EXECUTIVE SUMMARY

In June 1997, Governor George W. Bush signed into law Senate Bill 1 (SB1), a comprehensive water planning and management bill enacted by the 75th Texas Legislature. With the passage of SB1, the Legislature put in place a "bottom up" water planning process designed to ensure that the water needs of all Texans are met as Texas enters the 21st Century. Individuals representing various interested groups served as members of Regional Water Planning Groups (RWPGs) to prepare regional water plans for their respective areas. These plans map out how to conserve water supplies, meet future water supply needs and respond to future droughts in the planning areas.

The Texas Water Development Board (TWDB) established 16 distinct planning areas that are directed by 16 different RWPGs. The Panhandle Water Planning Group (PWPG) was formed to develop a 50-year regional water plan for Region A, the Panhandle Water Planning Area (PWPA). The PWPA consists of a 21-county area of the Panhandle that includes: Armstrong, Carson, Childress, Collingsworth, Dallam, Donley, Gray, Hall, Hansford, Hartley, Hemphill, Hutchinson, Lipscomb, Moore, Ochiltree, Oldham, Potter, Randall, Roberts, Sherman, and Wheeler Counties.

The Regional Water Plan was developed in accordance with the Regional Water Planning Guidelines set forth in the 31 Texas Administrative Code § 357.7 (a) (1). The project was divided into the following six tasks: Task 1, Description of the Region; Task 2, Current and Projected Population and Water Demand; Task 3, Evaluation of Adequacy of Current Water Supplies; Task 4, Comparison of Current Water Supplies to Demands; Task 5, Water Management Strategies; and Task 6, Regulatory, Administrative or Legislative Recommendations.

DESCRIPTION OF THE REGION

The current total population in the PWPA is estimated to be approximately 379,018 in 2000 and is projected to be 552,072 by year 2050. This represents an increase of 46 percent from 2000 to 2050. Essentially all the increase is in the larger communities, with a declining rural population projected. Counties with a projected population of 10,000 or greater in 2000 include Gray, Hutchinson, Moore, Potter, and Randall. These counties include the cities of Amarillo, Borger, Canyon, Dumas, and Pampa. The city of Amarillo is estimated to have a population of 177,644 in the year 2000, increasing to 286,692 by 2050, and accounts for much of the population increase, especially in northern Randall County.

The economy of the region may generally be divided into the following sectors: agriculture and agribusiness, oil and gas operations, wholesale and retail trade, various manufacturing, tourism, and institutional. Major water-using activities include irrigation, petroleum refining, agricultural production, food processing and kindred, chemical and allied products, and electric power generation.

The climate of the Panhandle is characterized by low and erratic precipitation, widely variable seasonal temperatures, moderately high wind speeds, and low humidity. Annual precipitation declines across the planning area from east to west. Precipitation ranges from a high of about 22 inches in the east to about 16 inches in the west.

The Major Water Providers identified and designated by the PWPG include the Canadian River Municipal Water Authority (CRMWA), Greenbelt Municipal and Industrial Water Authority (GMIWA), and the city of Amarillo. The CRMWA serves more than 450,000 urban residents and provides water in the PWPA to Borger, Pampa and Amarillo. The GMIWA is located in Donley County and provides water to local municipalities. The city of Amarillo currently services over 60,000 active water accounts with an average usage of 42 million gallons per day, 45% of which is from groundwater and 55% from surface water.

Water supplies in the PWPA include both surface and groundwater sources. In the PWPA there are two major aquifers, the Ogallala and Seymour, and four minor aquifers, the Blaine, Rita Blanca, Whitehorse, and Dockum, that serve as groundwater sources for the study area.

Groundwater

Parts or all of 18 counties in the PWPA study area are included in the following six groundwater districts:

- Collingsworth County Underground Water District,
- Dallam County Underground Water District,
- Hemphill County Underground Water District,
- High Plains Underground Water Conservation District,
- North Plains Groundwater District, and
- Panhandle Groundwater District.

