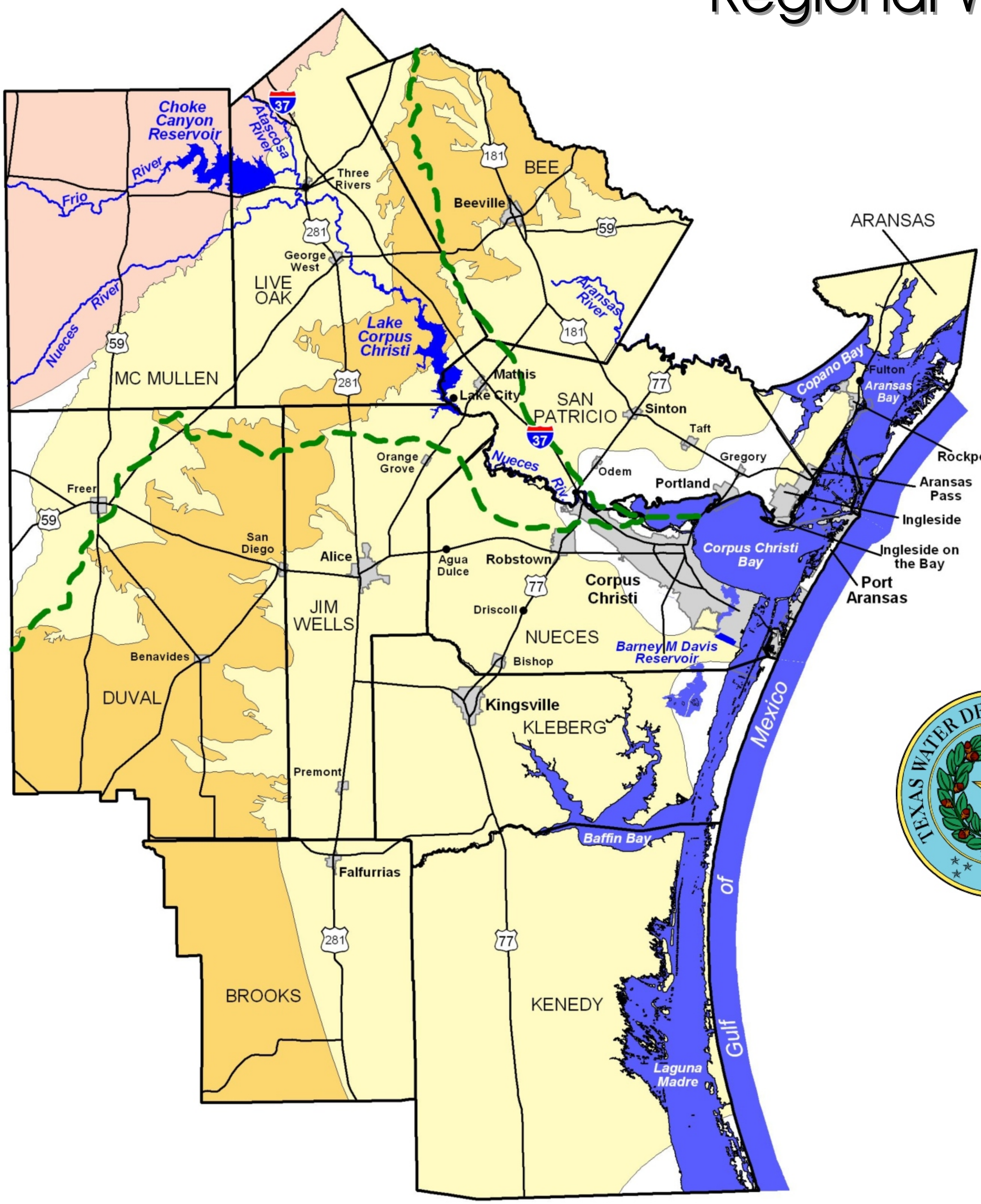
Coastal Bend
Regional Water Planning Area
Region N



Regional Water Plan

Volume I
Executive Summary and Regional Water Plan

January 2006

Prepared for:

Texas Water Development Board

Prepared by:

Coastal Bend
Regional Water Planning Group

With administration by:

Nueces River Authority

With technical assistance by:

HDR Engineering, Inc.

In association with:

The Rodman Company

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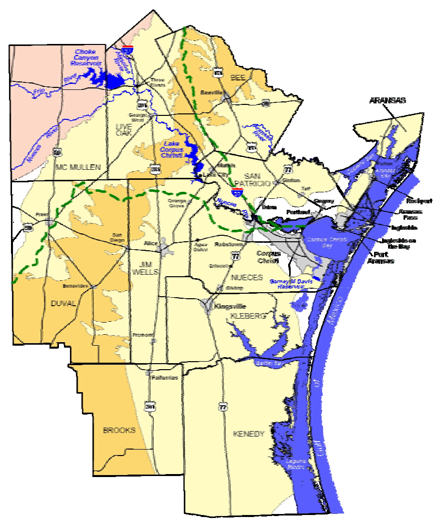
Coastal Bend
Regional Water Planning Area

Regional Water Plan
Volume I
Executive Summary and Regional Water Plan



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Coastal Bend Regional Water Planning Area
2006 Regional Water Plan

Acknowledgements

The thoughtful consideration, input, public service, and direction of the members of the Coastal Bend Regional Water Planning Group is gratefully acknowledged in producing the water plan for this diverse planning area.

Coastal Bend Regional Water Planning Group

Voting Members

Co-Chair	Ms. Carola Serrato, South Texas Water Authority	Water Utilities Representative
Co-Chair	Mr. Scott Bledsoe III, Live Oak UWCD	Water Districts Representative
Secretary	Dr. Patrick Hubert, Hubert Veterinary Clinic	Small Business Representative
	Mr. Tom Ballou, Sherwin Alumina	Industry Representative
	Mr. Bill Beck, Barney M. Davis LP	Electric Generating Utilities Representative
	Mr. Chuck Burns, Rancher	Agricultural Representative
	Ms. Teresa Carrillo, Coastal Bend Bays Foundation	Environmental Representative
	Mr. Billy Dick, City of Rockport	Municipal Representative
	Mr. Pearson Knolle	Small Business Representative
	Mr. Robert Kunkel, Equistar Chemical LP	Industry Representative
	Ms. Josephine Miller, San Patricio Economic Development Corporation	County Representative
	Mr. Bobby Nedbalek, Farmer	Agricultural Representative
	Mr. Bernard Paulson, Port Authority	Other Representative
	Mr. Thomas M. Reding, Jr., Nueces River Authority	River Authorities Representative
	Mr. Mark Scott, City of Corpus Christi Councilmember District 4	Municipal Representative
	Ms. Kimberly Stockseth	Public Representative

Non-Voting Members

Mr. Matt Nelson	Texas Water Development Board
Mr. Vincente Guerra	Freer WCID
Mr. George Aguilar	Texas Department of Agriculture
Dr. Jim Tolan	Texas Parks and Wildlife Department
Mr. Tomas Dominguez	USDA – NRCS
Mr. Con Mims, Nueces River Authority	South Central Texas RWPG
Mr. Robert Fulbright	Rio Grande RWPG
Mr. Haskell Simon	Lower Colorado RWPG

The efforts, long hours, and diligence is specially noted and appreciated of these individuals:

Ms. Rocky Freund, Deputy Executive Director	Nueces River Authority
Mr. Ralph Boeker	Texas Water Development Board (resigned)
Mr. Sam Sugarek	Nueces River Authority
Ms. Jew-Lee I. Lann	Nueces River Authority

Coastal Bend Regional Water Planning Area

Regional Water Plan

Mr. Scott Bledsoe III, Co-Chair
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Mr. Robert Kunkel
Industry Representative

Ms. Josephine Miller
County Representative

Mr. Bobby Nedbalek
Agricultural Representative

Mr. Mark Scott
Municipal Representative

Ms. Kimberly Stockseth
Public Representative

As adopted by the Coastal Bend
Regional Water Planning Group
on this date December 8, 2005

Coastal Bend Regional Water Planning Area
Regional Water Plan

For HDR Engineering, Inc.

1/4/06

Kenneth L. Choffel, P.E., Senior Vice President
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Coastal Bend (Region N) Regional Water Plan

Executive Summary

Background

Senate Bill 1 was enacted by the 75th Session of the Texas Legislature in 1997. It specified that water plans be developed for regions of Texas and 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 water plans. As stated in Senate Bill 1, the purpose of this region-based 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 Coastal Bend Region, which is comprised of 11 counties (Figure ES-1), is one of the State's 16 planning regions established by the TWDB.

The 16-member Coastal Bend Regional Water Planning Group (CBRWPG) was appointed by the TWDB to represent a wide range of stakeholder interests and act as the steering and decision-making body of the regional planning effort. The CBRWPG designated the Nueces River Authority as the administrative agency and principal contractor to receive a grant from the TWDB to develop the water plan. The CBRWPG selected HDR Engineering, Inc. as prime consultant for planning and engineering tasks for plan development.

The CBRWPG's members represent 12 interests: the public, counties, municipalities, industries, agriculture, the environment, small businesses, electric-generating utilities, river authorities, water districts, water utilities, and others. Table ES-1 lists the interest groups and individual members of the CBRWPG.

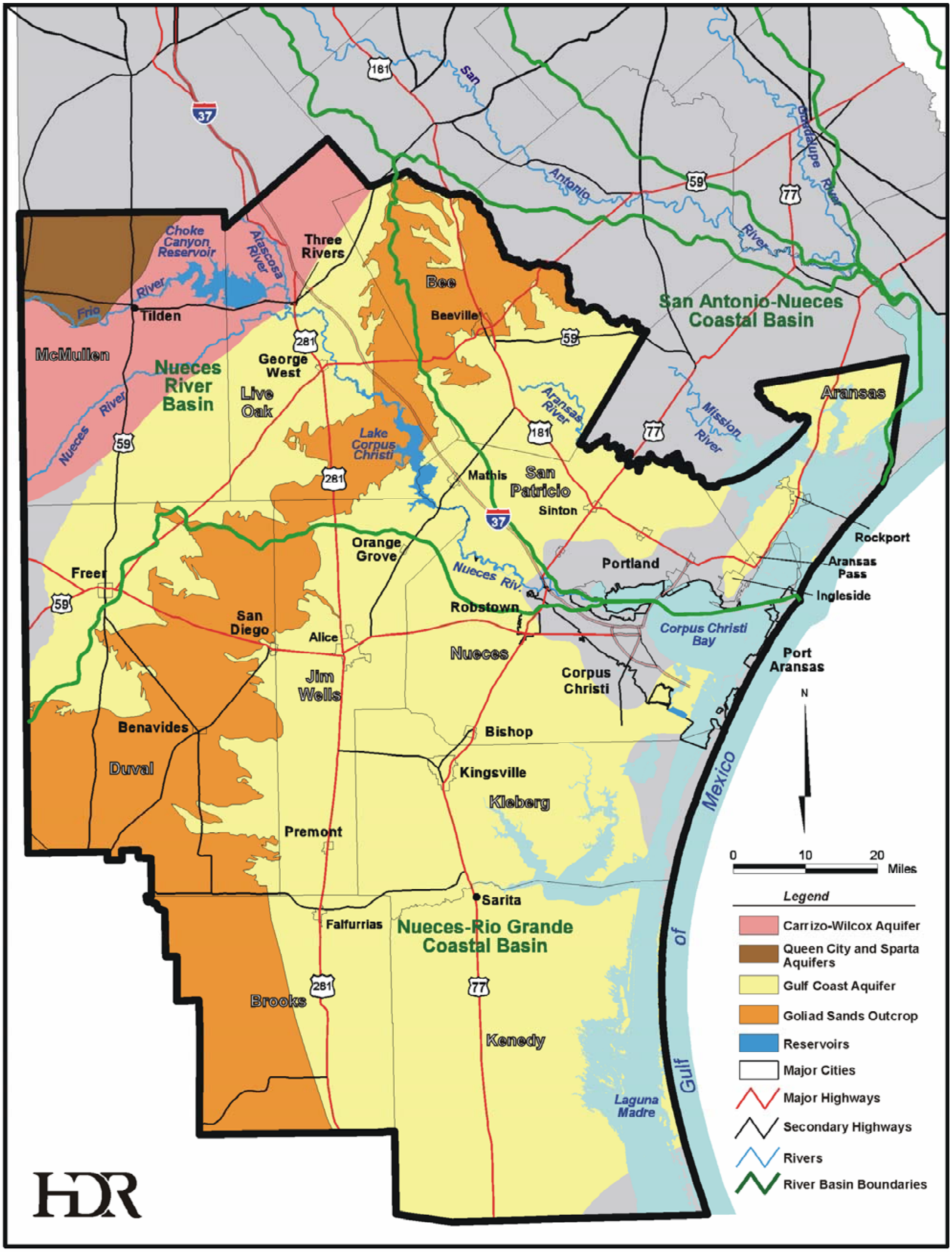

Figure ES-1. Coastal Bend Regional Water Planning Area

Table ES-1.
Coastal Bend RWPG Members
(as of December 2005)

Interest Group	Name	Entity
Voting Members		
Agriculture	Mr. Chuck Burns Mr. Bobby Nedbalek	Rancher Farmer
County	Ms. Josephine Miller	San Patricio Economic Development Corporation
Electric Generating Utilities	Mr. Bill Beck	Barney M. Davis LP
Environmental	Ms. Teresa Carrillo	Coastal Bend Bays Foundation
Industry	Mr. Tom Ballou Mr. Robert Kunkel	Sherwin Alumina Equistar Chemical LP
Municipalities	Mr. Billy Dick Mr. Mark Scott	City of Rockport City of Corpus Christi Councilmember-District 4
Other	Mr. Bernard Paulson, Executive Committee	Port Authority
Public	Ms. Kimberly Stockseth	
River Authorities	Mr. Thomas M. Reding, Jr., Executive Committee	Nueces River Authority
Small Business	Dr. Patrick Hubert, Secretary Mr. Pearson Knolle	Hubert Veterinary Clinic
Water Districts	Mr. Scott Bledsoe III, Co-Chair	Live Oak UWCD
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	Dr. Jim Tolan	Texas Parks and Wildlife Department
	Mr. Tomas Dominguez	USDA – NRCS
Liaison, South Central Texas RWPG	Mr. Con Mims	Nueces River Authority
Liaison, Rio Grande RWPG	Mr. Robert Fulbright	
Liaison, Lower Colorado RWPG	Mr. Haskell Simon	
Staff	Ms. Rocky Freund	Nueces River Authority

On January 3, 2001, the CBRWPG adopted and submitted to the TWDB the "Coastal Bend Regional Water Planning Area Regional Water Plan." In response to directives of Senate Bill 2 (77th Texas Legislature, 2001), the CBRWPG prepared a Scope of Work and Budget to update and revise the January 3, 2001, Coastal Bend Regional Water Plan, and on March 29, 2002, the CBRWPG applied to the TWDB for funding to accomplish the update and revision directed by Senate Bill 2. The updated and revised Coastal Bend Regional Water Plan is presented below.

The planning horizon used in the plan is the 60-year period from 2000 to 2060. This planning period allows for long-term forecast of the prospective water situation, sufficiently in advance of needs, to allow for appropriate water management strategies 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.

This executive summary and the accompanying *Regional Water Plan* convey water supply planning information, projected needs in the region, the CBRWPG proposed water management strategies to meet those needs, and other findings. The report is provided in two volumes. Figure ES-2 shows the contents of each volume.

Description of the Region

The area represented by the CBRWPG ("Region N" or "Coastal Bend Region") includes the following counties: Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio (Figure ES-1). The Coastal Bend Region has four regional Wholesale Water Providers: the City of Corpus Christi, San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces County Water Control and Improvement District #3 (Nueces County WCID #3). The City of Corpus Christi, the largest of the four, sells water to two of the other regional water providers—SPMWD and STWA. The City of Corpus Christi and the SPMWD distribute water to cities, water districts, and water supply corporations providing water to residential, commercial, and industrial customers. STWA provides water to cities and water supply corporations that supply both residential and commercial customers within the western portion of Nueces County as well as Kleberg County.

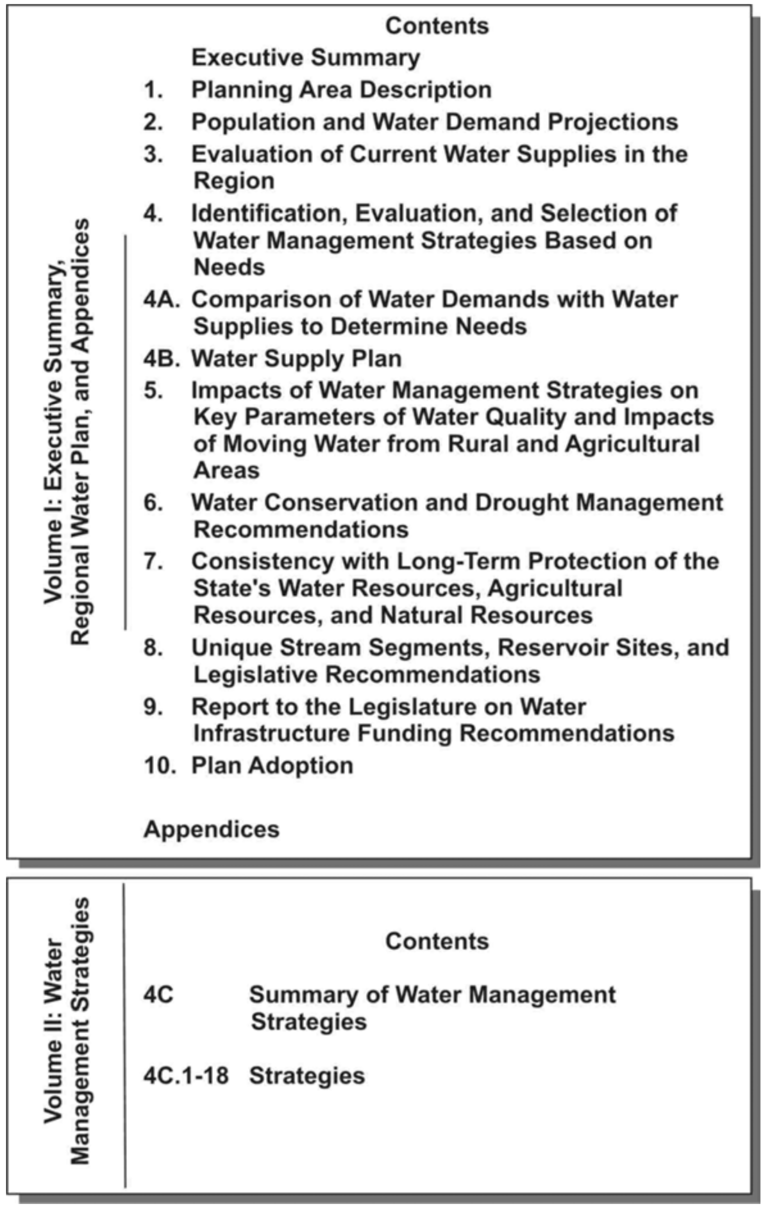

Figure ES-2. Plan Structure

Copies of Volumes I and II are filed at each County Clerk's office and at one public library in each county. Copies of individual sections can be obtained by calling the Nueces River Authority at (361) 825-3193.

In addition to the work contained in the two volumes of the *Regional Water Plan*, other important products produced as part of the Coastal Bend planning effort include:

1. Projected groundwater pumping estimates from 2000 to 2060 used in the TWDB Central Gulf Coast Groundwater Availability Model. These pumping estimates were submitted to the TWDB and approved for use in their predictive model (2000 to 2060). For more detail regarding the new Gulf Coast Aquifer model development and application, please refer to Appendix D.
2. Hydrologic updates to the City of Corpus Christi Lower Nueces River Basin and Estuary Model (NUBAY) from 1998 to 2003.
3. Periodic newsletters were prepared by the Rodman Company and are included in Appendix H.

The smallest regional wholesale water provider, Nueces County WCID #3, provides water to the City of Robstown and other municipal entities within the western portion of Nueces County. The major water demand areas are primarily municipal systems in the greater Corpus Christi area, as well as large industrial (manufacturing, steam-electric, and mining) users primarily located along the Corpus Christi and La Quinta Ship Channels. Based on state surveys[1] of industrial water use, industries in the Coastal Bend area are very efficient in their use of water. For example, petroleum refineries in the Coastal Bend area use on the average 60 percent less water to produce a barrel of refined crude oil than refineries in the Houston/Beaumont area.

The Coastal Bend Region depends mostly on surface water sources for municipal and industrial water supply use. The two major surface water supply sources include the Choke Canyon Reservoir/Lake Corpus Christi System (CCR/LCC System) in the Nueces River Basin and Lake Texana on the Navidad River in Jackson County. The water quality of these sources is generally good. However, there are some areas of concern, specifically within the Lower Nueces River and the Calallen Reservoir Pool, where the bulk of the region's water supply intakes are located.

There are some areas in the region that are dependent on groundwater. There are two major aquifers that lie beneath the region—the Carrizo-Wilcox and Gulf Coast Aquifers. The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of both fresh and slightly saline water. The Carrizo-Wilcox Aquifer only underlies parts of McMullen, Live Oak, and Bee Counties and contains moderate to large amounts of either fresh or slightly saline water.

In 1990, the population of the Coastal Bend Region was 492,829 and per capita income was $13,296. In 2000, the population of the Coastal Bend Region had grown to 541,184 with a regional average per capita income of $19,833, ranging from $14,876 in Brooks County to $26,458 in McMullen County.[2] The Corpus Christi Metropolitan Statistical Area, consisting of Aransas, Nueces, and San Patricio Counties, accounts for 75 percent of the Coastal Bend Region's population and 80 percent of the Total Personal Income.

[1] Texas Water Development Board, "Industrial Water Use Efficiency Study," 1993.
[2] U.S. Department of Commerce Bureau of Economic Analysis, Regional Economic Information System (REIS) Database, 2005.

The primary economic activities within the Coastal Bend Region include oil/gas production and refining, petrochemical manufacturing, military installations, retail/trade, agriculture, and service industries including health services, tourism/recreation industries, and governmental agencies. In 2000, these industries employed nearly 280,000 people in the Coastal Bend Region with annual earnings over $8.4 billion.[3] The retail/trade sector had the biggest economic impact in 2000, with an economic contribution of $3.1 billion, and created over 39 percent of the jobs in the Region. The petrochemical and refining industries brought over $450 million into the Coastal Bend Region's economy.

Population and Water Demand Projections

In December 2002, the TWDB published new population and water demand projections[4] for each county in the state. In the Coastal Bend Region, population projections were developed for cities with a population greater than 500 and water supply corporations and special utility districts using water volumes of 280 acft or more in 2000. To account for people living outside the cities, projections were also developed for a 'county-other' category for each county. Requests for revisions to the population and municipal water demand projections were forwarded to the TWDB and adopted.

Population Projections

Figure ES-3 illustrates population growth in the entire Coastal Bend Regional Water Planning Area for 1990 and 2000 and projected growth for 2010, 2020, 2030, 2040, 2050, and 2060. In 2060, the population of the Coastal Bend Regional Water Planning Area is projected to be 885,665.

As can be seen in Figure ES-4, the average annual growth rate of the region over the 50-year planning period is 0.82 percent. San Patricio and Nueces Counties have growth rates higher than the regional average, while the other counties have lower growth rates than the average, and in the case of McMullen County, negative growth rate.

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[3] Ibid.
[4] The population and water demand projections were developed in consultation with the Texas Parks and Wildlife Department and Texas Natural Resources Conservation Commission. The completed projections are referred to as the 1997 Consensus Population and Water Demand Projections.

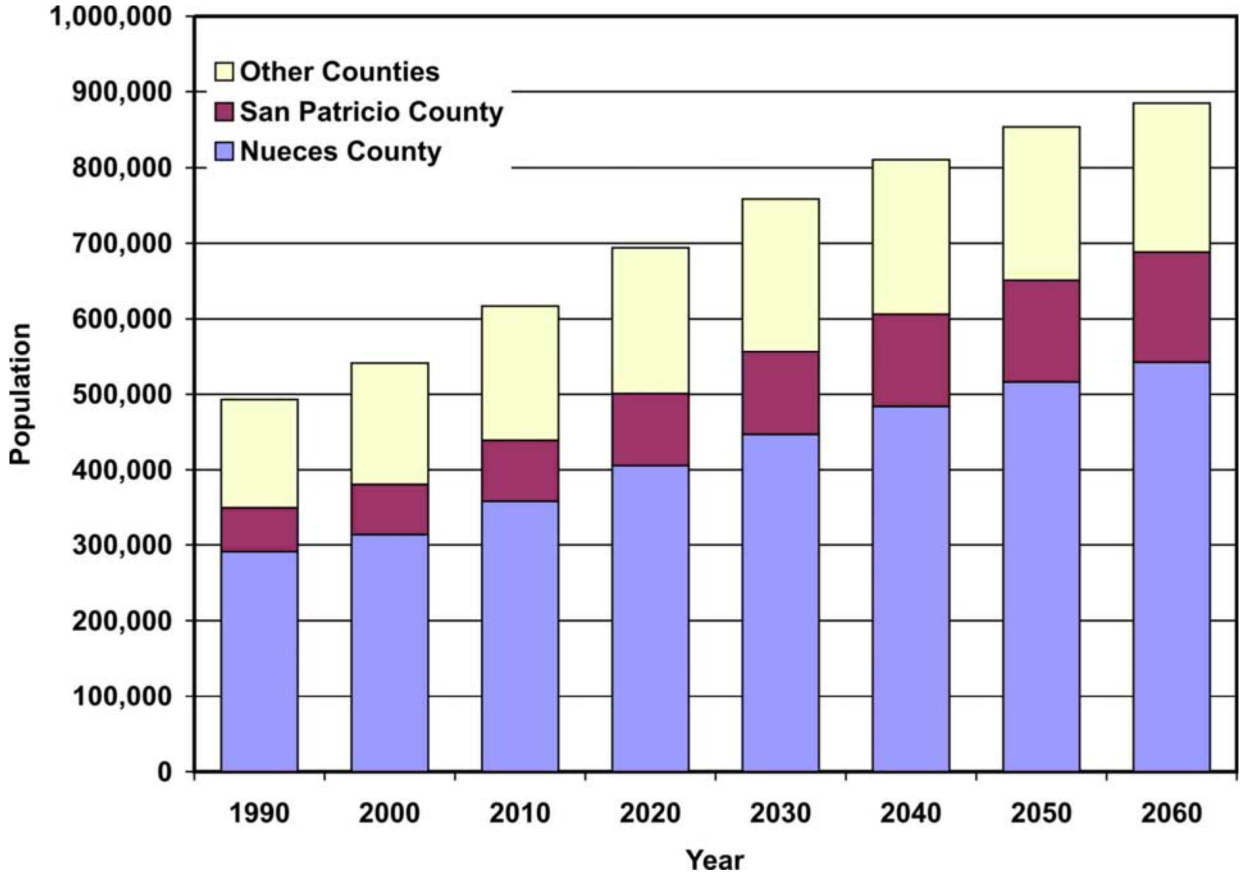


Figure ES-3. Historical and Projected Coastal Bend Regional Water Planning Area Population

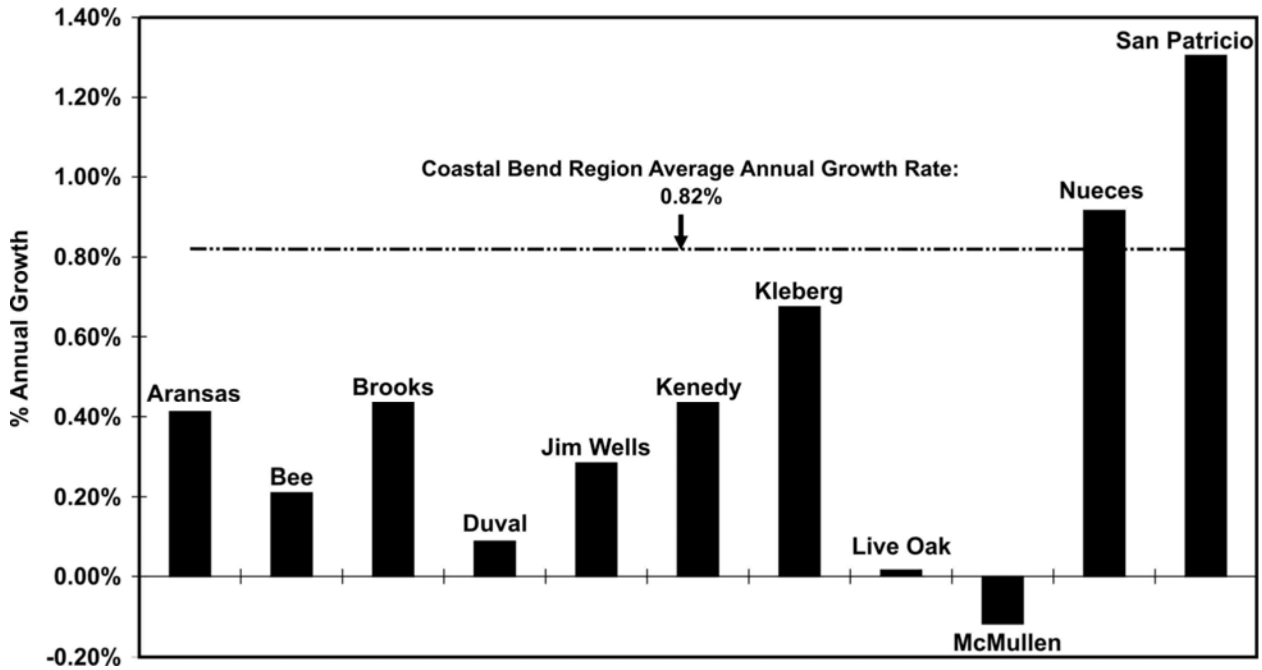


Figure ES-4. Percent Annual Population Growth Rate for 2000 through 2060 by County

Water Demand Projections

Water demand projections have been compiled for six categories of water use: (1) Municipal, (2) Manufacturing, (3) Steam-Electric Cooling, (4) Mining, (5) Irrigation, and (6) Livestock.

Water User Groups

Each of these consumptive water uses is termed a "water user group" according to Senate Bill 1. Incorporated cities and County-Other category are water user groups within the Municipal Use category. County-Other category includes persons residing outside of cities and also outside water utility boundaries. Water demand projections and supplies have been estimated for all water user groups.

Total water use for the region is projected to increase from 205,936 acft in 2000 to 308,577 acft in 2060, a 49.8 percent increase. The trend in total water use is shown in Figure ES-5. The six types of water use and associated demands are shown for 2000 and 2060 in Figure ES-6. All categories of water use increase during the 2000 to 2060 period except for irrigation, which decreases, and livestock, which remains constant.

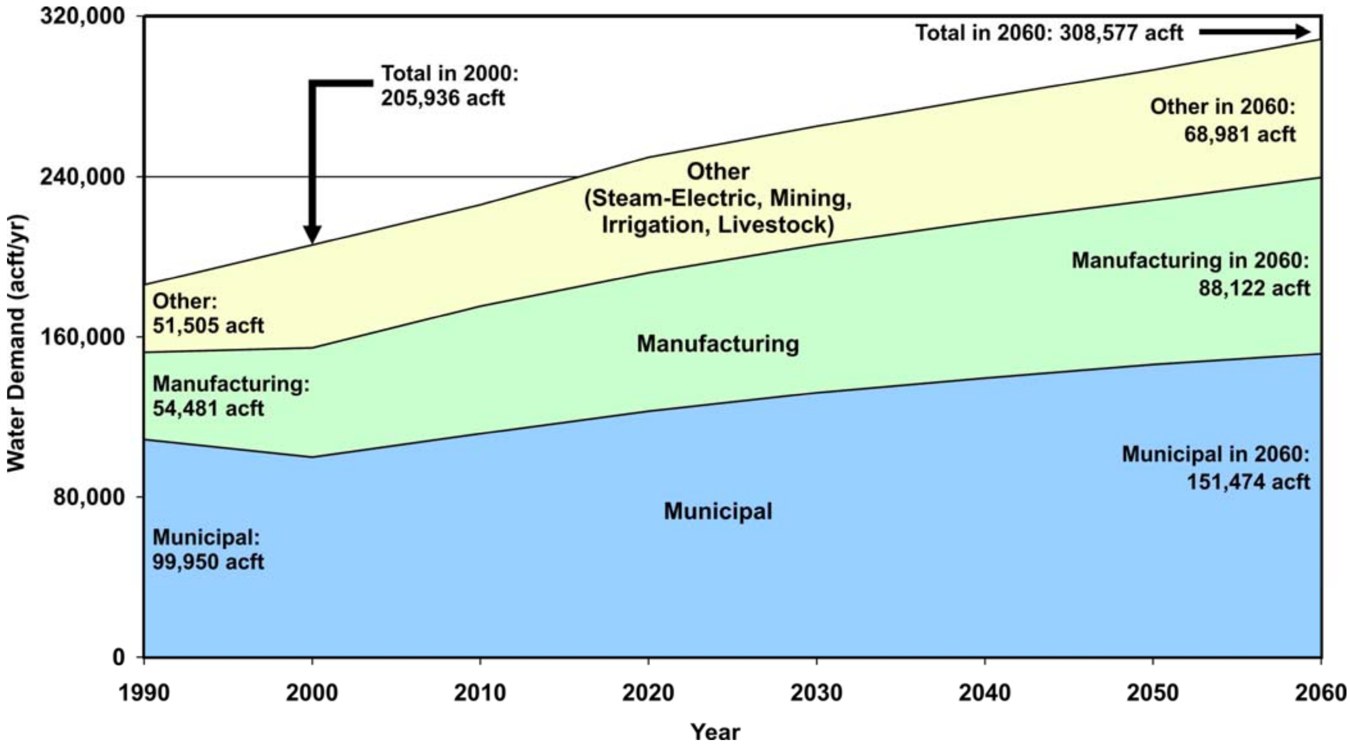


Figure ES-5. Projected Total Water Demand

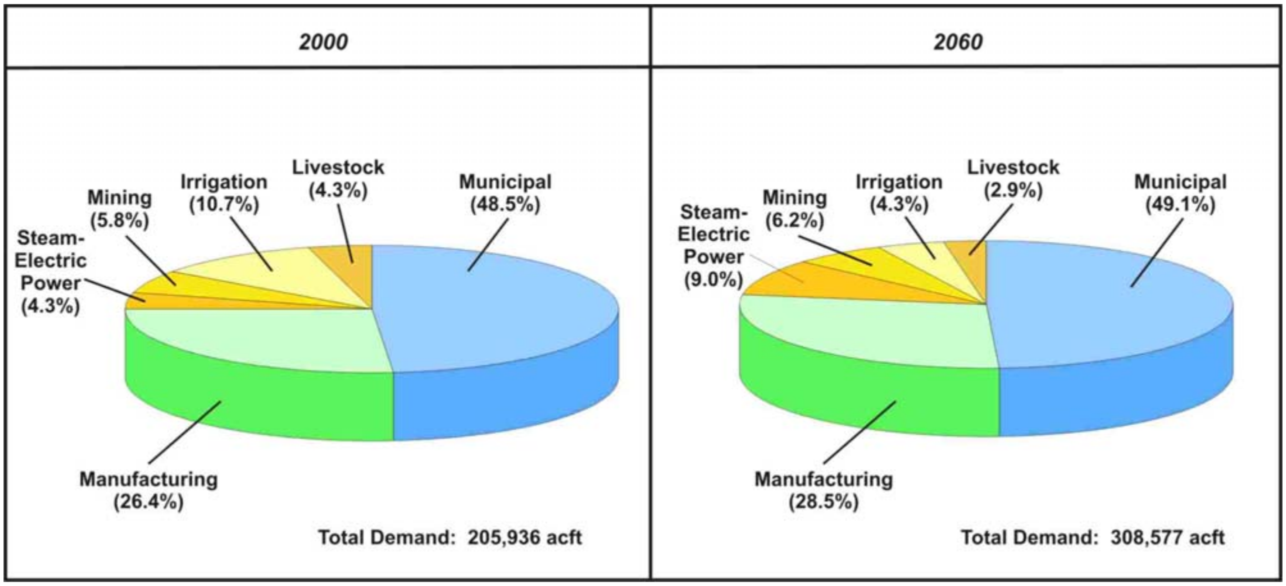


Figure ES-6. Total Water Demand by Type of Use

Municipal Use and Water Conservation

The 51.5 percent projected increase in municipal water demand over the 60-year planning horizon is lower than the projected population increase of 63.6 percent due to expected savings in per capita water use resulting from water conservation. Average per capita municipal water use in 2000 was 165 gallons per capita per day and is projected to decrease to 152 gallons per capita per day by 2060 due to built-in savings for low flow plumbing fixtures. This results in a reduction of 13,313 acft/yr in municipal water demand in 2060.

Water Supply

Surface Water Supplies

Streamflow in the Nueces River and its tributaries, along with reservoirs in the Nueces River Basin and interbasin transfers from Lake Texana, comprise the most significant supply of surface water in the Coastal Bend Region. Water rights associated with major water supply reservoirs are owned by the City of Corpus Christi and the Nueces River Authority. The western and southern parts of the region are heavily dependent on groundwater sources, due to limited access to surface water supplies.

Many entities within the Coastal Bend Region obtain surface water through water supply contracts. The City of Corpus Christi is the largest provider of water supply contracts in the Region with 205,000 acft/yr available from its reservoir system (2010 sediment conditions).[5]

[5] The City of Corpus Christi holds a contract with the Lavaca-Navidad River Authority to provide a base amount of 41,840 acft/yr and a maximum of 12,000 acft/yr on an interruptible basis from Lake Texana to the City.

Run-of-river and small municipal water rights provide 8,835 acft/yr of reliable water.[6] Other surface water supplies are provided by on-farm local sources and small supplies from adjacent coastal basins. Total supply from all surface water sources in year 2010 is 215,843 acft/yr, of which 93 percent is provided by the City of Corpus Christi's supplies (Table ES-2).

Table ES-2.
Total Supply in 2060 from
All Surface Water Sources
(acft)

Municipal	133,596
Manufacturing	42,639
Steam-Electric	27,664
Mining	12
Irrigation	4,352
Livestock	7,580
Total	**215,843**

Groundwater Supplies

Two major aquifers and two minor aquifers underlie parts of the Coastal Bend Planning Region (Figure ES-1) and have a combined reliable yield of about 102,628 acft/yr and projected 2060 use of 54,603 acft.[7] The two major aquifers include the Gulf Coast Aquifer, which supplies significant quantities of water throughout the region and the Carrizo-Wilcox Aquifer, which supplies water to the northwest portion of the study area in parts of McMullen, Live Oak, and Bee Counties (Figure ES-1). Groundwater supplies are based on projected groundwater use, well capacities, and drawdown constraints adopted by the Coastal Bend Region. In the northwestern part of the region, the Carrizo-Wilcox is a prolific aquifer with lesser quality water in most areas. Two minor aquifers, the Queen City and Sparta Aquifers, underlie McMullen County and provide moderate supplies to the region.

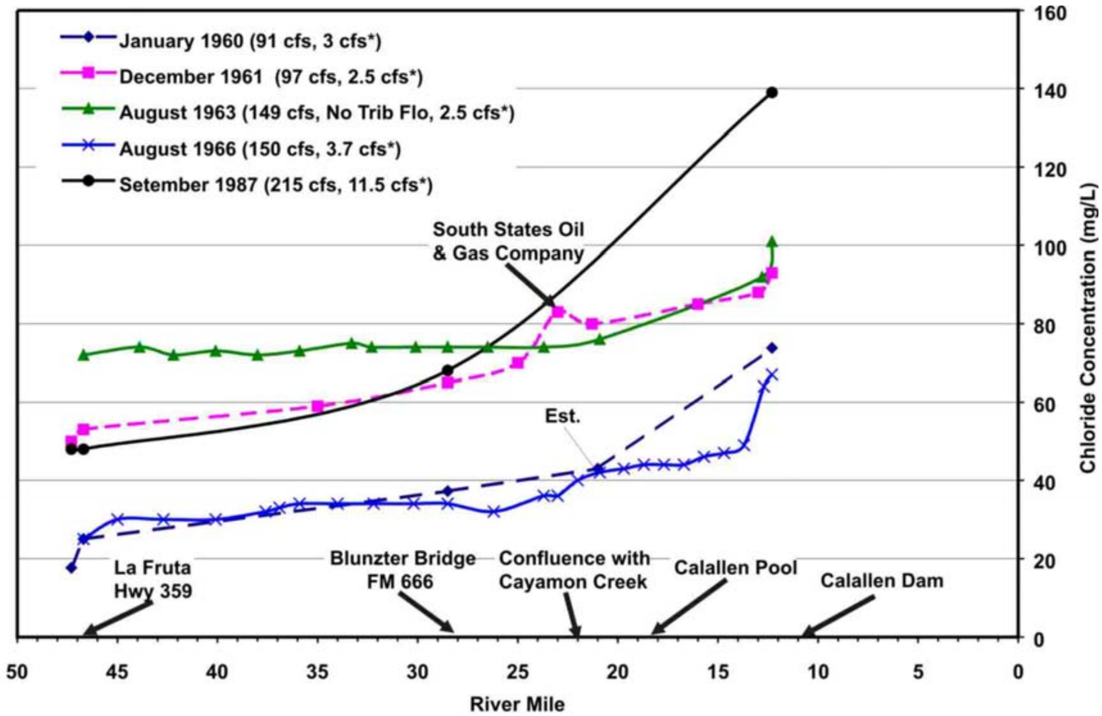
[6] This includes City of Corpus Christi permits for irrigation and mining uses, totaling 226 acft in Nueces and Live Oak Counties.
[7] Based on TWDB Central Gulf Coast Groundwater Availability Model analyses.

Water Quality

Previous studies by the U.S. Geological Survey and others show a significant increase in the concentration of dissolved minerals occurring in the Lower Nueces River between Lake Corpus Christi and the Calallen Saltwater Barrier Dam, where the vast majority of the Region's surface water is diverted. Figure ES-7, which summarizes these past studies, shows that chloride concentrations at the Calallen Pool on the average are 2.5 times the level of chlorides in water released from Lake Corpus Christi. The results of these studies indicate that on the average about 60 percent of the increase in chlorides occurs upstream of the Calallen Pool and about 40 percent of the increase within the pool. Potential sources of minerals to the Calallen Pool include saltwater intrusion, groundwater seepage, and upstream sources of contamination from abandoned wells in adjacent oil fields and gravel washing operations. The previous 2001 Plan included results of a Nueces River sampling program confirming the increase in mineral concentrations and evaluating the source of dissolved minerals within the Calallen Pool. The results of this sampling program strongly suggested that poor quality groundwater is entering the river and resulting in the increase. The effect of the high dissolved solids concentrations is two-fold and includes an increase in industrial water demands due to accelerated buildup of minerals in industrial cooling facilities, as well as high levels of chlorides and bromides, which sometimes exceed drinking water standards. Since a large portion of the Region's water demands are for industrial use, improvements in water quality will result in reduced levels of water consumption and provide additional water conservation for the region. Reductions in chloride and bromide levels will help ensure Safe Drinking Water Act requirements can be achieved without having to resort to expensive treatment methods.

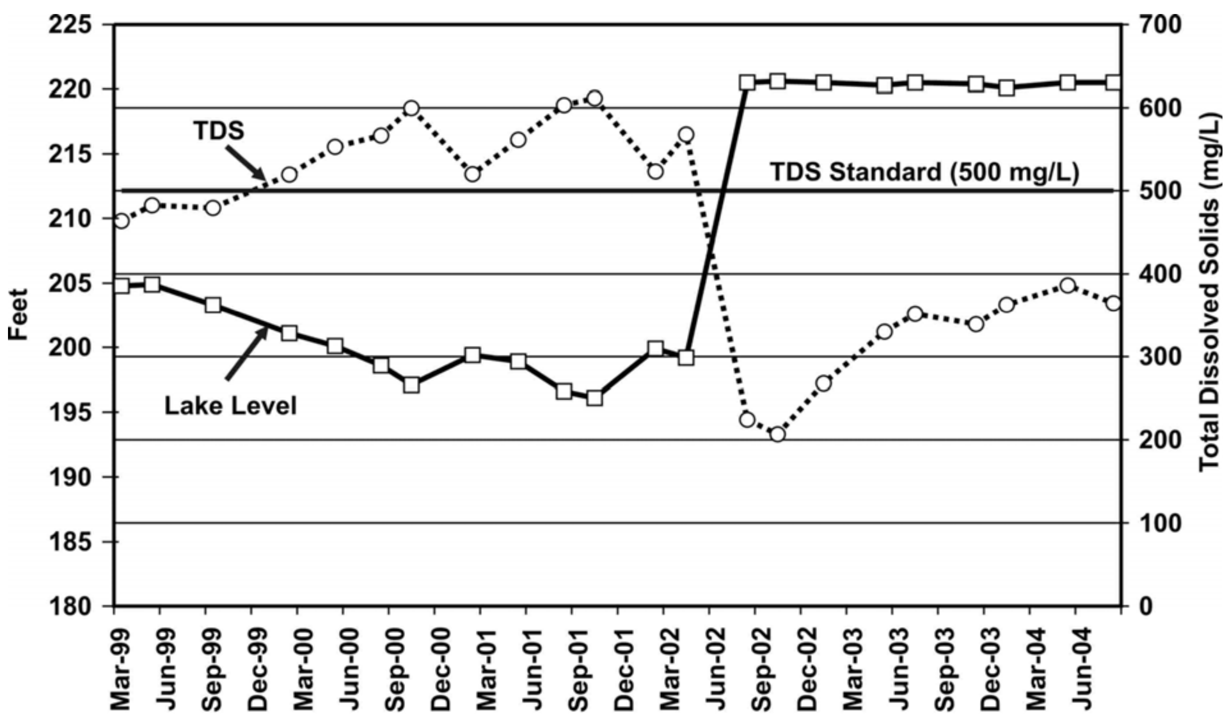
During drought conditions, Choke Canyon Reservoir water levels are lower, which results in higher concentrations of total dissolved solids (Figure ES-8). By operating the CCR/LCC System with safe yield supply conditions and keeping a reserve quantity of water in storage in Lake Corpus Christi for blending purposes, total dissolved solids concentrations can be better managed.

