Meeting. |

### *10.5 Coordination with Other Regions and Counties of Region O*

Notices of all public meetings were sent to the chairs of the regional water planning groups in the state and all who requested them. In addition, Region O cooperated with Region A in the development and filing of an application to the TWDB for supplemental funding to identify and evaluate water management strategies to increase quantities and reliability of supplies from CRMWA during periods of drought. Region A revised yields of Lake Meredith and has provided revised information to Region O, which has been used in water supply analyses for CRMWA member cities of Region O.

### *10.6 Texas Water Development Board Comments for Llano Estacado Region (Region O) Regional Water Planning Group Initially Prepared Plan, TWDB Contract No. 904830874 and LERWPG Responses*

**ATTACHMENT A**

## TWDB Comments on Initially Prepared 2011 Region O Regional Water Plan

**LEVEL 1-- Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.**

**Section 1**

1. Pages 1-66 through 1-69, Section 1.8; pages 5-1 through 5-3, Section 5.1: Please clarify in the plan whether any existing threats of limited water quantity with respect to irrigated agriculture were considered (page 1-66) and whether such a threat would be addressed or affected by the recommended water management strategies (page 5-1). *[Title 31 Texas Administrative Code (TAC) §357.7 (a)(1)(L) and (a)(8)(C)]*

**Response: Sub-Section 5.3 has been added to Section 5.0 "Impacts of Water Management Strategies on Key Parameters of Water Quality [31 TAC §357.7(a)(12)] and Impacts of Moving Water from Rural and Agricultural Areas [31 TAC §357.7(a)(8)(G)]," which provides a summary of the water demand, water supply, water needs projections, and socioeconomic impact analyses relating to the projected effects of declining water supplies upon the irrigated agriculture water using sector of the Llano Estacado Water Planning Region (Region O).**

Section 3

2. Page 3-5, Section 3.3.C: Please confirm in the plan that the surface water availability is based on firm yield as determined using the Texas Commission on Environmental Quality Water Availability Model Run 3, or revise accordingly.

   **Response: All surface water availability in the Regional Water Plan is based upon firm yield as determined using the Texas Commission on Environmental Quality Water Availability Model Run 3, and a statement to this effect has been added in the text of Section 3.3.C of the Regional Water Plan.**

Section 4

3. If applicable, please describe third party impacts from voluntary redistributions of water and moving water including from rural and agricultural areas. *[31 TAC §357.7(a)(8)(G)]*

   **Response: Third party impacts are addressed in Section 5 on page 5-4, as follows: Recommended water management strategies for municipal uses would result in the voluntary transfer of approximately 4,150 acft/yr ( 0.13 percent to 0.28 percent of available regional annual supplies) of water from rural and agricultural areas to municipal areas through the acquisition of additional sites for well fields in approximately 12 to 15 widely dispersed locations near to the municipalities that acquire them. The impacts of these transfers are not considered to be significant to the local areas, however, to the extent that such transfers reduce water supplies available to irrigated agriculture and/or livestock or dairies, the economic impacts would result in lower levels of farm production and farm incomes, and would reduce business of agricultural input suppliers and agricultural marketing establishments; i.e.; the adverse results would extend throughout the local economy including third party agricultural service, finance, and marketing sectors of the local region.**

4. Please explain how the region considered emergency transfers of non-municipal use surface water without causing unreasonable damage to the property of the non-municipal water rights holder pursuant to Texas Water Code §11.139. *[31 TAC §357.5(i)]*

   **Response: The Regional Water Planning Group did not identify nor consider emergency transfers of non-municipal use surface water.**

5. Pages 4-2, 4-111, 4-146 through 4-147, and ES-13: The number of municipal water user groups cited as showing needs is not consistent. (e.g. 29 municipalities on pages ES-13 and 4-111; 31 cities on pages 4-146 and 4-147; and, 23 municipalities on page 4-2). Please reconcile the numbers in the plan.

   **Response: The number of municipal water user groups has been corrected on pages 4-2, 4-146, 4-147, and ES-14. The correct number is 29 cities and one (1) water supply district. The number 45 on page 4-111 is the number of municipal WUGS having per capita water use less than the regional average of 172 gpcd, and is correct.**

6. Page 4-149, paragraph 2: Please revise cost estimates or justify why a 30-year debt service period rather than the TWDB-recommended 20-year debt service period was used for evaluating water management strategies other than reservoirs. *[Contract Exhibit "C" Section 4.1.2]*

   **Response: Revisions were made, and revised tables numbered Table 4.4-15 through Table 4.4-38 (Pages 4-150 through 4-173) were placed in the text. These revisions did not change the project implementation or**

**construction cost estimates, however, at the 20-year debt service period, the unit costs of water increased in comparison to the 30-year debt service period.**

7. Page 4-185, Section 4.4.3.3, second paragraph: The plan indicates that that "Only natural unappropriated flows were subjected to the Consensus Criteria for Environmental Flow Needs (CCEFN) requirements". Since the CCEFN are calculated using naturalized flows, please clarify whether the CCEFN criteria was established using naturalized flows and was applied, as appropriate, to any increase in yield.

   **Response: The CCEFN criteria were calculated using naturalized flows and were applied appropriately to unappropriated natural flows.**

8. Page 4-212, Table 4.4-51; ES-18, Table ES-2: Two different versions (Options A and B) of The Lubbock North Fork Diversion water management strategy are presented as recommended water management strategies. Because all recommended water management strategies must take into account all other recommended water management strategies, please include only one recommended version of the North Fork Diversion strategy. Other versions may be included as alternatives in the plan. Note that if the Option B North Fork Diversion is retained as a recommended water management strategy, it would appear to require the removal of two of the other recommended water management strategies. *[31 TAC §357.7(a)(7)(H)]*

   **Response: The Lubbock North Fork Diversion water management strategy (Option B) of Table ES-2, page ES-18 of the IPP was intended as an explanatory footnote, and was not one of the recommended water management strategies for Lubbock. The Lubbock North Fork Diversion (Option B) has been removed from Table ES-2, and the wording of the footnote has been revised, accordingly.**

9. Page 4-214, Section 4.4.3.5.2, last paragraph: The plan states "(3) Natural, unappropriated flows are subject to instream flow requirements equivalent to Consensus Criteria for Environmental Flow Needs (CCEFN)". Since the CCEFN are calculated using naturalized flows, please clarify whether the CCEFN criteria was established using naturalized flows and was applied, as appropriate, to any increase in yield.

   **Response: The CCEFN criteria were calculated using naturalized flows and were applied to the entire Post Reservoir water right, which is existing. CCEFN were applied to the entire existing permit due to imprecise language in special conditions of the permit regarding environmental flow requirements.**

Section 6

10. The sample municipal water conservation plan for the City of Lubbock is dated 2005 and does not contain 5 and 10 year practicable goals as according to Texas Water Code, Chapter 11.1271 or measurable water loss goals. Please include a sample municipal conservation plan that includes 5 and 10-year goals and measurable water loss goals. *[31 TAC §357.7(c)]*

    **Response: The City of Lubbock Retail and Wholesale 2010 Water Conservation Plan and Drought and Emergency Contingency Plan was included as Appendix D. The 2010 Plan contains both 5 and 10 year water conservation goals.**

11. Page 6-9, Section 6.3; pages ES-16, ES-18; Table ES-2: Please clarify how drought management as a water management strategy was considered in the plan. *[31 TAC §357.5(d)(1)&(2)]*

    **Response: Drought Management is not a recommended water management strategy to meet projected water needs in Region O, in part because it cannot be demonstrated to be an economically feasible strategy. It is important to note that in Region O, municipal, irrigation, and livestock water supply delivery systems are well fields and wells that produce from the region's aquifers (mostly the Ogallala). The capability of these systems is based upon system capacity and aquifer characteristics, and does not fluctuate with weather conditions. However, the LERWPG recognizes the individual cities "Demand Management and Drought Contingency Plans" that are on file with the TCEQ.**

12. *(Attachment B)* Comments on the online planning database (i.e. DB12) are herein being provided in spreadsheet format. These Level 1 comments are based on a direct comparison of the online planning database against the Initially Prepared Regional Water Plan document as submitted. The table only includes numbers that do not reconcile between the plan (left side of spreadsheet) and online database (right side of spreadsheet). An electronic version of this spreadsheet will be provided upon request.

    **Response: Review and changes are in progress.**

13. *(Attachment C)* Based on the information provided to date by the regional water planning groups, TWDB has also attached a summary, in spreadsheet format, of potential interregional conflicts, apparent water source over allocations, and apparent unmet water needs that were identified during the review of the online planning database and Initially Prepared Regional Water Plan. *[Additional TWDB comments regarding the general conformance of the online planning database (DB12) format and content to the Guidelines for Regional Water Planning Data Deliverables (Contract Exhibit D) are being provided by TWDB staff under separate cover as 'Exception Reports']*

    **Response: Review and changes are in progress.**

**LEVEL 2--Comments and suggestions that might be considered to clarify or enhance the plan.**

Section 1

1. Pages 1-102; page 1-105, Table 1-30: The total water loss presented in text of 847.30 acft is inconsistent with table (848.30 acft). Please reconcile numbers in plan.

   **Response: The correct value is 847.31 acft, and was entered in the text of the Regional Plan.**

Section 4

2. Pages 4-302 through 4-410, Page 4-313: Several of the Tables in Chapter 4 do not include dollar sign units (e.g Tables 4.5-3, 4.5-22, and 4.5-74). Please consider including units in all plan tables.

   **Response: Dollar signs were entered in all Tables of Chapter 4, as appropriate. It is noted that all rows of the Tables of Chapter 4 of the IPP referenced here and the revised IPP (Version being considered for adoption) are labeled with the correct and appropriate units; i.e.; acre-feet and dollars.**

## *10.7 Public Comments and LERWPG Responses*

***April 15, 2010 at Public Hearing on Initially Prepare 2011 Region O Regional Water Plan***

***Oral Comments of Kevin Riley, Springlake, Texas***

"My name is Kevin Riley and I am a fourth-generation farmer from Castro County. I would like my kids to be able to be the fifth generation, if they so desire. My grandfather was among the first to use irrigation tubes instead of cutting I's in the ditches like they used to. He and dad laid miles of concrete and plastic line because it saved water. I'm also the third generation to buy new center pivots to more efficiently apply the water to our crops. Grandfather despised wasting the tailwater in the ditches and I was taught the importance of conservation of our water.

"With this in mind, I'd like to offer the following points:

1. Each regional water planning group is charged with determining the amount of surface water and groundwater currently available within our region. My concern is with the accuracy of this mapping of the saturated thickness of the Ogallala. The U.S. Geological Survey was involved in a project in the North Platte River Valley of Nebraska where they used a heli-borne electromagnetic device that showed large variations in the saturated

thickness of the aquifer that was previously unknown. Some more and some less. If we are to be regulated based on a percentage of the water available, I think it is vitally important that we deal with as close to a known as possible—and not an educated guess.

2. My second point is that Castro County is more similar to the amount of water available and crops grown in two counties north, such as Dallas and Hartley Counties than to areas south and east of Castro. With these similarities in mind and with the precedent that has been set, I would respectfully request that a similar target saturated thickness of 40 percent being left in 50 years be made available for Castro County. I think this is an attainable goal if we eliminate double cropping and we use the technologies that are coming in the near future. You mention drought tolerance and some of those that are being developed by conventional breeding. I was watching your presentation a while ago and I believe, within the next 3-7 years, that the drought tolerant with the genetic engineering will offer significant (water) savings.

3. My third and final point is please ensure that the restrictions will be fairly applied and that the areas with the most water are not used as a reserve for the whole area. Thank you."

**Response: The Llano Estacado Regional Water Planning Group (LERWPG) very much appreciates the comments, and hereby includes them in the 2011 Regional Water Plan. However, the LERWPG does not have responsibility for regulation of the quantities of water available for use within the region.**

***Oral Comments of Mack Steffey, Hart, Texas.***

"I'm Mack Steffey and I farm between Dimmitt and Hart in Castro County. I've grown corn for 37 years there and we use about 20-26 inches of irrigation. We feel like it is a viable crop. It has to be there for our cattle feeding industry and we want to protect it. The recent invasion of dairies have come there, they double crop, and are using considerably more than 22-24 inches of water—probably double that. We are not trying to run the dairy industry off—but if these laws are in place to limit us to where we can grow corn—some of those operations do wheat silage, corn silage, and alfalfa in the frost-free period time—so I'd like to keep that in mind that we need enough water to grow corn in our county. Thank you."

**Response: The Llano Estacado Regional Water Planning Group (LERWPG) very much appreciates the comments, and hereby includes them in the 2011 Regional Water Plan. However, the LERWPG does not have responsibility nor authority for determination as to what purposes or uses water can be put.**

### Letter from Silverton

MAYOR
LANE B. GARVIN

City of Silverton

P. O. BOX 250
SILVERTON, TEXAS 79257

CITY SECRETARY
JERRY PATTON
PHONE (806) 823·2125

June 10, 2010

Mr. Herbert W. Grubb
HDR Engineering, Inc.
4401 West Gates Blvd.
Austin, Texas 78745

Re: Llano Estacado Regional Water Plan: City of Silverton, Briscoe County

Dear Mr. Grubb:

As per our phone conversation this date, I have reviewed the new 2010 Llano Estacado Regional Water Plan and find it liken as it does not show the City of Silverton as having a water problem. The plan shows the City as having no need for new water sources.

The City of Silverton does in fact have a big water problem as Lake Mackenzie is getting lower and has not shown that it is going to get any better in the future. We also have a water quality issue, with high arsenic in our well water. Please see attached Alert letter from TCEQ dates January 14,2005.

The City of Silverton hereby request that the new 2010 Llano Estacado Regional Water Plan includes a water plan for the City that would include a well field, pipe and pumps that would insure the City of Silverton a dependable arsenic free water supply in the years to come.

Respectfully submitted:
Jerry Patton
City Administrator
City of Silverton

> **Response: A Local Groundwater Water Management Strategy was added for Silverton to meet projected needs.**

### Letter from Texas Parks and Wildlife Department

June 3, 2010

Mr. H.P. Brown, Jr., Chairman
Llano Estacado Regional Water Planning Group
P.O. Box 2426
Lubbock, TX 79408-2426

Re: 2010 Llano Estacado Region O Initially Prepared Plan

Dear Mr. Brown:

Thank you for the opportunity to review and comment on the 2010 Initially Prepared Regional Water Plan (IPP) for Llano Estacado Region O. Texas Parks and Wildlife (TPW) acknowledges the time, money and effort required to produce the regional water plan as mandated by Senate Bill 1 of the 75th Legislature. A number of positive steps have been taken since the first planning cycle to advance the issue of environmental protection. For example, the regional water planning groups are required by TAC §357.7(a)(8)(A), to perform a “quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico” when evaluating water management strategies (WMS). Quantification of environmental impacts is a critical step in planning for our state’s future water needs while also protecting environmental resources.

TPW staff has reviewed the IPP with a focus on the following questions:

- Does the plan include a quantitative reporting of environmental factors including the effects on environmental water needs, and habitat?
- Does the plan include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the plan discuss how these threats will be addressed?
- Does the plan describe how it is consistent with long-term protection of natural resources?
- Does the plan include water conservation as a water management strategy? Reuse?
- Does the plan recommend any stream segments be nominated as ecologically unique?
- If the plan includes strategies identified in the 2006 regional water plan, does it address concerns raised by TPW at that time?

In general, the Llano Estacado Region O IPP includes more of a narrative rather than quantitative reporting of the impacts of the proposed water supply strategies. This is in large part due to the nature of the proposed strategies which rely primarily on water conservation and reuse. Potential reductions in streamflow for surface water strategies are identified, but the connection between instream flows and downstream habitat and biota is lacking. The report does a good job in documenting the county occurrences of threatened, endangered and rare species, as well as other species. In addition, the sections on playa lake structure, function, biota, and management are useful. While Appendix B of the IPP includes a good review of existing and historical springs and seeps, potential impacts to spring flows and spring ecosystems should be identified where continued groundwater depletion and additional groundwater development are identified as water management strategies.

Agricultural and municipal water conservation are the principle strategies in the IPP for meeting future water needs. The planning group has proposed municipal water conservation strategies that can potentially reduce per capita water use in the region from an average of 180 gallons per person per day in 2010 to 154 gallons per person per day in 2060. TPW supports the planning group’s consideration of brush control/management as an additional means of conserving water if done in a manner that can also benefit wildlife habitat. The Region O IPP also includes reuse of treated municipal effluent for meeting future water needs.

TPW notes that the plan does not recommend nomination of any stream segments as ecologically unique. TPW has identified several stream segments in the region that meet at least one of the criteria for classification as ecologically unique should the regional planning group decide to pursue nomination of an ecologically significant stream in the future. These segments include portions of the Prairie Dog Town Fork Red River, the North Prong Little Red River, and the South Prong Little Red River.

In general the 2010 Region O IPP is a well-written document. TPW appreciates the fact that many of our earlier comments have been addressed in the plan. However concerns remain regarding the proposed Post Reservoir and other surface water strategies and their potential impacts to downstream instream uses including aquatic and riparian habitats and water quality. Since surface flows are so rare in Region O, environmental stream flows are of considerable importance.

Thank you for your consideration of these comments. TPW looks forward to continuing to work with the planning group to develop water supply strategies that not only meet the future water supply needs of the region but also preserve the ecological health of the region's aquatic resources. Please contact Cindy Loeffler at (512) 389-8715 if you have any questions or comments.

Sincerely,
Ross Melinchuk
Deputy Executive Director, Natural Resources

RM:CL:ms

**Response: The Llano Estacado Regional Water Planning Group appreciates the comments by The Texas Parks and Wildlife Department.**

### *10.8 Final Plan Adoption*

The LERWPG held a public hearing on the Initially Prepared Regional Water Plan (IPP) in Lubbock, Texas on April 15, 2010 and received oral and written comments from various individuals and organizations as well as public agencies, including the Texas Parks and Wildlife Department. The Texas Water Development Board reviewed the IPP and sent a letter of comments. The TWDB comments, together with LERWPG responses are included in Section 10.6. A copy of public comments and LERWPG responses are presented in Section 10.7. In response to the comments, revisions were made to the Initially Prepared Regional Water Plan. The Llano Estacado Regional Water Planning Group adopted the 2011 Llano Estacado Regional Water Plan in a public meeting on August 12, 2021.

# *Appendix A*

## *Threatened, Endangered, and Rare Species of the Llano Estacado Region*

## *Table 1. Threatened, Endangered, and Rare Species of the Llano Estacado Region*

| ***Common Name*** | ***Scientific Name*** | ***Habitat Preference*** | ***Listing USFWS*** | ***Listing TPWD*** |
|---|---|---|---|---|
| American Peregrine Falcon | *Falco peregrinus anatum* | Potential migrant; nests in west Texas | DL | E |
| Artic Peregrine Falcon | *Falco peregrinus tundrius* | Potential migrant | DL | T |
| Baird's Sparrow | *Ammodramus bairdii* | Shortgrass prairie with scattered low bushes and matted vegetation | | |
| Ferruginous Hawk | *Buteo regalis* | Open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers | | |
| Interior Least Tern | *Sterna antillarum athalassos* | Nests along sand and gravel bars within braided streams and rivers; known to nest on man-made structures as well | LE | E |
| Lesser Prairie Chicken | *Tympanuchus pallidicinctus* | Arid grasslands, generally interspersed with shrubs and dwarf trees; nests in a scrape lined with grasses | C1 | |
| Mountain Plover | *Charadrius montanus* | Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; non-breeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous | | |
| Snowy Plover | *Charadrius alexandrinus* | Formerly an uncommon breeder in the Panhandle; potential migrant | | |
| Western Burrowing Owl | *Athene cunicularia hypugaea* | Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows | | |
| Whooping Crane | *Grus americana* | Potential migrant | LE | E |
| Sharpnose Shiner | *Notropis oxyrhynchus* | Endemic to Brazos River drainage; also apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom combination of sand, gravel, and clay-mud. | C1 | |
| Smalleye Shiner | *Notropis buccula* | Endemic to upper Brazos River system and its tributaries; apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumable eats small aquatic invertebrates. | C1 | |
| Black Bear | *Ursus americanus* | Within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves or brush piles. | T/SA; NL | T |
| Black-footed Ferret | *Mustela nigripes* | Considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area | LE | E |
| Black-tailed Prairie Dog | *Cynomys ludovicianus* | Dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups | | |

***Table 1 continued***

| ***Common Name*** | ***Scientific Name*** | ***Habitat Preference*** | ***Listing USFWS*** | ***Listing TPWD*** |
|---|---|---|---|---|
| Cave Myotis Bat | *Myotis velifer* | Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Hirundo pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore | | |
| Jones' Pocket Gopher | *Geomys knoxjonesi* | Southwestern plains of Texas; deep sandy soils of aeolian origin; small isolated population vulnerable to land use changes | | |
| Palo Duro Mouse | *Peromyscus truei comanche* | Rocky, juniper-mesquite-covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado; juniper woodlands in canyon country of the panhandle; primarily nocturnal | | T |
| Plains Spotted Skunk | *Spilogale putorius interrupta* | Open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie | | |
| Swift Fox | *Vulpes velox* | Restricted to current and historical shortgrass prairie; western and northern portions of Panhandle | | |
| Texas Garter Snake | *Thamnophis sirtalis annectens* | Wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August | | |
| Texas Horned Lizard | *Phrynosoma cornutum* | Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sand to rocky; burrows in soil, enters rodent burrows, or hides under rocks when inactive; breeds March-September | | T |
| Texas Kangaroo Rat | *Dipodomys elator* | Mesquite not required, but mostly in association with scattered mesquite shrubs and sparse, short grasses in areas underlain by firm clay soils; along fencerows adjacent to cultivated fields/roads; burrowing into soil with openings usually at base of mesquite or shrub; dirt pushed into openings to give burrow a closed appearance; active throughout year; nocturnal; feeds on grass, seeds, insects, and annual and perennial forbs; metabolizes water from foods, but will drink water when available; young born in underground nest chamber | | T |
| Mexican mud-plantain | *Heteramthera mexicana* | Aquatic; ditches and ponds; flowering June-August | | |

LE, LT - Federally Listed Endangered/Threatened
PE, PT - Federally Proposed Endangered/Threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
C1 - Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
DL, PDL - Federally Delisted/Proposed for Delisting
E, T - State Endangered/Threatened
"blank" - Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

Source: Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' Special Species. 8/24/04.

# *Appendix B*

# *Springs and Seeps of the Llano Estacado Water Planning Region*

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# Appendix B

## Springs and Seeps of the Llano Estacado Region

**By**
**Jim Steiert, Member**
**Llano Estacado Regional Water Planning Group**

The Environmental Committee of the Llano Estacado Regional Water Planning Group is aware that springs and seeps historically existed in the region. They never emitted water in quantities comparable to the high-volume springs noted elsewhere in Texas. Most of the region's springs and seeps disappeared as native grassland was cultivated and irrigated agriculture evolved. Ogallala aquifer pumpage that drew down the water table is usually blamed for the demise of springs. In his 1981 work "Springs of Texas," Gunnar Brune maintains that siltation that began when the native grass cover was removed from the land was also a factor. Topsoil that washed into creeks and draws choked many springs. Landscape lost capacity to absorb recharge water. Brune notes invasive brush species including salt cedar and juniper adjacent to many now-defunct spring sites. Interception of recharge flow by brush species cannot be discounted as a factor in the loss of spring flow.

Springs and seeps still occur in the Llano Estacado Region. Their flow is minimal in comparison to historic times. While some springs pour water from the Ogallala aquifer, others flow only after prolonged, substantial rainfall. Water that soaks into surrounding lands still gradually feeds the springs. Many springs and seeps are located on private land and their presence can only be confirmed through frequent and close observation. Landowners may be reluctant to allow public access to these sites due to concern over liability, the wish to avoid damage to the landscape, etc. The flow from most of these springs is local and does not contribute to river flow. Spring water may travel a short distance and generally evaporates or runs back into the ground. Seeps are generally little more than small pools sustained by minimal flow from underground. Where springs and seeps still exist they are important to local wildlife and may be a source of livestock or recreational water.

The Llano Estacado region experienced unusually heavy rainfall during 2004 that renewed spring and seep flows in some locations. Where normal annual rainfall is roughly 18 inches, 42 inches of more of precipitation fell on parts of the region. Renewed spring flows noted in 2004-2005 are out-of-the-ordinary, localized, and a direct result of abundant rainfall.

According to "Major and Historical Springs of Texas" published by the TWDB, and from information garnered by area residents, several active springs and seeps are located within the Llano Estacado Planning Region. Their flows can fluctuate substantially. Included here is a list of historic springs in the Llano Estacado Region, as well as information on any spring and seep sites still active. Material in this report is taken primary from "Springs of Texas" Volume 1 by Gunnar Brune, and is supplemented with anecdotal information.[1] **BOLD TYPE IN THE DESCRIPTIVE TEXT INDICATES CURRENTLY ACTIVE SPRINGS AND SEEPS.**

**BAILEY COUNTY:** At the time of his 1978 documentation, Brune found that the springs of Bailey County had nearly all ceased flowing. Through history, several springs issued from Tertiary Ogallala sand and more recent sand and caliche, and from Cretaceous limestone. Springs were located primarily along Blackwater Draw and its larger tributaries, and adjacent to the larger lakes. Cultivation of grassland diminished the soil's ability to absorb recharge water and the springs along Blackwater Draw were largely gone by the 1930s. Among historic springs mentioned by Brune, and their location are Alkali Springs, 1.5 miles south of Baileyboro; Barnett Springs, 6.8 miles southeast of Coyote Lake and just over a half-mile northeast of Baileyboro; Blackwater Lake and Springs, 6.2 miles west of Muleshoe; Jumbo and Turnbo Springs, 1.8 miles northeast of Muleshoe; Butler Springs, in the northeast corner of the county on the Parmer County line and just over a half-mile west of Lamb County line; and White Springs, in the Muleshoe National Wildlife Refuge 6.2 miles south of Needmore. **In a telephone interview on March 24, 2005, Mr. Jim Young of Muleshoe reported that springs have consistently maintained seeps on property he owns south of Baileyboro Lake just south of the Baileyboro community for the 10 years he has owned the land. These are not large flows but do maintain standing water. Mr. Harold Beierman, manager of the Muleshoe National Wildlife Refuge near Needmore said that abundant rainfall during 2004 has caused seeps to moisten the ground at several sites on the refuge. Beierman said that spring flow also occurred at Paul's Lake on private property north of the refuge, and that water was present in the lake throughout the fall and winter of 2004-2005.**

**BRISCOE COUNTY:** Most of the historic springs in Briscoe County issued from Tertiary Ogallala sand and Quaternary sands and gravels such as the Tule, in the western part of the county. From 15,000 years ago, when Clovis man frequented the springs, until over a century ago, nearly all of the springs ran continuously. Remains of mammoths hunted by the Clovis people have been found in Briscoe County, Hearths, projectile points, knives and scrapers and paintings on rock cliffs indicated that from Clovis to historic times, man and animal have associated with spring sites here. Irrigation caused a severe decline in the water table, a major cause of the failure of most springs, but extensive erosion also resulted in creeks being choked with sand and silt, and many springs were buried. Evidence indicates that Coronado followed the waters of Tule Creek in 1541 and stopped at **HULSEY SPRINGS,** located just below the caprock in Palo Duro Canyon, approximately nine miles north of Vigo Park. This name evidently represented several small springs at that location. Brune documented springs still running on **Deer**, **Turkey**, and **Cedar** springs with flow rates of 20.5, 39.6 and 15.8 gallons per minute respectively on September 4, 1978. **According to NRCS records, Dick Cogdell is the current landowner of the site. A telephone interview with Mrs. Dick Cogdell on February 2, 2005 revealed that Turkey Springs remains the primary active spring at that location. The spring does not flow during hot, dry summers. Any spring flow is dependent on abundant rainfall soaking into the surrounding**

[1] Brune, Gunnar, Springs of Texas, Vol I, Texas A&M University Press, College Station, Texas, 2002.

**landscape and feeding the spring, and water does not flow a large distance from the site when the spring is running.**

A number of other spring sites were also documented by Brune in Briscoe County. Some of these go by other localized names. **In favorable seasons such as 2004, when abundant rainfall provides a recharge source, some of these springs revive, but run only a small distance before going back underground or evaporating. Mr. Rank Cogdell of the Vigo Park area reported in a phone interview on February 2, 2005, that he observed many active springs along Tule Canyon during a helicopter flight over the area in January of 2005. He reported that the Tule has numerous springs along its length, and that in the winter Tule Creek and Deer Creek are the only locations with spring flow sufficient to provide dependable livestock water, with flow from Deer Creek estimated at roughly 20 gallons per minute. The best of the small localized springs on the Tule was located within two miles of Highway 207 that runs between Claude and Silverton. Mr. Cogdell commented that a favorable fall and winter of rainfall had created spring flows in Briscoe County that likely would not be maintained once dryer weather set in. Water from these springs does not travel large distances or contribute to river flows.**

Among other historic springs mentioned by Brune are Marting Springs, roughly 5 miles southwest of Brice; Burson Springs, 9.3 miles northwest of Turkey; Bell Springs, 6.2 miles northwest of Turkey; Gyp Springs, 5.5 miles northwest of Quitaque; Haynes Springs, 2.4 miles upstream from Gyp Springs on the South Prong of the Little Red River; Cottonwood and Red Rock Springs, 4.3 miles west-northwest of Quitaque on Little Cottonwood Creek; Las Lenguas Springs, 8.6 miles west-southwest of Quitaque; Rock Springs, 7.4 miles west-northwest of Silverton; and Mayfield Spring, 1.8 miles north-northeast of Rock Springs.

**CASTRO COUNTY**: As late as 1978 Brune indicated that no springs flow in Castro County, although in historic times many issued from Ogallala sand, gravel, silt and caliche. Springs once maintained a flowing stream in Running Water Draw, but this has not been the case in modern times. Decline of the water table due to pumping from the Ogallala and siltation contributed to the failure of springs. Among historic spring sites and their locations was Flagg Springs, 3.1 miles south of the Flagg community and 6.8 miles upstream from Sunnyside on Running Water Draw. Jumbo Lake, 6.2 miles northeast of Easter, was once kept full by seeps from Ogallala silt and sand. Middle Tule Draw northeast of Nazareth held some pools of live water, as did the North Fork of the Running Water Draw. Running Water Draw was fed by springs near Sunnyside.

**COCHRAN COUNTY:** Brune documented in1978 that hardly any springs still flowed in Cochran County, although they issued in abundance from the Ogallala when the water table was at or near the surface. Springs were especially numerous around Silver Lake and along the major draws. Historic spring sites include Morton Springs, 3.1 miles west of Morton, that dried up in 1907, and Silver Springs, on the northwest side of Silver Lake. Discharge of springs around the lake was impacted by irrigation pumping, and the presence of salt cedars could also account for some water loss. South-southeast of Lehman about 6.2 miles springs or seeps may have flowed in former times. In the southeast corner of the county just over a half-mile from north of the Yoakum County line and 8.6 miles west of the Hockley County line springs formerly kept a draw running with water year-round.

**CROSBY COUNTY:** Historically, Crosby County was abundantly endowed with springs, mostly in the canyon breaks below the caprock, with water flowing from Ogallala and Triassic Dockum sands. Over the past 75 years the springs declined markedly as the Ogallala water table dropped. Brune noted in 1978 that Crawfish Creek was dry except in times of heavy rainstorms. Among historic creeks and their location, as listed by Brune were Rock House Springs, near the junction of Highway 651 and 193 in northern Crosby County; Ericson Springs, 1.2 miles west-southwest of Mount Blanco, issuing in a ravine with vertical caliche cliffs, the site offered only a seep in 1978; Dewey Springs, a group of springs on the north side of Dewey Lake located 4.3 miles east-northeast of Crosbyton, now dry; Silver Falls, below the Highway 82 crossing of the White River, was once a source of water for White River Reservoir, but the spring flow diminished; Couch, or English Springs, 8 miles east of Crosbyton in Blanco Canyon, dry now; Davidson Springs, 4.9 miles southeast of Crosbyton; Cold Springs, 8 miles southeast of Crosbyton; L7 Springs,9.3 miles south-southeast of Crosbyton; Wilson Springs, 2.4 miles east-southeast of Cap Rock; Cottonwood Springs, 9.9 miles east-northeast of Slaton on Plum Creek; C Bar Springs, 8.6 miles east-southeast of Slaton; and Gholson Springs, 6.2 miles east-northeast of Slaton.

**DAWSON COUNTY:** The larger springs of Dawson County were in the breaks and canyons below the caprock such as TJF Draw, Tobacco Creek and Gold Creek Canyons. Small springs on the plains such as those along Sulphur Springs Draw were the first to fail as the water table began declining. Many creeks also were filled with drifting sand during dust storms. Brune's field studies during 1975 showed the springs issuing from Pleistocene sand, Tertiary Ogallala sand and lower Cretaceous limestone. Among spring sites documented by Brune and their location are Sulphur Springs Draw, 3.1 south of Welch, where several small springs or seeps are speculated to have flowed during historic times; Rock Crusher or turner Springs, 6.8 miles south of O'Donnell, where Brune metered a flow rate of 30.1 gallons per minute in October of 1978, with the water flow increasing greatly over that metered in June of 1938; Earl Springs, 1.2 miles north of Rock Crusher Springs; Tobacco Springs, at the head of Tobacco Creek, 8.6 miles south-southeast of O'Donnell; Indian Springs, 5.5 miles east-northeast of Tobacco Springs, where an historic people lived in caves and left pictographs on the walls; West Tobacco Springs, 4.9 miles south-southwest of Tobacco Springs; and Mullins Springs, 14.2 miles east of Lamesa and 3.7 miles northeast of the Midway community in a canyon. Mullins Springs flowed until 1969.

**DEAF SMITH COUNTY:** Springs flowed along Tierra Blanca and Palo Duro creeks below the caprock in the northwest corner, and at Garcia Lake and other large lakes or deep depressions. In nearly all cases historic springs flowed from Ogallala sand and caliche, with a few issuing from Dockum sandstone. Tierra Blanca Creek once flowed constantly and large blue holes of spring water flowed to the surface at the community of Blue Water, later named Hereford. While irrigation's drawdown of the Ogallala aquifer was a factor in the decline of spring flow, Brune's studies indicated the plowing of native grasslands loosened fragile topsoil that washed into Tierra Blanca Creek and smothered many springs. Ability of the soil to recharge water to the aquifer was also damaged. During studies in May of 1977, Brune documented historic spring sites and their locations. Based on his studies at that time, Brune concluded that Big Springs on the Gault Ranch along Tierra Blanca Creek, about 4.3 miles west of the Randall County line, was the only flowing spring in Deaf Smith County, with a flow of about 5 gallons per minute. **Southeast of the Big Springs site about 3.1 miles, Parker Springs flowed from the base of caliche caprock Most of the springs at this location had disappeared by April of 2002, but one small spring has continued to seep, maintaining a small pool of water. Heavy rains in the area revitalized Devil's Canyon, south of Parker Springs. Seepage continues to maintain water in a cattle watering tank at that site. Sulphur Springs in Sulphur Park on the old L.R. Bradly farm, just upstream from the junction of Tierra Blanca Creek and Frio Draw was once the site of a lake popular for recreation. The Sulphur Springs area is today part of the City of Hereford's farm, some 4.9 miles northeast of Hereford, and two or three springs run intermittently here. Brune believed that Sulphur Springs failed by the 1940s. Recharge from rainfall or some other factor served to rejuvenate at least light flow, and several seeps can be found along Tierra Blanca Creek on the City of Hereford property. Spring flow in this area travels only a small distance before evaporating or going below ground. Just east of the Sulphur Springs area, several live springs are present on ranch property along the Tierra Blanca Creek. From 1972 through 1994 the flow of some 20 springs on the site did not stop, although it was often minimal. Most springs at this location flow intermittently, declining during the heavy irrigation season. During the fall and winter months water may flow for a mile or more in the channel of Tierra Blanca Creek. One spring at the site has flowed at a rate as high as 30 gallons per minute, but the flow falls off to approximately 15 gallons per minute during irrigation season. There is some question as to whether this water originates from the Ogallala, or a local perched aquifer.**

Bridwell Springs, on the Bridwell Ranch in the northwestern corner of the county have gone dry. Fowler Springs was found 1.8 miles west of the Randall County line on Palo Duro Creek, and Hodges Spring, 2.4 miles west of the Randall County line, are among springs that formerly flowed along Palo Duro Creek. Ojo Frio or Cold Spring was located in the Frio Draw upstream from its junction with Tierra Blanca Creek. Punta De Agua or Source of Water was 5.5 miles west of Hereford in Tierra Blanca Creek. Below this point Tierra Blanca Creek flowed constantly, but began to falter in 1925, well before massive development of irrigation, and after about 1940 there was no flow except from surface runoff. In western Deaf Smith County, 2.4 miles east of the New Mexico state line, the XIT Ranch used Escarbada Springs in historic times, but they are now dry. At least one small seep is still active in this area of western Deaf Smith County, adjacent to the New Mexico border. Ojo de Garcia or Little Garcia Springs formerly flowed from Dockum sandstone 1.2 miles west-northwest of Garcia Lake in western Deaf Smith County. Spring flow eventually decline to seeps, and water is only present in Garcia Lake now when large localized rainstorms cause runoff to flow to the lake.

**DICKENS COUNTY:** The northwest corner of Dickens County lies on the High Plains, underlain by Tertiary Ogallala sand, gravel and caliche. Abundant springs once flowed from this formation all along the caprock escarpment, but most have disappeared due to heavy pumping for the Ogallala aquifer. The remainder of the county lies in the Rolling Plains, where springs trickle from Permian gypsum and sandstone. Some historic springs were choked by erosion and buried as early as 1914. Most springs declined permanently by 1979. Historic springs and their locations include Browning Springs, 3.1 miles northwest of Dickens in Hobble Scobble Canyon; another spring is 4.9 miles northwest of Dickens. Pecan Grove Spring was 5.5 miles southeast of McAdoo. On Grapevine Creek were White House Springs, 4.3 miles northeast of McAdoo. Cottonwood Springs were just over a half-mile west of Afton, which can still flow in the event of heavy local rainfall. Erosion choked the creek bed in this area. A half-mile north of Afton are Patton Springs, which was eventually covered by a lake; Jackson Springs, 6.2 miles north of Dickens went dry and the creek channel filled with sand; **Sanders Springs**, **east-northeast of Afton, is also subject to rainfall recharge, with Brune documenting a flow of 158.4 gallons per minute in August, 1979 after a heavy local rainstorm; Shinnery Springs 6.2 miles southwest of Dumont on the Pitchfork Ranch still run year around according to Wyman Meinzer of Benjamin, TX. Brune documented a flow of less than 5 gallons per minute in August, 1979. Meinzer reports the flow is not large but is consistent. The water does not flow a long distance.** Dripping Springs are 5.5 miles southwest of Dumont, and were termed similar to Shinnery Springs. Law Springs are 2.4 miles northeast of Dickens. Dickens or Crow Springs are less than a mile northeast of Dickens. Brune noted a flow of 38 gallons per minute in August, 1979 following heavy rain. Mitchell Springs are 1.8 miles east-southeast of Dickens.

**FLOYD COUNTY:** Brune pronounced the story of springs in Floyd County as largely one of water sources that were once important, but are no more due to decline of the water table. Springs formerly issued from sands and gravels of the Ogallala formation. Blue Hole Springs was on Quitaque Creek 6.2 miles east of South Plains. It had no water flow in July of 1978 and had been partially filled with cobbles and gravel. Likewise, Bain Springs 8.6 miles southwest of Flomot, just below the caprock, was dry. Montgomery Springs, in Blanco Canyon, just north of the Crosby County line, ceased flowing in 1948. Massie Springs, 6.2 miles southwest of Floydada, ceased flowing about 1945.

**GAINES COUNTY**: Most of the springs here flowed from Ogallala and more recent sands. Decline of the Ogallala aquifer is cited as a cause for most springs drying up. Boar's Nest Springs in northwest Gaines County were dry by 1955. Cedar Lake or Laguna Sabinas in northeastern Gaines County was once surrounded and fed by numerous fresh and saline springs. Buffalo Springs on the north side of the lake and Johnson Springs on the south side of the lake had only small flows by 1963, but none of the Cedar Lake springs were flowing by 1977, although a few seeps were still evident. Balch Springs on McKensie Draw south of Cedar Lake was still yielding 39.6 gallons of water a minute when Brune measured in March, 1977, but **Bobby Tabor, soil conservationist with the Seminole Field office of NRCS, in a telephone interview on**

**February 3, 2005, reported there is no flow in that area today. A number of seeps were cited by Brune as existing along McKenzie Draw. Mr. Tabor related that a local landowner reported to him early in 2005 that at McKenzie Lake 19.2 miles east of Seminole and south of Cedar Lake two springs located on private property still run into McKenzie Lake. The flow rate isn't known, but probably isn't large.** South of Seminole 5.5 miles, Indian Wells was the site of as many as 20 seeps issuing from Ogallala sand. Downstream on Seminole Draw, six springs formerly flowed. Brune projects there were probably also seeps along Monument Draw in the southwestern corner of the county. Ward's Well at Hackberry Grove 2.4 miles south of Seminole was a former area of shallow water that could be hand-dipped, but the water table declined at this site.

**GARZA COUNTY**: The western edge of the county lies on the High Plains and on the edge of these plains springs flowed from Tertiary sand, gravel and caliche. Much of the county lies on the Red Bed or Gypsum Plains where some springs issued from Quaternary sand, gravel and caliche and from Triassic Dockum sandstone. Many springs weakened or failed as groundwater declined and severe erosion filled many stream channels and buried springs. **Mr. Glen Killough, district conservationist with the Post field office of the NRCS, says many seeps still exist off the caprock. They are local and their waters do not contribute to in-stream flows. Seeps and any small spring flows remaining are highly dependent on rainfall.** In the way of historic references: Post Springs, 3.1 miles west of Post, once a source of part of the water for that city, are now dry. Golf Course Springs 3.1 miles northwest of Post once discharged water over a mile downstream and were strong in the 1930s, declined to only a seep in 1975. Tipton Springs, 4.3 miles northwest of Post, have been dry since about 1945. Barnum Springs were 7.4 miles north-northwest of Post. Live water existed in holes until about 1975. Double U Springs were noted 3.7 miles southeast of Eastland. Brune measured a flow of 3.1 gallons per minute in June, 1979. Whiskey Springs, 3.1 miles northeast of Southland were a tiny trickle of 0.79 gallons per minute in June of 1979 and a similar spring in Red Creek 1.2 miles south-southwest flowed even less. Llano Springs 8 miles north of Post on the northeast side of the Brazos River flowed until the 1940s, and seeps could still occur in the event of wet weather. Lane Springs 6.2 miles southwest of Kalgary had declined to seep status by the time of Brune's survey and Indian Springs 5.5 miles south-southeast of Kalgary trickled at 1.9 gallons per minute when Brune measured in August of 1979, and might be subject to some seepage in the event of favorable rainfall. Chimney Springs were noted less than a half-mile upstream. K Springs were located 3.7 miles east-southeast of Indian Springs. Southeast of Lane Springs some seeps were noted and 2.4 miles farther south Slick Nasty Springs were once an important watering site on the Spur Ranch, but reduced to seeps. OS Springs was cited 9.3 miles east of Post, south of the North Fork of the Double Mountain Fork of the Brazos River, characterized even in 1979 as only wet weather seeps. Reed Springs, 4.9 miles east of Justiceburg was a seep from Dockum sandstone. Rocky Springs, 5.5 miles east-southeast of Justiceburg fed Rocky Creek with slightly saline water from Dockum sandstone bluffs. Spring Creek Springs were 4.3 miles southeast of Grassland, and were about seven groups of springs that flowed 34.8 gallons per minute in the winter, but less in summer. Spring water flowed as much as two miles. Cooper Springs in Cooper's Canyon 4.3 miles south of

Post were once strong but flowed only about 11 gallons per minute in 1979. Boy Scout Springs, 2.4 miles southwest of Post stopped flowing about 1946 but there were still wet weather seeps in 1979. Box Canyon Springs, 2.4 miles west-southwest of Post flowed at 13.1 gallons per minute in June of 1979.

**HALE COUNTY:** Brune noted no flowing springs in Hale County, although historically, springs and spring-fed creeks were abundant. Decline of the water table is a factor in the demise of the springs. Norfleet Springs were in the northwest corner of the county 1.2 miles from the Lamb County line on Running Water Draw and bubbled up in 12 or 13 springs in the 1930s, but failed by 1945. Downstream on Running Water Draw 6.2 miles west of Edmonson was Ojo de Agua Springs. These and other springs maintained a running stream in Running Water Draw. These springs dried up in the 1950s with some seepage until the 1960s. Jones Springs were 3.1 miles west of Edmonson. Running Water Springs were roughly 2.4 miles south of Edmonson, on the north side of the draw. Up to 12 feet of silt from erosion had filled the draw by the late 1970s. On Crawfish Draw were once Crawfish Springs 7.4 miles south of Hale Center. They dried up by 1920. Eagle Springs were 7.4 miles west-northwest of Abernathy on Blackwater Draw. It dried up in the 1930s and seeped intermittently until the 1940s.

**HOCKLEY COUNTY:** The springs of Hockley County issued from Tertiary Ogallala sand and gravel. Decline of the water table impacted local springs. Silver Springs was located at Silver Lake or Laguna Plata, in the northwest corner of the county, where springs issued at various points around the lake. The flow was less than a gallon per minute in October of 1978. The Devil's Ink Well was a pool of water in Sucker Rod Draw 3.7 miles east-southeast of Pep. Yellow House Springs were two small springs 4.3 miles east of Pep. Small springs once flowed 4.3 miles northeast of Pettit. Some seeps existed in Yellow House Draw until about 1920.

**LAMB COUNTY:** The channel from Water Draw 6.2 miles east-southeast of Sunnyside, has been choked with sand washed in by erosion. King Springs was 6.8 miles north of Olton. It fed into Running Water Draw, but failed in the 1950s, however there was some seepage into the 1960s. Many springs once flowed on Blackwater Draw. Alamosa Springs was 4.3 miles east of the Bailey County line on Blackwater Draw. Soda Lake and Springs were two miles farther south. Spring Lake was located on Blackwater Draw 4.9 miles west of Earth. Springs here lasted until 1942, with seeps persisting until the early 1960s. In the sandhills, many lakes were once fed by springs and seeps. Sod House Spring 6.2 miles north of Amherst on Blackwater Draw flowed until the 1950s. Rocky Ford Springs were just upstream from the Highway. Brune noted only a few springs still flowing here in the late 1970s. Springs formerly ran on County Road 385 crossing of Blackwater Draw 6.8 miles northeast of Amherst, but faltered in the 1940s and were gone in the 1950s. Fieldton Springs south of Fieldton were gone around 1949. Hart Springs were a little over a half mile southeast of Hart Camp, but the springs, draw and lake that dried up in the 1930s. Bull Springs, at Bull Lake 8 miles west of Littlefield, were already only a seep by 1978. Rains could cause some seepage. Roland Springs formed a chain of pools in Bull Draw, and they were only seeps in October of 1978, although the springs ran a bit in the winter. Glumpler Springs were 3.1 miles north-

northeast of Pep and flowed about 8 gallons per minute in October, 1978. Just south of Glumpler Creek on Goat Creek Green Springs flowed 11.8 gallons per minute of slightly saline water in October, 1978. Illusion Springs on the north end of Illusion Lake flowed 25.3 gallons per minute of moderately saline water in October, 1978. At the end of Yellow Lake Yellow Springs was part of a series of freshwater springs once present along the eastern shore of Yellow Lake, and flowed an intermittent 2.2 gallons per minute in October, 1978. Some saline springs were 1.8 miles west of Yellow Lake, near the Hockley County line, with one flowing 11.2 gallons per minute in 1978 and several others dry.

**LUBBOCK COUNTY:** Springs once flowed abundantly along Yellowhouse and Blackwater Draws, emerging chiefly from Ogallala sand and gravel. Lubbock Springs were at the Lubbock Lake archaeological site near the intersection of Highway 84 and Loop 289. These springs had failed to flow by the early 1950s. **Buffalo Springs, in Yellow House Canyon 9.9 miles southeast of Lubbock, were immersed by a lake at the site. Brune reported that measurement of the flow of Buffalo Springs could be made only by comparing discharge above and below Buffalo Lake and allowing for evaporation. Discharge including all springs in the Buffalo Lake area was 1,246.9 gallons per minute as measured by Brune in 1976, and the historic high discharge was 1,521.2 gallons in 1969, when all spring flow combined was measured. Currently, effluent from Lubbock of 1 to 2 million gallons per day flows into Buffalo Lake. Johnson Springs are at Lake Ransom Canyon just downstream from Buffalo Lake and may receive some recharge from Buffalo Lake. Brune measured 15.8 gallons per minute in December, 1975, but the flow had declined to less than a gallon per minute by August, 1978.** Tinsley Springs, 3.7 miles downstream in Yellow House Canyon, flowed 11.5 gallons per minute in August, 1978.

**LYNN COUNTY:** In Lynn County, spring water flowed mainly from Ogallala sand and gravel, with some from Triassic Dockum sandstone, but spring output has been reduced due to the decline of the aquifer. Double Lakes Springs, 8.6 miles northwest of Tahoka on the north side of Double Lakes, issued 15.8 gallons per minute in December 1975. Spring sites were partially buried by sediment. **Tahoka Springs on the west side of Tahoka Lake 6.21 miles north of Tahoka included a large spring near the north end of the lake that flowed 53.8 gallons per minute in December, 1974, and several other springs farther south combined for a flow of 95 gallons per minute at that time.** Moore Springs, 2.4 miles southeast of Grassland in Moore's Draw produced 25.3 gallons per minute in 1975. Guthrie Springs were in Chimney Draw northwest of Guthrie Lake, 3.7 miles southwest of Tahoka, but last flowed some 75 years ago. Saleh Lake and Seeps were noted 3.7 miles southeast of New Moore. Gooch Springs about 1.2 miles farther west at Gooch Lake, and the largest spring flowed 12.3 gallons per minute in October 1978. **Frost Lake, 4.3 miles south-southwest of New Moore was fed by water from Frost Springs, which discharge 66.5 gallons per minute in October, 1978. New Moore Springs**, **1.8 miles west-northwest of New Moore were reported by Brune as being suddenly rejuvenated in 1968 by a combination of high rainfall and potential injection of water brought in from Rich Lake at the upstream Ozark-Mahoning mine. Brune measured a flow of 90.3 gallons per minute of moderately saline water**

**in October of 1978. Historically, the flow at this location has been greater in the winter months. Mr. Pat Childress of O'Donnell reported in a telephone interview on February 6, 2005, that a lake had formed at the New Moore Springs site as the spring flow had been greatly enhanced by the heavy rainfall of 2004. The springs were at that time covered by the lake water and Mr. Childress estimated that the flow was probably comparable to past measurements, although spring flow had declined severely and the springs had about dried up prior to the high rainfall year of 2004. The lake at the location is filled with what Mr. Childress called "gyppy" water, not suitable for human consumption, but used by wildlife. Frost Springs was also reported by Mr. Childress to have regained strength thanks to the high rainfall. Brune noted in 1975 that water flowed into the swampy area at New Moore Springs from Ogallala sand and that salt cedars were numerous around the site, with flow increasing in the winter when salt cedars and other vegetation were dormant. Spring and seep-fed lakes and pools in this area have historically been important to large numbers of sandhill cranes as well as to wintering ducks.**

**MOTLEY COUNTY:** Nearly all springs in the county flow from Ogallala sand and Triassic Dockum sandstone. Pumping from the Ogallala aquifer has caused a decline in the aquifer and lessened spring flow. Quitaque Creek, estimated in the 1940s to be capable of furnishing 3 million gallons per day, had greatly reduced flows by the mid1970s. **Roaring Springs, 3.1 miles south of the town of that name, remains one of the crown jewels of spring flow in the Llano Estacado Region, although its flow is greatly diminished from historic levels. The area around the springs has been developed with a golf course, camp ground and RV parking. Spring waters fall with namesake sound over a sandstone ledge. The recharge area for Roaring Springs is 12 miles or more to the west, where rainfall runoff slowly seeps into Ogallala sands. Today, irrigation of pasture land just upstream from the spring site can greatly diminish the flow when wells begin operating in the summer. Brune noted, when measuring spring flow in 1978 at 633 gallons per minute, that very little decline in spring slow had occurred in the previous 40 years; i.e.; the flow was 664 gallons per minute in 1962, and the all-time high flow since records began in 1937 was 1,125 gallons per minute in 1946. However, heavy irrigation pumping wasn't occurring adjacent to the springs at that time. While anecdotal information was obtained via phone calls in February 2005, current flow measurements were not available. Anecdotes from local residents indicate that spring flow has declined appreciably over the past two decades. One local resident related that filling a recreational swimming pool with flow from the springs could once be accomplished overnight, but now the process takes days. Water from Roaring Springs feeds into a swimming pool and runs only a short distance before entering the South Pease or Tongue River, where it quickly goes underground. The South Pease merges with the Middle and North Pease to form the Pease River that eventually flows into the Red River.** Scab Springs, 13.6 miles east of Matador on Highway 70, have been dry since 1945. Wolf Spring, 7.4 miles southwest of Roaring Springs were the source of Wolf Creek, where the combined flow of several springs at the site amounted to 112.5 gallons per minute when Brune noted them in June of 1975. Anecdotal information taken in February 2005 indicated they do not flow now. **Dutchman Springs on Dutchman**

**Creek 6.21 miles west-northwest of Roaring Springs was measured by Brune at 36.4 gallons per minute in July, 1979. Anecdotal information gathered in February 2005 indicated that some seasonal seepage still occurs at the site, though it is little more than a trickle. The presence of several earthen dams along the headwaters of the spring drainage may be one of the reasons for the decline of this spring.** Ballard Springs, 1.2 miles south of Matador, were measured at 13.4 gallons per minute in July, 1978, and fed an earthen stock tank. Priest Springs, 2.4 miles southwest of Matador, measured 20.5 gallons per minute in August 1978. Willow Springs, 3.7 miles southwest of Matador, flowed 15 gallons per minute in August 1978. Dripping Springs, now dry, were 6.21 miles west-southwest of Matador. Lost Canyon springs were 5.5 miles west of Matador in Lost Canyon. Mott Camp Springs were 10.5 miles west of Matador. Chimney Springs were 1.2 miles northwest of Mott Camp Springs and were only wet weather seeps in 1978. Burleson Springs, 8.6 miles west-southwest of Whiteflat, had ceased flowing by 1978. Chimney Springs, 1.2 miles northwest of Mott Camp Springs were cited as wet weather seeps in 1978. Miller Springs, 7.4 miles west of Whiteflat flowed only 1.5 gallons per minute in 1979.

