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 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 South 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 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 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

Tom Adams – Municipalities (Large)

Melanie Barnes, Ph.D. — Public

Alan Bayer — County Government

Delaine Baucum — Agriculture

Bruce Blalack — Municipalities (Large)

Delmon Ellison, Jr. — Agriculture

Don Ethridge, Ph.D. – Agriculture

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 Group 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 (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 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 planning groups is the 60-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 total 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.

Generally, the water in the Ogallala 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 at 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, 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.

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.

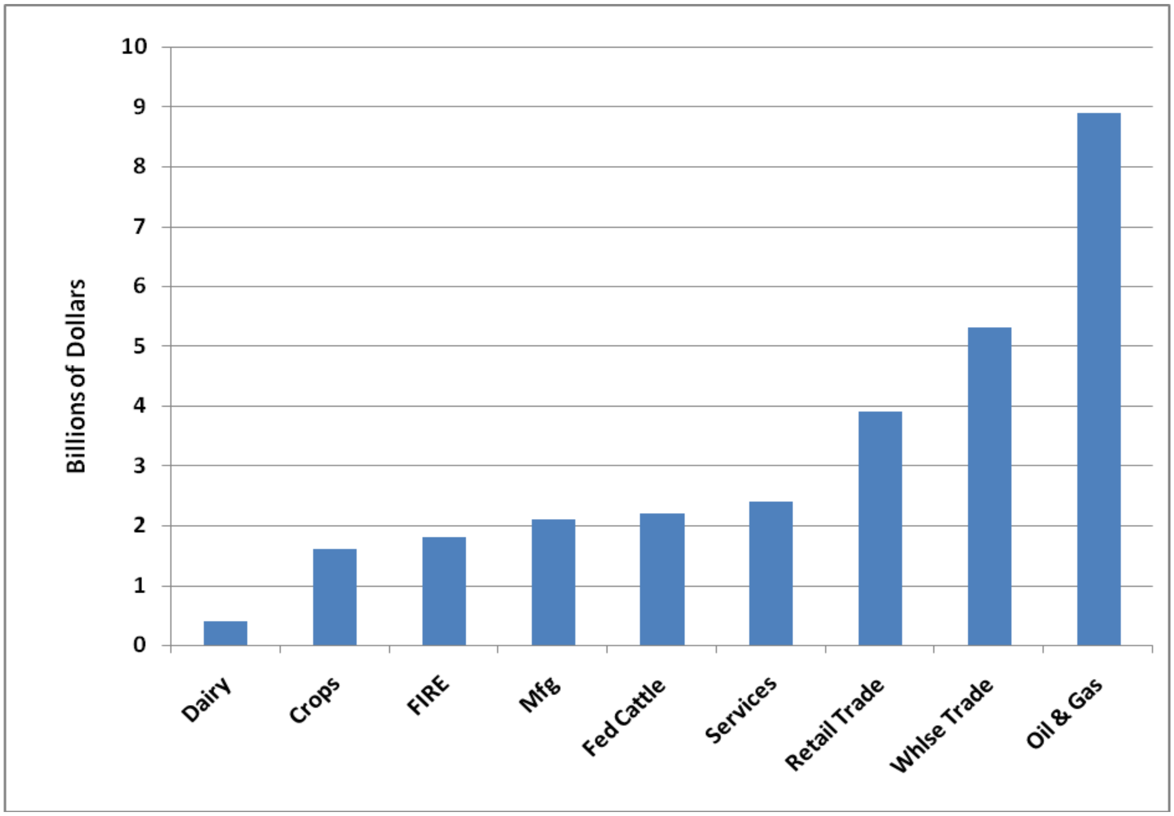

Figure ES-1. Llano Estacado Regional Economy Annual Value of Sales

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 thinning 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 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—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 in 2000 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 mining 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 1.23 million acft/yr in 2010, increasing to 2.03 million acft/yr in 2030 and to 2.28 million acft/yr by 2060. The water needs assessment identified 29 municipalities and one water supply district, with municipal water needs (shortages), 20 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 is performing a socioeconomic economic impact analysis of the effects of not meeting projected water needs. The TWDB has informed the Regional Water Planning Groups that the socioeconomic economic impact analysis will not be completed by the March 1, 2010 due date for submission of the Regional IPPs and that they can be added later. This is the placeholder space for a summary of the socioeconomic economic impact analysis when it becomes available.