Groundwater supplies are generally of good water quality. However, some areas in the region have slightly brackish groundwater (TDS ≈ 1,000 to 1,500 mg/L). The TWDB Central Gulf Coast Groundwater Availability Model shows more available groundwater than previous



* Estimated groundwater and/or tributary inflow based upon chloride concentration of 1,700 mg/L

Figure ES-7. Summary of Historical Data — Chloride Content of the Lower Nueces River, Segment 2102



Source: Nueces River Authority, 2005 Basin Highlights Report

Figure ES-8. Comparison of Total Dissolved Solids and Choke Canyon Reservoir Lake Levels

estimates.[8] Increased groundwater demands are mostly for non-municipal uses (i.e., mining, irrigation, manufacturing) and do not have salinity concerns. In previous studies, Freer had water quality concerns associated with salinity and other water quality constituents. Their projected water demands have decreased; however, brackish groundwater desalination may be considered in the future. The Coastal Bend Region has recommended monitoring water quality from mining activities and their affects on water supplies.

Supply and Demand Comparison

The CBRWPG identified 14 individual cities and water user groups that showed unmet needs during drought of record supply conditions during the 60-year planning horizon. Figure ES-9 shows these water user groups with shortages for both the 2030 and 2060 timeframes.

Seven of the 11 counties in the region have a projected shortage in at least one of the water user groups in the county. These are Aransas, Duval, Jim Wells, Kleberg, Live Oak, Nueces and San Patricio. None of the water user groups in Bee, Brooks, Kenedy, or McMullen Counties have projected shortages. Table ES-5 (at the end of this Executive Summary) is organized by county and information on each municipality and water use category in the county is listed. The tables can be examined for each county to determine which cities and water user groups have projected shortages.

Constraints on Water Supply

Water supplies are also affected by contractual arrangements and infrastructure constraints. Expiring contracts, and insufficient well capacity - each of these supply constraints was taken into account in estimating water supplies available to municipal water user groups. Consequently, the water supply listed for a given city may be less than the quantity in their water purchase contract or water right.

Wholesale Water Providers

There are four wholesale water providers in the Region: the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3. In 2000, the City of Corpus Christi supplied about 77 percent of the Region's water demands, and SPMWD (a major customer of the City of Corpus Christi) supplied about 11 percent of the Region's water demands. Both STWA and Nueces County WCID #3 combined provided less than 3 percent of the Region's water demand.

[8] Coastal Bend Regional Water Plan, January 2001.

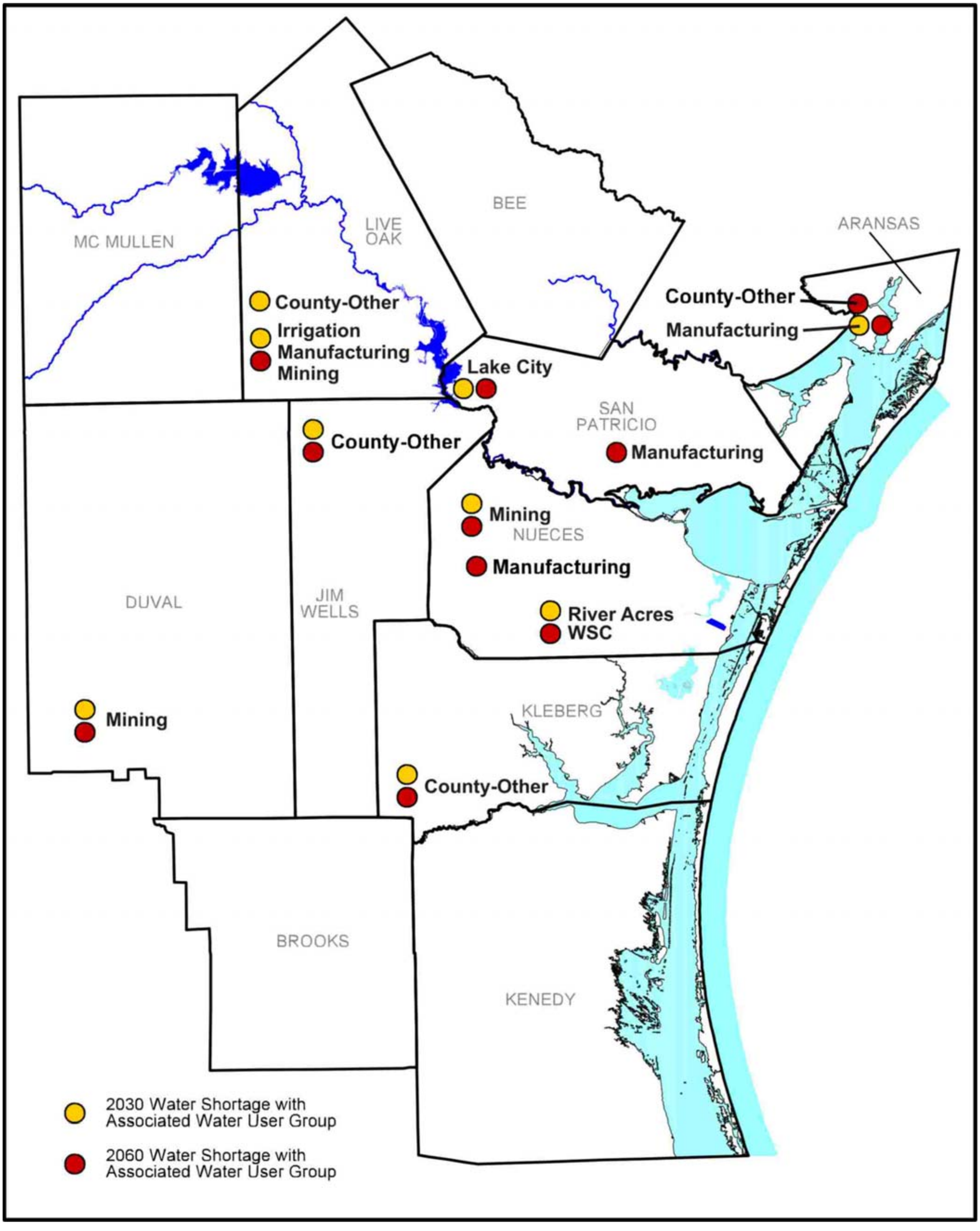


Figure ES-9. Location and Type of Use for 2030 and 2060 Water Supply Shortage

Figure ES-10 shows a comparison of water demands to currently available water supplies for each of these providers. The City of Corpus Christi needs additional supplies beginning about 2030. SPMWD needs additional supplies beginning around 2041. STWA and Nueces County WCID #3 have sufficient supplies to meet their projected customer demands to 2060.

By 2060, the Corpus Christi Service Area is estimated to need 39,505 acft of additional water supply. SPMWD Service Area is estimated to need 5,743 acft of additional water supply.

Water Supply Strategies to Meet Needs

Numerous water management strategies were identified by the CBRWPG as potentially feasible to meet water supply shortages. Each strategy was evaluated by the consultant team and compared to criteria adopted by the CBRWPG. The Coastal Bend Regional Water Plan includes recommended water management strategies that emphasize water conservation; maximize utilization of available resources, water rights, and reservoirs; engage the efficiency of conjunctive use of surface and groundwater; and limit depletion of storage in aquifers. There are additional strategies that have significant support within the region, yet require further study regarding quantity of dependable water supply made available during severe drought, feasibility, and/or cost of implementation, that are also included in the plan. The strategies are tabulated in Tables ES-3 and ES-4. Table ES-3 summarizes potential strategies for the Corpus Christi Service Area, while Table ES-4 summarizes strategies to other service areas. Additionally, Figure ES-11 provides a graphical comparison of unit costs and quantities of water provided for strategies evaluated. Section 4C in Volume II contains sections discussing each of these possible strategies in detail.

Table ES-5 summarizes findings and recommendations for every water user group with projected water shortages. The table also lists each municipality and water user group by county. Water demands are listed for years 2010, 2030, and 2060. Shortages are listed for years 2010, 2030, and 2060, along with recommended actions to meet these shortages. The recommended water supply plans are presented by county in greater detail in Section 4B of Volume I. Water management strategies recommended in the Coastal Bend Region could produce new supplies in excess of the projected regional need of 53,431 acft in Year 2060. Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under current interbasin water supply contracts. Total estimated project cost (in 2002 dollars) for the recommended water management strategies for the Coastal Bend Region is $458,421,250.[9] The capital costs for Wholesale Water Providers is $455,725,250 (99% of total cost), while remaining project cost of $2,696,000 is distributed amongst water user groups that are not customers of a wholesale water provider.

Future projects involving authorization from either the TCEQ and/or TWDB, which are not specifically addressed in the plan, are considered to be consistent with the plan under the following circumstances:

- TWDB receives applications for financial assistance for many types of water supply projects, including water conservation, and when appropriate, wastewater reuse strategies. Other projects involve repairing, replacing, or expanding treatment plants, pump stations, pipelines, and water storage facilities. The CBRWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even though not specifically recommended in the plan.
- TCEQ considers water rights applications for various types of uses (e.g., recreation, navigation, irrigation, hydroelectric power, industrial, recharge, municipal, and others). Many of these applications are for small amounts of water, some are temporary, and some are even non-consumptive. Because waters of the Nueces River Basin are fully appropriated to the City of Corpus Christi and others, any new water rights application for consumptive water use from this Basin will need to protect the existing water rights or provide appropriate mitigation to existing water right owners. Throughout the Coastal Bend Region, the types of small projects that may arise are so unpredictable that the CBRWPG is of the opinion that each project should be considered by the TWDB and TCEQ on their merits, and that the Legislature foresaw this situation and provided appropriate language for each agency to deal with it.

  (Note: The provision related to TCEQ is found in Texas Water Code §11.134. It provides that the Commission shall grant an application to appropriate surface water, including amendments, only if the proposed appropriator addresses a water supply need in a manner consistent with an approved regional water plan. TCEQ may waive this requirement if conditions warrant. For TWDB funding, Texas Water Code §16.053(j) states that after January 5, 2002, TWDB may provide financial assistance to a water supply project only after the Board determines that the needs to be addressed by the project will be addressed in a manner that is consistent with that appropriate regional water plan. The TWDB may waive this provision if conditions warrant.)

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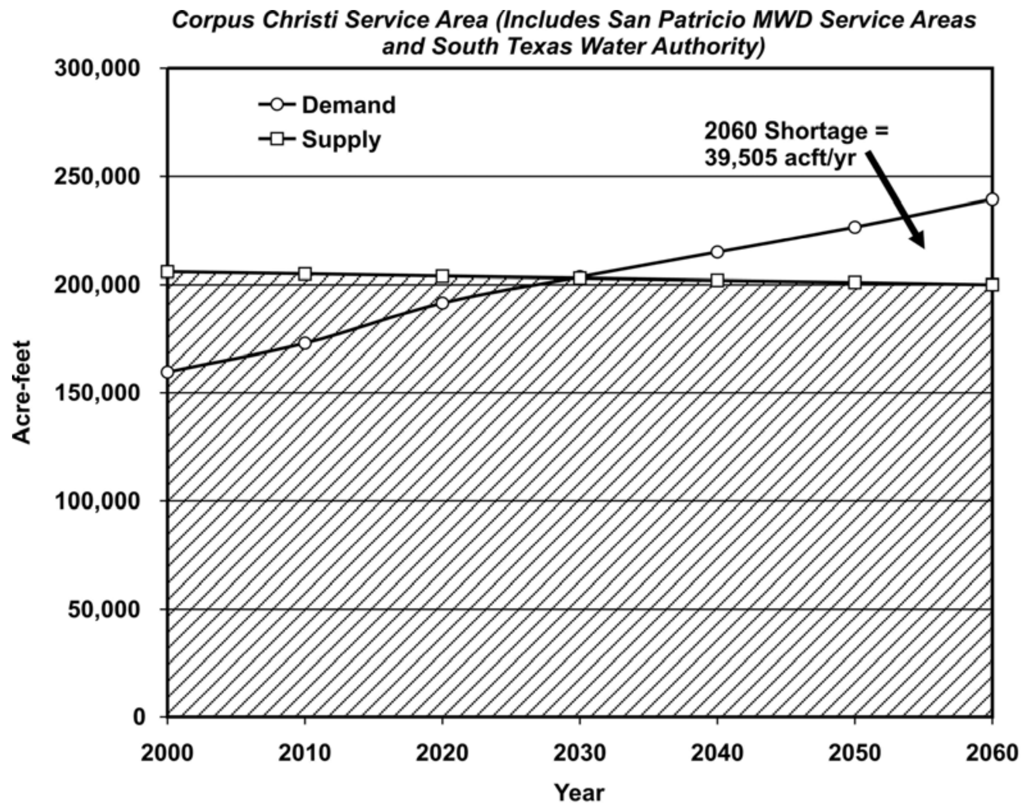
[9] The total capital cost is provided by request from the TWDB. It is understood that not all projects will be implemented, and that projects will be selected by water user groups from the recommended list(s) to meet needs.



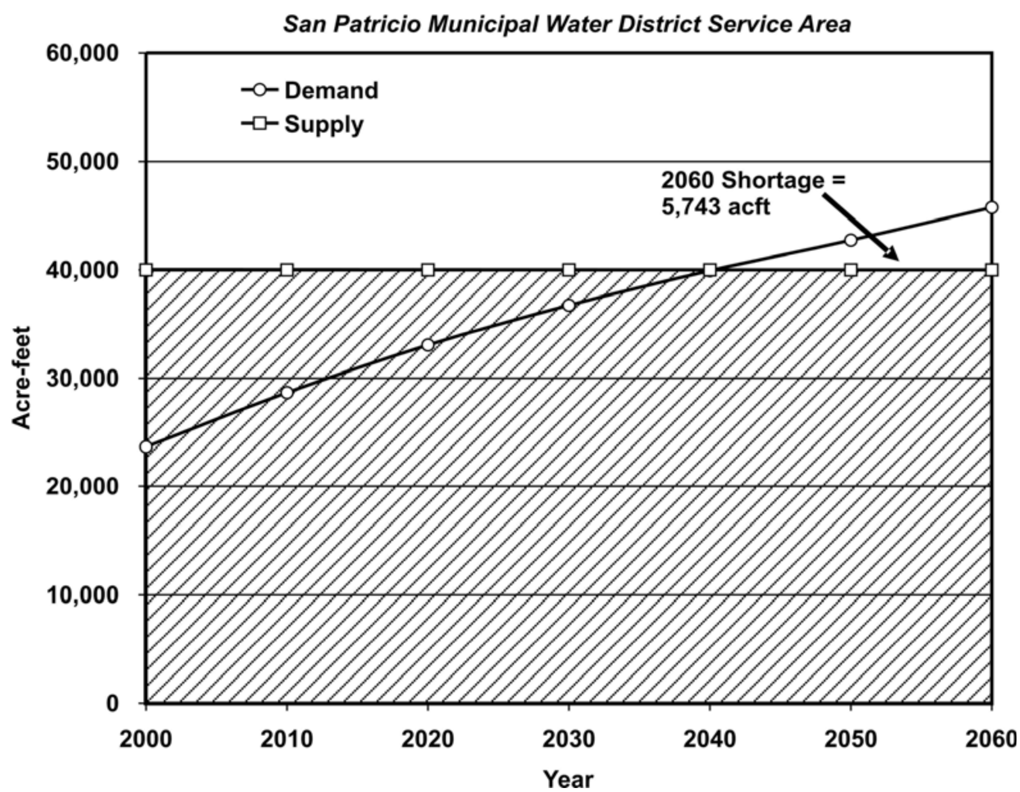
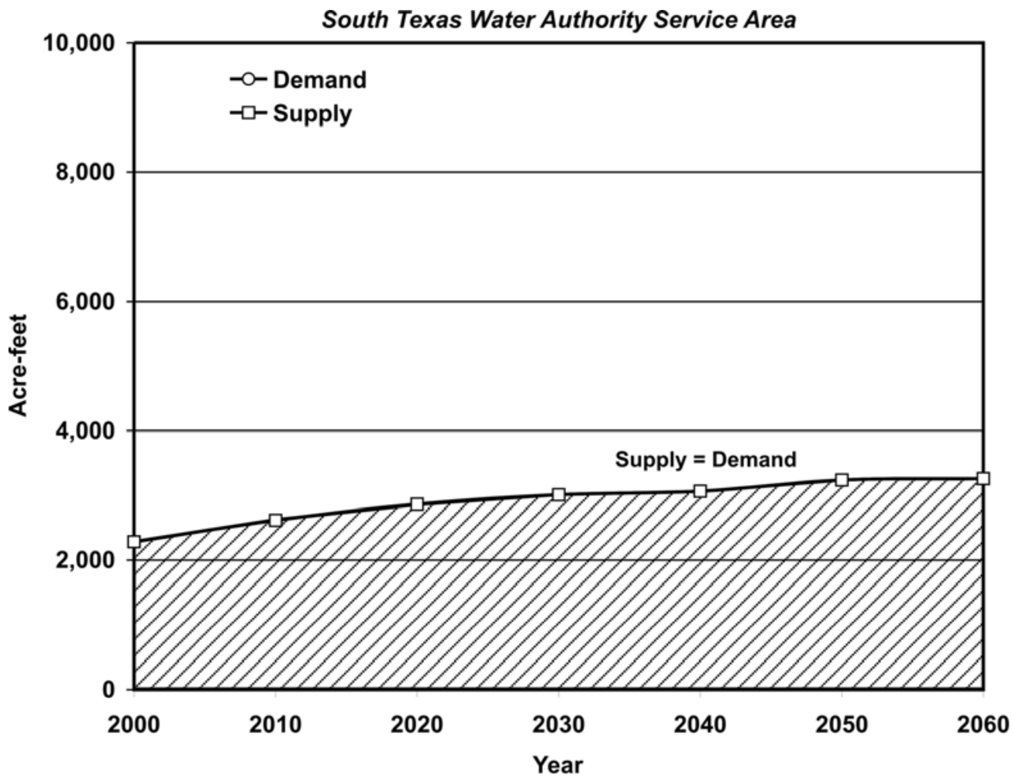


Figure ES-10. Water Supply vs. Demand for Major Water Providers Water Plan Findings and Recommendations (Page 1 of 2)



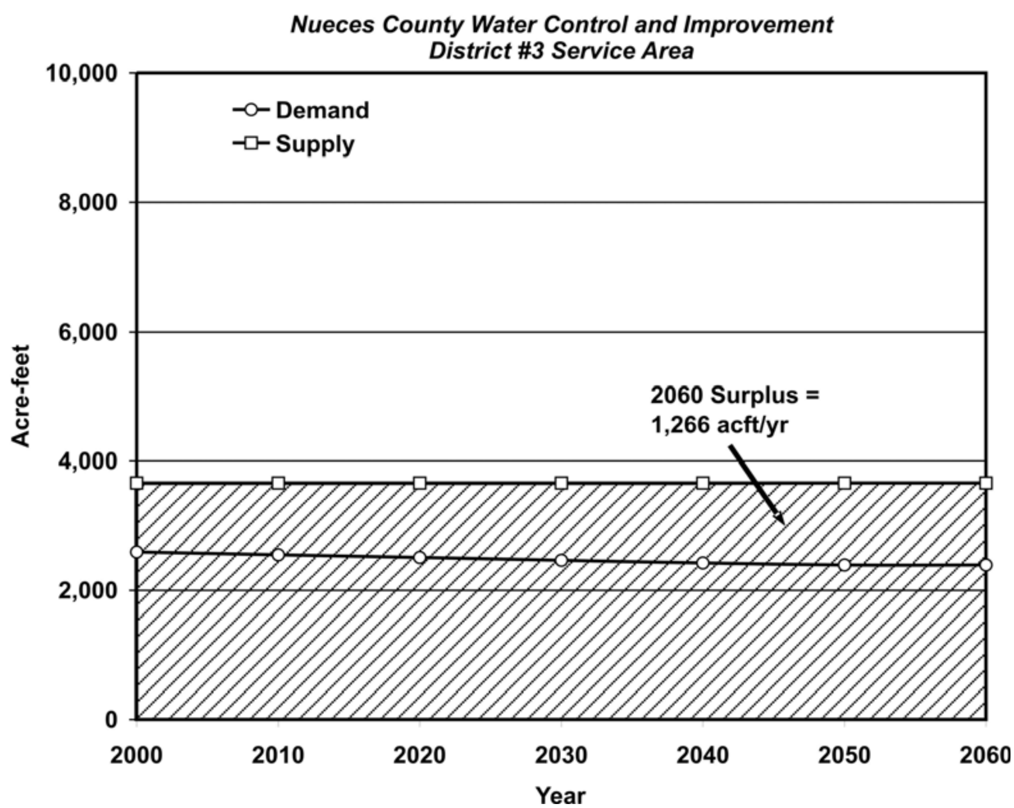


Figure ES-10. Water Supply vs. Demand for Major Water Providers Water Plan Findings and Recommendations (Page 2 of 2)

Table ES-3.
Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers

WMS ID	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 1,428	Variable; Regional Cost up to $803,457[1]	Variable	$69-$1,248	No Change	Possible reduction in return flows to bay and estuary.
N-3	**Manufacturing Water Conservation**						
N-3-1	Blending of Texana Water	up to 2,050	Not Applicable	Up to $461,250	$225 [2]	Significant Improvement	None
N-3-2	Outlet works to remove high TDS from Calallen Pool	150-730	$2,240,000	$343,250[2]	$470- $1,418 [2]	Significant Improvement	None
N-3-3	Intake Modifications	150-300	$5,884,000	$575,500[2]	$1,918- $3,612 [2]	Significant Improvement	None
N-3-4	Pipeline from LCC to Calallen	19,600-23,900	$122,100,000	$16,374,500[2]	$709- $795 [2]	Significant Improvement	Potentially significant environmental impacts/Construction and maintenance of pipeline corridors
N-4	**Mining Water Conservation**	up to 259	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	Variable	$1,500,000[4]	$500,000[4]	$725[4]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Groundwater supplies from Refugio, Bee, and/or San Patricio Counties	Variable	$45,642,000	$10,757,000[2]	$598 [2,3]	Some Degradation	Potential for increased freshwater inflows to estuary
N-8	**Multi-Year ASR along STWA Pipeline**	Negligible	Not Applicable[5]	Not Applicable[5]	-	No Change	Minor impacts
	Seasonal ASR in CC Distribution System	None	Variable				
N-10	**Pipeline from CCR to LCC**	39,500	$105,428,000	$17,671,500[2]	$447 [2]	No Change	Reduction in stream flows between CCR and LCC
N-11	**Off-channel Reservoir near Lake Corpus Christi**	34,000	$155,028,000	$20,301,000[2]	$597 [2]	No Change	Direct impact to 4,000 to 6,000 acres, depending on reservoir size
N-12	**Voluntary Redistribution and USACOE Nueces Feasibility Study**	Variable	$178,281,250[6]	Up to $30,549,725[7]	Variable	Variable	Possible cost reduction with federal participation. Ecosystem restoration benefits. Portion of projects may be used for additional inflows to Nueces Bay and Estuary.
N-13	**Stage II of Lake Texana**	23,000	$149,185,000	$18,132,000[2]	$788 [2]	No Change	Direct impact to 4,769 acres
N-14	**Garwood Pipeline**	35,000	$81,117,000	$17,679,000[2]	$505 [2]	No Change	Construction and maintenance of pipeline corridors and off-channel storage
N-17	**Desalination**						
	Desalination of Seawater[8]	28,000	$248,919,000	$37,561,000	$1,341	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor
	Desalination of Combined Seawater and Brackish Groundwater	15,680	$84,420,000	$10,630,000	$678	Significant Improvement	Construction and maintenance of pipeline corridors. Potential lowering of groundwater levels

[1] Assuming unit costs of $323 to $342 per acft.
[2] Cost has been adjusted to include treatment. Cost for treatment is estimated at $225 per acft.
[3] Cost based on 18,000 acft supply.
[4] Unit costs for Allison Demonstration Project based on annual program costs for $500,000 per year and $225/acft for treatment.
[5] ASR is not recommended as a viable water management strategy to provide water supply. Costs are not included.
[6] Includes off-channel reservoir, CCR/LCC pipeline, and seawater desalination projects with cost reduction of 65 percent due to Federal participation.
[7] Cost reduction of 65 percent due to Federal participation. Annual cost is for water supplied at 65 percent of project potential, with $225/acft added for treatment for supplies from Off-Channel Reservoir and CCR/LCC Pipeline.
[8] Additional water supply is unlimited. Supply numbers and unit costs are shown for a 25 MGD facility.

Table ES-4.
Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas

WMS	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 2,415	Variable; Regional Cost up to $803,457[1]	Variable	$69-$1,248	No Change	Possible reduction in return flows to bay and estuary.
N-2	**Irrigation Water Conservation**	up to 342	$836,400	$36,593 - $60,764	$69-$173	No Change	None
N-4	**Mining Water Conservation**	up to 2,343	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	Variable	$1,500,000[2]	$500,000[2]	$725[2]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Drill additional well	Variable	Variable; up to $2,950,000[3]	Variable; up to $236,000[3]	Variable	Some Degradation	Minor impacts
	Brackish groundwater desalination	Variable	Variable; up to $6,471,000[4]	Variable; up to $1,437,000[4]	Variable	Significant Improvement	Brine from desalt plant requires disposal by evaporation, deep well injection, blending, or discharging to saltwater body.
N-12	**Voluntary Redistribution/ Reallocation**	Variable	Variable; as needed	Variable; as needed	$500[5]	Variable	None
N-18	**Potential System Interconnections**						
	Duval County	974-2,520	Up to $22,903,000	Up to $3,302,000	$824-$1,310	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Jim Wells County	246-1,434	Up to $8,233,000	Up to $1,346,000	$939-$1,512	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Brooks County	2554	$12,318,000	$2,489,000	$975	Some Negative Impact	Construction and maintenance of pipeline corridor.
	San Patricio County	125-1,120	$1,915,000 to $2,385,000	$269,000 to $741,000	$662- $2,152	Some Negative Impact	Construction and maintenance of pipeline corridor.

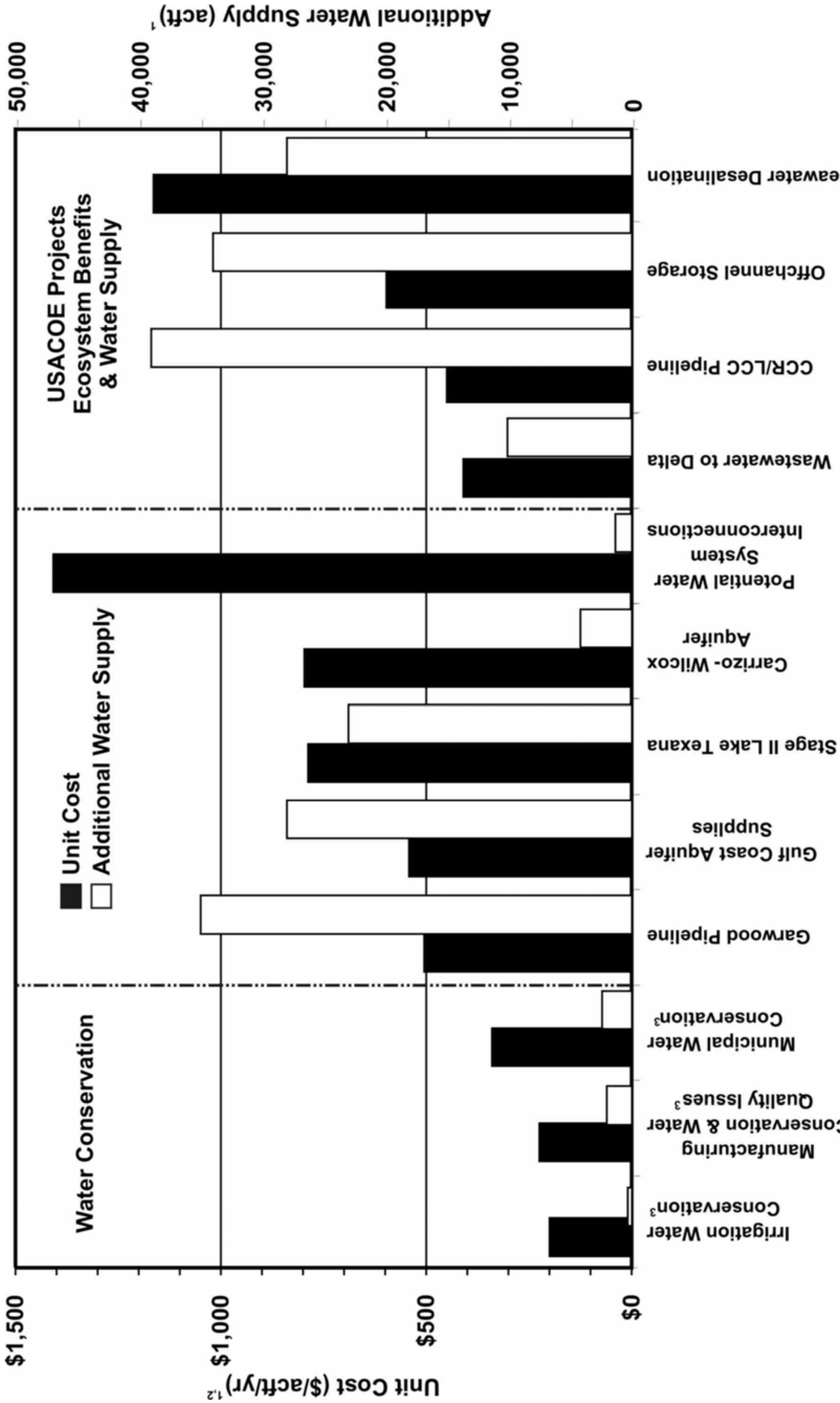
[1]Assumes unit costs of $323 to $342/acft.

[2]Unit costs for Allison Demonstration Project based on annual program costs of $500,000 per year and $225/acft for treatment.

[3]Costs based on drilling 11 wells for Duval County – Mining.

[4]Estimated cost for 3 MGD facility.

[5]Unit cost of $500 per acft assumed to be comparable to cost of Garwood water. Costs should be revised in the future, as rate study information becomes available.



Footnotes:
[1]Some strategies have more than one alternative.
[2]Costs include $225 for water treatment, except for municipal and irrigation water conservation.
[3]Costs and water supplies for Municipal, Manufacturing, and Irrigation Water Conservation are variable based on best management practice selected.

Figure ES-11. Comparison of Unit Costs and Water Supply Quantities for Potential Water Management Strategies for Coastal Bend

Table ES-5.
Water Plan Summary for Coastal Bend Region

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Aransas County	**See Section 4A.3.1**						**See Section 4B.2**
Aransas Pass (P)	168	195	169	none	none	none	
Fulton	307	365	318	none	none	none	
Rockport	1,590	1,868	1,620	none	none	none	
County-Other	1,766	2,016	1,728	none	none	(1,443)	Development of additional water supplies for SPMWD (i.e., Municipal Conservation and Reuse, Gulf Coast Aquifer groundwater supplies, reclaimed wastewater supplies, and Manufacturing Water Conservation and improvement of water quality).
Manufacturing	267	292	331	(72)	(97)	(136)	Gulf Coast Aquifer Supplies – Drill additional well.
Steam-Electric	0	0	0	none	none	none	
Mining	103	123	146	none	none	none	
Irrigation	0	0	0	none	none	none	
Livestock	23	23	23	none	none	none	
Bee County	**See Section 4A.3.2**						**See Section 4B.3**
Beeville	2,619	2,722	2,618	none	none	none	
El Oso WSC (P)	62	66	64	none	none	none	
County-Other	1,661	1,704	1,609	none	none	none	
Manufacturing	1	1	1	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	36	42	48	none	none	none	
Irrigation	2,455	1,889	1,274	none	none	none	
Livestock	995	995	995	none	none	none	

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Table ES-5 continued

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Brooks County	**See Section 4A.3.3**						**See Section 4B.4**
Falfurrias	2,135	2,795	3,032	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
County-Other	180	62	13	none	none	none	
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	150	167	184	none	none	none	
Irrigation	24	23	21	none	none	none	
Livestock	747	747	747	none	none	none	
Duval County	**See Section 4A.3.4**						**See Section 4B.5**
Benavides	326	334	302	none	none	none	
Freer	645	663	600	none	none	none	
San Diego (P)	479	479	426	none	none	none	
County-Other	950	987	895	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	5,860	7,119	8,553	(1,738)	(2,973)	(4,205)	Mining water conservation including potential reuse; consider possible socioeconomic impact analysis of unmet needs.
Irrigation	4,444	4,289	4,064	none	none	none	
Livestock	873	873	873	none	none	none	

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Table ES-5 continued

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Jim Wells County	**See Section 4A.3.5**						**See Section 4B.6**
Alice	5,606	6,076	5,904	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gallons per capita per day in 2060.
Orange Grove	374	405	393	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
Premont	858	931	905	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
San Diego (P)	103	106	101	none	none	none	
County-Other	2,127	2,238	2,130	(167)	(262)	(170)	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	423	484	550	none	none	none	
Irrigation	3,278	2,528	1,717	none	none	none	
Livestock	1,064	1,064	1,064	none	none	none	
Kenedy County	**See Section 4A.3.6**						**See Section 4B.7**
County-Other	50	53	53	none	none	none	
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	1	1	1	none	none	none	
Irrigation	107	107	107	none	none	none	
Livestock	901	901	901	none	none	none	

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Table ES-5 continued

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Kleberg County	**See Section 4A.3.7**						**See Section 4B.8**
Kingsville	4,570	4,604	4,619	none	none	none	
Ricardo WSC	682	1,130	1,397	none	none	none	
County-Other	799	930	1,004	none	(81)	(155)	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	2,180	2,207	2,232	none	none	none	
Irrigation	866	644	410	none	none	none	
Livestock	1,900	1,900	1,900	none	none	none	
Live Oak County	**See Section 4A.3.8**						**See Section 4B.9**
Choke Canyon WS (P)	397	435	346	none	none	none	
El Oso WSC (P)	206	223	176	none	none	none	
George West	703	767	608	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
McCoy WSC	54	58	46	none	none	none	
Three Rivers	465	505	399	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
County-Other	748	808	638	none	(44)	none	Gulf Coast Aquifer Supplies – Drill additional well.
Manufacturing	1,946	2,032	2,194	(337)	(559)	(764)	Voluntary Redistribution of City of Three Rivers supply.
Steam-Electric	0	0	0	none	none	none	
Mining	3,894	4,583	5,341	(64)	(928)	(1,755)	Mining water conservation including potential reuse; consider possible socioeconomic impact analysis of unmet needs.
Irrigation	3,289	2,840	2,277	(627)	(514)	(373)	Irrigation water conservation; Gulf Coast Aquifer Supplies – drill additional well.
Livestock	833	833	833	none	none	none	

Continued on next page

Table ES-5 continued

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
McMullen County	**See Section 4A.3.9**						**See Section 4B.10**
Choke Canyon WS (P)	43	42	35	none	none	none	
County-Other	143	138	117	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
Manufacturing	0	0	0	none	none	none	
Steam-Electric	0	0	0	none	none	none	
Mining	195	207	218	none	none	none	
Irrigation	0	0	0	none	none	none	
Livestock	659	659	659	none	none	none	
Nueces County	**See Section 4A.3.10**						**See Section 4B.11**
Agua Dulce	112	107	103	none	none	none	
Aransas Pass (P)	26	53	81	none	none	none	
Bishop	444	422	404	none	none	none	
Corpus Christi	61,953	73,592	86,962	none	none	none	Seasonal ASR (also see Manufacturing and Mining needs)
Driscoll	122	171	224	none	none	none	
Nueces County WCID #4	1,913	3,729	5,655	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
Port Aransas	2,606	4,558	6,637	none	none	none	Additional municipal water conservation recommended by CBRWPG for all municipal entities reported use greater than 165 gpcd in 2060.
River Acres WSC	429	646	881	(138)	(355)	(590)	Voluntary Redistribution- increase contracted amount from Nueces County WCID #3.
Robstown	2,110	2,024	1,953	none	none	none	
County-Other	894	395	118	(261)	none	none	Increase contracted amount provided by Wholesale Water Providers (City of Corpus Christi, STWA, and Nueces County WCID#3).
Manufacturing	46,510	53,425	63,313	none	none	(37,893)	Development of additional water supplies for City of Corpus Christi (Manufacturing Water Conservation, Garwood Pipeline, Stage II of Lake Texana, Gulf Coast Aquifer Groundwater Supplies, Voluntary Redistribution and USACOE Nueces Feasibility Projects).

Continued on next page

Table ES-5 continued

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)
	2010	2030	2060	2010	2030	2060	
Nueces County continued							
Steam-Electric	7,316	16,733	27,664	none	none	none	
Mining	1,472	1,599	1,724	none	(570)	(1,612)	Mining water conservation including potential reuse; Development of additional water supplies for City of Corpus Christi (Mining Water Conservation, Garwood Pipeline, Stage II of Lake Texana, Gulf Coast Aquifer Groundwater Supplies, Voluntary Redistribution and USACOE Nueces Feasibility Projects).
Irrigation	1,449	1,077	692	none	none	none	
Livestock	279	279	279	none	none	none	
San Patricio County	**See Section 4A.3.11**						**See Section 4B.12**
Aransas Pass (P)	1,405	1,828	2,386	none	none	none	
Gregory	239	223	210	none	none	none	
Ingleside	1,294	2,202	3,394	none	none	none	
Ingleside On The Bay	92	130	181	none	none	none	
Lake City	79	99	125	none	(11)	(37)	Gulf Coast Aquifer Supplies – Drill additional well.
Mathis	648	615	586	none	none	none	
Odem	330	361	408	none	none	none	
Portland	2,399	3,290	4,498	none	none	none	
Sinton	1,052	1,076	1,135	none	none	none	
Taft	586	648	735	none	none	none	
County-Other	1,946	2,189	2,533	none	none	none	
Manufacturing	15,096	18,111	22,283	none	none	(4,300)	Development of additional water supplies for SPMWD (i.e. Municipal Conservation and Reuse, Gulf Coast Aquifer groundwater supplies, reclaimed wastewater supplies, and Manufacturing Water Conservation and potential strategies pursued by City of Corpus Christi).
Steam-Electric	0	0	0	none	none	none	
Mining	99	108	117	none	none	none	
Irrigation	4,160	3,680	2,803	none	none	none	
Livestock	564	564	564	none	none	none	

Continued on next page

Table ES-5 concluded

County/Water User Group	Demand (acft)			Need (Shortage) (acft)			Recommended Management Strategies to Meet Need (Shortage)[1]
	2010	2030	2060	2010	2030	2060	
Total Needs by Water User Type							
Municipal	111,495	132,063	151,474	(566)	(753)	(2,395	Municipal Water Conservation, Irrigation Water Conservation, Manufacturing Water Conservation and Nueces River Water Quality, Mining Water Conservation, Reclaimed Wastewater Supplies, Gulf Coast Aquifer Supplies, Safe Yield Analysis of CCR/LCC System Voluntary Redistribution of Available Supplies and U.S. Army Corps of Engineers Nueces Feasibility Studies,[2] Stage II of Lake Texana, Garwood Pipeline
Manufacturing	63,820	73,861	88,122	(409)	(656)	(43,092)	
Steam-Electric	7,316	16,733	27,664	—	—	—	
Mining	14,413	16,640	19,114	(1,802)	(4,471)	(7,572)	
Irrigation	20,072	17,077	13,365	(627)	(514)	(373)	
Livestock	8,838	8,838	8,838	—	—	—	
Region N Total	**225,954**	**265,212**	**308,577**	**(3,404)**	**(6,394)**	**(53,431)**	

(P) = Partial listing — water user group is in multiple counties.

[1]The City of Corpus Christi is considering seasonal ASR; however, ASR is not a recommended strategy for add itional water supply.

[2]The USCOE feasibility studies include Off-Channel Reservoir (N-11), CCR/LCC Pipeline (N-10), and Seawater Desalination Projects (N-17).

Social and Economic Impacts of Not Meeting Projected Water Needs

If projected water needs are not met, the region could expect 400 fewer people in 2010, 800 fewer in 2030, and 64,140 fewer in 2060 under drought of record water supply conditions. The expected 2060 population under the unmet water need (shortage) condition would be 7.2 percent lower than the region's growth projection with adequate water supplies.

The estimated effect of projected water shortages upon income in the region, are $21.68 million per year in 2010, $50.18 million per year in 2030, and $3,214 million per year in 2060. If the water needs are left entirely unmet, the level of shortage in 2010 results in 230 fewer jobs than would be expected if the water needs of 2010 are fully met. The gap in job growth due to water shortages grows to 460 by 2030 and to 36,785 by 2060. Socioeconomic impacts of unmet needs were evaluated by the TWDB and costs of unmet needs were provided to represent regional impacts of leaving water needs entirely unmet, representing a worst-case scenario.

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

1.1 Water Use Background

The area represented by the Coastal Bend Regional Water Planning Group ("Region N" or "Coastal Bend Region") includes the following counties: Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio (Figure 1-1). The Coastal Bend Region has four regional wholesale water providers: the City of Corpus Christi, San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces County Water Control and Improvement District #3 (Nueces County WCID #3). The City of Corpus Christi, the largest of the four, sells water to two of the other regional water providers—SPMWD and STWA. The City of Corpus Christi and the SPMWD distribute water to cities, water districts, and water supply corporations providing water to residential, commercial, and industrial customers. SPMWD also sells water directly to large industrial facilities located on the La Quinta Ship Channel. STWA provides water to cities and water supply corporations that supply both residential and commercial customers within the western portion of Nueces County as well as Kleberg County. The smallest regional wholesale water provider, Nueces County WCID #3, provides water to the City of Robstown and other municipal entities within the western portion of Nueces County.

Municipal and industrial water use accounts for the greatest amount of water demand in the Coastal Bend Region, totaling 85 percent of the region's total water use in 2000 (Figure 1-2). The major water demand areas are primarily municipal systems in the greater Corpus Christi area, as well as large industrial (manufacturing, steam-electric, and mining) users primarily located along the Corpus Christi and La Quinta Ship Channels. Agriculture (irrigation and livestock) is the third largest category of water use in the region (Figure 1-2).