The Ogallala is primary aquifer that supports the major irrigated agricultural production base, as well as municipal water needs in the PWPA. Water-table elevations approximately parallel the land surface and dip from the northwest to the southeast. The aquifer is recharged by precipitation and runoff that drains to lakes, rivers, and streams.

The Seymour is a major aquifer located in north central Texas and some Panhandle counties. This aquifer consists of isolated areas of alluvium that are erosional remnants of a larger area or areas.

The Dockum is a minor aquifer which underlies the Ogallala Aquifer and extends laterally into parts of West Texas and New Mexico. The primary water-bearing zone in the Dockum Group, commonly called the “Santa Rosa,” consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale. Aquifer permeability is typically low, and well yields normally do not exceed 300 gal/min.

The Rita Blanca is a minor aquifer which underlies the Ogallala Formation in western Dallam and Hartley counties in the northwest corner of the Texas Panhandle. The portion of the aquifer

located in the PWPA makes up a small part of a large aquifer system that extends into Oklahoma, Colorado, and New Mexico.

The Blaine is a minor aquifer located in portions of Wheeler, Collingsworth, and Childress Counties of the RWPA and extends into western Oklahoma.

The Whitehorse is a Permian aquifer occurring in beds of shale, sand, gypsum, anhydrite, and dolomite. It is an important source of water in and near the outcrop area around Wheeler County.

Surface Water

The PWPA is located within portions of the Canadian River Basin and Red River Basin. These two river systems and associated impoundments provide surface water for municipal, agricultural, and industrial users in the area.

In 1996, only three percent of the total water use in the Canadian River Basin portion of the PWPA was from surface water sources. There are three major reservoirs in the Texas portion of the Basin: Lake Meredith, Palo Duro Reservoir, and Greenbelt Reservoir. According to the TNRCC's 1996 State of Texas Water Quality Inventory, the principal water quality problems in the Canadian and Red River Basins are elevated dissolved solids, nutrients, and dissolved metals.

Important reservoirs in the Red River Basin include Greenbelt Reservoir, Bivens Lake, Baylor Lake and Lake Childress, Lake Tanglewood, Buffalo Lake and Lake McClellan. Surface water is used in a larger scale in the Red River Basin portion of the PWPA than in the Canadian River Basin.

Regional Water Uses

Water use in the PWPA may be divided into three major categories – municipal, industrial, and agricultural. Industrial water use includes mining, manufacturing, and power generation activities. Agricultural water use includes both irrigation and livestock watering.

The PWPA is among the largest water-consuming regions in the State with over 90 percent of water used in the region for agricultural purposes. Use of this water in the PWPA produces 35 percent of the wheat, 49 percent of the corn, and 14 percent of the grain sorghum, along with 33 percent of the cattle on feed, 74 percent of the swine, and 47 percent of the beef slaughter capacity in the state. In 1990, the region accounted for only 1.9 percent of the State's total population, but accounted for approximately 13 percent of the State's annual water use. Projections indicate that total water use in the region will increase approximately five percent during the planning period (PWPG, 1999).

Municipal water use is closely tied to population centers. The TWDB estimates that during 1990, the total municipal water use in the PWPA was 75,394 ac-ft. Potter and Randall Counties, comprised 61 percent of the total municipal water use in the PWPA.

Industrial water consumption reached approximately 46,207 ac-ft in 1997. Hutchinson, Potter and Moore counties are the largest industrial water consumers with a combined use of 36,370 ac-ft in 1997. This consumption represents 79 percent of the total industrial water use for the region.

Agricultural water use represents the most significant use of water within the PWPA. Productive activities include crop irrigation and livestock watering. Dallam, Hansford, Hartley, Moore, and Sherman counties, accounted for approximately 78 percent of the total irrigation water in PWPA in 1996.