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		
Dimmitt (Castro)	2030	844
Hart (Castro)	2050	82
Morton (Cochran)	2020	496
Crosbyton Crosby)	2060	336
Lorenzo (Crosby)	2030	108
Ralls (Crosby)	2030	318
Spur (Dickens)	2050	257
Lockney (Floyd)	2030	212
Post (Garza)	2040	206
Lake Alan Henry WSD (Garza)	2010	22
Abernathy (Hale & Lubbock)	2020	446
Petersburg (Hale)	2050	306
Anton (Hockley)	2010	243
Ropesville (Hockley)	2030	81
Smyer (Hockley)	2060	62
Sundown (Hockley)	2020	316
Earth (Lamb)	2040	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)	2020	55
Farwell (Parmer)	2030	106
Friona (Parmer)	2030	431
Tulia (Swisher)	2020	417
Kress (Swisher)	2010	76
Brownfield (Terry)	2020	457
Denver City (Yoakum)	2030	1,000
Plains (Yoakum)	2020	457
Total Mun Shortages		**29,123**

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**

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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	220,242
Hockley	2010	80,582
Lamb	2010	250,327
Lubbock	2010	95,586
Lynn		0
Motley	2010	1,025
Parmer	2010	345,957
Swisher	2010	107,061
Terry	2010	89,756
Yoakum	2010	17,028
Total Irrigation Shortages		**2,290,109**

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;
- Post Reservoir – Raw Water at the Reservoir;
- 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, and best management irrigation practices by irrigators, 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 the plan, a selected strategy is presented for each city that is estimated to need additional water supplies. The individual plans show the approximate dates at which new wells 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 $16.78 million. In addition, estimates for projects for Lubbock are $639 million, projects by CRMWA for Region O are approximately $59.5 million, and projects for White River Municipal Water District are approximately $39 million. The cost estimates range from $48 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 2.95 million acft/yr in year 2010 to 1.85 million ft/yr in 2030, and 1.22 million acft/yr in 2060 resulting in a projected irrigation water shortage of 1.23 million acft/yr in 2010, and 2.29 million acft/yr in 2060.

The Region O Planning Group recognizes that the High Plains Ogalalla 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. We believe 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 the 786 thousand 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 $26.8 million. Cost per acre-foot of water conserved is estimated at $56 in 2010, $70 in 2030, and $95 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, and although data are not available with which to estimate its value, it is recognized that this is one of 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 planning group 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 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.

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.

Desalt Brackish Groundwater

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 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/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). 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).

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/yr of municipal water needs in Region O in 2010, 10,583 acft/yr in 2020, 10,264 acft/yr in 2040, and 10,424 acft/yr 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/yr 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.