1.2 Water Resources and Quality

1.2.1 Surface Water Sources

The Coastal Bend Region depends mostly on surface water sources for municipal and industrial water supply use. The two major surface water resources include the Choke Canyon

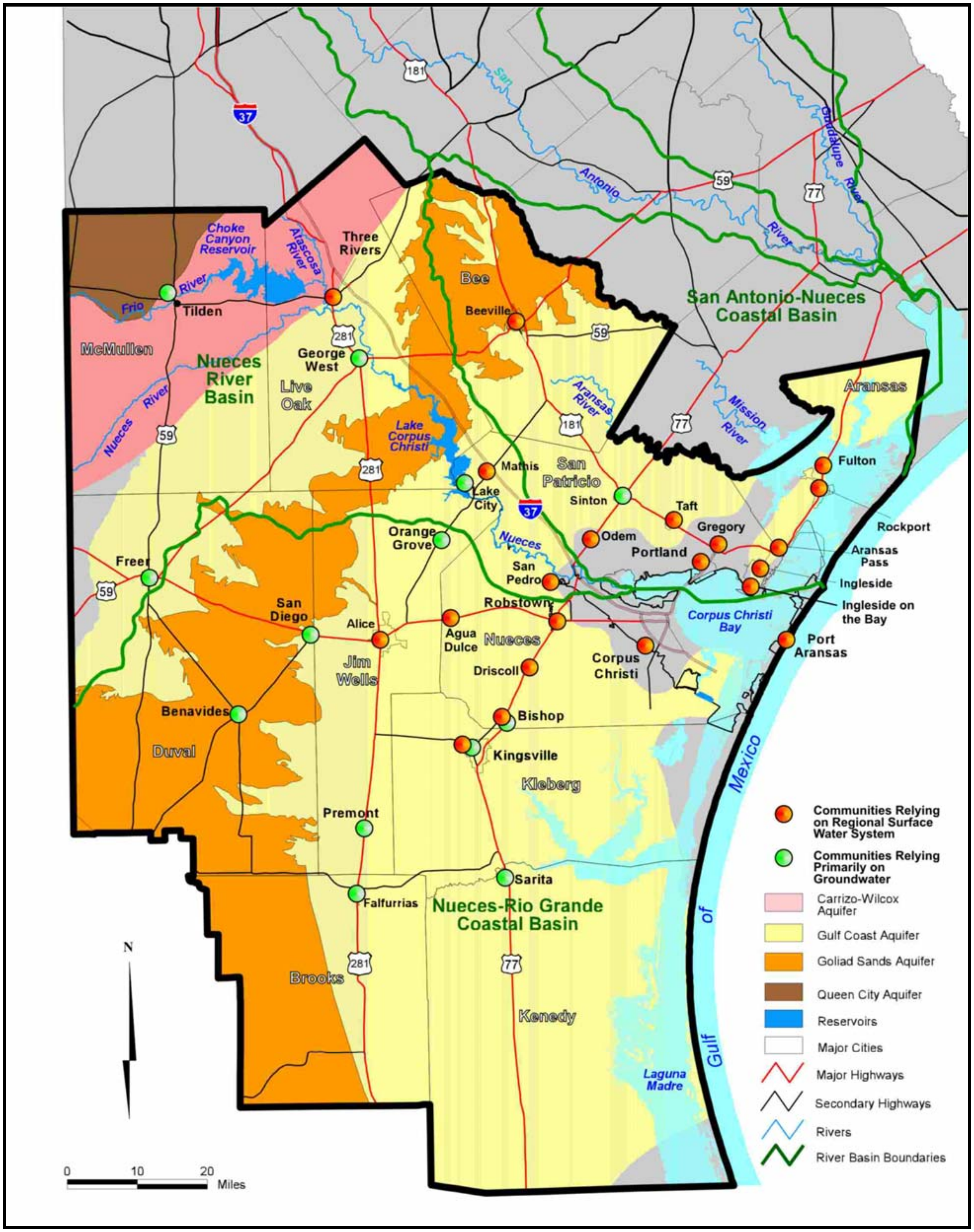

Figure 1-1. Water Providers in the Planning Region

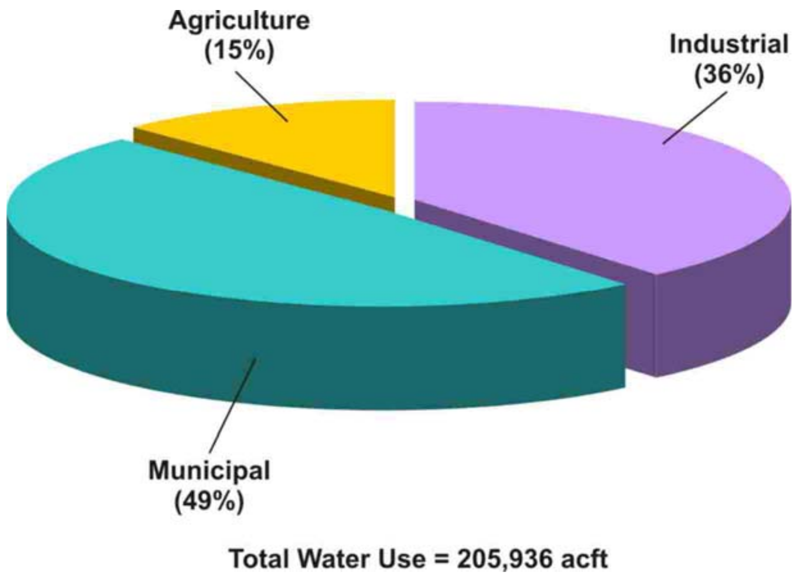

Figure 1-2. 2000 Water Use in the Coastal Bend Regional Water Planning Area

Reservoir/Lake Corpus Christi System (CCR/LCC System) in the Nueces River Basin and Lake Texana on the Navidad River in Jackson County. Water supply from Lake Texana is transported to the Coastal Bend Region via the Mary Rhodes Pipeline and provides the Coastal Bend Region with 41,840 acre-feet per year (acft/yr) and 12,000 acft/yr on an interruptible basis, according to the contract between the City of Corpus Christi and the Lavaca-Navidad River Authority (LNRA). Based on 2010 sediment conditions and Phase IV operating policy, including the 2001 Agreed Order governing freshwater pass-throughs to Nueces Estuary, the CCR/LCC System with supplies from Lake Texana has a safe annual yield of 205,000 acft/yr in 2010. The safe annual yield is based on keeping 75,000 acft in system storage (i.e., storage reserve of 7 percent CCR/LCC System) during the critical month of the drought of record. The Coastal Bend Regional Water Planning Group adopted use of safe yield supply for the 2006 Plan, which provides approximately 22,000 acft less than firm yield supply in 2010 (227,000 acft).

The Nueces River Authority's 2005 Basin Highlights Report compiled information from Draft 2004 303 (d) List of Impaired Waters and 305 (b) Water Quality Inventory and found that the water quality is generally good. However, there are some areas of concern. A few stream segments in the Nueces River Basin had elevated levels of dissolved solids, nutrients, and bacteria (Table 1-1). Since the 2001 Plan, water quality concerns of fecal coliforms and nutrients have been removed from the Nueces/Lower Frio River (stream segment 2106), Lake Corpus

Christi (stream segment 2103), and Nueces River below Lake Corpus Christi (stream segment 2102).

Table 1-1.
Water Quality Concerns

Surface Water Resource (stream segment number)	***Water Quality Concerns (1996 Assessment for Clean Rivers Program)***
Nueces above Frio River (*2104*)	Bacteria, Dissolved Oxygen
Atascosa River (*2107*)	Fecal Bacteria, Dissolved Oxygen
Petronila Creek above Tidal (*2204*)	Chloride, Sulfate, Dissolved Solids
Copano Bay (*2472*)	Bacteria in oyster waters
Nueces Bay (*2482*)	Zinc (bay recovering naturally)
Oso Bay (*2485*)	Dissolved Oxygen, Fecal Bacteria
Aransas River at Tidal (*2003*)	Bacteria
Choke Canyon Reservoir (*2116*)	Dissolved Solids, Bacteria
Frio Above Choke Canyon Reservoir (*2117*)	Fecal Bacteria, Dissolved Oxygen
St. Charles Bay (*2473*)	Bacteria
Corpus Christi Bay (*2481*)	Bacteria in oyster waters

Source: Nueces River Authority Basin Highlights Report for Nueces River Basin, San Antonio-Nueces Coastal Basin and Nueces-Rio Grande Coastal Basin, March 2005.

The water quality of the water from Lake Texana has been reported as good. In fact, it exceeds the general quality of the water supply from the Nueces River Basin and has less Total Dissolved Solids (TDS) than the Nueces River water. However, because Lake Texana water is blended with Nueces River water prior to treatment, the higher Total Suspended Solids (TSS) levels in the Lake Texana water and the pH difference between the two different sources requires precise controls during the treatment process.

1.2.2 Groundwater Sources

Some areas in the region are dependent on groundwater. There are two major aquifers that lie beneath the region—the Carrizo-Wilcox and Gulf Coast Aquifers (Figure 1-1). (Note: For in-depth descriptions of these aquifer systems, the reader is referred to the extensive list of references in Appendix A.) The Carrizo-Wilcox Aquifer contains moderate to large amounts of either fresh or slightly saline water. Slightly saline water is defined as water that contains 1,000 to 3,000 milligrams per liter (mg/L) of dissolved solids. Although this aquifer reaches from the Rio Grande River north into Arkansas, it only underlies parts of McMullen and Live Oak Counties within the Coastal Bend Region. In this downdip portion of the Carrizo-Wilcox Aquifer, the water is softer, hotter (140 degrees Fahrenheit), and contains more dissolved solids.

The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of both fresh and slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of five aquifer formations: Catahoula, Jasper, Burkeville, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water formations within the Gulf Coast Aquifer System and, consequently, are the formations utilized most commonly. The Evangeline portion of the Gulf Coast Aquifer features the highly transmissive Goliad Sands. The Chicot portion of the Gulf Coast Aquifer is comprised of many different geologic formations; however, the Beaumont and Lissie Formations are predominant in the Chicot Aquifer within the Coastal Bend area. The Burkeville Aquifer is predominantly clay, and therefore provides limited water supplies. The Texas Water Development Board (TWDB) developed a Central Gulf Coast Groundwater Availability Model (CGCGAM) used by the Coastal Bend Region to determine groundwater availability. The TWDB CGCGAM includes four aquifer layers: Jasper, Burkeville, Evangeline, and Chicot.

Within Texas, the Houston area is the largest user of the Gulf Coast Aquifer. Due to growing population and water demand in that area, over-pumping of the aquifer has resulted in subsidence of up to 9 feet being recorded in Harris County. While not as severe as in the Houston area, subsidence has been reported within the Gulf Coast Aquifer in the Coastal Bend Region. In 1979, the Texas Department of Water Resources developed a Gulf Coast Aquifer Model to evaluate pumpage, water level drawdowns, and subsidence for the 10-year period of 1960 through 1969 for Houston, Jackson-Wharton Counties, and Kingsville areas. The objective of the study was to compare modeled results to historical water level declines and subsidence.[1] Areas in Kleberg County have recorded a 0.5-foot drop in elevation due to pumping of the Gulf Coast Aquifer. However, due to the increase in surface water use within Kleberg County, water levels of the aquifer are rising and the rate of subsidence has diminished. Water quality in the shallower parts of the aquifer is generally good; however, there is saltwater intrusion occurring in the southeast portion of the aquifer along the coastline. It should also be noted that the water quality deteriorates moving southwestward towards the Texas-Mexico border.

[1] "Groundwater Availability in Texas," Texas Department of Water Resources, Report 238, September 1979.

1.2.3 Major Springs

Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region. According to *Springs of Texas-Volume I* by Gunnar Brune, there are 18 small springs in the Coastal Bend Region with flows between 0.28 and 2.8 cfs and a number of these springs produce saline, hard, alkaline spring water. These are the largest documented springs in the Coastal Bend Region. There are no major springs in the Coastal Bend Region.

1.3 Economic Aspects

In 1990, the population of the Coastal Bend Region was 492,829 and per capita income was $13,296. In 2000, the population of the Coastal Bend Region had grown to 541,184 with a regional average per capita income of $19,833 and ranging from $14,876 in Brooks County to $26,458 in McMullen County.[2] The Corpus Christi Metropolitan Statistical Area (MSA), consisting of Aransas, Nueces, and San Patricio Counties, accounts for 75 percent of the Coastal Bend Region's population and 80 percent of the total personal income. In 2000, the total personal income in the Coastal Bend Region was nearly $11.7 billion, including net earnings, dividends, and personal transfer receipts[3,4] (Figure 1-3).

The primary economic activities within the Coastal Bend Region include oil/gas production and refining, petrochemical manufacturing, military installations, retail/trade, agriculture, and service industries including health services, tourism/recreation industries, and governmental agencies. In 2000, these industries employed nearly 280,000 people in the Coastal Bend Region with annual earnings over $8.4 billion (Figures 1-4 and 1-5).[5] The retail/trade sector had the biggest economic impact in 2000, with an economic contribution of $3.1 billion, and created over 39 percent of the jobs in the Region (Figures 1-4 and 1-5). The retail/trade sector includes construction, manufacturing, wholesale trade, retail trade, and finance/real estate businesses.

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[2] U.S. Department of Commerce Bureau of Economic Analysis, Regional Economic Information System (REIS) Database, 2005.
[3] Ibid.
[4] Personal transfer receipts are government payments to individuals, including retirement and disability insurance and medical services.
[5] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2005.

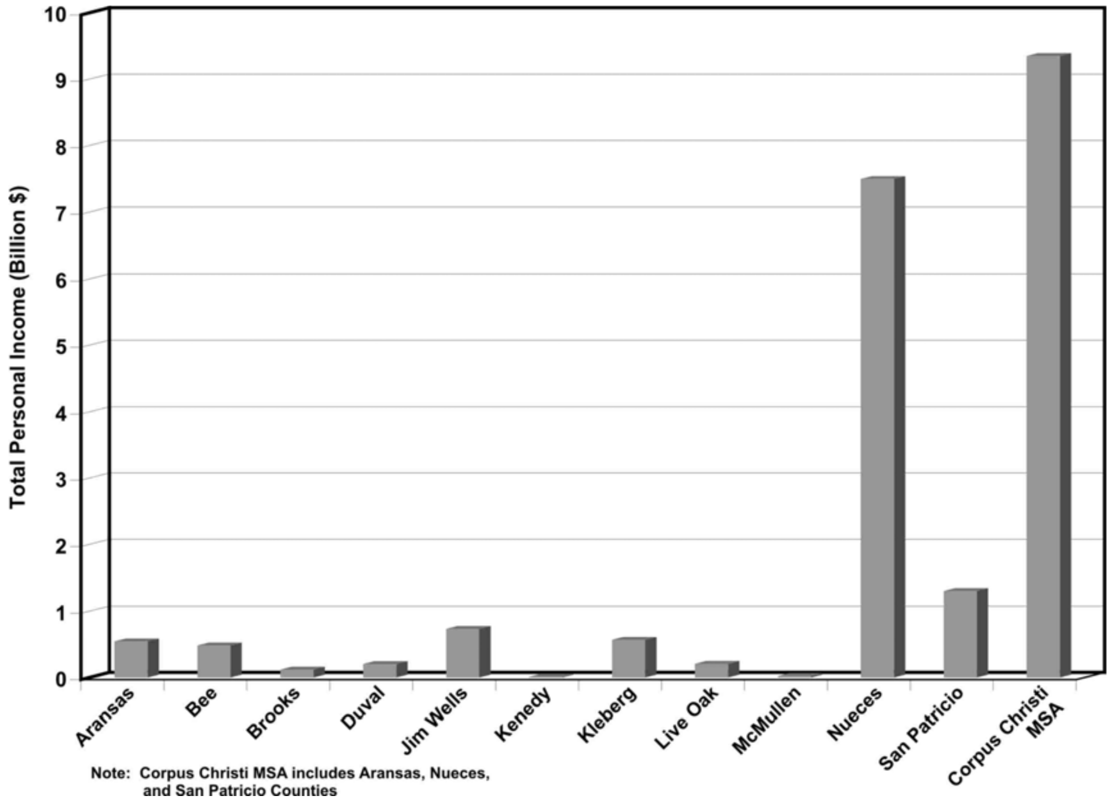

Figure 1-3. Total Personal Income (Earnings) by County

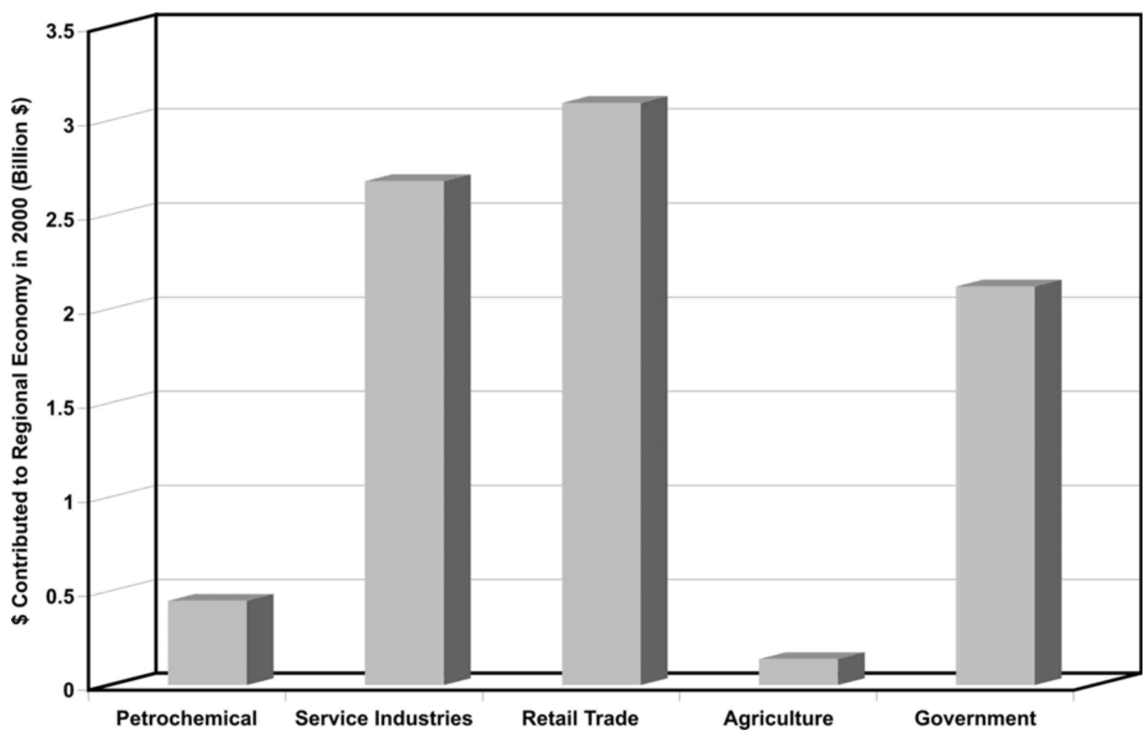

Figure 1-4. Economic Contributions to Coastal Bend Region by Sector

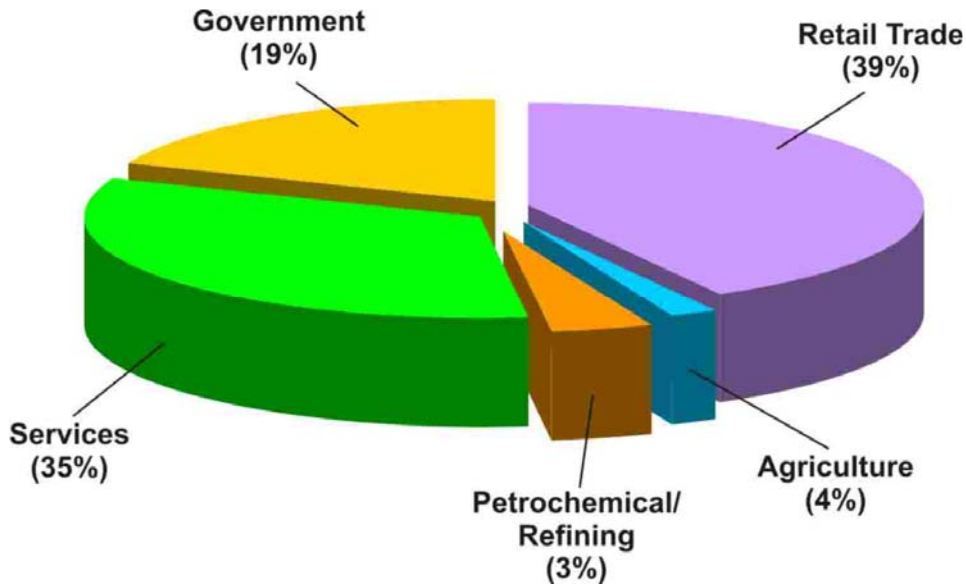

Figure 1-5. 2000 Percentages of Major Employment by Sector in the Coastal Bend Region — Total Number Employed – 277,890

Service industries represent over 42 percent of all industries located in the Coastal Bend Region and generate over \$2.7 billion.[6] Health services, the largest economic service industry contributor, generated nearly \$900 million for the Coastal Bend Region. According to a recent study by Texas A&M-Corpus Christi,[7] employment in health services accounts for 11 percent of the regional total.

Government agencies created more than 53,000 jobs (19 percent of total employment) in the Coastal Bend Region. In 2000, these government agencies—consisting of federal, military, state and local government—brought \$2.1 billion into the Coastal Bend Region's economy.

The petrochemical and refining industries brought over \$450 million into the Coastal Bend Region.

Agriculture accounts for a major portion of the land use within the Coastal Bend Region. Of the cultivated land in 2002, over 98 percent was dryland farmed and approximately 27,090 acres of cultivated land was irrigated (Table 1-2). The dominant crops of the region are corn, wheat, sorghum, cotton, and hay. Livestock is a major agricultural product of the Coastal

[6] Texas Comptroller of Public Accounts; data presented for Year 2000.
[7] "Coastal Bend Industry Clusters," The Economic Pulse, Texas A&M-Corpus Christi newsletter, Spring 2005.

Table 1-2.
CBRWPA Agriculture Statistics — 2002

Counties	Region	Aransas	Bee	Brooks	Duval	Jim Wells	Kenedy*	Kleberg*	Live Oak	McMullen	Nueces	San Patricio
Total Cropland (acres)	1,440,268	893	143,978	53,611	162,488	198,348	6,289	102,739	130,194	28,993	353,736	258,999
Irrigated Cropland (acres)	27,090	29	4,660	811	3,795	5,597	N/A	N/A	1,999	N/A	2,428	7,771
Irrigated cropland /Total cropland	1.88%	3.25%	3.24%	1.51%	2.34%	2.82%	N/A	N/A	1.54%	N/A	0.69%	3.00%
Total Market value of agriculture product ($1,000)	$305,992	N/A	19,472	7,572	12,951	47,345	8,982	57,786	13,993	6,398	62,360	68,863
Market value of crop products sold ($1,000)	$147,141	N/A	7,438	276	1,815	13,291	0	9,814	1,828	176	59,448	53,055
Market value of livestock products sold ($1,000)	$158,851	N/A	12,034	7,296	11,136	34,054	8,982	47,972	12,165	6,222	3,182	15,808
Crop products/Total agriculture products	48%	N/A	38%	4%	14%	28%	0%	17%	13%	3%	95%	77%
Livestock products/Total agriculture products	52%	N/A	62%	96%	86%	72%	100%	83%	87%	97%	5%	23%

N/A: Data not available. Withheld to avoid disclosing data for individual farms.

Source: 2002 Census of Agriculture.

Bend Region. In 1997, livestock products made up 36 percent of the total market value of agriculture products. In 2002, livestock products increased to 52 percent of the total market value of agricultural products in the Coastal Bend Region.[8]

Fishing is another industry that adds to the economic value of the Coastal Bend Region. In 2000, reported bay and gulf commercial fishing generated over $18 million in sales and value to the Region.[9] Overall impact to the State's economy of commercial fishing, sport fishing and other recreational activities has been estimated by the TWDB to be $814 million per year for the 352,000-acre Nueces Estuary System.

Unemployment rates in the Region in 1990 were between 6 and 7 percent, whereas in 1996 the unemployment rate ranged between 8 and 9 percent. In December 2004, the unemployment rate for the Coastal Bend Region was 6.5 percent.[10]

1.4 Identified Threats to Agricultural and Natural Resources

The Coastal Bend Region's agricultural business relies on groundwater for irrigation and water for livestock. In the 2001 Plan, the Coastal Bend Regional Water Planning Group identified continuing groundwater depletion as a threat to agricultural and natural resources. As part of the 2006 Planning Process, the Coastal Bend Region recognized the following additional potential threats to agricultural and natural resources:

- Shortage of freshwater and economically accessible groundwater attributable to increased irrigation demands.
- Deterioration of surface water quality associated with sand and gravel operations and other activities.
- Deterioration of groundwater quality and increasing concerns of possible arsenic and uranium contamination attributable to uranium mining activities.
- Impacts of potential off-channel reservoir on terrestrial wildlife habitats.
- Potential impacts to threatened, endangered, and other species of concern.
- Potential impacts of brush control and other land management practices as addressed in the U.S. Army Corps of Engineers (USCOE) Nueces River Basin Feasibility Study.
- Abandoned wells (oil, gas, and water).

These threats are considered for each water management strategy, and when applicable, are specifically addressed in Section 4C.

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[8] 2002 Census of Agriculture.
[9] U.S. Department of Commerce Bureau of Economic Analysis, REIS Database, 2005.
[10] Texas Workforce Commission, 2005.

1.5 Resource Aspects and Threatened, Endangered, and Rare Species of the Coastal Bend Region

While the Coastal Bend Region is known for its valuable mineral resources, especially oil and gas, the area is also rich and diverse in living natural resources. The Coastal Bend Region contains ecosystems ranging from the South Texas Brush Country characterizing the inland portion of the Coastal Bend Region to the Coastal Sand Plains along the southern coastline and the Gulf Coast Prairies and Marshes along the northern coastline of the Coastal Bend Region (Figure 1-6).

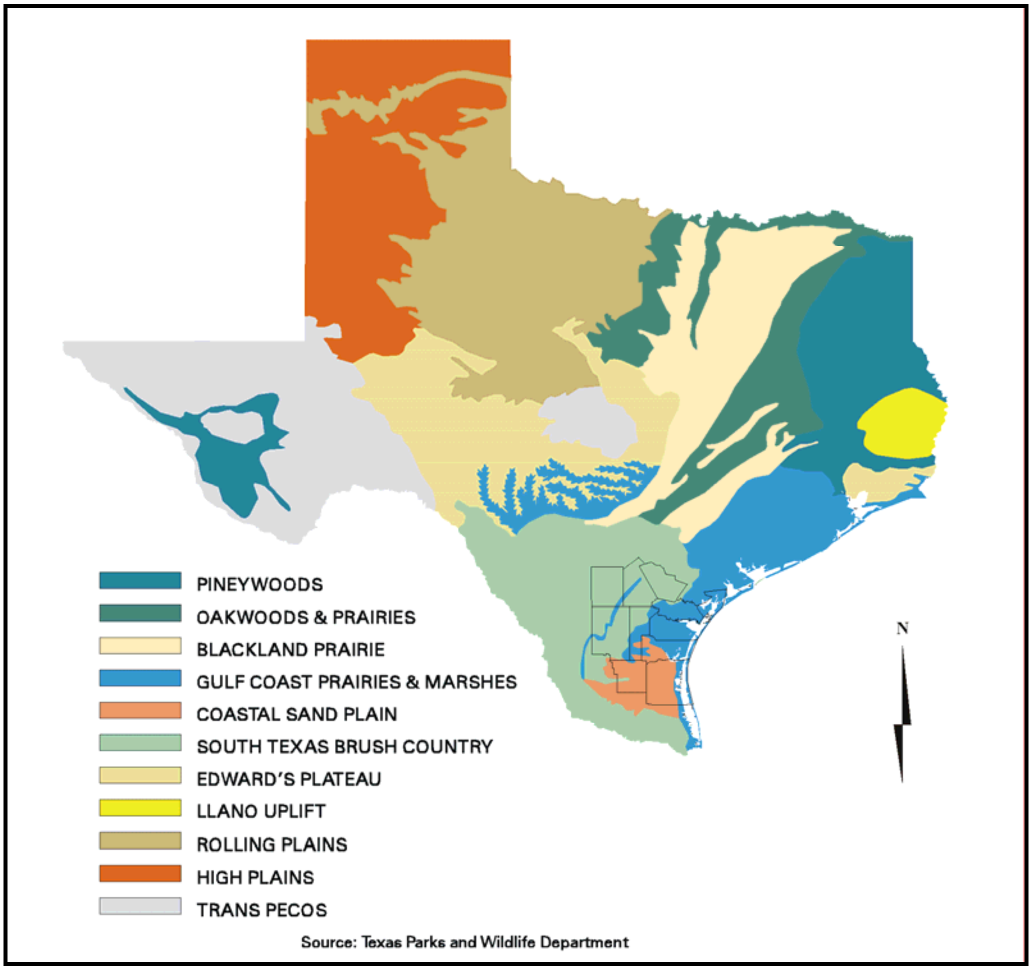

Figure 1-6. Natural Regions of Texas

The new regional water plan guidelines require additional reporting of environmental factors for water management strategies including effects on wildlife habitat, cultural resources, environmental water needs, and inflows to bays and estuaries. Each water management strategy summary (Section 4C) includes a discussion of these environmental issues and an environmental summary table identifying impacts. Because the Coastal Bend Region is located along many migratory flyways, birds comprise a major portion of the wildlife population of the area. The area offers birds unique nesting and forage resources within its coastal prairies, wetlands, and riverine ecosystems. The threatened brown pelican and the endangered whooping crane use the Coastal Bend's natural resources both seasonally and year-round. The Coastal Bend Region is also home to other state- and federally-listed endangered and threatened species. These listed species include amphibians, reptiles, mammals, and vascular plants (Table 1-3). Appendix B includes a map identifying the potential habitats (by county) of each endangered or threatened species. These potential habitats are considered for each water management strategy and when possibly impacted, are noted in the appropriate water management strategy summary (Section 4C).

Bay and estuary systems depend on freshwater inflows for maintaining habitats and productivity. Freshwater inflows provide a mixing gradient that establishes a range of salinity as well as nutrients that are important for productivity of estuarine systems. In addition, freshwater inflows deposit sediments, which help maintain the deltas and barrier islands that protect the bays and marshes. Without freshwater inflows, many plant and animal species could not survive. In accordance with an order issued by the Texas Commission on Environmental Quality (TCEQ) in 1995 and subsequent amendments, the CCR/LCC System is operated to "pass through" a certain target amount of water each month in order to provide important freshwater inflows for the Nueces Estuary. The 2001 Agreed Order includes operational procedures for Choke Canyon Reservoir and Lake Corpus Christi and requires passage of inflows to the Nueces Bay and Estuary based on maximum harvest studies and inflow recommendations to maintain the health of the Nueces Estuary. According to the TPWD,[11] the maximum harvest flow to the Nueces Bay and Estuary produced slightly higher harvests of red drum, black drum, spotted sea trout, and brown shrimp but slightly decreased amounts of blue crab.

Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region. According to *Springs of Texas-Volume I* by Gunnar Brune, there are 18 small springs in the Coastal Bend Region with flows

[11] Texas Parks and Wildlife Department, "Freshwater Inflow Recommendation for the Nueces Estuary," September 2002.

Table 1-3.
Endangered and Threatened Species of the Coastal Bend Region

Common Name	Scientific Name	Possible Habitats in Coastal Bend Region (Counties)	Classification
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	Aransas	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Aransas, Kleberg	Threatened
Black Lace Cactus	*Echinocereus reichenbachii var. albertii*	Duval, Jim Wells, Kleberg	Endangered
Brown Pelican	*Pelecanus occidentalis*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Green Sea Turtle	*Chelonia mydas*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Gulf Coast Jaguarundi	*Herpailurus (=Felis) yagouaroundi cacomitli*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	Endangered
Hawksbill Sea Turtle	*Eretmochelys imbricate*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Threatened
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	Brooks, Kenedy, Kleberg	Endangered
Ocelot	*Leopardus (=Felis) pardalis*	Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, San Patricio	Endangered
Piping Plover	*Charadrius melodus*	Aransas, Kenedy, Kleberg, Nueces, San Patricio	Endangered
Slender Rush Pea	*Hoffmannseggia tenella*	Kleberg, Nueces	Endangered
South Texas Ambrosia	*Ambrosia cheiranthifolia*	Jim Wells, Kenedy, Kleberg, Nueces	Endangered
Whooping Crane	*Grus americana*	Aransas	Endangered

Source: http://ifw2es.fws.gov/EndangeredSpecies/lists/ListSpecies.cfm

between 0.28 and 2.8 cfs and a number of these springs produce saline, hard, alkaline spring water. These are the largest documented springs in the Coastal Bend Region. Before Year 1965, the region relied heavily on groundwater for irrigation resulting in decreased water levels and springflow. Since then, irrigation water demands have been substantially reduced due to reduced irrigated acreage and more efficient irrigation practices, which would presumably have less of an adverse impact on existing local springs.

1.6 Water Quality Initiatives

The Clean Water Act of 1972 established a Federal program for restoring, maintaining, and protecting the nation's water resources. The Clean Water Act remains focused on eliminating discharge of pollutants into water resources and making rivers and streams fishable and swimmable. Water quality standards are to be met by industries, states, and communities under the Clean Water Act. Since the enactment of the Clean Water Act, more than two-thirds of the nation's waters have become fishable and swimmable, as well as a noticeable decrease of wetland and soil loss. One aspect of the Clean Water Act is the National Pollution Discharge Elimination System (NPDES). This program regulates and monitors pollutant discharges into water resources. Whereas in the past the Environmental Protection Agency and the State of Texas each required separate permits to discharge (one under NPDES and one under state law), recently, the State of Texas has received delegation to administer a joint "TPDES" program.

In 1998, the Clean Water Action Plan (Plan) was initiated to meet the original goals of the Clean Water Act. The main priority of this Plan is to identify watersheds and their level of possible concern. The identification of these concerns has been defined within the Texas Unified Watershed Assessment (Assessment). Each watershed was then placed into one of four defined categories—Category I: Watersheds in need of restoration, Category II: Watersheds in need of preventive action to sustain water quality, Category III: Pristine Watersheds, and Category IV: Watersheds with insufficient data. Within the Nueces River Basin some areas of concern have been placed on the Clean Water Act 303(d) medium priority list; consequently both TCEQ and the Environmental Protection Agency are targeting these areas as a Category I.

The State of Texas has initiated other water quality programs. The Texas Clean Rivers Act of 1991 created the Clean Rivers Program within TCEQ. The purpose of this program is to maintain and improve the water quality of the State of Texas's river basins with aid from river authorities and municipalities. The Clean Rivers Program encourages public education, watershed planning, and water conservation, as well as provides technical assistance to identify pollutants and improve water quality in contaminated areas.

In the Coastal Bend Region, the Nueces River Authority (NRA) and TCEQ share the responsibility for surface water monitoring under the Clean Rivers Program. Surface water monitoring within the Coastal Bend Region focuses on freshwater stream segments within the Nueces River Basin, as well as local coastal waters. Each year, NRA and TCEQ coordinate sampling stations and divide stream segment stations between each other in order to eliminate sampling duplication. TCEQ and NRA work together to create the 305(b) Water Quality Inventory Report, which provides an overview of the status of surface waters in the Nueces River Basin and Nueces Coastal Basins. The TCEQ is responsible for administering the Total Maximum Daily Load Program, which addresses the water quality concerns of highest priority as identified in the 305(b) list. Under both the Clean Water Act and the Clean Rivers Program, surface waters must be sampled and monitored for identification of pollutants and possible areas of concern. Currently, certain water segments within the Nueces River Basin are posing some concerns (Table 1-1).

1.7 2001 Coastal Bend Regional Water Plan

Senate Bill 1 was enacted by the 75th Session of the Texas Legislature in 1997. It specified that water plans be developed for regions of Texas and provided that future regulatory and financing decisions of the TCEQ and the TWDB be consistent with approved regional water plans. Furthermore, Senate Bill 1 specified that regional water planning groups submit a regional water plan by January 2001, and at least as frequently as every 5 years thereafter, for TWDB approval and inclusion in the state water plan. The Coastal Bend Region, which is comprised of 11 counties (Figure ES-1), is one of the State's 16 planning regions established by the TWDB.

In January 2001, the Coastal Bend Region submitted a plan for a 50-year planning period from 2000 to 2050, which consisted of water supply planning information, projected needs in the Region, and the Region's proposed water plans to meet needs. The total population of the Coastal Bend Region was projected to increase from 569,292 in 2000 to 943,912 by 2050. Similarly, the total water demand was projected to increase from 223,797 acft to 309,754 acft by 2050. There were 20 individual cities and water user groups (i.e., non-municipal water users, such as industrial and agricultural users) that showed projected needs during the 50-year planning horizon. Water management strategies were identified by the Coastal Bend Region to potentially meet water supply shortages. The TWDB evaluated social and economic impacts of not meeting projected water needs, which was included in the 2001 Coastal Bend Regional Water Plan.

1.8 2002 State Water Plan

In Water for Texas 2002 (State Plan), the TWDB utilized information and recommendations from the 16 individual Regional Water Plans developed by the Regional Water Planning Groups established under Senate Bill 1. In the State Plan, TWDB acknowledges that each Regional Water Planning Group identified many of the same basic recommendations to meet future water demands. These recommendations include: continued use of developed surface and groundwater supplies, new development of surface and groundwater resources, increased water conservation, water reuse, and new interbasin transfers.

Also, within the State Plan, the TWDB submitted the twelve strategies that were recommended by the Coastal Bend Region in their 2001 Coastal Bend Regional Water Plan. These included:

- System interconnects involving a surface source;
- Additional interruptible Lake Texana water;
- Reallocation of surface water;
- Conservation from industry;
- Aquifer storage and recovery;
- Use of acquired surface water rights via the Garwood Pipeline;
- Short-term over-drafting of groundwater;
- Voluntary reallocation of groundwater;
- Utilizing small desalination plant;
- Recycling and reusing groundwater;
- Use of non-potable groundwater for mining; and
- Irrigation conservation.

The State Plan also includes the Coastal Bend Region's recommendations to further investigate large-scale desalination, interregional cooperation on interbasin transfers and the exchange of surface water rights, and consideration for setting groundwater pumping level cutoffs.

In addition to summarizing each Regional Water Planning Group's recommendations, the TWDB defines its own policy recommendations. These include:

- The regional water planning process should continue;
- Planning Groups should continue exploring the potential for voluntary, cooperative agreements that can meet water supply, quality, management, and financing needs of

all parties while protecting instream flows and freshwater inflows to our bays and estuaries; and

- The Legislature should encourage ways and provide legal and regulatory flexibility to continue the planning process and the development of voluntary, cooperative agreements.

1.9 Local Water Plans

There has been a number of regional water planning studies done for the Coastal Bend Region, focusing mainly on municipal and industrial water supply issues (refer to Appendix A for list of references). The following is a summary of the major planning efforts in the last 15 years.

In 1989, the Coastal Bend Alliance of Mayors created a Regional Water Task Force. The Regional Water Task Force Final Report,[12] issued in June of 1990, examined the historical and current regional water supply situation and made recommendations for water supply development in the area.

Throughout 1990 and 1991, the TWDB, NRA, the City of Corpus Christi, Edwards Underground Water District, and the STWA sponsored a study[13] that focused on the development of additional water supplies within the Nueces River Basin. The objectives of the study centered upon determining the feasibility of constructing additional recharge structures for the Edwards Aquifer within the basin. The study was also concerned with the effects of the proposed recharge structures on the firm yield of the CCR/LCC System and the required inflows to the Nueces Estuary. The recommendations that emerged from this study determined that additional recharge structures would increase the recharge of the Edwards Aquifer. The study also recommended that additional evaluations consider water supply alternatives for the CCR/LCC System service area as well as a benefit/cost analysis of each additional recharge project. Finally, one of the most useful products to emerge from this study is the Lower Nueces River Basin and Estuary Model, which is still used for evaluating reservoir-operating alternatives.

In 1991, a joint investigation sponsored by the LNRA, the Alamo Conservation and Reuse District, and the City of Corpus Christi, studied additional water supplies for the cities of

[12] Rauschuber, et al., "Regional Water Task Force: Final Report," Regional Water Conference, Coastal Bend Alliance of Mayors, Corpus Christi Area Economic Development Corporation, Port of Corpus Christi-Board of Trade, Dr. Manuel L. Ibanez, President, Texas A&I University, June 30, 1990.
[13] HDR Engineering, Inc. (HDR), et al., "Nueces River Basin Regional Water Supply Planning Study – Phase I," Vols. 1, 2, and 3, Nueces River Authority (NRA), et al., May 1991.

San Antonio and Corpus Christi. The study[14] addressed the feasibility of transferring water from Lake Texana (Palmetto Bend Project), developing Stage II of the Palmetto Bend Project, and acquiring water from the Colorado River. The cost and efficiency of the diversion projects that would deliver the water to both cities was examined as well. The final recommendation of this study was to purchase the water from Lake Texana and the Garwood Irrigation Company water rights in the Colorado River and construct diversion structures to both San Antonio and Corpus Christi.

In 1992, the TWDB and the cities of Houston, Corpus Christi, and San Antonio initiated the *Trans-Texas Water Program* to address the water supply needs for each of these cities. The Corpus Christi service area was comprised of virtually the same region as the Coastal Bend Region with the exceptions that Refugio and Atascosa Counties were included in the study and Kenedy County was excluded from the study. The City of Corpus Christi, the Port of Corpus Christi Authority, the Corpus Christi Board of Trade, the TWDB, and the LNRA sponsored the *Trans-Texas Water Program* study[15] for the Corpus Christi Service Area. In 1993, an interim report (Phase I) was issued to give an overview of the objectives of the Program for the Corpus Christi Service Area.

Objectives of the *Trans-Texas Water Program* for the Corpus Christi Service Area:

- Determine water demands for a 50-year period (2000 through 2050);
- Identify possible water supply options that will meet the projected water demands; and
- Provide a general assessment of each water supply alternative as well as their cost and environmental impacts.

In Phase II, twenty-two different water supply alternatives were evaluated. Combinations of these alternatives would be necessary to meet the projected water demands. The 1995 report[16] on Phase II of the *Trans-Texas Water Program* study for the Corpus Christi Service Area recommended two integrated water supply plans (Plan A and Plan B). Both Plan A and Plan B recommended such water supply alternatives as the incorporation of changes in the CCR/LCC System operating policies and the 1995 Agreed Order for freshwater inflows to the Nueces Estuary. Other alternatives included additional water conservation practices within the service

[14] HDR, "Regional Water Planning Study, Cost Update for Palmetto Bend Stage 2 and Yield Enhancement Alternative for Lake Texana and Palmetto Bend Stage 2," Lavaca-Navidad River Authority, et. al., May 1991.
[15] HDR, et al., "Trans-Texas Water Program – Corpus Christi Study Area – Phase II Report," City of Corpus Christi, et. al., September 1995.
[16] Ibid.

area and construction of pipelines from Lake Texana and the Colorado River. However, Plan A recommended the construction of an additional pipeline from Choke Canyon Reservoir to Lake Corpus Christi, whereas Plan B recommended obtaining additional water from the Colorado River as well as modifying the target operating elevation of Lake Corpus Christi. Each recommended plan from the *Trans-Texas Water Program* potentially provided the additional 100,000 acft that were projected as being needed in the study area by the year 2050.

In 1995, SPMWD sponsored a system evaluation study.[17] This study was developed in an effort to establish future water demands, evaluate SPMWD's current facilities and supplies, and recommend possible water supply alternatives for SPMWD's service area. The 1995 plan defined four water supply alternatives that would allow SPMWD to meet projected demands. These alternatives included: the purchasing of additional, or all, treated water from the City of Corpus Christi; expansion of SPMWD's existing facilities; or constructing a new water treatment facility near Odem or Portland. Phase I also recommended that a Phase II study be conducted for the preferred alternative to better identify the cost of the selected project, the time schedule commitment, any environmental issues, and the financial impact the alternative might have on the SPMWD. Based on the Phase II study, SPMWD began to upgrade their existing systems in 1997, including pipe refurbishment and construction of a microfiltration plant. In late 2000, SPMWD finished building the microfiltration plant and pipeline that connects their facilities with the Mary Rhodes Pipeline, which can divert an average of 7.5 million gallons per day of Lake Texana water into a new 193 million-gallon aboveground reservoir, where it is blended with incoming Nueces River water.

TWDB and NRA sponsored a regional water planning study to examine possible water supply alternatives for Duval and Jim Wells Counties. The regional water supply study[18] recommended that Freer, San Diego, and Benavides initiate surface water projects to replace existing groundwater sources. The study also determined that it would be best for Premont and Orange Grove to remain on groundwater supplies.

The Coastal Bend Bays and Estuaries Program (CBBEP) has developed the Coastal Bend Bays Plan[19] (Bays Plan) for the Coastal Bend Region. This plan is a long-term, comprehensive management plan designed to restore, maintain, and protect the Coastal Bend Region's bay and

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[17] Naismith Engineering, Inc. (NEI), et al., "Study of System Capacity, Evaluation of System Condition, and Projections of Future Water Demands – Phase 1," San Patricio Municipal Water District, September 1995.
[18] NEI, et al., "Regional Water Supply Study, Duval and Jim Wells Counties, Texas," NRA, et al., October 1996.
[19] "Coastal Bend Bays Plan," Coastal Bend Bays and Estuaries Program, August 1998.

estuary ecosystems. Included within the Bays Plan is the allowance for coordination with the Regional Water Planning Group. The CBBEP does not possess taxing, federal, state, or local authority. Rather the CBBEP coordinates the implementation of the Bays Plan by providing limited amounts of technical and financial assistance towards meeting operating goals.

CBBEP Operating Goals:

- Understand the interdependence of the bays and estuaries with human uses;
- Maintain clean water quality for native living resources as well as providing clean waters for recreation;
- Maintain freshwater inflows;
- Preserve open spaces to meet growing populations; and
- Manage the region's bays and estuaries so they may survive catastrophic events and adapt to condition changes.

In 1998, the Texas Agricultural Extension Service published the *Wetland and Coastal Resources Information Manual for Texas*, 2nd Edition, which includes the Texas Wetland Plan. Initiated in April of 1994, the Texas Wetland Plan employs a non-regulatory, voluntary approach to conserving Texas' wetlands. The plan describes how wetlands have economic and ecological benefits, such as flood control, improved water quality, harvestable products, and habitat for fish, shellfish, and wildlife resources. It also identifies each type of wetland resource throughout the State of Texas and then makes recommendations for conservation actions. The focus of the plan includes enhancing the landowner's ability to use existing incentive programs and other land use options through outreach and technical assistance, developing and encouraging land management options that provide an economic incentive for conserving existing wetlands or restoring former ones, and coordinating regional wetlands conservation efforts. The plan addresses each of these goals by utilizing such tools as education, economic incentives, statewide and regional conservation, assessment and evaluation, and coordination and funding activities.