**PARMER COUNTY:** Springs were once numerous along the county’s major draws, but they began to disappear by 1900. On Frio Draw, about a half-mile east of the Texas-New Mexico state line, on the north side, a spring flowed intermittently from a cave in 1927. At Mustang Lake, 2.4 miles north-northwest of Bovina, springs flowed until the 1930s. A spring also once flowed intermittently 3.7 miles east of Bovina on Running Water Draw.

**SWISHER COUNTY:** In Swisher County**,** springs once flowed along Tule Creek, and historically, spring water flowed in North, Middle, and South Tule Creeks. As the aquifer level declined, spring flow diminished. Some springs were also buried by silt from severe erosion. Rogers Springs in western Mackenzie Lake Park offered only seeps from Triassic sandstone when measured by Brune in September 1978. Prairie Dog Springs were at the Highway 2301 crossing of Tule Creek, but are now only a seep. About a half-mile northwest of the bridge JA or Anderson Springs once flowed, but they were dry when Brune noted them. Hackberry Springs were some 1,600 feet farther upstream. They dried up in 1974. Dawson Springs were 3.1 miles downstream from the Highway 1318 crossing of Tule Creek. They ran until the 1930s when some were buried by silt. Just over a half-mile downstream from the Highway 1318 crossing were Elkins Springs, now, long dry. Edwards Springs were 1.2 miles upstream from the Highway 1318 crossing. They flowed in winter until drying up in 1956. Poff Springs were 0.62 miles downstream from the Highway 146 crossing and 3.1 miles north-northeast of Tulia. They ceased flowing about 1940. Faulkner Springs were in Mackenzie Park in southeast Tulia, and flowed until the 1930s. Maupin Springs, 1.8 miles upstream from Highway 87 flowed until the 1920s. Hardy Springs, 3.1 miles past the Highway 87 crossing, are dry.

**TERRY COUNTY:** Springs in Terry County issue primarily from Ogallala sand and caliche, and in modern times, are highly wet-weather dependent. **Mr. Jason Coleman of the South Plains Underground Water Conservation District reported in February 2005 that abundant summer, fall, and early winter rainfall in 2004**

**contributed to a renewal of some springs and seeps that generally flow from Ogallala sands. Some on the perimeter of saline lakes are not Ogallala, but flow from a Cretaceous outcrop exposed at the surface. Mr. Coleman reports that many of his observations are of pools only, without measurable flow, probably supported by slow seeps. One member of the South Plains UWCD board has several such seeps on his dryland farm on the Terry-Lynn County line. Another board member reported several seeps/springs near his house north of Wellman along Sulphur Springs Draw. This gentleman had not seen water standing in that draw for nearly 60 years prior to the 2004 wet-weather-related events. Mr. Coleman found one section of Lost Draw running from southeast Terry County into Lynn County that contained a small lake lying in Terry County, probably spring or seep-fed.** Decline of the groundwater level has been a factor in the demise of most springs and seeps in this county. At Rich Springs at Rich Lake, 4.3 miles south-southeast of Meadow, water issued from Tahoka Sand on Duck Creek shale. Brune measured flow from springs at the north end of the lake totaling 19 gallons per minute in October 1978, and noted the presence of many other very small springs flowing around the lake. Rich Lake has historically been important to sandhill cranes as a roost site. Local anecdotal information indicated that in previous times, the lake rose before rains, indicating that springs and the lake were impacted by barometric pressure. Mound Springs at Mound Lake, 10.5 miles east-northeast of Brownfield was documented by Brune as flowing 63.3 gallons per minute of highly saline water in December of 1975. This water fed into Mound Lake. On South Lost Draw, 10.5 miles southeast of Brownfield, Seven Lakes was fed by numerous springs and seeps, with the springs increasing flow before a rain when barometric pressure changed. Brune documented the historic presence of many small springs along Sulphur Springs Draw 6.21 miles east-southeast of Wellman. Many of these seep-fed lakes and pools have historically been important to wildlife including sandhill cranes and waterfowl.

**YOAKUM COUNTY**: Brune noted following studies in March 1977 that springs and seeps formerly existed along all of the major draws in Yoakum County, flowing mainly from Ogallala and more recent sands, but decline of the water table resulted in all of the springs of the county drying up. Oho Springs were in New Mexico, 3.1 miles west of Bronco, Texas. Ulou was downstream on Sulphur Springs Draw, about halfway between Bronco and Plains, where springs once likely existed. Other springs also likely existed farther downstream on Sulphur Springs Draw. Southwest of Plains 9.9 miles, INK Basin was once a seep-fed freshwater basin, has been dry since 1949. Evidence of springs was also found present in Lost Draw in the northeast part of the county.

# *Appendix C*

## *Socioeconomic Impacts of Unmet Water Needs in the Llano Estacado Water Planning Area*

**Appendix C**
**Table C-01.**
**Projected Water Needs (Shortages) and**
**Socioeconomic Impacts of Failing to Meet Projected Water Needs (Shortages)**
**Llano Estacado Water Panning Region (Region O)**

| County/WUG | Basin | Use | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Water Shortages** | | | | | | | | |
| **Bailey** | | | | | | | | |
| Irrigation | Brazos | Irrig | 81,561 | 85,721 | 84,647 | 84,229 | 83,647 | 83,220 |
| | | | | | | | | |
| **Briscoe** | | | | | | | | |
| Irrigation | Red | Irrig. | | 4,751 | 12,101 | 13,656 | 14,905 | 14,610 |
| | | | | | | | | |
| **Castro** | | | | | | | | |
| Dimmitt | Red | Mun | | 0 | 744 | 805 | 832 | 844 |
| | | | | | | | | |
| Irrigation | Red | Irrig | 54,494 | 86,700 | 108,378 | 121,663 | 118,476 | 116,498 |
| Irrigation | Brazos | Irrig | 92,201 | 104,644 | 154,660 | 228,901 | 232,260 | 228,527 |
| Irrigation Total | | | 146,695 | 191,344 | 263,038 | 350,564 | 350,736 | 345,025 |
| | | | | | | | | |
| Beef Feedlots | Red | CAFO | | | | 852 | 1,207 | 1,282 |
| Beef Feedlots | Brazos | CAFO | | 759 | 1,612 | 3,427 | 3,638 | 3,862 |
| Dairies | Brazos | CAFO | | | 450 | 749 | 1,107 | 1,228 |
| CAFO Total | | | | 759 | 2,062 | 5,028 | 5,952 | 6,372 |
| | | | | | | | | |
| **Cochran** | | | | | | | | |
| Morton | Brazos | Mun | | 560 | 565 | 547 | 521 | 496 |
| | | | | | | | | |
| Irrigation | Brazos | Irrig | 30,699 | 28,328 | 32,371 | 32,657 | 51,833 | 49,407 |
| Irrigation | Colo | Irrig | 9,210 | 9,412 | 3,865 | 2,155 | 24,189 | 22,675 |
| Irrigation Total | | | 39,909 | 37,741 | 36,236 | 34,812 | 76,022 | 72,083 |
| | | | | | | | | |
| **Crosby** | | | | | | | | |
| Lorenzo | Brazos | Mun | | | 37 | 69 | 92 | 108 |
| Ralls | Brazos | Mun | | | 4 | 7 | 323 | 318 |
| Municipal Total | | | 0 | 0 | 41 | 76 | 415 | 426 |
| | | | | | | | | |
| Irrigation | Red | Irrig | 887 | 831 | 790 | 751 | 726 | 675 |
| Irrigation | Brazos | Irrig | 8,401 | 8,000 | 7,589 | 7,192 | 5,859 | 5,535 |
| Irrigation Total | | | 9,288 | 8,831 | 8,378 | 7,943 | 6,585 | 6,210 |

| County/WUG | Basin | Use | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Hale** | | | | | | | | |
| Abernathy (part) Hale | Brazos | Mun | | 122 | 178 | 217 | 243 | 260 |
| Abernathy (part) Lubbo | Brazos | Mun | | 182 | 188 | 186 | 190 | 186 |
| Petersburg | Brazos | Mun | | | | | 312 | 306 |
| Municipal Total | | | 0 | 304 | 366 | 403 | 745 | 752 |
| | | | | | | | | |
| Irrigation | Red | Irrig | 2,726 | 3,437 | 3,323 | 3,213 | 3,107 | 3,004 |
| Irrigation | Brazos | Irrig | 18,234 | 51,447 | 134,921 | 202,571 | 218,895 | 217,238 |
| Irrigation Total | | | 20,960 | 54,884 | 138,244 | 205,784 | 222,002 | 220,242 |
| | | | | | | | | |
| Beef Feedlots | Brazos | CAFO | | | 573 | 609 | 1,939 | 2,058 |
| Dairies | Brazos | CAFO | | | | 187 | 208 | 460 |
| CAFO Total | | | | | 573 | 796 | 2,147 | 2,518 |
| | | | | | | | | |
| **Hockley** | | | | | | | | |
| Anton | Brazos | Mun | 263 | 270 | 272 | 268 | 256 | 243 |
| Ropesville | Brazos | Mun | | | 91 | 89 | 85 | 81 |
| Smyer | Brazos | Mun | | | | | | 62 |
| Sundown | Colo | Mun | | 350 | 353 | 347 | 332 | 316 |
| Municipal Total | | | 263 | 620 | 716 | 704 | 673 | 702 |
| | | | | | | | | |
| Irrigation | Brazos | Irrig | 58,043 | 68,825 | 74,757 | 80,030 | 76,343 | 74,621 |
| Irrigation | Colo | Irrig | 5,070 | 5,869 | 6,930 | 6,739 | 6,532 | 5,961 |
| Irrigation Total | | | 63,113 | 74,694 | 81,687 | 86,769 | 82,876 | 80,582 |
| | | | | | | | | |
| **Lamb** | | | | | | | | |
| Amherst | Brazos | Mun | | | 0 | 0 | 0 | 0 |
| Earth | Brazos | Mun | | | | 283 | 280 | 276 |
| Municipal Total | | | 0 | 0 | 0 | 283 | 280 | 276 |
| | | | | | | | | |
| Irrigation | Brazos | Irrig | 114,832 | 158,445 | 201,653 | 238,161 | 248,021 | 250,327 |
| | | | | | | | | |
| Beef Feedlots | Brazos | CAFO | | | 241 | 1,023 | 1,358 | 1,730 |
| Dairies | Brazos | CAFO | | | 134 | 595 | 990 | 1,280 |
| CAFO Total | | | | | 375 | 1,618 | 2,348 | 3,010 |

| County/WUG | Basin | Use | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Lubbock** | | | | | | | | |
| Idalou | Brazos | Mun | | | | 274 | 273 | 272 |
| Lubbock | Brazos | Mun | 8,602 | 10,496 | 13,454 | 15,765 | 19,333 | 20,649 |
| New Deal | Brazos | Mun | | 12 | 20 | 20 | 25 | 20 |
| Shallowater | Brazos | Mun | 157 | 180 | 190 | 184 | 192 | 184 |
| Slaton | Brazos | Mun | | | | | 0 | 0 |
| Wolfforth | Brazos | Mun | | | | | 165 | 388 |
| Municipal Total | | | 8,759 | 10,688 | 13,664 | 16,243 | 19,988 | 21,513 |
| | | | | | | | | |
| Irrigation | Brazos | Irrig | 60,657 | 89,918 | 98,898 | 108,668 | 100,910 | 95,586 |
| | | | | | | | | |
| **Lynn** | | | | | | | | |
| Wilson | Brazos | Mun | | 68 | 65 | 63 | 60 | 55 |
| | | | | | | | | |
| Irrigation | Colo | Irrig | 550 | 508 | 464 | 408 | 406 | 402 |
| | | | | | | | | |
| **Motley** | | | | | | | | |
| Irrigation | Red | Irrig | 1,332 | 1,266 | 1,208 | 1,154 | 1,092 | 1,025 |
| | | | | | | | | |
| **Parmer** | | | | | | | | |
| Friona | Red | Mun | | | 384 | 425 | 437 | 431 |
| Farwell | Brazos | Mun | | 1 | 46 | 80 | 99 | 106 |
| Municipal Total | | | 0 | 1 | 430 | 505 | 536 | 537 |
| | | | | | | | | |
| Irrigation | Red | Irrig | 46,723 | 97,024 | 101,411 | 84,198 | 81,912 | 83,715 |
| Irrigation | Brazos | Irrig | 114,658 | 234,206 | 259,793 | 272,089 | 268,728 | 262,242 |
| Irrigation Total | | | 161,381 | 331,230 | 361,204 | 356,287 | 350,640 | 345,957 |
| | | | | | | | | |
| Beef Feedlots | Brazos | CAFO | | | | 749 | 2,386 | 3,377 |
| Dairies | Brazos | CAFO | | | 180 | 797 | 1,326 | 1,715 |
| CAFO Total | | | | | 180 | 1,546 | 3,712 | 5,092 |
| | | | | | | | | |
| **Swisher** | | | | | | | | |
| Kress | Red | Mun | 0 | 0 | 0 | 0 | 0 | 0 |
| Tulia | Red | Mun | 417 | 417 | 417 | 417 | 417 | 417 |
| Municipal Total | | | 417 | 417 | 417 | 417 | 417 | 417 |
| | | | | | | | | |
| Irrigation | Red | Irrig | 7,849 | 12,520 | 24,737 | 33,364 | 35,512 | 35,931 |
| Irrigation | Brazos | Irrig | 14,031 | 47,142 | 70,459 | 71,418 | 71,555 | 71,130 |
| Irrigation Total | | | 21,879 | 59,662 | 95,196 | 104,782 | 107,067 | 107,061 |

| County/WUG | Basin | Use | Projections 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Terry** | | | | | | | | |
| Brownfield | Colo | Mun | | 115 | 280 | 435 | 458 | 457 |
| | | | | | | | | |
| Irrigation | Brazos | Irrig | 3,581 | 3,400 | 3,228 | 3,541 | 3,109 | 2,703 |
| Irrigation | Colo | Irrig | 71,307 | 88,577 | 97,838 | 102,699 | 94,640 | 87,053 |
| Irrigation Total | | | 74,888 | 91,977 | 101,066 | 106,240 | 97,749 | 89,756 |
| | | | | | | | | |
| **Yoakum** | | | | | | | | |
| Denver City | Colo | Mun | | | 979 | 1,046 | 1,024 | 1,000 |
| Plains | Colo | Mun | | 448 | 468 | 488 | 473 | 457 |
| Municipal Total | | | 0 | 448 | 1,447 | 1,534 | 1,497 | 1,457 |
| | | | | | | | | |
| Irrigation | Colo | Irrig | 23,779 | 22,126 | 20,029 | 18,898 | 17,937 | 17,028 |
| | | | | | | | | |
| **Region O Basin Totals** | Basin | | | | | | | |
| | Canadian | | | | | | | |
| | | Mun | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Irrig | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | |
| | Red | | | | | | | |
| | | Mun | 417 | 417 | 1,785 | 1,881 | 1,910 | 1,904 |
| | | Irrig | 336,769 | 469,622 | 547,513 | 583,833 | 571,328 | 563,818 |
| | | Beef Fdlt | 0 | 0 | 0 | 1,369 | 1,755 | 1,864 |
| | | Dairies | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total | Total | 337,186 | 470,039 | 549,298 | 587,083 | 574,993 | 567,586 |
| | | | | | | | | |
| | Brazos | | | | | | | |
| | | Mun | 9,044 | 11,913 | 15,132 | 18,335 | 22,865 | 24,495 |
| | | Irrig | 645,721 | 927,937 | 1,169,223 | 1,374,753 | 1,405,052 | 1,381,721 |
| | | Beef Fdlt | | 759 | 2,426 | 5,808 | 9,321 | 11,027 |
| | | Dairies | | 0 | 764 | 2,328 | 3,631 | 4,683 |
| | Total | | 654,765 | 940,609 | 1,187,545 | 1,401,224 | 1,440,869 | 1,421,926 |
| | | | | | | | | |
| | Colorado | | | | | | | |
| | | Mun | 0 | 913 | 2,080 | 2,316 | 2,287 | 2,230 |
| | | Irrig | 271,286 | 325,132 | 337,110 | 343,166 | 355,959 | 344,972 |
| | | Beef Fdlt | | | | | | |
| | | Dairies | | | | | | |
| | Total | | 271,286 | 326,045 | 339,190 | 345,482 | 358,246 | 347,202 |

| | | | Projections | | | | | |
|---|---|---|---|---|---|---|---|---|
| **County/WUG** | **Basin** | **Use** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | | | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Region O Totals** | | | | | | | | |
| | | Mun | 9,461 | 13,243 | 18,997 | 22,532 | 27,062 | 28,629 |
| | | Irrig | 1,253,776 | 1,722,690 | 2,053,846 | 2,301,752 | 2,332,340 | 2,290,511 |
| | | Beef Fdlt | 0 | 759 | 2,426 | 7,177 | 11,076 | 12,891 |
| | | Dairies | 0 | 0 | 764 | 2,328 | 3,631 | 4,683 |
| **Total Shortage** | | | 1,263,237 | 1,736,692 | 2,076,032 | 2,333,789 | 2,374,109 | 2,336,714 |
| | | | | | | | | |
| | | | | | | | | <><><> |

# Appendix C

## Socioeconomic Impacts of Projected Water Needs for the Llano Estacado (Region O) Regional Water Planning Area

Prepared in support of the 2011 Llano Estacado Regional Water Plan


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April 2010

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**Tables**

# Introduction

Water needs (referred to as shortages in the main body of this report) during drought would likely curtail or eliminate economic activity in business and industries reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline, and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on existing businesses and industry, but they could also adversely affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Administrative rules require that regional water planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process, and rules direct TWDB staff to provide technical assistance: "*The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs*" [(§357.7 (4)(A)]. Staff of the TWDB's Water Resources Planning Division designed and conducted this report in support of the Llano Estacado Regional Water Planning Area (Region O).

This document summarizes results of our analysis and discusses the methodology used to generate the results. Section 1 outlines the overall methodology and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 2 presents the results for each category where shortages are reported at the regional planning area level and river basis level. Results for individual water user groups are not presented, but are available upon request.

# 1. Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

## 1.1 Economic Impacts of Water Shortages

### 1.1.1 General Approach

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts or benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. When analyzing the economic impacts of water shortages as defined in Texas water planning, three potential scenarios are possible:

1) Scenario 1 involves situations where there are physical shortages of raw surface or groundwater due to drought of record conditions. For example, City A relies on a reservoir with average conservation storage of 500 acre-feet per year and a firm yield of 100 acre feet. In 2010, the city uses about 50 acre-feet per year, but by 2030 their demands are expected to increase to 200

acre-feet. Thus, in 2030 the reservoir would not have enough water to meet the city's demands, and people would experience a shortage of 100 acre-feet assuming drought of record conditions. Under normal or average climatic conditions, the reservoir would likely be able to provide reliable water supplies well beyond 2030.

2) Scenario 2 is a situation where despite drought of record conditions, water supply sources can meet existing use requirements; however, limitations in water infrastructure would preclude future water user groups from accessing these water supplies. For example, City B relies on a river that can provide 500 acre-feet per year during drought of record conditions and other constraints as dictated by planning assumptions. In 2010, the city is expected to use an estimated 100 acre-feet per year and by 2060 it would require no more than 400 acre-feet. But the intake and pipeline that currently transfers water from the river to the city's treatment plant has a capacity of only 200 acre-feet of water per year. Thus, the city's water supplies are adequate even under the most restrictive planning assumptions, but their conveyance system is too small. This implies that at some point – perhaps around 2030 - infrastructure limitations would constrain future population growth and any associated economic activity or impacts.

3) Scenario 3 involves water user groups that rely primarily on aquifers that are being depleted. In this scenario, projected and in some cases existing demands may be unsustainable as groundwater levels decline. Areas that rely on the Ogallala aquifer are a good example. In some communities in the Panhandle region, irrigated agriculture forms a major base of the regional economy. With less irrigation water from the Ogallala, population and economic activity in the region could decline significantly assuming there are no offsetting developments.

Assessing the social and economic effects of each of the above scenarios requires various levels and methods of analysis and would generate substantially different results for a number of reasons; the most important of which has to do with the time frame of each scenario. Scenario 1 falls into the general category of static analysis. This means that models would measure impacts for a small interval of time such as a drought. Scenarios 2 and 3, on the other hand imply a dynamic analysis meaning that models are concerned with changes over a much longer time period.

Since administrative rules specify that planning analysis be evaluated under drought of record conditions (a static and random event), socioeconomic impact analysis developed by the TWDB for the state water plan is based on assumptions of Scenario 1. Estimated impacts under scenario 1 are point estimates for years in which shortages are reported (2010, 2020, 2030, 2040, 2050 and 2060). They are independent and distinct "what if" scenarios for a particular year and shortages are assumed to be temporary events resulting from drought of record conditions. Estimated impacts measure what would happen if water user groups experience water shortages for a period of one year.

The TWDB recognize that dynamic models may be more appropriate for some water user groups; however, combining approaches on a statewide basis poses several problems. For one, it would require a complex array of analyses and models, and might require developing supply and demand forecasts under "normal" climatic conditions as opposed to drought of record conditions. Equally important is the notion that combining the approaches would produce inconsistent results across regions resulting in a so-called "apples to oranges" comparison.

A variety tools are available to estimate economic impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Since the planning horizon extends through 2060, economic variables in the baseline are adjusted in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Future values for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category.

The following steps outline the overall process.

Step 1*: Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[1] Using IMPLAN software and data, transaction tables conceptually similar to the one discussed previously were estimated for each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales -** total production measured by sales revenues;
- **intermediate sales -** sales to other businesses and industries within a given region;
- **final sales –** sales to end users in a region and exports out of a region**;**
- **employment -** number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income -** total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes -** sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in constant year 2006 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted

[1]The IMPLAN database consists of national level technology matrices based on benchmark input-output accounts generated by the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment, and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to national totals using a matrix ratio allocation system and county data are balanced to state totals.

as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. Each IMPLAN sector was assigned to a specific water use category.

Step 2: *Estimate Direct and Indirect Economic Impacts of Water Shortages*

Direct impacts are reductions in output by sectors experiencing water shortages. For example, without adequate cooling and process water a refinery would have to curtail or cease operation, car washes may close, or farmers may not be able to irrigate and sales revenues fall. Indirect impacts involve changes in inter-industry transactions as supplying industries respond to decreased demands for their services, and how seemingly non-related businesses are affected by decreased incomes and spending due to direct impacts. For example, if a farmer ceases operations due to a lack of irrigation water, they would likely reduce expenditures on supplies such as fertilizer, labor and equipment, and businesses that provide these goods would suffer as well.

Direct impacts accrue to immediate businesses and industries that rely on water and without water industrial processes could suffer. However, output responses may vary depending upon the severity of shortages. A small shortage relative to total water use would likely have a minimal impact, but large shortages could be critical. For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky.[2] As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production, but it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in

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[2] Royal, W. "*High And Dry - Industrial Centers Face Water Shortages*." in Industry Week, Sept, 2000.

[3] The efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

- if water shortages are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;
- if water shortages are 5 to 30 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.50 percent reduction in output;
- if water shortages are 30 to 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.75 percent reduction in output; and
- if water shortages are greater than 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 1.0 percent (i.e., a proportional reduction).

In some cases, elasticities are adjusted depending upon conditions specific to a given water user group.

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. The formula for a given IMPLAN sector is:

$D_{i,t} = Q_{i,t} *_{,} S_{i,t} * E_Q * RFD_i * DM_{i(Q, L, I, T)}$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

$E_Q$ = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Secondary impacts were derived using the same formula used to estimate direct impacts; however, indirect multiplier coefficients are used. Methods and assumptions specific to each water use sector are discussed in Sections 1.1.2 through 1.1.4.

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[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages,*" Spectrum Economics, Inc. November, 1991.

***General Assumptions and Clarification of the Methodology***

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1. Shortages as reported by regional planning groups are the starting point for socioeconomic analyses.

2. Estimated impacts are point estimates for years in which shortages are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct “what if” scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities shortages are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, regardless of whether or not there is a drought. This implies that infrastructure limitations would constrain economic growth. However, since shortages as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under “normal” or “most likely” future climatic conditions.

3. While useful for planning purposes, this study is not a benefit-cost analysis. Benefit cost analysis is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of shortages. Nevertheless, one could include some impacts measured in this study as part of a benefit cost study if done so properly. Since this is not a benefit cost analysis, future impacts are not weighted differently. In other words, estimates are not discounted. If used as a measure of economic benefits, one should incorporate a measure of uncertainty into the analysis. In this type of analysis, a typical method of discounting future values is to assign probabilities of the drought of record recurring again in a given year, and weight monetary impacts accordingly. This analysis assumes a probability of one.

4. IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as “final sales,” multipliers for the ranching sector do fully account for all losses to a region’s economy. Thus, as mentioned previously, in some cases closely linked sectors were moved from one water use category to another.

5. Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on ”fixed-proportion production functions,” which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a

scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an upper bound. Similarly, since projected population losses are based on reduced employment in the region, they should be considered an upper bound as well.

6. IO models are static. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in 2006. In contrast, water shortages are projected to occur well into the future. Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon, and the farther out into the future we go, this assumption becomes less reliable.

7. Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in most regions of Texas lasted several years.

8. Monetary figures are reported in constant year 2006 dollars.

### 1.1.2 Impacts to Agriculture

***Irrigated Crop Production***

The first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Default IMPLAN data do not distinguish irrigated production from dry-land production. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and Farm Services Agency (FSA) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 1 shows the TWDB crops included in corresponding IMPLAN sectors, and Table 2 summarizes acreage and estimated annual water use for each crop classification (five-year average from 2003-2007). Table 3 displays average (2003-2007) gross revenues per acre for IMPLAN crop categories.

**Table 1: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors Applied in Socioeconomic Impact Analysis**

| IMPLAN Category | TWDB Category |
|---|---|
| Oilseeds | Soybeans and other oil crops |
| Grains | Grain sorghum, corn, wheat and other grain crops |
| Vegetable and melons | Vegetables and potatoes |
| Tree nuts | Pecans |
| Fruits | Citrus, vineyard and other orchard |
| Cotton | Cotton |
| Sugarcane and sugar beets | Sugarcane and sugar beets |
| All other crops | Forage crops, peanuts, alfalfa, hay and pasture, rice and all other crops |

**Table 2: Summary of Irrigated Crop Acreage and Water Demand for Region O (Average 2003-2007)**

| Sector | Acres (1000s) | Distribution of acres | Water use (1000s of AF) | Distribution of water use |
|---|---|---|---|---|
| Oilseeds | 24 | 1% | 31 | 1% |
| Grains | 1,092 | 37% | 1,453 | 41% |
| Vegetable and melons | 41 | 1% | 44 | 1% |
| Tree nuts | 3 | >1% | 5 | >1% |
| Fruits | 1 | >1% | 1 | >1% |
| Cotton | 1,512 | 52% | 1,613 | 46% |
| Sugarcane and sugar beets | 0 | 0 | 0 | 0 |
| All other crops | 243 | 8% | 380 | 11% |
| Total | 2,916 | 100% | 3,527 | 100% |

Source: Water demand figures are a 5- year average (2003-2007) of the TWDB's annual Irrigation Water Use Estimates. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the Farm Service Agency. Values do not include acreage or water use for the TWDB categories classified by the Farm Services Agency as "failed acres," "golf course" or "waste water".

**Table 3: Average Gross Sales Revenues per Acre for Irrigated Crops in Region O (2003-2007)**

| IMPLAN Sector | Gross revenues per acre | Crops Included in Estimates |
|---|---|---|
| Oilseeds | $230 | Based on five-year (2003-2007) average weighted by acreage for "irrigated soybeans" and "irrigated other oil crops." |
| Grains | $290 | Based on five-year (2003-2007) average weighted by acreage for "irrigated grain sorghum," "irrigated corn," "irrigated wheat" and "irrigated 'other' grain crops." |
| Vegetable and melons | $6,180 | Based on five-year (2003-2007) average weighted by acreage for "irrigated shallow and deep root vegetables," "irrigated Irish potatoes" and "irrigated melons." |
| Tree nuts | $3,420 | Based on five-year (2003-2007) average weighted by acreage for "irrigated pecans." |
| Fruits | $7,720 | Based on five-year (2003-2007) average weighted by acreage for "irrigated citrus," "irrigated vineyards" and "irrigated 'other' orchard." |
| Cotton | $450 | Based on five-year (2003-2007) average weighted by acreage for "irrigated cotton." |

Source: Based on data from the Texas Agricultural Statistics Service, Texas Water Development Board, and Texas A&M University.

An important consideration when estimating impacts to irrigation was determining which crops are affected by water shortages. One approach is the so-called rationing model, which assumes that farmers respond to water supply cutbacks by fallowing the lowest value crops in the region first and the highest valued crops last until the amount of water saved equals the shortage.[5] For example, if farmer A grows vegetables (higher value) and farmer B grows wheat (lower value) and they both face a proportionate cutback in irrigation water, then farmer B will sell water to farmer A. Farmer B will fallow her irrigated acreage before farmer A fallows anything. Of course, this assumes that farmers can and do transfer enough water to allow this to happen. A different approach involves constructing farm-level profit maximization models that conform to widely-accepted economic theory that farmers make decisions based on marginal net returns. Such models have good predictive capability, but data requirements and complexity are high. Given that a detailed analysis for each region would require a substantial amount of farm-level data and analysis, the following investigation assumes that projected shortages are distributed equally across predominant crops in the region. Predominant in this case are crops that comprise at least one percent of total acreage in the region.

The following steps outline the overall process used to estimate direct impacts to irrigated agriculture:

1. *Distribute shortages across predominant crop types in the region*. Again, shortages were distributed equally across crop sectors that constitute one percent or more of irrigated acreage.

2. *Estimate associated reductions in output for affected crop sectors*. Output reductions are based on elasticities discussed previously and on estimated values per acre for different crops. Values per acre stem from the same data used to estimate output for the year 2006 baseline. Using multipliers, we then generate estimates of forgone income, jobs, and tax revenues based on reductions in gross sales and final demand.

***Livestock***

Only a small percent of gross sales from ranching and other livestock producers are in the form of exports or final sales. Most are in the form of intermediate sales to meat packers, which produces about $1.6 billion in final sales (purchases by end users or exports out of the region) indicating that the meat packing sector is the final link in the livestock industry. Since so much livestock passes through the meat packing sector; and because it employs so many people, we consider it part of the livestock water use category.

The approach used for the livestock sector is basically the same as that used for crop production. As is the case with crops, livestock categorizations used by the TWDB differ from those used in IMPLAN datasets, and TWDB groupings were assigned to a given IMPLAN sector (Table 4). Then we:

1) *Distribute projected water shortages equally among predominant livestock sectors and estimate lost output*: As is the case with irrigation, shortages are assumed to affect all livestock sectors equally; however, the category of "other" is not included given its small size. If water shortages were small relative to total demands, we assume that producers would haul in water by truck to fill stock tanks. The cost per acre-foot ($24,000) is based on 2008 rates charged by

[5] The rationing model was initially proposed by researchers at the University of California at Berkeley, and was then modified for use in a study conducted by the U.S. Environmental Protection Agency that evaluated how proposed water supply cutbacks recommended to protect water quality in the Bay/Delta complex in California would affect farmers in the Central Valley. See, Zilberman, D., Howitt, R. and Sunding, D. "*Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delt*a." Western Consortium for Public Health. May 1993.

various water haulers in Texas, and assumes that the average truck load is 6,500 gallons at a hauling distance of 60 miles.

3) *Estimate reduced output in forward processors for livestock sectors*. Reductions in output for livestock sectors are assumed to have a proportional impact on forward processors in the region such as meat packers. In other words, if the cows were gone, meat-packing plants or fluid milk manufacturers) would likely have little to process. This is not an unreasonable premise. Since the 1950s, there has been a major trend towards specialized cattle feedlots, which in turn has decentralized cattle purchasing from livestock terminal markets to direct sales between producers and slaughterhouses. Today, the meat packing industry often operates large processing facilities near high concentrations of feedlots to increase capacity utilization.[6] As a result, packers are heavily dependent upon nearby feedlots. For example, a recent study by the USDA shows that on average meat packers obtain 64 percent of cattle from within 75 miles of their plant, 82 percent from within 150 miles and 92 percent from within 250 miles.[7]

**Table 4: Description of Livestock Sectors**

| IMPLAN Category | TWDB Category |
|---|---|
| Cattle ranching and farming | Cattle, cow calf, feedlots and dairies |
| Poultry and egg production | Poultry production. |
| Other livestock | Livestock other than cattle and poultry (i.e., horses, goats, sheep, hogs ) |
| Milk manufacturing | Fluid milk manufacturing, cheese manufacturing, ice cream manufacturing etc. |
| Meat packing | Meat processing present in the region from slaughter to final processing |

[6] Ferreira, W.N. "*Analysis of the Meat Processing Industry in the United States*." Clemson University Extension Economics Report ER211, January 2003.

[7] Ward, C.E. "*Summary of Results from USDA's Meatpacking Concentration Study*." Oklahoma Cooperative Extension Service, OSU Extension Facts WF-562.

### 1.1.3 Impacts to Municipal Water User Groups

***Disaggregation of Municipal Water Demands***

Estimating the economic impacts for the municipal water user groups is complicated for a number of reasons. For one, municipal use comprises a range of consumers including commercial businesses, institutions such as schools and government and households. However, reported water shortages are not distributed among different municipal water users. In other words, how much of a municipal need is commercial and how much is residential (domestic)?

The amount of commercial water use as a percentage of total municipal demand was estimated based on "GED" coefficients (gallons per employee per day) published in secondary sources.[8] For example, if year 2006 baseline data for a given economic sector (e.g., amusement and recreation services) shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) or 6.7 acre-feet per year. Water not attributed to commercial use is considered domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as "county-other." Based on our analysis, commercial water use is about 5 to 35 percent of municipal demand. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

After determining the distribution of domestic versus commercial water use, we developed methods for estimating impacts to the two groups.

***Domestic Water Uses***

Input output models are not well suited for measuring impacts of shortages for domestic water uses, which make up the majority of the municipal water use category. To estimate impacts associated with domestic water uses, municipal water demand and shortages are subdivided into residential, and commercial and institutional use. Shortages associated with residential water uses are valued by estimating proxy demand functions for different water user groups allowing us to estimate the marginal value of water, which would vary depending upon the level of water shortages. The more severe the water shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic impacts would be much higher in the latter case because people, and would be forced to find emergency alternatives assuming alternatives were available.

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[8] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not*: *The Potential for Urban Water Conservation in California*." Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: "*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*," Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States*." Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, "*Evaluation of Water Conservation for Municipal and Industrial Water Supply*." U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

To estimate the value of domestic water uses, TWDB staff developed marginal loss functions based on constant elasticity demand curves. This is a standard and well-established method used by economists to value resources such as water that have an explicit monetary cost.

A constant price elasticity of demand is estimated using a standard equation:

$$w = kc^{(-\varepsilon)}$$

where:

- w is equal to average monthly residential water use for a given water user group measured in thousands of gallons;
- k is a constant intercept;
- c is the average cost of water per 1,000 gallons; and
- ε is the price elasticity of demand.

Price elasticities (-0.30 for indoor water use and -0.50 for outdoor use) are based on a study by Bell et al.[9] that surveyed 1,400 water utilities in Texas that serve at least 1,000 people to estimate demand elasticity for several variables including price, income, weather etc. Costs of water and average use per month per household are based on data from the Texas Municipal League's annual water and wastewater rate surveys - specifically average monthly household expenditures on water and wastewater in different communities across the state. After examining variance in costs and usage, three different categories of water user groups based on population (population less than 5,000, cities with populations ranging from 5,000 to 99,999 and cities with populations exceeding 100,000) were selected to serve as proxy values for municipal water groups that meet the criteria (Table 5).[10]

**Table 5: Water Use and Costs Parameters Used to Estimate Water Demand Functions**
**(average monthly costs per acre-foot for delivered water and average monthly use per household)**

| Community Population | Water | Wastewater | Total Monthly Cost | Avg. Monthly Use (gallons) |
|---|---|---|---|---|
| Less than or equal to 5,000 | $1,335 | $1,228 | $2,563 | 6,204 |
| 5,000 to 100,000 | $1,047 | $1,162 | $2,209 | 7,950 |
| Great than or equal to 100,000 | $718 | $457 | $1,190 | 8,409 |

**Source: Based on annual water and wastewater rate surveys published by the Texas Municipal League.**

[9] Bell, D.R. and Griffin, R.C. "*Community Water Demand in Texas as a Century is Turned*." Research contract report prepared for the Texas Water Development Board. May 2006.

[10] Ideally, one would want to estimate demand functions for each individual utility in the state. However, this would require an enormous amount of time and resources. For planning purposes, we believe the values generated from aggregate data are more than sufficient.

As an example, Table 6 shows the economic impact per acre-foot of domestic water shortages for municipal water user groups with population exceeding 100,000 people. There are several important assumptions incorporated in the calculations:

> 1) Reported values are net of the variable costs of treatment and distribution such as expenses for chemicals and electricity since using less water involves some savings to consumers and utilities alike; and for outdoor uses we do not include any value for wastewater.
>
> 2) Outdoor and "non-essential" water uses would be eliminated before indoor water consumption was affected, which is logical because most water utilities in Texas have drought contingency plans that generally specify curtailment or elimination of outdoor water use during droughts.[11] Determining how much water is used for outdoor purposes is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of single family residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[12] Earlier findings of the U.S. Water Resources Council showed a national average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[13] A study conducted for the California Urban Water Agencies (CUWA) calculated average annual values ranging from 25 to 35 percent.[14] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study.

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[11] In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses." Non-essential uses include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

[12] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water*." Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

[13] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation*." USEPA Report no. 841-B-95-002. April, 1995.

[14] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual*." Prepared for the California Urban Water Agencies. February 1992.

| Table 6: Economic Losses Associated with Domestic Water Shortages in Communities with Populations Exceeding 100,000 people | | | | |
|---|---|---|---|---|
| **Water shortages as a percentage of total monthly household demands** | **No. of gallons remaining per household per day** | **No of gallons remaining per person per day** | **Economic loss (per acre-foot)** | **Economic loss (per gallon)** |
| 1% | 278 | 93 | $748 | $0.00005 |
| 5% | 266 | 89 | $812 | $0.0002 |
| 10% | 252 | 84 | $900 | $0.0005 |
| 15% | 238 | 79 | $999 | $0.0008 |
| 20% | 224 | 75 | $1,110 | $0.0012 |
| 25% | 210 | 70 | $1,235 | $0.0015 |
| 30%[a] | 196 | 65 | $1,699 | $0.0020 |
| 35% | 182 | 61 | $3,825 | $0.0085 |
| 40% | 168 | 56 | $4,181 | $0.0096 |
| 45% | 154 | 51 | $4,603 | $0.011 |
| 50% | 140 | 47 | $5,109 | $0.012 |
| 55% | 126 | 42 | $5,727 | $0.014 |
| 60% | 112 | 37 | $6,500 | $0.017 |
| 65% | 98 | 33 | $7,493 | $0.02 |
| 70% | 84 | 28 | $8,818 | $0.02 |
| 75% | 70 | 23 | $10,672 | $0.03 |
| 80% | 56 | 19 | $13,454 | $0.04 |
| 85% | 42 | 14 | $18,091 ($24,000)[b] | $0.05 ($0.07)[b] |
| 90% | 28 | 9 | $27,363 ($24,000) | $0.08 ($0.07) |
| 95% | 14 | 5 | $55,182 ($24,000) | $0.17 ($0.07) |
| 99% | 3 | 0.9 | $277,728 ($24,000) | $0.85 ($0.07) |
| 99.9% | 1 | 0.5 | $2,781,377 ($24,000) | $8.53 ($0.07) |
| 100% | 0 | 0 | Infinite ($24,000) | Infinite ($0.07) |

[a] The first 30 percent of shortages are assumed to be restrictions of outdoor water use; when shortages reach 30 percent of total demands all outdoor water uses would be restricted. Shortages greater than 30 percent include indoor use.

[b] As shortages approach 100 percent the value approaches infinity assuming there are not alternatives available; however, we assume that communities would begin to have water delivered by tanker truck at an estimated cost of $24,000 per acre-foot when shortages breached 80 percent.

*Source: Texas Water Development Board, Water Resources Planning Division.

3) As shortages approach 100 percent values become immense and theoretically infinite at 100 percent because at that point death would result, and willingness to pay for water is immeasurable. Thus, as shortages approach 80 percent of monthly consumption, we assume that households and non-water intensive commercial businesses (those that use water only for drinking and sanitation would have water delivered by tanker truck or commercial water delivery companies. Based on reports from water companies throughout the state, we estimate that the cost of trucking in water is around $21,000 to $27,000 per acre-foot assuming a hauling distance of between 20 to 60 miles. This is not an unreasonable assumption. The practice was widespread during the 1950s drought and recently during droughts in this decade. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water delivered to their homes by private contractors.[15] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[16]

***Commercial Businesses***

Effects of water shortages on commercial sectors were estimated in a fashion similar to other business sectors meaning that water shortages would affect the ability of these businesses to operate. This is particularly true for “water intensive” commercial sectors that require large amounts of water (in addition to potable and sanitary water) to provide their services. These include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hospitals and medical facilities,
- hotels and lodging places, and
- eating and drinking establishments.

A key assumption is that commercial operations would not be affected until water shortages were at least 50 percent of total municipal demand. In other words, we assume that residential water consumers would reduce water use including all non-essential uses before businesses were affected.

An example will illustrate the breakdown of municipal water shortages and the overall approach to estimating impacts of municipal shortages. Assume City A experiences an unexpected shortage of 50 acre-feet per year when their demands are 200 acre-feet per year. Thus, shortages are only 25 percent of total municipal use and residents of City A could eliminate shortages by restricting landscape irrigation. City B, on the other hand, has a deficit of 150 acre-feet in 2020 and a projected demand of 200 acre-feet.

[15] Zewe, C. “*Tap Threatens to Run Dry in Texas Town*.” July 11, 2000. CNN Cable News Network.

[16] Associated Press, “*Ballinger Scrambles to Finish Pipeline before Lake Dries Up*.” May 19, 2003.

Thus, total shortages are 75 percent of total demand. Emergency outdoor and some indoor conservation measures could eliminate 50 acre-feet of projected shortages, yet 50 acre-feet would still remain. To eliminate" the remaining 50 acre-feet water intensive commercial businesses would have to curtail operations or shut down completely.

Three other areas were considered when analyzing municipal water shortages: 1) lost revenues to water utilities, 2) losses to the horticultural and landscaping industries stemming for reduction in water available for landscape irrigation, and 3) lost revenues and related economic impacts associated with reduced water related recreation.

### *Water Utility Revenues*

Estimating lost water utility revenues was straightforward. We relied on annual data from the "*Water and Wastewater Rate Survey*" published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, average retail rates multiplied by total water shortages served as a proxy. For lost wastewater, total shortages were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Shortages reported as "county-other" were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and shortages are considered non-billed or "unaccountable" water that comprises things such as leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the "miscellaneous gross receipts tax, "which the state collects from utilities located in most incorporated cities or towns in Texas. We do not include lost water utility revenues when aggregating impacts of municipal water shortages to regional and state levels to prevent double counting.

### *Horticultural and Landscaping Industry*

The horticultural and landscaping industry, also referred to as the "green Industry," consists of businesses that produce, distribute and provide services associated with ornamental plants, landscape and garden supplies and equipment. Horticultural industries often face big losses during drought. For example, the recent drought in the Southeast affecting the Carolinas and Georgia horticultural and landscaping businesses had a harsh year. Plant sales were down, plant mortality increased, and watering costs increased. Many businesses were forced to close locations, lay off employees, and even file for bankruptcy. University of Georgia economists put statewide losses for the industry at around $3.2 billion during the 3-year drought that ended in 2008.[17] Municipal restrictions on outdoor watering play a significant role. During drought, water restrictions coupled with persistent heat has a psychological effect on homeowners that reduces demands for landscaping products and services. Simply put, people were afraid to spend any money on new plants and landscaping.

In Texas, there do not appear to be readily available studies that analyze the economic effects of water shortages on the industry. However, authors of this report believe negative impacts do and would result in restricting landscape irrigation to municipal water consumers. The difficulty in measuring them is two-fold. First, as noted above, data and research for these types of impacts that focus on Texas are limited; and second, economic data provided by IMPLAN do not disaggregate different sectors of the green industry to a level that would allow for meaningful and defensible analysis.[18]

[17] Williams, D. *"Georgia landscapers eye rebound from Southeast drought."* Atlanta Business Chronicle, Friday, June 19, 2009

[18] Economic impact analyses prepared by the TWDB for 2006 regional water plans did include estimates for the horticultural industry. However, year 2000 and prior IMPLAN data were disaggregated to a finer level. In the current dataset (2006), the sector previously listed as "Landscaping and Horticultural Services" (IMPLAN Sector 27) is aggregated into "Services to Buildings and Dwellings" (IMPLAN Sector 458).

***Recreational Impacts***

Recreational businesses often suffer when water levels and flows in rivers, springs and reservoirs fall significantly during drought. During droughts, many boat docks and lake beaches are forced to close, leading to big losses for lakeside business owners and local communities. Communities adjacent to popular river and stream destinations such as Comal Springs and the Guadalupe River also see their business plummet when springs and rivers dry up. Although there are many examples of businesses that have suffered due to drought, dollar figures for drought-related losses to the recreation and tourism industry are not readily available, and very difficult to measure without extensive local surveys. Thus, while they are important, economic impacts are not measured in this study.

Table 7 summarizes impacts of municipal water shortages at differing levels of magnitude, and the shows ranges of economic costs or losses per acre-foot of shortage for each level.

**Table 7: Impacts of Municipal Water Shortages at Different Magnitudes of Shortages**

| Water shortages as percent of total municipal demands | Impacts | Economic costs per acre-foot* |
|---|---|---|
| 0-30% | ✓ Lost water utility revenues<br>✓ Restricted landscape irrigation and non-essential water uses | $730 - $2,040 |
| 30-50% | ✓ Lost water utility revenues<br>✓ Elimination of landscape irrigation and non-essential water uses<br>✓ Rationing of indoor use | $2,040 - $10,970 |
| >50% | ✓ Lost water utility revenues<br>✓ Elimination of landscape irrigation and non-essential water uses<br>✓ Rationing of indoor use<br>✓ Restriction or elimination of commercial water use<br>✓ Importing water by tanker truck | $10,970 – $201,690 |

* Source: Texas Water Development Board, Water Resources Planning Division.
*Figures are rounded

### 1.1.4 Industrial Water User Groups

*Manufacturing*

Impacts to manufacturing were estimated by distributing water shortages among industrial sectors at the county level. For example, if a planning group estimates that during a drought of record water supplies in County A would only meet 50 percent of total annual demands for manufactures in the county, we reduced output for each sector by 50 percent. Since projected manufacturing demands are based on TWDB Water Uses Survey data for each county, we only include IMPLAN sectors represented in the TWBD survey database. Some sectors in IMPLAN databases are not part of the TWDB database given that they use relatively small amounts of water - primarily for on-site sanitation and potable purposes. To maintain consistency between IMPLAN and TWDB databases, Standard Industrial Classification (SIC) codes both databases were cross referenced in county with shortages. Non-matches were excluded when calculating direct impacts.

*Mining*

The process of mining is very similar to that of manufacturing. We assume that within a given county, shortages would apply equally to relevant mining sectors, and IMPLAN sectors are cross referenced with TWDB data to ensure consistency.

In Texas, oil and gas and sand and gravel (aggregates) operations are the primary mining industries that rely heavily on large volumes of water. For sand and gravel, estimated output reductions are straightforward; however, oil and gas is more complicated for a number of reasons. IMPLAN does not necessarily report the physical extraction of minerals by geographic local, but rather the sales revenues reported by a particular corporation.

For example, at the state level revenues for IMPLAN sector 19 (oil and gas extraction) and sector 27 (drilling oil and gas wells) totals $257 billion. Of this, nearly $85 billion is attributed to Harris County. However, only a very small fraction (less than one percent) of actual production takes place in the county. To measure actual potential losses in well head capacity due to water shortages, we relied on county level production data from the Texas Railroad Commission (TRC) and average well-head market prices for crude and gas to estimate lost revenues in a given county. After which, we used to IMPLAN ratios to estimate resultant losses in income and employment.

Other considerations with respect to mining include:

1) Petroleum and gas extraction industry only uses water in significant amounts for secondary recovery. Known in the industry as enhanced or water flood extraction, secondary recovery involves pumping water down injection wells to increase underground pressure thereby pushing oil or gas into other wells. IMPLAN output numbers do not distinguish between secondary and non-secondary recovery. To account for the discrepancy, county-level TRC data that show the proportion of barrels produced using secondary methods were used to adjust IMPLAN data to reflect only the portion of sales attributed to secondary recovery.

2) A substantial portion of output from mining operations goes directly to businesses that are classified as manufacturing in our schema. Thus, multipliers measuring backward linkages for a given manufacturer might include impacts to a supplying mining operation. Care was taken not to double count in such situations if both a mining operation and a manufacturer were reported as having water shortages.

*Steam-electric*

At minimum without adequate cooling water, power plants cannot safely operate. As water availability falls below projected demands, water levels in lakes and rivers that provide cooling water would also decline. Low water levels could affect raw water intakes and outfalls at electrical generating units in several ways. For one, power plants are regulated by thermal emission guidelines that specify the maximum amount of heat that can go back into a river or lake via discharged cooling water. Low water levels could result in permit compliance issues due to reduced dilution and dispersion of heat and subsequent impacts on aquatic biota near outfalls.[19] However, the primary concern would be a loss of head (i.e., pressure) over intake structures that would decrease flows through intake tunnels. This would affect safety related pumps, increase operating costs and/or result in sustained shut-downs. Assuming plants did shutdown, they would not be able to generate electricity.

Among all water use categories steam-electric is unique and cautions are needed when applying methods used in this study. Measured changes to an economy using input-output models stem directly from changes in sales revenues. In the case of water shortages, one assumes that businesses will suffer lost output if process water is in short supply. For power generation facilities this is true as well. However, the electric services sector in IMPLAN represents a corporate entity that may own and operate several electrical generating units in a given region. If one unit became inoperable due to water shortages, plants in other areas or generation facilities that do not rely heavily on water, such as gas powered turbines, might be able to compensate for lost generating capacity. Utilities could also offset lost production via purchases on the spot market.[20] Thus, depending upon the severity of the shortages and conditions at a given electrical generating unit, energy supplies for local and regional communities could be maintained. But in general, without enough cooling water, utilities would have to throttle back plant operations, forcing them to buy or generate more costly power to meet customer demands.

Measuring impacts to end users of electricity is not part of this study as it would require extensive local and regional level analysis of energy production and demand. To maintain consistency with other water user groups, impacts of steam-electric water shortages are measured in terms of lost revenues (and hence income) and jobs associated with shutting down electrical generating units.

## 1.2 Social Impacts of Water Shortages

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature – more so analytic in the sense that social impacts are harder to quantify. Nevertheless, social effects associated with drought and water shortages are closely tied to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,

[19] Section 316 (b) of the Clean Water Act requires that thermal wastewater discharges do not harm fish and other wildlife.

[20] Today, most utilities participate in large interstate "power pools" and can buy or sell electricity "on the grid" from other utilities or power marketers. Thus, assuming power was available to buy, and assuming that no contractual or physical limitations were in place such as transmission constraints; utilities could offset lost power that resulted from waters shortages with purchases via the power grid.

- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities.[21]

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on demographic projection models developed by the Texas State Data Center and used by the TWDB for state and regional water planning. Basically, the social impact model uses results from the economic component of the study and assesses how changes in labor demand would affect migration patterns in a region. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

# 2.0 Results

Section 2 presents the results of the analysis at the regional level. Included are baseline economic data for each water use category, and estimated economic impacts of water shortages for water user groups with reported deficits. According to the 2011 *Llano Estacado Region Water Plan*, during severe drought irrigation and municipal water user groups would experience water shortages in the absence of new water management strategies.

## 2.1 Overview of Regional Economy

The Region O economy generates nearly $19 billion in gross state product for Texas ($17.5 in income and $1.4 in business taxes), and supports 311,500 jobs (Table 8). Key base industries in the region are agriculture, manufacturing (much of which is related to agriculture and petroleum) and mining (oil and gas extraction).[22] Each year agricultural sectors generate about one billion dollars per year worth of income for Texas residents; provide jobs for nearly 25,000 people, and add $54 million in tax revenues to local and state government accounts. The largest irrigation sectors are grains (primarily sorghum and corn) and cotton. Key livestock sectors include cattle ranching and (dairies, feedlots and range cattle), and associated forward linkages such as meat packing and milk processors. Manufacturing and mining generate about $4.2 billion in income and provide nearly 49,500 jobs for the region. Sanitary paper products, petroleum refining and new home construction are the manufacturing largest sectors, while oil

[21] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment*." in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

[22] Base industries are those that supply markets outside of the region. These industries are crucial to the local economy and are called the economic base of a region. Appendix A displays individual economic sectors for each water use category.

and gas extraction and supporting sectors dominate mining activities. Municipal sectors generate $11.9 billion worth of income and 232,550 jobs. While municipal sectors are the largest employer and source of income, many businesses that make up the municipal category such as restaurants and retail stores are non-basic industries meaning they exist to provide services to people who work would in base industries such as manufacturing, agriculture and mining. In other words, without base industries such as agriculture, many municipal jobs in the region would not exist.

**Table 8: The Llano Estacado Regional Baseline Economy by Water User Group ($millions)**

| Water Use Category | Total Sales | Intermediate Sales | Final Sales | Jobs | Income | Business Taxes |
|---|---|---|---|---|---|---|
| Irrigation | $1,280.27 | $82.40 | $1,198.12 | 12,397 | $605.34 | $14.93 |
| Livestock | $2,954.36 | $1,304.28 | $1,650.08 | 12,582 | $303.73 | $36.74 |
| Manufacturing | $8,346.10 | $1,352.63 | $6,993.47 | 40,129 | $2,314.24 | $58.68 |
| Mining | $3,222.32 | $1,545.80 | $1,676.52 | 8,797 | $1,936.48 | $165.65 |
| Steam-electric | $408.57 | $114.94 | $293.63 | 1,032 | $283.71 | $48.41 |
| Municipal | $20,458.19 | $5,458.11 | $15,000.08 | 232,546 | $11,848.15 | $1,091.61 |
| Regional totals | $38,573.43 | $10,270.07 | $28,303.60 | 311,499 | $17,550.27 | $1,430.57 |

* Appendix A displays individual economic sectors for each water use category. Based on data from the Texas Water Development Board, and year 2006 data from the Minnesota IMPLAN Group, Inc.