Issues of concern for water supply in the PWPA include aquifer depletions due to pumping exceeding recharge; contamination of the resource; and drought related shortages. Another potential concern is the presence of endangered or threatened species in the PWPA. Restrictions for groundwater pumping and maintenance of stream flows may be implemented if an endangered or threatened species is found in the area. The recent Federal listing of the Arkansas River shiner as a threatened species has the potential to affect water resources projects in Hutchinson, Hemphill, Oldham, Potter and Roberts Counties.

Drought contingency plans are required to be developed by wholesale water suppliers, irrigation districts and retail water suppliers. Drought contingency plans prepared by various water providers in the planning area and submitted to the PWPG include the Canadian River Municipal Water Authority, Greenbelt Municipal and Industrial Water Authority, city of Gruver, city of Canyon, city of Borger, Pantex Water System, TCW Supply Inc., and Moortex Water Supply Corporation.

Federal regulations with a direct impact in the regional planning efforts include the Clean Water Act and the Safe Drinking Water Act. The Canadian River Compact is an interstate program that sets forth water allocation policies for Oklahoma, Texas and New Mexico. Under this program, Texas shall have free and unrestricted use of all water of the Canadian River in Texas, subject to water storage limitations. The Red River Compact is an interstate program that apportions water of the Red River and its tributaries between the states of Texas, Oklahoma, Arkansas and Louisiana.

State programs affecting the water planning in the region include: Surface Water Rights Regulations, the Texas Pollutant Discharge Elimination System (TPDES), and the Texas Clean Rivers Program. In 1997 the TWDB adopted the Water for Texas Plan. This comprehensive State water plan identifies current and prospective water uses, water supplies and water users, and identifies needed water-related management measures, facility needs and costs. The plan also offers recommendations to better manage the State's water resources through the year 2050. The Texas Natural Resource Conservation Commission (TNRCC) provides groundwater protection through different programs and offices including Water Resource Management, Waste Management, Compliance and Enforcement, Department of Licensing and Regulations and Groundwater Districts.

Local water supply studies and plans developed in the region include the CRMWA Regional Water Supply Study completed in 1993 and an evaluation of the City of Amarillo's water supply

and distribution systems performed in 1996. In addition, groundwater districts have developed water management plans that detail each district's goals for managing groundwater withdrawal within its jurisdictional area.

CURRENT AND PROJECTED POPULATION AND WATER DEMANDS

This Regional Water Supply Plan documents historical and estimates of projected population and water demands of cities and counties in the PWPA, as well as the demands on designated major water providers. Prior to the development of these projections, the TWDB in coordination with the TNRCC and the Texas Parks Wildlife Department (TPWD) had prepared population and water demand projections for the Region.

Population Projections

The planning group developed revised population and water demand projections for the 50-year planning period of 2000 to 2050 based on new information made available to the PWPG. Revisions to projected water demands for municipal, agricultural, and industrial uses were developed based on available data provided by the TWDB and input by regional water users.

Recognizing the importance of a water plan that would meet the unique needs of the Panhandle Water Planning Area, the PWPG compiled a database containing municipal, industrial, and agricultural water demands for the region. Municipal and industrial demands were identified using a survey questionnaire that was distributed to 155 entities identified as stakeholders in the PWPA.

Total PWPA population is projected to increase from 379,018 in 2000 to 552,072 in 2050. The data indicate that a major portion of the projected increase occurs in larger communities, such as Amarillo, with lesser increases projected in rural populations.

Water use in the PWPA during 1996 totaled over 2 million ac-ft, or approximately 17 percent of the state total. Five counties in the PWPA, Dallam, Hansford, Hartley, Moore, and Sherman County, reported a combined water use of approximately 1.5 million acre-feet in 1996, representing approximately 74 percent of the total regional water use.

The revised total water demand projections for the 21-county region for 2000 is 1,718,402 ac-ft and steadily increases to 1,812,949 ac-ft for the year 2050. Dallam County has the highest projected annual demand of 394,935 acre-feet in 2000, increasing to 405,458 acre-feet by 2050. Counties with projected increases in demand during the planning period include Dallam, Gray, Hansford, Hartley, Hutchinson, Lipscomb, Moore, Potter, Ochiltree, Randall, and Sherman County.