1.10 Groundwater Conservation District Management Plans

The Texas Legislature authorized in 1947 the creation of groundwater conservation districts to conserve and protect groundwater and later recognized them, in 1997, as the "preferred method of determining, controlling, and managing groundwater resources." According to Texas Water Code statue, the purpose of groundwater districts is to provide for the conservation, preservation, protection, and recharge of underground water and prevent waste and control subsidence caused by pumping water.[20] There are four counties in the 11-county Coastal Bend Region that contain groundwater conservation districts: Bee, Live Oak, McMullen, and Kenedy. Rules for groundwater conservation districts in the Coastal Bend Region are included in Appendix K.

1.10.1 Bee Groundwater Conservation District

The Bee Groundwater Conservation District was created and adopted Management Rules in September 2002. The Rules require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits pumping to 10 gallons/minute per acre at a maximum annual production of 4 acft per acre. The District does not allow operation of Aquifer Storage and Recovery projects.

1.10.2 Live Oak Underground Water Conservation District

The Live Oak Underground Water Conservation District (LOUWCD) was created in February 1991. The District adopted Management Rules in June 1998 and amended the Rules in July 2000. The Rules require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits pumping to 10 gallons/minute per acre at a maximum annual production of 8 acft per acre. The District does not allow operation of Aquifer Storage and Recovery projects.

The Live Oak Underground Water Conservation District Management Plan was amended and adopted, by unanimous vote of all directors, on July 26, 2005. A copy of their management plan is included in Appendix K.[21]

1.10.3 McMullen Groundwater Conservation District

The McMullen Groundwater Conservation District was created and published District Rules in November 1999. The Rules, amended in August 2003, require registration for all existing and future wells in the District. The District imposes spacing and production limitations on new users and limits annual production of 4 acft per acre. The District does not allow operation of Aquifer Storage and Recovery projects.

[20] Texas Water Code 6 36.0015.
[21] LOUWCD Management Plan references 2002 TWDB State Water Planning Database.

1.10.4 Kenedy Groundwater Conservation District

Kenedy Groundwater Conservation District was created in November 2004 and includes all King Ranch properties in the Coastal Bend Region.[22] District rules have not been established.

1.11 Current Status of Water Resources Planning and Management

Currently, the Coastal Bend Region is planning to meet future water demands in a number of ways. The City of Corpus Christi contracted with LNRA to receive 41,840 acft/yr from Lake Texana, which is delivered to the Region via the Mary Rhodes Pipeline. In 2002, LNRA submitted an application to TCEQ for an amendment to their water right, which would allow LNRA to divert an additional 7,500 acft of interruptible water to the Region. In July 2003, the LNRA entered into an agreement with the City of Corpus Christi to provide the Region an additional 4,500 acft water on an interruptible basis. This resulted in a total interruptible supply of 12,000 acft/yr provided to the Region from Lake Texana. In addition, the City of Corpus Christi has purchased 35,000 acft of water rights from the Garwood Irrigation Company to be transported to the Coastal Bend Region via an extension of the Mary Rhodes Pipeline.

For rural municipal communities and non-municipal water users that have historically used groundwater supplies, new groundwater availability studies (using the TWDB CGCGAM) indicate that in most cases, groundwater is available to meet local demands in the future.

Finally, a subcommittee of the City of Corpus Christi's Regional Water Supply Task Force has been further investigating the economics and development of desalination for the Coastal Bend Region.

1.12 Assessment of Water Conservation and Drought Preparation

Besides extensive studies of the Coastal Bend Region's water needs and future resources, much of the Region has implemented the City of Corpus Christi's Water Conservation and Drought Contingency Plan. The City of Corpus Christi's Water Conservation Plan,[23] updated in November 2005, focuses on two goals: (1) to reduce summertime peak pumping, and (2) to reduce overall per capita consumption by 1 percent per year from the City's consumption of

[22] Correspondence with Carola Serrato, May 2005.
[23] City of Corpus Christi Water Conservation and Drought Contingency Plan, Amended November 15, 2005 (Appendix E.4).

259 gallons per capita per day (gpcd) in 1988 to 200 gpcd by 2014. The City of Corpus Christi's Water Conservation Plan outlines a Drought Contingency Plan, which is implemented when current water supplies are threatened. In 2001, the City of Corpus Christi amended their Drought Contingency Plan to reflect changes to the operation of the CCR/LCC System. These amendments removed the "Conditions" hierarchical stages in their Drought Contingency Plan, which were previously used to implement the different water conservation measures as the threat of water shortage increased. The Drought Contingency Plan, updated in November 2005, is initiated as the percentage of combined storage of the CCR/LCC System decreases and includes water reduction targets based on storage levels (Table 1-4).

Table 1-4.
City of Corpus Christi Drought Contingency Plan

Combined Storage below 50%	• City Manager issues a public notice requesting voluntary conservation measures • Target water demand reduction of 1 percent, including for wholesale water contracts
Combined Storage below 40%	• City Manager issues a public notice implementing required water conservation measures • Outdoor watering restricted; no outdoor watering allowed between 10:00 a.m. and 6:00 p.m. • No runoff from yards or plants into gutters or streets allowed • All defective plumbing in a home or business must be addressed • No water shall be allowed to flow constantly through a tap, hydrant, valve, or otherwise by any user • Target Inflows to Nueces Bay are reduced to 1,200 acft per month • Target water demand reduction of 5 percent, including for wholesale water contracts
Combined Storage below 30%	• City Manager publishes a lawn-watering schedule • Target Inflows to Nueces Bay are reduced to 0 acft per month • Target water demand reduction of 10 percent, including for wholesale water contracts
Combined Storage below 20%	• Target water demand reduction of 15 percent, including for wholesale water contracts

In addition, during drought conditions, both municipal and wholesale customers are subject to water allocation from the City of Corpus Christi. In turn, wholesale customers are responsible to impose similar allocations on their customers. The City's Water Conservation Plan includes water conservation targets and goals for their wholesale customers (Table 1-4).

In response to rules adopted by TCEQ, the City of Corpus Christi evaluated their existing Water Conservation Plan and amended it to meet those requirements by September 1, 1999. It was amended again in 2001 to reflect changes to the TCEQ Agreed Operating Order of the CCR/LCC System. The focus of the City of Corpus Christi's Water Conservation Plan is public information. The plan provides everyday water conservation tips, including plumbing codes and retrofit programs, and educational demonstrations and programs for the public. The City of Corpus Christi's Water Conservation Plan recognizes its long-held conservation-based water rate structure, universal metering and a meter repair/replacement program, and leak detection program. Other programs outlined within the water conservation plan are such practices as reuse and recycling of wastewater and greywater, the establishment of landscape ordinances, and an outlined procedure to determine and control unaccounted-for water loss. The City of Corpus Christi's Water Conservation Plan not only recognizes the ongoing water conservation practices within the City of Corpus Christi service area but it also defined water conservation goals.

City of Corpus Christi Water Conservation Goals:

- Maintain per capita water usage below the median for the previous 5-year per capita consumption for cities with populations greater than 50,000 situated in the central climatological region of the state;
- Limit unaccounted-for water from the City's system to no more than 15 percent (based on a moving 5-year average);
- Assist the Coastal Bend ("Region N") Regional Water Planning Group in completing the Senate Bill 1 Regional Water Plan; and
- Assist City customers in continuing efforts toward water conservation.

The TCEQ provides guidance for Water Conservation and Drought Contingency Plans in 30 TAC Chapter 288, which requires "specific, quantified 5- and 10-year targets for water savings to be included in all water conservation plans to be submitted to the TCEQ no later than May 1, 2005." Due to timing constraints, these water conservation target savings for Coastal Bend Region entities will not be included in the 2006 Plan. These targets should be included in future water planning efforts.

Section 2
Population and Water Demand Projections
[31 TAC §.57.7 (a)(2)]

2.1 Introduction

In December 2002, the TWDB published the new population and water demand projections for each county in the state. Population projections were developed for cities with a population greater than 500, water supply corporations and special utility districts using volumes of 280 acft or more in 2000, and 'county-other' to capture those people living outside the cities or water utility service areas for each county. Water demand projections were developed by type of use: municipal for cities and water supply corporations/special utility districts (along with a 'county-other' for each county), and countywide for manufacturing, steam-electric, mining, irrigation, and livestock. This section presents these figures for the 11-county Coastal Bend Regional Water Planning Area. The population projections are a consensus-based "most-likely" scenario of growth, based on recent and prospective growth trends as determined by the opinions of a Technical Advisory Committee consisting of state agencies, key interest groups, and the general public. The demand projections for each type of water use were made under various assumptions that will be addressed in each water-use section below.

Each city within the region was provided an opportunity to review their respective population and water demand projections. During this review period, no city within the Coastal Bend Region chose to revise their projections. Appendix C contains figures for population, per capita water use, and water demand projections for each city and county-other and manufacturing (including steam-electric, if applicable), mining, and irrigation and livestock water demand projections for each county.

2.2 Population Projections

From 1980 to 2000, the population in the 11-county region grew by 72,927 (from 468,257 to 541,184), an increase of 15.6 percent (0.73 percent compound annual growth), as shown in Table 2-1. This compares with a statewide increase in population of 46.5 percent (1.93 percent annually). The majority of the growth occurred in Nueces and San Patricio Counties, the two largest counties in the region. Combined, they accounted for 75 percent of the total increase, and in 2000 their populations totaled 70 percent of the region. In 2000,

Table 2-1.
Coastal Bend Regional Population
(by County and River Basin)

	Historical			Projections[1]						Percent Growth[2]	Percent Growth[2]
	1980	1990	2000	2010	2020	2030	2040	2050	2060	(1980-00)	(2000-60)
County											
Aransas	14,260	17,892	22,497	26,863	30,604	32,560	32,201	30,422	28,791	2.31%	0.41%
Bee	26,030	25,135	32,359	34,298	36,099	37,198	37,591	37,598	36,686	1.09%	0.21%
Brooks	8,428	8,204	7,976	8,607	9,303	9,909	10,288	10,399	10,349	-0.28%	0.44%
Duval	12,517	12,918	13,120	13,881	14,528	14,882	14,976	14,567	13,819	0.24%	0.09%
Jim Wells	36,498	37,679	39,326	42,434	45,303	47,149	47,955	47,615	46,596	0.37%	0.28%
Kenedy	543	460	414	467	495	523	527	529	537	-1.35%	0.43%
Kleberg	33,358	30,274	31,549	36,959	40,849	43,370	44,989	47,118	47,212	-0.28%	0.67%
Live Oak	9,606	9,556	12,309	13,735	14,929	15,386	15,018	13,808	12,424	1.25%	0.02%
McMullen	789	817	851	920	957	918	866	837	793	0.38%	-0.12%
Nueces	268,215	291,145	313,645	358,278	405,492	447,014	483,692	516,265	542,327	0.79%	0.92%
San Patricio	58,013	58,749	67,138	80,701	95,381	109,518	122,547	134,806	146,131	0.73%	1.30%
Total for Region	468,257	492,829	541,184	617,143	693,940	758,427	810,650	853,964	885,665	0.73%	0.82%
River Basin											
Nueces	38,122	40,062	56,482	62,655	68,897	73,705	77,095	79,088	80,134	1.99%	0.58%
Nueces-Rio Grande	341,308	360,810	372,608	422,954	473,751	516,683	552,859	584,074	606,293	0.44%	0.81%
San Antonio-Nueces	88,827	91,957	112,094	131,534	151,292	168,039	180,696	190,802	199,238	1.17%	0.96%
Total for Region	**468,257**	**492,829**	**541,184**	**617,143**	**693,940**	**758,427**	**810,650**	**853,964**	**885,665**	**0.73%**	**0.82%**
Total for Texas	**14,229,191**	**16,986,510**	**20,851,790**	**24,909,072**	**29,108,012**	**33,040,035**	**36,877,046**	**41,054,973**	**45,533,734**	**1.93%**	**1.31%**

[1]Projections from Texas Water Development Board.
[2]Compound annual growth rate.

58.0 percent of the region's total population lived in Nueces County, 12.4 percent in San Patricio County, 7.3 percent in Jim Wells County, 5.8 percent in Kleberg County, 6.0 percent in Bee County, and less than 5.0 percent in each of the remaining six counties.

The population in the 11-county region is projected to increase by 344,481 from 2000 to 2060, an increase of 63.7 percent (0.82 percent annually), as shown in Table 2-1. This compares to a statewide projected population growth in the same period of 118 percent (1.31 percent annually). The total population for the region in 2000 was 2.6 percent of the 20.85 million population statewide. It declines slightly by 2060, to 1.9 percent of the projected 45.5 million statewide totals. In 2060, it is projected that 61.2 percent of the region's population will live in Nueces County, 16.5 percent in San Patricio County, 5.3 percent in Kleberg County, 5.3 percent in Jim Wells County, and less than 5.0 percent in each of the remaining seven counties. Figure 2-1 shows the trend in population for the region from 1990 to 2060.

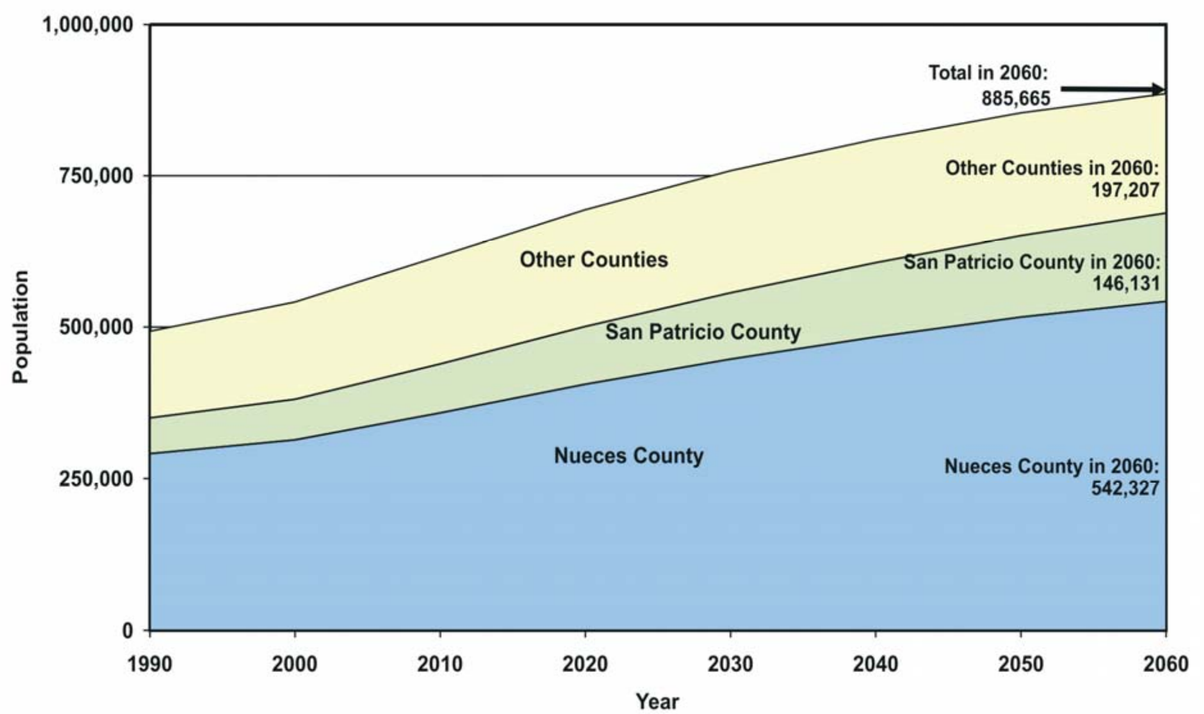

Figure 2-1. Coastal Bend Region Population

San Patricio and Nueces Counties are the fastest growing counties in the region, growing at an annual rate higher than the regional average of 0.82 percent (Figure 2-2). The population growth in those counties accounts for 89.3 percent of the total increase over the next 60 years.

Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg and Live Oak Counties all have positive annual growth rates, but less than the regional average. The growth rate in McMullen County, the second smallest in the region, is negative, as their population declines over the 60-year period, from 851 to 793.

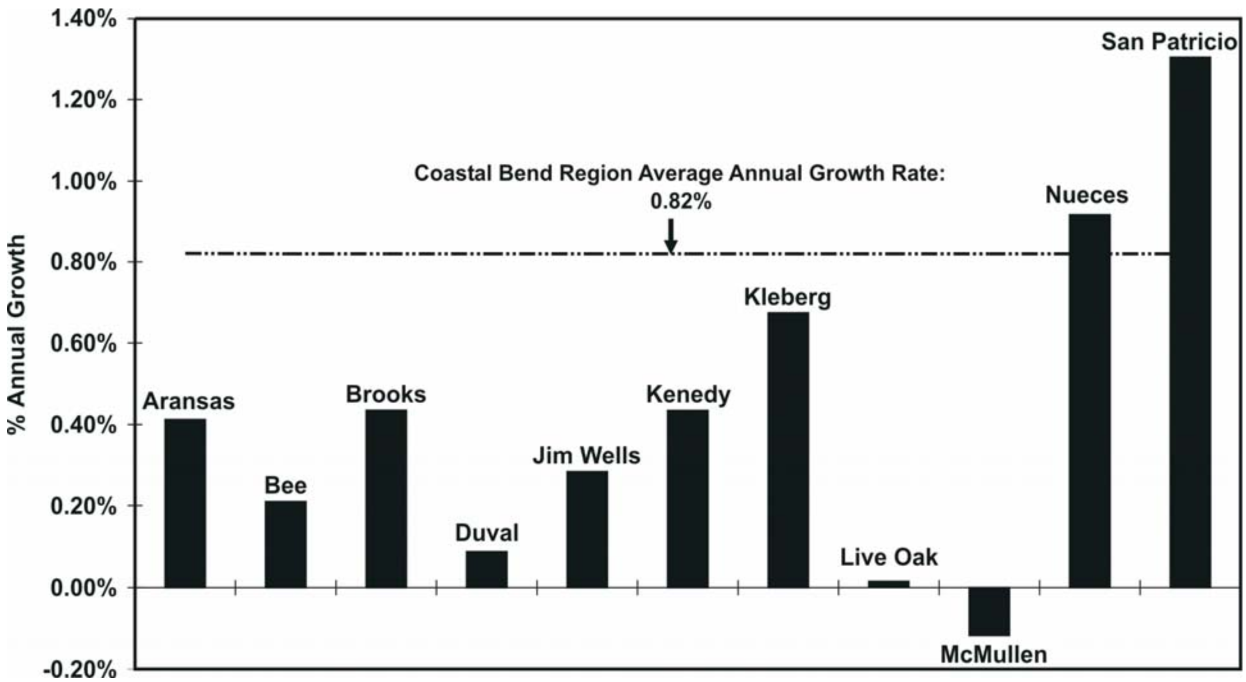

Figure 2-2. Percent Annual Population Growth Rate for 2000 through 2060 by County

Corpus Christi and Kingsville are the two largest cities in the region, accounting for 56.0 percent of the total population in 2000, increasing to 56.4 percent of the total in 2060. Population projections for the 51 cities, water supply corporations, and 'county-other' users in the region are shown in Table 2-2. County-Other category includes persons residing outside of cities and also outside water utility boundaries.

2.3 Water Demand Projections

The TWDB water demand projections have been compiled for each type of consumptive water use: municipal, manufacturing, steam-electric power, mining, irrigation, and livestock. In these consumptive types of water use there is a "loss" in water. In non-consumptive water use, such as navigation, hydroelectric generating, or recreation, there is little or no water loss.

Table 2-2.
Coastal Bend Region Population
(by City/County)

City/County	*Historical*			*Projections*						*Percent Growth[2]*	*Percent Growth[2]*
	1980	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*	*1980-00*	*2000-60*
ARANSAS PASS (P)	860	912	867	1,035	1,179	1,255	1,241	1,172	1,110	0.04%	0.41%
FULTON		763	1,553	1,854	2,113	2,248	2,223	2,100	1,987	N/A	0.41%
ROCKPORT	3,686	5,355	7,385	8,818	10,046	10,688	10,570	9,987	9,451	3.54%	0.41%
COUNTY-OTHER	9,714	10,862	12,692	15,156	17,266	18,369	18,167	17,163	16,243	1.35%	0.41%
Aransas County	*14,260*	*17,892*	*22,497*	*26,863*	*30,604*	*32,560*	*32,201*	*30,422*	*28,791*	*2.31%*	*0.41%*
BEEVILLE	14,574	13,547	13,129	13,916	14,646	15,092	15,252	15,255	14,885	-0.52%	0.21%
EL OSO WSC (P)		271	320	339	357	368	372	372	363	N/A	0.21%
COUNTY-OTHER	11,456	11,317	18,910	20,043	21,096	21,738	21,967	21,971	21,438	2.54%	0.21%
Bee County	*26,030*	*25,135*	*32,359*	*34,298*	*36,099*	*37,198*	*37,591*	*37,598*	*36,686*	*1.09%*	*0.21%*
FALFURRIAS	6,103	5,788	5,297	6,981	8,316	9,310	9,924	10,178	10,215	-0.71%	1.10%
COUNTY-OTHER	2,325	2,416	2,679	1,626	987	599	364	221	134	0.71%	-4.87%
Brooks County	*8,428*	*8,204*	*7,976*	*8,607*	*9,303*	*9,909*	*10,288*	*10,399*	*10,349*	*-0.28%*	*0.44%*
BENAVIDES	1,978	1,788	1,686	1,784	1,867	1,912	1,925	1,872	1,776	-0.80%	0.09%
FREER	3,213	3,271	3,241	3,429	3,589	3,676	3,699	3,598	3,414	0.04%	0.09%
SAN DIEGO (P)	4,331	4,109	3,928	4,156	4,350	4,456	4,484	4,361	4,137	-0.49%	0.09%
COUNTY-OTHER	2,995	3,750	4,265	4,512	4,722	4,838	4,868	4,736	4,492	1.78%	0.09%
Duval County	*12,517*	*12,918*	*13,120*	*13,881*	*14,528*	*14,882*	*14,976*	*14,567*	*13,819*	*0.24%*	*0.09%*
ALICE	20,961	19,788	19,010	20,512	21,899	22,792	23,181	23,017	22,524	-0.49%	0.28%
ORANGE GROVE	1,212	1,175	1,288	1,390	1,484	1,544	1,571	1,559	1,526	0.30%	0.28%
PREMONT	2,984	2,914	2,772	2,991	3,193	3,323	3,380	3,356	3,284	-0.37%	0.28%
SAN DIEGO (P)	894	874	825	890	950	989	1,006	999	978	-0.40%	0.28%
COUNTY-OTHER	10,447	12,928	15,431	16,651	17,777	18,501	18,817	18,684	18,284	1.97%	0.28%
Jim Wells County	*36,498*	*37,679*	*39,326*	*42,434*	*45,303*	*47,149*	*47,955*	*47,615*	*46,596*	*0.37%*	*0.28%*
COUNTY-OTHER	543	460	414	467	495	523	527	529	537	-1.35%	0.43%
Kenedy County	*543*	*460*	*414*	*467*	*495*	*523*	*527*	*529*	*537*	*-1.35%*	*0.43%*
KINGSVILLE	28,808	25,276	25,575	26,844	27,756	28,347	28,727	29,226	29,248	-0.59%	0.22%
RICARDO WSC		1,503	2,301	5,687	8,122	9,700	10,713	12,046	12,105	N/A	2.81%
COUNTY-OTHER	4,550	3,495	3,673	4,428	4,971	5,323	5,549	5,846	5,859	-1.06%	0.78%
Kleberg County	*33,358*	*30,274*	*31,549*	*36,959*	*40,849*	*43,370*	*44,989*	*47,118*	*47,212*	*-0.28%*	*0.67%*
CHOKE CANYON WS (P)		539	2,250	2,511	2,729	2,812	2,745	2,524	2,271	N/A	0.02%
EL OSO (P)		*812*	1,000	1,116	1,213	1,250	1,220	1,122	1,009	N/A	0.01%
GEORGE WEST	2,627	2,586	2,524	2,816	3,061	3,155	3,079	2,831	2,548	-0.20%	0.02%
MCCOY WSC (P)		185	443	494	537	554	540	497	447	N/A	0.01%
THREE RIVERS	2,133	1,889	1,878	2,096	2,278	2,347	2,291	2,107	1,896	-0.63%	0.02%
COUNTY-OTHER	4,846	3,545	4,214	4,702	5,111	5,268	5,143	4,727	4,253	-0.70%	0.02%
Live Oak County	*9,606*	*9,556*	*12,309*	*13,735*	*14,929*	*15,386*	*15,018*	*13,808*	*12,424*	*1.25%*	*0.02%*

Table 2-2.
Coastal Bend Region Population
(by City/County) (Concluded)

City/County	Historical			Projections						Percent Growth[2]	Percent Growth[2]
	1980	1990	2000	2010	2020	2030	2040	2050	2060	1980-00	2000-60
CHOKE CANYON WS (P)		60	250	270	281	270	254	246	233	N/A	-0.12%
COUNTY-OTHER	789	757	601	650	676	648	612	591	560	-1.35%	-0.12%
McMullen County	*789*	*817*	*851*	*920*	*957*	*918*	*866*	*837*	*793*	*0.38%*	*-0.12%*
AGUA DULCE		794	737	737	737	737	737	737	737	N/A	0.00%
ARANSAS PASS (P)	5	22	70	163	259	343	417	482	534	14.11%	3.44%
BISHOP	3,706	3,337	3,305	3,305	3,305	3,305	3,305	3,305	3,305	-0.57%	0.00%
CORPUS CHRISTI	231,999	257,453	277,450	316,058	356,123	391,077	421,761	448,879	470,523	0.90%	0.88%
DRISCOLL		688	825	1,090	1,364	1,603	1,813	1,999	2,147	N/A	1.61%
NUECES COUNTY WCID #4		2,192	4,663	9,434	14,385	18,704	22,496	25,847	28,521	N/A	3.06%
PORT ARANSAS	1,968	2,233	3,370	5,565	7,843	9,830	11,575	13,117	14,348	2.73%	2.44%
RIVER ACRES WSC		2,130	2,750	3,947	5,189	6,273	7,224	8,065	8,736	N/A	1.95%
ROBSTOWN	12,100	12,849	12,727	12,727	12,727	12,727	12,727	12,727	12,727	0.25%	0.00%
COUNTY-OTHER	18,437	9,447	7,748	5,252	3,560	2,415	1,637	1,107	749	-4.24%	-3.82%
Nueces County	*268,215*	*291,145*	*313,645*	*358,278*	*405,492*	*447,014*	*483,692*	*516,265*	*542,327*	*0.79%*	*0.92%*
ARANSAS PASS (P)	6,308	6,246	7,201	8,653	10,225	11,739	13,134	14,447	15,660	0.66%	1.30%
GREGORY	2,739	2,458	2,318	2,318	2,318	2,318	2,318	2,318	2,318	-0.83%	0.00%
INGLESIDE	5,436	5,696	9,388	15,003	21,080	26,933	32,327	37,402	42,090	2.77%	2.53%
INGLESIDE ON THE BAY		529	659	857	1,071	1,277	1,467	1,646	1,811	N/A	1.70%
LAKE CITY		465	526	619	719	816	905	989	1,066	N/A	1.18%
MATHIS	5,667	5,423	5,034	5,034	5,034	5,034	5,034	5,034	5,034	-0.59%	0.00%
ODEM	2,363	2,366	2,499	2,701	2,920	3,131	3,325	3,508	3,677	0.28%	0.65%
PORTLAND	12,023	12,224	14,827	18,786	23,071	27,197	31,000	34,578	37,884	1.05%	1.58%
SINTON	6,044	5,549	5,676	5,869	6,078	6,279	6,465	6,640	6,801	-0.31%	0.30%
TAFT	3,686	3,222	3,396	3,661	3,947	4,223	4,477	4,716	4,937	-0.41%	0.63%
COUNTY-OTHER	13,747	14,571	15,614	17,200	18,918	20,571	22,095	23,528	24,853	0.64%	0.78%
San Patricio County	*58,013*	*58,749*	*67,138*	*80,701*	*95,381*	*109,518*	*122,547*	*134,806*	*146,131*	*0.73%*	*1.30%*
Total For Region	**468,257**	**492,829**	**541,184**	**617,143**	**693,940**	**758,427**	**810,650**	**853,964**	**885,665**	**0.73%**	**0.82%**

Notes:
[1] Projections from Texas Water Development Board
[2] Compound annual growth rate
(P) Partial

As shown in Table 2-3, total water use for the region is projected to increase by 102,641 acft/yr between 2000 and 2060, from 205,936 acft/yr to 308,577 acft/yr, a 49.8 percent rise. Municipal, manufacturing, steam-electric, and mining water use are projected to increase, while irrigation use is projected to decline, and livestock use is unchanged. The trend in total water use for 2000 to 2060 is shown in Figure 2-3. In 2000, 48.5 percent of the total water use was for municipal purposes, 26.4 percent for manufacturing, 4.3 percent for steam-electric water, 5.8 percent for mining, 10.7 percent for irrigation, and 4.3 percent for livestock. In 2060, municipal use as a percentage of the total is projected to increase to 49.1 percent, manufacturing use to increase to 28.5 percent, steam-electric water use to increase to 9.0 percent, mining use to increase to 6.2 percent, irrigation water use to decrease to 4.3 percent, and livestock use to decrease to 2.9 percent. These components of total water use for 2000 and 2060 are shown in Figure 2-4.

Table 2-3.
Coastal Bend Region Total Water Demand by Type of Use and River Basin (acft/yr)

	Historical		*Projections[1]*					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Water Use								
Municipal	108,620	99,950	111,495	122,861	132,063	139,425	146,036	151,474
Manufacturing	43,611	54,481	63,820	69,255	73,861	78,371	82,283	88,122
Steam-Electric	2,404	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Mining	7,563	11,897	14,413	15,787	16,640	17,490	18,347	19,114
Irrigation	14,237	21,971	20,072	18,611	17,077	15,703	14,470	13,365
Livestock	9,624	8,838	8,838	8,838	8,838	8,838	8,838	8,838
Total for Region	**186,059**	**205,936**	**225,954**	**249,664**	**265,212**	**279,510**	**293,254**	**308,577**
River Basin								
Nueces	23,734	38,217	40,749	50,576	53,816	57,286	61,033	65,637
Nueces-Rio Grande	135,782	137,622	152,734	164,339	175,110	184,816	193,843	203,406
San Antonio-Nueces	26,543	30,097	32,471	34,749	36,286	37,408	38,378	39,534
Total for Region	**186,059**	**205,936**	**225,954**	**249,664**	**265,212**	**279,510**	**293,254**	**308,577**

[1] Projections from Texas Water Development Board

The Coastal Bend Region encompasses parts of three river basins: the Nueces, the Nueces-Rio Grande, and the San Antonio-Nueces. Total water demand in each basin is shown in Table 2-3.

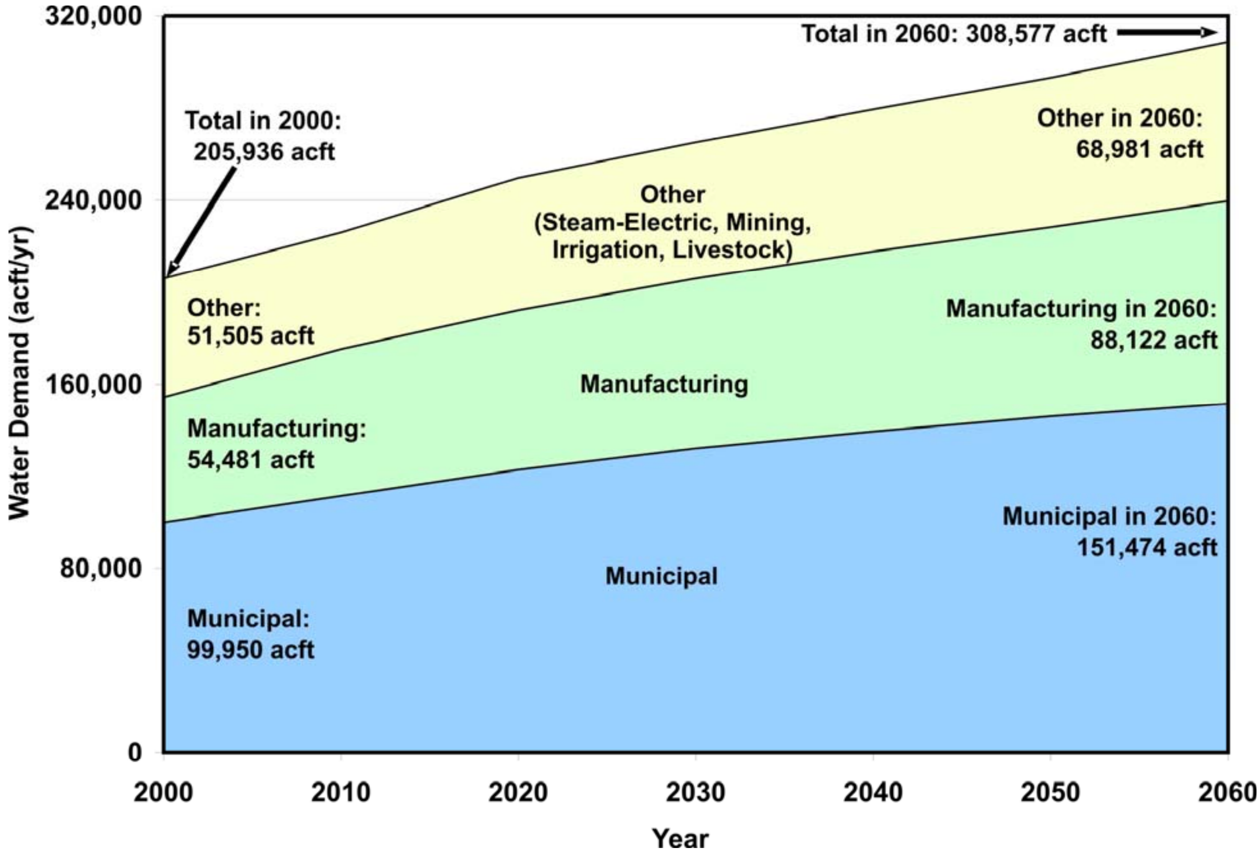

Figure 2-3. Coastal Bend Region Water Demand

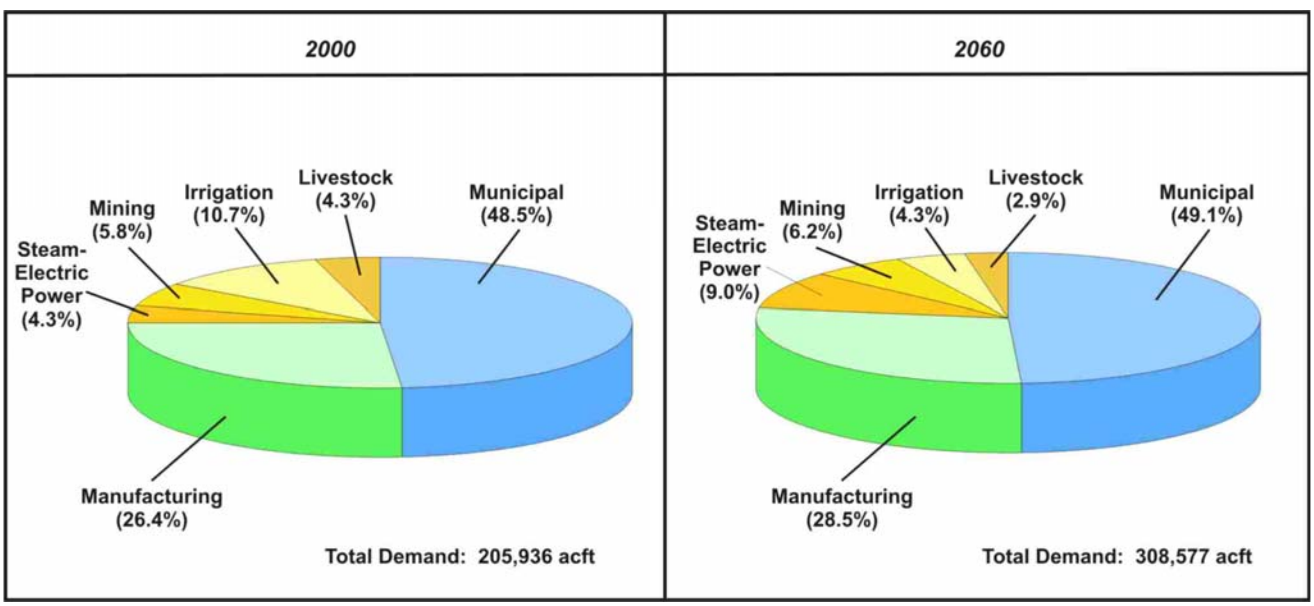

Figure 2-4. Total Water Demand by Type of Use

2.3.1 Municipal Water Demand

Water that is used by households (e.g., drinking, bathing, food preparation, dishwashing, laundry, flushing toilets, lawn watering and landscaping, swimming pools and hot tubs) commercial establishments (e.g., restaurants, car washes, hotels, laundromats, and office buildings) and for fire protection, public recreation and sanitation are all referred to as municipal water. This type of water must meet safe drinking water standards as specified by Federal and State laws and regulations.

The TWDB computes the municipal water demand projections by multiplying the projected population of an entity by the entity's projected per capita water use, adjusted for conservation savings. Again, projected population is the "most-likely" scenario. The projected per capita water use takes into account current plumbing fixtures as well as anticipated effects of the 1991 State Water-Efficient Plumbing Act and is estimated based on year 2000 water use, which represents below-normal rainfall in most of the state. The projected per capita water use is an "expected" scenario of water conservation including installation of water-efficient plumbing fixtures as defined by the 1991 State Water-Efficient Plumbing Act. In all cases, applying this conservation scenario to the per capita use results in a declining per capita water use over time.

In 2000 total municipal use in the Coastal Bend Region was 99,950 acft/yr. Nueces and San Patricio Counties accounted for 71.6 percent of the total. Municipal use is projected to increase 51.5 percent to 151,474 acft by year 2060 (Table 2-4). Brooks, Nueces, and San Patricio Counties will experience the largest increases, 54.6 percent, 64.3 percent, and 82.5 percent, respectively. By 2060, Nueces and San Patricio Counties will account for 78.7 percent of the total municipal water use in the region (Figure 2-5).

The increase in municipal water demand correlates to an increase in the region's population. This is illustrated in the entities of the City of Corpus Christi and Ricardo Water Supply Corporation (WSC). Both are projected to experience large increases in population, and as a result, in water use as well. Corpus Christi's water use is projected to increase 56.3 percent over the next 60 years while Ricardo WSC's increase is projected to increase 372.0 percent. However, the increase in water use for each of these entities is less than their respective increases in population (i.e., low flow plumbing fixtures). This is attributable to a declining per capita water use, which includes conservation built-in the TWDB demand projections. Per capita water use in Corpus Christi is projected to decline 7.8 percent, from 179 gallons per capita daily (gpcd)

Table 2-4.
Municipal Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	*Historical*		*Projections[1]*					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Aransas	2,614	3,314	3,831	4,263	4,444	4,326	4,053	3,835
Bee	3,569	4,220	4,342	4,456	4,492	4,439	4,397	4,291
Brooks	1,150	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Duval	2,090	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Jim Wells	6,535	8,562	9,068	9,526	9,756	9,761	9,640	9,433
Kenedy	44	46	50	52	53	53	52	53
Kleberg	6,261	5,415	6,051	6,436	6,664	6,762	7,008	7,020
Live Oak	1,796	2,350	2,573	2,750	2,796	2,693	2,459	2,213
McMullen	109	175	186	190	180	168	160	152
Nueces	76,521	62,702	70,609	78,691	85,697	91,988	97,882	103,018
San Patricio	7,931	8,873	10,070	11,423	12,661	13,813	14,997	16,191
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**
River Basin								
Nueces	10,862	10,017	10,832	11,628	12,184	12,521	12,698	12,821
Nueces-Rio Grande	84,992	74,787	83,683	92,369	99,570	105,617	111,198	115,677
San Antonio-Nueces	12,766	15,146	16,980	18,864	20,309	21,287	22,140	22,976
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**

[1] Projections from Texas Water Development Board

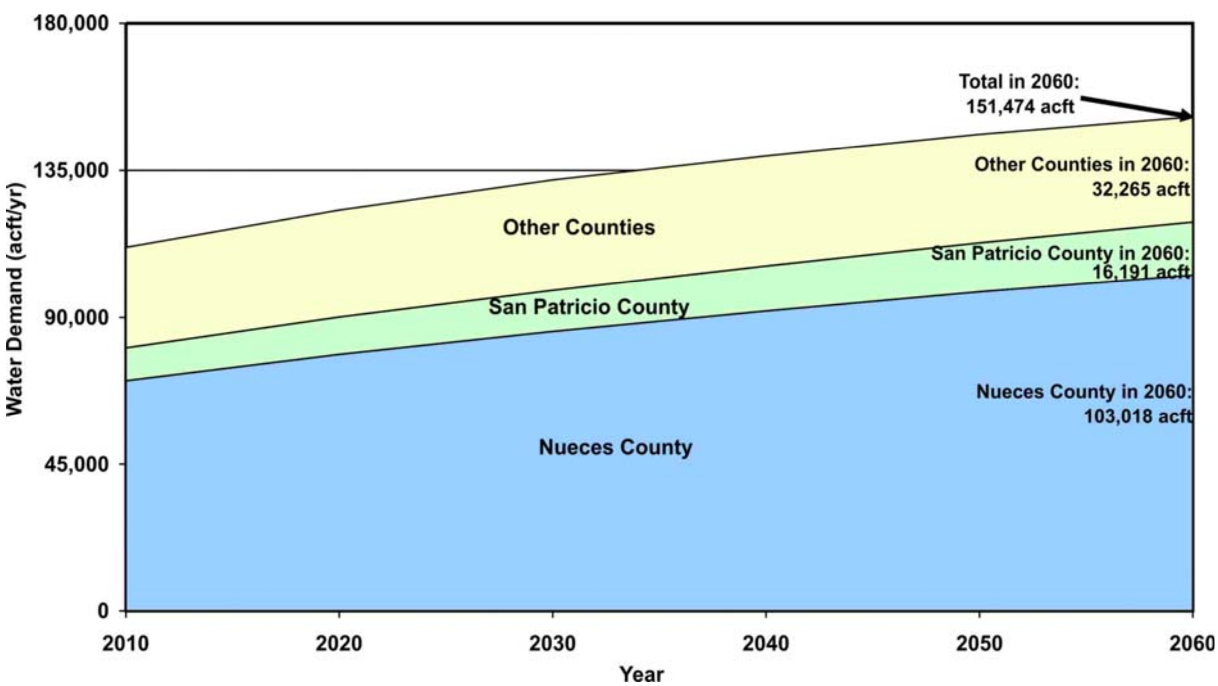

Figure 2-5. Coastal Bend Region Municipal Water Demand

in 2000 to 165 gpcd in 2060. Per capita water use for Ricardo WSC was estimated to be 115 gpcd in 2000, declining 10.4 percent to 103 gpcd in 2060. Municipal water use projections for the 51 entities in the region are presented in Table 2-5.