## 2.2 Impacts of Agricultural Water Shortages

*Irrigation*

According to the 2011 *Llano Estacado Region Water Plan*, during severe drought most counties in the region would experiences shortages of irrigation water. Depending on the decade, shortages range from 5 to 65 percent of annual irrigation demands. In total, farmers would be short nearly 1.3 million acre-feet in 2010, and slightly more than 2.3 million in 2060. Shortages of these magnitudes would reduce gross state product by about $370 million in 2010 and $1,109 million in 2060 (Table 9). Job losses could run as high 5,560 in 2010 to 15,920 in 2060.

Please note the impacts take into account not only direct losses for farmers, but include losses to farm suppliers and other business due to reduced spending in the economy. In contrast, impacts do not consider potential effects on forward processors. Losses of irrigation water could substantially reduce supplies of local feed crops; however, TWDB staff lack the data and resources needed to measure these effects accurately.[23] Another important consideration involves the future availability of drought resistant crops in the region. The Monsanto and DuPont companies are developing and marketing drought resistant corn; which if adopted by growers in the region, could significantly lower irrigation water demands in region.

[23] Although feedlots and ranchers would likely be affected by reduced grain and forage production to some extent, cattle feeders in the region import substantial amounts of grain from the Midwest by rail at prices competitive with local supplies. See: Ishmael, W. "*High and Dry*." Texas Cattle Feeders Annual Bulletin, Texas Cattle Feeders, 2002.

| Table 9: Economic Impacts of Water Shortages for Irrigation Water User Groups ($millions, 2010-2060) | | | |
|---|---|---|---|
| **Decade** | **Lost income from reduced crop production [a]** | **Lost state and local tax revenues from reduced crop production** | **Lost jobs from reduced crop production** |
| 2010 | $353.29 | $17.26 | 5,465 |
| 2020 | $687.56 | $35.80 | 10,158 |
| 2030 | $895.63 | $47.81 | 13,134 |
| 2040 | $1,085.94 | $57.75 | 15,631 |
| 2050 | $1,124.63 | $59.92 | 16,114 |
| 2060 | $1,101.93 | $59.03 | 15,824 |

[a] Changes to Income and business taxes collectively are equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results for individual water user groups.

*Livestock*

According to the regional plan, during severe drought livestock producers in Castro, Deaf Smith, Hale, Lamb and Parmer counties would experience water shortages that range about 10 to 80 percent of annual irrigation demands. Shortages of these magnitudes would reduce gross state product by about $4 million in 2020 and $274 million in 2060 (Table 10). Job losses could run as high as 92 in 2020 to 6,117 in 2060.

| Table 10: Economic Impacts of Water Shortages for Livestock Water User Groups ($millions, 2010-2060) | | | |
|---|---|---|---|
| **Decade** | **Lost income from reduced livestock production [a]** | **Lost state and local tax revenues from reduced livestock production** | **Lost jobs from reduced livestock production** |
| 2010 | $0.00 | $0.00 | 0 |
| 2020 | $3.68 | $0.27 | 92 |
| 2030 | $15.46 | $1.13 | 386 |
| 2040 | $78.30 | $7.34 | 2,303 |
| 2050 | $236.21 | $17.30 | 5,892 |
| 2060 | $274.40 | $20.10 | 6,117 |

[a] Changes to Income and business taxes collectively are equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results for individual water user groups.

## 2.3 Impacts of Municipal Water Shortages

In the absence of water management strategies, water shortages are projected to occur in several municipal water user groups. Deficits are anywhere from 3 to 100 percent of total annual use. The costs of domestic water shortages range from $13 million in 2010 to $134 million in 2060 (Table 11). Curtailment of commercial business activity would reduce gross state product (income plus taxes) by an estimated $3 million in 2010 and about $67 million in 2060.

**Table 11: Economic Impacts of Water Shortages for Municipal Water User Groups ($millions, 2010-2060)**

| Decade | Monetary value of domestic water shortages | Lost income from reduced commercial business activity | Lost state and local taxes from reduced commercial business activity | Lost jobs from reduced commercial business activity | Lost water utility revenues |
|---|---|---|---|---|---|
| 2010 | $13.48 | $2.81 | $0.32 | 81 | $16.63 |
| 2020 | $48.32 | $22.91 | $2.03 | 593 | $23.28 |
| 2030 | $107.27 | $37.94 | $4.36 | 1,240 | $34.13 |
| 2040 | $111.18 | $49.98 | $5.69 | 1,598 | $40.61 |
| 2050 | $125.91 | $53.81 | $6.26 | 1,755 | $48.98 |
| 2060 | $134.74 | $60.51 | $7.18 | 2,025 | $52.19 |

[a] Changes to Income and business taxes collectively are equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results for individual water user groups.

## 2.4 Social Impacts of Water Shortages

As discussed previously, estimated social impacts focus on changes in population and school enrollment. In 2010, estimated population losses total 7,160 with corresponding reductions in school enrollment of 1,680 students (Table 12). In 2060, population in the region would decline by 30,030 people and school enrollment would fall by 7,040 students.

| Table 12: Social Impacts of Water Shortages (2010-2060) | | |
|---|---|---|
| **Year** | **Population Losses** | **Declines in School Enrollment** |
| 2010 | 7,160 | 1,680 |
| 2020 | 13,910 | 3,270 |
| 2030 | 18,670 | 4,380 |
| 2040 | 24,590 | 5,770 |
| 2050 | 29,830 | 7,000 |
| 2060 | 30,030 | 7,040 |

## 2.5 Distribution of Impacts by Major River Basin

Administrative rules require that impacts are presented by both planning region and major river basin (Table 13). To meet rule requirements impacts were allocated among river basin based on distribution of water shortages in basins that occupy the planning region. For example, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin B then impacts were split equally among the two basins. Table 12 shows the distributions of impacts by major river basin.

| Table 12: Distribution of Economic and Social Impacts by Major River Basin (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| **River Basin** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Canadian** | | | | | | |
| Lost income* | $0 | $0 | $0 | $0 | $0 | $0 |
| Lost Business Taxes | $0 | $0 | $0 | $0 | $0 | $0 |
| Lost Jobs | 0 | 0 | 0 | 0 | 0 | 0 |
| Lost Population | 0 | 0 | 0 | 0 | 0 | 0 |
| Declines in School Enrollment | 0 | 0 | 0 | 0 | 0 | 0 |
| **Red River** | | | | | | |
| Lost income | $102.64 | $210.54 | $278.76 | $335.24 | $383.69 | $391.55 |
| Lost Business Taxes | $6.02 | $17.94 | $26.20 | $31.11 | $32.81 | $34.80 |
| Lost Jobs | 1,592 | 3,134 | 4,111 | 5,147 | 6,011 | 6,070 |
| Lost Population | 1,915 | 3,770 | 4,946 | 6,192 | 7,233 | 7,303 |
| Declines in School Enrollment | 449 | 886 | 1,160 | 1,453 | 1,697 | 1,712 |
| **Brazos** | | | | | | |
| Lost income | $198.62 | $420.26 | $601.36 | $798.73 | $959.63 | $978.96 |
| Lost Business Taxes | $11.65 | $35.82 | $56.51 | $74.13 | $82.07 | $87.01 |
| Lost Jobs | 3,080 | 6,255 | 8,869 | 12,263 | 15,034 | 15,176 |
| Lost Population | 3,705 | 7,525 | 10,670 | 14,754 | 18,091 | 18,260 |
| Declines in School Enrollment | 869 | 1,769 | 2,503 | 3,462 | 4,245 | 4,281 |
| **Colorado** | | | | | | |
| Lost income | $82.56 | $146.02 | $172.10 | $197.25 | $239.03 | $239.49 |
| Lost Business Taxes | $4.84 | $12.44 | $16.17 | $18.31 | $20.44 | $21.29 |
| Lost Jobs | 1,280 | 2,173 | 2,538 | 3,028 | 3,745 | 3,713 |
| Lost Population | 1,540 | 2,615 | 3,054 | 3,644 | 4,506 | 4,467 |
| Declines in School Enrollment | 361 | 615 | 716 | 855 | 1,057 | 1,047 |

* Includes the estimated value of domestic water shortages, which is treated as an income effect when aggregating for river basins.

# Appendix 1: Economic Data for Individual IMPLAN Sectors for the Llano Estacado Regional Water Planning Area

**Economic Data for Agricultural Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060)**

| Water Use Category | IMPLAN Sector | IMPLAN Code | Total Sales | Intermediate Sales | Final Sales | Jobs | Income | Business Taxes |
|---|---|---|---|---|---|---|---|---|
| Irrigation | Oilseed farming | 1 | 5.52 | 1.66 | 3.86 | 72 | 2.85 | 0.12 |
| Irrigation | Grain farming | 2 | 314.79 | 49.87 | 265.16 | 5061 | 144.69 | 5.67 |
| Irrigation | Vegetable and melon farming | 3 | 246.08 | 6.74 | 239.34 | 1470 | 180.65 | 2.31 |
| Irrigation | Tree nut farming | 4 | 9.35 | 0 | 9.35 | 83 | 6.57 | 0.23 |
| Irrigation | Fruit farming | 5 | 6.8 | 0.36 | 6.44 | 77 | 3.79 | 0.15 |
| Irrigation | Greenhouse and nursery production | 6 | $21.34 | $4.71 | $16.64 | 251 | $17.67 | $0.21 |
| Irrigation | Tobacco farming | 7 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Irrigation | Cotton farming | 8 | 676.39 | 19.06 | 657.33 | 5382 | 249.12 | 6.24 |
| Irrigation | Sugarcane and sugar beet farming | 9 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Irrigation | All other crop farming | 10 | 132.99 | 124.66 | 8.33 | 645 | 65 | 2.57 |
| Livestock | Cattle ranching and farming | 11 | $1,189.91 | $825.07 | $364.83 | 7,801 | $94.00 | $25.01 |
| Livestock | Poultry and egg production | 12 | $3.57 | $2.79 | $0.77 | 12 | $1.20 | $0.01 |
| Livestock | Animal production- except cattle and poultry | 13 | $13.15 | $11.15 | $2.00 | 339 | $1.28 | $0.20 |
| Livestock | Animal- except poultry- slaughtering | 67 | $1,671.70 | $446.97 | $1,224.73 | 4,298 | $200.62 | $11.13 |
| Livestock | Fluid milk manufacturing | 62 | $76.04 | $18.29 | $57.75 | 132 | $6.62 | $0.39 |
| Total | NA | NA | $4,367.62 | $1,511.33 | $2,856.53 | 25,623 | $974.07 | $54.25 |

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

| Economic Data for Mining and Steam-Electric Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Mining | Oil and gas extraction | 19 | $1,451.74 | $1,348.21 | $103.53 | 1,878 | $833.50 | $89.58 |
| Mining | Support activities for oil and gas operations | 28 | $975.98 | $135.56 | $840.42 | 5,510 | $883.26 | $41.71 |
| Mining | Drilling oil and gas wells | 27 | $636.73 | $3.18 | $633.55 | 1,031 | $181.76 | $23.97 |
| Mining | Natural Gas Distribution | 31 | $143.32 | $57.44 | $85.87 | 308 | $29.92 | $9.93 |
| Mining | Sand- gravel- clay- and refractory mining | 25 | $11.77 | $1.24 | $10.53 | 51 | $6.98 | $0.39 |
| Mining | Other nonmetallic mineral mining | 26 | $1.51 | $0.15 | $1.36 | 11 | $0.55 | $0.03 |
| Mining | Support activities for other mining | 29 | $1.28 | $0.02 | $1.26 | 8 | $0.52 | $0.04 |
| Total Mining | NA | NA | $3,222.32 | $1,545.80 | $1,676.52 | 8,797 | $1,936.48 | $165.65 |
| Steam-electric | Power generation and supply | 30 | $408.57 | $114.94 | $293.63 | 1,032 | $283.71 | $48.41 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Manufacturing Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Manufacturing | Sanitary paper product manufacturing | 134 | $1,225.53 | $10.52 | $1,215.02 | 1,797 | $387.38 | $17.90 |
| Manufacturing | Petroleum refineries | 142 | $799.99 | $297.36 | $502.63 | 98 | $27.67 | $1.18 |
| Manufacturing | New residential 1-unit structures- all | 33 | $681.63 | $0.00 | $681.62 | 4,715 | $215.99 | $3.40 |
| Manufacturing | Other oilseed processing | 53 | $564.78 | $18.40 | $546.38 | 266 | $30.77 | $4.13 |
| Manufacturing | Commercial and institutional buildings | 38 | $376.67 | $0.00 | $376.66 | 4,111 | $184.93 | $2.28 |
| Manufacturing | Flour milling | 48 | $369.83 | $23.58 | $346.25 | 477 | $44.95 | $2.52 |
| Manufacturing | Agriculture and forestry support activities | 18 | $365.58 | $207.81 | $157.77 | 12,097 | $257.90 | $3.47 |
| Manufacturing | Semiconductors and related devices | 311 | $353.45 | $188.11 | $165.33 | 400 | $70.16 | $1.99 |
| Manufacturing | Fruit and vegetable canning and drying | 61 | $295.54 | $10.95 | $284.59 | 629 | $72.08 | $2.21 |
| Manufacturing | Farm machinery and equipment manufacturing | 257 | $263.83 | $43.30 | $220.53 | 675 | $48.25 | $0.48 |
| Manufacturing | Other animal food manufacturing | 47 | $177.35 | $21.39 | $155.96 | 256 | $11.42 | $0.88 |
| Manufacturing | Other new construction | 41 | $163.85 | $0.00 | $163.85 | 1,886 | $85.79 | $0.68 |
| Manufacturing | Other snack food manufacturing | 79 | $143.10 | $24.10 | $118.99 | 214 | $49.17 | $1.22 |
| Manufacturing | Bread and bakery product- except frozen | 73 | $141.74 | $31.65 | $110.09 | 816 | $66.55 | $1.04 |
| Manufacturing | Fabricated pipe and pipe fitting | 252 | $132.61 | $14.98 | $117.63 | 612 | $54.23 | $0.75 |
| Manufacturing | Truck trailer manufacturing | 347 | $106.89 | $2.35 | $104.53 | 421 | $18.92 | $0.34 |
| Manufacturing | Reconstituted wood product manufacturing | 114 | $100.16 | $41.93 | $58.23 | 243 | $53.27 | $0.50 |
| Manufacturing | Paperboard container manufacturing | 126 | $99.12 | $1.05 | $98.07 | 328 | $22.94 | $0.89 |
| Manufacturing | New residential additions and alterations-all | 35 | $96.13 | $0.00 | $96.12 | 559 | $34.16 | $0.48 |
| Manufacturing | Dog and cat food manufacturing | 46 | $90.80 | $8.76 | $82.04 | 93 | $6.04 | $0.33 |
| Manufacturing | Highway- street- bridge- and tunnel construct | 39 | $80.87 | $0.00 | $80.87 | 798 | $39.61 | $0.50 |
| Manufacturing | New multifamily housing structures- all | 34 | $73.33 | $0.00 | $73.33 | 685 | $33.36 | $0.19 |
| Manufacturing | Travel trailer and camper manufacturing | 349 | $73.26 | $3.98 | $69.28 | 384 | $15.10 | $0.21 |
| Manufacturing | Nitrogenous fertilizer manufacturing | 156 | $68.64 | $34.58 | $34.05 | 51 | $13.74 | $0.41 |
| Manufacturing | Fabricated structural metal manufacturing | 233 | $65.35 | $3.38 | $61.96 | 259 | $22.62 | $0.36 |
| Manufacturing | Soft drink and ice manufacturing | 85 | $63.42 | $3.54 | $59.87 | 104 | $8.14 | $0.36 |
| Manufacturing | Plastics plumbing fixtures and all other plastics | 177 | $59.53 | $43.13 | $16.41 | 321 | $20.74 | $0.36 |
| Manufacturing | Water- sewer- and pipeline construction | 40 | $59.18 | $0.00 | $59.18 | 520 | $25.36 | $0.37 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Manufacturing Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Manufacturing | Metal can- box- and other container manufactu | 240 | $57.61 | $15.48 | $42.13 | 118 | $10.37 | $0.31 |
| Manufacturing | Plate work manufacturing | 234 | $53.48 | $3.37 | $50.11 | 206 | $22.34 | $0.29 |
| Manufacturing | Metal valve manufacturing | 248 | $48.63 | $5.27 | $43.36 | 240 | $16.31 | $0.21 |
| Manufacturing | Scales- balances- and miscellaneous general p | 301 | $47.33 | $10.18 | $37.14 | 190 | $14.62 | $0.24 |
| Manufacturing | Motor vehicle parts manufacturing | 350 | $46.85 | $3.77 | $43.09 | 137 | $8.90 | $0.14 |
| Manufacturing | Ready-mix concrete manufacturing | 192 | $42.82 | $0.21 | $42.61 | 143 | $15.31 | $0.45 |
| Manufacturing | Logging | 14 | $41.72 | $31.17 | $10.54 | 155 | $12.69 | $0.43 |
| Manufacturing | Metal tank- heavy gauge- manufacturing | 239 | $41.22 | $1.70 | $39.52 | 244 | $13.08 | $0.18 |
| Manufacturing | Pump and pumping equipment manufacturing | 288 | $41.14 | $0.90 | $40.24 | 122 | $11.97 | $0.22 |
| Manufacturing | Wood container and pallet manufacturing | 120 | $38.15 | $25.37 | $12.78 | 303 | $15.71 | $0.21 |
| Manufacturing | Plastics pipe- fittings- and profile shapes | 173 | $37.80 | $23.25 | $14.55 | 110 | $9.89 | $0.22 |
| Manufacturing | Other millwork- including flooring | 119 | $37.00 | $28.74 | $8.26 | 231 | $9.22 | $0.16 |
| Manufacturing | Hunting and trapping | 17 | $34.89 | $2.85 | $32.04 | 279 | $5.24 | $1.50 |
| Manufacturing | Commercial printing | 139 | $32.88 | $16.33 | $16.54 | 494 | $22.36 | $0.28 |
| Manufacturing | Machine shops | 243 | $30.04 | $7.25 | $22.79 | 263 | $11.41 | $0.18 |
| Manufacturing | Manufacturing and industrial buildings | 37 | $29.61 | $0.00 | $29.61 | 357 | $15.36 | $0.16 |
| Manufacturing | Meat processed from carcasses | 68 | $26.75 | $7.89 | $18.86 | 61 | $2.81 | $0.14 |
| Manufacturing | Other miscellaneous chemical product manufacturing | 171 | $26.13 | $13.67 | $12.46 | 58 | $4.84 | $0.13 |
| Manufacturing | Sawmills | 112 | $25.85 | $22.93 | $2.92 | 104 | $6.39 | $0.11 |
| Manufacturing | Buttons- pins- and all other miscellaneous ma | 389 | $24.85 | $0.80 | $24.05 | 213 | $6.80 | $0.10 |
| Manufacturing | Spring and wire product manufacturing | 242 | $21.86 | $2.33 | $19.53 | 120 | $7.69 | $0.12 |
| Manufacturing | Tire manufacturing | 179 | $19.86 | $0.00 | $19.85 | 71 | $6.42 | $0.50 |
| Manufacturing | Institutional furniture manufacturing | 366 | $19.52 | $0.94 | $18.59 | 133 | $9.83 | $0.06 |
| Manufacturing | Metal coating and non-precious engraving | 246 | $18.05 | $4.45 | $13.60 | 121 | $5.91 | $0.08 |
| Manufacturing | Sheet metal work manufacturing | 236 | $17.99 | $0.98 | $17.01 | 99 | $7.09 | $0.09 |
| Manufacturing | Spice and extract manufacturing | 83 | $17.67 | $7.89 | $9.78 | 44 | $4.15 | $0.09 |
| Manufacturing | Concrete pipe manufacturing | 194 | $17.28 | $0.09 | $17.18 | 74 | $6.39 | $0.14 |
| Manufacturing | Paint and coating manufacturing | 161 | $17.08 | $0.22 | $16.86 | 31 | $2.32 | $0.05 |

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

| Economic Data for Manufacturing Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Manufacturing | Other commercial and service industry machine | 273 | $15.61 | $4.72 | $10.89 | 62 | $3.48 | $0.04 |
| Manufacturing | Fertilizer- mixing only- manufacturing | 158 | $14.60 | $3.96 | $10.64 | 26 | $3.71 | $0.14 |
| Manufacturing | Motor and generator manufacturing | 334 | $14.50 | $1.38 | $13.12 | 45 | $5.90 | $0.13 |
| Manufacturing | Surgical appliance and supplies manufacturing | 376 | $13.65 | $3.41 | $10.24 | 76 | $5.69 | $0.05 |
| Manufacturing | Power boiler and heat exchanger manufacturing | 238 | $13.32 | $0.23 | $13.09 | 65 | $4.71 | $0.06 |
| Manufacturing | Speed changers and mechanical power transmissions | 287 | $13.22 | $6.88 | $6.34 | 77 | $3.82 | $0.04 |
| Manufacturing | Tortilla manufacturing | 77 | $12.95 | $1.38 | $11.57 | 82 | $4.03 | $0.09 |
| Manufacturing | Roasted nuts and peanut butter manufacturing | 78 | $12.90 | $0.35 | $12.54 | 24 | $3.21 | $0.11 |
| Manufacturing | Prefabricated metal buildings and components | 232 | $12.55 | $0.63 | $11.92 | 49 | $3.25 | $0.08 |
| Manufacturing | Electric lamp bulb and part manufacturing | 325 | $11.88 | $0.00 | $11.89 | 37 | $5.94 | $0.11 |
| Manufacturing | Glass and glass products- except glass containers | 190 | $11.87 | $7.44 | $4.43 | 52 | $5.14 | $0.11 |
| Manufacturing | Asphalt paving mixture and block | 143 | $10.50 | $9.42 | $1.08 | 16 | $1.89 | $0.01 |
| Manufacturing | Wineries | 87 | $10.14 | $1.34 | $8.80 | 34 | $0.98 | $0.48 |
| Manufacturing | Broom- brush- and mop manufacturing | 387 | $9.73 | $0.53 | $9.21 | 68 | $3.12 | $0.04 |
| Manufacturing | Manifold business forms printing | 136 | $9.64 | $1.26 | $8.37 | 60 | $5.61 | $0.09 |
| Manufacturing | Industrial gas manufacturing | 148 | $9.33 | $4.91 | $4.42 | 13 | $2.79 | $0.04 |
| Manufacturing | All other industrial machinery manufacturing | 269 | $9.08 | $2.30 | $6.77 | 41 | $2.79 | $0.02 |
| Manufacturing | Construction machinery manufacturing | 259 | $8.69 | $1.19 | $7.50 | 13 | $1.41 | $0.04 |
| Manufacturing | Fiber- yarn- and thread mills | 92 | $7.68 | $3.33 | $4.35 | 34 | $1.04 | $0.04 |
| Manufacturing | Miscellaneous wood product manufacturing | 123 | $7.55 | $2.50 | $5.05 | 57 | $3.24 | $0.04 |
| Manufacturing | Wood kitchen cabinet and countertop | 362 | $6.60 | $5.14 | $1.46 | 57 | $2.68 | $0.05 |
| Manufacturing | Non-chocolate confectionery manufacturing | 59 | $6.46 | $0.58 | $5.88 | 21 | $1.71 | $0.04 |
| Manufacturing | Gasket- packing- and sealing device | 385 | $5.85 | $0.34 | $5.51 | 46 | $2.20 | $0.02 |
| Manufacturing | Other miscellaneous textile product mills | 103 | $5.74 | $0.08 | $5.66 | 43 | $1.33 | $0.02 |
| Manufacturing | Sporting and athletic goods manufacturing | 381 | $5.00 | $0.02 | $4.98 | 29 | $0.98 | $0.03 |
| Manufacturing | Polish and other sanitation good | 164 | $4.96 | $1.73 | $3.23 | 6 | $0.78 | $0.02 |
| Manufacturing | Other concrete product manufacturing | 195 | $4.37 | $0.06 | $4.31 | 29 | $1.68 | $0.04 |
| Manufacturing | Coated and uncoated paper bag manufacturing | 130 | $4.34 | $0.12 | $4.21 | 6 | $2.68 | $0.13 |

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

| Economic Data for Manufacturing Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Manufacturing | Iron and steel forging | 224 | $3.93 | $0.25 | $3.69 | 17 | $1.32 | $0.02 |
| Manufacturing | Nonferrous foundries- except aluminum | 223 | $3.80 | $0.11 | $3.69 | 25 | $1.00 | $0.02 |
| Manufacturing | Dental laboratories | 379 | $3.75 | $3.70 | $0.05 | 62 | $2.46 | $0.02 |
| Manufacturing | Textile bag and canvas mills | 101 | $3.28 | $0.04 | $3.24 | 26 | $0.84 | $0.01 |
| Manufacturing | Non-upholstered wood household furniture | 364 | $3.21 | $0.09 | $3.12 | 31 | $1.12 | $0.01 |
| Manufacturing | Miscellaneous nonmetallic mineral products | 202 | $3.09 | $0.06 | $3.03 | 16 | $1.03 | $0.02 |
| Manufacturing | Switchgear and switchboard apparatus | 335 | $2.95 | $0.74 | $2.22 | 13 | $1.21 | $0.02 |
| Manufacturing | Sign manufacturing | 384 | $2.94 | $0.95 | $1.98 | 35 | $1.38 | $0.01 |
| Manufacturing | Wood windows and door manufacturing | 117 | $2.74 | $2.50 | $0.24 | 18 | $1.00 | $0.01 |
| Manufacturing | Lighting fixture manufacturing | 326 | $2.29 | $0.00 | $2.29 | 9 | $0.85 | $0.02 |
| Manufacturing | Oil and gas field machinery and equipment | 261 | $2.17 | $0.08 | $2.09 | 6 | $0.49 | $0.01 |
| Manufacturing | Ornamental and architectural metal work | 237 | $2.15 | $0.12 | $2.03 | 13 | $0.66 | $0.01 |
| Manufacturing | Forest nurseries- forest products- and timber | 15 | $2.02 | $0.03 | $1.99 | 3 | $0.42 | $0.06 |
| Manufacturing | Surgical and medical instrument manufacturing | 375 | $1.95 | $0.66 | $1.29 | 7 | $1.01 | $0.01 |
| Manufacturing | Other engine equipment manufacturing | 286 | $1.92 | $1.15 | $0.78 | 3 | $0.13 | $0.00 |
| Manufacturing | Upholstered household furniture manufacturing | 363 | $1.91 | $0.02 | $1.88 | 14 | $0.80 | $0.01 |
| Manufacturing | Concrete block and brick manufacturing | 193 | $1.87 | $0.01 | $1.86 | 9 | $0.49 | $0.01 |
| Manufacturing | Gypsum product manufacturing | 197 | $1.81 | $0.01 | $1.80 | 4 | $0.26 | $0.01 |
| Manufacturing | All other food manufacturing | 84 | $1.53 | $0.13 | $1.40 | 6 | $0.32 | $0.01 |
| Manufacturing | Doll- toy- and game manufacturing | 382 | $1.43 | $0.03 | $1.40 | 7 | $0.32 | $0.01 |
| Manufacturing | Conveyor and conveying equipment | 292 | $1.29 | $0.53 | $0.76 | 5 | $0.22 | $0.00 |
| Manufacturing | Electroplating- anodizing- and coloring metal | 247 | $1.27 | $0.45 | $0.82 | 9 | $0.52 | $0.01 |
| Manufacturing | Tradebinding and related work | 140 | $1.21 | $0.29 | $0.92 | 13 | $0.83 | $0.01 |
| Manufacturing | Cut stone and stone product manufacturing | 199 | $1.16 | $0.96 | $0.20 | 12 | $0.38 | $0.01 |
| Manufacturing | Office supplies- except paper- manufacturing | 383 | $1.10 | $0.05 | $1.05 | 10 | $0.41 | $0.01 |
| Manufacturing | Paper and paperboard mills | 125 | $0.94 | $0.00 | $0.94 | 2 | $0.16 | $0.01 |
| Manufacturing | Miscellaneous electrical equipment | 343 | $0.94 | $0.09 | $0.84 | 4 | $0.34 | $0.01 |
| Manufacturing | Wet corn milling | 51 | $0.92 | $0.64 | $0.29 | 1 | $0.04 | $0.00 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Manufacturing Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Manufacturing | Rolled steel shape manufacturing | 206 | $0.84 | $0.06 | $0.77 | 2 | $0.06 | $0.00 |
| Manufacturing | Frozen food manufacturing | 60 | $0.82 | $0.03 | $0.79 | 3 | $0.16 | $0.01 |
| Manufacturing | Cut and sew apparel manufacturing | 107 | $0.68 | $0.02 | $0.67 | 6 | $0.21 | $0.00 |
| Manufacturing | Metal household furniture manufacturing | 365 | $0.66 | $0.00 | $0.66 | 5 | $0.35 | $0.00 |
| Manufacturing | Coffee and tea manufacturing | 80 | $0.63 | $0.01 | $0.62 | 1 | $0.04 | $0.00 |
| Manufacturing | Metal window and door manufacturing | 235 | $0.52 | $0.04 | $0.48 | 3 | $0.16 | $0.00 |
| Manufacturing | Heavy duty truck manufacturing | 345 | $0.50 | $0.00 | $0.49 | 1 | $0.02 | $0.00 |
| Manufacturing | Laboratory apparatus and furniture | 374 | $0.47 | $0.06 | $0.41 | 3 | $0.12 | $0.00 |
| Manufacturing | Fluid power pump and motor manufacturing | 300 | $0.44 | $0.01 | $0.44 | 2 | $0.10 | $0.00 |
| Manufacturing | Industrial pattern manufacturing | 253 | $0.31 | $0.01 | $0.30 | 3 | $0.11 | $0.00 |
| Manufacturing | Other aircraft parts and equipment | 353 | $0.29 | $0.05 | $0.24 | 2 | $0.06 | $0.00 |
| Manufacturing | Automatic environmental control manufacturing | 315 | $0.23 | $0.20 | $0.03 | 1 | $0.08 | $0.00 |
| Manufacturing | Industrial and commercial fan and blower | 276 | $0.22 | $0.00 | $0.22 | 1 | $0.04 | $0.00 |
| Manufacturing | Textile and fabric finishing mills | 97 | $0.13 | $0.05 | $0.08 | 1 | $0.02 | $0.00 |
| Manufacturing | Industrial process variable instruments | 316 | $0.13 | $0.04 | $0.09 | 1 | $0.03 | $0.00 |
| Manufacturing | Carbon and graphite product manufacturing | 342 | $0.13 | $0.06 | $0.07 | 1 | $0.06 | $0.00 |
| Manufacturing | Books printing | 137 | $0.13 | $0.06 | $0.07 | 1 | $0.08 | $0.00 |
| Manufacturing | Prefabricated wood building manufacturing | 122 | $0.11 | $0.00 | $0.10 | 1 | $0.04 | $0.00 |
| Manufacturing | Hand and edge tool manufacturing | 229 | $0.11 | $0.01 | $0.09 | 1 | $0.03 | $0.00 |
| Manufacturing | Engineered wood member and trusses | 116 | $0.10 | $0.09 | $0.01 | 1 | $0.03 | $0.00 |
| Manufacturing | Vitreous china and earthenware articles | 183 | $0.08 | $0.01 | $0.07 | 2 | $0.03 | $0.00 |
| Manufacturing | Explosives manufacturing | 168 | $0.08 | $0.02 | $0.06 | 1 | $0.02 | $0.00 |
| Manufacturing | Ophthalmic goods manufacturing | 378 | $0.05 | $0.00 | $0.05 | 1 | $0.02 | $0.00 |
| Manufacturing | Prepress services | 141 | $0.04 | $0.02 | $0.03 | 1 | $0.03 | $0.00 |
| Manufacturing | Vitreous china and earthenware articles | 183 | $0.08 | $0.01 | $0.07 | 2 | $0.03 | $0.00 |
| Total | NA | NA | $8,346.10 | $1,352.63 | $6,993.47 | 40,129 | $2,314.24 | $58.68 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Municipal Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Municipal | Telecommunications | 422 | $1,768.20 | $607.34 | $1,160.85 | 5,064 | $722.45 | $121.40 |
| Municipal | Owner-occupied dwellings | 509 | $1,543.86 | $0.00 | $1,543.86 | 0 | $1,195.98 | $182.55 |
| Municipal | Wholesale trade | 390 | $1,511.94 | $723.86 | $788.08 | 10,472 | $796.24 | $223.39 |
| Municipal | State & Local Education | 503 | $1,374.61 | $0.00 | $1,374.61 | 32,572 | $1,374.61 | $0.00 |
| Municipal | Hospitals | 467 | $882.81 | $0.00 | $882.81 | 7,087 | $494.25 | $6.31 |
| Municipal | Monetary authorities and depository credit in | 430 | $864.63 | $284.77 | $579.86 | 4,259 | $607.15 | $11.06 |
| Municipal | Food services and drinking places | 481 | $837.96 | $107.01 | $730.95 | 17,993 | $335.31 | $39.15 |
| Municipal | State & Local Non-Education | 504 | $665.63 | $0.00 | $665.63 | 11,345 | $665.62 | $0.00 |
| Municipal | Truck transportation | 394 | $651.18 | $352.60 | $298.58 | 5,261 | $285.47 | $6.50 |
| Municipal | Offices of physicians- dentists- and other he | 465 | $587.17 | $0.00 | $587.17 | 5,675 | $411.43 | $3.61 |
| Municipal | Real estate | 431 | $537.07 | $212.60 | $324.47 | 3,382 | $310.89 | $66.02 |
| Municipal | Motor vehicle and parts dealers | 401 | $399.88 | $43.48 | $356.39 | 4,197 | $204.38 | $57.69 |
| Municipal | General merchandise stores | 410 | $337.98 | $35.62 | $302.36 | 6,318 | $150.98 | $48.13 |
| Municipal | Other State and local government enterprises | 499 | $296.90 | $96.68 | $200.22 | 1,414 | $109.33 | $0.04 |
| Municipal | Food and beverage stores | 405 | $275.88 | $36.88 | $238.99 | 5,338 | $136.95 | $29.95 |
| Municipal | Securities- commodity contracts- investments | 426 | $271.26 | $180.14 | $91.12 | 2,237 | $99.38 | $2.99 |
| Municipal | Home health care services | 464 | $247.99 | $0.00 | $247.99 | 6,044 | $157.48 | $0.93 |
| Municipal | Nonstore retailers | 412 | $241.29 | $37.27 | $204.02 | 7,980 | $151.57 | $27.63 |
| Municipal | Insurance carriers | 427 | $218.46 | $63.70 | $154.76 | 964 | $69.42 | $8.62 |
| Municipal | Nursing and residential care facilities | 468 | $216.07 | $0.00 | $216.07 | 4,891 | $130.82 | $3.08 |
| Municipal | Civic- social- professional and similar organ | 493 | $206.94 | $72.71 | $134.23 | 6,365 | $97.02 | $0.61 |
| Municipal | Insurance agencies- brokerages- and related | 428 | $201.24 | $118.10 | $83.15 | 2,348 | $170.66 | $1.10 |
| Municipal | Building material and garden supply stores | 404 | $195.05 | $30.25 | $164.80 | 2,284 | $91.95 | $27.99 |
| Municipal | Services to buildings and dwellings | 458 | $191.64 | $141.40 | $50.24 | 3,867 | $88.02 | $3.37 |
| Municipal | Architectural and engineering services | 439 | $185.69 | $117.05 | $68.64 | 1,639 | $94.82 | $0.80 |
| Municipal | Automotive repair and maintenance- except car | 483 | $185.56 | $44.08 | $141.48 | 2,492 | $68.83 | $13.67 |
| Municipal | Other ambulatory health care services | 466 | $173.55 | $11.29 | $162.26 | 1,331 | $80.02 | $1.20 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Municipal Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Municipal | Legal services | 437 | $173.15 | $109.89 | $63.26 | 1,855 | $103.60 | $3.27 |
| Municipal | Scenic and sightseeing transportation and sup | 397 | $166.16 | $62.34 | $103.82 | 414 | $112.21 | $19.81 |
| Municipal | Office administrative services | 452 | $164.92 | $73.37 | $91.55 | 1,131 | $83.62 | $1.48 |
| Municipal | Gasoline stations | 407 | $153.50 | $23.31 | $130.18 | 1,817 | $82.54 | $22.49 |
| Municipal | Pipeline transportation | 396 | $152.74 | $66.80 | $85.94 | 178 | $53.39 | $11.30 |
| Municipal | Nondepository credit intermediation and rela | 425 | $147.13 | $90.07 | $57.06 | 1,168 | $81.90 | $6.27 |
| Municipal | Management of companies and enterprises | 451 | $137.73 | $129.53 | $8.21 | 763 | $76.88 | $1.23 |
| Municipal | Federal Non-Military | 506 | $131.55 | $0.00 | $131.55 | 1,098 | $131.55 | $0.00 |
| Municipal | Waste management and remediation services | 460 | $131.11 | $73.70 | $57.42 | 753 | $63.21 | $5.49 |
| Municipal | Commercial machinery repair and maintenance | 485 | $127.91 | $67.34 | $60.57 | 1,124 | $57.25 | $4.13 |
| Municipal | Newpaper publishers | 413 | $127.87 | $84.85 | $43.02 | 631 | $81.57 | $1.18 |
| Municipal | Cable networks and program distribution | 421 | $123.79 | $29.39 | $94.40 | 90 | $53.59 | $3.04 |
| Municipal | Accounting and bookkeeping services | 438 | $122.93 | $99.83 | $23.10 | 1,516 | $57.25 | $0.47 |
| Municipal | Maintenance and repair of nonresidential buil | 43 | $121.90 | $80.77 | $41.13 | 1,054 | $45.53 | $0.85 |
| Municipal | Clothing and clothing accessories stores | 408 | $119.60 | $14.97 | $104.63 | 2,257 | $61.29 | $17.38 |
| Municipal | Radio and television broadcasting | 420 | $119.32 | $94.72 | $24.60 | 672 | $36.65 | $0.47 |
| Municipal | Machinery and equipment rental and leasing | 434 | $116.84 | $63.54 | $53.30 | 375 | $47.41 | $1.69 |
| Municipal | Hotels and motels- including casino hotels | 479 | $113.34 | $58.39 | $54.95 | 1,795 | $61.01 | $10.49 |
| Municipal | Other personal services | 490 | $106.91 | $9.03 | $97.88 | 839 | $32.56 | $3.69 |
| Municipal | Business support services | 455 | $105.99 | $49.60 | $56.39 | 2,224 | $52.80 | $2.01 |
| Municipal | State and local government electric utilities | 498 | $105.14 | $28.40 | $76.73 | 285 | $53.08 | $0.28 |
| Municipal | Health and personal care stores | 406 | $102.42 | $16.35 | $86.07 | 1,574 | $50.41 | $14.65 |
| Municipal | Rail transportation | 392 | $99.44 | $48.08 | $51.36 | 297 | $60.42 | $1.92 |
| Municipal | Colleges- universities- and junior colleges | 462 | $92.32 | $4.90 | $87.43 | 1,897 | $43.41 | $0.00 |
| Municipal | Software publishers | 417 | $89.47 | $10.28 | $79.19 | 276 | $49.48 | $0.79 |
| Municipal | Information services | 423 | $81.06 | $19.71 | $61.35 | 267 | $29.79 | $0.69 |
| Municipal | Furniture and home furnishings stores | 402 | $76.73 | $11.73 | $65.00 | 871 | $37.59 | $11.07 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Municipal Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Municipal | Miscellaneous store retailers | 411 | $73.85 | $9.16 | $64.68 | 2,200 | $44.71 | $10.73 |
| Municipal | Management consulting services | 444 | $71.86 | $55.32 | $16.54 | 674 | $30.57 | $0.24 |
| Municipal | Grantmaking and giving and social advocacy or | 492 | $70.87 | $0.00 | $70.87 | 2,075 | $14.53 | $0.07 |
| Municipal | Federal Military | 505 | $70.45 | $0.00 | $70.45 | 1,295 | $70.44 | $0.00 |
| Municipal | Automotive equipment rental and leasing | 432 | $68.55 | $28.03 | $40.52 | 504 | $21.57 | $1.07 |
| Municipal | Other maintenance and repair construction | 45 | $67.80 | $23.63 | $44.17 | 1,100 | $41.86 | $0.40 |
| Municipal | Couriers and messengers | 399 | $67.49 | $61.36 | $6.13 | 1,276 | $39.32 | $0.91 |
| Municipal | Postal service | 398 | $65.28 | $44.44 | $20.84 | 1,115 | $50.45 | $0.00 |
| Municipal | Child day care services | 469 | $63.79 | $0.00 | $63.79 | 2,085 | $37.48 | $0.44 |
| Municipal | All other miscellaneous professional and tech | 450 | $61.76 | $55.14 | $6.62 | 114 | $24.06 | $0.48 |
| Municipal | Employment services | 454 | $59.74 | $49.44 | $10.30 | 3,644 | $47.88 | $0.27 |
| Municipal | Lessors of nonfinancial intangible assets | 436 | $58.74 | $32.03 | $26.71 | 17 | $27.63 | $2.62 |
| Municipal | Personal care services | 487 | $52.45 | $1.48 | $50.97 | 1,112 | $24.83 | $1.86 |
| Municipal | Transit and ground passenger transportation | 395 | $52.28 | $13.63 | $38.65 | 1,113 | $28.59 | $1.13 |
| Municipal | Veterinary services | 449 | $52.05 | $6.91 | $45.14 | 734 | $20.20 | $1.24 |
| Municipal | Other amusement- gambling- and recreation ind | 478 | $51.48 | $2.80 | $48.67 | 1,219 | $22.11 | $3.31 |
| Municipal | Drycleaning and laundry services | 489 | $49.88 | $12.69 | $37.18 | 1,419 | $24.45 | $2.86 |
| Municipal | Video tape and disc rental | 433 | $48.19 | $0.25 | $47.94 | 878 | $19.48 | $2.69 |
| Municipal | General and consumer goods rental except vide | 435 | $47.15 | $16.00 | $31.15 | 899 | $25.36 | $0.52 |
| Municipal | Social assistance- except child day care serv | 470 | $46.21 | $0.01 | $46.20 | 1,326 | $26.71 | $0.18 |
| Municipal | Sporting goods- hobby- book and music stores | 409 | $44.66 | $6.30 | $38.36 | 1,159 | $20.47 | $6.27 |
| Municipal | Advertising and related services | 447 | $43.91 | $40.93 | $2.98 | 381 | $16.48 | $0.28 |
| Municipal | Electronics and appliance stores | 403 | $41.70 | $5.52 | $36.18 | 1,057 | $28.08 | $6.14 |
| Municipal | Motion picture and video industries | 418 | $40.46 | $28.95 | $11.51 | 289 | $5.52 | $0.20 |
| Municipal | Investigation and security services | 457 | $39.55 | $25.29 | $14.26 | 679 | $29.45 | $0.74 |
| Municipal | Religious organizations | 491 | $38.43 | $0.00 | $38.43 | 305 | $20.02 | $0.00 |
| Municipal | Private households | 494 | $35.01 | $0.00 | $35.01 | 4,109 | $35.01 | $0.00 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Municipal Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Municipal | Maintenance and repair of farm and nonfarm re | 42 | $33.35 | $11.17 | $22.18 | 249 | $10.36 | $0.15 |
| Municipal | Warehousing and storage | 400 | $32.98 | $30.33 | $2.65 | 482 | $24.39 | $0.17 |
| Municipal | Other educational services | 463 | $31.72 | $2.68 | $29.04 | 752 | $15.09 | $0.86 |
| Municipal | Death care services | 488 | $31.31 | $0.00 | $31.31 | 597 | $13.63 | $2.13 |
| Municipal | Funds- trusts- and other financial vehicles | 429 | $31.16 | $0.59 | $30.56 | 117 | $4.46 | $0.22 |
| Municipal | Air transportation | 391 | $29.11 | $3.24 | $25.86 | 147 | $6.48 | $0.82 |
| Municipal | Performing arts companies | 471 | $27.56 | $13.49 | $14.07 | 1,637 | $6.22 | $0.84 |
| Municipal | Scientific research and development services | 446 | $27.02 | $20.76 | $6.26 | 171 | $16.62 | $0.13 |
| Municipal | Data processing services | 424 | $25.66 | $5.27 | $20.40 | 100 | $13.80 | $0.18 |
| Municipal | Fitness and recreational sports centers | 476 | $25.00 | $6.97 | $18.03 | 1,035 | $10.01 | $1.20 |
| Municipal | Car washes | 482 | $24.53 | $4.84 | $19.68 | 551 | $12.59 | $1.45 |
| Municipal | Environmental and other technical consulting | 445 | $23.19 | $21.35 | $1.84 | 146 | $11.18 | $0.08 |
| Municipal | Other support services | 459 | $22.84 | $21.41 | $1.43 | 327 | $8.97 | $0.21 |
| Municipal | Household goods repair and maintenance | 486 | $22.34 | $10.84 | $11.50 | 172 | $7.64 | $0.66 |
| Municipal | Photographic services | 448 | $18.93 | $6.25 | $12.69 | 266 | $6.98 | $0.52 |
| Municipal | Maintenance and repair of highways- streets- | 44 | $18.40 | $0.00 | $18.39 | 232 | $9.75 | $0.13 |
| Municipal | Specialized design services | 440 | $17.69 | $16.64 | $1.05 | 118 | $8.05 | $0.22 |
| Municipal | Facilities support services | 453 | $17.13 | $4.03 | $13.10 | 321 | $11.14 | $0.05 |
| Municipal | Electronic equipment repair and maintenance | 484 | $16.41 | $3.07 | $13.34 | 126 | $7.18 | $0.54 |
| Municipal | State and local government passenger transit | 497 | $15.21 | $3.97 | $11.24 | 232 | $5.72 | $0.00 |
| Municipal | Promoters of performing arts and sports and a | 474 | $14.46 | $4.74 | $9.73 | 305 | $9.39 | $0.60 |
| Municipal | Database- directory- and other publishers | 416 | $13.60 | $6.55 | $7.05 | 39 | $7.20 | $0.11 |
| Municipal | Elementary and secondary schools | 461 | $13.42 | $0.00 | $13.42 | 441 | $7.48 | $0.00 |
| Municipal | Computer systems design services | 442 | $10.79 | $6.57 | $4.22 | 202 | $9.16 | $0.22 |
| Municipal | Travel arrangement and reservation services | 456 | $10.37 | $7.35 | $3.02 | 98 | $3.60 | $0.14 |
| Municipal | Periodical publishers | 414 | $10.33 | $5.07 | $5.26 | 57 | $3.26 | $0.05 |
| Municipal | Sound recording industries | 419 | $9.44 | $2.21 | $7.23 | 33 | $7.06 | $0.04 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

| Economic Data for Municipal Water User Groups in the Llano Estacado Regional Water Planning Area ($millions, 2010-2060) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Water Use Category** | **IMPLAN Sector** | **IMPLAN Code** | **Total Sales** | **Intermediate Sales** | **Final Sales** | **Jobs** | **Income** | **Business Taxes** |
| Municipal | Custom computer programming services | 441 | $9.23 | $0.77 | $8.46 | 148 | $7.81 | $0.05 |
| Municipal | Water transportation | 393 | $7.23 | $2.18 | $5.05 | 16 | $1.39 | $0.12 |
| Municipal | Other accommodations | 480 | $6.74 | $0.10 | $6.64 | 83 | $2.15 | $0.21 |
| Municipal | Independent artists- writers- and performers | 473 | $6.16 | $5.99 | $0.17 | 106 | $1.34 | $0.03 |
| Municipal | Bowling centers | 477 | $6.14 | $0.38 | $5.76 | 144 | $2.60 | $0.53 |
| Municipal | Museums- historical sites- zoos- and parks | 475 | $4.97 | $0.00 | $4.97 | 80 | $2.34 | $0.08 |
| Municipal | Water- sewage and other systems | 32 | $2.71 | $0.82 | $1.90 | 38 | $2.07 | $0.10 |
| Municipal | Book publishers | 415 | $2.48 | $0.22 | $2.26 | 11 | $0.62 | $0.01 |
| Municipal | Other Federal Government enterprises | 496 | $2.28 | $0.97 | $1.31 | 74 | $1.70 | $0.00 |
| Municipal | Spectator sports | 472 | $2.24 | $1.28 | $0.96 | 73 | $1.50 | $0.19 |
| Municipal | Other computer related services | 443 | $0.28 | $0.17 | $0.11 | 2 | $0.21 | $0.00 |
| Municipal | Federal electric utilities | 495 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Municipal | Non-comparable imports | 500 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Municipal | Scrap | 501 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Municipal | Used and secondhand goods | 502 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Municipal | Rest of the world adjustment to final uses | 507 | $0.00 | $0.00 | $0.00 | 0 | $0.00 | $0.00 |
| Municipal | Inventory valuation adjustment | 508 | -$31.19 | -$31.19 | $0.00 | 0 | -$31.19 | $0.00 |
| Total | | $20,458.19 | $5,458.11 | $15,000.08 | 232,546 | $11,848.15 | $1,091.61 | $20,458.19 |
| Based on year 2006 data from the Minnesota IMPLAN Group, Inc. | | | | | | | | |