Projections of municipal water demands are calculated based on estimated changes in populations for cities and rural areas and on estimates of per capita water use. Per capita water use is estimated to decrease for each decade of the planning period based on the assumption that conservation measures will be implemented and result in lower water use.

Revisions to previous TWDB projections for municipal water use were made for those cities and counties for which population projections were revised. The major portion of municipal water demand occurs in Potter and Randall Counties which, along with Carson and Moore County, are the only counties in the PWPA projected to have an increase in municipal water demand.

Most counties are estimated to observe decreases in municipal water use, due to anticipated conservation or decreasing populations. Total municipal water use for the PWPA is projected to increase from 84,814 ac-ft in 2000 to 105,268 ac-ft by 2050, primarily due to significant population growth in population centers such as Amarillo.

Industrial water demand projections were developed for manufacturing, steam power generation, and mining activities within PWPA. Total manufacturing water demand for the PWPA is projected to increase from 37,493 ac-ft in 2000 to 53,009 ac-ft by 2050.

Mining operations in the PWPA consist primarily of oil and gas extraction and removal of industrial minerals such as sand, gravel, and gypsum. It is estimated that mining water demand will decrease from 7,817 ac-ft in 2000 to 5,062 acre-feet by 2050. This decrease is driven primarily by projected decreases in mining activities for Carson, Gray, Hansford, and Moore Counties.

Projections for agricultural water demand were also developed for the 21 counties included in PWPA. Agricultural use is divided into crop irrigation and livestock water demand.

According to the TWDB (1998), water used for irrigation totaled 1,850,192 ac-ft in 1996. As part of the regional water planning process, representatives of commodity groups, producers, and underground water districts expressed concerns that TWDB projections for irrigation demand tended to over estimate irrigation water use.

The Texas Agricultural Experiment Station and Texas Agricultural Extension Service (TAES/TAEX) developed a model to estimate the amount of irrigation water pumped in a county during a given year. Projections of annual future water use were made using planted irrigated acreage (pia) and the long-term averages for rainfall and potential evapotranspiration (PET) by county. The crop mix and acreage was assumed to remain unchanged from what was reported in 1997. Where available, demonstration data and well depletion data were used to verify the model estimates.

The current annual projections are 15 percent less than previous TWDB values in 2000, but only 2 percent different by 2050. The revised regional projected irrigation water demand is approximately 1.5 million acre-feet per year. The irrigation water use projections should be re-evaluated as more data becomes available to accurately reflect changes in the farming community due to new technologies, economic considerations, or crop acreages.

Revised livestock water use projections were developed which include the most recent inventories of various livestock species for each county, estimates of annual industry growth rates, and regional species-level water use estimates. Livestock water use projections indicate a total water demand of 46,793 acre-feet in 2000, gradually increasing to reach 96,414 acre-feet in 2050.

EVALUATION OF ADEQUACY OF CURRENT WATER SUPPLIES

This regional water plan includes an evaluation of current groundwater and surface water supplies available to the Region for use during the drought of record. Evaluation of groundwater sources include the Ogallala, Seymour, Blaine, Dockum, Rita Blanca, and Whitehorse aquifers.

The volume of water available from the Ogallala aquifer was determined using a numerical model developed by the Bureau of Economic Geology (BEG). Available supplies of water from the remaining aquifers was determined using estimates of saturated thickness, specific yield, and recharge rates from historical studies and published reports. For some of the minor aquifers, this detailed information was not available. Therefore, maximum historical pumpage was used as the available supply. Table 1 includes the estimated annual available groundwater supply for aquifers within PWPA.