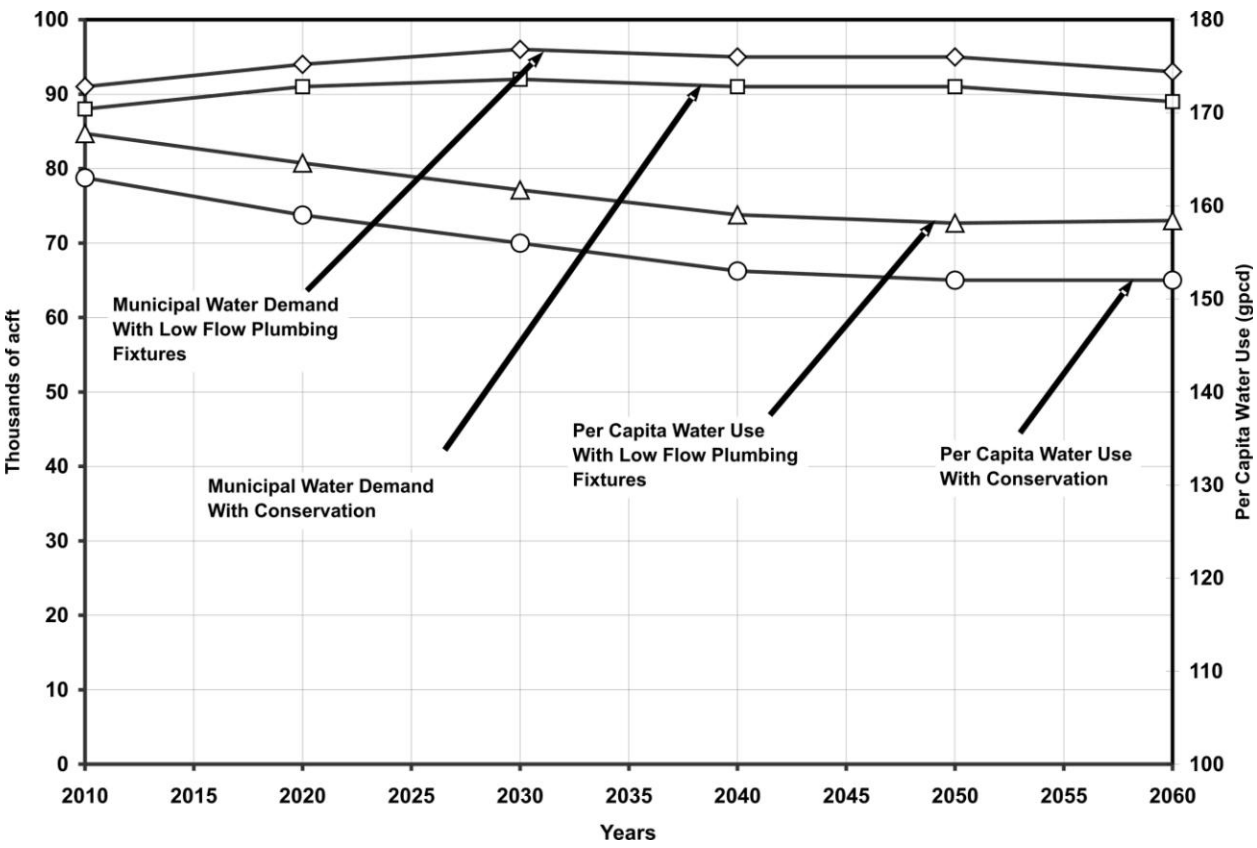

Figure ES-2. Municipal Water Demand Without and With Water Conservation

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 Planning Groups 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 Planning Groups. 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 Planning Group 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 Planning Group 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 Planning Group 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 Planning Group 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 Planning Group 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 2006 plan, the Planning Group 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 planning group 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 Planning Group 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 Planning Group 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 Region O of West Texas. 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; Demand in 2020 = 173,622), 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 planning group made some revisions and adjustments to the water supply data provided by the GAMS, however, the planning group did not have a fast, inexpensive 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 Planning Group recognizes that the planning process, with periodic updates to the plan will serve to allow the introduction of newer 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 Planning Group 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 Planning Group 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 our recommendations must focus on how to best utilize the available supply to the maximum benefit of the people of the region.

Moving on to the ultimate water management question – 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 Planning Group has chosen to strongly recommend water conservation Best Management Practices (BMPs) for both municipal and irrigated agriculture so that the economy of the region 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 Planning Group 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 potentials from irrigation water conservation will not be adequate 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 will indeed 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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