# Appendix 1: Economic Impacts by Water User Group

| Bailey County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $28.61 | $30.07 | $29.69 | $29.55 | $29.34 | $29.19 |
| Lost state and local business taxes from reduced crop production | $1.57 | $1.65 | $1.63 | $1.63 | $1.61 | $1.61 |
| Lost jobs from reduced crop production | 464 | 488 | 482 | 479 | 476 | 474 |

| Briscoe County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $0.00 | $0.80 | $8.11 | $9.15 | $9.99 | $9.79 |
| Lost state and local business taxes from reduced crop production | $0.00 | $0.04 | $0.44 | $0.50 | $0.55 | $0.54 |
| Lost jobs from reduced crop production | 0 | 11 | 116 | 131 | 143 | 140 |

| Castro County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Dimmitt** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $10.45 | $11.21 | $13.75 | $13.98 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $1.31 | $2.96 | $3.16 | $6.55 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.17 | $0.37 | $0.40 | $0.83 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 57 | 131 | 139 | 288 |
| Lost utility revenues | $0.00 | $0.00 | $1.31 | $1.42 | $1.47 | $1.49 |
| **City of Hart** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $0.08 | $0.13 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.12 | $0.14 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $25.11 | $65.80 | $90.82 | $121.85 | $122.29 | $120.48 |
| Lost state and local business taxes from reduced crop production | $1.47 | $3.84 | $5.30 | $7.11 | $7.13 | $7.03 |
| Lost jobs from reduced crop production | 975 | 1,114 | 1,280 | 1,452 | 1,410 | 1,385 |
| **Livestock** | | | | | | |
| Lost income from reduced livestock production | $0.00 | $3.68 | $10.00 | $48.75 | $115.42 | $123.56 |
| Lost state and local business taxes from reduced livestock production | $0.00 | $0.27 | $0.73 | $3.57 | $8.45 | $9.05 |
| Lost jobs from reduced livestock production | 0 | 92 | 249 | 1216 | 2879 | 3082 |

| Cochran County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Morton** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $11.29 | $11.39 | $11.03 | $10.50 | $10.00 |
| Lost income from reduced commercial business activity | $0.00 | $12.58 | $12.69 | $12.29 | $11.71 | $11.14 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.76 | $0.76 | $0.74 | $0.70 | $0.67 |
| Lost jobs due to reduced commercial business activity | 0 | 258 | 260 | 252 | 240 | 228 |
| Lost utility revenues | $0.00 | $0.99 | $1.00 | $0.96 | $0.92 | $0.87 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $14.58 | $13.78 | $13.23 | $12.71 | $55.53 | $52.65 |
| Lost state and local business taxes from reduced crop production | $0.72 | $0.68 | $0.65 | $0.63 | $2.74 | $2.59 |
| Lost jobs from reduced crop production | 192 | 181 | 174 | 167 | 730 | 693 |

| Crosby County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| **City of Crosbyton** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $6.87 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $2.85 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.40 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 0 | 0 | 95 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.59 |
| **City of Lorenzo** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.05 | $0.11 | $0.76 | $0.89 |
| Lost utility revenues | $0.00 | $0.00 | $0.07 | $0.12 | $0.16 | $0.19 |
| **City of Ralls** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.01 | $6.51 | $6.41 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $2.39 | $2.36 |
| Lost state and local taxes from reduced commercial business activity | 0 | 0 | 0 | 0 | 92 | 91 |
| Lost jobs due to reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.33 | $0.33 |
| Lost utility revenues | $0.00 | $0.00 | $0.01 | $0.01 | $0.57 | $0.56 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $1.85 | $1.76 | $1.67 | $1.58 | $1.31 | $1.23 |
| Lost state and local business taxes from reduced crop production | $0.19 | $0.18 | $0.17 | $0.16 | $0.13 | $0.12 |
| Lost jobs from reduced crop production | 21 | 20 | 19 | 18 | 15 | 14 |

| Dawson County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $39.02 | $38.62 | $36.69 | $35.08 | $32.32 | $29.80 |
| Lost state and local business taxes from reduced crop production | $1.21 | $1.90 | $2.15 | $2.30 | $2.42 | $2.52 |
| Lost jobs from reduced crop production | 491 | 486 | 461 | 441 | 406 | 375 |

| Deaf Smith County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $69.99 | $79.94 | $91.87 | $104.02 | $101.00 | $99.17 |
| Lost state and local business taxes from reduced crop production | $3.08 | $3.52 | $4.05 | $4.58 | $4.45 | $4.37 |
| Lost jobs from reduced crop production | 880 | 1,005 | 1,155 | 1,308 | 1,270 | 1,247 |
| **Livestock** | | | | | | |
| Lost income from reduced livestock production | $1.85 | $1.76 | $1.67 | $1.58 | $1.31 | $1.23 |
| Lost state and local business taxes from reduced livestock production | $0.19 | $0.18 | $0.17 | $0.16 | $0.13 | $0.12 |
| Lost jobs from reduced livestock production | 21 | 20 | 19 | 18 | 15 | 14 |

| Dickens County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Spur** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $1.56 | $5.18 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.18 | $1.72 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.02 | $0.23 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 0 | 7 | 66 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.27 | $0.45 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $0.86 | $0.83 | $0.79 | $0.76 | $0.72 | $0.69 |
| Lost state and local business taxes from reduced crop production | $0.05 | $0.05 | $0.04 | $0.04 | $0.04 | $0.04 |
| Lost jobs from reduced crop production | 12 | 11 | 11 | 10 | 10 | 9 |

| Floyd County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Lockney** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $4.84 | $4.72 | $4.52 | $4.27 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $1.93 | $1.88 | $1.80 | $1.70 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.24 | $0.23 | $0.22 | $0.21 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 61 | 59 | 57 | 54 |
| Lost utility revenues | $0.00 | $0.00 | $0.42 | $0.41 | $0.39 | $0.37 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $20.78 | $48.73 | $49.72 | $49.74 | $48.01 | $45.70 |
| Lost state and local business taxes from reduced crop production | $0.76 | $1.80 | $1.96 | $2.09 | $1.99 | $1.94 |
| Lost jobs from reduced crop production | 202 | 478 | 522 | 555 | 530 | 515 |

| Gaines County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $9.22 | $28.90 | $32.74 | $34.98 | $36.81 | $38.37 |
| Lost state and local business taxes from reduced crop production | $0.49 | $1.54 | $1.75 | $1.86 | $1.96 | $2.05 |
| Lost jobs from reduced crop production | 128 | 400 | 453 | 484 | 510 | 531 |

| Garza County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Lake Alan Henry WSD** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $2.58 | $2.41 | $2.04 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.46 | $0.43 | $0.36 |
| **City of Post** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $2.58 | $2.41 | $2.04 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.46 | $0.43 | $0.36 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $2.07 | $1.89 | $1.75 | $1.63 | $1.52 | $1.41 |
| Lost state and local business taxes from reduced crop production | $0.10 | $0.09 | $0.09 | $0.08 | $0.08 | $0.07 |
| Lost jobs from reduced crop production | 23 | 21 | 20 | 18 | 17 | 16 |

| Hale County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Abernathy** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $2.29 | $4.27 | $2.28 | $2.78 | $3.18 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.57 | $0.69 | $0.77 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.06 | $0.07 | $0.08 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 14 | 17 | 19 |
| Lost utility revenues | $0.00 | $0.29 | $0.35 | $0.39 | $0.42 | $0.43 |
| **City of Petersburg** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $6.29 | $6.17 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $2.31 | $2.27 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.32 | $0.32 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 0 | 89 | 87 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.55 | $0.54 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $3.39 | $9.17 | $47.09 | $140.64 | $152.70 | $151.78 |
| Lost state and local business taxes from reduced crop production | $0.22 | $0.59 | $3.02 | $7.39 | $8.02 | $7.97 |
| Lost jobs from reduced crop production | 49 | 131 | 673 | 1,945 | 2,112 | 2,099 |
| **Livestock** | | | | | | |
| Lost income from reduced livestock production | $0.00 | $0.00 | $2.78 | $3.86 | $10.41 | $12.21 |
| Lost state and local business taxes from reduced livestock production | $0.00 | $0.00 | $0.20 | $0.28 | $0.76 | $0.89 |
| Lost jobs from reduced livestock production | 0 | 0 | 69 | 96 | 260 | 305 |

| Hockley County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| **City of Anton** | | | | | | |
| Monetary value of domestic water shortages | $9.72 | $9.98 | $10.05 | $5.40 | $5.16 | $4.90 |
| Lost income from reduced commercial business activity | $2.81 | $2.88 | $2.90 | $2.86 | $2.73 | $2.59 |
| Lost state and local taxes from reduced commercial business activity | $0.32 | $0.33 | $0.33 | $0.33 | $0.31 | $0.30 |
| Lost jobs due to reduced commercial business activity | 81 | 84 | 84 | 83 | 79 | 75 |
| Lost utility revenues | $0.46 | $0.48 | $0.48 | $0.47 | $0.45 | $0.43 |
| **City of Ropesville** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $2.01 | $1.97 | $1.88 | $1.79 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.49 | $0.47 | $0.45 | $0.43 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.06 | $0.05 | $0.05 | $0.05 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 14 | 14 | 13 | 13 |
| Lost utility revenues | $0.00 | $0.00 | $0.16 | $0.16 | $0.15 | $0.14 |
| **City of Smyer** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $1.25 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.46 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.06 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 0 | 0 | 18 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.11 |
| **City of Sundown** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $7.73 | $7.79 | $7.66 | $7.33 | $6.98 |
| Lost income from reduced commercial business activity | $0.00 | $3.74 | $3.77 | $3.70 | $3.54 | $3.37 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.43 | $0.43 | $0.42 | $0.41 | $0.39 |
| Lost jobs due reduced commercial business activity | 0 | 108 | 109 | 108 | 103 | 98 |
| Lost utility revenues | $0.00 | $0.62 | $0.62 | $0.61 | $0.58 | $0.56 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $20.19 | $23.90 | $52.27 | $55.53 | $53.03 | $51.57 |
| Lost state and local business taxes from reduced crop production | $1.02 | $1.21 | $2.65 | $2.82 | $2.69 | $2.61 |
| Lost jobs from reduced crop production | 230 | 272 | 595 | 632 | 604 | 587 |

| Lamb County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Earth** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $2.04 | $2.02 | $5.56 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $2.10 | $2.07 | $2.04 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.29 | $0.29 | $0.29 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 81 | 80 | 79 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.50 | $0.49 | $0.49 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $28.95 | $39.90 | $101.78 | $120.82 | $126.17 | $127.67 |
| Lost state and local business taxes from reduced crop production | $1.56 | $2.16 | $5.50 | $6.53 | $6.82 | $6.90 |
| Lost jobs from reduced crop production | 456 | 628 | 1,602 | 1,901 | 1,985 | 2,009 |
| **Livestock** | | | | | | |
| Lost income from reduced livestock production | $0.00 | $0.00 | $1.82 | $15.69 | $45.53 | $58.37 |
| Lost state and local business taxes from reduced livestock production | $0.00 | $0.00 | $0.13 | $1.15 | $3.33 | $4.27 |
| Lost jobs from reduced livestock production | 0 | 0 | 45 | 196 | 1136 | 728 |

| Lubbock County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Abernathy** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $3.42 | $4.51 | $1.96 | $2.18 | $2.27 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.49 | $0.54 | $0.55 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.05 | $0.05 | $0.06 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 12 | 13 | 13 |
| Lost utility revenues | $0.00 | $0.24 | $0.29 | $0.32 | $0.34 | $0.35 |
| **City of Idalou** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $5.52 | $5.50 | $5.48 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $7.16 | $7.13 | $7.11 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.00 | $0.67 | $0.67 | $0.67 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 0 | 168 | 167 | 166 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.48 | $0.48 | $0.48 |
| **City of Lubbock** | | | | | | |
| Monetary value of domestic water shortages | $10.86 | $10.64 | $15.33 | $20.13 | $69.00 | $73.84 |
| Lost utility revenues | $15.15 | $18.49 | $23.70 | $27.77 | $34.05 | $36.37 |
| **City of New Deal** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.01 | $0.02 | $0.02 | $0.03 | $0.02 |
| Lost utility revenues | $0.00 | $0.02 | $0.04 | $0.04 | $0.04 | $0.04 |
| **City of Shallowater** | | | | | | |
| Monetary value of domestic water shortages | $1.55 | $1.97 | $2.08 | $2.02 | $2.11 | $2.02 |
| Lost utility revenues | $0.28 | $0.32 | $0.33 | $0.32 | $0.34 | $0.32 |
| **City of Slaton** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $0.52 | $0.52 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.45 | $0.45 |
| **City of Wolfforth** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.00 | $0.00 | $0.20 | $0.61 |
| Lost utility revenues | $0.00 | $0.00 | $0.00 | $0.00 | $0.29 | $0.68 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $7.65 | $22.67 | $24.93 | $54.79 | $50.88 | $48.19 |
| Lost state and local business taxes from reduced crop production | $0.41 | $1.22 | $1.35 | $2.96 | $2.75 | $2.60 |
| Lost jobs from reduced crop production | 120 | 357 | 392 | 862 | 801 | 758 |

| Lynn County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Wilson** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $1.37 | $1.31 | $1.27 | $1.21 | $1.11 |
| Lost income from reduced commercial business activity | $0.00 | $0.39 | $0.37 | $0.36 | $0.35 | $0.32 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.05 | $0.05 | $0.05 | $0.05 | $0.04 |
| Lost jobs due to reduced commercial business activity | 0 | 16 | 15 | 15 | 14 | 13 |
| Lost utility revenues | $0.00 | $0.12 | $0.11 | $0.11 | $0.11 | $0.10 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $0.08 | $0.07 | $0.06 | $0.06 | $0.06 | $0.06 |
| Lost state and local business taxes from reduced crop production | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Lost jobs from reduced crop production | 1 | 1 | 1 | 1 | 1 | 1 |

| Motley County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $0.18 | $0.17 | $0.16 | $0.15 | $0.15 | $0.14 |
| Lost state and local business taxes from reduced crop production | $0.01 | $0.01 | $0.01 | $0.01 | $0.01 | $0.01 |
| Lost jobs from reduced crop production | 2 | 2 | 2 | 2 | 2 | 2 |

| Parmer County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| **City of Friona** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $17.72 | $17.54 | $16.89 | $15.95 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $4.38 | $4.33 | $4.17 | $3.94 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.91 | $0.90 | $0.87 | $0.82 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 250 | 248 | 239 | 225 |
| Lost utility revenues | $0.00 | $0.00 | $1.55 | $1.53 | $1.48 | $1.39 |
| **City of Farewell** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $0.06 | $0.13 | $0.14 | $0.22 |
| Lost utility revenues | $0.00 | $0.00 | $0.08 | $0.14 | $0.17 | $0.19 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $49.93 | $204.95 | $223.61 | $221.41 | $219.26 | $217.21 |
| Lost state and local business taxes from reduced crop production | $2.76 | $11.32 | $12.35 | $12.23 | $12.11 | $12.00 |
| Lost jobs from reduced crop production | 805 | 3,304 | 3,605 | 3,569 | 3,534 | 3,501 |
| **Livestock** | | | | | | |
| Lost income from reduced livestock production | $0.00 | $0.00 | $0.87 | $7.49 | $35.99 | $49.37 |
| Lost state and local business taxes from reduced livestock production | $0.00 | $0.00 | $0.06 | $0.55 | $2.64 | $3.62 |
| Lost jobs from reduced livestock production | 0 | 0 | 22 | 187 | 898 | 1232 |

| Swisher County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Tulia** | | | | | | |
| Monetary value of domestic water shortages | $3.76 | $3.76 | $3.76 | $3.76 | $3.76 | $3.76 |
| Lost utility revenues | $0.73 | $0.73 | $0.73 | $0.73 | $0.73 | $0.73 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $2.61 | $14.26 | $22.75 | $25.04 | $25.59 | $25.58 |
| Lost state and local business taxes from reduced crop production | $0.14 | $0.78 | $1.24 | $1.36 | $1.39 | $1.39 |
| Lost jobs from reduced crop production | 40 | 435 | 693 | 763 | 780 | 780 |

| Terry County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Brownfield** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.12 | $0.34 | $0.60 | $0.64 | $0.63 |
| Lost utility revenues | $0.00 | $0.20 | $0.49 | $0.77 | $0.81 | $0.80 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $23.09 | $56.73 | $62.33 | $65.52 | $60.29 | $55.36 |
| Lost state and local business taxes from reduced crop production | $1.21 | $2.97 | $3.27 | $3.43 | $3.16 | $2.90 |
| Lost jobs from reduced crop production | 303 | 745 | 819 | 860 | 792 | 727 |

| Yoakum County (2010-2060, $millions) | | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| **City of Denver City** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $0.00 | $20.05 | $21.37 | $20.90 | $20.39 |
| Lost income from reduced commercial business activity | $0.00 | $0.00 | $6.64 | $7.19 | $7.09 | $6.96 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.00 | $0.93 | $1.01 | $0.99 | $0.97 |
| Lost jobs due to reduced commercial business activity | 0 | 0 | 255 | 277 | 273 | 268 |
| Lost utility revenues | $0.00 | $0.00 | $1.72 | $1.84 | $1.80 | $1.76 |
| **City of Plains** | | | | | | |
| Monetary value of domestic water shortages | $0.00 | $9.03 | $9.43 | $9.84 | $9.54 | $9.21 |
| Lost income from reduced commercial business activity | $0.00 | $3.32 | $3.47 | $3.61 | $3.50 | $3.38 |
| Lost state and local taxes from reduced commercial business activity | $0.00 | $0.46 | $0.49 | $0.51 | $0.49 | $0.47 |
| Lost jobs due to reduced commercial business activity | 0 | 128 | 133 | 139 | 135 | 130 |
| Lost utility revenues | $0.00 | $0.79 | $0.82 | $0.86 | $0.83 | $0.80 |
| **Irrigation** | | | | | | |
| Lost income from reduced crop production | $4.90 | $4.56 | $4.13 | $3.90 | $3.70 | $3.51 |
| Lost state and local business taxes from reduced crop production | $0.26 | $0.25 | $0.22 | $0.21 | $0.20 | $0.19 |
| Lost jobs from reduced crop production | 70 | 65 | 59 | 56 | 53 | 50 |

# Appendix D

# Example
# Municipal Water Conservation Plan

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# Appendix D

# City of Lubbock Water Conservation And Drought Contingency Plan

**Lubbock, Texas**
**July 2010**

# City of Lubbock
## Retail and Wholesale 2010 Water Use Management Plan – Water Conservation Plan And Drought and Emergency Contingency Plan
## Contents

***Section*** ***Page***

## 1.0 Introduction

The City of Lubbock (the "City") is located in Lubbock County in the Texas Panhandle and is the eleventh largest city in the State of Texas and the largest city in West Texas. The City's population was estimated by the City of Lubbock planning department to be 219,643 in 2010. According to the Llano Estacado (Region O) Regional Water Plan, the City's population is expected to increase to almost 228,000 by 2020, while the City's planning department estimates the most probable population to be 231,730 by 2020. The City is situated in a semi-arid region that requires more water per capita for landscape irrigation than in many other parts of the State. Evidence of landscape irrigation demand is apparent when comparing the average winter water usage of 135 gallons per capita per day (gpcd) to the average summer water usage of 227 gpcd. In response to this, recent City efforts on water conservation have focused on techniques to reduce the amount of water used in landscape irrigation.

This Water Use Management Plan – Water Conservation Plan and Drought and Emergency Contingency Plan pertains to the use of water by both the City's retail and wholesale water customers, and is intended to meet the requirements of the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB).

## 1.1 System Description

The City of Lubbock water system currently utilizes two separate water supply sources. During 2010, approximately 80% of the City's annual water usage will be supplied from the Canadian River Municipal Water Authority (CRMWA). Lubbock is a member city of the CRMWA. Water supplied from CRMWA is a blend of surface water and groundwater. The surface water source is Lake Meredith and the ground water source is the CRMWA well field located in Roberts County. The supply capacity of this system to Lubbock is 42 million gallons per day (MGD). This blended supply is treated at the Lubbock Water Treatment Plant in Lubbock. The treatment plant is a conventional water treatment plant, and treats water for the City of Lubbock and for six other CRMWA southern division member cities: Slaton, Tahoka, O'Donnell, Lamesa, Levelland and Brownfield. CRMWA supplies the raw water to these cities.

The City provides water treatment services only to these cities. These cities reimburse Lubbock for their respective portions of the water treatment cost. CRMWA operates a 250 million gallon capacity raw water reservoir located near the treatment plant. The City owns and operates a 400 million gallon raw water storage reservoir located adjacent to the CRMWA reservoir. This reservoir is used during summertime peak water use periods to supplement the normal supply from CRMWA. Its peak supply capacity is 25 MGD.

During 2010, approximately 20% of the City's annual water usage will be supplied from a well field located in Bailey and Lamb Counties, which is owned and operated by the City of Lubbock. This well field is commonly referred to as the Bailey County Well Field (BCWF), and is made up of 165 production wells. All ground water from this source is treated at a central location in the well field. Disinfection is the only treatment required for this source. The supply capacity of this system is 40 MGD.

The Lubbock water distribution system contains approximately 1,471 miles of pipeline mains, 12 pump stations, 12 ground storage tanks totaling 64.5 million gallons, 4 conventional elevated storage tanks totaling 4.15 million gallons, and the BCWF pipeline that functions as an unconventional elevated storage system totaling 11.0 million gallons.

The City sells water on a wholesale basis to six separate public water supply systems, the City of Shallowater, Lubbock Reese Redevelopment Authority, Lubbock County Water Control & Improvement District No. 1 (also known as Buffalo Springs Lake community), the Town of Ransom Canyon, the City of Littlefield, and the City of New Deal. The water is supplied to the City of Littlefield only for infrequent emergency use. The water supplied to the City of New Deal is water purchased from the City of Slaton by the City of New Deal and delivered through the City of Lubbock water distribution system, for which Lubbock charges only a delivery fee.

## 2.0 Water Conservation Plan

### 2.1 Introduction

The City of Lubbock provides retail water service to City residents and also provides water on a wholesale basis to six additional entities. While the City can try to directly influence the water use of its retail water users through the water conservation measures discussed in this Plan, as the six wholesale customer's retail utility systems are separate from the City's retail system, the City does not have the ability to implement most of the water conservation measures discussed in this Plan for the wholesale customers. The wholesale customers will be able to implement these measures as a part of their respective retail water supply operations.

### 2.2 Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply, the City adopts the following regulations concerning water conservation through this ordinance. Water uses regulated or prohibited under this Water Conservation Plan are considered to be discretionary and are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section 2.16 of this Plan.

### 2.3 Authorization

The City Manager or his/her designee is authorized and directed to implement the applicable provisions of this plan. The City Manager or his/her designee will act as the administrator of the plan, oversee the execution and implementation of the plan, and will be responsible for keeping adequate records for program verification.

### 2.4 Conservation Goals

The City's water conservation goals are to: (1) provide an adequate supply of suitable treated water to meet the needs of its retail and wholesale customers; and to (2) encourage its wholesale customers to adopt and implement water conservation plans that will reduce their per capita water use rates.

The City's wholesale customer water conservation program is predicated on the fact that the implementation of conservation measures must occur largely at the local level. Due to this fact, the City's wholesale program is focused on encouraging and supporting initiatives by its wholesale customers.

TCEQ rules require that water conservation plans contain specific, quantifiable five- and ten-year goals for use in gallons per capita per day. The goals established as part of this plan are not enforceable. The gpcd calculation, as defined by TCEQ, is the total average daily amount of water diverted or pumped for treatment by potable uses divided by the population served.

In order to set a per capita goal for municipal water conservation, baseline per capita water use was determined from the average per capita water use from 2005 to 2009 as determined by the City of Lubbock. In order to determine these values, the City uses total water pumped from all sources divided by the estimated City population as determined by the City's Planning Department. This resulted in an average value reflecting both wet and dry years. The average per capita use from 2005 to 2009 was 155 gpcd with a high of 177 gpcd in 2006 and a low of 136 gpcd in 2007. This average per capita use rate is less than the target rate of 172 gpcd recommended by the Llano Estacado Regional Water Planning Group, but greater than the target rate of 140 gpcd recommended by the State of Texas Water Conservation Task Force. The Water Conservation Task Force recommends a one percent per year reduction until the target of 140 gpcd is reached; however, in light of the fact that the City of Lubbock has already achieved a significant conservation response, the goals for this plan were developed utilizing a 0.5% per year reduction in per capita water use. This results in a **per capita goal for year 2015 of 150 gpcd and a year 2020 goal of 146 gpcd**. This reflects a reduction of 0.5%per year from the current average of 155 gpcd.

This methodology is similar to that used in Lubbock's previous water conservation plan adopted in 2006. The previous plan started with an average daily usage of 190 gpcd and included goals to reduce that by approximately 5% over a five year period for a 2011 goal of 180 gpcd, by approximately 10% over a ten year period for a 2016 goal of 170 gpcd, and by approximately 15% over a 14-year period for a 2020 goal of 160 gpcd. The new goals established under this revised plan are much lower than those previously established due to starting with a lower base-year per capita value, which is based on data from recent years.

In addition to the per capita water use goal above, **the City has set a maximum water loss water goal of 10% for the retail water delivery system for both 2015 and 2020. This would correspond to a loss rate of 16.2 gpcd in 2015 and 15.4 gpcd in 2020.** This goal is a benchmark established by the TCEQ for water loss.

### *2.5 Metering Water Diverted from the Source of Supply*

The City meters the amount of raw water pumped from both the BCWF and from the CRMWA supply using meters that are maintained to record flow with an accuracy of plus or minus 5.0%. The amount of water delivered to each wholesale water customer is also metered by the City.

## 2.6 Universal Metering Program

Using meters that meet at least the minimum standards developed by the American Water Works Association and with a metering accuracy range of plus or minus 5.0%, the City individually meters all water usage, except that utilized for fire protection. Combined with the City's computerized billing system, the City's universal metering program has a water delivery accuracy rate of plus or minus 5%, which meets the TCEQ standards for meter accuracy. The City encourages each wholesale water customer to meter all water usage as well.

The City uses a random sampling technique to test meter accuracy and to determine when meters need to be repaired or replaced. The City randomly samples approximately 400 water meters each year. Depending on the results of this sample, additional sampling may be done to target meters of a certain age or meters located within a certain geographical portion of the City. Meters found to have an accuracy of less than plus or minus 5% are either repaired or replaced as needed.

## 2.7 Records Management System

The City maintains a records management system which tracks the volume of water pumped, water delivered to retail customers, water sold to wholesale customers, and the volume of water losses. The City's utility billing database allows water sales and uses to be desegregated into the volume used by residential, commercial, public and institutional, and industrial customers.

## 2.8 Measures to Control Unaccounted-For Uses of Water

The City takes the appropriate steps to monitor and audit its water system for water loss in an effort to conserve water, manages the replacement of old water lines that are prone to leaks and breaks, investigates customer complaints of low pressure and possible leaks, visually inspects suspected leaks, and tracks water delivery to customers to determine illegal connections and abandoned service lines.

## 2.9 Program for Achieving Water Conservation Goals

The City has established goals, objectives and programs that support a standard for water use. The City's Water Conservation Program is comprised of five main strategies in the following order of priority: (1) administrative water conservation efforts, (2) water use standards, (3) public education and information, (4) enforcement, and (5) structural changes.

The City will evaluate and implement certain administrative changes to programs, policies, and rules that support water conservation efforts. In 1992, the City moved from a declining block rate to a uniform block rate. In 2007, the City passed a revised water rate ordinance with an inclining block rate structure. Other administrative changes may include the continued review and revision of city codes to determine their affect on the use of water and active enforcement of rules, codes, and regulations affecting water use.

In an effort to manage annual and maximum daily water use, the Water Conservation Program establishes the following water use standards for outdoor landscape irrigation:

1. Landscape irrigation is allowed to occur only between the hours of 6:00 p.m. to 10:00 a.m. from April 1st through September 30th.
2. Summer irrigation should provide a maximum of 1.5 inches per zone per week.
3. Winter irrigation may occur only when temperatures are above 35°F so as not to cause a freezing hazard and should provide a maximum of 1.0 inch per zone per month for dormant grasses (i.e. Bermuda) and 1.0 inch per zone every two weeks for cool season grasses (i.e. Fescue).
4. Irrigation should occur without water runoff. This may be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.

The City will support programs to educate the public regarding water conservation activities that support its goals. This includes educating the general public on the need for and practices of water conservation through public service announcements, participation in home and garden shows, coordination efforts with the Chamber of Commerce, West Texas Home Builders Association and Lubbock Apartment Association, and supporting water conservation efforts in the local education system.

Structural changes that have been and may be adopted by the City are those programs that result in a physical modification of water use devices or practices, such as landscape design and maintenance, rain and freeze sensors on automatic irrigation systems, plumbing retrofit or rehabilitation programs, controlling water loss, and by reusing treated wastewater and stormwater.

In regards to the City's wholesale water customers, their retail utility systems are separate from the City's retail water system; therefore, the City does not have the ability to implement most of the water conservation items discussed above. The City encourages its wholesale customers to implement these or other appropriate water conservation measures as a part of their respective retail water supply operations.

### *2.10 Water Rate Structure*

The City of Lubbock has adopted a water rate structure which is non-promotional (see City Code of Ordinance Chapter 28-53).

### *2.11 Reservoir Operations Plan*

This requirement is not applicable to the City of Lubbock at this time. The City only owns and operates one water supply reservoir, Lake Alan Henry, which is located on the South Fork of the Double Mountain Fork of the Brazos River.

### *2.12 Coordination with Regional Planning Groups*

The water service area of the City of Lubbock is located within Llano Estacado Regional Planning Area (Region O) and the City has provided a copy of this Plan to the Llano Estacado Regional Water Planning Group to ensure consistency with the regional water plan.

### 2.13 Leak Detection/Repair and Water Loss Accounting Program

The City routinely monitors the water storage, delivery, and distribution system components for leaks. Waterline leaks are detected by utility personnel while reading meters, maintaining their water and wastewater systems, and while performing other routine surveillance programs. Any reported leaks are repaired in a timely manner. The wholesale water customers are responsible for managing their ongoing leak detections, location, and repair programs.

At a minimum, the City will conduct a water audit using the methodology outlined by the TWDB every five years in accordance with current TWDB rules. Water audits may be conducted on a more frequent basis if the City deems that action to be appropriate.

### 2.14 Water Supply Contracts

It is a mandatory requirement for the City to require wholesale customers with any new or amended contracts or successor contracts to develop a water conservation plan. Minimum plan requirements for municipal wholesale customers entering or renewing City contracts include:

- A completed TCEQ utility profile;
- Specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use, in gallons per capita per day.
- Metering devices having accuracy within plus or minus 5 percent in order to measure and account for the amount of water diverted from the supply source;
- A program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;
- Measures to determine and control unaccounted-for uses of water (for example, periodic visual inspections along distribution lines, annual or monthly audit of the water system to determine illegal connections, abandoned services, etc.);
- A program of continuing public education and information regarding water conservation;
- A water rate structure which is not "promotional," meaning a rate structure which is cost-based and which does not encourage the excessive use of water;
- A reservoir systems operation plan, if applicable, providing for the coordinated operation of reservoirs owned by the utility within a common watershed or river basin in order to optimize available water supplies;
- A means of implementation and enforcement of conservation practices, as evidenced by either: 1) a copy of the ordinance, resolution, or tariff, indicating official adoption of the water conservation plan by the customer; or 2) a description of the authority by which the customer will implement and enforce the water conservation plan; and
- Documentation of coordination with the regional water planning groups for the service area of the customer in order to ensure consistency with the appropriate regional water plans.

Water conservation plan must include the following additional elements if the customer serves, or plans to serve in the next 10 years, a population of 5,000 or greater:

- A program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted-for uses of water;
- A record management system to record water pumped, water deliveries, water sales, and water losses which allows for the desegregation of water sales and uses into the following user classes: residential, commercial, public and institutional, and industrial; and
- For wholesale water customers, that they include a requirement that every wholesale water supply contract entered into or renewed after official adoption of the customer's water conservation plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable TCEQ requirements.

Other measures that the customer could adopt to meet the stated conservation goals might include but are not limited to:

- Measurement and control of excessive pressure in the distribution system;
- Ordinances to promote efficiency and avoid water waste;
- Plumbing fixture replacement and retrofit programs;
- Other beneficial reuse of water such as grey water and rainwater harvesting systems; and
- Other measures as may be applicable.

All customer plans must be reviewed and approved by City Council before water sales contracts are signed.

### 2.15 Revisions to the Water Conservation Plan

The City shall review and update, as appropriate, the Water Conservation Plan at least every five (5) years, based on, in part, an assessment of the previous five- and ten-year goals, new or updated information such as the adoption or revision of the regional water plan, or changes in laws or regulations.

### 2.16 Penalties for Non-Compliance with the Water Conservation Plan

Any water customer or other user of the City's water supply that violates this Water Conservation Plan shall be guilty of a misdemeanor and subject to a penalty and fine as set forth in Section 1-4 of the Code of Ordinances of the City of Lubbock for each day of non-compliance. In addition, (i) service shall be discontinued to those customers who do not pay their water bills until all required payments are made; and (ii) new water service taps will be provided to new construction and new construction will be approved only if such construction conforms to adopted ordinances.

### 2.17 Severability

It is hereby to be the intention of the City of Lubbock that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph or section shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, or sections of this Plan.

## 3.0 Drought and Emergency Contingency Plan

### 3.1 Introduction

- A number of situations may limit the City's ability to deliver a sufficient amount of water to meet the demands of all customers. In those instances, the City will take steps to ensure that water is available for essential life and safety needs. This Drought and Emergency Contingency Plan (the Plan) is designed to address the following situations. Reduction in available water supply up to a repeat of the drought of record;
- Water production or distribution limitations (peak water supply);
- Supply source contamination; and/or
- System outages.

There are four stages to address drought and emergency conditions. Each stage has triggers for initiation, for restrictions on water use to assist in reaching water use reduction goals, and has provisions for rescinding the stage once the conditions that caused the drought or emergency have ceased to exist. The stages are defined as:

- Stage 1 – Mild Water Shortage Conditions
- Stage 2 – Moderate Water Shortage Conditions
- Stage 3 – Severe Water Shortage Conditions
- Stage 4 – Emergency Water Shortage Conditions

### 3.2 Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the City adopts the following regulations and restrictions on the delivery and consumption of water through Ordinance No. XXXXX.

Water uses regulated or prohibited under this Drought and Emergency Contingency Plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section 3.13 of this Plan.

### 3.3 Authorization

The City Manager or his/her designee, is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The City Manager, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

### 3.4 Public Involvement

Opportunity for the public and for the wholesale water customers to provide input into the preparation of the Plan was provided by the City by means of scheduling and providing public notice of a public meeting to accept input on the Plan held on July 8, 2010. The Plan was adopted under the open meetings requirement of the TCEQ during the July 22, 2010 City Council meeting.

### 3.5 Public and Wholesale Customer Education

The City will periodically provide the public and wholesale customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided to the public. The City will periodically provide the public and wholesale customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided to the public by means necessary to educate and provide information to the public, including but not limited to, public service announcements, newspaper notices, utility bill inserts, and educational presentations. This information will be provided to the wholesale customers by providing them with a copy of this Plan.

### 3.6 Coordination with Regional Water Planning Groups

The water service area of the City of Lubbock is located within the Llano Estacado Regional Water Planning Area (Region O). The City has provided a copy of this Plan to the Llano Estacado Regional Water Planning Group to ensure consistency with the approved regional water plan.

### 3.7 Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by the City, included the City's wholesale water customers. The terms "person" and "customer" as used in the Plan includes individuals, corporations, partnerships, associations, and all other legal entities.

### 3.8 Triggering Criteria for Initiation and Termination of Drought Response Stages

The City Manager, or his/her designee, shall monitor water supply and/or demand conditions on a daily basis and shall determine when conditions warrant initiation or termination of each stage of the Plan, that is, when the specified "triggers" are reached. Public notification of the initiation or termination of drought response stages will be made by publication in a newspaper of general circulation, public service announcements, and/or signs posted in public places. Wholesale customer notification of the initiation or termination of drought response stages will be made by email, mail, or telephone.

The triggering criteria below are based on an evaluation of the historical water system capacities and customer use patterns, and consider the impact of drought, emergencies, and high use upon capacities and patterns.

**Stage 1. Mild Water Shortage Conditions**

Requirements for initiation – Stage 1 of the Plan shall be implemented if any of the following conditions arise:

- Daily water use exceeds 80% of the City's maximum daily supply capacity for ten consecutive days;
- Water supply available from all sources is only sufficient to meet projected needs; or
- Water availability is adequate but lake levels, reservoir capacities, or groundwater supplies are low enough that some concern exists for future water supplies if the drought or emergency condition continues.

Requirement for termination – Stage 1 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the City Manager or his/her designee.

**Stage 2 – Moderate Water Shortage Conditions**

Requirements for initiation – Stage 2 of the Plan shall be implemented if any of the following conditions arise:

- Daily water use exceeds 90% of the City's maximum daily supply capacity for ten consecutive days;
- Water supply available from all sources are reduced, but are greater than 90% of projected needs; or
- Water availability from lakes and groundwater is below normal and may continue to decline and cause moderate concern for both current and future water supplies or water supplies have been reduced due to failure of a portion of the water supply system.

Requirement for termination – Stage 2 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the City Manager or his/her designee. When Stage 2 is terminated, Stage 1 automatically becomes effective.

**Stage 3 – Severe Water Shortage Conditions**

Requirements for initiation – Stage 3 of the Plan shall be implemented if any of the following conditions arise:

- Daily water use exceeds 100% of the City's maximum daily supply capacity for five consecutive days;
- Water supply available from all sources are reduced to 90% or less of projected needs; or
- Water availability from lakes and groundwater is well below normal, may continue to decline, and additional reductions in current or future water supplies are evident or water supplies have been reduced due to failure of a portion of the water supply system.

Requirement for termination – Stage 3 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the City Manager or his/her designee. When Stage 3 is terminated, Stage 2 automatically becomes effective.

**Stage 4 - Emergency Water Shortage Conditions**

Requirements for initiation – Stage 4 of the Plan shall be implemented if any of the following conditions arise:

- Daily water use exceeds 105% of the City's maximum daily supply capacity for five consecutive days;

- Water supply available from all sources are reduced to less than 70% of projected needs;

- There has been a failure in a major water supply source or system, such as the failure of a dam, storage reservoir, pumping system, transmission pipeline, water treatment facility, major power failure, or natural disaster that causes a severe and prolonged limit on the ability of the water supply system to meet the water supply demands; or

- The source water supply has been contaminated.

Requirement for termination – Stage 4 restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the City Manager or his/her designee. When Stage 4 is terminated, Stage 3 automatically becomes effective.

## *3.9 Drought Response Stages*

The City Manager, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria set forth in Section 3.8, shall determine that mild, moderate, or severe water shortage conditions exist or that an emergency condition exists and shall implement the following actions. The City shall notify the

Executive Director of the TCEQ within five business days of the implementation of any mandatory provisions of the Plan.

**Stage 1 – Mild Water Shortage Conditions**

**Target: Reduce water use to less than 90% of the City's maximum daily supply capacity.**

Best Management Practices for Supply Management:

- The City may reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.
- Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the City of Lubbock will be added into any new contract or contract revision.

Water Use Restrictions for Reducing Demand:

- Landscape irrigation is restricted to two days per week. The City Manager or his/her designee may, after notice to the citizens of the City of Lubbock, designate irrigation schedules.
- Irrigation shall provide a maximum of 1.5 inches per zone per week.
- Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.
- All City of Lubbock operations shall adhere to the water use restrictions.
- Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.
- New plant material may be irrigated on a more frequent basis until the new plant material is established.
- The City Manager, or his/her designee, will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use (i.e., implement Stage 1 of the customer's drought contingency plan).

**Stage 2 – Moderate Water Shortage Conditions**

**Target: Reduce water use to less than 80% of the City's maximum daily supply capacity.**

Best Management Practices for Supply Management:

- The City will reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.
- Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring

wholesale customers to implement mandatory drought restrictions consistent with the City of Lubbock will be added into any new contract or contract revision.

Water Use Restrictions for Reducing Demand:

- Landscape irrigation is restricted to one day per week. The City Manager, or his/her designee, after notice to the citizens of the City of Lubbock, may designate an irrigation watering schedule.
- Irrigation shall provide a maximum of 1.5 inches per zone per week.
- Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.
- Water customers will refrain from or significantly limit aesthetic and non-essential water use. Water shall not be used to wash down hard surfaced areas, including, without limitation, sidewalks, parking lots, gutters, and patios. Water shall not be used for dust control. However, water may be used for road construction or to clean surfaces for painting. Pools and Jacuzzi type pools may not be drained and refilled.
- All City of Lubbock operations shall adhere to the water use restrictions.
- Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.
- New plant material may be irrigated on a more frequent basis until then new plant material is established.
- The City Manager, or his/her designee, will request wholesale water customers to initiate mandatory measures to reduce non-essential water use (i.e., implement Stage 2 of the customer's drought contingency plan).

**Stage 3 – Severe Water Shortage Conditions**

**<u>Target</u>: Reduce water use to less than 70% of the City's maximum daily supply capacity.**

Best Management Practices for Supply Management:

- The City will reduce or discontinue the flushing of water mains as well as utilize reclaimed water for non-potable purposes where practicable.
- Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the City of Lubbock will be added into any new contract or contract revision.

Water Use Restrictions for Reducing Demand:

- Irrigation shall occur without significant water runoff, which can be accomplished by correctly cycling the sprinkler system and allowing time for the water to soak into the landscape between irrigation events.
- Landscape irrigation shall not occur more than one day per month and not for more than 1.5 inches per zone. The City Manager, or his/her designee, may designate the irrigation schedule.

- Use of water from fire hydrants shall be limited to fire fighting or other related activities necessary to maintain public health, safety, and welfare. Under the direction of the City Manager, use of water from fire hydrants for construction purposes may be allowed by permit.
- All City of Lubbock operations shall adhere to the water use restrictions.
- Hand watering for landscape irrigation purposes is allowed on a daily basis regardless of the time of year.
- The City Manager, or his/her designee, will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use (i.e., implement Stage 3 of the customer's drought contingency plan).

**Stage 4 - Emergency Water Shortage Conditions**

**<u>Target:</u> Reduce water use to less than 50% of the City's maximum daily supply capacity.**

Best Management Practices for Supply Management:

- The City will discontinue the flushing of water mains, discontinue the irrigation of public landscaped areas, and will utilize reclaimed water for non-potable purposes where practicable.
- In addition, in the event of a large-scale system failure or if the source water supply is contaminated, the City may truck in additional fresh water supplies as appropriate.
- Wholesale customers are required in specific contract provisions to implement these measures as well as any other measures specified in the wholesale supply contract to better manage a limited water supply. Contract provisions requiring wholesale customers to implement mandatory drought restrictions consistent with the City of Lubbock will be added into any new contract or contract revision.

Water Use Restrictions for Reducing Demand:

- All aesthetic and non-essential water use, including landscape irrigation use, is prohibited except where necessary to protect the health, safety, and welfare of the public. No new landscape material may be installed.
- All City of Lubbock operations will adhere to the water use restrictions.
- The City of Lubbock may reduce water system pressure to conserve water.
- All wholesale water customers will be encouraged to implement Stage 4 of their drought contingency plans.

In addition, whenever emergency water shortage conditions exist as defined in Section 3.8 of the Plan, the City Manager, or his/her designee(s), shall:

- Assess the severity of the problem and identify the actions needed and the time required to solve the problem;
- Inform the utility director or other responsible official of each wholesale water customer by telephone, email, or in person and suggest actions, as appropriate to alleviate problems (i.e., notification of the public to reduce water use until service is restored);

- If appropriate, notify city, county, and/or state emergency response officials for assistance;
- Undertake necessary actions, including repairs and/or clean-up as needed; and
- Prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

### 3.10 Coordination with the Canadian River Municipal Water Authority

The City of Lubbock is a wholesale water customer of the Canadian River Municipal Water Authority (CRMWA), and as such must coordinate any drought responses with CRMWA. The City of Lubbock will periodically consult with CRMWA concerning supplies available to the City and at the request of CRMWA enact additional drought conservation measures if so directed by CRMWA.

### 3.11 Revisions to the Drought and Emergency Contingency Plan

The City shall review and update, as appropriate, the Drought and Emergency Contingency Plan at least every five (5) years based, in part, on new or updated information, such as the adoption or revision of the regional water plan.

### 3.12 Pro Rata Water Allocation

In the event that the triggering criteria specified in Section 3.8 of the Plan for Stage 4 – Emergency Water Shortage Conditions have been met, the City Manager, or his/her designee, is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039. A provision shall be included in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code Section 11.039.

### 3.13 Enforcement

Any water customer or other user of the City's water supply who violates the Drought and Emergency Contingency Plan shall be guilty of a misdemeanor and subject to a penalty and fine as set forth in Section 1-4 of the Code of Ordinances of the City of Lubbock for each day of non-compliance. In addition, in the event (i) the failure to comply with this ordinance creates an imminent threat to public health, safety, or welfare; or (ii) the subject person is convicted of three or more distinct violations (as opposed to consecutive multiple day events of the same violation) within a one (1) year period, the City, after ten (10) days notice and opportunity to cure the violation, may discontinue water service until such time as the user shall be in compliance with this ordinance and, in the case of disconnection due to an imminent health, safety, or welfare threat, pay the required charges and fees for re-connection or, in the case of disconnection due to three or more distinct violations within a one (1) year period, pay the required charges and fees for re-connections and provide suitable assurance to the City Manager that the same action will not be repeated while the subject stage of the Drought and Emergency Contingency Plan is in effect.

Any person in apparent control of the property where a violation occurs or originates shall be presumed to be the violator and proof thereof shall constitute a rebuttable presumption that the person in apparent control of such property committed the violation.

### 3.14 Variances

The City of Lubbock Water Board of Appeals, as established in Section 28-44 of the Code of Ordinances of the City of Lubbock, may grant, in writing, a temporary variance for existing water uses otherwise prohibited under the Drought and Emergency Contingency Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

(1) Compliance with this Plan cannot be technically accomplished during the duration of this water supply shortage or other condition for which the Plan is in effect.

(2) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Plan shall file a petition for variance with the Water Board of Appeals. All petitions for variances shall be reviewed by the Water Board of Appeals and shall include, in addition to the information provided in Section 28-44 of the Code of Ordinances of the City of Lubbock, the following:

(1) Name and address of the petitioner;

(2) Purpose of water use;

(3) Specific provision(s) of this Plan from which the petitioner is requesting relief;

(4) Detailed statement with supporting data and information as to how the specific provision(s) of this Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance;

(5) Description of the relief requested;

(6) Period of time for which the variance is sought;

(7) Alternative measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date; and

(8) Other pertinent information.

Variances granted by the Water Board of Appeals shall be subject to the following conditions, unless waived or modified by the Water Board of Appeals.

(1) Variances granted shall include a timetable for compliance.

(2) Variances granted shall expire on the earlier to occur of (i) the scheduled expiration; (ii) when the Drought and Emergency Contingency Plan is no longer in effect; and (iii) the date upon which the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

### 3.15 Severability

It is hereby declared to be the intention of the City that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such declaration shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan.

## 4.0 Irrigation Water Conservation Plan

The City of Lubbock owns Water Right No. 3985 in order to land apply sewage effluent from the City's wastewater treatment plant. The permit allows the City to use up to 18,430 acre-feet per year to irrigate 10,000 acres of land. The TCEQ requires a holder of an irrigation right greater than 10,000 acre-feet/year to develop an irrigation water conservation plan. This system is designed for inefficiency in order to ensure that the greatest volume of wastewater possible can be disposed of through this method. Consequently, a water conservation plan is not applicable in this circumstance.

The City currently has two land application sites. The Lubbock Land Application Site, located east of the City, encompasses 6,000 acres with 2,500 acres irrigated by center pivot systems. The Hancock Land Application Site, located southeast of the City, encompasses 4,000 acres with 2,500 acres irrigated by center pivot systems. Effluent from the Southeast Water Reclamation Plant is used to irrigate crops such as wheat, jose wheat, bermuda, and rye. A 412 million gallon storage reservoir allows the site to store and distribute treated effluent to 31 center pivot sprinkler systems as needed. Irrigation practices are designed to prevent contamination of surface and groundwater in the area.

The City's current and future goals for this system are to be able to dispose of the total wastewater volume necessary through this system and to not implement any water conserving devices or practices for this system. The City monitors the delivery system for any leaks by visually inspecting the system on a regular basis, and all leaks are repaired in a timely manner.

## 5.0 Definitions

For the purposes of this Plan, the following definitions shall apply:

Aesthetic water use: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Annual water supply: the amount of water available to the City of Lubbock within a given year. Normally measured in billions of gallons or acre-feet.

Average winter consumption: the amount of water used by a customer on average during the winter months of December, January, and February.

Conservation: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative use.

<u>Domestic water use</u>: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution, except as provided under the definition of "Non-essential Water Use" below.
<u>Drought</u>: an extended period of time of below normal precipitation (rainfall, snow, etc.).
<u>Drought of record</u>: extended period of time of below normal precipitation (rainfall, snow, etc) that exceeds the length of time and impact on water supplies of previous droughts. The drought of record is used to help determine the estimated yield of reservoirs.
<u>Hand watering</u>: the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf course greens, tees, fairways, parks, athletic fields, street or alley rights-of-way and medians through the use of manual water devices supplied by a water hose and actively attended to by a person.
<u>Increasing block rate</u>: a water rate structure that has a rate that increases as more water is consumed.
<u>Landscape irrigation or landscape irrigation use</u>: water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf course greens, tees, and fairways, parks, athletic fields, street or alley rights-of-way and medians.
<u>Maximum daily supply</u>: the amount of water available to the City of Lubbock during a given day. The amount may be limited due to the water transmission line size, water pump size, the number of operating wells, the amount of raw and treated water storage, the water rights owned by the City and other related factors.
<u>Non-essential water use</u>: water uses that are neither essential nor required for the protection of public health, safety, and welfare, including without limitation:

(a) landscape irrigation;
(b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle of any kind;
(c) use of water to spray or wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
(d) use of water to spray or wash down buildings or structures for purposes other than immediate fire protection;
(e) flushing gutters or permitting water to run or accumulate in any gutter or street;
(f) use of water to fill, refill, or add to any indoor or outdoor swimming pools or hot tubs;
(g) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic and avian life; and
(h) failure to repair a leak(s) within a reasonable period of time after having been given notice directing the repair of such leak(s).

<u>Per capita water use</u>: a measure of water use for a city or other entity, expressed in gallons per capita per day (gpcd). The measure compares water use to the number of citizens in the area. The measure does not reflect the amount used on average by a citizen.
<u>Water Loss</u>: measured as the volume of water metered into the water distribution system minus the volume billed for a given time period.

# *Appendix E*

## *Derivation of Volume of Water in Storage*
## *Bailey County Example*

# Appendix E

Derivation of Volume of Water in Storage
and Supply and Demand
(LERWPG Regional Water Plan 2006)

by
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High Plains Underground Water Conservation District #1
May, 2005

Volume of water in storage, supply, and demand are values that provide the scientific backbone of any water plan. These values indicate the amount of groundwater available from an aquifer, the amount of water available to user groups, and the amount of water that user groups have determined necessary to sustain lifestyles and a standard of living. Each of the values can be provided as a historic, current, or future (projected) value.

There are numerous methods used to calculate the volume of water in storage and quantities of supply and demand for an aquifer. This appendix describes the volume of water in storage and the supply and demand values derived for the 2006 Llano Estacado Regional Water Planning Area (LERWPA) Regional Water Plan. The State of Texas stipulates that the three values be presented on a county-by-county basis. In this appendix, Bailey County is used as an example to illustrate the "by county" calculation process.

For each county, one of three methods was used to calculate volume of water in storage. Because volume of water in storage is directly related to supply, the outcome of the calculation method will be reflected in the supply values.

## Volume of Water in Storage

Volume of water in storage is calculated three ways in the 2006 Regional Water Plan. HDR, the planning group's contractor, refers to the three different volumes as Volume V1, Volume V2, and Volume V3, as described below. Table 1 lists the V1, V2 and V3 designations applied to the counties in this water plan.

**Volume V1:** V1 is a volume derived from two surfaces, the base of the Ogallala (the same base of aquifer surface used in the Groundwater Availability Model (GAM) 04-05) and the water table surface (the output of head values in the GAM model for a particular time step). The surfaces are derived by interpolating the point data (for the water table surface) and the line data (for the base of the aquifer) to raster grid cells. For each raster cell, the elevation of the base of the aquifer is then subtracted from the elevation of the water table. The difference is then multiplied by the specific yield (the same *Sy* used in the GAM) and the area of the grid (1 mile by 1 mile). The total volume of water in storage in each county is the sum of the volumes for each raster cell. Volume V1 is therefore a GAM-derived volume of water in storage.

**Table 1**
**County Volume Designations**
**2006 Regional Water Plan**

| V1 | V2 | V3 |
|---|---|---|
| Briscoe | Cochran | Bailey |
| Castro | Dickens | Gaines |
| Crosby | Garza | Parmer |
| Dawson | Lynn | |
| Deaf Smith | Motley | |
| Floyd | Yoakum | |
| Hale | | |
| Hockley | | |
| Lamb | | |
| Lubbock | | |
| Swisher | | |
| Terry * | | |

* (changed from V2 by request of the South Plains Water District)

**Volume V2**: The Llano Estacado Regional Water Planning Group (LERWPG) requested the Texas Water Development Board (TWDB) to tabulate the volume of water in storage using a "non-GAM" method. This has been referred to as the "mass balance" method[1] or "V2". To derive V2, the volume of water in storage in 1995[2] was used as the starting point and projected out to the year 2000[3]. Water demands approved by the TWDB on September 17, 2003 for the years 2000 to 2060 were subtracted from the 2000 base value on a yearly basis. The only input value was average recharge from the GAM. This approach completely ignores the spatial distributions of storage, pumpage, and recharge in the counties.

**Volume V3**: Volume V3 is calculated as the midpoint of V1 and V2 until the time when the only water left in the aquifer is the amount recharged, after which the volume of water in storage follows the same trend as the GAM trend line.

[1] Richard Smith of the TWDB GAM modeling group performed the "mass balance" calculations. Since it was conducted by the GAM modeling group, GAM number 04-07 was assigned to the report documenting the calculations. Although there is a GAM number, it is NOT a set of values derived from a groundwater model.

[2] In 1995, the High Plains Underground Water Conservation District #1 used a planimeter method to derive the volumes of water in each county of the Llano Estacado Regional Water Planning Group. At the time of the request for the "mass balance" calculations, the 1995 data was considered the most accurate volume data set available.

[3] 1996 to 2000 volumes were calculated by subtracting annual water use numbers generated by Dr. Stephen Amosson and others for the Southern Ogallala GAM (Blandford, R.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico: Numerical Simulations Through 2050) and adding average recharge from GAM 04-05 on an annual basis.

## Derivation of Volume of Water in Storage in Bailey County

Bailey County is used to illustrate the derivation of volume of water in storage (V1 vs. V2 vs. V3) and subsequently supply. Demand is derived independently of volume of water in storage and supply. Empirical data for the years 1990 to 2004 in Bailey County is provided to illustrate actual volumes of water in storage. From the empirical data we can see the actual aquifer trend from 1990 through 2004 and get a better sense of how the projected data fits with historical data.

Figure 1 compares volume of water in storage in Bailey County using various calculation methods. The two lines on the graph labeled TTU Baseline and TTU Drought are volumes calculated by the Texas Tech University Water Resources Center for the Llano Estacado Regional Water Planning Group (LERWPG) in 2001[4]. The LERWPG requested that several scenarios be modeled, including a baseline simulation and a drought simulation. The TTU modelers used a MODFLOW groundwater model that was designed to meet stringent calibration requirements stipulated by the LERWPG. As shown on the graph, the volumes for the baseline and drought scenarios start in 2000 at approximately 5.4 million acre-feet. After drought conditions are introduced in the year 2015, the two lines diverge and the volumes are reduced to 4.7 (baseline) and 4.3 (drought) million acre-feet.

The LERWPG elected not to use the results of the TTU model in the 2001 Llano Estacado Regional Water Plan. Instead, the planning group used what has been referred to as the “cedar pencil model” which was primarily based on a depletion estimate of 10% per decade. An initial starting point for volume came from the planimetered value performed by the High Plains Water District in 1995[5]. The “cedar pencil model” was not a numerical groundwater model, but rather a rough projected estimate. Those counties that showed actual increases in storage between 1985 and 1995 (Briscoe, Cochran, Crosby, Dickens, Garza, Hockley, Lynn, however not Dawson and Gaines counties) were estimated to remain constant throughout the planning period.

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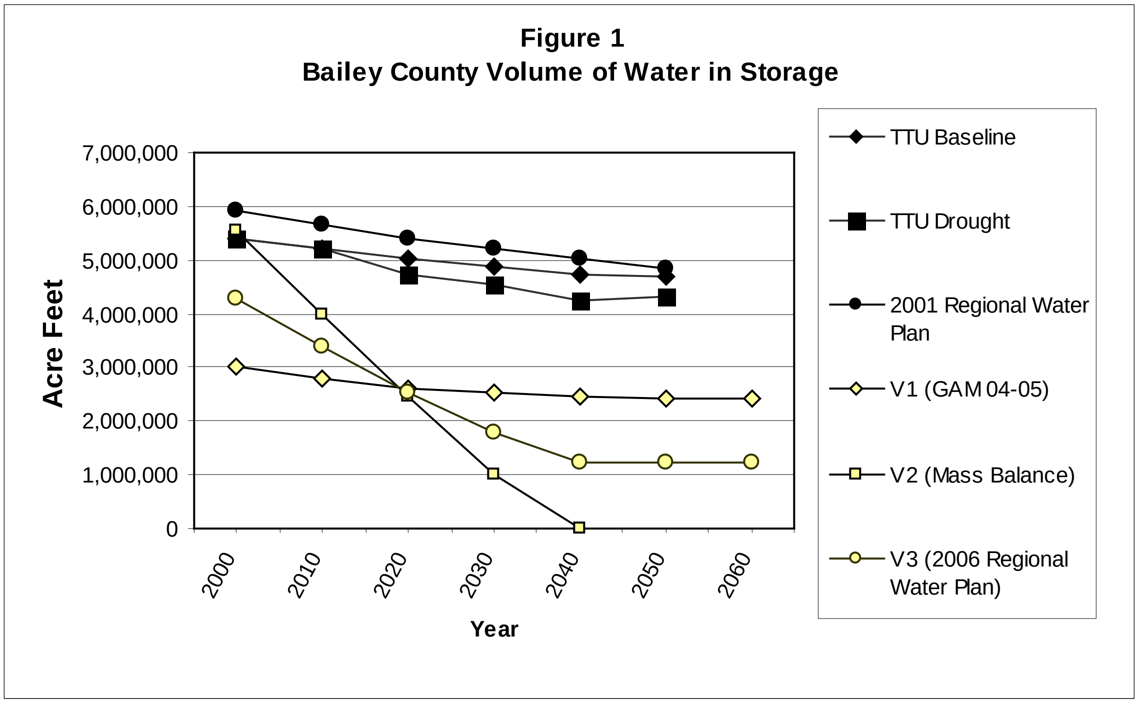
[4] Stovall, J., Rainwater, K., and Frailey, S., 2001, Groundwater Modeling for the Southern High Plains: Submitted to the Llano Estacado Regional Water Planning Group, 298p.