Table 1 Estimated available water supply in aquifers underlying PWPA

Aquifer	***Estimated Available Water Supply (ac-ft/year)***
Ogallala	129,120,000
Seymour	40,189
Blaine	94,782
Dockum	7,862
Rita Blanca	5,250
Whitehorse	566

The evaluation of surface water resources included an estimation of annual water availability from Lake Meredith, Palo Duro Reservoir, and Greenbelt Reservoir. Water supply from these sources was determined using historical yield studies, estimated sedimentation, assessments of existing infrastructure and contractual provisions. The firm yield for Lake Meredith is 76,000 acre-feet per year. The firm yield of Palo Duro Reservoir is expected to decrease from 6,543 ac-ft in 2000 to 6,092 ac-ft by 2050. The firm yield of Greenbelt Reservoir expected to decrease from 7,699 ac-ft in 2000 to 6,942 ac-ft by 2050.

Information provided in the existing yield studies of Lake Meredith, Palo Duro Reservoir, and Greenbelt Reservoir should be updated as new information and studies become available, specifically, the determination of critical periods, net evaporation rates, and sedimentation surveys. Changes in these parameters may significantly change the estimates of available surface water supply in the PWPA

Ten minor reservoirs in the PWPA have been identified as other potential sources of surface water. These include Lake McClellan, Buffalo Lake, Lake Tanglewood, Rita Blanca Lake, Lake Marvin, Lake Baylor, Lake Childress, Lake Fryer, Club Lake, and Bivens Lake. The historical

or current supply of these water bodies has not been quantified through yield studies. In addition, there are regulatory constraints currently in place that do not permit the use of these surface water bodies for water supply.

COMPARISON OF CURRENT WATER SUPPLIES TO DEMANDS

A comparison of current water supply resources in the Panhandle Water Planning Area (PWPA) to the projected demands was performed. Results from this analysis indicate that available water supply in the PWPA exceeds the demands by nearly 380,000 acre-feet per year in the year 2000. Total regional water demand begins to surpass the available resources in year 2020. Projections for 2050 indicate a total regional need of 777,406 acre-feet per year. Irrigation represents 86 percent of this amount with a total projected need of 668,579 acre-feet per year.

Irrigation needs for 2020 are projected to be 505,682 acre-feet per year increasing to 668,579 acre-feet per year in the year 2050. The largest needs are attributed to high irrigation use and limited groundwater resources in Dallam, Moore, Oldham, Potter, and Randall counties. The numerical groundwater model developed by BEG indicates that there may be other counties in the PWPA with localized shortages.

Municipal needs are typically associated with growth and limited development of existing groundwater rights. Projected municipal water needs begin in 2010 with a deficit of 1,844 acre-feet per year, gradually increasing to 51,092 acre-feet per year in 2050. Cities showing needs are Amarillo, Cactus, Canadian, Canyon, Claude, Dumas, Groom, Gruver, Lake Tanglewood, Lefors, McLean, Panhandle, Perryton, Shamrock, Skellytown, Sunray, Vega, White Deer and Wheeler. In addition, there are county-other municipal needs in Moore, Oldham, Potter, and Randall counties. There may be other municipalities in the PWPA which are not listed, but may develop needs as the yields of existing wells decline, and additional wells will be installed to maintain adequate supply capacity. In addition, groundwater quality may supersede quantity as a need to develop additional supplies. The cities of Perryton and Wheeler are experiencing localized groundwater contamination in some of their supply wells.

Livestock needs are projected for Dallam, Moore, and Randall counties and are primarily due to competition for Ogallala water. Livestock needs are estimated to be 7,459 acre-feet per year in 2030 and increase to 29,989 acre-feet per year by 2050.

Manufacturing needs are relatively small in the PWPA. Identified needs in 2020 in Dallam, Lipscomb and Moore counties and total just under 1,500 acre-feet per year. By 2050 the manufacturing needs are projected to be in Dallam Gray, Hansford, Hemphill, Hutchinson, Lipscomb, Moore, Potter and Randall counties and total 14,451 acre-feet per year.

Mining needs of 367 acre-feet-per year begin in 2040 in Potter County. By 2050 the total mining needs are 741 acre-feet per year and occur in Hall, Oldham, Potter, and Randall counties.