Table 2-5.
Municipal Water Demand
Coastal Bend Region by City/County
(acft/yr)

City/County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas Pass (P)	116	146	168	186	195	190	179	169
Fulton	128	261	307	346	365	359	336	318
Rockport	1,001	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other	1,369	1,550	1,766	1,953	2,016	1,954	1,826	1,728
Aransas County	*2,614*	*3,314*	*3,831*	*4,263*	*4,444*	*4,326*	*4,053*	*3,835*
Beeville	1,929	2,529	2,619	2,690	2,722	2,699	2,683	2,618
El Oso (P)		60	62	65	66	66	65	64
County-Other	1,640	1,631	1,661	1,701	1,704	1,674	1,649	1,609
Bee County	*3,569*	*4,220*	*4,342*	*4,456*	*4,492*	*4,439*	*4,397*	*4,291*
Falfurrias	819	1,661	2,135	2,515	2,795	2,957	3,021	3,032
County-Other	331	309	180	106	62	37	22	13
Brooks County	*1,150*	*1,970*	*2,315*	*2,621*	*2,857*	*2,994*	*3,043*	*3,045*
Benavides	456	315	326	333	334	330	319	302
Freer	521	624	645	659	663	655	633	600
San Diego (P)	660	471	479	482	479	467	449	426
County-Other	453	913	950	979	987	976	944	895
Duval County	*2,090*	*2,323*	*2,400*	*2,453*	*2,463*	*2,428*	*2,345*	*2,223*
Alice	3,581	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Orange Grove	212	353	374	394	405	406	402	393
Premont	970	807	858	905	931	935	925	905
San Diego (P)	140	99	103	105	106	105	103	101
County-Other	1,632	2,022	2,127	2,210	2,238	2,213	2,177	2,130
Jim Wells County	*6,535*	*8,562*	*9,068*	*9,526*	*9,756*	*9,761*	*9,640*	*9,433*
County-Other	44	46	50	52	53	53	52	53
Kenedy County	*44*	*46*	*50*	*52*	*53*	*53*	*52*	*53*
Kingsville	4,776	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Ricardo WSC		296	682	955	1,130	1,236	1,390	1,397
County-Other	1,485	679	799	880	930	957	1,002	1,004
Kleberg County	*6,261*	*5,415*	*6,051*	*6,436*	*6,664*	*6,762*	*7,008*	*7,020*

Continued on next page

Table 2-5 Concluded

City/County	***Historical***		***Projections[1]***					
	1990	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Choke Canyon WS (P)		360	397	425	435	421	384	346
El Oso WSC (P)		189	206	220	223	215	196	176
George West	530	642	703	754	767	738	675	608
McCoy WSC		50	54	57	58	56	51	46
Three Rivers	379	425	465	498	505	485	444	399
County-Other	887	684	748	796	808	778	709	638
Live Oak County	*1,796*	*2,350*	*2,573*	*2,750*	*2,796*	*2,693*	*2,459*	*2,213*
Choke Canyon WS (P)		40	43	44	42	39	37	35
County-Other	109	135	143	146	138	129	123	117
McMullen County	*109*	*175*	*186*	*190*	*180*	*168*	*160*	*152*
Agua Dulce	99	115	112	110	107	105	103	103
Aransas Pass (P)	3	12	26	41	53	64	73	81
Bishop	465	459	444	433	422	411	404	404
Corpus Christi	66,966	55,629	61,953	68,212	73,592	78,422	82,961	86,962
Driscoll	88	97	122	148	171	191	208	224
Nueces County WCID #4		977	1,913	2,884	3,729	4,460	5,124	5,655
Port Aransas	1,308	1,601	2,606	3,655	4,558	5,355	6,068	6,637
River Acres WSC		314	429	546	646	736	813	881
Robstown	2,429	2,153	2,110	2,067	2,024	1,982	1,953	1,953
County-Other	5,163	1,345	894	595	395	262	175	118
Nueces County	*76,521*	*62,702*	*70,609*	*78,691*	*85,697*	*91,988*	*97,882*	*103,018*
Aransas Pass (P)	792	1,210	1,405	1,615	1,828	2,015	2,201	2,386
Gregory	239	249	239	231	223	216	210	210
Ingleside	613	873	1,294	1,771	2,202	2,607	3,016	3,394
Ingleside On The Bay		74	92	112	130	148	164	181
Lake City		70	79	89	99	107	116	125
Mathis	770	671	648	632	615	598	586	586
Odem	260	319	330	347	361	372	389	408
Portland	1,794	1,976	2,399	2,868	3,290	3,715	4,106	4,498
Sinton	789	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Taft	432	559	586	619	648	672	703	735
County-Other	2,242	1,836	1,946	2,077	2,189	2,277	2,398	2,533
San Patricio County	*7,931*	*8,873*	*10,070*	*11,423*	*12,661*	*13,813*	*14,997*	*16,191*
Total for Region	**108,620**	**99,950**	**111,495**	**122,861**	**132,063**	**139,425**	**146,036**	**151,474**

[1] Projections from Texas Water Development Board
(P) Partial

2.3.2 Manufacturing Water Demand

Manufacturing is an integral part of the Texas economy, and for many industries, water plays a key role in the manufacturing process. Some of these processes require direct consumption of water as part of the products; others consume very little water but use a large quantity for cleaning and cooling. Whether the water is a product component or used to transport waste heat and materials, it is considered manufacturing water use. The water-using manufacturers in the 11-county Coastal Bend Region are food processing, chemicals, petroleum refining, stone and concrete, fabricated metal, and electronic and electrical equipment. Of these industries present in the region, chemicals and petroleum refining are the largest and biggest water users.

The TWDB projects manufacturing water demand by taking industry-specific water demand coefficients, adjusted for water-use efficiencies (recycling/reuse), and applying them to growth trends for each industry. These growth trends assume expansion of existing capacity and building of new facilities; continuation of historical trends of interaction between oil price changes and industrial activity; and that the makeup of each county's manufacturing base remains constant throughout the 60-year planning period.

In 2000, total manufacturing water use for Coastal Bend Region was 54,481 acft. Nueces and San Patricio Counties accounted for 96.3 percent of this total (Table 2-6). Manufacturing use is projected to be 73,861 acft in 2030 and 88,122 acft in 2060, a 61.7 percent increase. In 2060, Nueces and San Patricio Counties are projected to account for 97.1 percent of the total manufacturing water use in the region (Figure 2-6). This projected increase can be attributed to continued growth in the petroleum refining industry in Nueces and San Patricio Counties.

As noted previously, petroleum refining is one of the largest industries in the region, accounting for about 60 percent of all manufacturing water use. Corpus Christi, in Nueces County, is home to nearly 13 percent of Texas' petroleum refining capacity. The refineries in the Corpus Christi area have implemented significant water conservation and water use efficiency improvement programs. These refineries use between 35 and 46 gallons of water per barrel of crude petroleum refined, compared to the State average of 100 gallons per barrel refined.[1]

[1] "Report of Water Use for Refineries and Selected Cities in Texas, 1976-1987," South Texas Water Authority, Kingsville, Texas, 1990.

Table 2-6.
Manufacturing Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	*Historical*		*Projections*[1]					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Aransas	283	235	267	281	292	302	311	331
Bee	1	1	1	1	1	1	1	1
Brooks	0	0	0	0	0	0	0	0
Duval	0	0	0	0	0	0	0	0
Jim Wells	0	0	0	0	0	0	0	0
Kenedy	0	0	0	0	0	0	0	0
Kleberg	0	0	0	0	0	0	0	0
Live Oak	943	1,767	1,946	1,998	2,032	2,063	2,088	2,194
McMullen	0	0	0	0	0	0	0	0
Nueces	34,949	39,763	46,510	50,276	53,425	56,500	59,150	63,313
San Patricio	7,435	12,715	15,096	16,699	18,111	19,505	20,733	22,283
Total for Region	**43,611**	**54,481**	**63,820**	**69,255**	**73,861**	**78,371**	**82,283**	**88,122**
River Basin								
Nueces	2,154	10,196	11,931	13,006	13,935	14,849	15,650	16,761
Nueces-Rio Grande	33,865	38,486	45,016	48,661	51,709	54,685	57,250	61,280
San Antonio-Nueces	7,592	5,799	6,873	7,588	8,217	8,837	9,383	10,081
Total for Region	**43,611**	**54,481**	**63,820**	**69,255**	**73,861**	**78,371**	**82,283**	**88,122**

[1] Projections from Texas Water Development Board

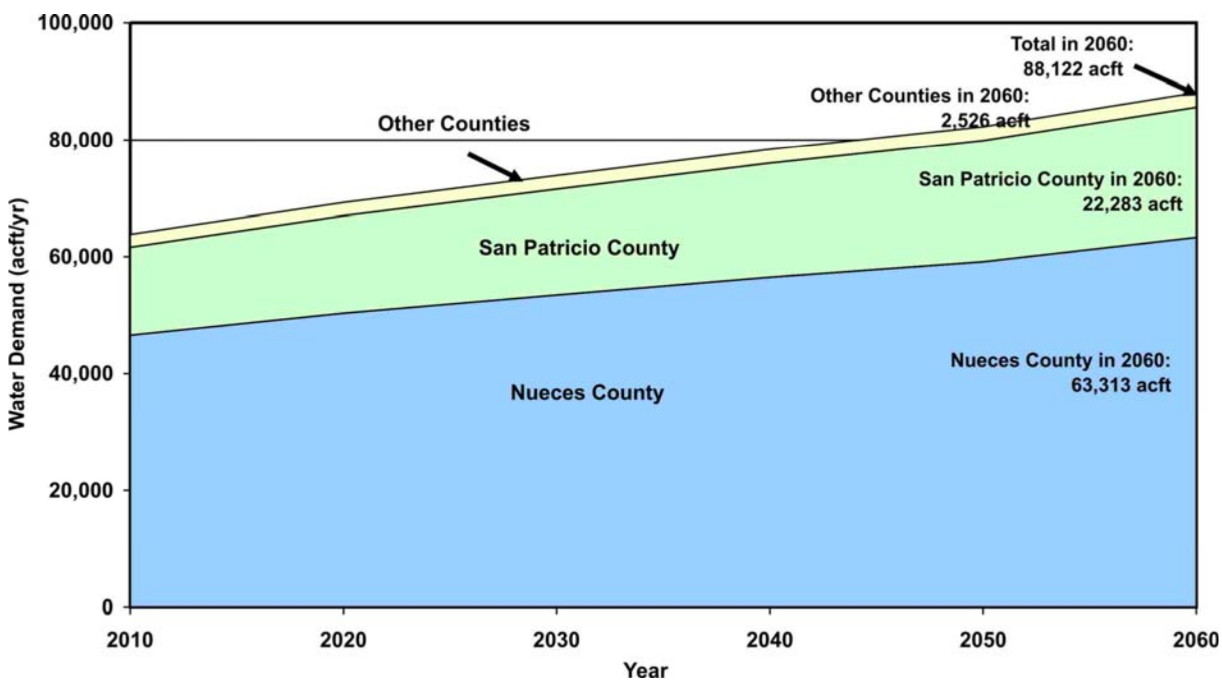

Figure 2-6. Coastal Bend Region Manufacturing Water Demand

2.3.3 Steam-Electric Water Demand

Projections for steam-electric power water demand are based on power generation projections—determined by population and manufacturing growth—and on power generation capacity and water use for that projected capacity. The steam-electric generation process uses water in boilers and for cooling the generating equipment. The usual practice is to use freshwater with a very low concentration of dissolved solids for boiler feed water and to use either freshwater or saline water for power plant cooling purposes. At two of the three plants located in Corpus Christi in Nueces County, freshwater is used for the boiler feed and seawater is used for cooling. The Nueces Bay Power Station is not currently operating. The use of saltwater for cooling at Topaz (formerly AEP-CPL's) Barney Davis Power Station saves approximately 6,300 acft/yr in freshwater (1999 figures). At the third plant, water is used for the boiler feed and cooling. Table 2-7 shows that in 2000, 8,799 acft/yr of water was used. According to AEP,[2] approximately two-thirds of the 8,799 acft/yr is forced evaporation of saltwater. In 2060, steam-electric demands for freshwater are projected to be 27,664 acft/yr (Figure 2-7). The large increase between 2010 and 2020 is attributable to a new 1200 MW plant in Nueces County, listed as a future plant by ERCOT.

2.3.4 Mining Water Demand

Projections for mining water demand are based on projected production of mineral commodities, and historic rates of water use, moderated by water requirements of technological processes used in mining.

In 2000 for the 11 counties of the Coastal Bend Planning Area, 11,897 acft was used in the mining of sand, gravel, and in the production of crude oil. Water is required in the mining of these minerals either for processing, leaching to extract certain ores, controlling dust at the plant site, or for reclamation. Duval, Kleberg and Live Oak Counties accounted for 82.2 percent of the 2000 total use (Table 2-8). Mining water use in 2030 is expected to be 16,640 acft and is projected to increase to 19,114 acft in 2060, a 60.7 percent from 2000- 2060. Duval, Kleberg, and Live Oak Counties, which will increase at 88.2 percent, 4.9 percent, and 72.0 percent, respectively, will account for 72.7 percent of the 2060 total use (Figure 2-8).

[2] Correspondence with Greg Carter, AEP-CPL.

Table 2-7.
Steam-Electric Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	0	0	0	0	0	0	0	0
Bee	0	0	0	0	0	0	0	0
Brooks	0	0	0	0	0	0	0	0
Duval	0	0	0	0	0	0	0	0
Jim Wells	0	0	0	0	0	0	0	0
Kenedy	0	0	0	0	0	0	0	0
Kleberg	0	0	0	0	0	0	0	0
Live Oak	0	0	0	0	0	0	0	0
McMullen	0	0	0	0	0	0	0	0
Nueces	2,404	8,799	7,316	14,312	16,733	19,683	23,280	27,664
San Patricio	0	0	0	0	0	0	0	0
Total for Region	**2,404**	**8,799**	**7,316**	**14,312**	**16,733**	**19,683**	**23,280**	**27,664**
River Basin								
Nueces	2,347	3,768	3,133	10,977	12,834	15,097	17,855	21,218
Nueces-Rio Grande	57	5,031	4,183	3,335	3,899	4,586	5,425	6,446
San Antonio-Nueces	0	0	0	0	0	0	0	0
Total for Region	**2,404**	**8,799**	**7,316**	**14,312**	**16,733**	**19,683**	**23,280**	**27,664**

[1] Projections from Texas Water Development Board

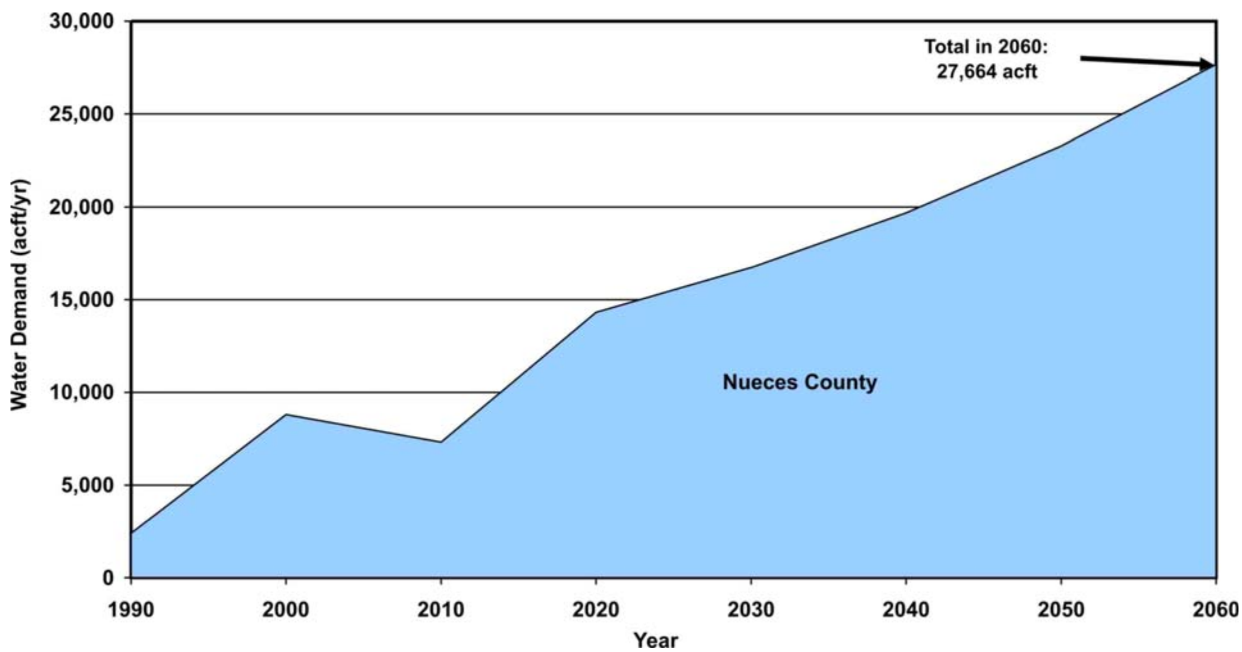

Figure 2-7. Coastal Bend Region Steam-Electric Water Demand

Table 2-8.
Mining Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	0	81	103	115	123	131	139	146
Bee	20	29	36	40	42	44	46	48
Brooks	145	127	150	161	167	173	179	184
Duval	3,049	4,544	5,860	6,630	7,119	7,610	8,108	8,553
Jim Wells	393	347	423	461	484	507	530	550
Kenedy	4	1	1	1	1	1	1	1
Kleberg	1,221	2,127	2,180	2,197	2,207	2,216	2,225	2,232
Live Oak	2,385	3,105	3,894	4,319	4,583	4,845	5,108	5,341
McMullen	239	176	195	203	207	211	215	218
Nueces	50	1,275	1,472	1,555	1,599	1,641	1,682	1,724
San Patricio	57	85	99	105	108	111	114	117
Total for Region	**7,563**	**11,897**	**14,413**	**15,787**	**16,640**	**17,490**	**18,347**	**19,114**
River Basin								
Nueces	3,787	5,046	6,350	7,068	7,515	7,963	8,414	8,814
Nueces-Rio Grande	3,719	5,876	6,925	7,509	7,875	8,239	8,609	8,938
San Antonio-Nueces	57	975	1,138	1,210	1,250	1,288	1,324	1,362
Total for Region	**7,563**	**11,897**	**14,413**	**15,787**	**16,640**	**17,490**	**18,347**	**19,114**

[1] Projections from Texas Water Development Board

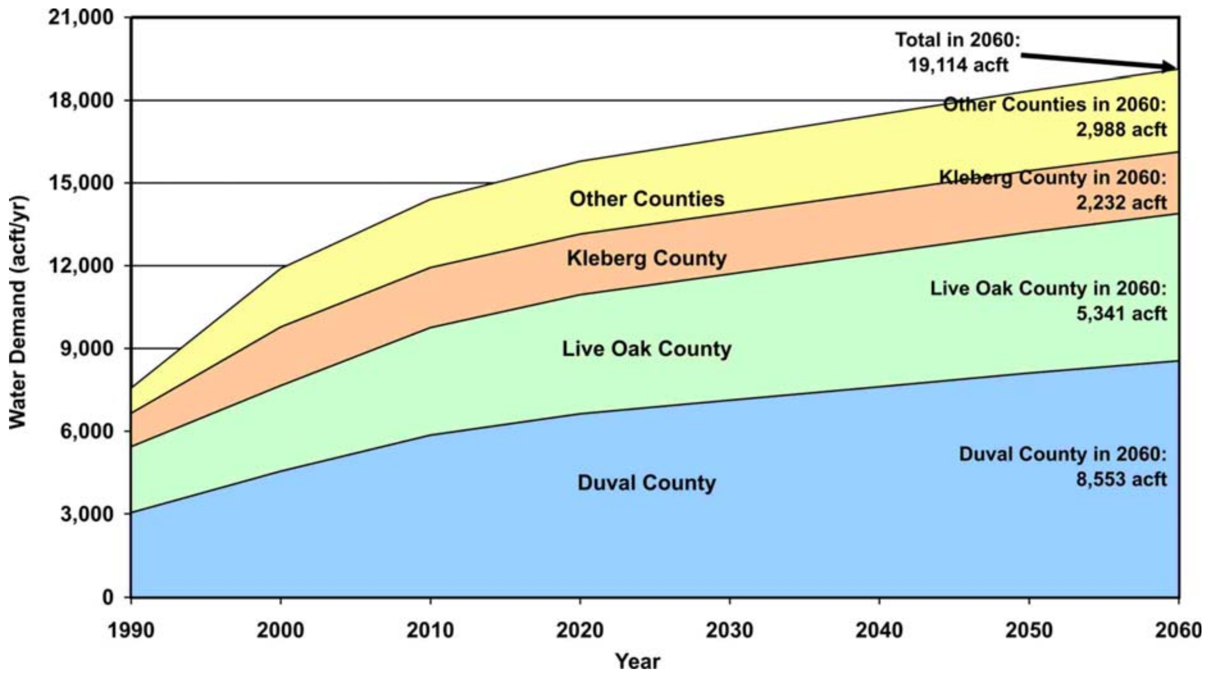

Figure 2-8. Coastal Bend Region Mining Water Demand

2.3.5 Irrigation Water Demand

Irrigated crop production in Coastal Bend Region is practiced in 9 of the 11 counties. Of the 4,951 farms in the region in 1997, 162 had 17,873 acres of irrigated farmland.[3] Irrigation surveys[4] by the Natural Resource Conservation Service reported 23,975 acres of irrigated farmland in 2000, with over 97 percent irrigated with groundwater. The region receives on average of about 29.2 inches of rainfall per year, which is generally adequate for dry-land crops. Irrigated cropland only accounts for 2.1 percent of all harvested cropland.[5] Major crops include corn, cotton, sorghum, hay and wheat, with over 97 percent of the irrigated land in the region irrigated with groundwater.

The irrigation water demand projections are based on specific assumptions regarding crop prices, crop yields, agricultural policy, and technological advances in irrigation systems. The TWDB estimated 2000 total irrigated water use in the Coastal Bend Region at 21,971 acft based on irrigation water use surveys (Table 2-9). Duval and San Patricio Counties accounted for 41.4 percent of that total. Irrigated water use is projected to decrease by 39.2 percent from 2000 to 2060, 21,971 acft to 13,365 acft (Figure 2-9). This decline is attributable to projected reduction in irrigated acreage and a decreasing dependence of agriculture in the region's economy.

2.3.6 Livestock Water Demand

In the 11-county Coastal Bend Region, the principal livestock type is beef cattle, with some dairy herds. Livestock drinking water is obtained from wells, stock watering tanks that are dug/constructed on the ranches, and streams that flow through the ranches.

The livestock water demand projections are based upon estimates of the maximum carrying capacity of the rangeland of the area and the estimated number of gallons of water per head of livestock per day. In 2000, livestock water use for the Coastal Bend region was 8,838 acft: 21.5 percent in Kleberg County, 12.0 percent in Jim Wells County, 11.3 percent in Bee County, 10.2 percent in Kenedy County, and 45.0 percent in the remaining counties. From 2000 to 2060, water use for livestock use is projected to remain constant at 8,838 acft (Figure 2-10 and Table 2-10).

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[3] U.S Department of Agriculture, 1997 Census of Agriculture.
[4] Surveys of Irrigation in Texas, TWDB Report 347, August 2001.
[5] "1998-99 Texas Almanac," Mary G. Ramos, ed. Dallas Morning News, Inc., 1997.

Table 2-9.
Irrigation Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	0	0	0	0	0	0	0	0
Bee	3,474	2,798	2,455	2,153	1,889	1,657	1,453	1,274
Brooks	350	25	24	24	23	22	21	21
Duval	2,586	4,524	4,444	4,365	4,289	4,212	4,138	4,064
Jim Wells	1,189	3,731	3,278	2,878	2,528	2,221	1,953	1,717
Kenedy	0	107	107	107	107	107	107	107
Kleberg	461	1,002	866	745	644	555	477	410
Live Oak	3,333	3,539	3,289	3,056	2,840	2,639	2,451	2,277
McMullen	0	0	0	0	0	0	0	0
Nueces	1,734	1,680	1,449	1,250	1,077	928	801	692
San Patricio	1,110	4,565	4,160	4,033	3,680	3,362	3,069	2,803
Total for Region	**14,237**	**21,971**	**20,072**	**18,611**	**17,077**	**15,703**	**14,470**	**13,365**
River Basin								
Nueces	5,483	6,971	6,284	5,678	5,129	4,637	4,197	3,804
Nueces-Rio Grande	4,214	8,100	7,585	7,123	6,715	6,347	6,019	5,723
San Antonio-Nueces	4,540	6,900	6,203	5,810	5,233	4,719	4,254	3,838
Total for Region	**14,237**	**21,971**	**20,072**	**18,611**	**17,077**	**15,703**	**14,470**	**13,365**

[1] Projections from Texas Water Development Board

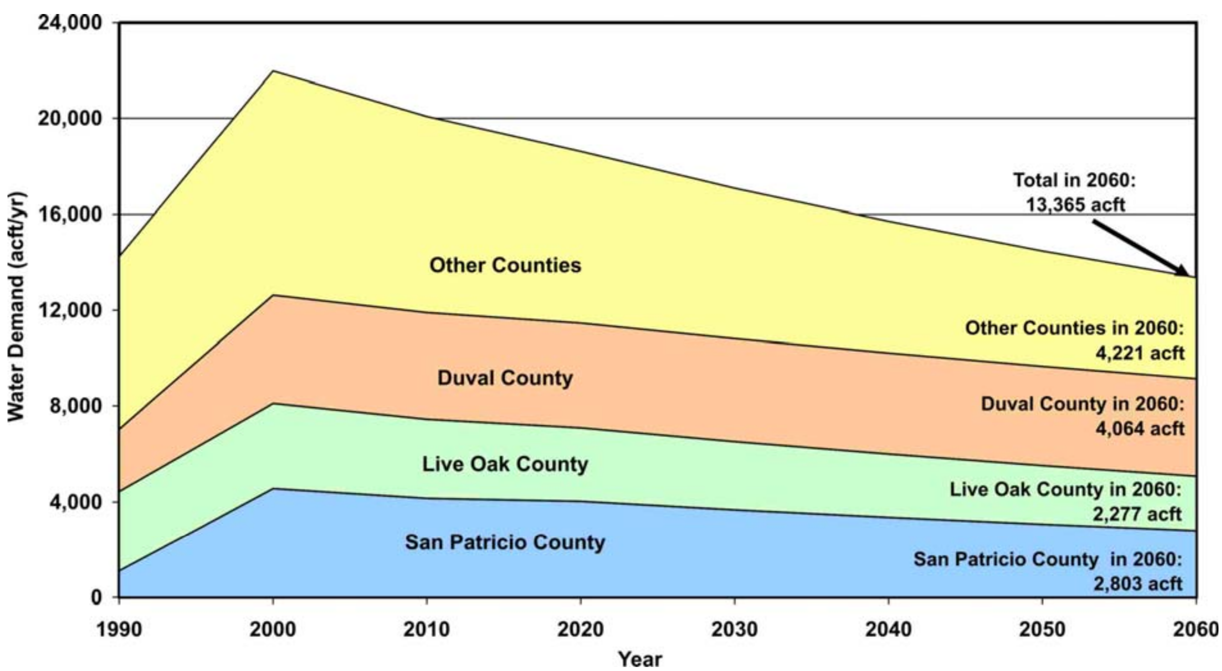

Figure 2-9. Coastal Bend Region Irrigation Water Demand

Table 2-10.
Livestock Water Demand by County and River Basin
Coastal Bend Region
(acft/yr)

County	Historical		Projections[1]					
	1990	2000	2010	2020	2030	2040	2050	2060
Aransas	52	23	23	23	23	23	23	23
Bee	1,088	995	995	995	995	995	995	995
Brooks	816	747	747	747	747	747	747	747
Duval	1,177	873	873	873	873	873	873	873
Jim Wells	907	1,064	1,064	1,064	1,064	1,064	1,064	1,064
Kenedy	1,065	901	901	901	901	901	901	901
Kleberg	1,745	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Live Oak	1,170	833	833	833	833	833	833	833
McMullen	484	659	659	659	659	659	659	659
Nueces	373	379	279	279	279	279	279	279
San Patricio	747	564	564	564	564	564	564	564
Total for Region	**9,624**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**
River Basin								
Nueces	2,500	2,219	2,219	2,219	2,219	2,219	2,219	2,219
Nueces-Rio Grande	5,613	5,342	5,342	5,342	5,342	5,342	5,342	5,342
San Antonio-Nueces	1,511	1,277	1,277	1,277	1,277	1,277	1,277	1,277
Total for Region	**9,624**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**	**8,838**

[1] Projections from Texas Water Development Board

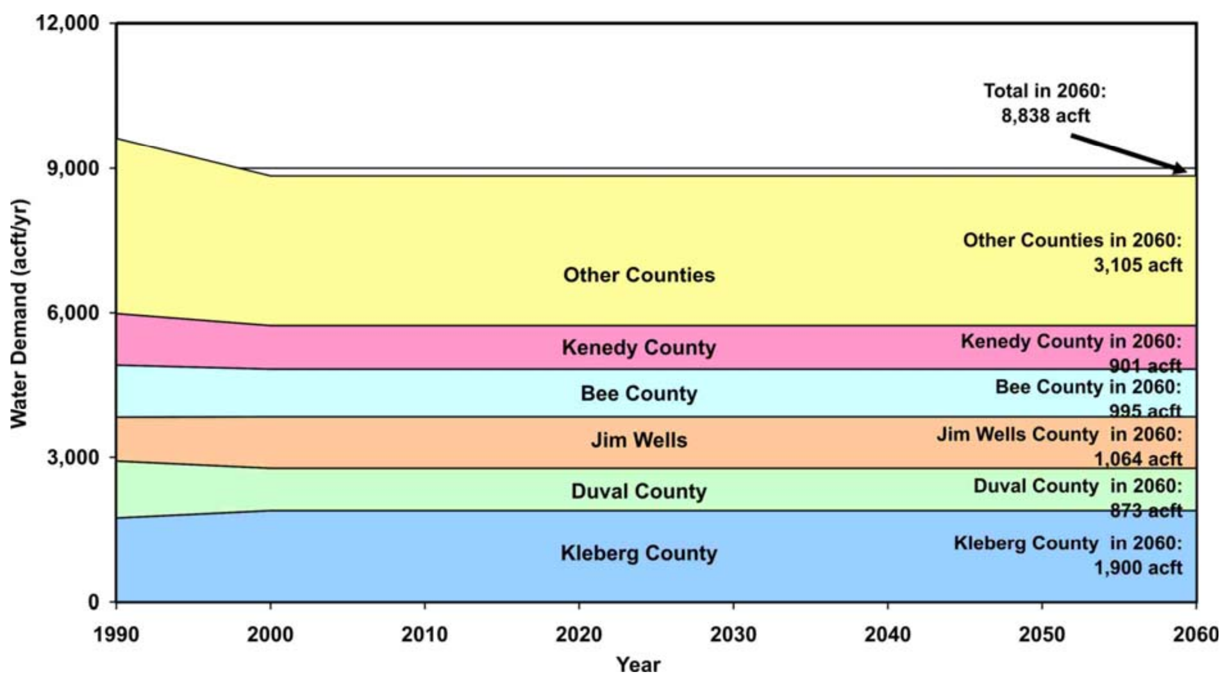

Figure 2-10. Coastal Bend Region Livestock Water Demand

2.4 Water Demand Projections for Wholesale Water Providers

There are four regional wholesale water providers in the Coastal Bend Region: the City of Corpus Christi, SPMWD, STWA, and Nueces WCID #3. The City of Corpus Christi provides water to SPMWD and STWA, as shown in Table 2-11. The City of Corpus Christi is contracted to provide 40,000 act/yr to SPMWD and meet demands of STWA and their customers. The water demands for each wholesale water provider and their customers are shown in Table 2-11.

Table 2-11.
Water Demand Projections for Wholesale Water Providers
Coastal Bend Region

Wholesale Water Provider (Water User/County)	2000 (acft/yr)	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
CITY OF CORPUS CHRISTI							
Municipal							
Jim Wells County							
City of Alice	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Bee County							
City of Beeville	2,529	2,619	2,691	2,722	2,699	2,683	2,618
San Patricio County							
City of Mathis	671	648	632	615	598	586	586
San Patricio MWD *(based on water supply contract)*	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Live Oak County							
City of Three Rivers	3,363	3,363	3,363	3,363	3,363	3,363	3,363
Nueces County							
Nueces County WCID #4 (Port Aransas)	977	1,913	2,884	3,729	4,460	5,124	5,655
City of Corpus Christi	55,629	61,953	68,212	73,592	78,422	82,961	86,962
County-Other[1,2]	116	116	116	116	116	116	116
Kleberg County							
South Texas Water Authority *(based on water supply contract)*	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Manufacturing							
Nueces County	38,791	45,373	49,047	52,119	55,119	57,704	61,765
Mining							
Nueces County[3]	1,189	1,375	1,453	1,494	1,534	1,572	1,612
Steam and Electric							
Nueces County	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Total Water Demand	**159,629**	**172,901**	**191,489**	**203,570**	**215,161**	**226,658**	**239,505**
River Basin							
Nueces	13,606	13,683	22,144	24,525	27,266	30,468	34,292
Nueces- Rio Grande	102,735	115,724	125,730	135,372	144,219	152,507	161,569
San Antonio- Nueces	43,288	43,494	43,615	43,673	43,676	43,683	43,644
Total Water Demand	**159,629**	**172,901**	**191,489**	**203,570**	**215,161**	**226,658**	**239,505**
SAN PATRICIO MUNICIPAL WATER DISTRICT							
Municipal							
Nueces County							
City of Aransas Pass	12	26	41	53	64	73	81
Nueces County WCID #4 (Port Aransas)	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Patricio County							
City of Aransas Pass	1,210	1,405	1,615	1,828	2,016	2,201	2,386
City of Gregory	249	239	231	223	216	210	210
City of Ingleside	873	1,294	1,771	2,202	2,607	3,016	3,395
City of Ingleside on the Bay	74	92	112	130	148	164	181
City of Portland	1,976	2,399	2,869	3,290	3,716	4,106	4,498

Table 2-11.
Water Demand Projections for Wholesale Water Providers
Coastal Bend Region (Concluded)

Wholesale Water Provider (Water User/County)	2000 (acft/yr)	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
SAN PATRICIO MUNICIPAL WATER DISTRICT (cont.)							
City of Odem	319	330	347	361	372	389	408
City of Taft	559	586	619	648	672	703	736
County-Other[2,3]	975	1,033	1,103	1,163	1,209	1,274	1,345
Aransas County							
City of Aransas Pass	146	168	186	195	190	179	169
City of Fulton	261	307	346	365	359	336	318
City of Rockport	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other[2]	1,338	1,524	1,686	1,740	1,687	1,575	1,491
Manufacturing							
San Patricio County	12,706	15,085	16,687	18,098	19,491	20,718	22,267
Total Water Demand	**23,656**	**28,684**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
River Basin							
Nueces	7,152	8,491	9,393	10,187	10,971	11,662	12,534
Nueces- Rio Grande	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Antonio- Nueces	14,903	17,587	19,998	21,977	23,599	24,994	26,571
Total Water Demand	**23,656**	**28,684**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
SOUTH TEXAS WATER AUTHORITY							
Municipal							
Nueces County							
City of Agua Dulce	115	112	110	107	105	103	103
City of Driscoll	97	122	148	171	191	208	224
City of Bishop	420	317	309	301	294	289	289
County-Other[2,5]	213	213	213	213	213	213	213
Kleberg County							
City of Kingsville	1,221	1,352	1,382	1,385	1,350	1,397	1,400
Ricardo WSC	218	503	705	834	912	1,026	1,031
Total Water Demand	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**
River Basin							
Nueces	0	0	0	0	0	0	0
Nueces- Rio Grande	2,284	2,619	2,867	3,011	3,065	3,236	3,260
San Antonio- Nueces	0	0	0	0	0	0	0
Total Water Demand	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**
NUECES COUNTY WCID #3							
Nueces County							
County-Other[2,6]	155	155	155	155	155	155	155
City of Robstown	2,153	2,110	2,067	2,024	1,982	1,953	1,953
River Acres WSC[7]	291	291	291	291	291	291	291
Total Water Demand	**2,599**	**2,556**	**2,513**	**2,470**	**2,428**	**2,399**	**2,399**
River Basin							
Nueces	291	291	291	291	291	291	291
Nueces- Rio Grande	2,308	2,265	2,222	2,179	2,137	2,108	2,108
San Antonio- Nueces	0	0	0	0	0	0	0
Total Water Demand	**2,599**	**2,556**	**2,513**	**2,470**	**2,428**	**2,399**	**2,399**

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Section 3
Evaluation of Current Water Supplies in the Region
[31 TAC §357.7 (a)(3)]

3.1 Surface Water Supplies

The Coastal Bend Region is located within three river basins: the Nueces River Basin, the San Antonio-Nueces Coastal Basin, and the Nueces-Rio Grande Coastal Basin (Figure 3-1). Streamflows in the two coastal basins are highly variable and intermittent and do not supply large quantities of water. However, streamflow in the Nueces River and its tributaries, along with municipal and industrial water rights in the Nueces River Basin, comprise a significant supply of water used in the Coastal Bend Region, as this basin drains about 17,000 square miles. These water rights provide authorization for an owner to divert, store and use the water; however, it does not guarantee that a dependable supply will be available from their source. The availability of water to a water right is dependent on several factors including hydrologic conditions (i.e., rainfall, runoff, springflows), priority date of the water right, quantity of authorized storage, and any special conditions associated with the water right (e.g., instream flow conditions, maximum diversion rate). Because the Nueces River Basin is subject to periods of significant drought and low flows, storage is very important to help “firm up” water rights.

3.1.1 Texas Water Right System

The State of Texas owns the surface water within the state watercourses and is responsible for the appropriation of these waters. Surface water is currently allocated by the TCEQ, formerly Texas Natural Resource Conservation Commission, for the use and benefit of all people of the state. Texas water law is based on the riparian and prior appropriation doctrines. The riparian doctrine extends from the Spanish and Mexican governments that ruled Texas prior to 1836. After 1840, the riparian doctrine provided landowners the rights to make reasonable use of water for irrigation or for other consumptive uses. In 1889, the prior appropriation doctrine was first adopted by Texas, which is based on the concept of “first in time is first in right.” Over the years, the riparian and prior appropriation doctrines resulted in an essentially unmanageable system. Various types of water rights existed simultaneously and many rights were unrecorded. In 1967, the Texas Legislature passed the Water Rights Adjudication Act that merged the riparian water rights into the prior appropriation system, creating a unified water permit system.

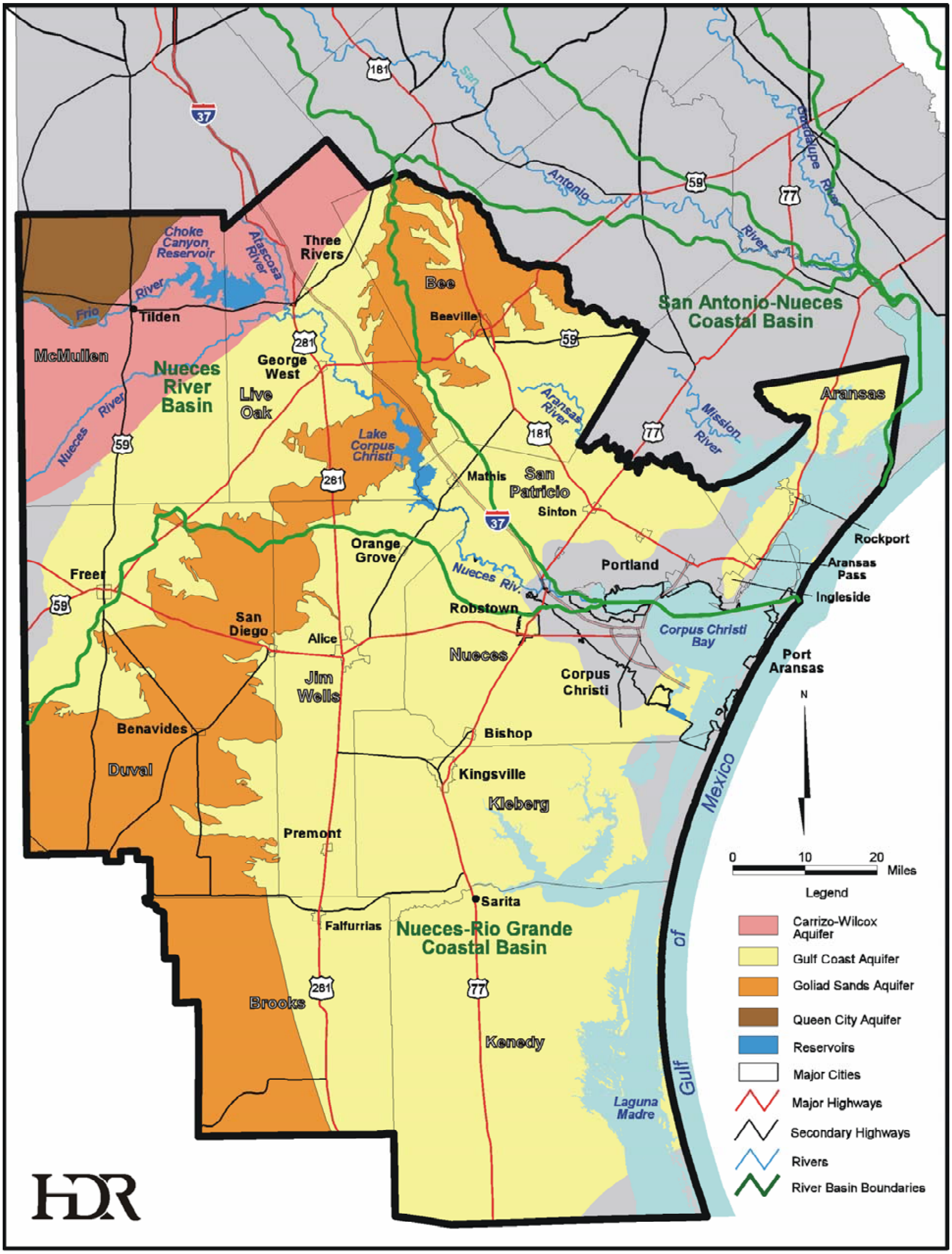


Figure 3-1. Watershed Boundaries and Aquifer Location Map

The adjudication process took many years, stretching into the late 1980s before it was finally completed. In the end, Certificates of Adjudication were issued for entities recognized as having legitimate water rights. Today, individuals or groups seeking a new water right must submit an application to the TCEQ. The TCEQ determines if the water right will be issued and under what conditions. The water rights grant a certain quantity of water to be diverted and/or stored, a priority date, location of diversion, and other restrictions. The priority date of a water right is essential to the operation of the water rights system. Each right is issued a priority date based on the date each right was filed at the TCEQ. When diverting or storing water for use, all water right holders must adhere to the priority system. A right holder must allow water to be passed to downstream senior water rights when conditions are such that the senior water rights would not be otherwise satisfied. Other restrictions may include a maximum diversion rate and instream flow restrictions to protect existing water rights and provide environmental flows for instream needs and needs of estuary systems, although most water rights issued prior to 1985 do not include such conditions. An important exception to the rule is Certificate of Adjudication Number (CA#) 21-3214 for Choke Canyon Reservoir, which represents approximately 75% of the Nueces River Basin water rights and requires instream flows and freshwater flows for the Nueces Estuary. Operations of the CCR/LCC System are governed, in part, by CA #21-3214, within which Special Conditions B and E state:

B. (Part)

> "Owners shall provide not less than 151,000 acft of water per annum for the estuaries by a combination of releases and spills from the reservoir system at Lake Corpus Christi Dam and return flows to the Nueces and Corpus Christi Bays and other receiving estuaries."

E.

> "Owners shall continuously maintain a minimum flow of 33 cubic feet per second below the dam at Choke Canyon Reservoir."

Special Condition B of CA #21-3214 further states:

> "Water provided to the estuaries from the reservoir system under this paragraph shall be released in such quantities and in accordance with such operational procedures as may be ordered by the Commission."

Hence, the certificate provided for a means to further establish specific rules governing operations of the CCR/LCC System with respect to maintaining freshwater inflows to the Nueces Estuary.

To address concerns about the health of the Nueces Estuary, a Technical Advisory Committee (TAC) chaired by the TCEQ was formed in 1990 to establish operational guidelines for the CCR/LCC System and desired monthly freshwater inflows to the Nueces Estuary. These operational guidelines were summarized in the 1992 Interim Order.[1]

The 1992 Interim Order established a monthly schedule of desired freshwater inflows to Nueces Bay to be satisfied by spills, return flows, runoff below Lake Corpus Christi, and/or dedicated releases from the CCR/LCC System. Mechanisms for relief from reservoir releases under the Interim Order were based on inflow banking, monthly salinity variation in upper Nueces Bay, and implementation of drought contingency measures tied to CCR/LCC System Storage.

The Nueces Estuary Advisory Council (NEAC) was formed under the 1992 Interim Order and charged with continued study of the interdependent relationship between the firm yield of the CCR/LCC System and the health of the Nueces Estuary. One of NEAC's primary goals was to evaluate the 1992 Interim Order and other alternative release policies and recommend a more permanent reservoir operations plan for providing freshwater inflows to the Nueces Estuary. This goal was to be achieved within 5 years of NEAC's formation.

The goal of recommending a more permanent reservoir operations plan was fulfilled on April 28, 1995, when the TCEQ issued an order regarding reservoir operations for freshwater inflows to the Nueces Estuary, known as the 1995 Agreed Order.[2] This Agreed Order is very similar to the Interim Order, with one major exception—monthly releases (pass-throughs) to the estuary were limited to CCR/LCC System inflows and stored water is not required to meet estuary freshwater flow needs.

On April 17, 2001, the TCEQ issued an amendment to the 1995 Agreed Order to revise operational procedures in accordance with revisions requested by the City of Corpus Christi. Changes included: (1) passage of inflows to Nueces Bay and Estuary at 40 percent and 30 percent reservoir system capacity upon institution of mandatory outdoor watering restrictions; (2) calculating reservoir system storage capacity based on most recently completed bathymetric

[1] Texas Water Commission, Interim Order Establishing Operational Procedures Pertaining to Special Condition B, Certificate of Adjudication No. 21-3214, held by the City of Corpus Christi, et al., March 9, 1992.
[2] Texas Commission on Environmental Quality (TCEQ), Agreed Order Establishing Operational Procedures Pertaining to Special Condition B, Certificate of Adjudication No. 21-3214, held by City of Corpus Christi, et al., April 28, 1995.

surveys; and (3) provisions for operating Rincon Bayou diversions and conveyance facility from Calallen Pool to enhance the amount of freshwater to the Nueces Bay and Delta. All CCR/LCC System yield analyses presented as part of this study were performed using the 2001 Agreed Order.

3.1.2 Types of Water Rights

There are various types of water rights. Water rights are characterized as Certificates of Adjudication, permits, short-term permits, or temporary permits. Certificates of Adjudication were issued in perpetuity for approved claims during the adjudication process. This type of water right was generally issued based on historical use rather than water availability. As a consequence, the amount of water to which rights on paper are entitled to generally exceeds the amount of water available during a drought. The TCEQ issues new permits generally when normal flows are sufficient to meet 75 percent of the requested amount 75 percent of the time. Permits, like Certificates of Adjudication, are issued in perpetuity and may be bought and sold like other property interests. Short-term permits may be issued by the TCEQ in areas where waters are fully appropriated, but not yet being fully used. Term permits are usually issued for 10 years and may be renewed if, after 10 years, water in the basin is still not being fully used by other water right holders. Temporary permits are issued for up to 3 years. Temporary permits are issued mainly for roadway and other construction projects, where water is used to suppress dust, to compact soils, and to start the growth of new vegetation.