[5] The planimeter method uses a drafting instrument called a planimeter to trace the perimeter of a defined contour interval on a saturated thickness map, thereby determining the area on the map that has a saturated thickness in the range between two contour lines. As commonly done today, the determination of areal extent was done using AutoCAD™, rather than the planimeter tool. The 1995 calculations were based on the saturated thickness maps from the High Plains Underground Water Conservation District #1 Hydrologic Atlases (Don McReynolds, 1995). The areas were then multiplied by the mean saturated thickness and a representative specific yield (15%) to obtain the volume of water in storage. This procedure was used for each contour interval on the mapped area of interest. Finally, the volumes calculated for each contour interval were summed to give the total volume in each county.
The planimeter method can be very accurate for the year that the saturated thickness was mapped. Potential errors in the volumetric calculations are introduced in measurements of water table elevations, accuracy of the base of the aquifer map, accuracy of the saturated thickness map, contouring techniques, and representativeness of the specific yield value.




The 2000 volume estimated for Bailey County in the 2001 Regional Water Plan was approximately 5.9 million acre feet, compared to 4.8 million acre feet in the year 2050. These volumes are labeled "2001 Regional Water Plan" on Figure 1.

In 1997, Senate Bill 1 was enacted which, among other things, stipulated that numerical groundwater models were to be developed for all major aquifers. Groundwater Availability Model (GAM) results were to be used for regional water planning, unless better data could be documented. The Groundwater Availability Model for the Southern Ogallala aquifer was completed in 2003[6] by Daniel B. Stephens and Associates under contract to the Texas Water Development Board. The GAM for the Southern Ogallala aquifer had less stringent calibration standards than the TTU model, consequently, the GAM model did not simulate actual aquifer conditions as closely as the TTU model in all counties. In counties where the GAM did replicate the actual water table fairly well, the volumes of water in storage are fairly accurate. In counties where the water table generated by the model was appreciably above or below the observed water table, the volumes of water in storage can be very inaccurate (either resulting in too much or too little water in storage).

Bailey County Volume V1. Bailey County is an example of a county where the GAM does not accurately represent the aquifer. On Figure 1, the GAM derived volume of water in storage (V1) shows a year 2000 volume of approximately 3 million acre feet and a projected 2060 volume of about 2.4 million acre feet. The low volume in 2000 reflects a large number of cells that went dry by the year 2000 in the GAM. These dry cells are mainly located in the northwestern portion of Bailey County, an area that, in

[6] Blandford, R.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico: Numerical Simulations Through 2050.

actuality, has about 100 feet of saturated thickness. The result is that the GAM derived volume of water in storage (approximately 3 million acre feet) significantly under-represents the volume of water in Bailey County, beginning in 2000.

Bailey County Volume V2. The "mass balance" volume is presented as V2 on Figure 1. For this method, the starting volume of approximately 6 million acre feet in 1995 was projected to the year 2000 with a volume of 5.5 million acre feet. By subtracting the demand values on an annual basis (and adding the GAM derived recharge value), there is no water left in Bailey County by the year 2037.

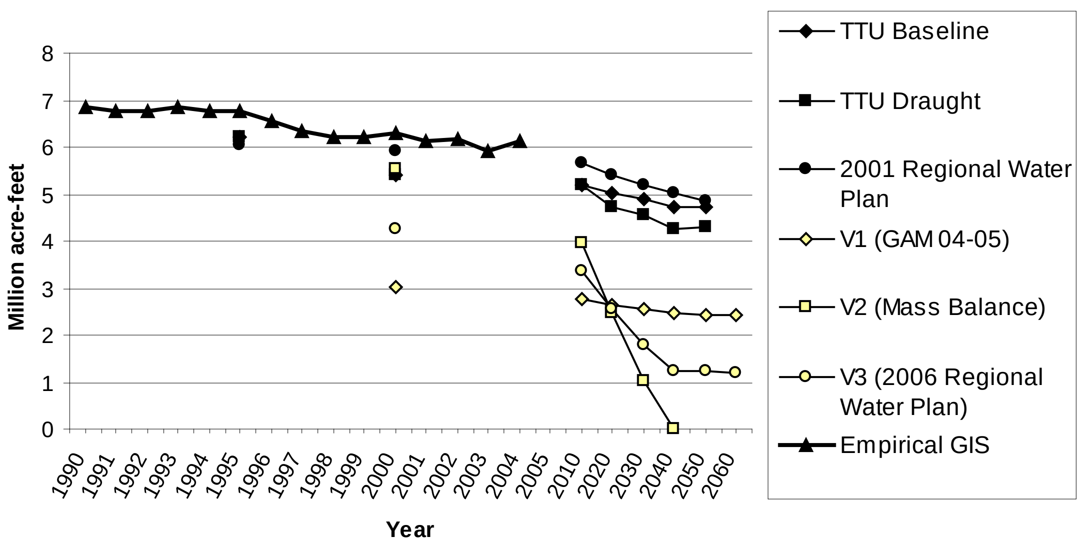
Bailey County Volume V3. Volume V3 is the volume chosen to represent Bailey County in the 2006 Regional Water Plan (Figure 1). Volume V3 is the mathematical midpoint between V1 and V2 through the year 2037, after which time the trend of the GAM model line (V1) is mimicked.

Discussion. How do we improve our understanding of the volume of water in storage in Bailey County? How do we get a sense which of the derived volumes most accurately represents the actual Ogallala aquifer conditions in Bailey County? One way is to look at actual data through time and plot the historical volumes on the same graph. Figure 2 shows the same volume trend lines as Figure 1, but adds a plot of the historical volumes from 1990 through 2004. Each year from 1990 through 2004, the High Plains Water District measured the depth to water in approximately 100 to 130 wells in Bailey County. To calculate the volume for each measurement year, a surface was created from the water level measurements to depict the actual water table in Bailey County. Using ArcGIS™ and ESRI Spatial Analyst™, the volume of water in the aquifer is determined by multiplying the difference between the base of the aquifer surface and the actual water table surface by the specific yield[7]. A raster grid cell size of 528 feet (or 0.1 mile) was used. The resultant volumes for the years 1990 to 2004 are presented in Figure 2 are labeled "Empirical GIS." These volumes are believed to be the most accurate volume calculations performed to date.

The actual data can be compared to the projected data from the models (e.g., TTU Baseline, TTU Drought, V1 (GAM 04-05)) or to the estimates using other techniques (e.g., 2001 Regional Water Plan, V2 (Mass Balance) or V3 (2006 Regional Water Plan)) to qualitatively determine if the projected lines "fit" the slope and magnitude of volumes indicted by the actual data. For example, in Figure 2, the projected trend lines with the most similar slope to actual data are the V1 (GAM 04-05) and TTU Baseline trend lines. Magnitude of volume is most closely replicated by the 2001 Regional Water Plan, TTU Baseline, and TTU Drought lines. Conversely, the most dissimilar slopes to the actual trend line are V2 (Mass Balance) and V3 (2006 Regional Water Plan)." The volumes that are most dissimilar to the historical values are V1 (GAM 04-05) and V3 (2006 Regional Water Plan)".

[7] Specific yield, or *Sy*, as used in GAM 04-05.

Figure 2
Bailey County Volume of Water in Storage




The distribution of the lines is not haphazard. The good correlation of the slope of the TTU and GAM model trend lines to the slope of the empirical data is due to the fact that models most closely replicate real conditions in the aquifer. This is precisely why we use models. However, if a model is not well calibrated (meaning that the model does not behave like the actual aquifer), the volume data will be skewed from the measured values. This is why the GAM 04-05 volume (V1) in Bailey County is only about half of the volume that the measured values indicate. The GAM in Bailey County was not well calibrated, and specifically, was plagued by what is known as the "dry cell phenomenon." For example, there were numerous 1 mile by 1 mile square cells in the model that showed no water in (i.e., went dry) in the year 2000; however, we know that, in actuality, there is water in that portion of the county, sometimes over 100 feet of water!

## Supply

Water supply is defined as "the volume of water apportioned to a WUG[8] or WWP[9] from each currently existing, connected, and accessible water source, during drought-of-record conditions, taking into consideration all constraints that limit the supply amount. A supply is current if it is existing, connected, and accessible for use as of January 1, 2002 or anticipated to be existing, connected, and accessible for use at the conclusion of the current regional water planning cycle." [10]

In its simplest form, supply can be defined as the amount of *currently available* water from the High Plains (Ogallala) aquifer plus any other known source of water that can increase the available water to a particular county or river basin. Examples of other

[8] Water User Group
[9] Wholesale Water Provider
[10] Texas Water Development Board, 2002, Guidelines for Regional Water Plan Development, Exhibit B, p. 12.

sources of water used in the 2006 Regional Water Plan are from other contributing aquifers such as the Dockum, Seymour, or Edwards-Trinity (High Plains) aquifers, Ogallala aquifer water brought in from outside of the planning region such as from Roberts County, surface water such as Lake Meredith, Lake Mackenzie, Lake Alan Henry, or the White River Reservoir, water obtained from stock tanks and windmills, or reclaimed water from municipal, industrial or irrigation processes.

The tabulation of available water from these “other sources” is rather straightforward. It’s the amount of water from the High Plains (Ogallala) aquifer that has caused much consternation. In the 2006 Regional Water Plan, supply from the High Plains (Ogallala) aquifer has been calculated three different ways, termed Supply V1, Supply V2, and Supply V3. The derivation of Supply V1, Supply V2, and Supply V3 are discussed below using Bailey County as an example.

## Derivation of Supply in Bailey County

Bailey County Supply V1. Supply V1 is simply the volume of water that was pumped within the model (GAM 04-05) on an annual basis plus contributions from other known sources of water to the county or river basin. As an annual value, it is best to designate supply units in ac-ft/yr. Most of the supply in each county comes from the water that was pumped in the model. Therefore, if the model is not accurately depicting the response of the aquifer to pumping, then the supply number can be seriously flawed. Bailey County is an example of a county in which the model’s pumping scenario does not mimic the actual pumping scenario in the aquifer.

Figure 3 shows the resultant Supply V1 for Bailey County starting with 85,719 ac-ft/yr in 2000 and reduced to 17,067 ac-ft/yr in 2060. A large number of model cells in Bailey County that should be available for pumping in the year 2000 are already dry cells, meaning that there is no pumping, and hence no supply from these cells. The problem in year 2000 propagates through the planning period out to year 2060. Since actual survey estimates of water use in Bailey County[11] for the year 2000 showed approximately 183,000 ac-ft, it goes without saying that the 85,719 ac-ft of supply indicated by the model grossly under represents supply in Bailey County.

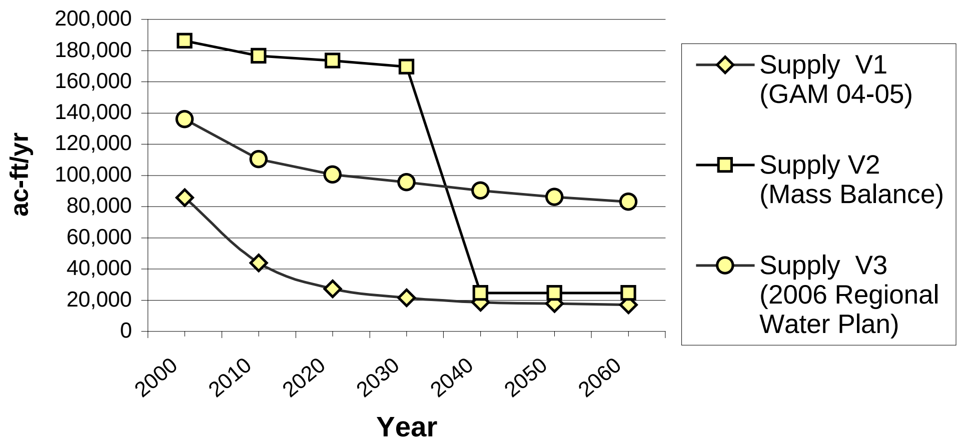
Bailey County Supply V2. Supply V2 is derived from the mass balance calculations performed by Richard Smith of the Texas Water Development Board. The values are a result of spreadsheet calculations and are not values derived from a numerical groundwater model. Supply V2 values are essentially set equal to the demand values up until the time when there is no water left in the aquifer. After all water is exhausted, only the GAM recharge value is added on an annual basis.

In Bailey County, no water is left in the aquifer by the year 2036, after which 24,599 ac-ft, or the average GAM recharge value, is added on an annual basis. Supply V2 is unrealistic because it is based on the premise that all future demands will be met at all well locations in Bailey County up until a time when there is not one drop of water left in the aquifer. We know that the aquifer will not behave this way. We know that in reality all wells are not created equal. Some demands on wells exceed (or will exceed)

[11] Performed mainly by the Natural Resource Conservation Service and reported in Texas Water Development Board Report 347 (2001).

the aquifer's capacity at a particular location, at which time the well will either go dry or the well must be pumped at a lower rate. In reality, wells in different locations will go dry at different times, pumping rates will vary, and some water will simply not be available for pumping due to hydraulic conditions of the aquifer.

**Figure 3**
**Bailey County Supply**




<u>Bailey County Supply V3.</u> Supply V3 is mathematically derived from Supply V1 and Supply V2. Supply V3 is the midpoint between Supply V1 and Supply V2 up until the time when the water in Supply V2 is exhausted, after which the Supply V3 line follows the trend of Supply V1.

The supply for Bailey County in the 2006 Regional Water Plan utilizes Supply V3. Supply V3 is viewed as a compromise for Bailey County, but the underlying problems associated with the Supply V1 and Supply V2 values must be recognized as part of the resultant Supply V3 value. In essence, Supply V3 is a midpoint between GAM generated values that grossly under represent supply (Supply V1) and the "mass balance" values (Supply V2) which represent an unrealistic aquifer.

## Demand

Calculation of demand is specific to the various water user groups (WUGs), i.e., municipal water demand, irrigation water demand, manufacturing and mining water demands, or steam electric power generation water demands. For example, projections for municipal water use consider population growth, climatic conditions, and water conservation practices and are comprised of residential, commercial and institutional water users. Demand, like supply, is expressed in units of ac-ft/yr.

Irrigation water demands are based on a survey performed primarily by the Natural Resource Conservation Service (NRCS) – U.S. Department of Agriculture[12] in 2000. The NRCS estimated irrigated crop acreages and corresponding irrigation water application for each crop to obtain the demand values.

The 2006 Regional Water Plan presents water demand projections for six major water user groups: 1.) municipal; 2.) mining; 3.) livestock; 4.) irrigation; 5.) manufacturing; and 6.) steam-electric power generation. As shown in Table 2, demand values for irrigation far exceed other categories of demands.

**Table 2**
**Bailey County Demand for Year 2000**
*(ac-ft/yr)*

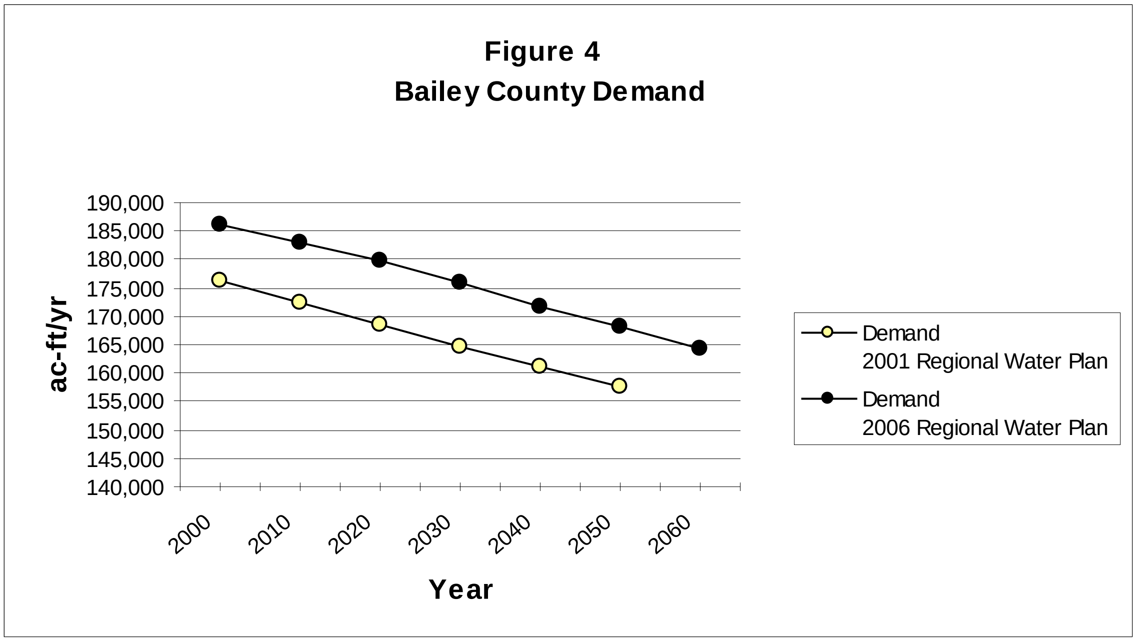
| | |
|---|---:|
| Municipal | 1,310 |
| Mining | 0 |
| Livestock | 1,723 |
| Irrigation | 182,865 |
| Manufacturing | 264 |
| Steam-Electric | 0 |

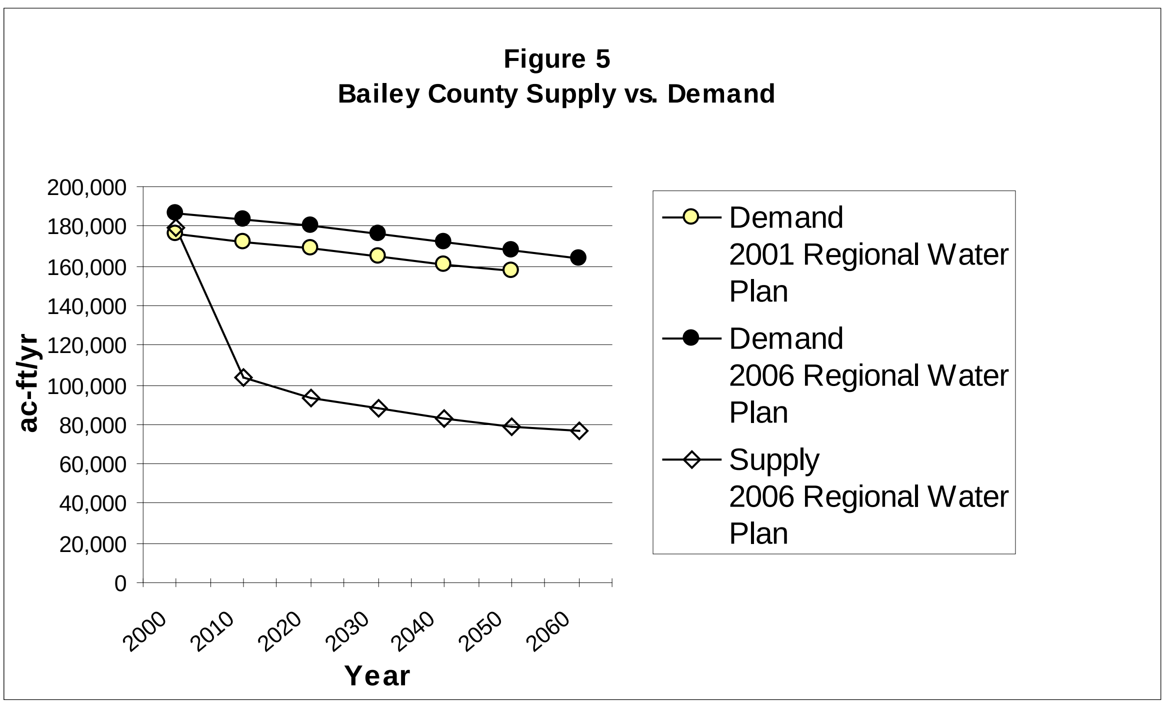
For the 2006 regional water plan, projections of irrigation water demand were made by TWDB using the projected irrigation water demand curves from the 2001 Regional Water Plan. The 2001 irrigation water demand projection for each county was shifted to the estimated quantity of irrigation water use for the year 2000. In the case of Bailey County, this caused an upward shift of the irrigation projected demand curve from 176,237 to 186,162 ac-ft for the year 2000 (Figure 4). This increased demand is considered by the TWDB as "dry weather irrigation demand" since year 2000 is considered "a dry year" on the Southern High Plains. However, "a dry year" designation must be tempered with the understanding that regional conditions may or may not reflect local conditions, since rainfall amounts are not ubiquitous over the planning region and that local variations in timing of the rainfall with respect to the crop season can critically affect irrigation demand.

## Discussion

Figure 5 illustrates the difference between supply and demand in Bailey County in the 2006 Regional Water Plan. Although the demand numbers have been questioned as being unrepresentative of "normal" irrigation conditions on the Southern High Plains, it is apparent by looking at the magnitude of change made by the upward shift in the demand line from the 2001 to 2006 Regional Water Plan that the "demand side of the equation" is not the bad actor. Indeed, it is actually the limited supply and problems associated with derivation of the supply trend line that cause significant difference between supply and demand in Bailey County.

[12] Texas Water Development Board, 2001, Surveys of Irrigation in Texas: Texas Water Development Board Report 347, 102p.




The parameters, volume of water in storage, and supply are interrelated. The accuracy of one parameter directly affects the accuracy of the other parameter, and as such, improvements in the quality of the parameters are tantamount to the success of regional planning. In addition, modern modeling tools must be properly calibrated to observed conditions to be of any benefit in predictions of future behavior.

## Appendix F: Surface Water Rights of Region O

SEE PAGE 3 FOR CONTINUATION OF ROWS 1 THROUGH 78

| Row No. | Water Right No | Type | Sequence | Permit No | Water Right Issue Date | Amend | Owner Name | Owner Type | Amount AcFt/yr | Use | Priority Date | Expire | Acreage | Reservoir Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3703 | 6 | 1 | | 2/20/1985 | | W T MILLEN | 1 | 152.23 | 3 | 11/25/1968 | | 152.23 | |
| 2 | 3703 | 6 | 2 | | 2/20/1985 | | RINGLAND J C GATEWOOD ET UX | 3 | 102.77 | 3 | 11/25/1968 | | 102.77 | |
| 3 | 5099 | 6 | 1 | | 8/7/1987 | | RAYMOND WARD | 1 | 117 | 3 | 6/25/1962 | | 138 | GRAHAMS LAKE |
| 4 | 5100 | 6 | 1 | | 8/7/1987 | | FLOYD J RICHARDSON | 1 | 19 | 3 | 9/16/1964 | | 25 | |
| 5 | 5100 | 6 | 2 | | 8/7/1987 | | FLOYD J RICHARDSON | 1 | | 7 | 9/16/1964 | | | |
| 6 | 5100 | 6 | 3 | | 8/7/1987 | | BILLIE JEANE GRIFFIN | 1 | | 7 | 9/16/1964 | | | |
| 7 | 5103 | 6 | 1 | | 8/7/1987 | | J A MAYFIELD | 1 | 28 | 3 | 5/12/1964 | | 82 | KENT CR WS |
| 8 | 5104 | 6 | 1 | | 8/7/1987 | | BILLY M PIGG & WIFE | 3 | 17 | 3 | 6/29/1964 | | 49 | |
| 9 | 5105 | 6 | 1 | | 8/7/1987 | | JOSEPHINE M MERRELL & HUSBAND | 4 | 30 | 3 | 6/22/1964 | | 30 | |
| 10 | 5105 | 6 | 2 | | 8/7/1987 | | JOSEPHINE M MERRELL & HUSBAND | 4 | | 7 | 6/22/1964 | | | |
| 11 | 5106 | 6 | 1 | | 8/7/1987 | | CHARLEY F TATE | 1 | 80 | 3 | 5/4/1964 | | 40 | |
| 12 | 5211 | 6 | 1 | | 9/25/1987 | | MACKENZIE MWA | 2 | 4000 | 1 | 6/26/1967 | | | MACKENZIE RESERVOIR |
| 13 | 5211 | 6 | 2 | | 9/25/1987 | | MACKENZIE MWA | 2 | | 7 | 6/26/1967 | | | MACKENZIE RESERVOIR |
| 14 | 5211 | 6 | 3 | | 9/25/1987 | | MACKENZIE MWA | 2 | 1200 | 2 | 6/26/1967 | | | MACKENZIE RESERVOIR |
| 15 | 5212 | 6 | 1 | | 9/25/1987 | | ROY MAYFIELD ESTATE | 5 | 107 | 3 | 5/15/1967 | | 130 | |
| 16 | 5219 | 6 | 1 | | 9/25/1987 | | WM ELBERT & DORA HAWKINS | 1 | | 7 | 3/16/1964 | | | |
| 17 | 5220 | 6 | 1 | | 9/25/1987 | | TEXAS PARKS & WILDLIFE DEPT | 2 | 20 | 1 | 3/9/1964 | | | |
| 18 | 5220 | 6 | 2 | | 9/25/1987 | | TEXAS PARKS & WILDLIFE DEPT | 2 | | 7 | 3/9/1964 | | | |
| 19 | 5267 | 6 | 1 | | 8/7/1987 | | DALE SMITH | 1 | 100 | 3 | 11/25/1963 | | 100 | |
| 20 | 5267 | 6 | 2 | | 8/7/1987 | | DALE SMITH | 1 | | 7 | 11/25/1963 | | | |
| 21 | 3675 | 6 | 1 | | 2/20/1985 | | TOM MCGILL | 1 | 86 | 3 | 6/30/1961 | | 62 | |
| 22 | 3676 | 6 | 1 | | 2/20/1985 | | THE TWELVE CO A TX CORP | 2 | 10 | 3 | 9/29/1969 | | 40 | |
| 23 | 3677 | 6 | 1 | | 2/20/1985 | | WILMA LEMONS | 1 | 31 | 3 | 2/9/1970 | | 165 | |
| 24 | 3677 | 6 | 2 | | 2/20/1985 | | KEITH DAVID LEMONS ET AL | 4 | 31 | 3 | 2/9/1970 | | 165 | |
| 25 | 3678 | 6 | 1 | | 2/20/1985 | | ROY TAACK | 1 | 40 | 3 | 10/9/1968 | | 43 | |
| 26 | 3679 | 6 | 1 | | 2/20/1985 | | L D AMERSON | 1 | 3 | 3 | 6/25/1973 | | 130 | |
| 27 | 3679 | 6 | 2 | | 2/20/1985 | | L D AMERSON | 1 | | 7 | 6/25/1973 | | | |
| 28 | 4383 | 1 | 1 | 4064 | 1/10/1984 | | DAVID W SMITH ET UX | 3 | 60 | 3 | 7/11/1983 | | 200 | |
| 29 | 5187 | 6 | 1 | | 9/25/1987 | | FLOYD COLE ESTATE | 5 | 40 | 3 | 7/31/1967 | | 100 | |
| 30 | 5196 | 6 | 1 | | 9/25/1987 | | DAN J HEARD | 1 | 124 | 3 | 5/31/1961 | | 174 | |
| 31 | 5199 | 6 | 1 | | 9/25/1987 | | CONE JOHNSON ET AL | 4 | 66.3 | 3 | 3/1/1971 | | 106.63 | |
| 32 | 5199 | 6 | 2 | | 9/25/1987 | | CONE JOHNSON | 1 | 89.03 | 3 | 3/1/1971 | | 143.2 | |
| 33 | 5199 | 6 | 3 | | 9/25/1987 | | ROXIE WYNN JOHNSON | 1 | 107.67 | 3 | 3/1/1971 | | 173.17 | |
| 34 | 3691 | 6 | 1 | | 2/20/1985 | | HARRISON N WATSON JR ET AL | 4 | 11 | 3 | 11/12/1963 | | 75 | |
| 35 | 3692 | 6 | 1 | | 2/20/1985 | | OTIS W ENGLISH JR ET AL | 4 | 29 | 3 | 5/12/1953 | | 12 | |
| 36 | 3693 | 6 | 1 | | 2/20/1985 | | WHITE RIVER MWD | 2 | 4000 | 1 | 9/22/1958 | | | WHITE RIVER RESERVOIR |
| 37 | 3693 | 6 | 2 | | 2/20/1985 | | WHITE RIVER MWD | 2 | 2000 | 4 | 9/22/1958 | | | WHITE RIVER RESERVOIR |
| 38 | 3694 | 6 | 1 | | 2/20/1985 | | W C HUFFAKER JR | 1 | 47 | 3 | 12/2/1966 | | 47 | |
| 39 | 3695 | 6 | 1 | | 2/20/1985 | | MARVIN SHURBET | 1 | 80 | 3 | 9/29/1969 | | 40 | |
| 40 | 3708 | 6 | 1 | | 2/20/1985 | | DELTON CADDELL | 1 | 120 | 3 | 8/1/1966 | | 1250 | |
| 41 | 3709 | 6 | 1 | | 2/20/1985 | | NATHANIEL CLARK WOOD JR ET UX | 3 | 15 | 3 | 12/31/1967 | | 15 | |
| 42 | 3709 | 6 | 2 | | 2/20/1985 | | NATHANIEL CLARK WOOD JR ET UX | 3 | 795 | 3 | 4/17/1968 | | 1265 | |
| 43 | 3710 | 6 | 1 | | 2/20/1985 | | R E JANES GRAVEL CO | 2 | 450 | 4 | 4/17/1968 | | | |
| 44 | 3417 | 1 | 1 | 3122 | 5/21/1975 | | CITY OF LAMESA | 2 | 918 | 3 | 3/24/1975 | | 375 | |
| 45 | 5179 | 6 | 1 | | 9/25/1987 | | RALPH R GRIGSBY JR ET AL | 4 | 796 | 3 | 7/31/1966 | | 835 | |
| 46 | 5182 | 6 | 1 | | 9/25/1987 | | WALTER L KAUL & WIFE | 3 | 37 | 3 | 7/31/1964 | | 50 | |
| 47 | 5184 | 6 | 1 | | 9/25/1987 | | CLARENCE W MARTIN ET UX | 3 | 54 | 3 | 7/31/1964 | | 73 | |
| 48 | 5184 | 6 | 2 | | 9/25/1987 | | LAWRENCE J MARTIN ET UX | 3 | | 3 | 7/31/1964 | | | |
| 49 | 5185 | 6 | 1 | | 9/25/1987 | | R L SIMPSON ET AL | 4 | 125 | 3 | 6/30/1965 | | 447 | |
| 50 | 3696 | 6 | 2 | | 2/20/1985 | | O J & ELEANORA S BARRON | 1 | 260 | 3 | 9/14/1965 | | 248 | |
| 51 | 3697 | 6 | 1 | | 2/20/1985 | | O J & ELEANORA S BARRON | 1 | | 7 | 8/28/1972 | | | |
| 52 | 3698 | 6 | 1 | | 2/20/1985 | | O J & ELEANORA S BARRON | 1 | 768 | 3 | 8/1/1966 | | 412 | |
| 53 | 3699 | 6 | 1 | | 2/20/1985 | | JOHN R & KATHRYN HUNTER | 1 | 160 | 3 | 6/2/1969 | | 80 | |
| 54 | 3699 | 6 | 2 | | 2/20/1985 | | JOHN R & KATHRYN HUNTER | 1 | | 7 | 6/2/1969 | | | |
| 55 | 3700 | 6 | 1 | | 2/20/1985 | | JESSE H & RUBY DAUGHERTY | 1 | 160 | 3 | 11/17/1969 | | 175 | |
| 56 | 5110 | 6 | 1 | | 8/7/1987 | | TRUMAN ELLIS ET UX | 3 | 40 | 3 | 1/1/1955 | | 79 | |
| 57 | 3690 | 6 | 1 | | 2/20/1985 | | CHARLES DONALD SCHULER | 1 | 2 | 3 | 12/31/1960 | | 5 | |
| 58 | 5101 | 6 | 1 | | 8/7/1987 | | MICHAEL HOOD CHAMALES ET UX | 3 | 20.77 | 3 | 5/25/1964 | | 22.46 | |
| 59 | 5101 | 6 | 2 | | 8/7/1987 | | MICHAEL HOOD CHAMALES ET UX | 3 | | 7 | 5/25/1964 | | | |
| 60 | 5101 | 6 | 3 | | 8/7/1987 | | BOB MCWILLIAMS | 1 | 16.23 | 3 | 5/25/1964 | | 17.54 | |
| 61 | 5101 | 6 | 4 | | 8/7/1987 | | BOB MCWILLIAMS | 1 | | 7 | 5/25/1964 | | | |
| 62 | 3711 | 6 | 1 | | 2/20/1985 | | WHITE RIVER MWD | 2 | 5600 | 1 | 1/20/1970 | Const. by | | POST DAM & RESERVOIR |
| 63 | 3711 | 6 | 2 | | 2/20/1985 | | WHITE RIVER MWD | 2 | 1000 | 2 | 1/20/1970 | 07/24/2012 | | POST DAM & RESERVOIR |
| 64 | 3711 | 6 | 3 | | 2/20/1985 | | WHITE RIVER MWD | 2 | 4000 | 4 | 1/20/1970 | 07/24/2012 | | POST DAM & RESERVOIR |
| 65 | 3715 | 6 | 1 | | 2/20/1985 | | CHARLES I SMITH | 1 | 166 | 1 | 11/16/1927 | | | |
| 66 | 4155 | 1 | 1 | 4146 | 9/25/1984 | A | BRAZOS RIVER AUTHORITY | 2 | 35000 | 1 | 10/5/1981 | | | LAKE ALAN HENRY |
| 67 | 4155 | 1 | 2 | 4146 | 9/25/1984 | A | BRAZOS RIVER AUTHORITY | 2 | 21000 | 3 | 10/5/1981 | | 10000 | LAKE ALAN HENRY |
| 68 | 4155 | 1 | 3 | 4146 | 9/25/1984 | A | BRAZOS RIVER AUTHORITY | 2 | 200 | 2 | 10/5/1981 | | | LAKE ALAN HENRY |
| 69 | 4155 | 1 | 4 | 4146 | 9/25/1984 | A | BRAZOS RIVER AUTHORITY | 2 | | 7 | 10/5/1981 | | | LAKE ALAN HENRY |
| 70 | 5359 | 1 | 1 | 5359 | 8/28/1991 | A | CITATION 1998 INVESTMENT LTD PARTERSHIP | 2 | 200 | 4 | 5/19/1991 | | | |
| 71 | 3680 | 6 | 1 | | 2/20/1985 | | K W CARSON | 1 | 1 | 3 | 7/31/1978 | | 141 | |
| 72 | 3681 | 6 | 1 | | 2/20/1985 | | MARJORIE W HECK | 1 | 1 | 3 | 12/19/1977 | | 272 | |
| 73 | 3682 | 6 | 1 | | 2/20/1985 | | RANDY FALKENBERG ET UX | 3 | 28 | 3 | 4/1/1970 | | 28 | |
| 74 | 3683 | 6 | 1 | | 2/20/1985 | | HIGH PLAINS PAVERS INC | 2 | 110 | 3 | 3/29/1976 | | 188 | |
| 75 | 3684 | 6 | 1 | | 2/20/1985 | | RICKY JOE JAMES | 1 | 80 | 3 | 3/15/1976 | | 140 | |
| 76 | 3685 | 6 | 1 | | 2/20/1985 | | FRED KEESEE JR | 1 | 150 | 3 | 7/14/1975 | | 478 | |
| 77 | 3685 | 6 | 2 | | 2/20/1985 | | FRED KEESEE JR | 1 | 170 | 3 | 5/21/1979 | | | |
| 78 | 3686 | 6 | 1 | | 2/20/1985 | | BILLY H TODD | 1 | 120 | 3 | 11/15/1976 | | 130 | |

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| Row No. | Water Right No | Type | Sequence | Permit No | Water Right Issue Date | Amend | Owner Name | Owner Type | Amount AcFt/yr | Use | Priority Date | Expire | Acreage | Reservoir Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79 | 3687 | 6 | 1 | | 2/20/1985 | | JUDITH E BRUECHERT TRUST UTD FEB 11 1992 | 5 | 75 | 3 | 11/15/1976 | | 209 | |
| 80 | 3688 | 6 | 1 | | 2/20/1985 | | JOEL B MITCHELL | 1 | 87 | 3 | 1/31/1963 | | 160 | |
| 81 | 3689 | 6 | 1 | | 2/20/1985 | | GLENITH B AMONETT | 1 | 48 | 3 | 3/10/1969 | | 65 | |
| 82 | 3704 | 6 | 1 | | 2/20/1985 | | ANNA M JOHNSTON ET AL | 4 | 50 | 3 | 6/30/1962 | | 200 | |
| 83 | 4111 | 1 | 1 | 3813 | 6/23/1981 | | FRANKLIN G GABRIEL ET AL | 4 | 8 | 3 | 3/24/1981 | | 160 | |
| 84 | 4215 | 1 | 1 | 3915 | 11/3/1982 | | TEXAS DEPT OF CRIMINAL JUSTICE | 2 | 60 | 3 | 5/10/1982 | | 158 | |
| 85 | 4369 | 1 | 1 | 4035 | 10/7/1983 | | MAURICE HASTEY | 1 | 200 | 3 | 5/31/1983 | | 165 | |
| 86 | 5405 | 1 | 1 | 5405 | 6/16/1992 | | HORNE & OWEN | 1 | 4 | 3 | 3/5/1992 | | 32 | |
| 87 | 3705 | 6 | 1 | | 2/20/1985 | | CITY OF LUBBOCK | 2 | | 7 | 4/6/1972 | | | |
| 88 | 3705 | 6 | 2 | | 2/20/1985 | A | CITY OF LUBBOCK | 2 | 657.46 | 3 | 6/10/1996 | | 154.58 | RESERVOIR 1 |
| 89 | 3705 | 6 | 3 | | 2/20/1985 | A | CITY OF LUBBOCK | 2 | 243.78 | 3 | 6/10/1996 | | 91.42 | RESERVOIR 2 |
| 90 | 3705 | 6 | 4 | | 2/20/1985 | A | CITY OF LUBBOCK | 2 | 261.68 | 3 | 6/10/1996 | | 98.13 | RESERVOIR 6 |
| 91 | 3706 | 6 | 1 | | 2/20/1985 | | LUBBOCK CO WCID 1 | 2 | | 7 | 4/8/1957 | | | |
| 92 | 3707 | 6 | 1 | | 2/20/1985 | | RANSOM CANYON | 1 | 150 | 1 | 4/6/1972 | | | LAKE RANSOM CANYON |
| 93 | 3707 | 6 | 2 | | 2/20/1985 | | RANSOM CANYON | 1 | | 7 | 8/25/1980 | | | |
| 94 | 3707 | 6 | 3 | | 2/20/1985 | | RANSOM CANYON | 1 | 4 | 3 | 8/25/1980 | | | LAKE RANSOM CANYON |
| 95 | 4340 | 1 | 1 | 3985 | 6/7/1983 | | CITY OF LUBBOCK | 2 | 4480 | 2 | 3/7/1983 | | | |
| 96 | 4340 | 1 | 2 | 3985 | 6/7/1983 | | CITY OF LUBBOCK | 2 | 18430 | 3 | 3/7/1983 | | 10000 | |
| 97 | 3713 | 6 | 1 | | 2/20/1985 | | GERALD HUFFAKER | 1 | 140 | 3 | 6/30/1967 | | 140 | |
| 98 | 4391 | 1 | 1 | 4127 | 7/30/1984 | | ROARING SPRINGS RANCH CLUB INC | 2 | | 7 | 8/22/1983 | | | |
| 99 | 5102 | 6 | 1 | | 8/7/1987 | | NANCY HORNER ALLEN ET AL | 4 | 50 | 1 | 3/11/1957 | | | HORNER LAKE |
| 100 | 5102 | 6 | 2 | | 8/7/1987 | | NANCY HORNER ALLEN ET AL | 4 | | 7 | 3/11/1957 | | | HORNER LAKE |
| 101 | 5102 | 6 | 3 | | 8/7/1987 | | NANCY HORNER ALLEN ET AL | 4 | 33 | 3 | 3/11/1957 | | 66 | |
| 102 | 5266 | 6 | 1 | | 8/7/1987 | | J N FLETCHER & WIFE | 3 | | 7 | 4/19/1971 | | | |
| 103 | 3664 | 6 | 1 | | 2/20/1985 | | TRUMAN & MARY ELLEN MCKILLIP | 1 | 3 | 3 | 9/27/1976 | | 33 | |
| 104 | 3665 | 6 | 1 | | 2/20/1985 | | TRUMAN MCKILLIP | 1 | 50 | 3 | 7/31/1978 | | 98 | |
| 105 | 3666 | 6 | 1 | | 2/20/1985 | | ARVEL & ETHEL MAE FLEMING | 1 | 14 | 3 | 5/30/1966 | | 30 | |
| 106 | 3667 | 6 | 1 | | 2/20/1985 | | HELEN ARLINE ESTLACK ET VIR | 6 | 125 | 3 | 4/17/1968 | | 150 | |
| 107 | 3668 | 6 | 1 | | 2/20/1985 | | ARLINE L HARTZOG JR ET UX | 3 | 75 | 3 | 2/5/1968 | | 204 | |
| 108 | 3669 | 6 | 1 | | 2/20/1985 | | KUNTZ CATTLE COMPANY | 2 | | 8 | 6/6/1977 | | | |
| 109 | 3670 | 6 | 1 | | 2/20/1985 | A | RANDY K ROBERTS | 1 | 120 | 3 | 11/17/1969 | | 240 | |
| 110 | 3671 | 6 | 1 | | 2/20/1985 | | J.W. GAMMON | 1 | 338 | 3 | 3/10/1975 | | 1300 | |
| 111 | 3672 | 6 | 1 | | 2/20/1985 | | A. WAYNE CLARK | 1 | 988 | 3 | 3/10/1975 | | 600 | |
| 112 | 3673 | 6 | 1 | | 2/20/1985 | | COX T-5 LTD | 2 | 1248 | 3 | 3/10/1975 | | 600 | |
| 113 | 3674 | 6 | 1 | | 2/20/1985 | | JIM ROY DANIEL | 1 | 26 | 3 | 3/10/1975 | | 320 | |
| 114 | 5186 | 6 | 1 | | 9/25/1987 | | HARLAND H FRYE ET AL | 4 | 200 | 3 | 1/8/1962 | | 1765 | |
| 115 | 2855 | 1 | 1 | 2616 | 10/27/1970 | | LELAND PAUL ROSSEAU ET UX | 5 | 197 | 3 | 7/20/1970 | | 207 | |
| 116 | 5197 | 6 | 1 | | 9/25/1987 | A | WILLIAM MASON BIVENS | 1 | 42.72 | 3 | 2/18/1963 | | 68.23 | |
| 117 | 5197 | 6 | 3 | | 9/25/1987 | A | ROYAL PLASTICS INC | 2 | 106.28 | 3 | 2/18/1963 | | 169.77 | |
| 118 | 5198 | 6 | 1 | | 9/25/1987 | | WYLIE A BYRD | 1 | 57 | 3 | 12/1/1969 | | 114 | |
| 119 | 5200 | 6 | 1 | | 9/25/1987 | | R L BRIGGS ET AL | 4 | 12 | 3 | 12/1/1969 | | 36 | |
| 120 | 5202 | 6 | 1 | | 9/25/1987 | | PAUL ROUSSEAU ET AL | 4 | 61 | 3 | 12/1/1969 | | 122 | |
| 121 | 5203 | 6 | 1 | | 9/25/1987 | | O B BARNES | 1 | 26 | 3 | 12/1/1969 | | 52 | |
| 122 | 5204 | 6 | 1 | | 9/25/1987 | | RAY ANDREW BIVENS ESTATE | 5 | 34 | 3 | 7/20/1970 | | 100 | |
| 123 | 5205 | 6 | 1 | | 9/25/1987 | | CITY OF TULIA | 2 | | 7 | 8/22/1938 | | | |
| 124 | 5206 | 6 | 1 | | 9/25/1987 | | R B DAWSON JR ET AL | 4 | 24 | 3 | 12/1/1969 | | 48 | |
| 125 | 5207 | 6 | 1 | | 9/25/1987 | | J E SIMPSON JR | 1 | 8 | 3 | 12/1/1969 | | 23 | |
| 126 | 5208 | 6 | 1 | | 9/25/1987 | | LARRY NELSON FARMS INC | 2 | 55 | 3 | 6/16/1970 | | 241 | |
| 127 | 5209 | 6 | 1 | | 9/25/1987 | | TULIA FEEDLOT INC | 2 | 284 | 3 | 3/4/1968 | | 400 | |
| 128 | 5210 | 6 | 1 | | 9/25/1987 | | J E SIMPSON JR | 1 | 60 | 3 | 12/1/1969 | | 90 | |
| 129 | 3447 | 1 | 1 | 3150 | 7/18/1975 | | CITY OF BROWNFIELD | 2 | 2000 | 3 | 5/5/1975 | | 378 | |

SEE PAGE 4 FOR CONTINUATION OF ROWS 79 THROUGH 129

On Page 3, rows 1 through 78 are continued. On page 4 rows 79 through 129 are continued.

For example, one can see all of the information for Water Right Number 3703, the first right listed, by reading across row 1 on Page 1, and Row 1 on Page 3.

Lidewise, one can see all of the infornmation for Water Right Number 3477, the final right listed, by reading row 129 on Page 2, and row 129 0n Page 4.

| Row No. | Water Right No | Type | Reservoir Capacity (Ac-Ft) | Basin | River Order | Plan Region Code | SWRA | Unamed Trib of (Y/N) | Stream Name | County | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3703 | 6 | | 12 | 9900000000 | O | | | BLACKWATER DRAW | Bailey | |
| 2 | 3703 | 6 | | 12 | 9900000000 | O | | | BLACKWATER DRAW | Bailey | |
| 3 | 5099 | 6 | 718 | 2 | 5170000000 | O | | | LTL COTTONWOOD | Briscoe | |
| 4 | 5100 | 6 | | 2 | 5157000000 | O | | Y | LOS LINGOS CRK | Briscoe | |
| 5 | 5100 | 6 | 179 | 2 | 5157000000 | O | | Y | LOS LINGOS CRK | Briscoe | |
| 6 | 5100 | 6 | | 2 | 5157000000 | O | | Y | LOS LINGOS CRK | Briscoe | RECREATIONAL USE OF RESERVOIR |
| 7 | 5103 | 6 | 235 | 2 | 5134000000 | O | | | KENT CRK | Briscoe | SCS SITE NO 1 |
| 8 | 5104 | 6 | | 2 | 5132000000 | O | | Y | KENT CRK | Briscoe | |
| 9 | 5105 | 6 | | 2 | 5131750000 | O | | | KENT CRK | Briscoe | |
| 10 | 5105 | 6 | | 2 | 5131750000 | O | | | KENT CRK | Briscoe | |
| 11 | 5106 | 6 | | 2 | 5131500000 | O | | Y | KENT CRK | Briscoe | |
| 12 | 5211 | 6 | 46,450 | 2 | 8375000000 | O | | | TULE CRK | Briscoe | |
| 13 | 5211 | 6 | | 2 | 8375000000 | O | | | TULE CRK | Briscoe | |
| 14 | 5211 | 6 | | 2 | 8375000000 | O | | | TULE CRK | Briscoe | |
| 15 | 5212 | 6 | | 2 | 8370000000 | O | | Y | ROCK CRK | Briscoe | EXEMPT LAKE |
| 16 | 5219 | 6 | | 2 | 8222000000 | O | | | HOLMES | Briscoe | EXEMPT LAKE |
| 17 | 5220 | 6 | 1,184 | 2 | 8220000000 | O | | | HOLMES | Briscoe | |
| 18 | 5220 | 6 | | 2 | 8220000000 | O | | | HOLMES | Briscoe | |
| 19 | 5267 | 6 | | 2 | 5165000000 | O | | | LTL COTTONWOOD | Briscoe | |
| 20 | 5267 | 6 | 132 | 2 | 5165000000 | O | | | LTL COTTONWOOD | Briscoe | |
| 21 | 3675 | 6 | | 12 | 5886800000 | O | | | RUNNING WATER DRAW | Castro | |
| 22 | 3676 | 6 | | 12 | 5885500000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 23 | 3677 | 6 | | 12 | 5885000000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 24 | 3677 | 6 | | 12 | 5885000000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 25 | 3678 | 6 | | 12 | 5884500000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 26 | 3679 | 6 | | 12 | 5884400000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 27 | 3679 | 6 | | 12 | 5884400000 | O | | | N FRK RUNNING WATER DRAW | Castro | |
| 28 | 4383 | 1 | 200 | 12 | 5886850000 | O | | | RUNNING WATER DRAW | Castro | |
| 29 | 5187 | 6 | 8 | 2 | 8976000000 | O | | | FRIO DRAW | Castro | |
| 30 | 5196 | 6 | 19 | 2 | 8975000000 | O | | Y | FRIO DRAW | Castro | |
| 31 | 5199 | 6 | 173 | 2 | 8462500000 | O | | | N TULE DRAW | Castro | & CO 219. 2 PRIORITY DATES |
| 32 | 5199 | 6 | | 2 | 8462500000 | O | | | N TULE DRAW | Castro | & CO 219. 2 PRIORITY DATES |
| 33 | 5199 | 6 | 90 | 2 | 8462500000 | O | | | N TULE DRAW | Castro | & CO 219. 2 PRIORITY DATES |
| 34 | 3691 | 6 | | 12 | 5870000000 | O | | Y | CRAWFISH DRAW | Crosby | |
| 35 | 3692 | 6 | 14 | 12 | 5860000000 | O | | | WHITE RIVER | Crosby | |
| 36 | 3693 | 6 | 44,897 | 12 | 5850000000 | O | | | WHITE RIVER | Crosby | |
| 37 | 3693 | 6 | | 12 | 5850000000 | O | | | WHITE RIVER | Crosby | |
| 38 | 3694 | 6 | | 12 | 5904000000 | O | | | YELLOWHOUSE CRK | Crosby | |
| 39 | 3695 | 6 | 1 | 12 | 5903500000 | O | | | MCDONALD CRK | Crosby | |
| 40 | 3708 | 6 | | 12 | 9675000000 | O | | | PLUM CRK | Crosby | |
| 41 | 3709 | 6 | 5 | 12 | 9671100000 | O | | | N FRK DBL MTN BRAZOS RIVER | Crosby | |
| 42 | 3709 | 6 | 196 | 12 | 9671100000 | O | | | N FRK DBL MTN BRAZOS RIVER | Crosby | |
| 43 | 3710 | 6 | 196 | 12 | 9670000000 | O | | | N FRK DBL MTN BRAZOS RIVER | Crosby | |
| 44 | 3417 | 1 | 202 | 14 | 8626000000 | O | | | SULPHUR SPRING | Dawson | 750 FROM CRA, 168 TO CUSTOMERS, 4 RES |
| 45 | 5179 | 6 | | 2 | 8620100000 | O | | | PALO DURO CRK | Deaf Smith | |
| 46 | 5182 | 6 | 15 | 2 | 8983000000 | O | | | TIERRA BLANCA | Deaf Smith | RATE COMBINED WITH ADJ 5183 & 5184 |
| 47 | 5184 | 6 | 40 | 2 | 8981000000 | O | | | TIERRA BLANCA | Deaf Smith | JOINTLY OWNS 54 AF TO IRR 73 ACRES |
| 48 | 5184 | 6 | | 2 | 8981000000 | O | | | TIERRA BLANCA | Deaf Smith | JOINTLY OWNS 54 AF TO IRR 73 ACRES |
| 49 | 5185 | 6 | 7 | 2 | 8979500000 | O | | | TIERRA BLANCA | Deaf Smith | |
| 50 | 3696 | 6 | 634 | 12 | 5847000000 | O | | | DUCK CRK | Dickens | |
| 51 | 3697 | 6 | 338 | 12 | 5846500000 | O | | | ROCK HOUSE | Dickens | |
| 52 | 3698 | 6 | 2,249 | 12 | 5846000000 | O | | | COTTONWOOD CRK | Dickens | |
| 53 | 3699 | 6 | 437 | 12 | 5843000000 | O | | | DOCKUM CRK | Dickens | |
| 54 | 3699 | 6 | | 12 | 5843000000 | O | | | DOCKUM CRK | Dickens | |
| 55 | 3700 | 6 | | 12 | 5842700000 | O | | | DOCKUM CRK | Dickens | |
| 56 | 5110 | 6 | 104 | 2 | 5154000000 | O | | | PATTON SPRING DRAW | Dickens | |
| 57 | 3690 | 6 | | 12 | 5870500000 | O | | | CRAWFISH DRAW | Floyd | |
| 58 | 5101 | 6 | | 2 | 5155000000 | O | | | ROBERTS CRK | Floyd | |
| 59 | 5101 | 6 | | 2 | 5155000000 | O | | | ROBERTS CRK | Floyd | |
| 60 | 5101 | 6 | | 2 | 5155000000 | O | | | ROBERTS CRK | Floyd | |
| 61 | 5101 | 6 | | 2 | 5155000000 | O | | | ROBERTS CRK | Floyd | |
| 62 | 3711 | 6 | 57,420 | 12 | 9661000000 | O | | | N FRK DBL MTN BRAZOS RIVER | Garza | 8/4/2005: CONSTR EXTENDED TO 7/24/2012 |
| 63 | 3711 | 6 | | 12 | 9661000000 | O | | | N FRK DBL MTN BRAZOS RIVER | Garza | 8/4/2005: CONSTR EXTENDED TO 7/24/2012 |
| 64 | 3711 | 6 | | 12 | 9661000000 | O | | | N FRK DBL MTN BRAZOS RIVER | Garza | 8/4/2005: CONSTR EXTENDED TO 7/24/2012 |
| 65 | 3715 | 6 | 526 | 12 | 9587000000 | O | | | COON CRK | Garza | OWNERSHIP VERIFIED BUT PENDING |
| 66 | 4155 | 1 | 115,937 | 12 | 9568000000 | O | 2 | | S FRK DBL MTN FRK BRAZOS RIVER | Garza | COS 153,85,132.AMEND 5/2/2005:CHG DIV PT |
| 67 | 4155 | 1 | | 12 | 9568000000 | O | 2 | | S FRK DBL MTN FRK BRAZOS RIVER | Garza | JUSTICEBURG.AMEND 5/2/2005:CHG DIV PT |
| 68 | 4155 | 1 | | 12 | 9568000000 | O | 2 | | S FRK DBL MTN FRK BRAZOS RIVER | Garza | AMEND 5/2/2005:CHG DIV PT |
| 69 | 4155 | 1 | | 12 | 9568000000 | O | 2 | | S FRK DBL MTN FRK BRAZOS RIVER | Garza | AMEND 5/2/2005:CHG DIV PT |
| 70 | 5359 | 1 | | 12 | 9591000000 | O | | | S FRK DBL MTN FRK BRAZOS RIVER | Garza | AMEND 8/93; GOES W/WSC#1871 |
| 71 | 3680 | 6 | 3 | 12 | 5884280000 | O | | | N FRK RUNNING WATER DRAW | Hale | |
| 72 | 3681 | 6 | 1 | 12 | 5884100000 | O | | | RUNNING WATER DRAW | Hale | |
| 73 | 3682 | 6 | | 12 | 5884000000 | O | | | RUNNING WATER DRAW | Hale | |
| 74 | 3683 | 6 | | 12 | 5883500000 | O | | | RUNNING WATER DRAW | Hale | |
| 75 | 3684 | 6 | 3 | 12 | 5882970000 | O | | | SLATON DRAW | Hale | |
| 76 | 3685 | 6 | 200 | 12 | 5882900000 | O | | | SLATON DRAW | Hale | |
| 77 | 3685 | 6 | 224 | 12 | 5882900000 | O | | | SLATON DRAW | Hale | |
| 78 | 3686 | 6 | | 12 | 5882400000 | O | | | RUNNING WATER DRAW | Hale | |