Steam electric needs occur in Moore and Potter County. The Moore County need of 200 acre-feet per year begins in 2030. Potter County needs are 12,294 acre-feet per year beginning in 2040. The total regional mining needs by 2050 are 16,060 acre-feet per year.

WATER MANAGMEMENT STRATEGIES

Water management strategies were developed to meet the water needs greater than 10 acre-feet per year for municipal, manufacturing, livestock and steam electric power. Since the irrigation needs cannot be met by developing additional supplies, the water management strategies for irrigation needs are directed toward reducing demands. The potentially feasible strategies for each individual water use were evaluated with respect to:

- Quantity, reliability and cost;
- Environmental factors;
- Impacts on water resources and other water management strategies;
- Impacts on agriculture and natural resources; and
- Other factors including, regulatory requirements, political and local issues, implementation time, recreational impacts and socioeconomic benefits or impacts.

Municipal

As discussed previously, there are 18 cities in PWPA that will need to develop additional municipal water supply sources during the planning period. Only the city of Amarillo and the city of Canyon have sufficient undeveloped water rights to supply the projected demand through 2050.

Groundwater is the main source for most of the cities in the Region. The Ogallala aquifer supplies the majority of the current municipal water demand in the PWPA. The Dockum aquifer supplies a small amount to county-other water users in Randall County. The Palo Duro River Authority (PDRA) plans to supply surface water to six cities in the area once a transmission system is completed in 2030.

Water management strategies for cities with water needs include the purchasing of additional water rights in the Ogallala aquifer. A total of 519,505 additional acre-feet of water rights will be needed to supply the total municipal demand in the PWPA for the planning period. The reliability of the resource is considered to be moderate; however, the increased demand on the aquifer will continue to deplete the Ogallala storage capacity. Other groundwater uses, particularly irrigation, have a direct impact on the long term sustainability of current water demands.

The development of additional groundwater rights to provide additional water supplies will have a different cost for each city, depending on the number of wells needed, the depth to water, and the transmission pipeline size and distance. In addition, there are additional costs developed for member cities of the Palo Duro River Authority to obtain water from Palo Duro Reservoir. In general, environmental impacts will be minimal during the projects' implementation, if water delivery systems are routed around environmental sensitive areas. However, detailed environmental reviews will be needed prior to building any infrastructure associated with water supply projects. Water management strategies may reduce the irrigated acreage for farming as additional water rights are purchased.

Manufacturing

Manufacturing needs were identified in Dallam, Gray, Hemphill, Moore, Potter, and Randall counties. The small manufacturing need in Gray County can most likely be met with supply from the city of Pampa. The needs identified for Dallam, Moore, Potter and Randall counties are due to competition for Ogallala water with other users in the county. To provide for manufacturing demands in these counties, additional water rights will need to be purchased or alternative supplies developed. In most cases, municipal water will supply a portion of the water needs. The city of Cactus in Moore County is assumed to provide water for manufacturing needs when the Palo Duro Reservoir pipeline is completed.

The development of additional water supplies for manufacturing needs ranging from $95.00 per acre-foot per year in Potter County to $155.00 per acre-foot per year in Randall County. Reliability will be high in all cases. Environmental impacts will need to be reviewed in detail prior to project implementation. The number of irrigated acres in production may be reduced as additional water rights are purchased.

Steam Electric Power

There are two needs identified for steam electric power, including a small need in Moore County (200 ac-ft/yr) and a significant need in Potter County by 2050 (15,860 ac-ft/yr). Currently, groundwater from Ogallala supplies Moore County steam electric power demand. In Potter County, supply is obtained from the city of Amarillo, Ogallala, and wastewater reuse. The projected demands in Potter County increase from 18,300 to 30,000 acre-feet per year by 2050. Additional supply could be obtained from groundwater resources for the needs in both counties, and the city of Amarillo could possibly sell additional treated wastewater effluent for steam electric demands in Potter County.

Reliability of the resource will be moderate for both cases. Development of additional sources will cost $159.00 and $122.00 per ac-ft/yr for Moore and Potter counties, respectively. Minimal environmental impacts are expected during project implementation in Potter County. This strategy will impact the irrigated acreage when additional water rights are purchased.