Water rights can include the right to divert and/or store the appropriated water. A run-of-river water right provides for the diversion of streamflows and generally does not include a significant storage volume for use during dry periods. A run-of-river right may be limited by streamflow, pumping rate, or diversion location.

Water rights that include provisions for storage of water allow a water right holder to impound streamflows for use at a later time. The storage provides water for use during dry periods, when water may not be available due to hydrologic conditions or because flows are required to be passed to downstream senior water rights.

Water rights are generally diverted and used within the river basin of origin. An interbasin transfer permit is required of all water that is diverted from one river basin and used in another basin. For diversion of water from a river basin for use in an adjoining coastal basin, such as from the Nueces River Basin to either the San Antonio-Nueces or the Nueces-Rio Grande Coastal Basins, the process is simplified and does not require an extensive process.

The annual availability of a water right is typically considered in terms of firm yield or safe yield supply. According to the TCEQ, the firm yield is defined as "that amount of water, based upon a simulation utilizing historic streamflows, that the reservoir could have produced annually if it had been in place during the worst drought of record."[3] Nueces County WCID #3 and small run-of river water rights on the Nueces Basin (less than 2000 acft/yr) are based on firm yield analyses.

Safe yield supply represents a more conservative approach to determining minimum annual availability in areas where the severity of droughts is uncertain. Safe yield supply is the amount of water that can be withdrawn from a reservoir such that a given volume remains in reservoir storage during the critical month of the drought of record. The surface water availabilities for the largest water rights in the Nueces Basin (i.e., City of Corpus Christi and their customers) are based on safe yield analyses and assume a reserve of 75,000 acft (i.e., 7 percent LCC/CCR System storage) for future drought conditions.

3.1.3 Water Rights in the Nueces River Basin

A total of 256 water rights exist in the Nueces River Basin with a total authorized diversion and consumptive use of 539,691 acft/yr.[4] It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the Nueces River Basin, four water rights (1.5 percent) make up 483,444 acft/yr (89.5 percent) of the authorized diversion volume. The remaining 252 water rights primarily consist of small municipal, industrial, irrigation and recharge rights distributed throughout the river basin. Figure 3-2 shows the location of the four primary water rights in the Nueces Basin. Of note in this figure, the largest of the rights, by diversion volume, are located in the Coastal Bend Region. Municipal and industrial diversion rights represent 76 percent of all authorized diversion rights in the Nueces River Basin. Based in large part on water stored in the CCR/LCC System, which is subsequently delivered via the Nueces River to Calallen Dam at Corpus Christi for diversion, the

[3] TCEQ, "A Regulatory Guidance Document for Applications to Divert, Store, or Use State Water," RG-141, June 1995.

[4] The number of water rights and corresponding authorized diversion amounts are based on the Texas Commission on Environmental Quality's Water Rights Database dated November, 2003.

Major Water Rights*

Water Right #	Owner	Diversion Rights (acft/yr)	Consumptive Rights (acft/yr)	Storage Rights	Notes
2464	City of Corpus Christi	304,898	304,898	300,000 1,175	Lake Corpus Christi Calallen Reservoir
3214	City of Corpus Christi, Nueces River Authority	139,000	139,000	700,000	Choke Canyon Reservoir
3082	Zavala-Dimmit Co. WCID #1	28,000	28,000	5,633	
2466	Nueces County WCID #3	11,546	11,546	0	

*Authorized Annual Diversions > 10,000 acft

Figure 3-2. Location of Major Water Rights in the Nueces River Basin

City of Corpus Christi and the NRA hold 98 percent of these municipal and industrial rights in the basin. With the inclusion of the municipal water rights held by the Nueces County WCID #3, diverted from the Nueces River upstream of the Calallen Dam, the Coastal Bend Region includes over 99 percent of the Nueces River Basin municipal and industrial surface water rights permits. Table 3-1 summarizes the surface water rights in the Nueces River Basin included in the Coastal Bend Planning Region.

Table 3-1.
Nueces River Basin Water Rights in the Coastal Bend Region

Water Right No.	Name	Annual Diversion Volume (acft/yr)	Reservoir Storage Capacity (acft)	Priority Date	Type of Use	Facility	County
2464	City of Corpus Christi	304,898	301,175	12/1913[1]	Municipal (51%) Industrial (49%) Irrigation (minimal) Mining (minimal)	Lake Corpus Christi (300,000 acft) and Calallen Dam (1,175 acft)	Nueces
2465A	Realty Traders & Exchange, Inc.	20	580	10/1952	Irrigation		San Patricio
2465B	Wayne Shambo	140	580	10/1952	Irrigation		San Patricio
2466	Nueces Co. WCID #3	11,546	0	2/1909[1]	Municipal (37%) Irrigation (63%)		Nueces
2467	Garnett T. & Patsy A. Brooks	221	0	2/1964	Irrigation		San Patricio
2468	CE Coleman Estate	27	0	2/1964	Irrigation		Nueces
2469	Ila M. Noakes Lindgreen	101	0	2/1964	Irrigation		Nueces
3141	Randy J. Corporron et. al.	8	0	12/1965	Irrigation		McMullen
3142	WL Flowers Machine & Welding Co.	132	100	12/1958	Irrigation		McMullen
3143	Ted W. True et. al.	220	40	12/1958	Irrigation		McMullen
3144	Edwin & Patsy Dunn Singer	0	285	2/1969	Recreation and Irrigation		McMullen
3204	Richard P. Horton	233	0	12/1963	Irrigation		McMullen
3205	Richard P. Horton	103	122	12/1963	Irrigation		McMullen
3206	James L. House Trust	123	0	12/1966	Irrigation		McMullen
3214	Nueces River Authority and City of Corpus Christi	139,000	700,000	7/1976	Municipal (43%) Industrial (57%) Irrigation (minimal)	Choke Canyon Reservoir	Nueces/ Live Oak
3215	City of Three Rivers	1,500	2,500	9/1914	Municipal (47%) Irrigation (53%)		Live Oak
4402	City of Taft	600	0	9/1983	Irrigation		San Patricio
5065	Diamond Shamrock Refining[2]	0	0	6/1986	Irrigation		Live Oak
5145	San Miguel Electric Co-Op, Inc.	300	335	12/1990	Industrial		McMullen
5258	Muriell E. McNeill	64	0	9/1989	Irrigation		Live Oak
5561	City of Mathis	50	0	11/1996	Irrigation		San Patricio
	TOTAL	**459,286**					

[1] Water right with multiple priority dates. Earliest date shown in table.
[2] Diamond Shamrock irrigation right is used for irrigation from onsite process water return flows. In effect, this permit is for a reuse project.

3.1.4 Coastal Basins

In addition to the Nueces River Basin, the Coastal Bend Regional Planning Area includes portions of two coastal river basins in Texas: the San Antonio-Nueces Coastal Basin and the Nueces-Rio Grande Coastal Basin. The San Antonio-Nueces Coastal Basin is located on the Texas Coast between the Nueces and Guadalupe-San Antonio River Basin. The drainage area of the basin is approximately 2,652 square miles, and it drains surface water runoff into Copano and Aransas Bays. The Nueces-Rio Grande Coastal Basin is located on the southern side of the Coastal Bend Region between the Nueces and Rio Grande Coastal Basins. This basin drains approximately 10,442 square miles into the Laguna Madre Estuary system. Combined, there are approximately 99 water rights in these two coastal basins authorizing diversions of about 1,838,600 acft/yr.[5] Approximately 1,738,000 acft (94 percent) of the combined authorized diversions are from within the Coastal Bend Region Planning Area, and of these rights, 1,699,000 acft (98 percent) are industrial diversions for steam-electric and manufacturing processes from the bays and saline water bodies along the coast. Most of this water is used for cooling purposes and is returned to the source. Based on the size and locations of the remaining freshwater rights in these coastal basins and on the lack of a major river or reservoir in these basins, there are few of these freshwater rights that are sustainable throughout an extended drought. In the San Antonio-Nueces Coastal Basin, firm yield supplies for irrigation users in Bee and San Patricio Counties total less than 200 acft/yr. The Nueces- Rio Grande Basin has firm yield supplies of 569 acft/yr for irrigation users in Nueces County. These water rights were considered as firm yield supplies for the irrigation users.

3.1.5 Interbasin Transfer Permits

A number of interbasin transfer permits exist in the Coastal Bend Regional Planning Area. These permits include authorizations for diversions from river basins north of the planning region into the Nueces River Basin. Both major interbasin transfer permits provide water to the City of Corpus Christi and include supplies from the Lavaca-Navidad and Colorado River Basins. The City of Corpus Christi benefits from an interbasin transfer permit[6] and a contract with the LNRA to divert 41,840 acft/yr on a firm basis and up to 12,000 acft/yr on an

[5] The number of water rights and corresponding authorized diversion amounts are based on the Texas Commission on Environmental Quality's Water Rights Database dated November 2003.
[6] TCEQ, Certificate of Adjudication No. 16-2095C, held by Lavaca-Navidad River Authority and Texas Water Development Board (TWDB), October 21, 1996.

interruptible basis from Lake Texana in the Lavaca-Navidad River Basin to the City's O.N. Stevens Water Treatment Plant. This water is delivered to the City via the Mary Rhodes Pipeline, which became operational in 1998. In addition, the pipeline was designed to convey a second interbasin transfer permit owned by the City of Corpus Christi. The second permit[7] allows the diversion of up to 35,000 acft/yr of run-of-river water on the Colorado River. Analyses of this water right, one of the most senior in the Colorado River Basin, indicate that nearly the full 35,000 acft/yr is available from this run-of-river right without off-channel storage.[8] Table 3-2 summarizes the major interbasin transfer permits in the Coastal Bend Region.

Table 3-2.
Summary of Major Interbasin Transfer Permits in the Coastal Bend Region

River Basin of Origin	***Name of Interbasin Transfer Permit Holder***	***Description***	***Authorized Diversion (acft/yr)***	***Priority Date***
Lavaca-Navidad	LNRA	Transfer from Lake Texana to adjacent river basins including the Nueces River Basin.	53,840[1]	5/1972
Colorado	City of Corpus Christi	Transfer from Garwood Irrigation Co. water right to the City of Corpus Christi.	35,000	11/1900

[1] City of Corpus Christi currently holds a contract with the Lavaca-Navidad River Authority to provide 41,840 acft/yr and a maximum of 12,000 acft/yr on an interruptible basis from Lake Texana to the City.

3.1.6 Water Supply Contracts

Many entities within the Coastal Bend Region obtain surface water through water supply contracts. These supplies are usually obtained from entities that have surface water rights to provide a specified or unspecified quantity of water each year to a buyer for an established unit price. The City of Corpus Christi is the largest provider of water supply contracts in the Coastal Bend Region. The City of Corpus Christi supplies water from the CCR/LCC System, including water from Lake Texana via the Mary Rhodes Pipeline, to two major wholesale customers: SPMWD and STWA. Each of these major wholesale customers in turn sells water to other entities within their service area. In addition to the two major wholesale customers, the City of Corpus Christi also provides wholesale raw surface water to a number of smaller customers.

[7] TCEQ, Certificate of Adjudication No. 14-5434B, held by the City of Corpus Christi (via the Garwood Irrigation Company), October 13, 1998.
[8] HDR Engineering, Inc. (HDR), "Dependability and Impact Analyses of Corpus Christi's Purchase of the Garwood Irrigation Company Water Right," Draft Report for the City of Corpus Christi, September 1998.

The City of Corpus Christi has contractual obligations to provide consumptive water use plus up to 10% growth each year to City of Alice, City of Beeville, City of Mathis, Nueces County WCID #4 (Port Aransas), Violet WSC, and South Texas Water Authority. The City of Corpus Christi is contracted to provide up to 3,363 acft/yr to City of Three Rivers and up to 40,000 acft/yr to San Patricio Municipal Water District. Furthermore, the City of Corpus Christi provides water supply to meet needs of Manufacturing, Mining, and Steam and Electric water users in Nueces County. SPMWD and STWA meet water needs of their customers (Figure 3-3). Within the Coastal Bend Region, the Nueces County WCID #3 also provides wholesale water supplies through contracts with a number of small municipalities and water supply corporations. Nueces County WCID #3 meets water needs of City of Robstown and City of North San Pedro and has contractual obligations to provide up to 291 acft/yr to River Acres WSC.

Figure 3-3 summarizes the major contract relationships in the Coastal Bend Region and Figure 3-4 presents water supply systems in the Coastal Bend Region. These relationships will be revisited in Section 4 when comparisons of supplies and demands in the region are presented.

3.1.7 Wholesale Water Providers

The Coastal Bend Region has four Wholesale Water Providers. The TCEQ defines Wholesale Water Providers as “any entity that has contracts to sell more than 1,000 acft of water wholesale in a given year.” These include the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3. Based on recent water use records, the City of Corpus Christi supplies about 67 percent of the municipal and industrial water demand in the region (not including supplies to SPMWD or STWA). SPMWD and STWA purchase 100 percent of their water from the City of Corpus Christi. The SPMWD subsequently treats and distributes water to numerous entities and supplies about 14 percent of the municipal and industrial water demand in the region. Both STWA and Nueces County WCID #3 provide less than 5 percent of the municipal and industrial water demand in the region. As for water supply planning, each Water User Group in the region was analyzed to the same level of detail to ensure that the needs of the entire region are met. If in the future the CBRWPG deems it necessary, the CBRWPG reserves the right to revisit wholesale water provider designations during subsequent planning efforts.

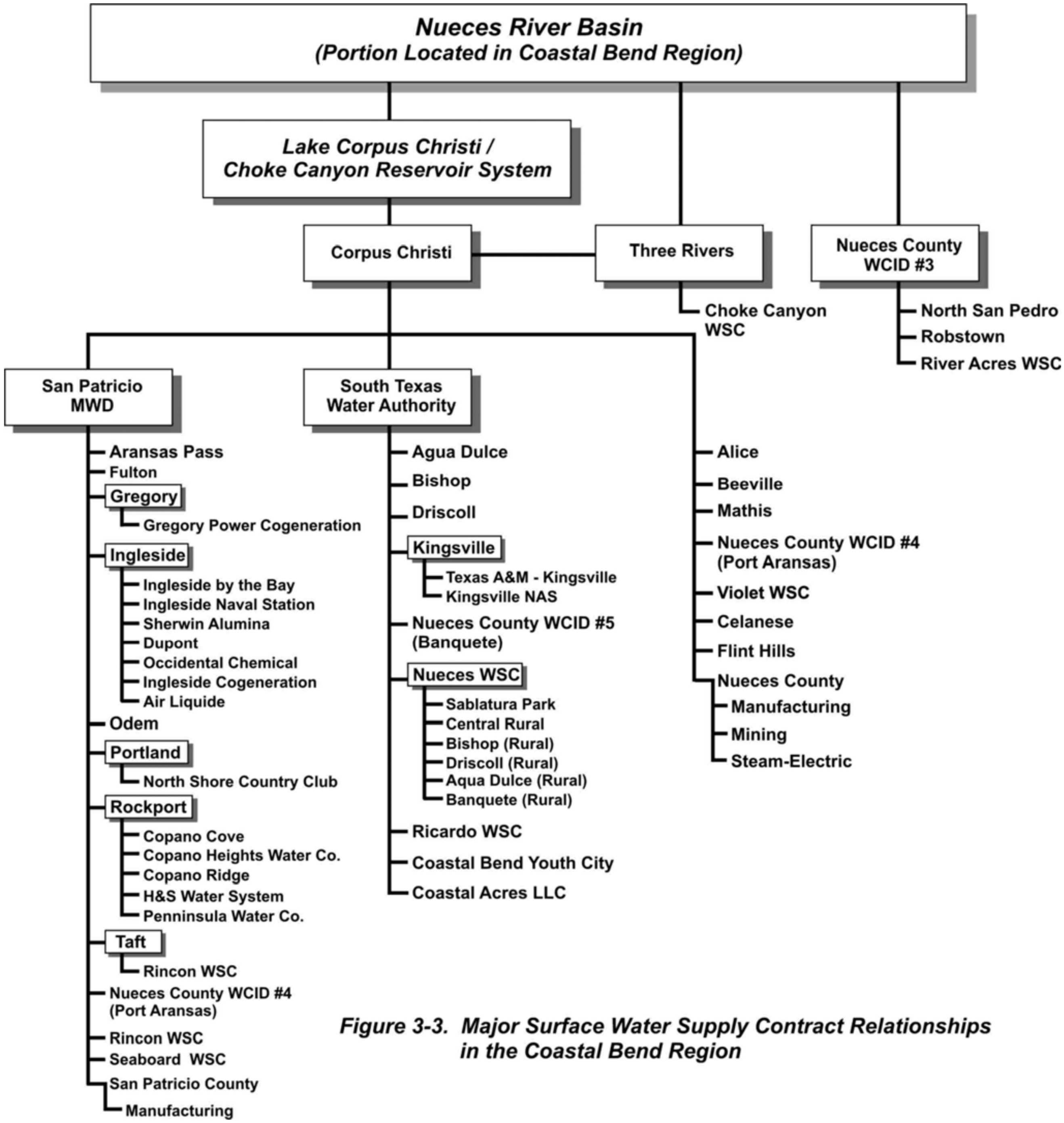
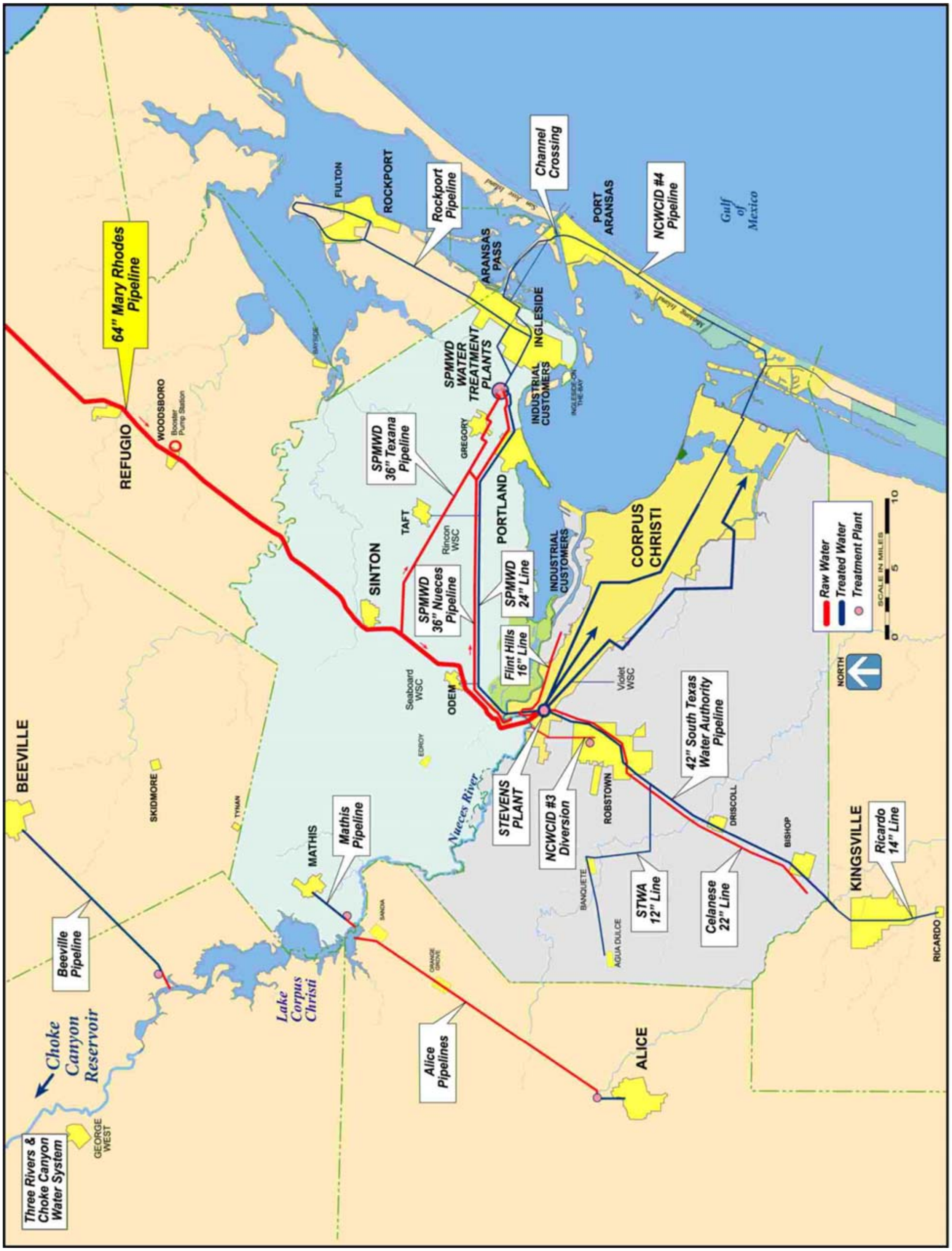


Figure 3-3. Major Surface Water Supply Contract Relationships in the Coastal Bend Region



Source: The Rodman Company

Figure 3-4. Coastal Bend Water Supply System

3.2 Reliability of Surface Water Supply

Hydrologic conditions are a primary factor that affects the reliability of a water right. Severe drought periods have been experienced in all areas of the Coastal Bend Region. Recurring droughts are common in the region with significant drought periods occurring in the 1950s, 1960s, 1980s, and 1990s. As shown in Figure 3-5, recent studies indicate that the 1990s drought appears to be the most severe on record for the CCR/LCC System,[9] decreasing average annual flows by 67,000 acft/yr (36 percent) when compare to flows in the 1950s.

Municipal and industrial water suppliers typically require a very high degree of reliability for their water sources. In most cases, interruptions to water supply are not acceptable, requiring the reliability of the supply to be 100 percent of the time. Municipal and industrial supplies are commonly based on firm yield; however, safe yield analyses are becoming commonly used in anticipation of future droughts greater in severity than the worst drought of record. Since each drought in the Nueces River Basin is more severe than previous droughts (Figure 3-5), the Coastal Bend Region has adopted use of safe yield analyses.

For reservoirs, the safe yield may decrease over time as a result of sedimentation. When a reservoir is constructed on a stream channel, the sediment carried by the stream accumulates on the bottom of the reservoir. This accumulation reduces the volume of water that can be stored in the reservoir, which in turn reduces the firm yield available for diversion. Sedimentation rates for the CCR/LCC System have been measured over a period of time and estimated sedimentation rates are well documented.[10] It is estimated that the CCR/LCC System capacity will be reduced by 47,850 acft due to sediment accumulations between 2010 and 2060.[11] For the 50-year planning period, the reduction in safe yield for future sedimentation was considered. Safe yield for the CCR/LCC System is presented for both the year 2010 and for the year 2060.

For Nueces County WCID #3 and smaller run-of-river water rights in the Nueces River Basin, firm yield supplies was based on the minimum annual supply that could be diverted over a historical period of record.

[9] HDR, "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, January 1999.

[10] Ibid.

[11] Calculation based on annual sedimentation rate of 717 acft/yr for LCC and 240 acft/yr for CCR.

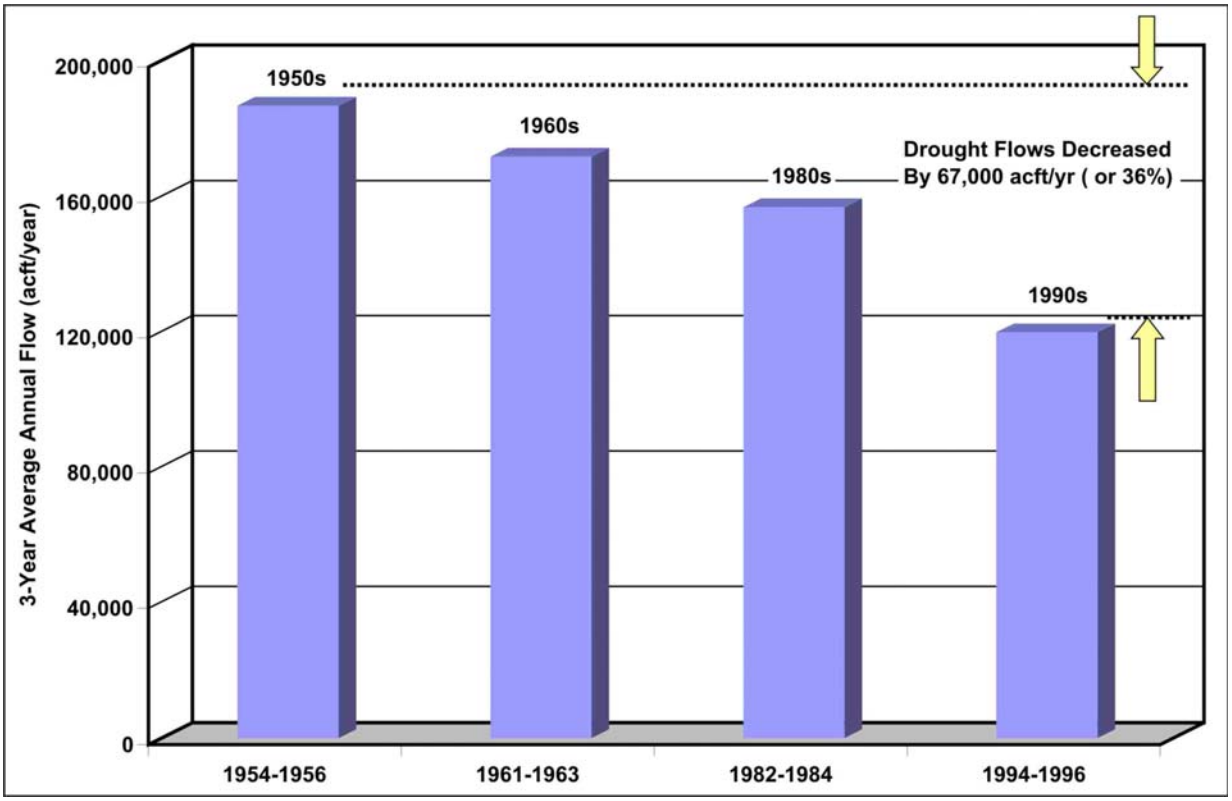


Figure 3-5. 3-Year Reservoir Inflows

3.3 Surface Water Availability

Two computer models were used to evaluate the water rights in the Nueces River Basin and within the Coastal Bend Region. The first model was a version of the Water Rights Analysis Package (WRAP) computer model developed by HDR Engineering, Inc. (HDR) for the TCEQ as part of its Water Availability Modeling (WAM) Program.[12] The WRAP model is designed for use as a water resources management tool. The model can be used to evaluate the reliability of existing water rights and to determine unappropriated streamflow potentially available for a new water right permit. WRAP simulates the management and use of streamflow and reservoirs over a historical period of record, adhering to the water right priority system. The second model used in determining surface water rights availability in the Nueces River Basin was the Lower Nueces River Basin and Estuary Model (NUBAY) developed for the City of Corpus Christi under previous studies.[13] The NUBAY model focuses on the operations of the CCR/LCC System and is capable of simulating this system subject to the City of Corpus Christi's Phased Operations Plan

[12] HDR, "Water Availability in the Nueces River Basin," TCEQ, October 1999.
[13] HDR, Op. Cit., January 1999.

and the 2001 Agreed Order governing freshwater inflow passage to the Nueces Estuary. The NUBAY model was used to estimate the safe yield of the CCR/LCC System and the WRAP Model was used to determine the availability of water to all other rights on the Nueces River and its tributaries within the Coastal Bend Region. A summary of the water rights and yield availability is presented in Table 3-3. These surface water supplies served as a basis for the supply and demand comparisons in Chapter 4.

3.4 Groundwater Availability

The Coastal Bend Region includes parts of four aquifers—two major (Gulf Coast and Carrizo-Wilcox Aquifers) and two minor (Queen City and Sparta Aquifers). Figure 3-1 shows the locations of the major aquifers. Table 3-4 summarizes estimates of groundwater availability on a sustained yield basis and projected groundwater use on a sustained yield basis, by aquifer, in the planning region. Groundwater availability estimates are based on either: (1) the amount of groundwater available based on 2001 Plan Coastal Bend Regional Water Planning Group (CBRWPG) groundwater results, or (2) recent Central Gulf Coast Groundwater Availability (CGCGAM) analyses, as noted. Groundwater use is based on projected groundwater demands and is the same as used for CGCGAM analyses as presented in Section 4.

Of the four aquifers, the Gulf Coast Aquifer underlies each of the 11 counties in the planning region, is the primary groundwater resource in the Coastal Bend Region, and is capable of providing more than 80 percent of the region’s groundwater supply.

3.4.1 Gulf Coast Aquifer

The Gulf Coast Aquifer underlies all counties within the Coastal Bend Region and yields moderate to large amounts of fresh and slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of five water-bearing formations: Catahoula, Jasper, Burkeville Confining System, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water-bearing formations, are the most productive and, consequently, are the formations utilized most commonly. The Evangeline Aquifer of the Gulf Coast Aquifer System features the highly transmissive Goliad Sands. The Chicot Aquifer is comprised of many different geologic formations; however, the Beaumont and Lissie Formations are predominant in the Coastal Bend Area. The Burkeville Confining System is a limited water-bearing formation and characterized as containing substantial amounts of clay.

Table 3-3.
Surface Water Rights Availability
Nueces River Basin Water Rights in the Coastal Bend Region

Water Right Owner	***Annual Permitted Diversion Volume (acft/yr)***	***Yield[1] (acft)***	***Type Of Use***	***Priority Date***	***County***
City of Corpus Christi and Nueces River Authority	497,738[2]	200,000[3]	Municipal & Industrial	12/1913[4]	Nueces
		14	Irrigation	12/1913	Nueces
		12	Mining	12/1913	Nueces
		200	Irrigation	12/1913	Live Oak
Reality Traders & Exchange, Inc.	20	0	Irrigation	10/1952	San Patricio
Wayne Shambo	140	0	Irrigation	10/1952	San Patricio
Nueces Co. WCID #3	4,246 7,300 11,546	3,665 3,438 7,103	Municipal Irrigation	2/1909[4]	Nueces
Garnett T. & Patsy A. Brooks	221	0	Irrigation	2/1964	San Patricio
CE Coleman Estate	27	0	Irrigation	2/1964	Nueces
Ila M. Noakes Lindgreen	101	0	Irrigation	2/1964	Nueces
Randy J. Corporron et. al.	8	0	Irrigation	12/1965	McMullen
WL Flowers Machine & Welding Co.	132	6	Irrigation	12/1958	McMullen
Ted W. True et. al.	220	0	Irrigation	12/1958	McMullen
Edwin & Patsy Dunn Singer	0	0	Recreation & Irrigation	2/1969	McMullen
Richard P. Horton	336	0	Irrigation	12/1963	McMullen
James L. House Trust	123	0	Irrigation	12/1966	McMullen
City of Three Rivers	700 800 1,500	700 800 1,500	Municipal Industrial	9/1914	Live Oak
City of Taft	600	0	Irrigation	9/1983	San Patricio
Diamond Shamrock Refining	0[5]	0	Irrigation	6/1986	Live Oak
San Miguel Electric Co-Op, Inc.	300	0	Industrial	12/1990	McMullen
Muriell E. McNeill	64	0	Irrigation	9/1989	Live Oak
City of Mathis	50	0	Irrigation	11/1996	San Patricio
TOTAL	513,126	208,835			

[1] Firm yield computed assuming 2060 sediment accumulation in all reservoirs.
[2] Corpus Christi annual permitted diversion includes CCR/LCC System (443,898 acft/yr) and LNRA contracts with Corpus Christi (41,840 acft/yr) and a maximum 12,000 acft/yr from Lake Texana on an interruptible basis.
[3] Corpus Christi minimum annual supply equals computed 2060 safe yield of the CCR/LCC System with Lake Texana water as per HDR, March 2005.
[4] Water right with multiple priority dates. Earliest date shown in table.
[5] Diamond Shamrock irrigation right is for irrigation from on-site process water return flows. In effect, this permit is for a reuse project.

Table 3-4.
Groundwater Availability and Use from Aquifers within the Coastal Bend Region

Aquifer	2060 Availability (acft/yr)	2060 Use[1] (acft/yr)
Gulf Coast	90,221[2]	54,090
Carrizo-Wilcox	10,702[3]	513
Queen City	1,105[3]	-
Sparta	600[3]	-
Total	102,628	54,603

[1] Source: CGCGAM analyses (see Appendix D).
[2] Source: Groundwater model analysis as part of 2001 Plan and CGCGAM analyses (2005).
[3] TWDB, "Water for Texas," August 1997. (Data supporting the 1997 Texas State Water Plan.)

A CGCGAM was developed by the TWDB to simulate steady-state, predevelopment and developed flow in the Gulf Coast Aquifer along the south Texas Gulf Coast and to assist in the determination of groundwater availability for the region. Steady-state, predevelopment flow conditions represent the state of the aquifer prior to development as a water supply source. Under these conditions, inflow from recharge is assumed to be equal to outflow to adjacent aquifers or other discharge areas and no significant diversion (pumpage) from aquifer storage is occurring. Under developed flow conditions, existing well fields and measured drawdowns are used to calibrate the aquifer parameters. The model consists of four layers with 1-mile (5,280-foot) grid spacing and extends from the outcrop areas in the Jasper outcrop areas in the west to the Gulf of Mexico in the east, and from the groundwater divide to the north through Colorado, Fort Bend, and Brazoria Counties to the south through Jim Hogg, Brooks, and Kenedy Counties, as shown in Figure 3-6. The four layers from top to bottom are: Chicot, Evangeline, Burkeville Confining System, and Jasper. The Catahoula Confining System provides the base of the model and is not included as a model layer.

The study area includes all or parts of several Regional Water Planning Group areas including Region H, Lower Colorado (Region K), Lavaca/Navidad (Region P), South Central Texas (Region L), Coastal Bend (Region N), and Rio Grande (Region M). It also includes all or parts of 15 groundwater conservation districts (GCDs) including Live Oak Underground Water Conservation District (UWCD), McMullen GCD, Bee GCD, and Kenedy County GCD for the Coastal Bend Region.

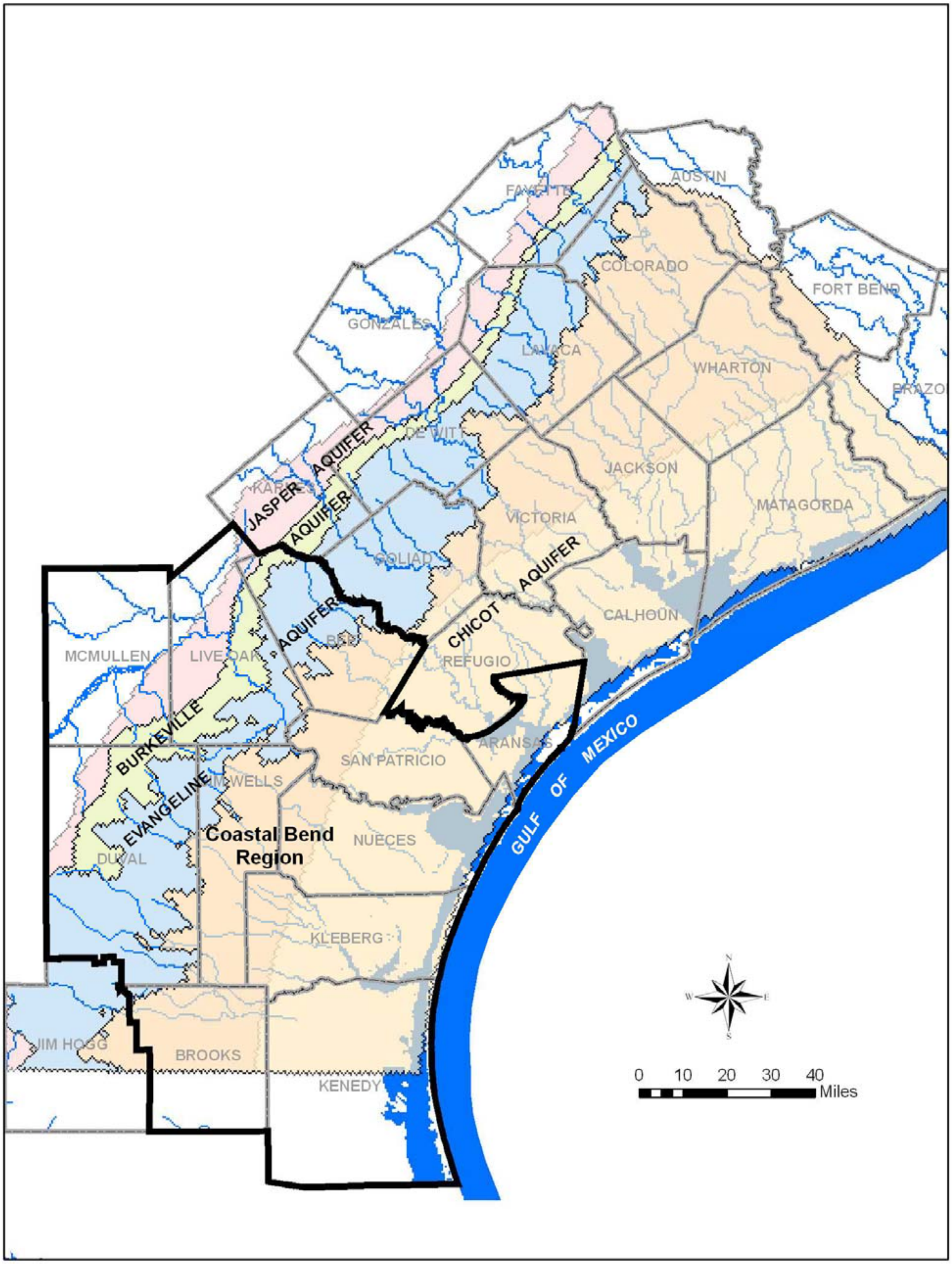


Figure 3-6. Location of Central Gulf Coast Groundwater Availability Model and Aquifer Layers

Predictive pumping estimates were developed using TWDB historical pumping amounts (Year 1999) prorated for anticipated groundwater use in 2000 to 2060 based on TWDB water demand projections using the following method:

- For entities solely using groundwater as their water supply, the projected groundwater pumpage was set equal to projected water demands.
- For entities using both groundwater and surface water, the future groundwater pumping was based on 2000 water use (i.e., if an entity satisfied their water demand using 20 percent groundwater in 2000, then the groundwater pumping in 2060 would be calculated at 20 percent their projected water demand in 2060).

The pumping amounts were distributed to individual cells for municipal, mining, steam-electric, and most manufacturing users. For irrigation, municipal county-other, and water supply corporations, pumping was distributed uniformly across the county to all active pumping cells included in the TWDB historical model. For more detail regarding the new Gulf Coast Aquifer model development and application, please refer to Appendix D.

The calibrated and verified groundwater flow model with projected pumping was used to run a number of groundwater availability simulations subject to acceptable drawdown and water quality constraints, as based on the following criteria adopted by the Coastal Bend Region, also used in the 2001 Plan:

1. Long-term (sustainable) pumping simulations (i.e., steady-state model simulation).
2. In the unconfined aquifer:
   a. Water level declines were limited to no more than 125 feet below predevelopment levels; and
   b. A minimum saturated thickness of 150 feet.
3. In the confined aquifer:
   a. Water level declines were limited to no more than 250 feet below predevelopment levels; and
   b. Water level declines were not to exceed 62.5 percent of the elevation difference between predevelopment flow heads and the top of the aquifer.

Based on these criteria, the available groundwater for the planning region was determined. There were three instances when the drawdown criteria were exceeded based on projected groundwater demands for Duval County-Mining, Live Oak County-Mining, and Live Oak County-Manufacturing users. In all cases, some of the pumping was distributed to nearby model cells. Based on the response of pumping that is distributed uniformly across the county, Live Oak and Duval Counties can sustain this pumping on a county basis without exceeding the drawdown criteria and therefore the full amount is included in the groundwater availability in Table 3-5. However, the local groundwater supply, associated with assigned individual pumping cells, cannot fully support the groundwater demand; therefore, the groundwater supply for Live Oak Mining-Manufacturing and Duval-Mining in Section 4A has been prorated back so that drawdown does not exceed the adopted criteria.

The resulting groundwater available by county in the Coastal Bend Region is presented in Table 3-5. The issue of determining future acceptable drawdown (past Year 2060) should be considered in future planning cycles. It is important to note that these availabilities are long-term (sustainable) yields. In addition, should projects be proposed outside the Coastal Bend Region setting, the Coastal Bend Region requests that site-specific analyses be performed by the project participants to demonstrate to the Coastal Bend Region that no long-term detrimental impacts to the aquifer will result from said "over-pumpage."

Table 3-5.
Groundwater Availability and Use from the Gulf Coast Aquifer within the Coastal Bend Region

County	***2060 Availability (acft/yr)***	***2060 Use[1] (acft/yr)***
Aransas	715[2]	715
Bee	14,900[3]	3,042
Brooks	3,325[2]	3,325
Duval	14,928[2]	14,928
Jim Wells	5,902[2]	5,902
Kenedy	12,700[3]	251
Kleberg	9,700[3]	8,419
Live Oak	10,051[2]	10,051
McMullen	1,200[3]	34
Nueces	2,100[3]	1,983
San Patricio	14,700[3]	5,440
Total	90,221	54,090

[1] Source: CGCGAM analyses (see Appendix D).
[2] Availability based on 2060 use from Central Gulf Coast Groundwater Availability Model analyses.
[3] Source: CBRWPG Groundwater Model analysis as part of 2001 Plan.

3.4.2 Carrizo-Wilcox Aquifer

Three counties within the Coastal Bend Region have significant Carrizo-Wilcox Aquifer reserves available to them. The Carrizo-Wilcox Aquifer contains moderate to large amounts of either fresh or slightly saline water. Slightly saline water is defined as water that contains 1,000 to 3,000 mg/L of dissolved solids. Although this aquifer reaches from the Rio Grande River north into Arkansas, it only underlies parts of McMullen, Live Oak, and Bee Counties within the Coastal Bend Region. In this downdip portion of the Carrizo-Wilcox Aquifer, the water is soft, hot (140 degrees Fahrenheit), and contains more dissolved solids than in updip parts of the aquifer. Long-term groundwater available from the Carrizo-Wilcox in the region is summarized in Table 3-6. Groundwater availabilities are based on TWDB analyses and are carried over from the 2001 Plan.[14]

Table 3-6.
Groundwater Availability and Use from the Carrizo-Wilcox Aquifer within the Coastal Bend Region

County	2060 Availability[1] (acft/yr)	2060 Use[2] (acft/yr)
Bee	394	—
Live Oak	2,399	60
McMullen	7,909	453
Total	**10,702**	**513**

[1] Source: CBRWPG Groundwater model analysis as part of 2001 Plan.
[2] Source: CGCGAM analyses (see Appendix D).

3.4.3 Queen City and Sparta Aquifers

The Queen City and Sparta Aquifers are classified by the TWDB as minor aquifers and underlie McMullen County. The Queen City is a thick sand and sandy clay aquifer and runs from its southern boundary in Frio and LaSalle Counties northeasterly towards Louisiana. The Queen City Aquifer supplies small to moderate amounts of either fresh or slightly saline water in the Coastal Bend Region. The Sparta Aquifer is composed of interbedded sands and clays that yield small to moderate quantities with fresh to slightly saline quality. Long-term groundwater available from these aquifers, as tabulated by the TWDB,[15] and are carried over from the 2001 Plan, in Table 3-7.

[14] TWDB, “Water for Texas,” August 1997. (Data supporting the 1997 Texas State Water Plan.)
[15] Ibid.

Table 3-7.
Groundwater Availability and Use from the Queen City and Sparta Aquifers within the Coastal Bend Region

County	Aquifer	2060 Availability[1] (acft/yr)	2060 Use[2] (acft/yr)
McMullen	Queen City	1,105	—
McMullen	Sparta	600	—
Total		**1,705**	**—**

[1] Source: CBRWPG Groundwater Model analysis as part of 2001 Plan.
[2] Source: Central Gulf Coast GAM analyses (see Appendix D).

3.4.4 Summary of Groundwater Availability

Groundwater resources in the Coastal Bend Region are made up of supplies from the Gulf Coast, Carrizo-Wilcox, Queen City, and Sparta Aquifers. Long-term (sustainable) yield from the aquifers, based on recent CGCGAM modeling of the Gulf Coast Aquifer (Appendix D) and estimates from the TWDB,[16] are summarized in Table 3-8. These availabilities were used in supply and demand comparisons in Chapter 4.