| Row No. | Water Right No | Type | Reservoir Capacity (Ac-Ft) | Basin | River Order | Plan Region Code | SWRA | Unamed Trib of (Y/N) | Stream Name | County | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79 | 3687 | 6 | | 12 | 5882200000 | O | | | RUNNING WATER DRAW | Hale | |
| 80 | 3688 | 6 | | 12 | 5882100000 | O | | | RUNNING WATER DRAW | Hale | |
| 81 | 3689 | 6 | | 12 | 5872000000 | O | | | CRAWFISH DRAW | Hale | |
| 82 | 3704 | 6 | 105 | 12 | 9780000000 | O | | | BLACKWATER DRAW | Hale | |
| 83 | 4111 | 1 | | 12 | 5884050000 | O | | | RUNNING WATER DRAW | Hale | OUT OF A 660 ACRE TRACT |
| 84 | 4215 | 1 | | 12 | 5882150000 | O | | | RUNNING WATER DRAW | Hale | |
| 85 | 4369 | 1 | | 12 | 5881800000 | O | | | RUNNING WATER DRAW | Hale | |
| 86 | 5405 | 1 | | 12 | 5881700000 | O | | | RUNNING WATER DRAW | Hale | |
| 87 | 3705 | 6 | 536 | 12 | 9760000000 | O | | | YELLOW HOUSE DRAW | Lubbock | MULTIPLE (3) PRIORITY DATES |
| 88 | 3705 | 6 | | 12 | 9760000000 | O | | | YELLOW HOUSE DRAW | Lubbock | AMENDED 2/28/97 |
| 89 | 3705 | 6 | | 12 | 9760000000 | O | | | YELLOW HOUSE DRAW | Lubbock | AMENDED 2/28/97 |
| 90 | 3705 | 6 | | 12 | 9760000000 | O | | | YELLOW HOUSE DRAW | Lubbock | AMENDED 2/28/97 |
| 91 | 3706 | 6 | 4,730 | 12 | 9715000000 | O | | | N FRK DBL MTN BRAZOS RIVER | Lubbock | |
| 92 | 3707 | 6 | 282 | 12 | 9700000000 | O | | Y | N FRK DBL MTN FRK BRAZOS RIVER | Lubbock | |
| 93 | 3707 | 6 | 278 | 12 | 9700000000 | O | | Y | N FRK DBL MTN FRK BRAZOS RIVER | Lubbock | |
| 94 | 3707 | 6 | 8 | 12 | 9700000000 | O | | Y | N FRK DBL MTN FRK BRAZOS RIVER | Lubbock | |
| 95 | 4340 | 1 | | 12 | 9759000000 | O | | | EFFLUENT | Lubbock | & BA 2, COS 117, 171, 188, 153 |
| 96 | 4340 | 1 | | 12 | 9759000000 | O | | | EFFLUENT | Lubbock | |
| 97 | 3713 | 6 | 430 | 12 | 9620000000 | O | | | DBL MTN FRK BRAZOS RIVER | Lynn | |
| 98 | 4391 | 1 | 51 | 2 | 5154810000 | O | | Y | TONGUE RIVER (S PEASE) | Motley | |
| 99 | 5102 | 6 | 1,092 | 2 | 5150000000 | O | | | CEDAR CRK | Motley | |
| 100 | 5102 | 6 | | 2 | 5150000000 | O | | | CEDAR CRK | Motley | |
| 101 | 5102 | 6 | | 2 | 5150000000 | O | | | CEDAR CRK | Motley | |
| 102 | 5266 | 6 | | 2 | 5154750000 | O | | Y | S PEASE RIVER | Motley | |
| 103 | 3664 | 6 | | 12 | 5891000000 | O | | | CATFISH DRAW | Parmer | |
| 104 | 3665 | 6 | | 12 | 5890500000 | O | | | CATFISH DRAW | Parmer | |
| 105 | 3666 | 6 | | 12 | 5890000000 | O | | | CATFISH DRAW | Parmer | |
| 106 | 3667 | 6 | | 12 | 5889000000 | O | | | CATFISH DRAW | Parmer | |
| 107 | 3668 | 6 | | 12 | 5888000000 | O | | | CATFISH DRAW | Parmer | |
| 108 | 3669 | 6 | 30 | 12 | 5887700000 | O | | Y | RUNNING WATER DRAW | Parmer | COA DOES NOT SPECIFY PURPOSE OF USE |
| 109 | 3670 | 6 | | 12 | 5887400000 | O | | | RUNNING WATER DRAW | Parmer | AMEND 2/26/90 |
| 110 | 3671 | 6 | | 12 | 5887220000 | O | | | RUNNING WATER DRAW | Parmer | IMPOUNDMENT SEE 12-3673 |
| 111 | 3672 | 6 | | 12 | 5887210000 | O | | | RUNNING WATER DRAW | Parmer | IMPOUNDMENT SEE 12-3673 |
| 112 | 3673 | 6 | 4,427 | 12 | 5887190000 | O | | | RUNNING WATER DRAW | Parmer | |
| 113 | 3674 | 6 | | 12 | 5887200000 | O | | | RUNNING WATER DRAW | Parmer | IMPOUNDMENT SEE 12-3673 |
| 114 | 5186 | 6 | 492 | 2 | 8977000000 | O | | | FRIO DRAW | Parmer | |
| 115 | 2855 | 1 | 197 | 2 | 8401500000 | O | | | N TULE DRAW | Swisher | |
| 116 | 5197 | 6 | | 2 | 8396000000 | O | | | MIDDLE TULE DRAW | Swisher | 2 EXEMPT LAKES-TULIA EFFLUENT, AMND 3/91 |
| 117 | 5197 | 6 | | 2 | 8396000000 | O | | | MIDDLE TULE DRAW | Swisher | 2 EXEMPT LAKES-TULIA EFFLUENT, AMND 3/91 |
| 118 | 5198 | 6 | | 2 | 8395500000 | O | | | MIDDLE TULE DRAW | Swisher | 2 EXEMPT LAKES |
| 119 | 5200 | 6 | | 2 | 8462050000 | O | | | N TULE DRAW | Swisher | EXEMPT LAKE |
| 120 | 5202 | 6 | | 2 | 8460000000 | O | | | N TULE DRAW | Swisher | 3 EXEMPT LAKES |
| 121 | 5203 | 6 | | 2 | 8458000000 | O | | | N TULE DRAW | Swisher | EXEMPT LAKE |
| 122 | 5204 | 6 | | 2 | 8401500000 | O | | | N TULE DRAW | Swisher | EXEMPT LAKE |
| 123 | 5205 | 6 | 500 | 2 | 8400000000 | O | | | N TULE DRAW | Swisher | |
| 124 | 5206 | 6 | | 2 | 8388000000 | O | | | TULE CRK | Swisher | EXEMPT LAKE |
| 125 | 5207 | 6 | | 2 | 8387000000 | O | | | TULE CRK | Swisher | EXEMPT LAKE |
| 126 | 5208 | 6 | | 2 | 8386000000 | O | | | S TULE DRAW | Swisher | EXEMPT LAKE |
| 127 | 5209 | 6 | 294 | 2 | 8385000000 | O | | | S TULE DRAW | Swisher | |
| 128 | 5210 | 6 | | 2 | 8379000000 | O | | | S TULE DRAW | Swisher | EXEMPT LAKE |
| 129 | 3447 | 1 | 39 | 14 | 8850000000 | O | | | LOST DRAW | Terry | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | <><><><><><><> |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

## Appendix G-1
## WWP Customers

| DBCUSTID | DBWWPID | wwp_name | sponsor_rwpg | RECIPIENT_NAME | RECIPIENT_ALPHA | wug_name | wug_rwpg | wug_basin | wug_county | city_id | wug_detail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | ODONNELL | 622000 | O'DONNELL | O | BRAZOS | LYNN | 0439 | NONE |
| 195 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | SLATON | 801800 | SLATON | O | BRAZOS | LUBBOCK | 0563 | NONE |
| 196 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | ODONNELL | 622000 | O'DONNELL | O | BRAZOS | DAWSON | 0439 | NONE |
| 197 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | LUBBOCK | 518000 | LUBBOCK | O | BRAZOS | LUBBOCK | 0370 | NONE |
| 198 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | LEVELLAND | 492400 | LEVELLAND | O | BRAZOS | HOCKLEY | 0354 | NONE |
| 199 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | LAMESA | 483600 | LAMESA | O | COLORADO | DAWSON | 0343 | NONE |
| 200 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | BROWNFIELD | 99200 | BROWNFIELD | O | COLORADO | TERRY | 0079 | NONE |
| 202 | 10 | CANADIAN RIVER MUNICIPAL WATER AUTHORITY | A | PLAINVIEW | 684600 | PLAINVIEW | O | BRAZOS | HALE | 0471 | NONE |
| 648 | 38 | MACKENZIE MUNICIPAL WATER AUTHORITY | O | TULIA | 877200 | TULIA | O | RED | SWISHER | 0612 | NONE |
| 650 | 38 | MACKENZIE MUNICIPAL WATER AUTHORITY | O | FLOYDADA | 290400 | FLOYDADA | O | BRAZOS | FLOYD | 0205 | NONE |
| 651 | 38 | MACKENZIE MUNICIPAL WATER AUTHORITY | O | LOCKNEY | 507000 | LOCKNEY | O | BRAZOS | FLOYD | 0365 | NONE |
| 653 | 38 | MACKENZIE MUNICIPAL WATER AUTHORITY | O | SILVERTON | 797800 | SILVERTON | O | RED | BRISCOE | 0561 | NONE |
| 1149 | 98 | LUBBOCK CITY OF | O | CITY OF LUBBOCK | | LUBBOCK | O | BRAZOS | LUBBOCK | 0370 | NONE |
| 1150 | 98 | LUBBOCK CITY OF | O | BUFFALO SPRINGS LAKE WSC | | COUNTY-OTHER | O | BRAZOS | LUBBOCK | 0757 | NONE |
| 1151 | 98 | LUBBOCK CITY OF | O | CITY OF RANSON CANYON | | RANSOM CANYON | O | BRAZOS | LUBBOCK | 0944 | NONE |
| 1152 | 98 | LUBBOCK CITY OF | O | CITY OF SHALLOWATER | | SHALLOWATER | O | BRAZOS | LUBBOCK | 0553 | NONE |
| 1153 | 98 | LUBBOCK CITY OF | O | LAKE ALAN HENRY WATER DISTRICT | | COUNTY-OTHER | O | BRAZOS | GARZA | 0757 | NONE |
| 1154 | 98 | LUBBOCK CITY OF | O | LUBBOCK-REESE REDEVELOPMENT AUTHORITY | | COUNTY-OTHER | O | BRAZOS | LUBBOCK | 0757 | NONE |
| 1010 | 66 | WHITE RIVER MWD | O | RALLS | 717800 | RALLS | O | BRAZOS | CROSBY | 0491 | NONE |
| 1011 | 66 | WHITE RIVER MWD | O | POST | 692600 | POST | O | BRAZOS | GARZA | 0482 | NONE |
| 1013 | 66 | WHITE RIVER MWD | O | RALLS | 717800 | MANUFACTURING | O | BRAZOS | CROSBY | 1001 | NONE |
| 1014 | 66 | WHITE RIVER MWD | O | SPUR | 820200 | SPUR | O | BRAZOS | DICKENS | 0576 | NONE |
| 1015 | 66 | WHITE RIVER MWD | O | POST | 692600 | MANUFACTURING | O | BRAZOS | GARZA | 1001 | NONE |
| 1016 | 66 | WHITE RIVER MWD | O | CROSBYTON | 193800 | CROSBYTON | O | BRAZOS | CROSBY | 0142 | NONE |
| 1155 | 66 | WHITE RIVER MWD | O | MINING | | MINING | O | RED | CROSBY | 1003 | NONE |
| 1156 | 66 | WHITE RIVER MWD | O | MINING | | MINING | O | BRAZOS | CROSBY | 1003 | NONE |
| 1157 | 66 | WHITE RIVER MWD | O | MINING | | MINING | O | BRAZOS | DICKENS | 1003 | NONE |
| 1158 | 66 | WHITE RIVER MWD | O | MINING | | MINING | O | BRAZOS | GARZA | 1003 | NONE |

# *Appendix H*

# *IFR Survey Procedures*

# A
# TWDB Infrastructure Financing Survey Instructions

As part of the regional and state water planning process, regional water planning groups recommend water supply projects for each of their respective regions. The purpose of this survey is gather information from your organization regarding how you plan to finance water supply projects recommended for the 2012 state water plan, and determine whether you intend to use financial assistance programs offered by the State of Texas and administered by the Texas Water Development Board (TWDB).

The TWDB has several funding programs for water projects identified in the 2012 state water plan. Funds are targeted toward: 1) construction of water supply projects, 2) planning and design and permitting for projects that have long development time frames meaning that construction would require 5-10 years of planning, design and permitting, and 3) projects that would be built with excess capacity intended to meet future water needs. These programs offer various attractive financing options such as subsidized interest rates, deferral of principal and interest during planning, design and permitting phase, partial deferral of interest and principal for those portions of the project which are optimally sized for future needs. Additionally, grant funding is available for those service areas which qualify as rural or economically disadvantaged. More information on these financial assistance programs (i.e., the Water Infrastructure Fund, the State Participation Fund, and the Economically Disadvantaged Areas Program) can be found at the TWDB website at:

http://www.twdb.state.tx.us/assistance/financial/financial_main.asp

Your cooperation and responses to these questions are crucial in helping the state in ensuring that our communities and our citizens have adequate water supplies. If you have any questions related to the financial programs offered by the TWDB or about the survey questions, please contact Herb Grubb by phone at (512)296-3917 (cell) or by email at herb.grubb@hdrinc.com. If you have any computer or technology related problems with the survey, please contact Wendy Barron by phone at (512) 936-0886 or by email at wendy.barron@twdb.state.tx.us.

**Section 1: Project Financing Information**

For project(s) identified in the State Water Plan, the TWDB has funding available for different aspects of a project. The different programs available are:

- WIF-Deferred offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

- WIF-Construction offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

- State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

- Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

- Economically Distressed Areas Program (EDAP) offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the

TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

•State Participation funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

If you are interested in receiving funds from the above programs, please complete the remainder of the survey.

**Please enter only the amounts you wish to receive from TWDB program in the Project Costs fields and do not enter a specific project cost more than once.**

**Section 2: Projects**

For each of the project(s) listed in the enclosed form, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. Each of the funding programs and categories are described below.

•Planning, design, permitting: Enter costs into the 'Planning, design, permitting' category if you want to participate in the WIF-Deferred program. The WIF-Deferred program offers subsidized interest and deferral of principal and interest for up to 10 years for planning, design and permitting costs.

•Acquisition and construction: Enter costs into the 'Acquisition and construction' category if you want to participate in the WIF-Construction program. The WIF-Construction program offers subsidized interest for all construction costs, including planning, acquisition, design, and construction.

•Excess Capacity: Enter costs into the 'Excess capacity' category if you want to participate in the State Participation program. State Participating funding offers partial interest and principal deferral for the incremental cost of project elements which are designed and built to serve needs beyond 10 years.

•Rural: Enter costs into the 'Rural' category if you want to participate in the Rural areas funding program. Rural areas funding offers grants and 0% interest loans for service areas which are not in a Metropolitan Statistical Area (MSA) and in which the population does not exceed 5,000. The service area must also meet the EDAP eligibility criteria.

•Disadvantaged: Enter costs into the 'Disadvantaged' category if you want to participate in the Economically Distressed Areas Program (EDAP). EDAP offers funding through grants and loans for service areas within a project which meet the EDAP eligibility criteria. Eligibility for the TWDB's EDAP requires that the median household income of the area to be served by the proposed project be less than 75 percent of the Texas median household income ($39,927), as shown in the 2000 Census. EDAP eligibility also requires adoption of Model Subdivision rules by the appropriate planning entities.

# TWDB INFRASTRUCTURE FINANCE SURVEY FORM

## *Name of Municipal Water User*

**WATER MANAGEMENT STRATEGIES FOR SILVERTON**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | |
|---|---|---|---|---|---|
| **62 - LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total** | **Total in Dollars** |
| | | **Dollars** | **Funding needed from TWDB Programs** | | |
| Planning, design, permitting | Cost: | | | Year: | |
| Acquisition and contruction | Cost: | | | Year: | |
| Excess Capacity | Cost: | | | Year: | |
| Rural | Cost: | | | Year: | |
| Disadvantaged | Cost: | | | Year: | |
| | **Total:** | | | | |

## Contact Information

1. **Name:**

2. **Phone Number:**

3. **Email:**

4. **Comments**

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# *Appendix I*

# *Detailed IFR Responses*

IFR Survey

## Projects

For each of the project(s) listed below, please enter only the amounts you wish to receive from TWDB programs in the 'Cost' field and the earliest date you wish to receive these amounts. In addition, the total amount entered into all five categories cannot exceed the total cost of the project. Each of the five categories corresponds to a funding program available at the TWDB. For an explanation of what funding program a category is related to, please click on the '?' button beside the category name.

| 64 - LAKE ALAN HENRY PIPELINE FOR THE CITY OF LUBBOCK | | | | $294,329,000.00 |
|---|---|---|---|---|
| Planning, design, permitting | Cost: | 0 | Year: | 2010 |
| Acquisition and construction | Cost: | 33491000 | Year: | 2010 |
| Excess capacity | Cost: | 0 | Year: | 2010 |
| Rural | Cost: | 0 | Year: | 2010 |
| Disadvantaged | Cost: | 0 | Year: | 2010 |
| | Total: | 33491000 | | |

| 89 - POST RESERVOIR- DELIVERED TO LAH PIPELINE | | | | $110,307,000.00 |
|---|---|---|---|---|
| Planning, design, permitting | Cost: | 8000000 | Year: | 2013 |
| Acquisition and construction | Cost: | 0 | Year: | 2015 |
| Excess capacity | Cost: | 0 | Year: | 2010 |
| Rural | Cost: | 0 | Year: | 2010 |
| Disadvantaged | Cost: | 0 | Year: | 2010 |
| | Total: | 8000000 | | |

| 632 - LUBBOCK BRACKISH GROUNDWATER DESALINATION | $13,167,000.00 |
|---|---|

| | | | | |
|---|---|---|---|---|
| Planning, design, permitting | Cost: | 1000000 | Year: | 2012 |
| Acquisition and construction | Cost: | 0 | Year: | 2015 |
| Excess capacity | Cost: | 0 | Year: | 2010 |
| Rural | Cost: | 0 | Year: | 2010 |
| Disadvantaged | Cost: | 0 | Year: | 2010 |
| | Total: | 1000000 | | |

| 633 - LUBBOCK JIM BERTRAM LAKE 7 | | | | $68,288,400.00 |
|---|---|---|---|---|
| Planning, design, permitting | Cost: | 8000000 | Year: | 2011 |
| Acquisition and construction | Cost: | 0 | Year: | 2016 |
| Excess capacity | Cost: | 0 | Year: | 2010 |
| Rural | Cost: | 0 | Year: | 2010 |
| Disadvantaged | Cost: | 0 | Year: | 2010 |
| | Total: | 8000000 | | |

| 634 - LUBBOCK NORTH FORK DIVERSION OPERATION (A) | | | | $153,040,000.00 |
|---|---|---|---|---|
| Planning, design, permitting | Cost: | 15000000 | Year: | 2013 |
| Acquisition and construction | Cost: | 0 | Year: | 2015 |
| Excess capacity | Cost: | 0 | Year: | 2010 |
| Rural | Cost: | 0 | Year: | 2010 |
| Disadvantaged | Cost: | 0 | Year: | 2010 |
| | Total: | 15000000 | | |

Back Next

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# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
# LORENZO

**WATER MANAGEMENT STRATEGIES FOR LORENZO**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | |
|---|---|---|---|---|---|
| **62 - LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total Cost** | **$276,408** |
| | | | **Funding needed from TWDB Programs** | | |
| Planning, design, permitting | Cost: | **$34,950** | | Year: | |
| Acquisition and contruction | Cost: | **$491,458** | $491,458.00 | Year: | 2015 |
| Excess Capacity | Cost: | | | Year: | |
| Rural | Cost: | | | Year: | |
| Disadvantaged | Cost: | | | Year: | |
| | **Total:** | **$526,408** | | | |

## Section 3: Contact Information

| | | |
|---|---|---|
| 1. | Name: | James Lively |
| 2. | Phone Number: | 806-634-5596 |
| 3. | Email: | cityadmin@cityoflorenzo.org |
| 4. | Comments | |

# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
## DENVER CITY
### WATER MANAGEMENT STRATEGIES FOR DENVER CITY

**COSTS AND FINANCE NEEDED FROM TWDB**

**62 - LOCAL GROUNDWATER DEVELOPMENT** **Total Cost** **$786,894**

| | | | Funding needed from TWDB Programs | | |
|---|---|---|---|---|---|
| Planning, design, permitting | Cost: | **$78,690** | $ 78,690 | Year: | 2012 |
| Acquisition and contruction | Cost: | **$708,204** | $ 708,204 | Year: | 2013 |
| Excess Capacity | Cost: | | | Year: | |
| Rural | Cost: | | $ 786,894 | Year: | 2012 |
| Disadvantaged | Cost: | | | Year: | |
| | **Total:** | **$786,894** | $ 786,894 | | |

## Section 3: Contact Information

| | | |
|---|---|---|
| 1. | Name: | Stan David |
| 2. | Phone Number: | 806-592-5426 |
| 3. | Email: | sdavid05@valornet.com |
| 4. | Comments | |

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# TWDB INFRASTRUCTURE FINANCE SURVEY FORM

## EARTH

**WATER MANAGEMENT STRATEGIES FOR EARTH**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **62 -** | **LOCAL GROUNDWATER DEVELOPMENT** | | | | | **Total Cost** | **$619,608** |
| | | | | | **Funding needed from TWDB Programs** | | |
| | Planning, design, permitting | Cost: | **$78,632** | | 78632 | Year: | 2031 |
| | Acquisition and contruction | Cost: | **$540,976** | | 540976 | Year: | 2031 |
| | Excess Capacity | Cost: | | | | Year: | |
| | Rural | Cost: | | | | Year: | |
| | Disadvantaged | Cost: | | | | Year: | |
| | | **Total:** | **$619,608** | | 613608 | | |

**Section 3: Contact Information**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Name: | LORRY | COLLOM | | PHIL | NEINAST |
| 2 | Phone Number: | 806 | 257 | | 2111 | |
| 3 | Email: | cityofearth@amaonline.com | | | | |
| 4 | Comments | | | | | |

August 9, 2010
Please find attached the survey you requested. Please let me know if there is anything else you might need.

Sue Hawkins
City of Hart
Hart, Texas

TWDB INFRASTRUCTURE FINANCE SURVEY FORM
HART
WATER MANAGEMENT STRATEGIES FOR HART

COSTS AND FINANCE NEEDED FROM TWDB

62 - LOCAL GROUNDWATER DEVELOPMENT Total Cost $200,338

Funding needed from TWDB Programs

Planning, design, permitting Cost: $20,034 Year:

Acquisition and contruction Cost: $180,304 Year:

Excess Capacity Cost: Year:

Rural Cost: Year:

Disadvantaged Cost: 2050 Year: $200,338

Total: $200,338

Section 3: Contact Information

1. Name: Sue Hawkins

2. Phone Number: 806/938-2171

3. Email: cityhart@amaonline.com

4. Comments These figures are way too low to drill new well in our area. Current cost estimates are approx $400,000.00 to $500,000.00

# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
## MORTON

**WATER MANAGEMENT STRATEGIES FOR MORTON**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | | |
|---|---|---|---|---|---|---|
| **62 -** | **LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total Cost** | **$1,185,162** |
| | | | | **Funding needed from TWDB Programs** | | |
| | Planning, design, permitting | Cost: | **$118,516** | $118,516 | Year: | 2010 |
| | Acquisition and contruction | Cost: | **$1,066,646** | $1,066,646 | Year: | 2010 |
| | Excess Capacity | Cost: | | | Year: | |
| | Rural | Cost: | | | Year: | |
| | Disadvantaged | Cost: | | | Year: | |
| | | **Total:** | **$1,185,162** | $1,185,162 | | |

**Section 3: Contact Information**

| | | | |
|---|---|---|---|
| 1. | Name: | Brenda | Shaw |
| 2. | Phone Number: | 806 | 266-8850 |
| 3. | Email: | bshaw@crosswind.net | |
| 4. | Comments | | |

# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
## WILSON
### WATER MANAGEMENT STRATEGIES FOR WILSON

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | | |
|---|---|---|---|---|---|---|
| **62 -** | **LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total Cost** | **$349,252** |
| | | | | **Funding needed from TWDB Programs** | | |
| | Planning, design, permitting | Cost: | **$34,925** | **34,925** | Year: | **2012** |
| | Acquisition and contruction | Cost: | **$314,327** | **64,327** | Year: | **2013** |
| | Excess Capacity | Cost: | | | Year: | |
| | Rural | Cost: | | **250,000** | Year: | **2013** |
| | Disadvantaged | Cost: | | | Year: | |
| | | **Total:** | **$349,252** | **349,252** | | |

**Section 3: Contact Information**

| | | | |
|---|---|---|---|
| 1. | Name: | **Joshua** | **Isham** |
| 2. | Phone Number: | **806** | **628-6221** |
| 3. | Email: | cityofwilson@nts-online.net | |
| 4. | Comments | | |

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# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
## PLAINS

**WATER MANAGEMENT STRATEGIES FOR PLAINS**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | | |
|---|---|---|---|---|---|---|
| **62 -** | **LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total Cost** | **$1,186,082** |
| | | | | **Funding needed from TWDB Programs** | | |
| | Planning, design, permitting | Cost: | **$118,608** | | Year: | |
| | Acquisition and contruction | Cost: | **$1,067,474** | | Year: | |
| | Excess Capacity | Cost: | | | Year: | |
| | Rural | Cost: | | | Year: | |
| | Disadvantaged | Cost: | | | Year: | |
| | | **Total:** | **$1,186,082** | | | |

## Section 3: Contact Information

| | | | |
|---|---|---|---|
| 1. | Name: | Terry | Howard |
| 2. | Phone Number: | 806 | 456-2288 |
| 3. | Email: | | thoward@hotmail.com |
| 4. | Comments | We are currently seeking land for purchase for anticipation of future water shortages and we have no cost at this time. | |

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# TWDB INFRASTRUCTURE FINANCE SURVEY FORM
# NEW DEAL
### WATER MANAGEMENT STRATEGIES FOR NEW DEAL

8/12/2010

### COSTS AND FINANCE NEEDED FROM TWDB

**62 - LOCAL GROUNDWATER DEVELOPMENT** **Total** **$547,803**

| | | | | Funding needed from TWDB | | |
|---|---|---|---|---|---|---|
| Planning, design, permitting | Cost: | $54,780 | | 116,426 | Year: | 2020 |
| Acquisition and contruction | Cost: | $493,023 | | 117,087 | Year: | 2030 |
| Excess Capacity | Cost: | | | 63,490 | Year: | 2040 |
| Rural | Cost: | | | 140,400 | Year: | 2050 |
| Disadvantaged | Cost: | | | 110,400 | Year: | 2060 |
| | Total: | $547,803 | | 547,803 | | |

## Section 3: Contact Information

1. Name: Stanley Cole, Sr.
2. Phone Number: 806 789-1897
3. Email: scolenewdeal@yahoo.com
4. Comments

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## TWDB INFRASTRUCTURE FINANCE SURVEY FORM

## SMYER

**WATER MANAGEMENT STRATEGIES FOR SMYER**

**COSTS AND FINANCE NEEDED FROM TWDB**

| | | | | | | |
|---|---|---|---|---|---|---|
| **62 -** | **LOCAL GROUNDWATER DEVELOPMENT** | | | | **Total Cost** | **$249,976** |
| | | | | **Funding needed from TWDB Programs** | | |
| | Planning, design, permitting | Cost: | **$24,997** | **24,997** | Year: | **2012** |
| | Acquisition and contruction | Cost: | **$224,979** | **224,979** | Year: | **2012** |
| | Excess Capacity | Cost: | | | Year: | |
| | Rural | Cost: | | | Year: | |
| | Disadvantaged | Cost: | | | Year: | |
| | | **Total:** | **$249,976** | **249,996** | | |

**Comments:**

The cost estimates presented in the survey form are not adequate to meet Smyer's needs.

The City of Smyer needs $261,000 in year 2012 for water planning. In addition, the City needs $535,000 for acquisition of land and construction of water wells.

### Section 3: Contact Information

| | | | | |
|---|---|---|---|---|
| 1. | Name: | Jo Ann | Beard | City Secretary |
| 2. | Phone Number: | 806 | 234-3071 | |
| 3. | Email: | jbeard@smyertexas.com | | |
| 4. | Comments | | | |

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# *Appendix J*

# *Assessment of Water Supplies of Municipal Water Users Of the Llano Estacado Water Planning Region (Region O)*

In the Llano Estacado Water Planning Region (Region O), the only source of water available for municipal use by approximately 29 of the Region's 51 municipal water users is the Ogallala Aquifer which lies beneath the Region. In addition, the Ogallala Aquifer meets a part of the needs of 14 of the Region's municipal water users, while other aquifers, and surface water impoundments meet the needs of the remaining 8 municipal water users. During the development of the 2001 Regional Water Plan for the Llano Estacado Water Planning Region, an assessment was made of the water resources and water supplies of the individual municipalities of the Llano Estacado Water Planning Region (Region O) from the Ogallala Aquifer. The assessment was made as of the date of 1995, and included the following: (1) locations of existing well fields and sites of undeveloped water rights available to the individual municipal water user on maps showing saturated thicknesses of the Ogallala Aquifer, (2) estimates of the quantities of water recoverable from the sites (existing well fields and undeveloped sites with water rights), and (3) projections of water demand and supply for the individual municipal water user group. The purpose of the present assessment is to: (1) compute quantities of water used for the period 10 year period of 1995 through 2004, the most recent year for which data are available, (2) compute the quantity of water remaining at year 2005 from the quantity estimated to have been available in 1995, (3) compute water level changes in the immediate vicinity of each municipal water user, using water level measurements in observation wells near each municipality, (4) identify the number and capacities of new water wells that have been added to each municipal water user's water supply system, and (5) assess and compare supplies available to meet projected demands of the 2011 regional Water Plan. The latter, comparison of supplies available with projected municipal demands, provides information as to when new supplies will be needed and the quantities of supplies needed in order to allow formulation and evaluation of water management strategies to meet projected needs (shortages) of individual municipal water user groups. The Municipal WUGs are listed below in alphabetical order, with a tabular summary of water supply information following in Table J-1 through Table J-51.

# Municipal Water Users of the Llano Estacado Water Planning Region

| No | Name | County | Basin | Source of Water |
|---|---|---|---|---|
| 1 | Abernathy | Hale & Lubbock | Brazos | Ogallala |
| 2 | Amherst | Lamb | Brazos | Ogallala |
| 3 | Anton | Hockley | Brazos | Ogallala |
| 4 | Bovina | Parmer | Brazos | Ogallala |
| 5 | Brownfield | Terry | Colorado | Ogallala & CRMWA |
| 6 | Crosbyton | Crosby | Brazos | White River Lake/MWA |
| 7 | Denver City | Yoakum | Colorado | Ogallala |
| 8 | Dimmitt | Castro | Brazos | Ogallala |
| 9 | Earth | Lamb | Brazos | Ogallala |
| 10 | Farwell | Parmer | Brazos | Ogallala |
| 11 | Floydada | Floyd | Brazos | Ogallala & Lake Mackenzie |
| 12 | Friona | Parmer | Red | Ogallala |
| 13 | Hale Center | Hale | Brazos | Ogallala |
| 14 | Happy | Swisher | Red | Santa Rosa/Dockum |
| 15 | Hart | Castro | Brazos | Ogallala |
| 16 | Hereford | Deaf Smith | Red | Ogallala & Dockum |
| 17 | Idalou | Lubbock | Brazos | Ogallala |
| 18 | Kress | Swisher | Brazos & Red | Ogallala |
| 19 | Lamesa | Dawson | Colorado | Ogallala & CRMWA |
| 20 | Levelland | Hockley | Brazos | Ogallala & CRMWA |
| 21 | Littlefield | Lamb | Brazos | Ogallala & Lubbock (Bailey Co.) |
| 22 | Lockney | Floyd | Brazos | Ogallala & Lake Mackenzie |
| 23 | Lorenzo | Crosby | Brazos | Ogallala |
| 24 | Lubbock | Lubbock | Brazos | Ogallala & CRMWA |
| 25 | Matador | Motley | Red | Seymour |
| 26 | Meadow | Terry | Colorado | Ogallala |
| 27 | Morton | Cochran | Brazos | Ogallala |
| 28 | Muleshoe | Bailey | Brazos | Santa Rosa & Ogallala |
| 29 | New Deal | Lubbock | Brazos | Ogallala & City of Lubbock |
| 30 | O'Donnell | Dawson & Lynn | Brazos | CRMWA |
| 31 | Olton | Lamb | Brazos | Ogallala |
| 32 | Perersburg | Hale | Brazos | Ogallala |
| 33 | Plains | Yoakum | Colorado | Ogallala |
| 34 | Plainview | Hale | Brazos | CRMWA & Ogallala |
| 35 | Post | Garza | Brazos | White River Lake & Slaton/CMWA |
| 36 | Ralls | Crosby | Brazos | White River Lake/MWA |
| 37 | Ransom Canyon | Lubbock | Brazos | City of Lubbock |
| 38 | Ropesville | Hockley | Brazos | Ogallala |
| 39 | Seagraves | Gaines | Colorado | Ogallala |
| 40 | Seminole | Gaines | Colorado | Ogallala |
| 41 | Shallowater | Lubbock | Brazos | Ogallala & Lubbock(Bailey Co.) |
| 42 | Silverton | Briscoe | Red | Lake Mackenzie & Ogallala |
| 43 | Slaton | Lubbock | Brazos | CRMWA & Ogallala |
| 44 | Smyer | Hockley | Brazos | Ogallala |
| 45 | Spur | Dickens | Brazos | White River Lake/MWA |
| 46 | Sudan | Lamb | Brazos | Ogallala |
| 47 | Sundown | Hockley | Colorado | Ogallala |
| 48 | Tahoka | Lynn | Brazos | CRMWA & Ogallala |
| 49 | Tulia | Swisher | Red | Lake Mackenzie & Dockum & Ogallala |
| 50 | Wilson | Lynn | Brazos | Ogallala |
| 51 | Wolfforth | Lubbock | Brazos | Ogallala |

**Table J-1: City of Abernathy Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Hale | Brazos | 486 | 508 | 526 | 531 | 525 | 514 |
| | Lubbock | Brazos | 171 | 182 | 188 | 186 | 190 | 186 |
| **Total** | | | 657 | 690 | 714 | 717 | 715 | 700 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 80 -- 140 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 3.38 | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | 0.34 | feet | 1966 | 289 | 250 | 340 |
| | | | | | 1975 | 410 | 420 | 650 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 9,737 | acft | 1976 | 415 | 600 | 600 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 5,599 | acft | 1978 | 351 | 625 | 625 |
| Quantity of Water Remaining in 2005. | | | 4,137 | acft | 2002 | 330 | 530 | 530 |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 657 | 690 | 714 | 717 | 715 | 700 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 657 | 193 | 174 | 157 | 141 | 127 |
| New Well # 1*** Implemented | 2011 | 2002 | | 193 | 174 | 157 | 141 | 127 |
| **Projected Total Municipal Water Supply** | | | 657 | 386 | 348 | 314 | 282 | 254 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 304 | 366 | 403 | 433 | 446 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 50 | 48 | 43 | 32 | 28 | 27 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well # 2 **** | 2015 | | | 428 | 385 | 346 | 312 | 280 |
| Well # 3 **** | 2015 | | | 202 | 182 | 164 | 147 | 132 |
| Well # 4 **** | 2025 | | | | 202 | 182 | 164 | 147 |
| Well # 5 **** | 2042 | | | | | | 196 | 176 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2006.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2006 Regional Water Plan.

**** Needed for 2011 Regional Water Plan.

[1] Value represents total municipal need after implementation of Well #1.

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**Table J-2: City of Amherst Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lamb | Brazos | 168 | 176 | 182 | 185 | 183 | 181 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 4.58 | feet | | | | |
| Average Annual Water Level Decline. | 0.91 | feet | 1956 | 200 | 20 | 300 |
| | | | 1989 | 220 | 100 | 300 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 3,721 | acft | 1999 | 230 | 25 | 200 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 1,534 | acft | 1999 | 200 | 90 | 300 |
| Quantity of Water Remaining in 2005. | 2,187 | acft | 2002 | 195 | 25 | 150 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 168 | 176 | 182 | 185 | 183 | 181 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 168 | 196 | 176 | 158 | 143 | 128 |
| New Well # 1*** Implemented | 2011 | 2002 | | 196 | 176 | 158 | 143 | 128 |
| **Projected Total Municipal Water Supply** | | | 168 | 391 | 352 | 317 | 285 | 257 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 7 | 5 | 2 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #2 **** | 2025 | | | | 202 | 182 | 164 | 147 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2006 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
[1] Value represents total municipal need after implementation of Well #1.

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**Table J-3: City of Anton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Hockley | Brazos | 263 | 270 | 272 | 268 | 256 | 243 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 20 -- 40 | feet | NA | 140 | 200 | 200 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 1.44 | feet | 1953 | 110 | 235 | 235 |
| Average Annual Water Level Decline. | 0.14 | feet | 1961 | 160 | 190 | 190 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 1,621 | acft | 1971 | 139 | 150 | 150 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 3,226 | acft | 1974 | 150 | 250 | 250 |
| Quantity of Water Remaining in 2005. | NA | acft | 1984 | 148 | 200 | 200 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 263 | 270 | 272 | 268 | 256 | 243 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 263 | 270 | 272 | 268 | 256 | 243 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 14 | 11 | 6 | 2 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2006 | | 204 | 184 | 165 | 149 | 134 | 120 |
| Well #2 *** | 2006 | | 204 | 184 | 165 | 149 | 134 | 120 |
| Well #3 *** | 2015 | | | 202 | 182 | 164 | 147 | 132 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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| Table J-4: City of Bovina Water Supply and Aquifer Information | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Location** | | **Years** | | | | | |
| | | **River** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **County** | **Basin** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Parmer | Brazos | 321 | 334 | 335 | 330 | 317 | 300 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 60 -- 80 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 14.96 | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | 1.49 | feet | 1966 | 358 | 180 | 265 |
| | | | | | 1982 | 340 | 200 | 200 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 6,110 | acft | 1982 | 350 | 200 | 0 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 3,226 | acft | 2000 | 350 | 125 | 0 |
| Quantity of Water Remaining in 2005. | | | 2,884 | acft | 2000 | 350 | 125 | 0 |
| | | | | | 2004 | 330 | 180 | 90 |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 321 | 334 | 335 | 330 | 317 | 300 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 321 | 334 | 335 | 330 | 317 | 300 |
| **Projected Total Municipal Water Supply** | | | 321 | 334 | 335 | 330 | 317 | 300 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2005 | revise | 202 | 182 | 164 | 147 | 132 | 118 |
| Well #2 *** | 2005 | cost | 202 | 182 | 164 | 147 | 132 | 118 |
| Well #3 *** | 2015 | schedule | | | 202 | 182 | 164 | 147 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

[1] Value represents total municipal need.

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**Table J-5: City of Brownfield Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Terry | Colorado | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **CRMWA** | | | | | | | |

| Aquifer Data in Vicinity of Wells | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 10.04 | feet |
| Average Annual Water Level Decline. | 1.00 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 28,387 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 19,499 | acft |
| Quantity of Water Remaining in 2005. | 8,888 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1945 | 157 | 400 | 400 |
| 1947 | 151 | 300 | 300 |
| 1951 | 145 | 200 | 200 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1953 | 140 | 350 | 350 |
| 1955 | 152 | 225 | 225 |
| 1957 | 141 | 300 | 300 |
| 1957 | 163 | 475 | 475 |
| 1960 | 170 | 325 | 325 |
| 1961 | 165 | 350 | 350 |
| 1961 | 165 | 450 | 450 |
| 1963 | 150 | 290 | 290 |
| 1964 | 175 | 155 | 155 |
| 1964 | 170 | 270 | 270 |
| 1964 | 150 | 250 | 250 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 2,747 | 2,905 | 3,047 | 3,181 | 3,185 | 3,167 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 2,816 | 2,790 | 2,767 | 2,746 | 2,727 | 2,710 |
| **Projected Total Municipal Water Supply** | | | 2,816 | 2,790 | 2,767 | 2,746 | 2,727 | 2,710 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 280 | 435 | 458 | 457 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 211 | 448 | 687 | 802 | 793 | 788 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Increase supplies from CRMWA *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

[1] Value represents total municipal need.

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**Table J-6: City of Crosbyton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Crosby | Brazos | 369 | 386 | 394 | 402 | 400 | 394 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **White River MWD** | | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 140--180 | feet | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | NA | feet | | | | |
| Average Annual Water Level Decline. | | | NA | feet | Source: White River MWD. | | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 19,458 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 3,412 | acft | | | | |
| Quantity of Water Remaining in 2005. | | | 16,046 | acft | | | | |
| | **Date Needed** | **Date Added** | **2010 (acft)** | **2020 (acft)** | **2030 (acft)** | **2040 (acft)** | **2050 (acft)** | **2060 (acft)** |
| **Projected Municipal Water Demand** | | | 369 | 386 | 394 | 402 | 400 | 394 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 439 | 439 | 439 | 439 | 439 | 58 |
| **Projected Total Municipal Water Supply** | | | 439 | 439 | 439 | 439 | 439 | 58 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 336 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Local Groundwater Development within White River MWD *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
[1] Value represents total municipal need.

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**Table J-7: City of Denver City Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | Yoakum | Colorado | 1,043 | 1,126 | 1,172 | 1,220 | 1,181 | 1,141 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | NA | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | NA | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | NA | feet | 1951 | 250 | 230 | 230 |
| | | | | | 1958 | 222 | 425 | 850 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 30,235 | acft | 1975 | 225 | 400 | 400 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 9,304 | acft | 1980 | 260 | 345 | 635 |
| Quantity of Water Remaining in 2005. | | | 20,931 | acft | 1980 | 261 | 150 | 600 |
| | | | | | 1983 | 251 | 680 | 800 |
| | | | | | 1984 | 240 | 535 | 535 |
| | | | | | 1984 | 253 | 250 | 250 |
| | | | | | 1984 | 187 | 450 | 450 |
| | | | | | 1985 | 240 | 325 | 325 |
| | | | | | 2004 | 230 | 225 | 225 |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 1,043 | 1,126 | 1,172 | 1,220 | 1,181 | 1,141 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 1,043 | 1,126 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2021 | 2004 | | | 193 | 174 | 157 | 141 |
| **Projected Total Municipal Water Supply** | | | 1,043 | 1,126 | 193 | 174 | 157 | 141 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 979 | 1,046 | 1,024 | 1,000 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 77 | 169 | 179 | 171 | 160 | 155 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #2 **** | 2023 | | | | 419 | 377 | 339 | 305 |
| Well #3 **** | 2025 | | | | 428 | 385 | 346 | 312 |
| Well #4 **** | 2027 | | | | 437 | 393 | 354 | 318 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Well #1.

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**Table J-8: City of Dimmitt Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Castro | Brazos | 1,041 | 1,103 | 1,137 | 1,159 | 1,150 | 1,130 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| Aquifer Data in Vicinity of Wells | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 100--160 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 41.45 | feet |
| Average Annual Water Level Decline. | 4.15 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 32,249 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 9,943 | acft |
| Quantity of Water Remaining in 2005. | 22,306 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1955 | 413 | 200 | 140 |
| 1957 | 427 | 300 | 500 |
| 1957 | 384 | 425 | 425 |
| 1957 | 427 | 300 | 300 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1967 | 410 | 150 | 120 |
| 1970 | 396 | 296 | 290 |
| 1970 | 400 | 150 | 280 |
| 1972 | 398 | 425 | 425 |
| 1973 | 406 | 200 | 290 |
| 1974 | 412 | 150 | 140 |
| 1974 | 402 | 200 | 120 |
| 1977 | 372 | 350 | 480 |
| 1977 | 376 | 350 | 420 |
| 1977 | 374 | 350 | 480 |
| 1979 | 376 | 475 | 475 |
| 1994 | 354 | 450 | 450 |
| 2005 | 380 | 350 | 500 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 1,041 | 1,103 | 1,137 | 1,159 | 1,150 | 1,130 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 1,041 | 1,103 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2017 | 2005 | | 437 | 393 | 354 | 318 | 286 |
| **Projected Total Municipal Water Supply** | | | 1,041 | 1,540 | 393 | 354 | 318 | 286 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 744 | 805 | 832 | 844 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 75 | 110 | 97 | 81 | 75 | 74 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #2 **** | 2019 | | | 446 | 401 | 361 | 325 | 292 |
| Well #3 **** | 2021 | | | | 410 | 369 | 332 | 299 |
| Well #4 **** | 2042 | | | | | | 414 | 373 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2001 Regional Water Plan.

**** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need after implementation of Well #1.

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**Table J-9: City of Earth Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lamb | Brazos | 257 | 268 | 277 | 283 | 280 | 276 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 60 -- 80 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 20.14 | feet |
| Average Annual Water Level Decline. | 2.01 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 9,766 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,686 | acft |
| Quantity of Water Remaining in 2005. | 7,080 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| NA | 220 | 330 | 550 |
| 1966 | 250 | 500 | 710 |
| 1986 | 261 | 300 | 350 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 257 | 268 | 277 | 283 | 280 | 276 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 257 | 268 | 277 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 257 | 268 | 277 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 283 | 280 | 276 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 20 | 28 | 25 | 21 | 20 | 17 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2031 | | | | | 193 | 174 | 157 |
| Well #2 *** | 2034 | | | | | 200 | 180 | 162 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-10: City of Farwell Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Parmer | Brazos | 388 | 405 | 410 | 408 | 393 | 371 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | Existing Wells * | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 80--120 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 34.73 | feet | | | | |
| Average Annual Water Level Decline. | 3.47 | feet | 1964 | 390 | 70 | 500 |
| | | | 1972 | 365 | 70 | 250 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 8,640 | acft | 1980 | 392 | 90 | 490 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 3,322 | acft | 1996 | 385 | 150 | 250 |
| Quantity of Water Remaining in 2005. | 5,318 | acft | 1996 | 380 | 150 | 250 |
| | | | 2000 | 372 | 200 | 275 |
| | | | 2002 | 394 | 250 | NA |
| | | | 2002 | 403 | 250 | NA |
| | | | 2002 | 412 | 250 | NA |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 388 | 405 | 410 | 408 | 393 | 371 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | ????? | 388 | 0 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2015 | 2002 | | 202 | 182 | 164 | 147 | 132 |
| New Well # 2*** Implemented | 2015 | 2002 | | 202 | 182 | 164 | 147 | 132 |
| **Projected Total Municipal Water Supply** | | | 388 | 404 | 363 | 327 | 294 | 265 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 1 | 47 | 81 | 99 | 106 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 33 | 64 | 94 | 101 | 97 | 91 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemeted from 2001 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1and #2.

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**Table J-11: City of Floydada Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Floyd | Brazos | 680 | 696 | 693 | 685 | 657 | 623 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **Lake Mackenzie** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 80--100 | feet | NA | 415 | 700 | 626 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 5.92 | feet | 1947 | 320 | 100 | 350 |
| Average Annual Water Level Decline. | 0.59 | feet | 1954 | 320 | 200 | 180 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 41,431 | acft | 1962 | 302 | 300 | 348 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 5,496 | acft | 1962 | 302 | 270 | 295 |
| Quantity of Water Remaining in 2005. | 35,935 | acft | 1966 | 304 | 200 | 233 |
| | | | 1966 | 312 | 170 | 295 |
| | | | 1998 | 416 | 364 | 364 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 680 | 696 | 693 | 685 | 657 | 623 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 680 | 696 | 693 | 685 | 657 | 623 |
| **Projected Total Municipal Water Supply** | | | 680 | 696 | 693 | 685 | 657 | 623 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| Ogallala and Lake Mackenzie *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-12: City of Friona Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Parmer | Red | 835 | 872 | 879 | 870 | 838 | 791 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| Aquifer Data in Vicinity of Wells | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 180--220 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 8.44 | feet |
| Average Annual Water Level Decline. | 0.84 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 26,003 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 8,036 | acft |
| Quantity of Water Remaining in 2005. | 17,967 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| NA | 501 | 300 | 300 |
| NA | 501 | 300 | 300 |
| 1953 | 222 | 100 | 100 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1959 | 218 | 110 | 110 |
| 1964 | 220 | 105 | 105 |
| 1966 | 220 | 180 | 180 |
| 1972 | 499 | 204 | 204 |
| 1973 | 220 | 150 | 150 |
| 1980 | 220 | 124 | 124 |
| 1994 | 497 | 300 | 300 |
| 1996 | 507 | 200 | 200 |
| 1996 | 490 | 200 | 200 |
| 2001 | 321 | 90 | 300 |
| 2004 | 364 | 100 | NA |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 835 | 872 | 879 | 870 | 838 | 791 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 835 | 872 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2010 | 2001 | 121 | 108 | 98 | 88 | 79 | 71 |
| New Well # 2*** Implemented | 2018 | 2004 | | 441 | 397 | 357 | 321 | 289 |
| **Projected Total Municipal Water Supply** | | | 956 | 1,421 | 495 | 445 | 401 | 360 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 384 | 425 | 437 | 431 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 46 | 34 | 20 | 5 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #3 **** | 2023 | | | | 419 | 377 | 339 | 305 |
| Well #4**** | 2023 | | | | 419 | 377 | 339 | 305 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1and #2.

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**Table J-13: City of Hale Center Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hale | Brazos | 470 | 493 | 509 | 513 | 507 | 498 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 120--160 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 12.37 | feet | | | | |
| Average Annual Water Level Decline. | 1.24 | feet | NA | 330 | 150 | NA |
| | | | 1976 | 307 | 80 | NA |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 15,860 | acft | 1988 | 330 | 120 | NA |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,122 | acft | 1988 | 320 | 140 | NA |
| Quantity of Water Remaining in 2005. | 11,738 | acft | 1988 | 312 | 85 | NA |
| | | | 1988 | 315 | 125 | NA |
| | | | 2001 | 325 | 123 | 123 |
| | | | 2003 | 330 | 215 | 200 |
| | | | 2003 | 325 | 200 | 200 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 470 | 493 | 509 | 513 | 507 | 498 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 470 | 493 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2021 | 2001 | | | 410 | 369 | 332 | 299 |
| New Well # 2*** Implemented | 2023 | 2003 | | | 198 | 178 | 160 | 144 |
| New Well # 3*** Implemented | 2031 | 2003 | | | | 193 | 174 | 157 |
| **Projected Total Municipal Water Supply** | | | 470 | 493 | 607 | 740 | 666 | 599 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1, #2, and #3.

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**Table J-14: City of Happy Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Swisher | Red | 109 | 110 | 111 | 110 | 108 | 103 |
| **Projected Municipal Water Supply** | **Santa Rosa/Dockum Aquifer** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet | 1971 | 803 | 0 | 400 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | NA | feet | 1978 | 830 | 0 | 450 |
| Average Annual Water Level Decline. | NA | feet | | | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 978 | acft | | | | |
| Quantity of Water Remaining in 2005. | NA | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 109 | 110 | 111 | 110 | 108 | 103 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 109 | 110 | 111 | 110 | 108 | 103 |
| **Projected Total Municipal Water Supply** | | | 109 | 110 | 111 | 110 | 108 | 103 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | | ????? | | | | | | |
| Well #2 *** | | Santa | | | | | | |
| Well #3 *** | | Rosa ??? | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-15: City of Hart Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Castro | Brazos | 238 | 251 | 258 | 262 | 260 | 256 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 160--200 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 41.29 | feet |
| Average Annual Water Level Decline. | 4.13 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 11,416 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,109 | acft |
| Quantity of Water Remaining in 2005. | 9,307 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| 1949 | 350 | 200 | 650 |
| 2002 | 415 | 530 | 708 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 238 | 251 | 258 | 262 | 260 | 256 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 238 | 251 | 258 | 262 | 0 | 0 |
| New Well # 1*** Implemented | 2041 | 2002 | 193 | 193 | 193 | 193 | 193 | 174 |
| **Projected Total Municipal Water Supply** | | | 431 | 444 | 451 | 455 | 193 | 174 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 67 | 82 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #2 **** | 2043 | | | | | | 198 | 178 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2006.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Well #1.