Mining

There are small mining needs identified with counties with limited supplies from the Ogallala: Oldham and Potter counties. To meet the mining needs, local supplies will need to be developed or non-potable water could be used. This may include local mining ponds, shallow groundwater, and local river diversions. Mining needs for Oldham and Potter counties are assumed to be supplied by additional wells in the Dockum aquifer.

Reliability of the resource will be moderate for the three cases. Development of additional sources will cost $154.00 and $188.00 per ac-ft/yr for Oldham and Potter counties, respectively. No environmental impacts are expected during project implementation. This strategy will

impact the irrigated acreage when additional water rights are purchased. Historically, the Dockum Aquifer has not been used for mining needs in the Red Basin portion of the county. Further review of the groundwater availability from this formation in the demand areas is needed.

Irrigation

There are substantial irrigation needs identified in the PWPA due to limitations of the available supply from the Ogallala Aquifer and the minor aquifers. By 2050 these needs are projected to be 668,579 acre-feet per year. There is no readily available water supply in or near the high irrigation counties that could be developed to fully meet these needs. Therefore, water management strategies to reduce irrigation demands were examined. These strategies focus on Dallam, Moore, Oldham, Potter, Randall and Sherman Counties, where the projected demands cannot be met with projected supplies. According to the Texas Agricultural Statistics Service a total of 713,454 irrigated acres are located in these counties. Although, these are the only counties showing needs county wide, the numerical groundwater model simulations indicate that there may be other counties that will experience localized shortages. Therefore, the PWPG recommends that the water management strategies to reduce demands be adopted by irrigators in all 21 counties across the region.

The irrigation management strategies include the use of the North Plains Potential Evapotranspiration Network (NPPET) to schedule irrigation, changes in crop variety, irrigation equipment efficiency improvements, changes in crop types, convert irrigated acreage to dryland acreage, implement conservation tillage methods and implement precipitation enhancement projects. Table 2 includes the anticipated annual water savings in acre-feet per acre per year, and the expected percentage of acres by decade that would be shifted to these methods.

Table 2 Water Management Strategies for Reducing Irrigation Demands

Water Management Strategy	Assumed Annual Regional Water Savings (ac-ft/ac/yr)	Assumed Baseline Use Year 2000	Goals for adoption per decade				
			2010	2020	2030	2040	2050
Use of NPPET	0.167	20%	70%	90%	90%	90%	90%
Change in Crop Variety	0.167	10%	40%	70%	70%	70%	70%
Irrigation Equipment Changes	0.25	55%	75%	95%	95%	95%	95%
Change in Crop Type	0.42	0%	20%	40%	40%	40%	40%
Convert irrigated acreage to dryland	1.2	0%	5%	10%	15%	15%	15%
Implement Conservation Tillage Methods	0.167	50%	60%	70%	70%	70%	70%
Precipitation Enhancement	0.08	0%	100%	100%	100%	100%	100%

Aggregate demand reductions by combining multiple strategies can significantly reduce the irrigation needs. Two different combinations of strategies for water demand reduction were evaluated. Both scenarios considered the use of NPPET, LEPA, conservation tillage, and precipitation enhancement. The first combination considered a change in crop variety, from long season to short season varieties, and the second combination considered a crop change from corn to sorghum. The first scenario resulted in a total irrigation demand reduction of 70,729 acre-feet per year in the region for the period from 2020 to 2050.

Revising the irrigation demands, using the aggregate reductions, results in four of the counties having enough supply to meet their needs during the 50-year planning period. Only two counties, Dallam and Moore, continue to show needs over the period. However, approximately 27 and 28 percent, respectively, of the total irrigation demands can be met by assuming the aggregate demand reductions.

In addition to evaluating the above irrigation demand reduction strategies, an economic analysis was conducted to determine the feasibility of importing irrigation water from counties with surplus availability to counties with identified needs. The analysis indicates that the cost of imported water needs to be lower than $120 acre-foot. Considering the distances between counties, it is unlikely that the associated cost of delivering imported water would be lower than $120 per acre-foot.