Table 3-8.
Total Groundwater Available in the Coastal Bend Region by County

County	2060 Groundwater Availability (acft/yr)				
	Gulf Coast Aquifer	Carrizo-Wilcox Aquifer	Queen City Aquifer	Sparta Aquifer	Total
Aransas	715	0	0	0	715
Bee	14,900	394	0	0	15,294
Brooks	3,325	0	0	0	3,325
Duval	14,928	0	0	0	14,928
Jim Wells	5,902	0	0	0	5,902
Kenedy	12,700	0	0	0	12,700
Kleberg	9,700	0	0	0	9,700
Live Oak	10,051	2,399	0	0	12,450
McMullen	1,200	7,909	1,105	600	10,814
Nueces	2,100	0	0	0	2,100
San Patricio	14,700	0	0	0	14,700
Total	**90,221**	**10,702**	**1,105**	**600**	**102,628**

[16] Ibid.

3.5 Drought Response

Texas Water Code Sections 16.053(e)(3)(A) and 31 TAC 357.5(e)(7) require that, for each source of water supply in the regional water planning area designated in accordance with 31 TAC 357.7(a)(1), the regional water plan shall identify: (A) factors specific to each source of water supply to be considered in determining whether to initiate a drought response; and (B) actions to be taken as part of the response. The Texas Commission on Environmental Quality has model municipal water conservation and drought management plans for entities to use for guidance (Appendix E.1 and E.2). The City of Corpus Christi and their customers receive surface water supplies from Lake Texana, through contract agreement with Lavaca Navidad River Authority as described earlier in Section 3.1.5. The Lavaca Navidad River Authority's Drought Contingency responses are summarized in Table 3-9. The LNRA drought contingency plan is included in Appendix E.3. Table 3-10 summarizes the drought contingency plan of the City of Corpus Christi (largest wholesale water provider in the Coastal Bend Region) and shows both trigger conditions and actions to be taken. Water Conservation and Drought Contingency Plans for the City of Corpus Christi, San Patricio Municipal Water District, and South Texas Water Authority are included in Appendices E.4 to E.6.

Through water purchase agreements, the customers of the City of Corpus Christi are required to implement similar water conservation measures when conditions warrant. Table 3-11 includes a summary of drought contingency plans for entities supplied by groundwater, within the Region.

Supplies from other surface water sources such as run-of-river water rights are determined on the basis of minimum year availability and firm yield, respectively. Hence, the current surface water supplies presented herein are, by TWDB definition, dependable during drought. Factors that are typically considered in initiating drought response for surface water sources are streamflow and reservoir storage as they may be conveniently measured and monitored. In contrast to groundwater sources, water right priority with respect to other rights and special permit conditions regarding minimum instream flows can also be important factors in determining whether to initiate drought responses for surface water sources. In the Nueces River Basin, coordination with the TCEQ Watermaster is an essential drought response for all entities dependent upon surface water supply sources.

Table 3-9.
Lavaca Navidad River Authority's Drought Contingency Response

Drought Condition	Reservoir System Storage	Actions
Condition I – Compromised Reservoir Condition One	Lake Texana Reservoir elevation is at or below elevation 43.00 msl	1. LRNA will notify TCEQ Watermaster of reservoir condition. 2. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and upstream water rights permit holders. Include in information to the public a recommendation that water users look for ways to conserve water. 3. *Impacts permit holders upstream of Lake Texana who divert water for irrigation purposes.* Diversions must cease within 24 hours following the time when the reservoir level drops below elevation 43.00 msl.
Condition II – Compromised Reservoir Condition Two	Lake Texana Reservoir elevation is at or below elevation 40.15 msl	In addition to Actions 1–3 under Conditions I, take the following actions 4. *Impacts freshwater releases to bays and estuaries.* LNRA may reduce the volume of freshwater releases to bays and estuaries to 5 cubic feet per second, when Lake Texana reaches elevation 40.15 (or roughly 78% of the reservoir capacity).
Condition III – Severe Local Drought Condition	Equal to or less than 30%	In addition to Actions 1–4 under Conditions I and II, take the following actions: 5. The goal is a 7% reduction of the use that would have occurred in the absence of drought contingency measures. *The water sales contract between the LNRA and City of Corpus Christi allows for the return of 10,400 acre-feet for meeting the needs of Jackson County.* 6. The affected communicates should continue implementation of relevant Drought Contingency Plan and water conservation actions. 7. Upon authorization by the TCEQ Watermaster, the LNRA will enact contractual provisions and assist the affected community as appropriate. 8. Certain industrial and commercial water uses which are not essential to the health and safety of the community should be prohibited; and 9. Through the news media, the public should be advised daily of the trigger conditions.

Table 3-10.
City of Corpus Christi Surface Water Sources Drought Contingency Response

Drought Condition	Reservoir System Storage	Actions
Condition I – Water Shortage Possibility	Below 50%	• City Manager issues a public notice to inform water users of the Corpus Christi water supply region to begin voluntary conservation measures. • Target water demand reduction of 1 percent, including for wholesale water contracts.
Condition II – Water Shortage Watch	Between 40% and 30%	• City Manager issues a public notice implementing required water conservation measures. • City Manager issues a public notice in a daily newspaper restricting outdoor watering between 10:00 am and 6:00 pm. • No runoff from yards or plants into gutters or streets allowed. • Prohibits defective plumbing in home or business establishment. • No water shall be allowed to flow constantly through a tap, hydrant, or valves by any user of water connected to the City system. • Requires City's wholesale customers to issue public notice advising water customers of required drought management measures. • Target inflows to Nueces Bay are reduced to 1,200 acre-ft per month. • Target water demand reduction of 5 percent, including for wholesale water contracts.
Condition III – Water Shortage Warning	Equal to or less than 30%	• In addition to Actions 1–8 under Conditions I and II, take the following actions: • City Manager issues a public notice and lawn watering schedule. • Target Inflows to Nueces Bay are reduced to 0 acre-feet per month. • Target water demand reduction of 10 percent, including for wholesale water contracts.
	Equal to or less than 20%	• Target water demand reduction of 15 percent, including for wholesale water contracts

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (if applicable)	Stage V (if applicable)
Utility Development & Research, Inc. (Riviera, TX)	***Customer Awareness*** Public announcement designed to increase water conservation	***Voluntary Water Conservation*** Overnight recovery rate reaches 4 feet - or - Pump hours per day is 17 hours.	***Mandatory Water Use Restrictions*** Overnight recovery rate reaches 2 feet - or - Pump hours per day is 20 hours.	***Critical Water Use Restrictions*** Overnight recovery rate reaches 0 feet - or - Pump hours per day is 22 hours.	
Escondido Creek Estates, Inc. (Kingsville, TX)	***Customer Awareness*** Public announcement designed to increase water conservation	***Voluntary Water Conservation*** Pump discharge flow is less than 180 gpm - or - Total daily demand as 60% of pumping capacity	***Mandatory Water Use Restrictions*** Pump discharge flow is less than 170 gpm - or - Total daily demand as 70% of pumping capacity	***Critical Water Use Restrictions*** Pump discharge flow is less than 160 gpm - or - Total daily demand as 80% of pumping capacity	
McCoy Water Supply Corporation (Service area includes 608 square miles located in Atascosa, Wilson, and Live Oak Counties)	***Mild Water Shortage Conditions*** Well flow from any regularly used well is less than 90% of full capacity. A storage facility is not filled for 72 consecutive hours. An elevated storage tank is out of service due to repainting or other required maintenance.	***Moderate Water Shortage Conditions*** Well flow from any regularly used well is less than 80% of full capacity. A storage facility is not filled for 96 consecutive hours.	***Severe Water Shortage Conditions*** Well flow from any regularly used well is less than 70% of full capacity. A storage facility is not filled for 120 consecutive hours.	***Critical Water Shortage Conditions*** Well flow from any regularly used well is less than 60% of full capacity. A storage facility is not filled for 144 consecutive hours.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service. Natural or man-made contamination of the water supply source(s).
El Oso Water Conservation District (Service area includes 500 square miles located in Karnes, Bee, Wilson, and Live Oak Counties)	***Mild Drought*** Average daily water usage reaches 85% of production capacity for three consecutive days. Consideration will be given to weather conditions, time of year and customer complaints of low water pressure. There is an extended period of low rainfall and daily use has risen 20% above the use for the same period during the previous year.	***Moderate Drought*** Average daily water use reaches 90% of production capacity for three consecutive days. Net water storage is continually decreasing on a daily basis, and falls below 80% storage for 48 hours. Water pressures fall to below 49 psi in the water distribution system, during non-peak water usage hours, as measured by the distribution line gages.	***Severe Drought*** The imminent or actual failure of a major component of the system that would interrupt water delivery for a prolonged period, or cause an immediate health or safety hazard. Water demand exceeds 97% of the production capacity for three consecutive days. Water demand exceeds 95% of production capacity for 30 days.		

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Continued)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
El Oso Water Conservation District (Continued)			Other unforeseen events which could pose imminent health or safety risks to the public.		
City of Falfurrias and Falfurrias Utility Board (Service area includes City of Falfurrias and Brooks County)	***Mild Water Shortages Conditions*** Initiated when one or more of the following exist: Static water level in the Falfurrias Utility Board's water well(s) is equal to or below mean sea level. Specific capacity of the Falfurrias Utility Board's water well(s) is equal to or less than 5% of the well's original specific capacity. Total daily water demand equals or exceeds 2.5 million gallons for 10 consecutive days or 5 million gallons on a single day (e.g., based on the "safe" operating capacity of water supply facilities). Continually falling treated water reservoir levels that do not refill above 80% overnight (e.g., based on an evaluation of minimum treated water storage required to avoid system outage).	***Moderate Water Shortage Conditions*** Initiated when two or more of the previous conditions exist.	***Severe Water Shortage Conditions*** Initiated when three or more of the previous conditions exist.	***Critical Water Shortage Conditions*** Initiated when four or more of the previous conditions exist.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; - or - Natural or man-made contamination of the water supply source(s).
Pettus Municipal Utility District (City of Pettus)	***Mild Water Shortage Conditions*** Total daily water demand equals or exceeds 85% of the system's safe operating capacity for three consecutive days or equals or exceeds 90% of system capacity on a single day.	***Moderate Water Shortage Conditions*** Total daily water demand equals or exceeds 90% of the system's safe operating capacity for three consecutive days or equals or exceeds 95% of system capacity on a single day.	***Severe Water Shortage Condition*** Total daily water demand equals or exceeds 95% of the system's safe operating capacity for three consecutive days, or equals or exceeds 100% of capacity on a single day.	***Critical Water Shortage Conditions*** Total daily water demand equals or exceeds 100% of the system's safe operating capacity for three consecutive days, or equals or exceeds 100% of capacity on a single day.	***Emergency Water Shortage Conditions*** System outage due to equipment failure.

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Continued)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
San Diego Municipal Water District No. 1 (City of San Diego)	***Mild Water Shortage Conditions*** Annually, beginning on May 1 through October 31 of every year. When the water supply available to the San Diego Municipal Utility District No. 1 is equal or less than 70% of storage capacity. When the static water level in the San Diego Municipal Water Utility District No. 1 well(s) is equal or less than 100 feet above water pump level. When the specific capacity of the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 70% of the well's original specific capacity. When total daily water demands equal or exceed one million gallons for three consecutive days.	***Moderate Water Shortage Conditions*** Water levels fall below 70% of storage capacity. Water demands exceed 70% of water well capacity. When the static water level in the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 100 feet above water pumps.	***Severe Water Shortage Conditions*** Water levels fall below 50% of storage capacity. Water demands exceed 90% of water well capacity. When the static water level in the San Diego Municipal Utility District No. 1 well(s) is equal to or less than 100 feet above water pumps. System outages due to equipment failure.	***Emergency Water Shortage Conditions*** Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service - or - Natural or man-made contamination of the water supply source(s).	
Freer WCID	***Mild Water Shortage Conditions*** ***(voluntary)*** Annually, beginning May 1 through September 1. When the static level in the Freer WCID is equal to or less than 10 feet above sea level. When the specific capacity of the Freer WCID wells are equal to or less than 70% of the well's original specific capacity. When total daily water demand equals or exceeds 700,000 gallons for 10 consecutive days or 700,000 gallons on a single	***Moderate Water Shortage Conditions*** When total daily water demand equals or exceeds 700,000 gallons for 10 consecutive days or 700,000 gallons on a single day.	***Severe Water Shortage Conditions*** When the specific capacity of the Freer WCID wells is equal to or less than 70% of the well's original specific capacity.	***Critical Water Shortage Conditions*** When the static water level in the Freer WCID wells is equal to or less than 10 feet above sea level.	

Table 3-11.
Water Supply Systems Using Groundwater Sources - Drought Contingency Response (Concluded)

Groundwater Systems	Stage I (Voluntary)	Stage II	Stage III	Stage IV (If applicable)	Stage V
Aransas County Municipal Utility District No. 1	***Mild Drought Conditions (voluntary) — Target Reduction in Well Run Time = 5%*** *When demand on the District's water supply reaches or exceeds 70% of the production capacity of such facilities for 5 consecutive days.*	***Moderate Drought Conditions — Target Reduction in Well Run Time = 10%*** *When demand on the District's water supply reaches or exceeds 90% of the production capacity of such facilities for 3 consecutive days.*	***Severe Drought Conditions — Target Reduction in Well Run Time = 15%*** *When demand on the District's water supply reaches or exceeds 100% of the production capacity of such facilities for 24 hours.*		
Blueberry Hills Water Works, LLC	***Customer Awareness (voluntary)*** *Annually, beginning April 1 through September 30* *Water customers are requested to voluntarily limit the use of water fro nonessential purposes and to practice water conservation.*	***Voluntary Water Conservation (voluntary)*** *Overnight recovery fails to restore 90% of full storage capacity.* *Production or distribution limitations.*	***Mandatory Water Use Restrictions*** *Overnight recovery fails to restore 85% of full storage capacity.* *Production or distribution limitations.*	***Critical Water Use Restrictions*** *Overnight recovery fails to restore 80% of full storage capacity.* *Production or distribution limitations.*	
McMullen County WCID #2	***Mild Water Shortage Conditions (voluntary)*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day.*	***Moderate Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 90% overnight.*	***Severe Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 80% overnight.*	***Critical Water Shortage Conditions*** *When total daily water demands equals or exceeds 2 million gallons on 3 consecutive days or 2.2 million gallons on a single day and/or continually falling treated water reservoir levels do not refill above 75% overnight.*	***Emergency Water Shortage Conditions*** Major line breaks, or pump or system failures occur, which cause unprecedented loss of capacity to provide water service. Natural or man-made contamination of water supply source(s).
City of Orange Grove	***Mild Water Shortage Conditions (voluntary)*** *When the static water level in City Water Well No. 4 is equal or more than 140 feet below the top of the casing.* *When total daily water demands equals or exceeds 90% of system safe operating capacity which is 750,000 gallons per day, for 10 consecutive days.*	***Moderate Water Shortage Conditions*** *When the static water level in City Water Well No. 4 drops to 150 feet below the top of the casing.*	***Severe Water Shortage Conditions*** *When the static water level in City Water Well No. 4 reaches 160 feet below the top of the casing.*	***Critical Water Shortage Conditions*** *When the static water level in City Water Well No. 4 reaches 165 feet below the top of the casing.*	***Emergency Water Shortage Conditions*** Major line breaks, or pump or system failures occur, which cause unprecedented loss of capacity to provide water service. Natural or man-made contamination of water supply source(s).

3.6 Potential for Emergency Transfers of Surface Water

TWDB Rules, Section 357.5(i) direct that the RWPG include recommendations for the emergency transfer of surface water and further direct that a determination be made of the portion of each right for non-municipal use that may be transferred without causing unreasonable damage to the property of the non-municipal water right holder. Senate Bill 1, Section 3.03 amends Texas Water Code Section 11.139 and allows the Executive Director of TCEQ, after notice to the Governor, to issue emergency permits or temporarily suspend or amend permit conditions without notice or hearing to address emergency conditions for a limited period of not more than 120 days if an imminent threat to public health and safety exists. A person desiring to obtain an emergency authorization is required to justify the request to TCEQ. If TCEQ determines the request is justified, it may issue an emergency authorization without notice and hearing, or with notice and hearing, if practicable. Applicants for emergency authorizations are required to pay fair market value for the water they are allowed to divert, as well as any damages caused by the transfer. In transferring the quantity of water pursuant to an emergency authorization request, the Executive Director, or the TCEQ, shall allocate the requested quantity among two or more water rights held for purposes other than domestic or municipal purposes.

Surface water availability models have been developed for the streams of Coastal Bend Region (Region N) in which the locations, quantities, and yields of the surface water rights of the region have been determined (Table 3-3). The Regional Water Plan incorporates Table 3-3 as a primary source of information to water user groups and the TCEQ for use in cases of emergencies that result in a threat to public health and safety. Water user groups who are located in proximity to one or more existing surface water diversion permits for non-municipal use can readily estimate quantities of water that might be available for emergency use applications, and TCEQ may also consider Table 3-3 in its administration of this provision of Senate Bill 1.

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Section 4A
Comparison of Water Demands with Water Supplies to Determine Needs [31 TAC §357.7(a)(5-7)]

4A.1 Introduction

In this section, the demand projections from Section 2 and the supply projections from Section 3 are brought together to estimate projected water needs in the Coastal Bend Region for the next 55 years. As a recap, Section 2 presented demand projections for six types of use: municipal, manufacturing, steam-electric, mining, irrigation, and livestock. Municipal water demand projections are shown for each city with a population of more than 500 and for County-Other users in each county. Section 3 presented surface water availability by water right and groundwater availability and projected use by aquifer.

For each of the 11 counties in the Coastal Bend Region there is a summary page that highlights specific supply and demand information in Section 4A.3, followed by two tables. The first table contains supply and demand comparisons for the six types of water use; the second table contains supply and demand comparisons for the municipal water user groups in the county.

Section 4A.6 summarizes the water supply and demand picture for the entire region, focusing on those cities and other users that have immediate and/or long-term needs.

4A.2 Allocation Methodology

Surface water and groundwater availability was allocated among the six user groups using the methods explained below.

4A.2.1 Surface Water Allocation

Surface water in the region available to meet projected demands consists of the yield of reservoirs, dependable supply of run-of-river water rights through drought of record conditions, and local on-farm sources. Surface water rights were allocated as supplies to their stated type of use: municipal, industrial (manufacturing, steam-electric, and mining), and irrigation. Municipal supply was further allocated among cities and other municipal water supply entities. This was done by obtaining water seller information (i.e., which wholesale water providers resell water to other water supply entities) and water purchase contract limits between buyers and sellers, provided by the TWDB and Wholesale Water Providers. In most cases, for those cities purchasing water on a wholesale basis the contract amount remains constant through 2060. It was also assumed that water associated with a wholesaler that is not resold remains as an available supply to the wholesaler. In the case where a wholesaler's supply is deficient to meet its own demands and contract requirements, a shortage would be expected for their non-municipal customers. A detailed explanation of water demand and supplies for Wholesale Water Providers is described in Section 4A.4. Figure 4A-1 presents major contract relationships in the Coastal Bend Region and Figure 4A-2 shows how the surface water in the Coastal Bend Region is distributed.

Two situations deserve special attention. The City of Corpus Christi has 200,000 acft in available safe yield supply in 2060, through its own water right in the CCR/LCC/Lake Texana System and a contract with the Lavaca-Navidad River Authority for a base amount of 41,840 acft/yr and up to 12,000 acft on an interruptible basis from Lake Texana. The City also has a permit to divert up to 35,000 acft/yr of run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert this water and convey it to the City. Therefore, under the rules governing the regional water planning process, this water is not a current water supply. The facilities to deliver Colorado River water to the region are analyzed as a water supply option in Section 4C.14 in Volume II.

From this availability—CCR/LCC/Lake Texana System and Lake Texana—Corpus Christi supplies its municipal customers throughout the Coastal Bend Region and manufacturing, mining, and steam-electric customers in Nueces County (Figure 4A-1). SPMWD has a contract to buy 40,000 acft of raw and treated water from the City of Corpus Christi and provides water to municipal customers in Aransas, Nueces and San Patricio Counties, as well as manufacturing needs in San Patricio County. STWA supplies municipal customers in Nueces and Kleberg Counties. Nueces County WCID #3 supplies municipal customers in Nueces County.

Local surface water supply from stock ponds and streams is available to meet livestock needs when groundwater supplies are insufficient to meet those demands. Generally, these ponds are not large enough to require a water rights permit (>200 acft of storage).

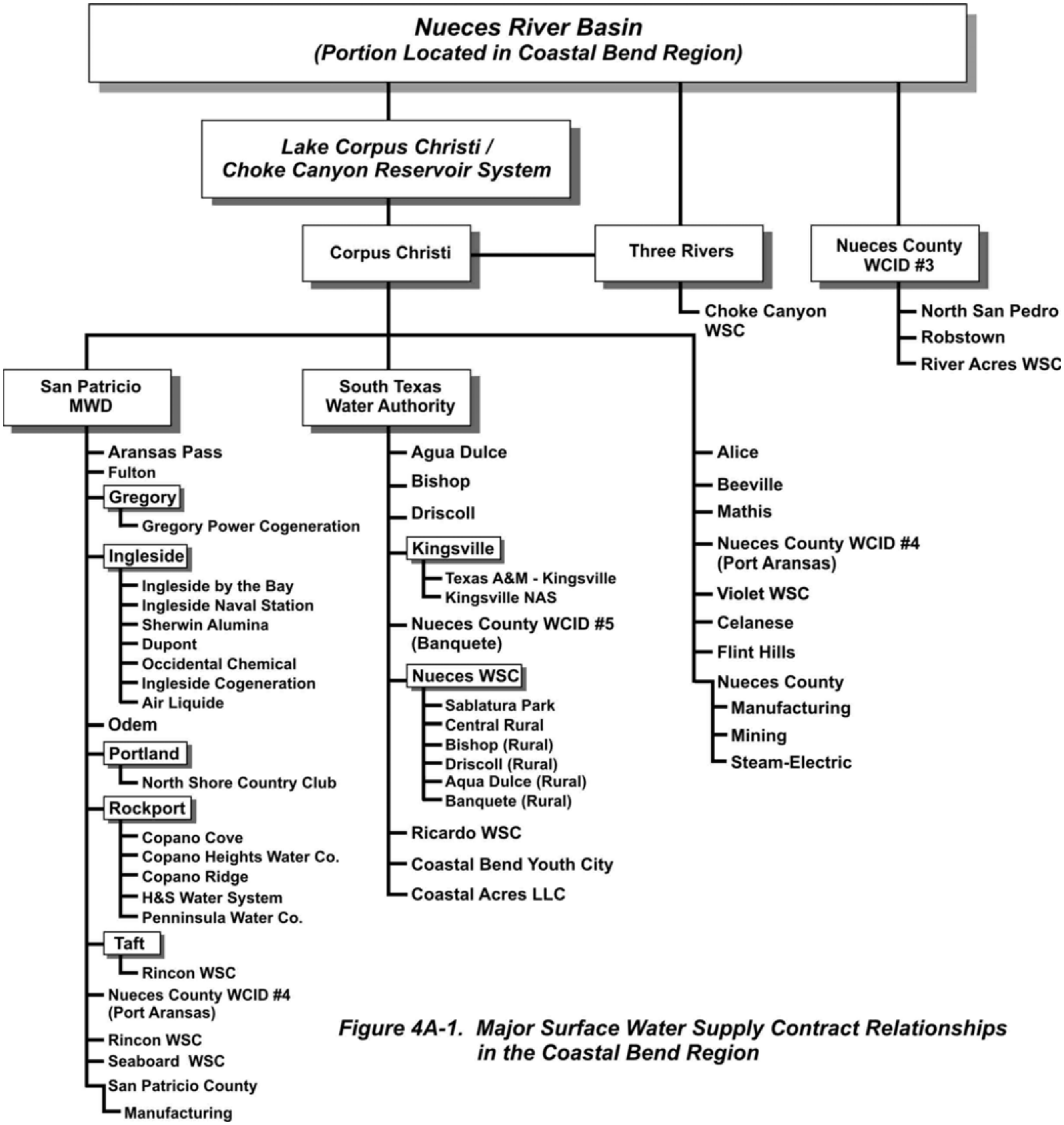
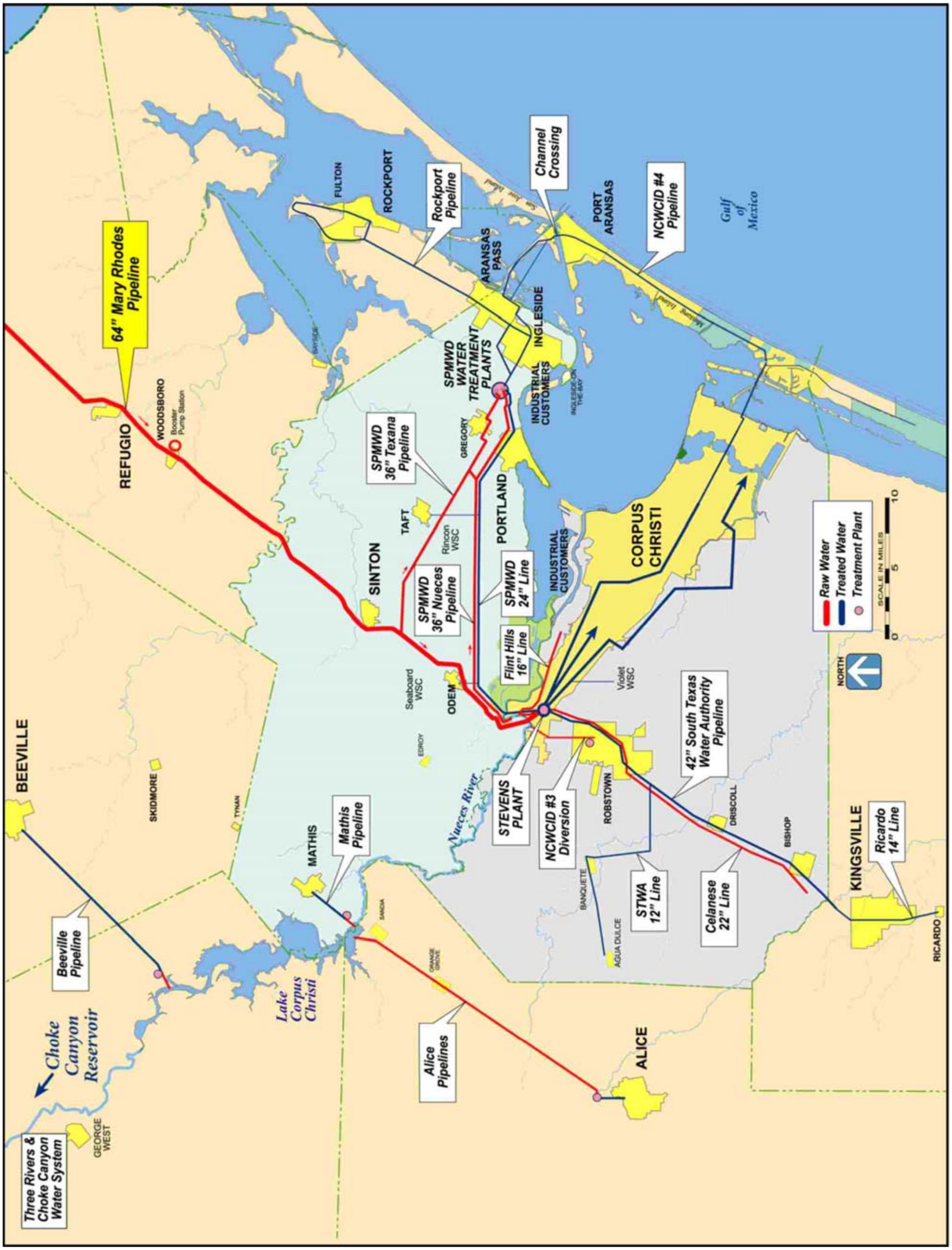


Figure 4A-1. Major Surface Water Supply Contract Relationships in the Coastal Bend Region



Source: The Rodman Company

Figure 4A-2. Coastal Bend Water Supply System

4A.2.2 Groundwater Allocation

For the previous 2001 Regional Water Plan, total groundwater availability in the region was determined based on the long-term sustainable pumpage of each of the aquifers in the region using an analytical groundwater model developed for the Coastal Bend Region. This approach was carried over to the 2006 Plan for Carrizo-Wilcox, Queen City, and Sparta Aquifers. For the Gulf Coast Aquifer, which provided over 90 percent of the groundwater supply in 2000, the TWDB's Central Gulf Coast Groundwater Availability Model was used to determine projected groundwater use from 2000 to 2060. Predictive pumping estimates were developed based on historic water use and projected water demands. The model was used to simulate the effects of future pumping on Gulf Coast Aquifer water levels, and to determine groundwater availability subject to acceptable drawdown constraints, as discussed in Section 3.4.1. There were only three instances when the drawdown criteria were exceeded based on projected groundwater demands through 2060. These included Duval County-Mining, Live Oak County-Mining, and Live Oak County-Manufacturing. In these instances, pumping was limited so that the drawdown in 2060 does not exceed the adopted drawdown criteria. For all other groundwater users, supply is limited to either well capacity or projected groundwater use, whichever is less. Well capacities were generally set at one-half the actual well capacity to accommodate for peak demands. For each county, groundwater is allocated among five of the six user groups—municipal, manufacturing, mining, irrigation, and livestock. Nueces County is the only county in the Coastal Bend Region with steam-electric demands, and these are met with surface water supplies. Groundwater supply was allocated in the following manner:

Municipal Use

- For cities, groundwater supply was based upon projected water use or well capacity reported to TCEQ, whichever is less.
- For rural areas, well capacities were estimated as 125 percent of the 2000 usage from the Gulf Coast Aquifer. Groundwater supply was based upon projected water use or well capacities, whichever is less.

Irrigation Use

- Irrigation supply was estimated as either the projected demand in each decade or well capacity, whichever is less. The well capacity was estimated as the amount of water used by irrigators in 2000. Surface water supplies for Bee, Live Oak, Nueces, and San Patricio Counties were also considered.

Manufacturing Use

- The manufacturing well capacity was generally estimated as 130 percent of the 2000 usage from the Gulf Coast Aquifer. Groundwater supply was based on projected water use or estimated well capacities, whichever is less. In cases when the projected water use on that portion (i.e., county and river basin) of the aquifer exceeded the adopted drawdown criteria, supply was prorated downwards.

Mining Use

- The mining supply was estimated as either the projected demand in each decade or well capacity, whichever is less. A portion of the projected water demand in Nueces County is met with surface water supplies. In cases when the projected water use on that portion (i.e., county and river basin) of the aquifer exceeded the adopted drawdown criteria, supply was prorated downwards.

Livestock Use

- The groundwater supply for livestock was calculated based on 1997 groundwater use reported by TWDB, represented as a percent of total groundwater used to meet demands. This percent of groundwater used is applied to each livestock demand by decade. The remaining demand is met with local surface water supplies.

4A.3 County Summaries — Comparison of Demand to Supply

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4A.3.1 Comparison of Demand to Supply – Aransas County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-1 for all categories of water use. Table 4A-2 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 3,314 acft in 2000 to 4,444 acft in 2030 and to 3,835 acft in 2060.
- Manufacturing demand increases from 235 acft to 331 acft from 2000 to 2060.
- Mining demand increases from 81 to 146 acft from 2000 to 2060.
- There is no irrigation demand projected; livestock demand is constant at 23 acft/yr.

Supplies

- Surface water from the CCR/LCC/Lake Texana System is supplied to municipalities by the City of Corpus Christi via the SPMWD.
- Groundwater supplies are from the Gulf Coast Aquifer.
- Surface water for livestock needs is provided from on-farm and local sources.

Comparison of Demand to Supply

- There are municipal shortages from 2050 to 2060, with the greatest shortage attributable to County-Other users in 2050 (1,527 acft), due to insufficient surface water supply for SPMWD.
- There are immediate and long-term shortages through 2060 for manufacturing users. Groundwater supply to manufacturing users is limited by well capacity, which results in groundwater supplies to the county being 136 acft less than projected groundwater use for Aransas County in 2060(Section 3.4).

Table 4A-1.
Aransas County
Population, Water Supply, and Water Demand Projections

Population Projection		Year						
		2000	2010	2020	2030	2040	2050	2060
		22,497	26,863	30,604	32,560	32,201	30,422	28,791
Supply and Demand by Type of Use		**Year**						
		2000 (acft)	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-2)	3,314	3,831	4,263	4,444	4,326	4,053	3,835
	Municipal Existing Supply							
	Groundwater	212	242	267	276	267	250	236
	Surface water	3,102	3,589	3,996	4,168	4,059	2,276	2,156
	Total Existing Municipal Supply	3,314	3,831	4,263	4,444	4,326	2,526	2,392
	Municipal Balance	0	0	0	0	0	(1,527)	(1,443)
Industrial	Manufacturing Demand	235	267	281	292	302	311	331
	Manufacturing Existing Supply							
	Groundwater	195	195	195	195	195	195	195
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	195	195	195	195	195	195	195
	Manufacturing Balance	(40)	(72)	(86)	(97)	(107)	(116)	(136)
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	81	103	115	123	131	139	146
	Mining Existing Supply							
	Groundwater	81	103	115	123	131	139	146
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	81	103	115	123	131	139	146
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	0	0	0	0	0	0	0
	Irrigation Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	0	0	0	0	0	0	0
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	23	23	23	23	23	23	23
	Livestock Existing Supply							
	Groundwater	2	2	2	2	2	2	2
	Surface water	21	21	21	21	21	21	21
	Total Livestock Supply	23	23	23	23	23	23	23
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	3,630	4,201	4,659	4,859	4,759	4,503	4,312
	Existing Municipal and Industrial Supply							
	Groundwater	488	540	577	594	593	584	577
	Surface water	3,102	3,589	3,996	4,168	4,059	2,275	2,155
	Total Municipal and Industrial Supply	3,590	4,129	4,573	4,762	4,652	2,859	2,732
	Municipal and Industrial Balance	(40)	(72)	(86)	(97)	(107)	(1,644)	(1,580)
	Agriculture Demand	23	23	23	23	23	23	23
	Existing Agricultural Supply							
	Groundwater	2	2	2	2	2	2	2
	Surface water	21	21	21	21	21	21	21
	Total Agriculture Supply	23	23	23	23	23	23	23
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	3,653	4,224	4,682	4,882	4,782	4,526	4,335
	Total Supply							
	Groundwater	490	542	579	596	595	586	579
	Surface water	3,123	3,610	4,017	4,189	4,080	2,296	2,176
	Total Supply	3,613	4,152	4,596	4,785	4,675	2,882	2,755
	Total Balance	(40)	(72)	(86)	(97)	(107)	(1,644)	(1,580)

Table 4A-2.
Aransas County
Municipal Water Demand and Supply by City/County
(acft)

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Aransas Pass							
Demand	146	168	186	195	190	179	169
Supply	146	168	186	195	190	179	169
Groundwater	—	—	—	—	—	—	—
Surface Water	146	168	186	195	190	179	169
Balance	—	—	—	—	—	—	—
Fulton							
Demand	261	307	346	365	359	336	318
Supply	261	307	346	365	359	336	318
Groundwater	—	—	—	—	—	—	—
Surface Water	261	307	346	365	359	336	318
Balance	—	—	—	—	—	—	—
Rockport							
Demand	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Supply	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Groundwater	—	—	—	—	—	—	—
Surface Water	1,357	1,590	1,778	1,868	1,823	1,712	1,620
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,550	1,766	1,953	2,016	1,954	1,826	1,728
Supply	1,550	1,766	1,953	2,016	1,954	299	285
Groundwater	212	242	267	276	267	250	236
Surface Water	1,338	1,524	1,686	1,740	1,687	49	49
Balance	—	—	—	—	—	(1,527)	(1,443)
Total for Aransas County							
Demand	3,314	3,831	4,263	4,444	4,326	4,053	3,835
Supply	3,314	3,831	4,263	4,444	4,326	2,526	2,392
Groundwater	212	242	267	276	267	250	236
Surface Water	3,102	3,589	3,996	4,168	4,059	2,276	2,156
Balance	—	—	—	—	—	(1,527)	(1,443)

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4A.3.2 Comparison of Demand to Supply – Bee County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-3 for all categories of water use. Table 4A-4 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 4,220 acft in 2000 to 4,492 acft in 2030 and to 4,291 acft in 2060.
- Manufacturing demand is constant at 1 acft from 2000 to 2060.
- Mining demand increases from 29 acft in 2000 to 48 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 2,798 acft to 1,274 acft; livestock demand is constant at 995 acft.

Supplies

- Surface water is provided to the City of Beeville from the City of Corpus Christi.
- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- There are sufficient municipal, industrial, and agricultural supplies through 2060.

Table 4A-3.
Bee County
Population, Water Supply, and Water Demand Projections

		Year						
Population Projection		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		32,359	34,298	36,099	37,198	37,591	37,598	36,686
Supply and Demand by Type of Use		**Year**						
		2000 (acft)	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-4)	4,220	4,342	4,456	4,492	4,439	4,397	4,291
	Municipal Existing Supply							
	Groundwater	1,691	1,723	1,766	1,771	1,740	1,714	1,673
	Surface water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
	Total Existing Municipal Supply	4,220	4,342	4,457	4,493	4,439	4,397	4,291
	Municipal Balance	0	0	1	1	0	0	0
Industrial	Manufacturing Demand	1	1	1	1	1	1	1
	Manufacturing Existing Supply							
	Groundwater	1	1	1	1	1	1	1
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	1	1	1	1	1	1	1
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	29	36	40	42	44	46	48
	Mining Existing Supply							
	Groundwater	29	37	40	42	44	46	48
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	29	37	40	42	44	46	48
	Mining Balance	0	1	0	0	0	0	0
Agriculture	Irrigation Demand	2,798	2,455	2,153	1,889	1,657	1,453	1,274
	Irrigation Existing Supply							
	Groundwater	2,756	2,413	2,111	1,847	1,615	1,411	1,232
	Surface water[1]	42	42	42	42	42	42	42
	Total Irrigation Supply	2,798	2,455	2,153	1,889	1,657	1,453	1,274
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	995	995	995	995	995	995	995
	Livestock Existing Supply							
	Groundwater	88	88	88	88	88	88	88
	Surface water	907	907	907	907	907	907	907
	Total Livestock Supply	995	995	995	995	995	995	995
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	4,250	4,379	4,497	4,535	4,484	4,444	4,340
	Existing Municipal and Industrial Supply							
	Groundwater	1,721	1,761	1,807	1,814	1,785	1,761	1,722
	Surface water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
	Total Municipal and Industrial Supply	4,250	4,380	4,498	4,536	4,484	4,444	4,340
	Municipal and Industrial Balance	0	1	1	1	0	0	0
	Agriculture Demand	3,793	3,450	3,148	2,884	2,652	2,448	2,269
	Existing Agricultural Supply							
	Groundwater	2,844	2,501	2,199	1,935	1,703	1,499	1,320
	Surface water	949	949	949	949	949	949	949
	Total Agriculture Supply	3,793	3,450	3,148	2,884	2,652	2,448	2,269
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	8,043	7,829	7,645	7,419	7,136	6,892	6,609
	Total Supply							
	Groundwater	4,565	4,262	4,006	3,749	3,488	3,260	3,042
	Surface water	3,478	3,568	3,640	3,671	3,648	3,632	3,567
	Total Supply	8,043	7,830	7,646	7,420	7,136	6,892	6,609
	Total Balance	0	1	1	1	0	0	0

[1] Surface water supplies from run-of-river water rights in the San Antonio-Nueces Coastal Basin.

Table 4A-4.
Bee County
Municipal Water Demand and Supply by City/County
(acft)

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Beeville							
Demand	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Supply[1]	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Groundwater	—	—	—	—	—	—	—
Surface Water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Balance	—	—	—	—	—	—	—
El Oso WSC							
Demand	60	62	65	66	66	65	64
Supply	60	62	65	66	66	65	64
Groundwater	60	62	65	66	66	65	64
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,631	1,661	1,701	1,705	1,674	1,649	1,609
Supply	1,631	1,661	1,701	1,705	1,674	1,649	1,609
Groundwater	1,631	1,661	1,701	1,705	1,674	1,649	1,609
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Bee County							
Demand	4,220	4,342	4,457	4,493	4,439	4,397	4,291
Supply	4,220	4,342	4,457	4,493	4,439	4,397	4,291
Groundwater	1,691	1,723	1,766	1,771	1,740	1,714	1,673
Surface Water	2,529	2,619	2,691	2,722	2,699	2,683	2,618
Balance	—	—	—	—	—	—	—

[1] According to Beeville contract with City of Corpus Christi, the City provides supply equal to the greater supply of previous years plus 10 percent. This amount was greater than demand; therefore supply was set equal to the demand.

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4A.3.3 Comparison of Demand to Supply – Brooks County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-5 for all categories of water use. Table 4A-6 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 1,970 acft in 2000 to 2,857 acft in 2030 and to 3,045 acft in 2060.
- Mining demand increases from 127 acft to 184 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation demand decreases from 25 acft to 21 acft; livestock demand is constant at 747 acft.

Supplies

- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- There are sufficient municipal, industrial, and agricultural supplies through 2060.

Table 4A-5.
Brooks County
Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		7,976	8,607	9,303	9,909	10,288	10,399	10,349

	Supply and Demand by Type of Use	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand (See Table 4A-6)	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Municipal Existing Supply							
	Groundwater	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	1,970	2,315	2,621	2,857	2,994	3,043	3,045
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	127	150	161	167	173	179	184
	Mining Existing Supply							
	Groundwater	127	150	161	167	173	179	184
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	127	150	161	167	173	179	184
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	25	24	24	23	22	21	21
	Irrigation Existing Supply							
	Groundwater	25	24	24	23	22	21	21
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	25	24	24	23	22	21	21
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	747	747	747	747	747	747	747
	Livestock Existing Supply							
	Groundwater	75	75	75	75	75	75	75
	Surface water	672	672	672	672	672	672	672
	Total Livestock Supply	747	747	747	747	747	747	747
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Existing Municipal and Industrial Supply							
	Groundwater	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	2,097	2,465	2,782	3,024	3,167	3,222	3,229
	Municipal and Industrial Balance	0	0	0	0	0	0	0
	Agriculture Demand	772	771	771	770	769	768	768
	Existing Agricultural Supply							
	Groundwater	100	99	99	98	97	96	96
	Surface water	672	672	672	672	672	672	672
	Total Agriculture Supply	772	771	771	770	769	768	768
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	2,869	3,236	3,553	3,794	3,936	3,990	3,997
	Total Supply							
	Groundwater	2,197	2,564	2,881	3,122	3,264	3,318	3,325
	Surface water	672	672	672	672	672	672	672
	Total Supply	2,869	3,236	3,553	3,794	3,936	3,990	3,997
	Total Balance	0	0	0	0	0	0	0

Table 4A-6
Brooks County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Falfurrias							
Demand	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Supply	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Groundwater	1,661	2,135	2,515	2,795	2,957	3,021	3,032
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	309	180	106	62	37	22	13
Supply	309	180	106	62	37	22	13
Groundwater	309	180	106	62	37	22	13
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Brooks County							
Demand	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Supply	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Groundwater	1,970	2,315	2,621	2,857	2,994	3,043	3,045
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.4 Comparison of Demand to Supply – Duval County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-7 for all categories of water use. Table 4A-8 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increase from 2,323 acft in 2000 to 2,463 acft in 2030 and decreases to 2,223 acft in 2060.
- Mining demand increases from 4,544 acft in 2000, to 7,119 acft in 2030, to 8,553 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 4,524 acft to 4,064 acft; livestock demand is constant at 873 acft.

Supplies

- Surface water for livestock needs is provided from on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- Groundwater supply for Duval County-Mining is limited by Coastal Bend Region drawdown criteria, described in Section 3.4. Duval County-Mining can receive 51% of their projected groundwater use in 2060 and still meet drawdown criteria, which accounts for the difference in groundwater supplies to the county and projected groundwater use for Duval County (Section 3.4).
- Due to limited groundwater availability without exceeding drawdown criteria and increased demand, mining has near- and long-term shortages with the highest projected shortage of 4,205 acft in 2060.