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**Table J-16: City of Hereford Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Deaf Smith | Red | 3,634 | 3,694 | 3,751 | 3,788 | 3,801 | 3,813 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **Santa Rosa** | **Dockum** | **Aquifer** | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 140--180 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 0.72 | feet |
| Average Annual Water Level Decline. | 0.07 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 32,792 | acft |
| Quantity of Water Remaining in 2005. | NA | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM | |
|---|---|---|---|---|
| 0 | 820 | 700 | 820 | |
| 1940 | 225 | 80 | 225 | |
| 1953 | 204 | 105 | 225 | |
| 1956 | 320 | 130 | 320 | Dockum |
| 1956 | 310 | 80 | 320 | |
| 1956 | 287 | 210 | 210 | Dockum |
| 1956 | 300 | 95 | 320 | Dockum |
| 1961 | 282 | 440 | 280 | |
| 1962 | 305 | 85 | 310 | |
| 1964 | 360 | 85 | 360 | Dockum |
| 1964 | 310 | 85 | 310 | Dockum |
| 1964 | 270 | 135 | 270 | |
| 1965 | 340 | 150 | 340 | |
| 1966 | 350 | 185 | 550 | |
| 1966 | 954 | 560 | 750 | |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1966 | 346 | 180 | 346 |
| 1967 | 350 | 175 | 550 |
| 1967 | 350 | 190 | 350 |
| 1969 | 390 | 100 | 390 |
| 1969 | 385 | 70 | 385 |
| 1969 | 385 | 130 | 385 |
| 1976 | 397 | 190 | 250 |
| 1976 | 357 | 80 | 357 |
| 1976 | 365 | 70 | 365 |
| 1979 | 412 | 135 | 412 |
| 1979 | 452 | 185 | 452 |
| 1979 | 467 | 240 | 467 |
| 1986 | 800 | 510 | 800 |
| 1989 | 462 | 85 | 462 |
| 1990 | 800 | 590 | 800 |
| 1994 | 880 | 580 | 880 |
| 1994 | 348 | 60 | 345 |
| 1995 | 328 | 115 | 315 |
| 1995 | 854 | 550 | 815 |
| 1995 | 880 | 550 | 810 |
| 2004 | 359 | 170 | NA |
| 2004 | 480 | 250 | NA |
| 2004 | 432 | 220 | NA |
| 2004 | 424 | 180 | NA |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 3,634 | 3,694 | 3,751 | 3,788 | 3,801 | 3,813 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 3,994 | 3,983 | 7,502 | 7,576 | 7,602 | 7,602 |
| **Projected Total Municipal Water Supply** | | | 3,994 | 3,983 | 7,502 | 7,576 | 7,602 | 7,602 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 302 | 572 | 649 | 610 | 596 | 598 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2006.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-17: City of Idalou Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 289 | 288 | 281 | 274 | 273 | 272 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | | 80--120 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | 10.18 | feet | | | | |
| Average Annual Water Level Decline. | | 1.01 | feet | None Listed | | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | 9,473 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | 3,642 | acft | | | | |
| Quantity of Water Remaining in 2005. | | 5,831 | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 289 | 288 | 281 | 274 | 273 | 272 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 289 | 288 | 281 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 289 | 288 | 281 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 274 | 273 | 272 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2031 | | | | | 410 | 369 | 332 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-18: City of Kress Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | | | | | | | | |
| | Swisher | Brazos | 22 | 22 | 22 | 22 | 21 | 20 |
| | Swisher | Red | 82 | 82 | 83 | 81 | 79 | 76 |
| **Total** | | | 104 | 104 | 105 | 103 | 100 | 96 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | Existing Wells * | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 60 -- 80 | feet | 1972 | 345 | 125 | 300 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 0.00 | feet | 1983 | 305 | 275 | 300 |
| Average Annual Water Level Decline. | 0.00 | feet | 1997 | 302 | 250 | 275 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 846 | acft | 2006 | 270 | 270 | 165 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 932 | acft | | | | |
| Quantity of Water Remaining in 2005. | 0 | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 104 | 104 | 105 | 103 | 100 | 96 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2006 | 2006 | 204 | 184 | 165 | 149 | 134 | 120 |
| **Projected Total Municipal Water Supply** | | | 204 | 184 | 165 | 149 | 134 | 120 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2006 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need after implementation of Well #1.

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**Table J-19: City of Lamesa Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Dawson | Colorado | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **CRMWA** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 50--120 | feet | | | | |
| Decline in Water Level 1996 -- 2006: MESAWCD measurements.* | 1.51 | feet | | | | |
| Average Annual Water Level Decline. | 0.15 | feet | 0 | 174 | 80 | 350 |
| | | | 0 | 190 | 190 | 350 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 68,182 | acft | 0 | 189 | 400 | 520 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 22,764 | acft | 1957 | 176 | 310 | 350 |
| Quantity of Water Remaining in 2005. | 45,418 | acft | 1957 | 209 | 170 | 250 |
| | | | 1957 | 181 | 40 | 300 |
| | | | 1957 | 193 | 220 | 250 |
| | | | 1957 | 182 | 210 | 350 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 2,540 | 2,573 | 2,602 | 2,603 | 2,529 | 2,433 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 3,093 | 3,036 | 2,985 | 2,939 | 2,698 | 2,661 |
| **Projected Total Municipal Water Supply** | | | 3,093 | 3,036 | 2,985 | 2,939 | 2,698 | 2,661 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 212 | 400 | 501 | 471 | 448 | 431 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** Mesa Underground Water Conservation District.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table -20: City of Levelland Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hockley | Brazos | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 60--100 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 6.80 | feet |
| Average Annual Water Level Decline. | 0.68 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 85,502 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 18,867 | acft |
| Quantity of Water Remaining in 2005. | 66,635 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1946 | 231 | 210 | 400 |
| 1949 | 241 | 220 | 400 |
| 1953 | 236 | 440 | 550 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1955 | 241 | 340 | 550 |
| 1955 | 255 | 280 | 550 |
| 1957 | 240 | 200 | 400 |
| 1958 | 245 | 440 | 550 |
| 1959 | 246 | 270 | 500 |
| 1960 | 220 | 300 | 550 |
| 1962 | 234 | 270 | 600 |
| 1965 | 254 | 220 | 500 |
| 1967 | 256 | 370 | 550 |
| 1979 | 212 | 175 | 200 |
| 1979 | 212 | 200 | 400 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 2,310 | 2,362 | 2,369 | 2,322 | 2,216 | 2,107 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 3,236 | 3,236 | 3,236 | 3,236 | 2,808 | 2,808 |
| **Projected Total Municipal Water Supply** | | | 3,236 | 3,236 | 3,236 | 3,236 | 2,808 | 2,808 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-21: City of Littlefield Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lamb | Brazos | 1,530 | 1,602 | 1,660 | 1,694 | 1,676 | 1,655 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | 1964 | 297 | 350 | 580 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 1.34 | feet | 1964 | 305 | 520 | 580 |
| Average Annual Water Level Decline. | 0.13 | feet | 1964 | 298 | 300 | 500 |
| | | | 1978 | 307 | 475 | 650 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 220,422 | acft | 1984 | 323 | 300 | 550 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 15,110 | acft | 1985 | 306 | 490 | 550 |
| Quantity of Water Remaining in 2005. | 205,312 | acft | 2002 | 315 | 425 | 500 |
| | | | 2004 | 309 | 340 | 400 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 1,530 | 1,602 | 1,660 | 1,694 | 1,676 | 1,655 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 1,530 | 1,602 | 1,660 | 1,694 | 1,676 | 1,655 |
| New Well # 1*** Implemented | 2010 | 2002 | 450 | 405 | 365 | 328 | 295 | 266 |
| New Well # 2*** Implemented | 2010 | 2004 | 450 | 405 | 365 | 328 | 295 | 266 |
| **Projected Total Municipal Water Supply** | | | 2,430 | 2,412 | 2,389 | 2,350 | 2,266 | 2,186 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 118 | 196 | 181 | 161 | 151 | 149 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1and #2.

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**Table J-22: City of Lockney Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Floyd | Brazos | 242 | 244 | 240 | 234 | 224 | 212 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 40--120 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 10.97 | feet |
| Average Annual Water Level Decline. | 1.10 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 5,365 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,806 | acft |
| Quantity of Water Remaining in 2005. | 2,559 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| 1959 | 339 | 100 | 100 |
| 1972 | 390 | 300 | 120 |
| 1976 | 374 | 180 | 180 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 242 | 244 | 240 | 234 | 224 | 212 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 242 | 244 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 242 | 244 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 240 | 234 | 224 | 212 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2021 | | | | 410 | 369 | 332 | 299 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

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**Table J-23: City of Lorenzo Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Crosby | Brazos | 275 | 288 | 296 | 302 | 301 | 296 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 140--160 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 9.54 | feet |
| Average Annual Water Level Decline. | 0.95 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 15,322 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,235 | acft |
| Quantity of Water Remaining in 2005. | 13,087 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| 1964 | 349 | 330 | NA |
| 1965 | 350 | 165 | NA |
| 1972 | 355 | 500 | NA |
| 1993 | 343 | 185 | NA |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 275 | 288 | 296 | 302 | 301 | 296 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 275 | 288 | 259 | 233 | 209 | 188 |
| **Projected Total Municipal Water Supply** | | | 275 | 288 | 259 | 233 | 209 | 188 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 37 | 69 | 92 | 108 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2011 | | | | 206 | 185 | 167 | 150 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-24: City of Lubbock Water Supply and Aquifer Information**

| Updated 10/21/2009 | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 49,822 | 51,587 | 52,416 | 52,600 | 53,040 | 54,305 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | **and CRMWA** | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | NA | feet |
| Average Annual Water Level Decline. | NA | feet |
| | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 412,046 | acft |
| Quantity of Water Remaining in 2005. | NA | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 145 Wells drilled between 1938 and 1986 | | | |
| Depth Range | 101- 267 | | |
| Average Depth | 209 | | |
| Tested Range GPM | | 52 -- 1,000 | |
| Average Tested GPM | | 279 | |
| Rated Range GPM | | 100--1,000 | |
| Average Rated GPM | | | 300 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 49,822 | 51,587 | 52,416 | 52,600 | 53,040 | 54,305 |
| **Projected Municipal Water Supply** | | | 42,000 | 42,000 | 40,000 | 38,000 | 35,000 | 35,000 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 7,822 | 9,587 | 12,416 | 14,600 | 18,040 | 19,305 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 4,132 | 7,662 | 7,112 | 6,441 | 6,256 | 6,405 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | | | | | | | | |
| Well #2 *** | | | | | | | | |
| Well #3 *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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| Table J-25: City of Matador Water Supply and Aquifer Information | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Location** | | **Years** | | | | | |
| | | **River** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **County** | **Basin** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | Motley | Red | 234 | 224 | 207 | 187 | 174 | 166 |
| **Projected Municipal Water Supply** | **Seymour** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | NA | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006.** | | | NA | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | NA | feet | 1976 | 112 | 430 | 400 |
| | | | | | 1976 | 106 | 360 | 400 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | NA | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 2,057 | acft | | | | |
| Quantity of Water Remaining in 2005. | | | NA | acft | | | | |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 234 | 224 | 207 | 187 | 174 | 166 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 234 | 224 | 207 | 187 | 174 | 166 |
| **Projected Total Municipal Water Supply** | | | 234 | 224 | 207 | 187 | 174 | 166 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 20 | 37 | 49 | 57 | 63 | 62 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** Not Available.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-26: City of Meadow Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Terry | Colorado | 73 | 75 | 78 | 80 | 79 | 79 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet | 1936 | 140 | 50 | 50 |
| Decline in Water Level 1996 -- 2006.** | NA | feet | 1951 | 151 | 100 | 100 |
| Average Annual Water Level Decline. | NA | feet | 1986 | 150 | 140 | 140 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 9,891 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 1,094 | acft | | | | |
| Quantity of Water Remaining in 2005. | 8,797 | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 73 | 75 | 78 | 80 | 79 | 79 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 73 | 75 | 78 | 80 | 79 | 79 |
| **Projected Total Municipal Water Supply** | | | 73 | 75 | 78 | 80 | 79 | 79 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** Not Available.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-27: City of Morton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Cochran | Brazos | 535 | 560 | 565 | 547 | 521 | 496 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 80 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 6.72 | feet |
| Average Annual Water Level Decline. | 0.67 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 11,264 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,916 | acft |
| Quantity of Water Remaining in 2005. | 6,348 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| 0 | 210 | 300 | 300 |
| 1941 | 260 | 225 | 320 |
| 1946 | 261 | 320 | 320 |
| 1989 | 226 | 325 | 525 |
| 1995 | 238 | 175 | 175 |
| 1996 | 206 | 352 | 500 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 535 | 560 | 565 | 547 | 521 | 496 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 535 | 0 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 535 | 0 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 560 | 565 | 547 | 521 | 496 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 41 | 56 | 48 | 38 | 34 | 32 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2015 | | | 428 | 385 | 346 | 312 | 280 |
| Well #2 *** | 2015 | | | 428 | 385 | 346 | 312 | 280 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-28: City of Muleshoe Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Bailey | Brazos | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 100--120 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 10.98 | feet |
| Average Annual Water Level Decline. | 1.10 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 169,509 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 9,674 | acft |
| Quantity of Water Remaining in 2005. | 159,835 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1969 | 214 | 200 | 200 |
| 1969 | 191 | 100 | 100 |
| 1969 | 200 | 125 | 125 |
| 1969 | 200 | 190 | 190 |
| 1969 | 200 | 230 | 230 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1970 | 201 | 350 | 350 |
| 1970 | 200 | 250 | 250 |
| 1970 | 200 | 320 | 320 |
| 1970 | 211 | 290 | 290 |
| 1975 | 227 | 100 | 250 |
| 1975 | 226 | 80 | 400 |
| 1982 | 215 | 80 | 80 |
| 1982 | 203 | 190 | 190 |
| 1983 | 210 | 80 | 120 |
| 1989 | 200 | 200 | 200 |
| 2002 | 220 | 220 | 300 |
| 2004 | 200 | 390 | 352 |
| 2005 | 233 | 450 | 390 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| **Projected Total Municipal Water Supply** | | | 1,027 | 1,082 | 1,109 | 1,137 | 1,135 | 1,114 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 79 | 81 | 67 | 51 | 44 | 44 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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| Table J-29: City of New Deal Water Supply and Aquifer Information | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Location | | Years | | | | | |
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 149 | 165 | 173 | 173 | 178 | 173 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 20--100 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 4.87 | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | 0.49 | feet | 1990 | 314 | 50 | 50 |
| | | | | | 1990 | 312 | 50 | 130 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 1,781 | acft | 1991 | 320 | 50 | 140 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 1,259 | acft | 1995 | 322 | 185 | 200 |
| Quantity of Water Remaining in 2005. | | | 522 | acft | 1995 | 319 | 100 | 125 |
| | **Date Needed** | **Date Added** | **2010 (acft)** | **2020 (acft)** | **2030 (acft)** | **2040 (acft)** | **2050 (acft)** | **2060 (acft)** |
| **Projected Municipal Water Demand** | | | 149 | 165 | 173 | 173 | 173 | 173 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 153 | 153 | 153 | 153 | 153 | 153 |
| **Projected Total Municipal Water Supply** | | | 153 | 153 | 153 | 153 | 153 | 153 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 12 | 20 | 20 | 20 | 20 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2011 | | | 193 | 174 | 157 | 141 | 127 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

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| Table J-30: City of O'Donnell Water Supply and Aquifer Information | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Location** | | **Years** | | | | | | |
| | **County** | **River Basin** | **2010 (acft)** | **2020 (acft)** | **2030 (acft)** | **2040 (acft)** | **2050 (acft)** | **2060 (acft)** | |
| **Projected Municipal Water Demand** | | | | | | | | | |
| | Dawson | Brazos | 17 | 17 | 17 | 17 | 17 | 16 | |
| | Lynn | Brazos | 144 | 146 | 142 | 138 | 130 | 121 | |
| **Total** | | | 161 | 163 | 159 | 155 | 147 | 137 | |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | | |
| | **CRMWA** | | | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 40 -- 60 | feet | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 1.82 | feet | NA | 65 | 75 | 75 | |
| Average Annual Water Level Decline. | | | 0.18 | feet | NA | 70 | 75 | 75 | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 5,187 | acft | | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 1,430 | acft | | | | | |
| Quantity of Water Remaining in 2005. | | | 3,757 | acft | | | | | |
| | **Date Needed** | **Date Added** | **2010 (acft)** | **2020 (acft)** | **2030 (acft)** | **2040 (acft)** | **2050 (acft)** | **2060 (acft)** | |
| **Projected Municipal Water Demand** | | | 161 | 163 | 159 | 155 | 147 | 137 | |
| **Projected Municipal Water Supply** | | | | | | | | | |
| **Existing Municipal Water Supply** | | | 322 | 322 | 322 | 322 | 292 | 292 | |
| **Projected Total Municipal Water Supply** | | | 322 | 322 | 322 | 322 | 292 | 292 | |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 | |
| **Water Management Strategies** | | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J 31: City of Olton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lamb | Brazos | 492 | 512 | 532 | 542 | 536 | 529 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 100--120 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 26.00 | feet |
| Average Annual Water Level Decline. | 2.60 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 13,435 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,777 | acft |
| Quantity of Water Remaining in 2005. | 8,658 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| 0 | 280 | 90 | 200 |
| 1963 | 330 | 140 | 230 |
| 1978 | 340 | 160 | 300 |
| 1986 | 324 | 1,330 | 300 |
| 2005 | 320 | 170 | 300 |
| 2005 | 320 | 170 | 300 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 492 | 512 | 532 | 542 | 536 | 529 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 492 | 512 | 532 | 542 | 536 | 529 |
| New Well # 1*** Implemented | 2021 | 2005 | 410 | 369 | 332 | 299 | 270 | 244 |
| New Well # 2*** Implemented | 2025 | 2005 | 428 | 385 | 346 | 312 | 282 | 255 |
| **Projected Total Municipal Water Supply** | | | 1,329 | 1,265 | 1,210 | 1,152 | 1,088 | 1,028 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 27 | 17 | 12 | 3 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2001 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need after implementation of Wells #1and #2.

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**Table J-32: City of Petersburg Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hale | Brazos | 289 | 304 | 313 | 316 | 312 | 306 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 120--180 | feet | 1958 | 420 | 300 | 300 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 17.54 | feet | 1965 | 380 | 300 | 200 |
| Average Annual Water Level Decline. | 1.75 | feet | 1997 | 425 | 400 | 275 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 17,858 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,434 | acft | | | | |
| Quantity of Water Remaining in 2005. | 15,424 | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 289 | 304 | 313 | 316 | 312 | 306 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 289 | 304 | 313 | 316 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 289 | 304 | 313 | 316 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 312 | 306 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 21 | 24 | 20 | 16 | 14 | 14 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2041 | | | | | | 410 | 369 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

<><><>

**Table J-33: City of Plains Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | Yoakum | Colorado | 416 | 448 | 468 | 488 | 473 | 457 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 40 -- 60 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006.** | | | NA | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | NA | feet | 0 | 130 | 100 | 100 |
| | | | | | 1971 | 198 | 170 | 180 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 9,278 | acft | 1971 | 196 | 90 | 120 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 3,430 | acft | 1995 | 190 | 250 | 500 |
| Quantity of Water Remaining in 2005. | | | 5,848 | acft | 1998 | 140 | 490 | 1,000 |
| | | | | | 1998 | 134 | 385 | 1,000 |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 416 | 448 | 468 | 488 | 473 | 457 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 416 | 0 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 416 | 0 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 448 | 468 | 488 | 473 | 457 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 33 | 68 | 106 | 107 | 102 | 98 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2012 | | | 414 | 373 | 335 | 302 | 272 |
| Well #2 *** | 2016 | | | 204 | 184 | 165 | 149 | 134 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** Not Available.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

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**Table J-34: City of Plainview Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hale | Brazos | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | NA | feet |
| Average Annual Water Level Decline. | NA | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 43,164 | acft |
| Quantity of Water Remaining in 2005. | NA | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1953 | 322 | 290 | NA |
| 1959 | 315 | 770 | 750 |
| 1961 | 313 | 120 | NA |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1963 | 330 | 480 | NA |
| 1965 | 330 | 620 | 800 |
| 1965 | 336 | 710 | 900 |
| 1968 | 344 | 550 | 800 |
| 1968 | 281 | 470 | 800 |
| 1968 | 299 | 520 | 535 |
| 1968 | 298 | 700 | 650 |
| 1982 | 314 | 500 | 850 |
| 1983 | 368 | 670 | 1,000 |
| 2001 | 353 | 720 | 600 |
| 2007 | 290 | 560 | 560 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 4,288 | 4,490 | 4,605 | 4,635 | 4,577 | 4,488 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 15,002 | 13,977 | 13,050 | 12,211 | 11,053 | 10,367 |
| New Well # 1*** Implemented | 2010 | 2001 | 500 | 450 | 405 | 365 | 328 | 295 |
| New Well # 2*** Implemented | 2010 | 2007 | 500 | 450 | 405 | 365 | 328 | 295 |
| **Projected Total Municipal Water Supply** | | | 16,002 | 14,877 | 13,860 | 12,940 | 11,709 | 10,957 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #3 **** | 2010 | | 500 | 450 | 405 | 365 | 328 | 295 |
| Well # 4 **** | 2010 | | 500 | 450 | 405 | 365 | 328 | 295 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2001 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1and #2.

<><><>

**Table J-35: City of Post Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Garza | Brazos | 631 | 642 | 616 | 579 | 549 | 512 |
| **Projected Municipal Water Supply** | **White River MWD** | | | | | | | |
| | **CRMWA via Slaton** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|---|---|
| Saturated Thickness -- 1995: | | | NA | feet | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Decline in Water Level 1996 -- 2006: | | | NA | feet | | | | |
| Average Annual Water Level Decline. | | | NA | feet | | | | |
| | | | | | **Sources** | White River MWD | | |
| Quantity of Water in Storage in 1995: | | | NA | acft | | CRMWA/via Slaton | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 5,913 | acft | | | | |
| Quantity of Water Remaining in 2005. | | | NA | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 631 | 642 | 616 | 579 | 549 | 512 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 1,327 | 1,279 | 799 | 318 | 306 | 306 |
| **CRMWA via Slaton** | | 2,007 | ???? | | | | | |
| **Projected Total Municipal Water Supply** | | | | | | | | |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 261 | 243 | 206 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | | | | | | | | |
| Well #2 *** | | | | | | | | |
| Well #3 *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

<><><>

**Table J-36: City of Ralls Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Crosby | Brazos | 304 | 315 | 322 | 325 | 323 | 318 |
| **Projected Municipal Water Supply** | **White River MWD** | | | | | | | |

| Aquifer Data in Vicinity of Wells | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 80--100 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 1.75 | feet |
| Average Annual Water Level Decline. | 0.17 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 10,380 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,948 | acft |
| Quantity of Water Remaining in 2005. | 7,432 | acft |

| Existing Wells * | | | |
|---|---|---|---|
| Date Drilled | Depths feet | Tested GPM | Rated GPM |
| **Source:** White River MWD | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 304 | 315 | 322 | 325 | 323 | 318 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 318 | 318 | 318 | 318 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 318 | 318 | 318 | 318 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 4 | 7 | 323 | 318 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | | | | | | | | |
| Well #2 *** | | | | | | | | |
| Well #3 *** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

<><><>

**Table J-37: City of Ransom Canyon Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 440 | 569 | 698 | 825 | 953 | 1,004 |
| **Projected Municipal Water Supply** | **Lubbock** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet | | | | |
| Decline in Water Level 1996 -- 2006: | NA | feet | | | | |
| Average Annual Water Level Decline. | NA | feet | | | | |
| | | | **Source:** | Lubbock | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 1,322 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,699 | acft | | | | |
| Quantity of Water Remaining in 2005. | NA | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 440 | 569 | 698 | 825 | 953 | 1,004 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 440 | 569 | 698 | 825 | 953 | 1,004 |
| **Projected Total Municipal Water Supply** | | | 440 | 569 | 698 | 825 | 953 | 1,004 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 35 | 90 | 162 | 248 | 325 | 342 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

<><><>

**Table J-38: City of Ropesville Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hockley | Brazos | 89 | 91 | 91 | 89 | 85 | 81 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| Aquifer Data in Vicinity of Wells | | | Existing Wells * | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | 1969 | 213 | 140 | 140 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 5.27 | feet | 1969 | 205 | 160 | 160 |
| Average Annual Water Level Decline. | 0.53 | feet | | | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 2,487 | acft | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | NA | acft | | | | |
| Quantity of Water Remaining in 2005. | NA | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 89 | 91 | 91 | 89 | 85 | 81 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 89 | 91 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 89 | 91 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 91 | 89 | 85 | 81 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2021 | | | | 193 | 174 | 157 | 141 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

<><><>

**Table J-39: City of Seagraves Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Gaines | Colorado | 449 | 482 | 502 | 513 | 506 | 499 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| Aquifer Data in Vicinity of Wells | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | NA | feet |
| Average Annual Water Level Decline. | NA | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 7,422 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,490 | acft |
| Quantity of Water Remaining in 2005. | 2,932 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1900 | 185 | 35 | NA |
| 1900 | 185 | 65 | NA |
| 1949 | 168 | 150 | 270 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1953 | 160 | 40 | 260 |
| 1956 | 160 | 150 | 220 |
| 1966 | 160 | 150 | 260 |
| 1975 | 170 | 125 | 150 |
| 1978 | 155 | 150 | 260 |
| 2000 | 181 | 50 | 50 |
| 2000 | 180 | 150 | 150 |
| 2002 | 165 | 50 | 50 |
| 2004 | 165 | 150 | NA |
| 2004 | 165 | 150 | NA |
| 2006 | 185 | 0 | 165 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 449 | 482 | 502 | 513 | 506 | 499 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2006 | 2004 | 432 | 389 | 350 | 315 | 283 | 255 |
| New Well # 2*** Implemented | 2010 | 2004 | 213 | 191 | 172 | 155 | 139 | 125 |
| New Well # 3*** Implemented | 2019 | 2006 | | 210 | 189 | 170 | 153 | 138 |
| **Projected Total Municipal Water Supply** | | | 645 | 790 | 711 | 640 | 576 | 519 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2001 Regional Water Plan

NA means not available.

[1] Value represents total municipal need after implementation of Wells #1, #2, and #3.

<><><>

**Table J-40: City of Seminole Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Gaines | Colorado | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | NA | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | NA | feet |
| Average Annual Water Level Decline. | NA | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 18,588 | acft |
| Quantity of Water Remaining in 2005. | NA | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| NA | 190 | NA | 200 |
| NA | 216 | NA | 150 |
| NA | 243 | 200 | 500 |
| NA | 234 | 250 | 200 |
| 1955 | 185 | NA | 300 |
| 1956 | 184 | NA | 100 |
| 1959 | 197 | NA | 200 |
| 1959 | 210 | NA | 600 |
| 1964 | 282 | NA | 420 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1964 | 214 | NA | 200 |
| 1970 | 252 | NA | 400 |
| 1975 | 246 | NA | 400 |
| 1988 | 253 | NA | 250 |
| 1988 | 253 | NA | 500 |
| 1995 | 250 | NA | 225 |
| 1995 | 260 | NA | 225 |
| 1995 | 251 | NA | 225 |
| 2002 | 225 | 206 | 206 |
| 2003 | 215 | NA | 250 |
| 2004 | 205 | NA | 400 |
| 2004 | 240 | NA | 100 |
| 2005 | 202 | NA | 125 |
| 2005 | 190 | NA | 100 |
| 2005 | 202 | NA | 500 |
| 2006 | 205 | NA | 500 |
| 2006 | 240 | NA | 150 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | ????? | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| **Projected Total Municipal Water Supply** | | | 2,214 | 2,401 | 2,525 | 2,605 | 2,579 | 2,544 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | ??????? | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 178 | 384 | 588 | 778 | 938 | 1,035 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | | ?????? | | | | | | |
| Well #2 *** | | ?????? | | | | | | |
| Well #3 *** | | ?????? | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-41: City of Shallowater Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 344 | 367 | 377 | 371 | 379 | 371 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | NA | 145 | 100 | 150 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 3.50 | feet | 1974 | 160 | 150 | 375 |
| Average Annual Water Level Decline. | 0.35 | feet | 1975 | 130 | 90 | 150 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 3,204 | acft | 1982 | 143 | 50 | 150 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 3,349 | acft | 1982 | 145 | 140 | 150 |
| Quantity of Water Remaining in 2005. | 0 | acft | 1982 | 148 | 100 | 150 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 344 | 367 | 377 | 371 | 379 | 371 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 187 | 187 | 187 | 187 | 187 | 187 |
| **Projected Total Municipal Water Supply** | | | 187 | 187 | 187 | 187 | 187 | 187 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 157 | 180 | 190 | 184 | 192 | 184 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2006 | | 432 | 389 | 350 | 315 | 283 | 255 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-42: City of Silverton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Briscoe | Red | 128 | 128 | 123 | 115 | 111 | 108 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **Mackenzie MWA** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | | | | |
| Decline in Water Level 1996 -- 2006.** | NA | feet | | | | |
| Average Annual Water Level Decline. | NA | feet | 0 | 220 | 35 | 35 |
| | | | 0 | 220 | 35 | 35 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 5,958 | acft | 1995 | 218 | 155 | 155 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 1,132 | acft | 1995 | 231 | 80 | 80 |
| Quantity of Water Remaining in 2005. | 4,826 | acft | 1997 | 225 | 50 | 200 |
| | | | 2005 | 323 | NA | 32 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 128 | 128 | 123 | 115 | 111 | 108 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | | | | | | |
| New Well # 1*** Implemented | 2006 | 2005 | 204 | 183 | 165 | 148 | 134 | 120 |
| **Projected Total Municipal Water Supply** | | | 204 | 183 | 165 | 148 | 134 | 120 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** Not Available.

*** Implemented from 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need after implementation of Well #1.

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**Table J-43: City of Slaton Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 907 | 889 | 870 | 849 | 837 | 836 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 40--160 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 7.80 | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | 0.78 | feet | | | | |
| | | | | | 22 wells | off-line | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 16,298 | acft | Source: | CRMWA | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 8,157 | acft | | | | |
| Quantity of Water Remaining in 2005. | | | 8,141 | acft | | | | |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 907 | 889 | 870 | 849 | 837 | 836 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | CRMWA | 306 acft/y | 1,063 | 1,063 | 1,063 | 1,063 | 583 | 583 |
| **Projected Total Municipal Water Supply** | adjusted | to Post | 1,063 | 1,063 | 1,063 | 1,063 | 583 | 583 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 254 | 253 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

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**Table J-44: City of Smyer Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | River | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| | County | Basin | (acft) | (acft) | (acft) | (acft) | (acft) | (acft) |
| **Projected Municipal Water Demand** | Hockley | Brazos | 69 | 70 | 70 | 68 | 65 | 62 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 40 -- 40 | feet | **Date** | **Depths** | **Tested** | **Rated** |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | | | 3.72 | feet | **Drilled** | **feet** | **GPM** | **GPM** |
| Average Annual Water Level Decline. | | | 0.37 | feet | 1964 | 137 | 50 | 50 |
| | | | | | 1970 | 148 | 50 | 85 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 3,467 | acft | 1978 | 133 | 60 | 70 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | NA | acft | 2003 | 119 | 60 | NA |
| Quantity of Water Remaining in 2005. | | | NA | acft | | | | |
| | **Date** | **Date** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| | **Needed** | **Added** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** | **(acft)** |
| **Projected Municipal Water Demand** | | | 69 | 70 | 70 | 68 | 65 | 62 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 69 | 70 | 70 | 68 | 65 | 0 |
| **Projected Total Municipal Water Supply** | | | 69 | 70 | 70 | 68 | 65 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 62 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2051 | | | | | | | 193 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Needed for 2011 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need.

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**Table J-45: City of Spur Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Dickens | Brazos | 271 | 267 | 263 | 260 | 257 | 257 |
| **Projected Municipal Water Supply** | **White** | **River** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995. | NA | feet | | | | | |
| Decline in Water Level 1996 -- 2006.** | NA | feet | | | | | |
| Average Annual Water Level Decline. | NA | feet | | | | | |
| | | | | **Source:** White River MWD | | | |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | NA | acft | | | | | |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,894 | acft | | | | | |
| Quantity of Water Remaining in 2005. | NA | acft | | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 271 | 267 | 263 | 260 | 257 | 257 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 271 | 267 | 263 | 260 | 106 | 0 |
| **Projected Total Municipal Water Supply** | | | 271 | 267 | 263 | 260 | 106 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 151 | 257 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 21 | 42 | 54 | 50 | 48 | 48 |
| **New Water Supplies Needed (acft/yr)** | | ??????? | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** Not Available.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-46: City of Sudan Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lamb | Brazos | 226 | 236 | 244 | 249 | 246 | 243 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 20 -- 40 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 1.64 | feet | | | | |
| Average Annual Water Level Decline. | 0.16 | feet | 1959 | 220 | 75 | 75 |
| | | | 1979 | 226 | 200 | 300 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 4,820 | acft | 1990 | 204 | 65 | 35 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 2,169 | acft | 1994 | 202 | 150 | 175 |
| Quantity of Water Remaining in 2005. | 2,651 | acft | 2003 | 218 | 100 | 87 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 226 | 236 | 244 | 249 | 246 | 243 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 226 | 0 | 0 | 0 | 0 | 0 |
| New Well # 1*** Implemented | 2016 | 2003 | | 432 | 389 | 350 | 315 | 283 |
| **Projected Total Municipal Water Supply** | | | 226 | 432 | 389 | 350 | 315 | 283 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 15 | 12 | 8 | 4 | 3 | 3 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.

** The Cross Section, High Plains Underground Water Conservation District, April 2006.

*** Implemented from 2001 Regional Water Plan.

NA means not available.

[1] Value represents total municipal need after implementation of Well #1.

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**Table J-47: City of Sundown Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Hockley | Colorado | 341 | 350 | 353 | 347 | 332 | 316 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet | 1941 | 225 | 155 | 180 |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 1.33 | feet | 1941 | 225 | 125 | 150 |
| Average Annual Water Level Decline. | 0.13 | feet | 1954 | 216 | 500 | 377 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 6,654 | acft | 1973 | 207 | 500 | 204 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 3,293 | acft | 1976 | 211 | 165 | 185 |
| Quantity of Water Remaining in 2005. | 3,361 | acft | 1976 | 203 | 160 | 150 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 341 | 350 | 353 | 347 | 332 | 316 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 341 | 0 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 341 | 0 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 350 | 353 | 347 | 332 | 316 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 24 | 25 | 19 | 14 | 11 | 11 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2016 | | | 204 | 184 | 165 | 149 | 134 |
| Well #2 *** | 2018 | | | 208 | 187 | 169 | 152 | 137 |
| Well #3 *** | 2023 | | | | 198 | 178 | 160 | 144 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-48: City of Tahoka Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lynn | Brazos | 492 | 504 | 490 | 478 | 453 | 421 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **CRMWA** | | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|
| | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | 60 -- 80 | feet | | | | |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 2.82 | feet | | | | |
| Average Annual Water Level Decline. | 0.28 | feet | 0 | 80 | 100 | 100 |
| | | | 0 | 116 | 125 | 125 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 13,528 | acft | 0 | 90 | 100 | 100 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,794 | acft | 1946 | 80 | 100 | NA |
| Quantity of Water Remaining in 2005. | 8,734 | acft | 2004 | 122 | 150 | 150 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 492 | 504 | 490 | 478 | 453 | 421 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 534 | 534 | 534 | 534 | 460 | 460 |
| **Projected Total Municipal Water Supply** | | | 534 | 534 | 534 | 534 | 460 | 460 |
| **Projected Municipal Water Need (acft/yr)**[1] | D-S | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-49: City of Tulia Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Swisher | Red | 1,050 | 1,065 | 1,072 | 1,064 | 1,038 | 993 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |
| | **Dockum** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | | | | **Existing Wells *** | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| Saturated Thickness -- 1995: HPUWCD analysis. | | | 40 -- 60 | feet | 1965 | 185 | 250 | 250 |
| Decline in Water Level 1996 -- 2006.** | | | NA | feet | 1965 | 186 | 250 | 250 |
| Average Annual Water Level Decline. | | | NA | feet | 1967 | 825 | 1,150 | 1,100 |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | | | 16,191 | acft | 1973 | 860 | 625 | 625 |
| Quantity of Water Used 1995-2004: Reported to TWDB. | | | 9,634 | acft | 1978 | 800 | 425 | 400 |
| Quantity of Water Remaining in 2005. | | | 6,557 | acft | | | | |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 1,050 | 1,065 | 1,072 | 1,064 | 1,038 | 993 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 663 | 648 | 655 | 647 | 621 | 576 |
| **Projected Total Municipal Water Supply** | | | 663 | 648 | 655 | 647 | 621 | 576 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 417 | 417 | 417 | 417 | 417 | 417 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 18 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2006 | | 432 | 389 | 350 | 315 | 283 | 255 |
| Well #2 *** | 2006 | | 432 | 389 | 350 | 315 | 283 | 255 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.

** Not Available.

*** Needed for 2011 Regional Water Plan.

NA means not available.

1 Value represents total municipal need.

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**Table J-50: City of Wilson Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lynn | Brazos | 67 | 68 | 65 | 63 | 60 | 55 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 20 -- 40 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 4.13 | feet |
| Average Annual Water Level Decline. | 0.41 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 1,668 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 634 | acft |
| Quantity of Water Remaining in 2005. | 1,034 | acft |

| **Existing Wells *** | | | |
|---|---|---|---|
| **Date Drilled** | **Depths feet** | **Tested GPM** | **Rated GPM** |
| NA | 120 | 40 | 40 |
| 1980 | 116 | 40 | 40 |
| 1980 | 110 | 44 | 50 |
| 1982 | 108 | 28 | 40 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 67 | 68 | 65 | 63 | 60 | 55 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 67 | 0 | 0 | 0 | 0 | 0 |
| **Projected Total Municipal Water Supply** | | | 67 | 0 | 0 | 0 | 0 | 0 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 68 | 65 | 63 | 60 | 55 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #1*** | 2011 | | | 193 | 174 | 157 | 141 | 127 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2007.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need.

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**Table J-51: City of Wolfforth Water Supply and Aquifer Information**

| | Location | | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | County | River Basin | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
| **Projected Municipal Water Demand** | Lubbock | Brazos | 1,468 | 1,758 | 1,822 | 1,884 | 1,962 | 2,006 |
| **Projected Municipal Water Supply** | **Ogallala** | **Aquifer** | | | | | | |

| **Aquifer Data in Vicinity of Wells** | | |
|---|---|---|
| Saturated Thickness -- 1995: HPUWCD analysis. | 40 -- 60 | feet |
| Decline in Water Level 1996 -- 2006: HPUWCD measurements.** | 6.49 | feet |
| Average Annual Water Level Decline. | 0.65 | feet |
| Quantity of Water in Storage in 1995: HPUWCD analysis. | 8,681 | acft |
| Quantity of Water Used 1995-2004: Reported to TWDB. | 4,083 | acft |
| Quantity of Water Remaining in 2005. | 4,598 | acft |

**Existing Wells ***

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| NA | 200 | 150 | 130 |
| NA | 200 | 60 | 30 |
| 1956 | 200 | 200 | 150 |

**Existing Wells * continued**

| Date Drilled | Depths feet | Tested GPM | Rated GPM |
|---|---|---|---|
| 1963 | 200 | 30 | 60 |
| 1963 | 200 | 150 | 125 |
| 1965 | 200 | 90 | 70 |
| 1974 | 200 | 90 | 70 |
| 1976 | 203 | 0 | 90 |
| 1983 | 200 | 100 | 60 |
| 1985 | 200 | 50 | 50 |
| 1985 | 200 | 20 | 20 |
| 2004 | 200 | 75 | 75 |
| 2007 | 209 | 200 | 300 |
| 2007 | 200 | 200 | 250 |
| 2007 | 198 | 200 | 250 |

| | Date Needed | Date Added | 2010 (acft) | 2020 (acft) | 2030 (acft) | 2040 (acft) | 2050 (acft) | 2060 (acft) |
|---|---|---|---|---|---|---|---|---|
| **Projected Municipal Water Demand** | | | 1,468 | 1,758 | 1,822 | 1,884 | 1,962 | 2,006 |
| **Projected Municipal Water Supply** | | | | | | | | |
| **Existing Municipal Water Supply** | | | 371 | 334 | 300 | 270 | 243 | 219 |
| New Well # 1*** Implemented | 2007 | 2007 | 1,164 | 1,048 | 943 | 849 | 764 | 687 |
| New Well # 2*** Implemented | 2011 | 2007 | | 193 | 174 | 157 | 141 | 127 |
| New Well # 3*** Implemented | 2019 | 2007 | | 891 | 802 | 722 | 650 | 585 |
| **Projected Total Municipal Water Supply** | | | 1,535 | 2,466 | 2,219 | 1,997 | 1,797 | 1,618 |
| **Projected Municipal Water Need (acft/yr)[1]** | D-S | | 0 | 0 | 0 | 0 | 165 | 388 |
| **Water Management Strategies** | | | | | | | | |
| **Water Conservation Water Management Strategy** | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **New Water Supplies Needed (acft/yr)** | | | | | | | | |
| Well #4**** | 2047 | | | | | | 437 | 393 |

* Texas Commission on Environmental Quality; Water System Data Sheets, 2008.
** The Cross Section, High Plains Underground Water Conservation District, April 2006.
*** Implemented from 2006 Regional Water Plan.
**** Needed for 2011 Regional Water Plan.
NA means not available.
[1] Value represents total municipal need after implementation of Wells #1, #2, and # 3.

<><><>

# Appendix K

## Water Supply Estimation
## for
## Water Management Strategy
## for
## Confined Animal Feeding Enterprises
## for
## Bailey, Castro, Deaf Smith, Hale, Lamb, and Parmer Counties

**Purpose:** The development of the CAFO water management strategy consisted of identifying those CAFOs that are projected to experience a water need (shortage) during the 2010 through 2060 planning period and developing a potential water management strategy to meet the projected need using groundwater from the Ogallala Aquifer within the county where the shortage is projected to occur.

**Methods**: The initial approach in determining which, if any, of the CAFOs would be expected to experience a water shortage was to utilize the Groundwater Availability Model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico. The intent was to use this model, called the E-T (HP) GAM, to simulate projected 2000-2060 groundwater pumpage and recharge to provide information on areas where the saturated thickness could not producing wells.[1] It was intended to use a comparison of the model's saturated thickness map with a map showing the locations of the CAFOs in order to identify water supplies for individual CAFOs for the purpose of estimating whether or not supplies at the respective locations would be adequate to meet projected water needs. However, a review of the model's calibration shows dry cells underlying large areas of Bailey, Parmer and Deaf Smith Counties; i.e.; the model calculated groundwater levels below the base of the aquifer. Since these results are inconsistent with the knowledge that few, if any, wells used by CAFOs in these counties were dry in 2009, the planned approach could not be used, and an alternative approach, as described below, was selected.

The selected alternative approach in determining which CAFOs, if any, would be expected to experience a shortage and when it would occur is based upon an analysis of historical and trends in groundwater levels and saturated thickness of the Ogallala at each CAFO.

[1] "Groundwater Availability Model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico," Blanford, T. Neil, P.G. Muthu Kuchanur, PhD, Allan Standen, P.G., Robert Ruggiero, P.G., Kenneth C. Calhoun, Paul Kirby, and Gopika Sha, Daniel B. Stephens & Assocoates, Inc. Texas Water Development Board, Austin, Texas, December 2008.

The primary data and information used included maps of the base of the Ogallala aquifer and recent measurements of groundwater levels in monitoring wells of Bailey, Castro, Deaf Smith, Hale, Lamb, and Parmer Counties where CAFOs are located. The steps included:

a. estimating the base of the Ogallala aquifer, the 1995 water level and 1995 saturated thickness of the aquifer at each CAFO location (available aquifer saturated thickness maps for these counties were prepared based upon 1995 water levels and is the beginning point for projecting future water levels and quantities of water in storage);[2]
b. compiling measured groundwater levels for each long-term monitor well in the six counties for the period 1990- 2009;
c. calculating the recent (1998-2009) trend in groundwater levels at each of the monitor wells in the vicinity of each CAFO;
d. calculating an adjustment to the 1998-2009 trend for use in projecting water levels from 2009-2060 (As water levels and saturation thicknesses decline, it is projected that well yields and quantities pumped will also decline, resulting in a slowing of the declining trends in water levels at the monitor wells. The adjustment factor selected for use here is to level out projected declining trends to result in projected saturated thickness in 50 years that is 50 percent of estimated saturated thickness in 2010.);
e. estimating the groundwater level trend at each CAFO that considers the historical trend and the adjustment for declining water levels described in item d, above;
f. calculating the projected groundwater level at each CAFO for each decade from 2010 through 2060 by using the estimated 1995 water levels and trends in groundwater level declines;
g. calculating the saturated thickness at each CAFO for each decade from 2010 through 2060 using the projected groundwater levels and the estimated base of the aquifer elevations at the CAFOs; and
h. determining if a moderate to high capacity well could continue to operate during each decade on the basis of saturated thickness.

A study of groundwater level hydrographs for the long-term monitor wells in the 6 county area indicates that the period 1998-2009 provides representative estimates of the recent trend in groundwater levels. An example of a 1998-2009 groundwater level hydrograph and trend for a monitor well in Castro County is shown in Figure K-1.

[2] McReynolds, D., 1996, Hydrologic Atlas for (Bailey, Castro, Deaf Smith, Hale, Lamb, and Parmer) Counties, Texas, High Plains Underground Water Conservation District No. 1.

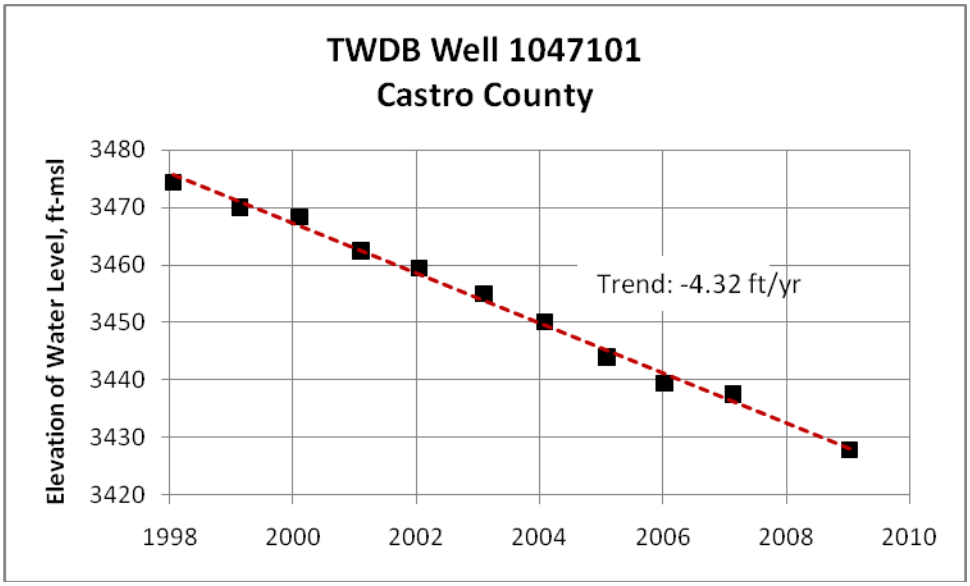



**Figure K-1: Groundwater Hydrograph—Castro County**

The procedure selected for estimating the declining trend in quantities of groundwater in storage in the 6 county area is based on the condition that future trends of groundwater levels in observation wells will be highly correlated with quantities of water withdrawn; i.e.; as water is withdrawn and water levels decline, for this analysis, the trends in quantities of groundwater in storage will follow the fixed percent depletion of storage each year with "50 percent of current saturated thickness remaining in 50 years." This results in a fixed annual depletion rate of 1.375 percent per year. During the early years, the quantity of depletion is greater than in the later years because of the difference in the volume of water in storage. For example, if a county has 4,000,000 acft of groundwater in storage in 2010, the depletion would be 55,000 acft; and with a remaining 2,000,000 acft in storage in 2060, the depletion would be 27,500 acft. With the assumption that groundwater level trends will follow the trend in groundwater storage, a water level declining at a rate of 4.0 ft/yr in 2010 will decline at a rate of 2.0 ft/yr in 2060. This assumption implies that groundwater pumping will decline in proportion to the amount of groundwater in storage. The fraction of the remaining water in storage within a county during this period and at the end of each decade is shown in Figure K-2. For purposes of this analysis, the historical trend computed for 1998-2009 was used for 1995-2010.

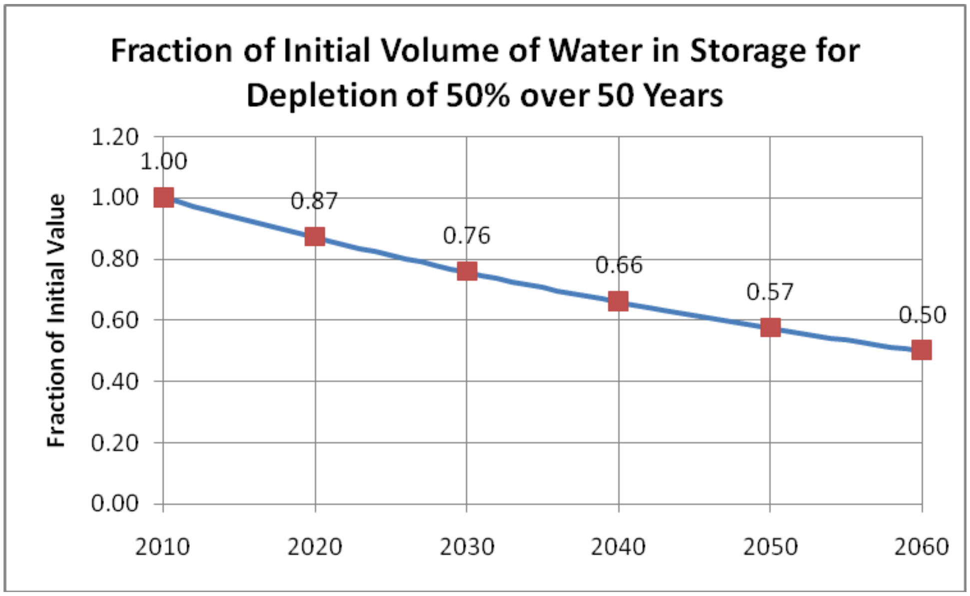



**Figure K-2: Fraction of Water in Storage in 50 Years**

After the trend in groundwater levels at long-term monitor wells near each CAFO was estimated, the selected approach in evaluating the potential shortage of a water supply at each CAFO was to: (1) estimate the trend of groundwater levels at the CAFO from nearby monitor wells, (2) use maps provided in Hydrologic Atlases[3] for each of the counties to estimate the (a) 1995 groundwater level and (b) base of the aquifer values, (3) calculate the saturated thickness by using the 1995 groundwater levels, trends in groundwater levels and base of the aquifer at the end of each decade, beginning in 2010, (4) assume a water shortage would exist if the saturated thickness became less than 10 ft. An example of the calculated groundwater level trend and the saturated thickness of the Ogallala Aquifer at representative feedyard in Castro County is shown in Figure K-3. This analysis shows that this feedyard would have a water shortage by 2030.

[3] Ibid.

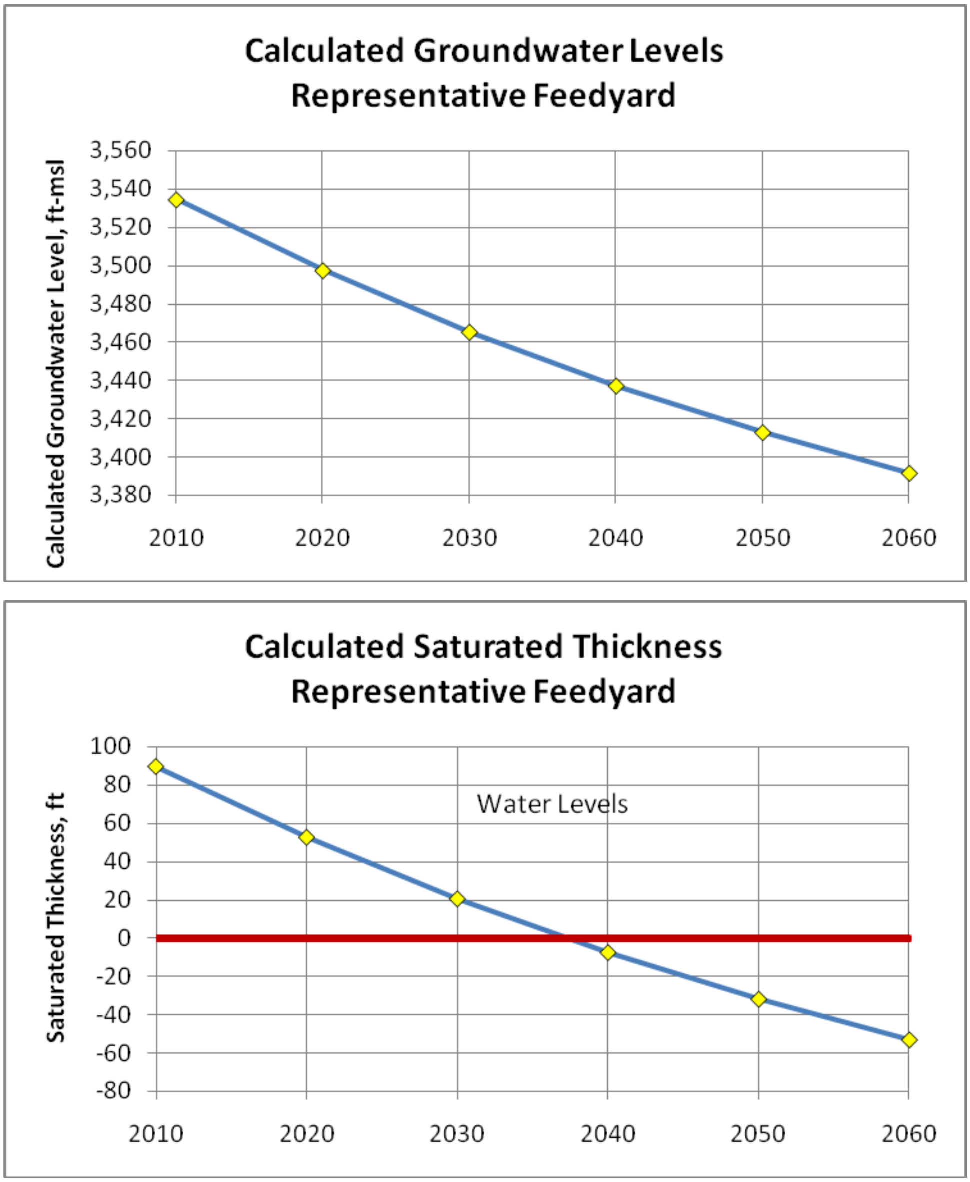



**Figure K-3: Calculated Groundwater Levels and Saturated Thickness—Representative Feedyard.**

# Appendix L

## Water Supply Estimation
## for
## Water Management Strategy
## for
## Canadian River Municipal Water Authority
## Llano Estacado Water Planning Region
## CRMWA-Member Cities
## and
## Water Level Trends in Observation Wells near
## CRMWA-Member Cities
## Hale, Hockley, Lubbock, Lynn,
## Terry, and Dawson
## Counties

**Purpose:** The development of the CRMWA Water Management Strategy consisted of identifying and evaluating potential water management strategies using groundwater from the Ogallala aquifer located in Region O for CRMWA-member cities of Region O (Plainview, Brownfield, Lamesa, Levelland, O'Donnell, Slaton, and Tahoka) that are presently being supplied from the CRMWA pipeline sources (Lake Meredith and Roberts County groundwater). The projected water demands of the member cities for which this water management strategy is a potential supply source are approximately 4,700 acft/yr for Plainview north of Lubbock and approximately 11,000 acft/yr for the remaining members located west of Lubbock, and south of Lubbock (Table 4.4-68).