Livestock needs are proposed to be met by each producer by developing additional groundwater supplies. It may also be economically feasible to import water into the counties showing needs from nearby counting with available developable supplies. The water could be diverted to individual or clusters of concentrated animal feeding operations (CAFOs) to accommodate the projected growth.

REGULATORY, ADMINISTRATIVE OR LEGISLATIVE RECOMMENDATIONS

According to SB1 guidelines, regulatory, administrative, and legislative recommendations were developed for the PWPA Regional Water Supply Plan. The objective of these recommendations is to facilitate 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 the state and regional water planning area. Following is a list of recommendations proposed by the PWPG for the TWDB to consider.

REGULATORY ISSUES

- TWDB should evaluate the notification requirements for amending the regional water supply plan.
- TNRCC should evaluate the rules governing reuse of wastewater effluent.
- TNRCC should encourage utilities to monitor unaccounted for water losses.
- TWDB should evaluate the definition of major water provider.
- TWDB should evaluate the methodology for developing irrigation demands.
- TWDB/TNRCC should evaluate the issue of groundwater rights vs. surface water rights.
- TWDB should submit plans for and results of reservoir feasibility studies to the appropriate Compact Commission (Red River Compact Commission or Canadian River Compact Commission) for review.

LEGISLATIVE ISSUES

- Provide interim funding for regional water planning.
- Prioritize state-sponsored water availability modeling, including groundwater availability modeling, especially as it relates to minor aquifers in the PWPA.
- Sponsor information gathering programs to improve the data on agricultural water use.
- Provide funding for implementation of water supply strategies.
- Create groundwater districts to manage groundwater resources through local districts across the State.
- Create a water conservation reserve program to make it economically feasible for farms to convert from irrigated acreage to dryland.
- Provide funding for utilities to replace/repair aging infrastructure.
- Provide funding for expansion of the NP-PET network and integration into a statewide network.
- Evaluate legislative barriers to using playa lakes for beneficial water supply.

- Provide funding for conducting feasibility studies of the Sweetwater Creek Reservoir project.
- Evaluate and clarify authority for reasonable and equitable export fees for groundwater districts.
- The PWPG requests that the Legislature requires coordination between Regional Water Planning Groups and State agencies regarding the development of the GAM and WAM models to ensure that the two models are not developed independently.

RECOMMENDATIONS FOR FUTURE STATE WATER PLANS

- TWDB should establish clear guidelines for eligibility for funding and needs assessment for very small cities and unincorporated areas.
- TNRCC should be made at least an ex-officio member of the RWPGs to provide input on known water quality/quantity problems.
- TWDB should provide clarification of the significance of designating unique reservoir sites and ecologically unique stream segments.
- TWDB should allow development of alternative near-term scenarios.
- TWDB should allow alternative definitions of the reliable supply from a reservoir.
- TWDB should continue to include potential PWPA reservoir sites in future water plans. These include, but are not limited to, Lelia Creek Reservoir site, Sweetwater Creek Reservoir site, and Red Deer Creek flood control/aquifer recharge structures.
- TWDB should separate water conservation from demand projections so conservation can be evaluated as a strategy.
- TWDB should provide clarification of the relationship between drought contingency planning and regional water supply planning.
- TWDB should simplify the format of required tables and provide better guidance for populating the tables.
- TWDB should allow complete access to TWDB and TNRCC database files by consultants.
- TWDB should include an economic impact analysis for the result of implementing water management strategies. The analysis should include impacts on water suppliers, users and major economic sectors.
- TWDB should include in future State Water Plans, salinity control projects for the Canadian River and/or Red River Basin.
- Water quality should play a more important role in future planning efforts.
- TWDB should include in future water plans, a detailed assessment for the interbasin/intrabasin water transfers in the PWPA.
- TWDB should provide guidance on how to account for brush control in the context of "new surface water supply."