**Method:** The approach used to locate potential sources of water to meet the projected needs of the CRMWA-member cities of Region O was based upon an analysis of saturated thickness and historical trends in groundwater levels, using available aquifer saturated thickness maps and groundwater levels of the Ogallala aquifer near the CRMWA member cities (Appendix L).[1] The primary data and information used included maps of the base of the Ogallala aquifer and recent measurements of groundwater levels in monitoring wells of Dawson, Hale, Hockley, Lubbock, Lynn, and Terry Counties. The steps included:

a. estimating the base of the Ogallala aquifer, the 1995 water level and 1995 saturated thickness of the aquifer near each well field (available aquifer saturated thickness
maps for these counties were prepared based upon 1995 water levels and is the beginning point for projecting future water levels and quantities of water in storage);
b. compiling measured groundwater levels for each long-term monitoring well in the three counties for the period 1990 to 2009;
c. calculating the recent (1998-2009) trend in groundwater levels at each of the monitoring wells in the vicinity of each member city;
d. calculating an adjustment to the 1998 to 2009 trend for use in projecting water levels from 2009 to 2060 (As water levels and saturation thicknesses decline, it is projected that well yields and quantities pumped will also decline, resulting in a slowing of the declining trends in water levels at the monitor wells. The adjustment factor selected for use here is to level out projected

[1] McReynolds, D., 1996, Hydrologic Atlas for (Dawson, Hale, Hockley, Lubbock, Lynn, and Terry) Counties, Texas, High Plains Underground Water Conservation District No. 1.

declining trends to result in projected saturated thickness in 50 years that is 50 percent of estimated saturated thickness in 2010.);

e. estimating the groundwater level trend at each well field that considers the historical trend and the adjustment for declining water levels described in item d, above;

f. calculating the projected groundwater level at each well field for each decade from 2010 through 2060 by using the estimated 1995 water levels and trends in groundwater level declines;

g. calculating the saturated thickness at each well field for each decade from 2010 through 2060 using the projected groundwater levels and the estimated base of the aquifer elevations at the well fields; and

h. determining if a moderate to high capacity well could continue to operate during each decade on the basis of saturated thickness.

A study of groundwater level hydrographs for the long-term monitoring wells in the six-county area for the period 1998 to 2009 provides estimates of the recent trend in groundwater levels (See hydrographs at end of Appendix L). An example of a 1998 to 2009 groundwater level hydrograph and trend for a monitor well number 1152703 in Hale County shows that average annual water level decline at monitor well number 1152703 for the period 1998 through 2009 is about 2.96 feet per year (The slope of the water level curve for well number 1152703 is minus 2.963; Figure L-1). Of the nine

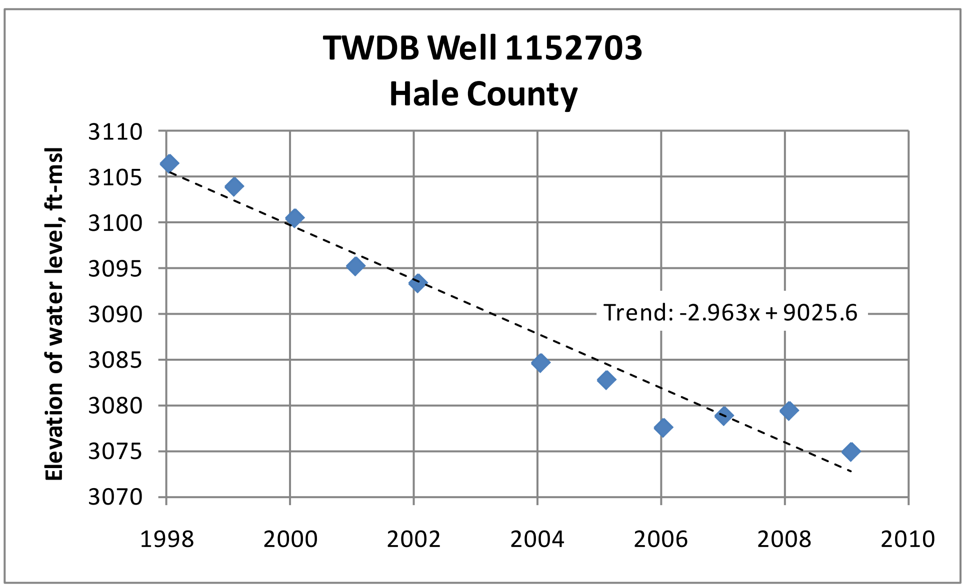



**Figure L-1: Groundwater Hydrograph for Hale County**

Hale County monitor wells considered for this analysis, the average annual water level decline for the period of 1998 through 2009 was calculated at 1.91 feet per year (See Hale County hydrographs near end of Appendix L).

In the case of Hockley County, water level measurements were obtained and graphed for four monitor wells. Average annual water level decline for these four wells was 0.50 feet per year for the 1998 through 2009 period (See Hockley County hydrographs near end of Appendix L). Average annual decline for four monitor wells in Lubbock County for the period 1998 through 2009 was calculated at 1.41 feet per year; average annual rise for five monitor wells in Lynn County for the 1998 through 2009 period was 0.45 feet per year (all the Lynn County monitor wells considered showed water level rises for the 1998—2009 period); average annual decline for three monitor wells in Terry County for the 1998 through 2009 period was 0.74 feet per year; while average annual decline for four monitor wells in Dawson County for the 1998 through 2009 period was 1.38 feet per year (See hydrographs near end of Appendix L).

The procedure selected for estimating the declining trend in quantities of groundwater in storage is based on the condition that future trends of groundwater levels in observation wells will be highly correlated with quantities of water withdrawn; i.e.; as water is withdrawn and water levels decline, for this analysis, the trends in quantities of groundwater in storage will follow the fixed percent depletion of storage each year with "50 percent of current storage remaining in 50 years." This results in a fixed annual depletion rate of 1.375 percent per year. During the early years, the quantity of depletion is greater than in the later years because of the difference in the volume of water in storage. For example, if a county has 4,000,000 acft of groundwater in storage in 2010, the depletion would be 55,000 acft; and with a remaining 2,000,000 acft in storage in 2060, the depletion would be 27,500 acft. With the assumption that groundwater level trends will follow the trend in groundwater storage, a water level declining at a rate of 4.0 ft/yr in 2010 will decline at a rate of 2.0 ft/yr in 2060. This assumption implies that groundwater pumping will decline in proportion to the amount of groundwater in storage. The fraction of the remaining water in storage within a county during this period and at the end of each decade is shown in Figure L-2. For purposes of this analysis, the historical trend computed for 1998-2009 was used for 1995-2010.

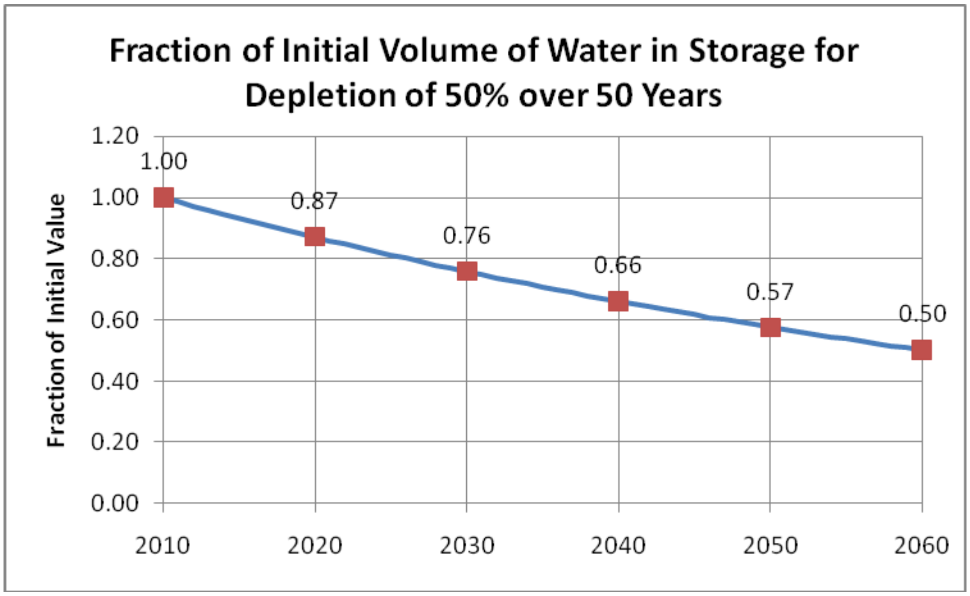
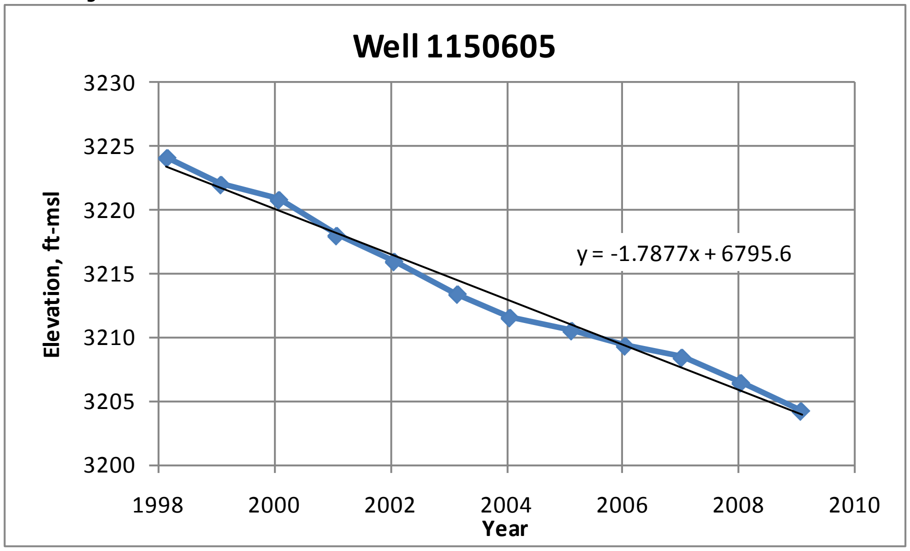



**Figure L-2: Fraction of Water in Storage in 50 Years**

Three potential well field sites were identified and evaluated. Water from either, or all of these sites could be routed to the existing CRMWA pipeline and become available for distribution to the CRMWA-member cities of Region O.

The analysis shows that there is sufficient groundwater at the three potential well fields to meet the projected demands for Plainview (Well Field 1 with a yield 4,635 acft/yr in 2040, declining to 4,488 acft/yr in 2060) and, for the remaining cities (Well Field 2 with 10,957 acft/yr yield in 2040, projected to decline to 10,649 acft/yr in 2060).

# Hale County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3225
3220
3215
3210
3205
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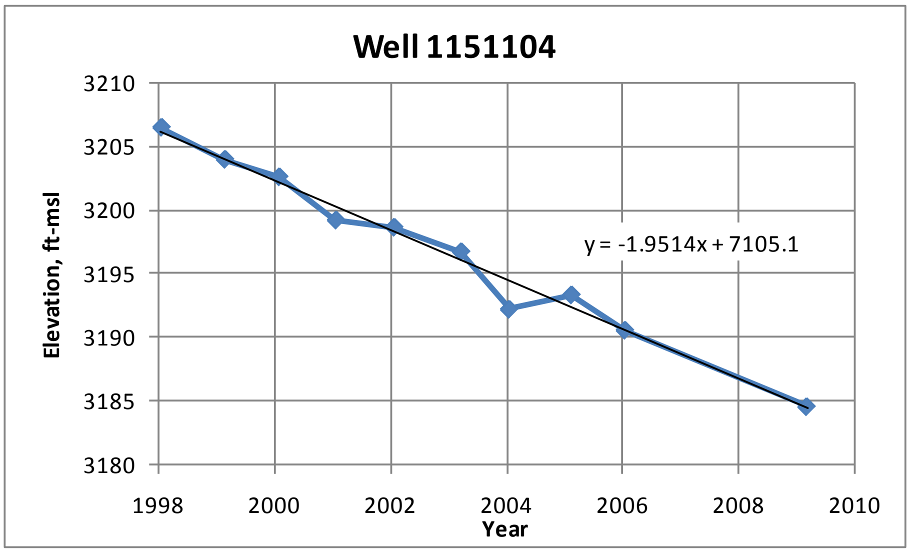
1998
2000
2002
2004
2006
2008
2010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3205
3200
3195
3190
3185
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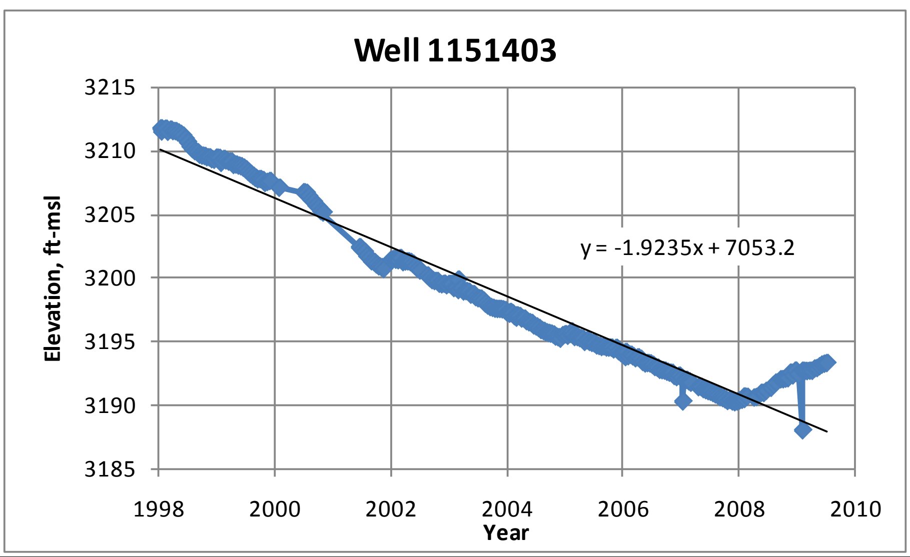
2000
2002
2004
2006
2008
2010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Elevation, ft-msl
Year
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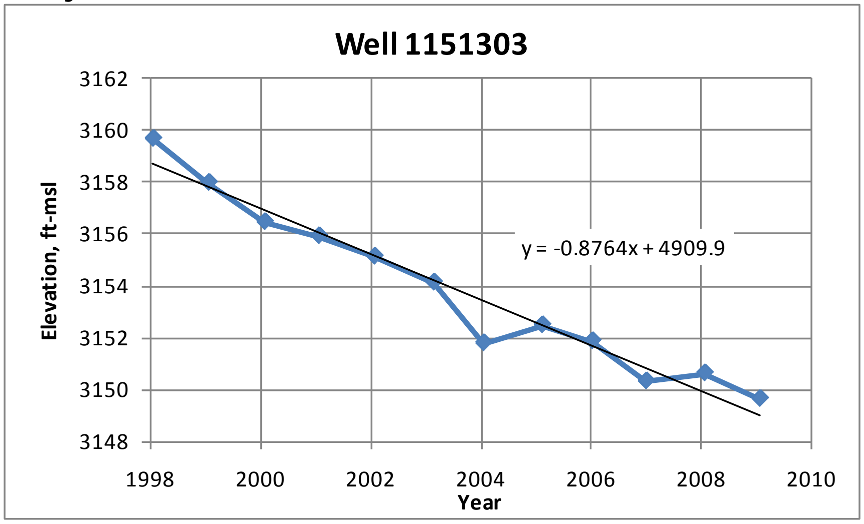
3210
3205
3200
3195
3190
3185
1998
2000
2002
2004
2006
2008
2010

# Hale County


Well 1151303
Elevation, ft-msl
3162
3160
3158
3156
3154
3152
3150
3148
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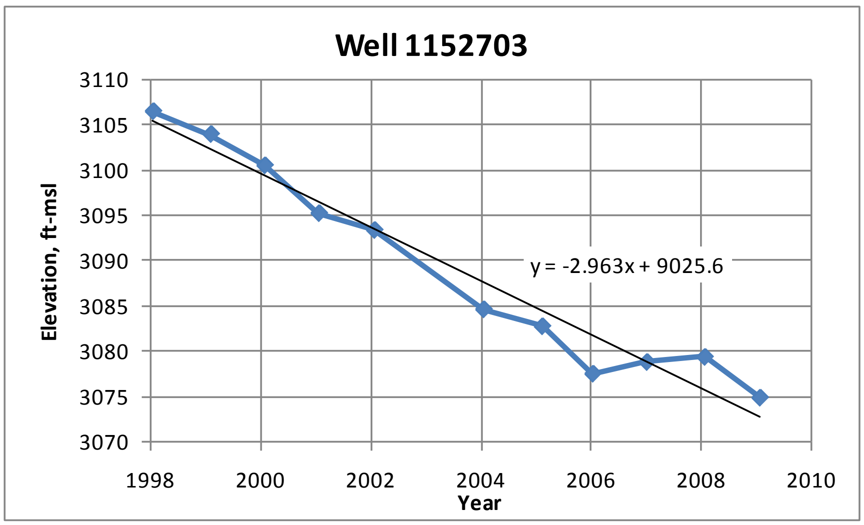
1998
2000
2002
2004
2006
2008
2010
Year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3105
3100
3095
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3075
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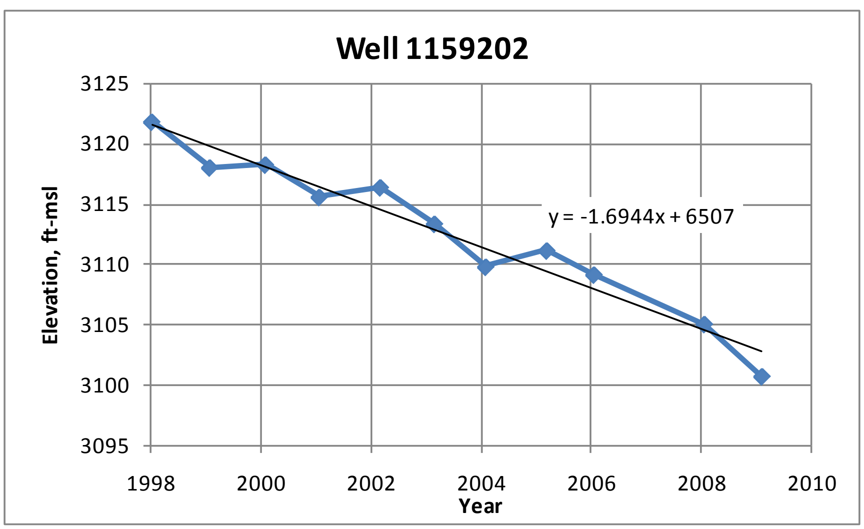
2000
2002
2004
2006
2008
2010
Year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Elevation, ft-msl
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3120
3115
3110
3105
3100
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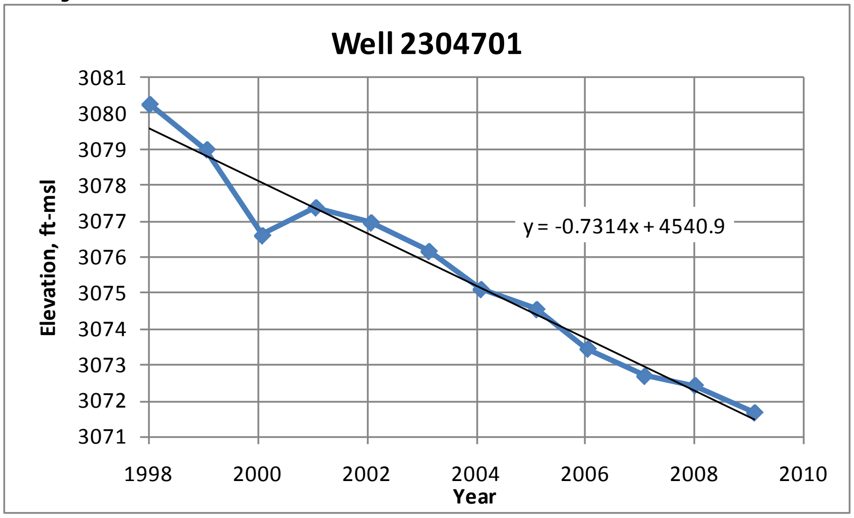
2000
2002
2004
2006
2008
2010
Year

# Hale County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Year
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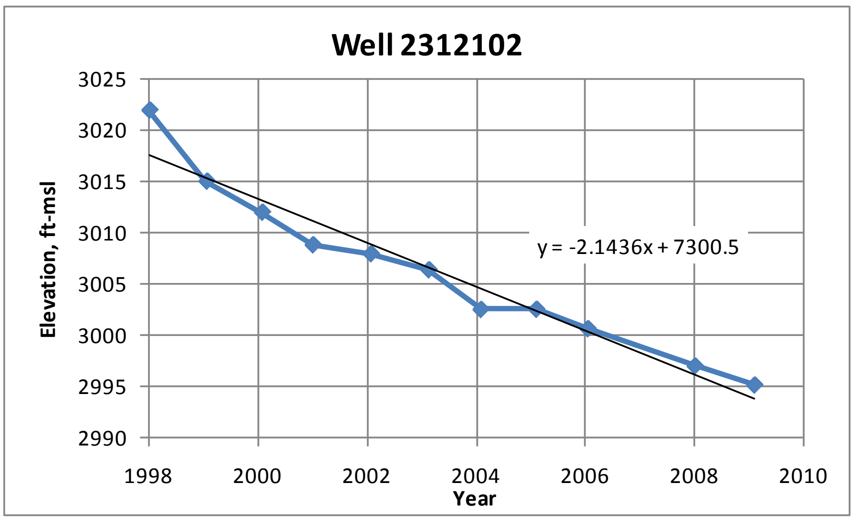
3081
3080
3079
3078
3077
3076
3075
3074
3073
3072
3071
1998
2000
2002
2004
2006
2008
2010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Elevation, ft-msl
Year
y = -2.1436x + 7300.5
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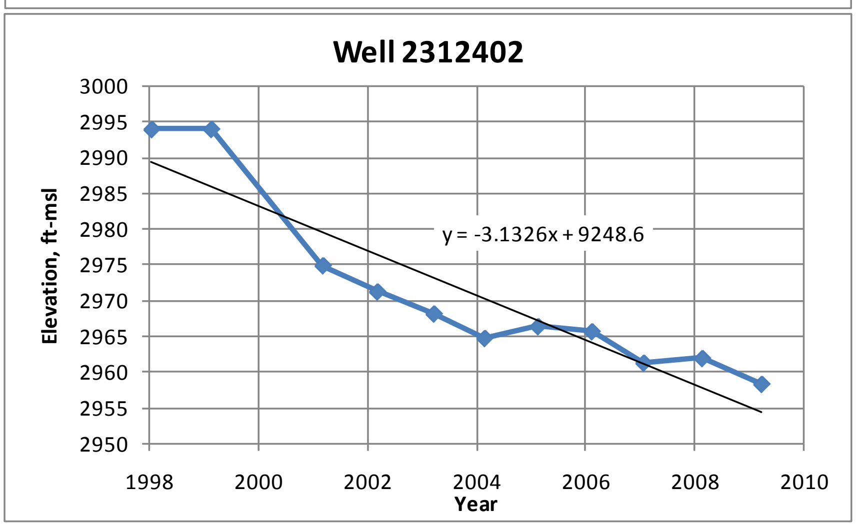
3020
3015
3010
3005
3000
2995
2990
1998
2000
2002
2004
2006
2008
2010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2995
2990
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2980
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2970
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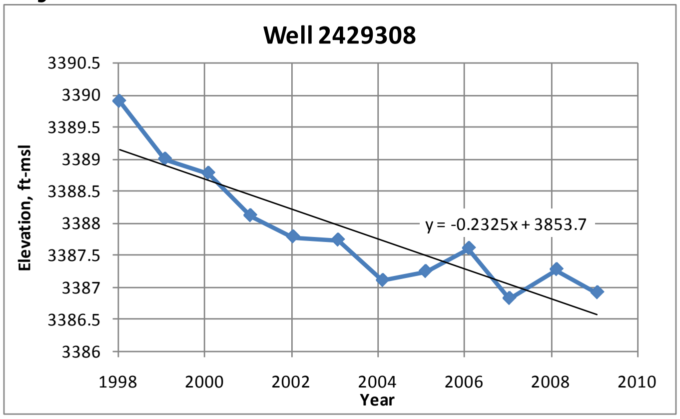
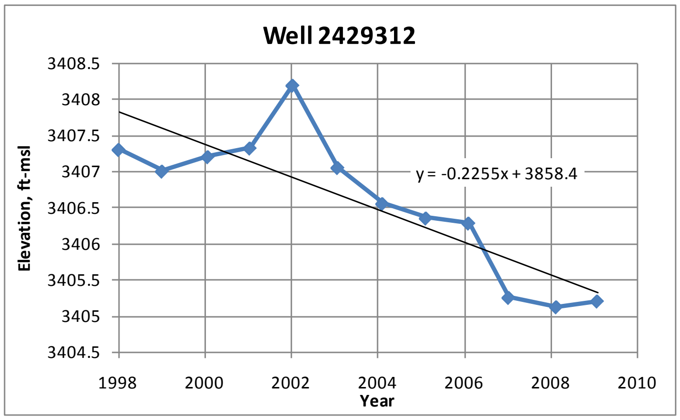
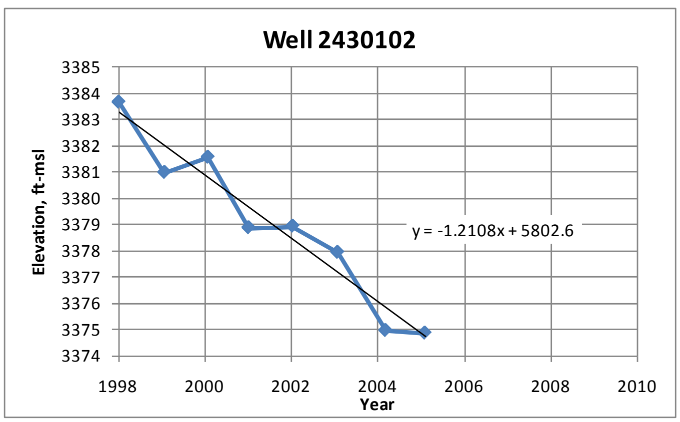
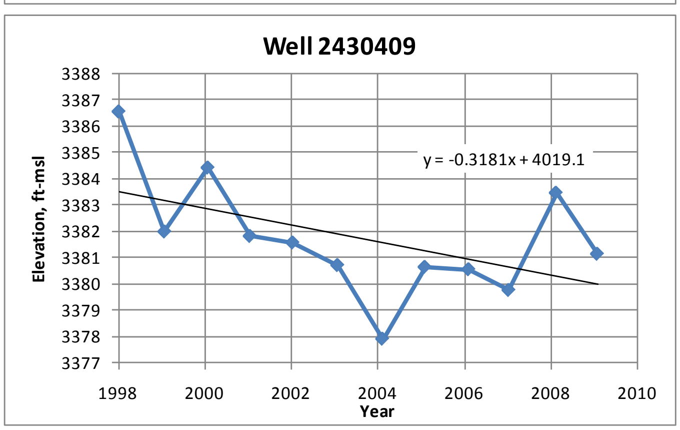
2960
2955
2950
1998
2000
2002
2004
2006
2008
2010

# Hockley County

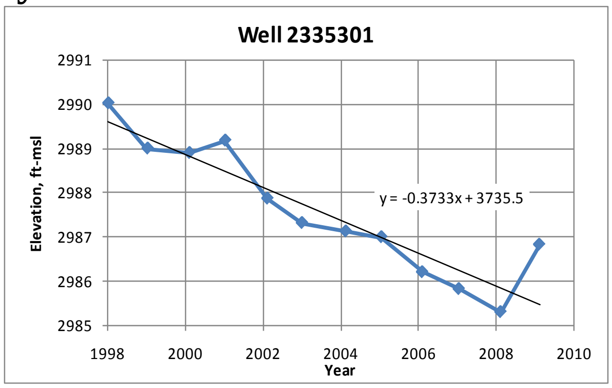


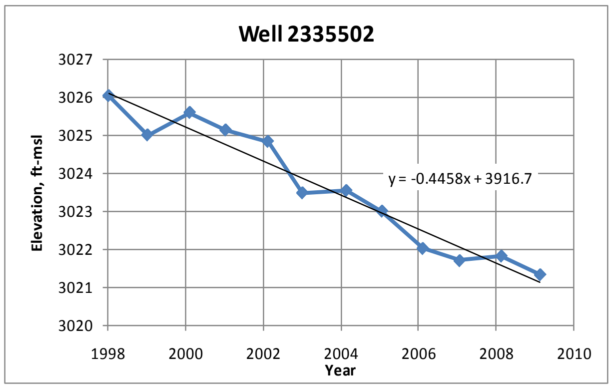



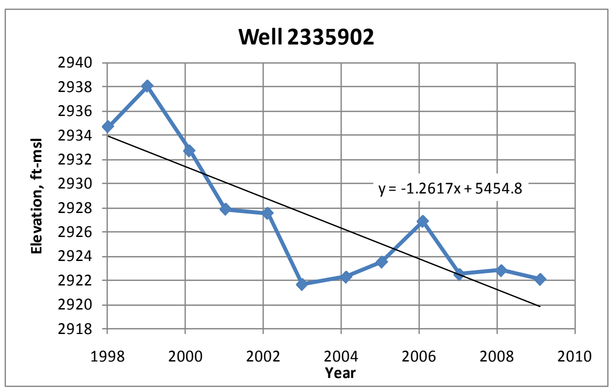



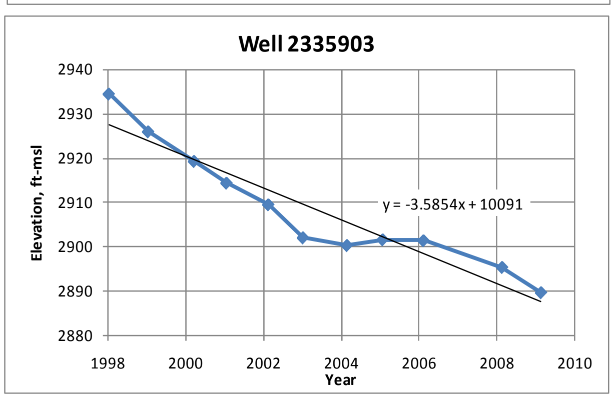



# Lubbock County

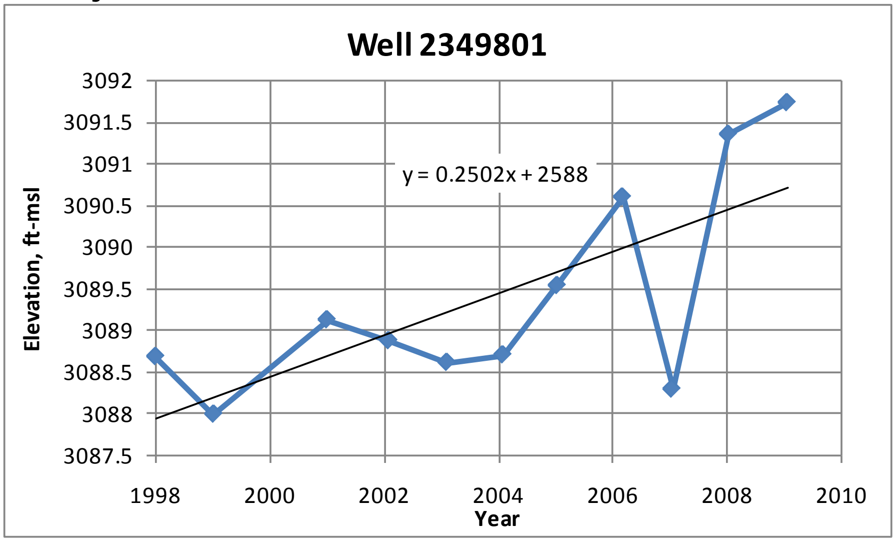


# Lynn County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3091
3090.5
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3089.5
3089
3088.5
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3087.5
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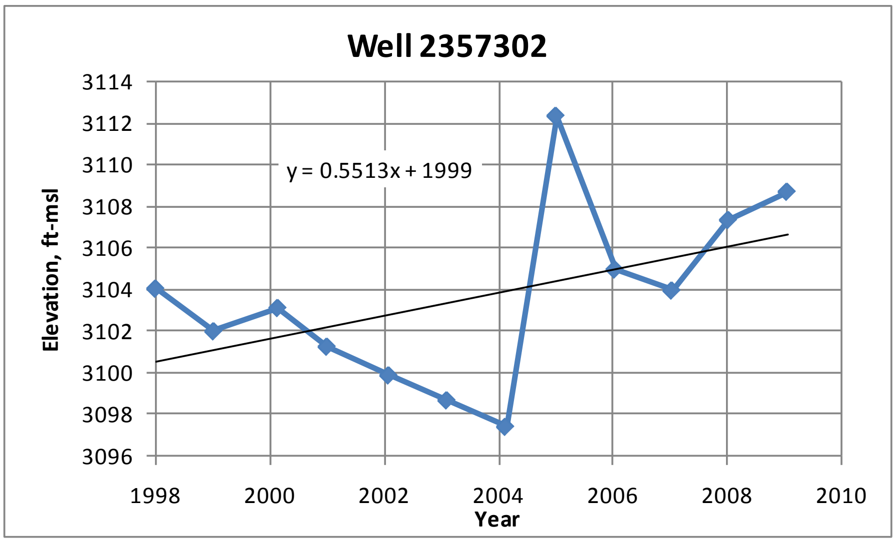
2000
2002
2004
2006
2008
2010
Year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3112
3110
3108
3106
3104
3102
3100
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3096
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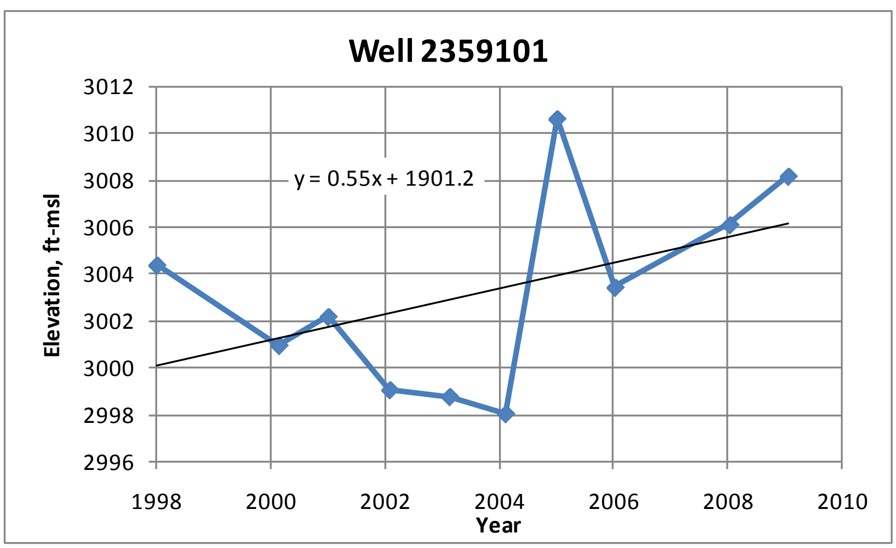
1998
2000
2002
2004
2006
2008
2010
Year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3010
3008
3006
3004
3002
3000
2998
2996
Elevation, ft-msl
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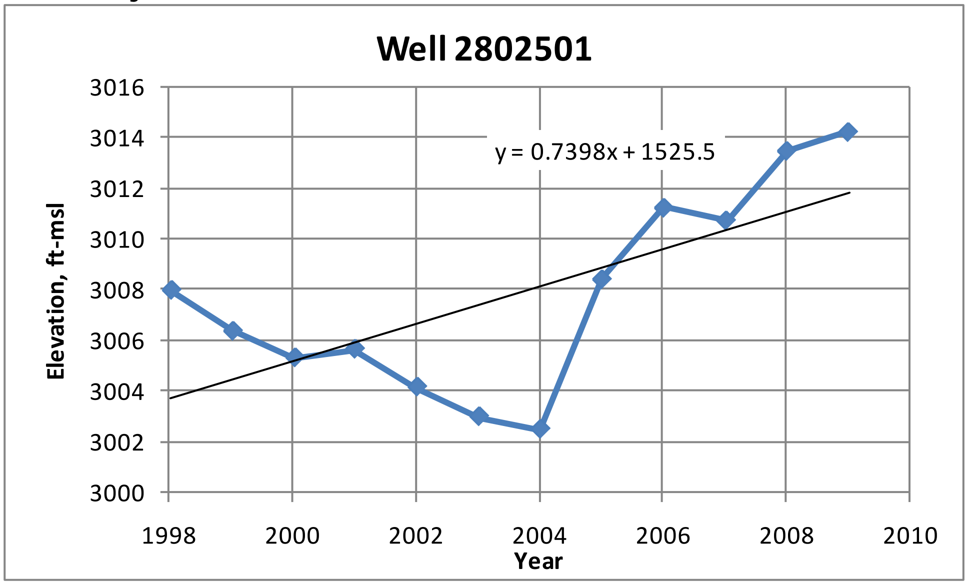
2004
2006
2008
2010
Year

# Lynn County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3004
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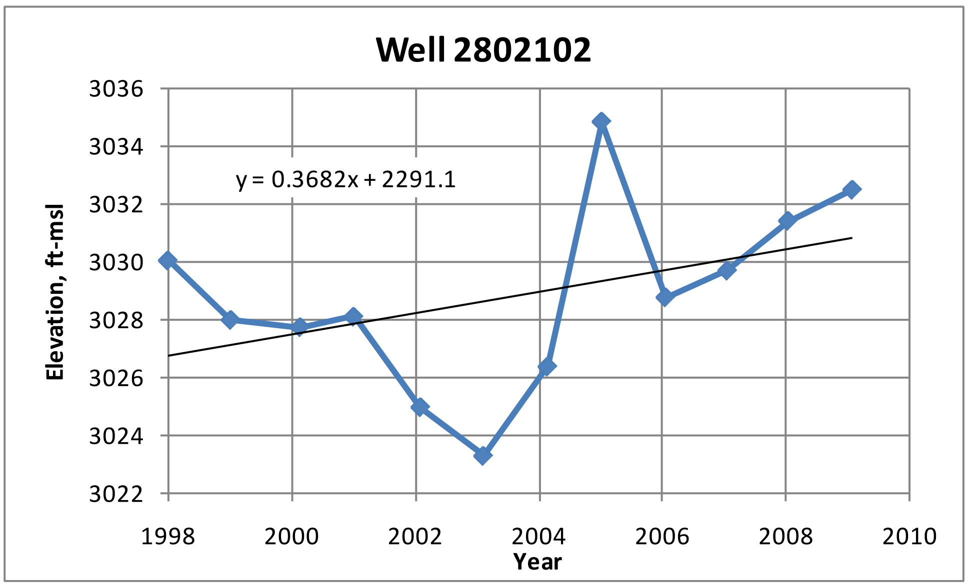
2000
2002
2004
2006
2008
2010
Year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Elevation, ft-msl
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3034
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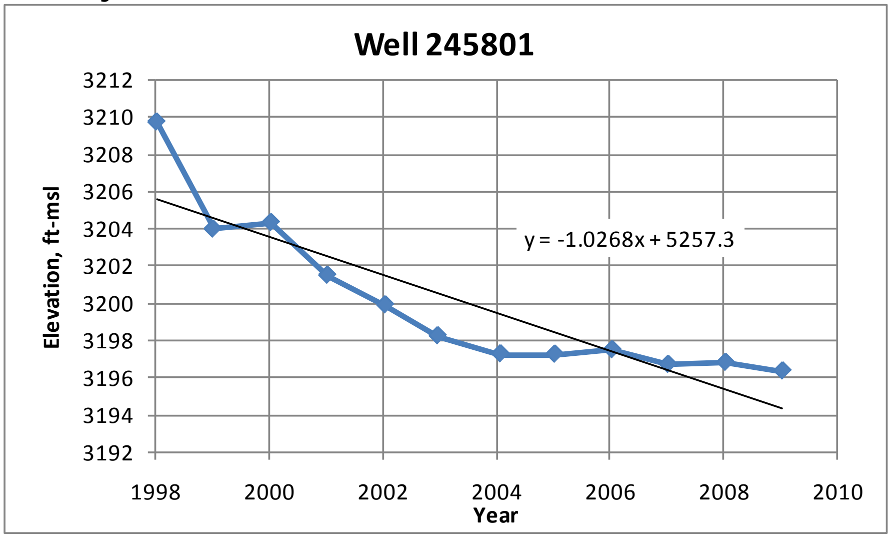
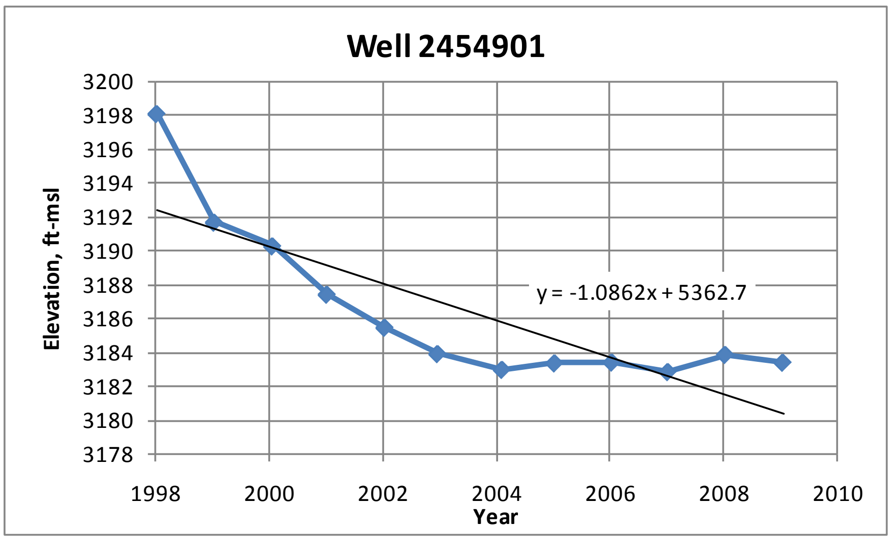
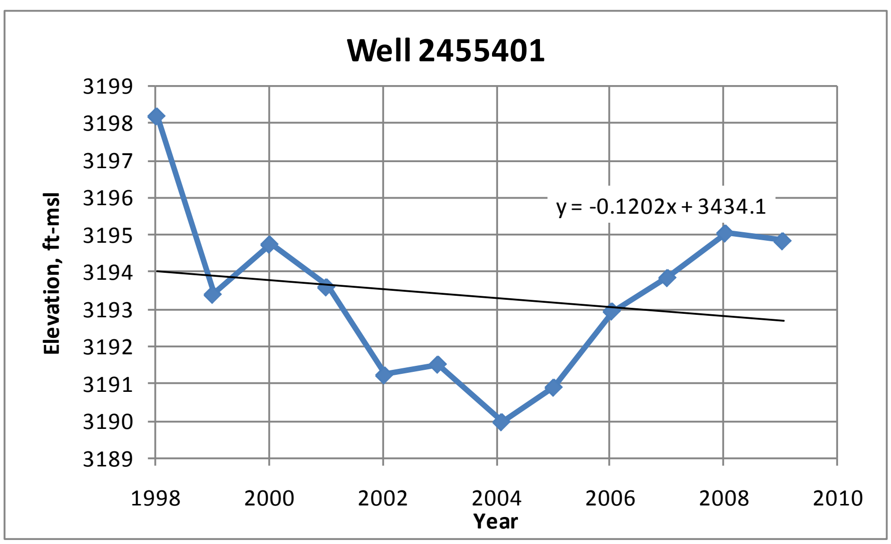
3030
3028
3026
3024
3022
1998
2000
2002
2004
2006
2008
2010
Year

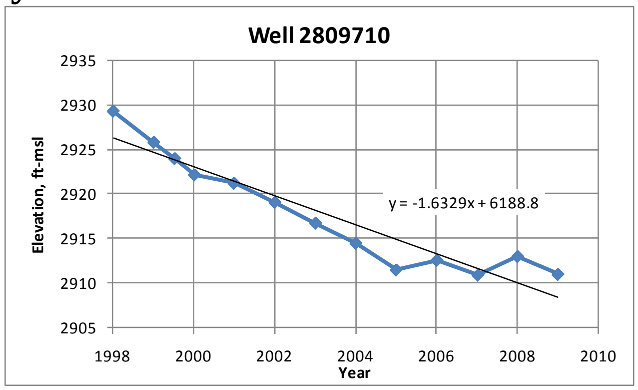
# Terry County

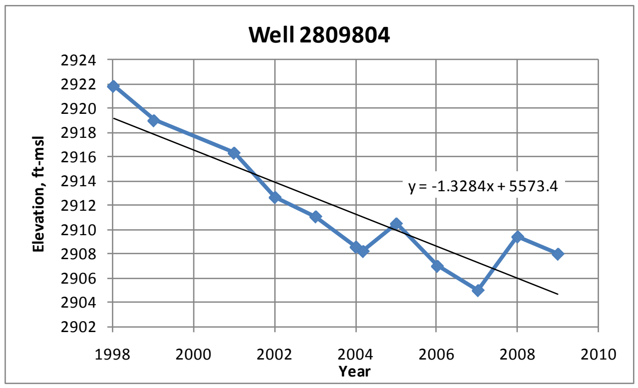


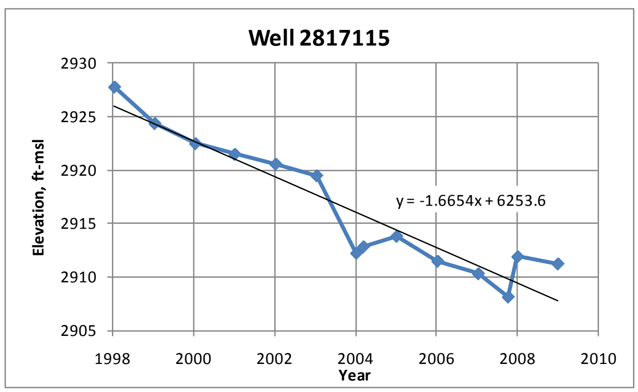



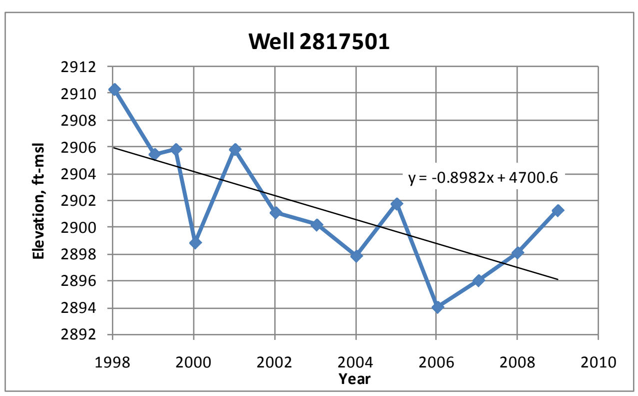



# Dawson County



# Appendix M

# Summary
# of
## *Llano Estacado Regional Water Planning Group (Region O) 2011 Regional Water Plan Phase I Report*

1. **Estimates of Population and Water Demands for New Ethanol Industries and Expanding Dairies;**

2. **Evaluation of Water Supplies and Desalination Costs of Dockum Aquifer Water; and**

3. **Video Conferencing Facilities Available for Coordination Between Regions A and O.**

**April 30, 2009**

The purposes of this study were to (1) make estimates of population and water demands for new ethanol plants and expanded numbers of dairies of the Llano Estacado Water Planning Region, (2) evaluate water supplies and desalination costs of Dockum Aquifer water, and (3) identify and describe video conferencing facilities available for coordination between Regions A and O. A summary of the results is presented below.

**Ethanol Plants:** In Deaf Smith, Hale, and Hockley Counties of the Llano Estacado Water Planning Region, as of 2008, three ethanol plants of 110 million gallons per year and one plant of 50 million gallons per year capacity have been constructed and either are in operation or will be in operation within a few months. These are new industries for the region, for which water supplies have not been included in previous regional water plans. The combined water requirements of these four plants are about 3.5 million gallons per day, or 3,920 acre-feet per year.

**Dairies and Dairy Cattle:** The number of dairies has increased from 37 in 2006 to 59 in 2008, with the estimated number of dairy cattle having increased from about 55,000 in 2005 to 130,498 head in 2008. During this period, milk production has increased from 4.14 million pounds per day in 2005 to 9.00 million pounds per day in March 2008. The projected number of head of dairy cattle in the eight-county area has been revised to 155,750 in 2010, 188,544 in 2020, and 280,714 head in 2060.

Revised projections of drinking water for dairy cattle and dairy milking parlor sanitation demands are 8,374 acre-feet per year in 2010, 11,198 acre-feet per year in 2030, and 15,093 acre-feet per year in 2060 compared to the 2006 Water Plan projection of 11,587 acre-feet per year in 2060.

The increased dairy production is projected to result in a larger number of dairy workers and their associated family members, resulting in an increased municipal water demand of 466 acre-feet per year for the increased population of 2,405 in 2010, increased municipal demand of 182 acre-feet per year in 2020, and for 2060 an increased demand of 769 acre-feet per year for the increased projected population of 4,255.

The irrigation water requirements for feed production for the revised dairy projections are 16,938 acre-feet per year higher in 2010, 20,504 acre-feet per year higher in 2020, 25,019 acre-feet per year higher in 2040, and 30,528 acre-feet per year higher in 2060.

**Increased Demand for Water for Ethanol Plants, Dairies, and Associated Population:** The total increased water demand for ethanol production, dairies, dairy population and dairy feed production is 23,362 acre-feet per year in 2010, of which 16.7 percent is for ethanol production, 8.7 percent is for dairies, 2.0 percent is for dairy worker population, and 72.5 percent is for dairy feed production. The total is 30,166 acre-feet per year in 2040, and 38,723 acre-feet per year in 2060, of which ethanol production is 10.1 percent, dairies are 9.1 percent, dairy worker population is 1.98 percent, and dairy feed production is 78.8 percent.

**Water Supply Potentials and Estimated Costs of Water from the Dockum Aquifer:** The Dockum Aquifer is a potential source of additional water in Bailey, Castro, Deaf Smith, Hale, and Parmer Counties. Dockum wells in the vicinity of Hereford and in northeast Castro County typically are 800-950 ft deep. The deepest well depths would be about 1,400 ft in Lamb County. Typical well yields of Dockum wells is estimated to range from about 400 gpm in Deaf Smith County area to about 200 gpm in the southern part of the study area. The salinity of water in the Deaf Smith County area typically ranges from concentrations of 800 to 1,500 milligrams per liter of total dissolved solids. In southern part of the study area, the salinity is greater than 20,000 mg/L of total dissolved solids.

Potential well field designs were prepared for two well fields and at three pumping rates (0.2, 1, 3, and 10 million gallons per day (MGD). The most economical water supply, not considering water treatment, was from the Deaf Smith well field pumping at a rate of 3 MGD. The delivery of raw water to a terminal near the well field is estimated to cost about $305 per acre foot.

**Estimated Costs of Water from the Dockum Aquifer:** Costs were estimated to obtain and desalt raw water from the Dockum Aquifer, and to dispose to concentrates resulting from desalination. Costs were estimated for desalination using Reverse Osmosis (RO) and concentrate disposal using solar evaporation and deep well injection for 0.2 MGD, 1 MGD, 3 MGD, and 10 MGD sized Dockum Aquifer well fields having 1,500, 3,000, 5,000, and 20,000 mg/L concentrations of TDS. Estimated total costs for raw water, desalination, and concentrate disposal for water from the Dockum Aquifer with TDS of 1,500 mg/L range from $5.35 per 1,000 gallons for a 0.2 MGD size facility, to $3.76 per 1,000 gallons for a 1 MGD facility, to $2.75 per 1,000 gallons for a 3 MGD facility, and $2.29 per 1,000 gallons for a 10 MGD facility. Estimated total costs for raw water, desalination, and concentrate disposal for water from the Dockum Aquifer with TDS of 3,000 mg/L range from $6.65 per 1,000 gallons for a 0.2 MGD size facility, to $4.77 per 1,000 gallons for a 1 MGD facility, to $3.07 per 1,000 gallons for a 3 MGD facility, and $2.61 per 1,000 gallons for a 10 MGD facility. Estimated total costs for raw water, desalination, and concentrate disposal for water from the Dockum Aquifer with TDS of 5,000 mg/L range from $7.94 per 1,000 gallons for a 0.2 MGD size facility, to $5.57 per 1,000 gallons for a 1 MGD facility, to $4.08 per 1,000 gallons for a 3 MGD facility, and $3.23 per 1,000 gallons for a 10 MGD facility. Estimated total costs for raw water, desalination, and concentrate disposal for water from the Dockum Aquifer with TDS of 20,000 mg/L range from $11.44 per 1,000 gallons for a 0.2 MGD size facility, to $7.21 per 1,000 gallons for a 1 MGD facility, to $5.62 per 1,000 gallons for a 3 MGD facility, and $5.10 per 1,000 gallons for a 10 MGD facility.

**Interactive Video Conferencing Facilities:** Interactive Video Conferencing Services needed by Regions A and O include, (1) video conferencing equipped meeting rooms located conveniently to each regional water planning group, and (2) staffing to operate the conferencing equipment. Fully staffed interactive video conferencing facilities and services, with capabilities to meet the needs of Regions A and O are in existence and are available to both Regions A and O at Offices of the AgriLife Research Facilities of the Texas A&M University System in Amarillo and Lubbock, respectively. Consequently it appears that justification can not be made at this time for the purchase and installation of such facilities.

**Conclusions:** The revised projections of water demand for the ethanol and expanded dairy water using sectors, the Dockum Aquifer water supply analyses, and the description of available interactive video conferencing facilities presented in this report are available for use in development of the 2011 Llano Estacado Regional Water.

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