Table 4A-7. Duval County Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		13,120	13,881	14,528	14,882	14,976	14,567	13,819
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-8)	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Municipal Existing Supply							
	Groundwater	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	2,323	2,400	2,453	2,463	2,428	2,345	2,223
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water							
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water							
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	4,544	5,860	6,630	7,119	7,610	8,108	8,553
	Mining Existing Supply							
	Groundwater	4,544	4,122	4,112	4,146	4,224	4,299	4,348
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	4,544	4,122	4,112	4,146	4,224	4,299	4,348
	Mining Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
Agriculture	Irrigation Demand	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Irrigation Existing Supply							
	Groundwater	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	4,524	4,444	4,365	4,289	4,212	4,138	4,064
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	873	873	873	873	873	873	873
	Livestock Existing Supply							
	Groundwater	87	87	87	87	87	87	87
	Surface water	786	786	786	786	786	786	786
	Total Livestock Supply	873	873	873	873	873	873	873
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	6,867	8,260	9,083	9,582	10,038	10,453	10,776
	Existing Municipal and Industrial Supply							
	Groundwater	6,867	6,522	6,565	6,609	6,652	6,644	6,571
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	6,867	6,522	6,565	6,609	6,652	6,644	6,571
	Municipal and Industrial Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
	Agriculture Demand	5,397	5,317	5,238	5,162	5,085	5,011	4,937
	Existing Agricultural Supply							
	Groundwater	4,611	4,531	4,452	4,376	4,299	4,225	4,151
	Surface water	786	786	786	786	786	786	786
	Total Agriculture Supply	5,397	5,317	5,238	5,162	5,085	5,011	4,937
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	12,264	13,577	14,321	14,744	15,123	15,464	15,713
	Total Supply							
	Groundwater	11,478	11,053	11,017	10,985	10,951	10,869	10,722
	Surface water	786	786	786	786	786	786	786
	Total Supply	12,264	11,839	11,803	11,771	11,737	11,655	11,508
	Total Balance	0	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)

Table 4A-8.
Duval County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Benavides							
Demand	315	326	333	334	330	319	302
Supply	315	326	333	334	330	319	302
Groundwater	315	326	333	334	330	319	302
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Freer							
Demand	624	645	659	663	655	633	600
Supply	624	645	659	663	655	633	600
Groundwater	624	645	659	663	655	633	600
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
San Diego							
Demand	471	479	482	479	467	449	426
Supply	471	479	482	479	467	449	426
Groundwater	471	479	482	479	467	449	426
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	913	950	979	987	976	944	895
Supply	913	950	979	987	976	944	895
Groundwater	913	950	979	987	976	944	895
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Duval County							
Demand	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Supply	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Groundwater	2,323	2,400	2,453	2,463	2,428	2,345	2,223
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.5 Comparison of Demand to Supply – Jim Wells County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-9 for all categories of water use. Table 4A-10 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 8,562 acft in 2000 to 9,756 acft in 2030 and to 9,433 acft in 2060.
- Mining demand increases from 347 acft in 2000 to 550 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 3,731 acft to 1,717 acft; livestock demand is constant at 1,064 acft.

Supplies

- Surface water is supplied to the City of Alice from the CCR/LCC/Lake Texana System by the City of Corpus Christi; livestock needs are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer. San Diego groundwater supply is obtained from Duval County.

Comparison of Demand to Supply

- There are sufficient municipal supplies available through 2060 for Alice, Orange Grove, San Diego, and Premont.
- County-Other shows immediate and long-term shortages to 2060. Groundwater supply to County-Other users is limited by well capacity in the Nueces-Rio Grande River Basin, which results in groundwater supplies to the county being 170 acft less than projected groundwater use for Jim Wells County (Section 3.4).
- There are sufficient water supplies through 2060 to meet projected mining, irrigation, and livestock demands.

Table 4A-9.
Jim Wells County
Population, Water Supply, and Water Demand Projections

		Year						
Population Projection		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		39,326	42,434	45,303	47,149	47,955	47,615	46,596
Supply and Demand by Type of Use		**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-10)	8,562	9,068	9,526	9,756	9,761	9,640	9,433
	Municipal Existing Supply							
	Groundwater	3,203	3,295	3,376	3,418	3,419	3,397	3,359
	Surface water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
	Total Existing Municipal Supply	8,484	8,901	9,288	9,494	9,521	9,430	9,263
	Municipal Balance	(78)	(167)	(238)	(262)	(240)	(210)	(170)
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	347	423	461	484	507	530	550
	Mining Existing Supply							
	Groundwater	347	423	461	484	507	530	550
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	347	423	461	484	507	530	550
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Irrigation Existing Supply							
	Groundwater	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	3,731	3,278	2,878	2,528	2,221	1,953	1,717
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	1,064	1,064	1,064	1,064	1,064	1,064	1,064
	Livestock Existing Supply							
	Groundwater	106	106	106	106	106	106	106
	Surface water	958	958	958	958	958	958	958
	Total Livestock Supply	1,064	1,064	1,064	1,064	1,064	1,064	1,064
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	8,909	9,491	9,987	10,240	10,268	10,170	9,983
	Existing Municipal and Industrial Supply							
	Groundwater	3,550	3,718	3,837	3,902	3,926	3,927	3,909
	Surface water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
	Total Municipal and Industrial Supply	8,831	9,324	9,749	9,978	10,028	9,960	9,813
	Municipal and Industrial Balance	(78)	(167)	(238)	(262)	(240)	(210)	(170)
	Agriculture Demand	4,795	4,342	3,942	3,592	3,285	3,017	2,781
	Existing Agricultural Supply							
	Groundwater	3,837	3,384	2,984	2,634	2,327	2,059	1,823
	Surface water	958	958	958	958	958	958	958
	Total Agriculture Supply	4,795	4,342	3,942	3,592	3,285	3,017	2,781
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	13,704	13,833	13,929	13,832	13,553	13,187	12,764
	Total Supply							
	Groundwater	7,387	7,102	6,821	6,536	6,253	5,986	5,732
	Surface water	6,239	6,564	6,870	7,034	7,060	6,991	6,862
	Total Supply	13,626	13,666	13,691	13,570	13,313	12,977	12,594
	Total Balance	(78)	(167)	(238)	(262)	(240)	(210)	(170)

Table 4A-10.
Jim Wells County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Alice							
Demand	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Supply	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Groundwater	—	—	—	—	—	—	—
Surface Water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Balance	—	—	—	—	—	—	—
Orange Grove							
Demand	353	374	394	405	406	402	393
Supply	353	374	394	405	406	402	393
Groundwater	353	374	394	405	406	402	393
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Premont							
Demand	807	858	905	931	935	925	905
Supply	807	858	905	931	935	925	905
Groundwater	807	858	905	931	935	925	905
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
San Diego							
Demand	99	103	105	106	105	103	101
Supply	99	103	105	106	105	103	101
Groundwater	99	103	105	106	105	103	101
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
County-Other							
Demand	2,022	2,127	2,210	2,238	2,213	2,177	2,130
Supply	1,944	1,960	1,972	1,976	1,972	1,967	1,960
Groundwater	1,944	1,960	1,972	1,976	1,972	1,967	1,960
Surface Water	—	—	—	—	—	—	—
Balance	(78)	(167)	(238)	(262)	(241)	(210)	(170)
Total for Jim Wells County							
Demand	8,562	9,068	9,526	9,756	9,794	9,640	9,433
Supply	8,484	8,901	9,288	9,494	9,520	9,430	9,263
Groundwater	3,203	3,295	3,376	3,418	3,418	3,397	3,359
Surface Water	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Balance	(78)	(167)	(238)	(262)	(241)	(210)	(170)

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4A.3.6 Comparison of Demand to Supply – Kenedy County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-11 for all categories of water use. Table 4A-12 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 46 acft in 2000 to 53 acft in 2060.
- Mining demand is constant at 1 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation is constant at 107 acft and livestock demand is constant at 901 acft.

Supplies

- Surface water for livestock needs is provided from on-farm and local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- All municipal, industrial, and agriculture demands are met through 2060.

Table 4A-11.
Kenedy County
Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		414	467	495	523	527	529	537
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-12)	46	50	52	53	53	52	53
	Municipal Existing Supply							
	Groundwater	46	50	52	53	53	52	53
	Surface water	0	0	0	0	0	0	0
	Total Existing Municipal Supply	46	50	52	53	53	52	53
	Municipal Balance	0	0	0	0	0	0	0
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	1	1	1	1	1	1	1
	Mining Existing Supply							
	Groundwater	1	1	1	1	1	1	1
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	1	1	1	1	1	1	1
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	107	107	107	107	107	107	107
	Irrigation Existing Supply							
	Groundwater	107	107	107	107	107	107	107
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	107	107	107	107	107	107	107
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	901	901	901	901	901	901	901
	Livestock Existing Supply							
	Groundwater	90	90	90	90	90	90	90
	Surface water	811	811	811	811	811	811	811
	Total Livestock Supply	901	901	901	901	901	901	901
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	47	51	53	54	54	53	54
	Existing Municipal and Industrial Supply							
	Groundwater	47	51	53	54	54	53	54
	Surface water	0	0	0	0	0	0	0
	Total Municipal and Industrial Supply	47	51	53	54	54	53	54
	Municipal and Industrial Balance	0	0	0	0	0	0	0
	Agriculture Demand	1,008	1,008	1,008	1,008	1,008	1,008	1,008
	Existing Agricultural Supply							
	Groundwater	197	197	197	197	197	197	197
	Surface water	811	811	811	811	811	811	811
	Total Agriculture Supply	1,008	1,008	1,008	1,008	1,008	1,008	1,008
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	1,055	1,059	1,061	1,062	1,062	1,061	1,062
	Total Supply							
	Groundwater	244	248	250	251	251	250	251
	Surface water	811	811	811	811	811	811	811
	Total Supply	1,055	1,059	1,061	1,062	1,062	1,061	1,062
	Total Balance	0	0	0	0	0	0	0

Table 4A-12.
Kenedy County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
County-Other							
Demand	46	50	52	53	53	52	53
Supply	46	50	52	53	53	52	53
Groundwater	46	50	52	53	53	52	53
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Total for Kenedy County							
Demand	46	50	52	53	53	52	53
Supply	46	50	52	53	53	52	53
Groundwater	46	50	52	53	53	52	53
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—

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4A.3.7 Comparison of Demand to Supply – Kleberg County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-13 for all categories of water use. Table 4A-14 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 5,415 acft in 2000 to 7,020 acft in 2060.
- Mining demand increases from 2,127 acft in 2000 to 2,207 acft in 2030 to 2,232 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 1,002 acft to 410 acft; livestock demand is constant at 1,900 acft.

Supplies

- Surface water is supplied to municipal users from the CCR/LCC/Lake Texana System by the City of Corpus Christi via the STWA; some livestock needs are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- The City of Kingsville supplies its own groundwater and purchases surface water from the STWA and has no projected shortages through 2060.
- Due to increasing demand, County-Other users show a shortage from 2020 through 2060. Groundwater supply to County-Other users is limited by well capacity.
- Groundwater supply to City of Kingsville and Kleberg County-other users is limited by well capacity, which results in groundwater supplies to the county being 155 acft less than projected groundwater use for Kleberg County in 2060 (Section 3.4)
- There are sufficient mining, irrigation, and livestock supplies through 2060.

Table 4A-13.
Kleberg County
Population, Water Supply, and Water Demand Projections

	Population Projection	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
		31,549	36,959	40,849	43,370	44,989	47,118	47,212
	Supply and Demand by Type of Use	*2000 (acft)*	*2010 (acft)*	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
Municipal	Municipal Demand (See Table 4A-14)	5,415	6,051	6,436	6,664	6,762	7,008	7,020
	Municipal Existing Supply							
	Groundwater	3,976	4,196	4,318	4,364	4,392	4,432	4,434
	Surface water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
	Total Existing Municipal Supply	5,415	6,051	6,405	6,583	6,654	6,855	6,865
	Municipal Balance	0	0	(31)	(81)	(108)	(153)	(155)
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Mining Existing Supply							
	Groundwater	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	2,127	2,917	2,934	2,207	2,216	2,225	2,232
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	1,002	866	745	644	555	477	410
	Irrigation Existing Supply							
	Groundwater	1,002	866	745	644	555	477	410
	Surface water	0	0	0	0	0	0	0
	Total Irrigation Supply	1,002	866	745	644	555	477	410
	Irrigation Balance	0	0	0	0	0	0	0
	Livestock Demand	1,900	1,900	1,900	1,900	1,900	1,900	1,900
	Livestock Existing Supply							
	Groundwater	190	190	190	190	190	190	190
	Surface water	1,710	1,710	1,710	1,710	1,710	1,710	1,710
	Total Livestock Supply	1,900	1,900	1,900	1,900	1,900	1,900	1,900
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	7,542	8,968	9,370	8,871	8,978	9,233	9,252
	Existing Municipal and Industrial Supply							
	Groundwater	6,103	7,114	7,252	6,571	6,608	6,657	6,666
	Surface water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
	Total Municipal and Industrial Supply	7,542	8,969	9,339	8,790	8,870	9,080	9,097
	Municipal and Industrial Balance	0	1	(31)	(81)	(108)	(153)	(155)
	Agriculture Demand	2,902	2,766	2,645	2,544	2,455	2,377	2,310
	Existing Agricultural Supply							
	Groundwater	1,192	1,056	935	834	745	667	600
	Surface water	1,710	1,710	1,710	1,710	1,710	1,710	1,710
	Total Agriculture Supply	2,902	2,766	2,645	2,544	2,455	2,377	2,310
	Agriculture Balance	0	0	0	0	0	0	0
	Total Demand	10,444	11,734	12,015	11,415	11,433	11,610	11,562
	Total Supply							
	Groundwater	7,295	8,170	8,187	7,405	7,353	7,324	7,266
	Surface water	3,149	3,565	3,797	3,929	3,972	4,133	4,141
	Total Supply	10,444	11,735	11,984	11,334	11,325	11,457	11,407
	Total Balance	0	1	(31)	(81)	(108)	(153)	(155)

Table 4A-14. Kleberg County Municipal Water Demand and Supply by City/County (acft)

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Kingsville							
Demand	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Supply	4,440	4,570	4,601	4,604	4,569	4,616	4,619
Groundwater	3,219	3,219	3,219	3,219	3,219	3,219	3,219
Surface Water	1,221	1,351	1,382	1,385	1,350	1,397	1,400
Balance	—	—	—	—	—	—	—
Ricardo WSC							
Demand	296	682	955	1,130	1,236	1,390	1,397
Supply	296	682	955	1,130	1,236	1,390	1,397
Groundwater	78	179	250	296	324	364	366
Surface Water	218	503	705	834	912	1,026	1,031
Balance	—	—	—	—	—	—	—
County-Other							
Demand	679	799	880	930	957	1,002	1,004
Supply	679	799	849	849	849	849	849
Groundwater	679	799	849	849	849	849	849
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(31)	(81)	(108)	(153)	(155)
Total for Kleberg County							
Demand	5,415	6,051	6,436	6,664	6,762	7,008	7,020
Supply	5,415	6,051	6,405	6,583	6,654	6,855	6,865
Groundwater	3,976	4,196	4,318	4,364	4,392	4,432	4,434
Surface Water	1,439	1,855	2,087	2,219	2,262	2,423	2,431
Balance	—	—	(31)	(81)	(108)	(153)	(155)

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4A.3.8 Comparison of Demand to Supply – Live Oak County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-15 for all categories of water use. Table 4A-16 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 2,350 acft in 2000 to 2,796 acft in 2030 and decreases to 2,213 acft in 2060.
- Manufacturing demands increase from 1,767 acft in 2000 to 2,194 acft in 2060.
- Mining demand increases from 3,105 acft to 5,341 acft from 2000 to 2060.
- For the period 2000 to 2060, irrigation demand decreases from 3,539 acft to 2,277 acft; livestock demand is constant at 833 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System and City of Three Rivers water rights on the Nueces River firm supply of 700 acft/yr; some livestock needs are met with on-farm/local sources.
- In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Surface water supplies from City of Three Rivers supplement groundwater supplies to meet former Choke Canyon WSC customer needs.
- Groundwater supplies are from the Carrizo-Wilcox and Gulf Coast Aquifers.

Comparison of Demand to Supply

- Three Rivers has a surplus of 3,453 acft in 2000 and 3,463 acft in 2060, after meeting their water demands for Choke Canyon WSC and City of Three Rivers. Due to this surplus, the overall municipal demand for the county is met through 2060.
- Live Oak County-Other users show a shortage from 2020 to 2040, due to groundwater supplies being limited by well capacity.
- Mining has near- and long-term shortages through 2060 due to increasing water demand. Groundwater supplies for Live Oak-Mining are limited by Coastal Bend Region drawdown criteria, described in Section 3.4. Live Oak- Mining can receive 67 percent of their projected groundwater use in 2060 and still meet drawdown criteria.
- Manufacturing has immediate and long-term shortages through 2060 due to increasing water demand and groundwater supplies limited by drawdown criteria. Live Oak- Manufacturing can receive 63% of their projected groundwater use in 2060 and still meet drawdown criteria.
- Irrigation has immediate and long-term shortages, limited by availability of groundwater.
- In 2060, the groundwater supplies to the county are less than projected groundwater use for Duval County (Section 3.4) attributable to supply reductions described above for Duval County Mining, Manufacturing, and Irrigation users.
- Livestock has sufficient supply through 2060.

Table 4A-15.
Live Oak County
Population, Water Supply, and Water Demand Projections

Population Projection		*Year*						
		2000	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
		12,309	13,735	14,929	15,386	15,018	13,808	12,424

Supply and Demand by Type of Use		*2000 (acft)*	*2010 (acft)*	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
Municipal	Municipal Demand (See Table 4A-16)	2,350	2,573	2,750	2,796	2,693	2,459	2,213
	Municipal Existing Supply							
	Groundwater	1,768	1,896	1,972	1,985	1,945	1,805	1,645
	Surface water	4,050	4,045	4,043	4,042	4,043	4,046	4,049
	Total Existing Municipal Supply	5,818	5,941	6,015	6,027	5,988	5,851	5,694
	Municipal Balance	3,468	3,368	3,265	3,231	3,295	3,392	3,481
Industrial	Manufacturing Demand	1,767	1,946	1,998	2,032	2,063	2,088	2,194
	Manufacturing Existing Supply							
	Groundwater	754	809	715	673	648	631	630
	Surface water	800	800	800	800	800	800	800
	Total Manufacturing Supply	1,554	1,609	1,515	1,473	1,448	1,431	1,430
	Manufacturing Balance	(213)	(337)	(483)	(559)	(615)	(657)	(764)
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	3,105	3,894	4,319	4,583	4,845	5,108	5,341
	Mining Existing Supply							
	Groundwater	3,105	3,830	3,841	3,655	3,611	3,604	3,586
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	3,105	3,830	3,841	3,655	3,611	3,604	3,586
	Mining Balance	0	(64)	(478)	(928)	(1,234)	(1,504)	(1,755)
Agriculture	Irrigation Demand	3,539	3,289	3,056	2,840	2,639	2,451	2,277
	Irrigation Existing Supply							
	Groundwater	2,649	2,462	2,287	2,126	1,975	1,835	1,704
	Surface water	200	200	200	200	200	200	200
	Total Irrigation Supply	2,849	2,662	2,487	2,326	2,175	2,035	1,904
	Irrigation Balance	(690)	(627)	(569)	(514)	(464)	(416)	(373)
	Livestock Demand	833	833	833	833	833	833	833
	Livestock Existing Supply							
	Groundwater	417	417	417	417	417	417	417
	Surface water	416	416	416	416	416	416	646
	Total Livestock Supply	833	833	833	833	833	833	833
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	7,222	8,413	9,067	9,411	9,601	9,655	9,748
	Existing Municipal and Industrial Supply							
	Groundwater	5,627	6,535	6,528	6,313	6,204	6,040	5,861
	Surface water	4,850	4,845	4,843	4,842	4,843	4,846	4,849
	Total Municipal and Industrial Supply	10,477	11,380	11,371	11,155	11,047	10,886	10,710
	Municipal and Industrial Balance	3,255	2,967	2,304	1,744	1,446	1,231	962
	Agriculture Demand	4,372	4,122	3,889	3,673	3,472	3,284	3,110
	Existing Agricultural Supply							
	Groundwater	3,066	2,879	2,704	2,543	2,392	2,252	2,121
	Surface water	616	616	616	616	616	616	616
	Total Agriculture Supply	3,682	3,495	3,320	3,159	3,008	2,868	2,737
	Agriculture Balance	(690	(627)	(569)	(514)	(464)	(416)	(373)
	Total Demand	11,594	12,535	12,956	13,084	13,073	12,939	12,858
	Total Supply							
	Groundwater	8,693	9,414	9,232	8,856	8,596	8,292	7,982
	Surface water	5,466	5,461	5,459	5,458	5,459	5,462	5,465
	Total Supply	14,159	14,875	14,691	14,314	14,055	13,754	13,477
	Total Balance	2,565	2,340	1,735	1,230	982	815	589

Note: City of Three Rivers acquired Choke Canyon WSC in January 2004. Choke Canyon WSC supply/demands in Live Oak County are met by the City of Three Rivers (Live Oak County).

Table 4A-16.
Live Oak County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Choke Canyon WSC							
Demand	360	397	425	435	421	384	346
Supply	365	406	430	437	422	386	350
Groundwater	193	179	174	171	168	165	163
Surface Water[1]	172	227	256	266	254	221	187
Balance	5	9	5	2	1	2	4
El Oso WSC							
Demand	189	206	220	223	215	196	176
Supply	189	206	220	223	215	196	176
Groundwater	189	206	220	223	215	196	176
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
George West							
Demand	642	703	754	767	738	675	608
Supply	642	703	754	767	738	675	608
Groundwater	642	703	754	767	738	675	608
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
McCoy WSC							
Demand	50	54	57	58	56	51	46
Supply	60	60	60	60	60	60	60
Groundwater	60	60	60	60	60	60	60
Surface Water	—	—	—	—	—	—	—
Balance	10	6	3	2	4	9	14
Three Rivers							
Demand	425	465	498	505	485	444	399
Supply	3,878	3,818	3,787	3,776	3,789	3,825	3,862
Groundwater	—	—	—	—	—	—	—
Surface Water[2]	3,878	3,818	3,787	3,776	3,789	3,825	3,862
Balance	3,453	3,353	3,289	3,271	3,304	3,381	3,463

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Table 4A-16 concluded

City/County	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
County-Other							
Demand	684	748	796	808	778	709	638
Supply	684	748	764	764	764	709	638
Groundwater	684	748	764	764	764	709	638
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(32)	(44)	(14)	—	—
Total for Live Oak County							
Demand	2,350	2,573	2,750	2,796	2,693	2,459	2,213
Supply	5,818	5,941	6,015	6,027	5,988	5,851	5,694
Groundwater	1,768	1,896	1,972	19,85	19,45	1,805	1,645
Surface Water	4,050	4,045	4,043	4,042	4,043	4,046	4,049
Balance	3,468	3,368	3,265	3,231	3,295	3,392	3,481

[1] Surface water supplied by City of Three Rivers.
[2] 700 acft/yr is supplied by City of Three Rivers and remainder by City of Corpus Christi.

4A.3.9 Comparison of Demand to Supply – McMullen County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-17 for all categories of water use. Table 4A-18 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 175 acft in 2000 to 190 acft in 2020 and then decreases to 152 acft in 2060.
- Mining demand increases from 176 acft to 218 acft from 2000 to 2060.
- Livestock demand is constant at 659 acft.

Supplies

- Surface water for irrigation needs is supplied by water rights on the Nueces River.
- In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Surface water supplies from City of Three Rivers supplement groundwater supplies to meet former Choke Canyon WSC customer needs.
- Groundwater supplies are from the Carrizo-Wilcox and Gulf Coast Aquifers.
- Surface water for livestock needs is met by on-farm/local sources.

Comparison of Demand to Supply

- All municipal, industrial, and agricultural demands are met through 2060.
- Groundwater availability is from four source aquifers: Gulf Coast (1,200 acft/yr); Carrizo-Wilcox (7,909 acft/yr); Queen City (1,105 acft/yr); and Sparta (600 acft/yr). The highest amount of groundwater needed to satisfy demands is 487 acft/yr in 2060.
- The largest source, the Carrizo-Wilcox Aquifer, is somewhat difficult to access due to depth, water chemistry, and temperature (140° F).
- All municipal, industrial, and agricultural demands are met through 2060.

Table 4A-17. McMullen County Population, Water Supply, and Water Demand Projections

Population Projection	Year 2000	2010	2020	2030	2040	2050	2060
	851	920	957	918	866	837	793

	Supply and Demand by Type of Use	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand (See Table 4A-18)	175	186	190	180	168	160	152
	Municipal Existing Supply							
	Groundwater	203	203	203	203	203	203	203
	Surface water	13	18	20	21	20	17	14
	Total Existing Municipal Supply	216	221	223	224	223	220	217
	Municipal Balance	41	35	33	44	55	60	65
Industrial	Manufacturing Demand	0	0	0	0	0	0	0
	Manufacturing Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Manufacturing Supply	0	0	0	0	0	0	0
	Manufacturing Balance	0	0	0	0	0	0	0
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	176	195	203	207	211	215	218
	Mining Existing Supply							
	Groundwater	176	195	203	207	211	215	218
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	176	195	203	207	211	215	218
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	0	0	0	0	0	0	0
	Irrigation Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	6	6	6	6	6	6	6
	Total Irrigation Supply	6	6	6	6	6	6	6
	Irrigation Balance	6	6	6	6	6	6	6
	Livestock Demand	659	659	659	659	659	659	659
	Livestock Existing Supply							
	Groundwater	66	66	66	66	66	66	66
	Surface water	593	593	593	593	593	593	593
	Total Livestock Supply	659	659	659	659	659	659	659
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	351	381	393	387	379	375	370
	Existing Municipal and Industrial Supply							
	Groundwater	379	398	406	410	414	418	421
	Surface water	13	18	20	21	20	17	14
	Total Municipal and Industrial Supply	392	416	426	431	434	435	435
	Municipal and Industrial Balance	41	35	33	44	55	60	65
	Agriculture Demand	659	659	659	659	659	659	659
	Existing Agricultural Supply							
	Groundwater	66	66	66	66	66	66	66
	Surface water	599	599	599	599	599	599	599
	Total Agriculture Supply	665	665	665	665	665	665	665
	Agriculture Balance	6	6	6	6	6	6	6
	Total Demand	1,010	1,040	1,052	1,046	1,038	1,034	1,029
	Total Supply							
	Groundwater	445	464	472	476	480	484	487
	Surface water	612	617	619	620	619	616	613
	Total Supply	1,057	1,081	1,091	1,096	1,099	1,100	1,100
	Total Balance	47	41	39	50	61	66	71

Table 4A-18.
McMullen County
Municipal Water Demand and Supply by City/County
(acft)

City/County	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Choke Canyon WSC							
Demand	40	43	44	42	39	37	35
Supply	47	52	54	55	54	51	48
Groundwater	34	34	34	34	34	34	34
Surface Water	13	18	20	21	20	17	14
Balance	7	9	10	13	15	14	13
County-Other							
Demand	135	143	146	138	129	123	117
Supply	169	169	169	169	169	169	169
Groundwater	169	169	169	169	169	169	169
Surface Water	—	—	—	—	—	—	—
Balance	34	26	23	31	40	46	52
Total for McMullen County							
Demand	175	186	190	180	168	160	152
Supply	216	221	223	224	223	220	217
Groundwater	203	203	203	203	203	203	203
Surface Water	13	18	20	21	20	17	14
Balance	41	35	33	44	55	60	65

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4A.3.10 Comparison of Demand to Supply – Nueces County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-19 for all categories of water use. Table 4A-20 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 62,702 acft in 2000 to 103,018 acft in 2060.
- Manufacturing demand increases from 39,763 acft in 2000 to 63,313 acft in 2060.
- Mining demand increases from 1,275 acft in 2000 to 1,724 acft in 2060; steam-electric demand increases from 8,799 acft in 2000 to 27,664 acft in 2060. The increase in steam-electric demand since the 2001 Regional Water Plan is attributable to a future 1,200-MW plant projected to be operating by 2020 and projections to use freshwater cooling for future electrical generation units as existing saltwater-cooled steam-electric plants are mothballed or retired.
- For the period 2000 to 2060, irrigation demand decreases from 1,680 acft to 692 acft; livestock demand is constant at 279 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System by the City of Corpus Christi, SPMWD, STWA, and Nueces County WCID #3; some livestock needs are met with on-farm/local sources. A small firm surface water supply of 12 acft for Nueces-Mining is from run-of-river rights in the Nueces River Basin.
- Groundwater supplies are from the Gulf Coast Aquifer.

Comparison of Demand to Supply

- River Acres WSC has shortages from 2000 to 2060, with the greatest shortage of 590 acft in 2060. These shortages are attributable to contract limits with Nueces WCID #3.
- County-Other receives water supplies form the City of Corpus Christi, STWA, and Nueces County WCID #3. Their projected water demands decrease and supplies remain constant based on contracts.
- Manufacturing has shortages ranging from 11,627 acft/yr in 2040 to 37,893 acft/yr in 2060.
- Mining has long-term shortages from 2030 through 2060, ranging from 570 acft in 2030 to 1,612 acft in 2060.
- In 2060, the groundwater supplies to the county is less than projected groundwater use for Nueces County (Section 3.4) due to surface water supplies meeting water demands for Aransas Pass.
- There are sufficient irrigation and livestock supplies through 2060.

Table 4A-19.
Nueces County
Population, Water Supply, and Water Demand Projections

	Population Projection	2000	2010	2020	2030	2040	2050	2060
		313,645	358,278	405,492	447,014	483,692	516,265	542,327
	Supply and Demand by Type of Use	**2000 (acft)**	**2010 (acft)**	**2020 (acft)**	**2030 (acft)**	**2040 (acft)**	**2050 (acft)**	**2060 (acft)**
Municipal	Municipal Demand (See Table 4A-20)	62,702	70,609	78,691	85,697	91,988	97,882	103,018
Municipal	Municipal Existing Supply							
Municipal	Groundwater	325	276	235	178	155	140	132
Municipal	Surface water	108,150	102,033	90,712	85,310	91,648	97,554	102,679
Municipal	Total Existing Municipal Supply	108,475	102,309	90,947	85,488	91,803	97,694	102,811
Municipal	Municipal Balance	45,773	31,700	12,256	(209)	(185)	(188)	(207)
Industrial	Manufacturing Demand	39,763	46,510	50,276	53,425	56,500	59,150	63,313
Industrial	Manufacturing Existing Supply							
Industrial	Groundwater	972	1,137	1,229	1,306	1,381	1,446	1,548
Industrial	Surface water	38,791	45,373	49,047	52,119	43,492	33,618	23,872
Industrial	Total Manufacturing Supply	39,763	46,510	50,276	53,425	44,873	35,064	25,420
Industrial	Manufacturing Balance	0	0	0	0	(11,627)	(24,086)	(37,893)
Industrial	Steam-Electric Demand	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Industrial	Steam-Electric Existing Supply							
Industrial	Groundwater	0	0	0	0	0	0	0
Industrial	Surface water	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Industrial	Total Steam-Electric Supply	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Industrial	Steam-Electric Balance	0	0	0	0	0	0	0
Industrial	Mining Demand	1,275	1,472	1,555	1,599	1,641	1,682	1,724
Industrial	Mining Existing Supply							
Industrial	Groundwater[1]	74	85	90	93	95	98	100
Industrial	Surface water	1,201	1,387	1,465	936	12	12	12
Industrial	Total Mining Supply	1,275	1,472	1,555	1,029	107	110	112
Industrial	Mining Balance	0	0	0	(570)	(1,534)	(1,572)	(1,612)
Agriculture	Irrigation Demand	1,680	1,449	1,250	1,077	928	801	692
Agriculture	Irrigation Existing Supply							
Agriculture	Groundwater	0	0	0	0	0	0	0
Agriculture	Surface water[2]	4,021	4,021	4,021	4,021	4,021	4,021	4,021
Agriculture	Total Irrigation Supply	4,021	4,021	4,021	4,021	4,021	4,021	4,021
Agriculture	Irrigation Balance	2,341	2,572	2,771	2,944	3,093	3,220	3,329
Agriculture	Livestock Demand	279	279	279	279	279	279	279
Agriculture	Livestock Existing Supply							
Agriculture	Groundwater	80	80	80	80	80	80	80
Agriculture	Surface water	199	199	199	199	199	199	199
Agriculture	Total Livestock Supply	279	279	279	279	279	279	279
Agriculture	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	112,539	125,907	144,834	157,454	169,812	181,994	195,719
Total	Existing Municipal and Industrial Supply							
Total	Groundwater	1,371	1,498	1,554	1,577	1,631	1,684	1,780
Total	Surface water	156,941	156,109	155,536	155,098	154,835	154,464	154,227
Total	Total Municipal and Industrial Supply	158,312	157,607	157,090	156,675	156,466	156,148	156,007
Total	Municipal and Industrial Balance	45,773	31,700	12,256	(779)	(13,346)	(25,846)	(39,712)
Total	Agriculture Demand	1,959	1,728	1,529	1,356	1,207	1,080	971
Total	Existing Agricultural Supply							
Total	Groundwater	80	80	80	80	80	80	80
Total	Surface water	4,220	4,220	4,220	4,220	4,220	4,220	4,220
Total	Total Agriculture Supply	4,300	4,300	4,300	4,300	4,300	4,300	4,300
Total	Agriculture Balance	2,341	2,572	2,771	2,944	3,093	3,220	3,329
Total	Total Demand	114,498	127,635	146,363	158,810	171,019	183,074	196,690
Total	Total Supply							
Total	Groundwater	1,451	1,578	1,634	1,657	1,711	1,764	1,860
Total	Surface water	161,161	160,329	159,756	159,318	159,055	158,684	158,447
Total	Total Supply	162,612	161,907	161,390	160,975	160,766	160,448	160,307
Total	Total Balance	48,114	34,272	15,027	2,165	(10,253)	(22,626)	(36,383)

[1] Includes 12 acft surface water supply fro Nueces Basin run-of-river rights for mining use in Nueces County.
[2] Includes 569 acft surface water supply from run-of-river water rights in the Nueces-Rio Grande Coastal Basin.

Table 4A-20.
Nueces County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Agua Dulce							
Demand	115	112	110	107	105	103	103
Supply	115	112	110	107	105	103	103
Groundwater	—	—	—	—	—	—	—
Surface Water	115	112	110	107	105	103	103
Balance	—	—	—	—	—	—	—
Aransas Pass							
Demand	12	26	41	53	64	73	81
Supply	12	26	41	53	64	73	81
Groundwater	—	—	—	—	—	—	—
Surface Water	12	26	41	53	64	73	81
Balance	—	—	—	—	—	—	—
Bishop							
Demand	459	444	433	422	411	404	404
Supply	551	444	433	422	411	404	404
Groundwater	131	127	124	121	117	115	115
Surface Water	420	317	309	301	294	289	289
Balance	92	—	—	—	—	—	—
Corpus Christi							
Demand	55,629	61,953	68,212	73,592	78,422	82,961	86,962
Supply	102,000	94,052	80,723	73,592	78,422	82,961	86,962
Groundwater	—	—	—	—	—	—	—
Surface Water	102,000	94,052	80,723	73,592	78,422	82,961	86,962
Balance	46,371	32,099	12,511	—	—	—	—
Driscoll							
Demand	97	122	148	171	191	208	224
Supply	97	122	148	171	191	208	224
Groundwater	—	—	—	—	—	—	—
Surface Water	97	122	148	171	191	208	224
Balance	—	—	—	—	—	—	—
Nueces County WCID #4							
Demand	977	1,913	2,884	3,729	4,460	5,124	5,655
Supply	977	1,913	2,884	3,729	4,460	5,124	5,655
Groundwater	—	—	—	—	—	—	—
Surface Water	977	1,913	2,884	3,729	4,460	5,124	5,655
Balance	—	—	—	—	—	—	—

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Table 4A-20 concluded

City/County	2000	2010	2020	2030	2040	2050	2060
Port Aransas							
Demand	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Supply	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Groundwater	—	—	—	—	—	—	—
Surface Water	1,601	2,606	3,655	4,558	5,355	6,068	6,637
Balance	—	—	—	—	—	—	—
River Acres WSC							
Demand	314	429	546	646	736	813	881
Supply	291	291	291	291	291	291	291
Groundwater	—	—	—	—	—	—	—
Surface Water	291	291	291	291	291	291	291
Balance	(23)	(138)	(255)	(355)	(445)	(522)	(590)
Robstown							
Demand	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Supply	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Groundwater	—	—	—	—	—	—	—
Surface Water	2,153	2,110	2,067	2,024	1,982	1,953	1,953
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,345	894	595	395	262	175	118
Supply	678	633	595	541	522	509	501
Groundwater	194	149	111	57	38	25	17
Surface Water	484	484	484	484	484	484	484
Balance	(667)	(261)	—	146	260	334	383
Total for Nueces County							
Demand	62,702	70,609	78,691	85,697	91,988	97,882	103,018
Supply	108,475	102,309	90,947	85,488	91,803	97,694	102,811
Groundwater	325	276	235	178	155	140	132
Surface Water	108,150	102,033	90,712	85,310	91,648	97,554	102,679
Balance	45,773	31,700	12,256	(209)	(185)	(188)	(207)

4A.3.11 Comparison of Demand to Supply – San Patricio County

A summary of population, water demands, water supply, and shortages are shown by decade for the 2000 through 2060 period in Table 4A-21 for all categories of water use. Table 4A-22 includes a summary of municipal demands.

Demands

- For the period 2000 to 2060, municipal demand increases from 8,873 acft in 2000 to 16,191 acft in 2060.
- Manufacturing demand increases from 12,715 acft in 2000 to 22,283 acft in 2060.
- Mining increases from 85 acft in 2000 to 117 acft in 2060.
- For the period 2000 to 2060, irrigation demand decreases from 4,565 acft to 2,803 acft; livestock demand is constant at 564 acft.

Supplies

- Surface water is supplied from the CCR/LCC/Lake Texana System by the City of Corpus Christi; the SPMWD has a contract to purchase 40,000 acft of water from the City of Corpus Christi; some livestock demands are met with on-farm/local sources.
- Groundwater supplies are from the Gulf Coast Aquifer

Comparison of Demand to Supply

- Lake City is projected to have shortages from 2020 through 2060. Groundwater supply to Lake City is limited by well capacity, which results in groundwater supplies to the county being 37 acft less than projected groundwater use for San Patricio County in 2060 (Section 3.4).
- There are sufficient mining and agricultural supplies through the year 2060.
- Manufacturing has projected shortages from 1,198 acft/yr in 2050 to 4,300 acft in 2060.

Table 4A-21.
San Patricio County
Population, Water Supply, and Water Demand Projections

		Year						
Population Projection		***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
		67,138	80,701	95,381	109,518	122,547	134,806	146,131
Supply and Demand by Type of Use		***Year***						
		2000 (acft)	***2010 (acft)***	***2020 (acft)***	***2030 (acft)***	***2040 (acft)***	***2050 (acft)***	***2060 (acft)***
Municipal	Municipal Demand (See Table 4A-22)	8,873	10,070	11,423	12,661	13,813	14,997	16,191
	Municipal Existing Supply							
	Groundwater	1,967	2,044	2,124	2,190	2,242	2,320	2,411
	Surface water	6,906	8,026	9,299	10,460	11,554	12,649	13,745
	Total Existing Municipal Supply	8,873	10,070	11,423	12,650	13,796	14,969	16,156
	Municipal Balance	0	0	(1)	(11)	(19)	(28)	(37)
Industrial	Manufacturing Demand	12,715	15,096	16,699	18,111	19,505	20,733	22,283
	Manufacturing Existing Supply							
	Groundwater	9	11	12	13	14	15	16
	Surface water	12,706	15,085	16,687	18,098	19,491	19,521	17,968
	Total Manufacturing Supply	12,715	15,096	16,699	18,111	19,505	19,536	17,984
	Manufacturing Balance	0	0	0	0	0	(1,197)	(4,299)
	Steam-Electric Demand	0	0	0	0	0	0	0
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	0	0	0	0	0	0	0
	Total Steam-Electric Supply	0	0	0	0	0	0	0
	Steam-Electric Balance	0	0	0	0	0	0	0
	Mining Demand	85	99	105	108	111	114	117
	Mining Existing Supply							
	Groundwater	85	99	105	108	111	114	117
	Surface water	0	0	0	0	0	0	0
	Total Mining Supply	85	99	105	108	111	114	117
	Mining Balance	0	0	0	0	0	0	0
Agriculture	Irrigation Demand	4,565	4,160	4,033	3,680	3,362	3,069	2,803
	Irrigation Existing Supply							
	Groundwater	4,565	4,160	4,033	3,680	3,362	3,069	2,803
	Surface water[1]	83	83	83	83	83	83	83
	Total Irrigation Supply	4,648	4,243	4,116	3,763	3,445	3,152	2,886
	Irrigation Balance	83	83	83	83	83	83	83
	Livestock Demand	564	564	564	564	564	564	564
	Livestock Existing Supply							
	Groundwater	57	57	57	57	57	57	57
	Surface water	507	507	507	507	507	507	507
	Total Livestock Supply	564	564	564	564	564	564	564
	Livestock Balance	0	0	0	0	0	0	0
Total	Municipal and Industrial Demand	21,673	25,265	28,227	30,880	33,429	35,844	38,591
	Existing Municipal and Industrial Supply							
	Groundwater	2,061	2,154	2,241	2,311	2,367	2,449	2,544
	Surface water	19,612	23,111	25,986	28,558	31,045	32,170	31,713
	Total Municipal and Industrial Supply	21,673	25,265	28,227	30,869	33,412	34,619	34,257
	Municipal and Industrial Balance	0	0	0	(11)	(17)	(1,226)	(4,335)
	Agriculture Demand	5,129	4,724	4,597	4,244	3,926	3,633	3,367
	Existing Agricultural Supply							
	Groundwater	4,622	4,217	4,090	3,737	3,419	3,126	2,860
	Surface water	590	590	590	590	590	590	590
	Total Agriculture Supply	5,212	4,807	4,680	4,327	4,009	3,716	3,450
	Agriculture Balance	83	83	83	83	83	83	83
	Total Demand	26,802	29,989	32,824	35,124	37,355	39,477	41,958
	Total Supply							
	Groundwater	6,683	6,371	6,331	6,048	5,786	5,575	5,404
	Surface water	20,202	23,701	26,576	29,148	31,635	32,760	32,303
	Total Supply	26,885	30,072	32,907	35,196	37,421	38,335	37,707
	Total Balance	83	83	83	72	66	(1,143)	(4,252)

[1] Surface water supplies from run-of-river water rights in the San Antonio-Nueces Coastal Basin.

Table 4A-22.
San Patricio County
Municipal Water Demand and Supply by City/County
(acft)

City/County	2000	2010	2020	2030	2040	2050	2060
Aransas Pass							
Demand	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Supply	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Groundwater	—	—	—	—	—	—	—
Surface Water	1,210	1,405	1,615	1,828	2,016	2,201	2,386
Balance	—	—	—	—	—	—	—
Gregory							
Demand	249	239	231	223	216	210	210
Supply	249	239	231	223	216	210	210
Groundwater	—	—	—	—	—	—	—
Surface Water	249	239	231	223	216	210	210
Balance	—	—	—	—	—	—	—
Ingleside							
Demand	873	1,294	1,771	2,202	2,607	3,016	3,395
Supply	873	1,294	1,771	2,202	2,607	3,016	3,395
Groundwater	—	—	—	—	—	—	—
Surface Water	873	1,294	1,771	2,202	2,607	3,016	3,395
Balance	—	—	—	—	—	—	—
Ingleside on the Bay							
Demand	74	92	112	130	148	164	181
Supply	74	92	112	130	148	164	181
Groundwater	—	—	—	—	—	—	—
Surface Water	74	92	112	130	148	164	181
Balance	—	—	—	—	—	—	—
Lake City							
Demand	70	79	89	99	107	116	125
Supply	70	79	88	88	88	88	88
Groundwater	70	79	88	88	88	88	88
Surface Water	—	—	—	—	—	—	—
Balance	—	—	(1)	(11)	(19)	(28)	(37)
Mathis							
Demand	671	648	632	615	598	586	586
Supply	800	648	632	615	598	586	586
Groundwater	—	—	—	—	—	—	—
Surface Water	671	648	632	615	598	586	586
Balance	—	—	—	—	—	—	—

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Table 4A-22 concluded

City/County	2000	2010	2020	2030	2040	2050	2060
Odem							
Demand	319	330	347	361	372	389	408
Supply	319	330	347	361	372	389	408
Groundwater	—	—	—	—	—	—	—
Surface Water	319	330	347	361	372	389	408
Balance	—	—	—	—	—	—	—
Portland							
Demand	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Supply	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Groundwater	—	—	—	—	—	—	—
Surface Water	1,976	2,399	2,869	3,290	3,716	4,106	4,498
Balance	—	—	—	—	—	—	—
Sinton							
Demand	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Supply	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Groundwater	1,036	1,052	1,062	1,076	1,086	1,108	1,135
Surface Water	—	—	—	—	—	—	—
Balance	—	—	—	—	—	—	—
Taft							
Demand	559	586	619	648	672	703	736
Supply	559	586	619	648	672	703	736
Groundwater	—	—	—	—	—	—	—
Surface Water	559	586	619	648	672	703	736
Balance	—	—	—	—	—	—	—
County-Other							
Demand	1,836	1,946	2,077	2,189	2,277	2,398	2,533
Supply	1,836	1,946	2,077	2,189	2,277	2,398	2,533
Groundwater	861	913	974	1,026	1,068	1,124	1,188
Surface Water	975	1,033	1,103	1,163	1,209	1,274	1,345
Balance	—	—	—	—	—	—	—
Total for San Patricio County							
Demand	8,873	10,070	11,423	12,661	13,815	14,997	16,193
Supply	8,873	10,070	11,423	12,650	13,796	14,969	16,156
Groundwater	1,967	2,044	2,124	2,190	2,242	2,320	2,411
Surface Water	6,906	8,026	9,299	10,460	11,554	12,649	13,745
Balance	—	—	(1)	(11)	(19)	(28)	(37)

4A.4 Wholesale Water Providers — Comparison of Demand and Supply

The Coastal Bend Region has four wholesale water providers. These include the City of Corpus Christi, San Patricio Municipal Water District (SPMWD), South Texas Water Authority (STWA), and Nueces WCID #3.

The City of Corpus Christi provides water to SPMWD and STWA, who then supply water to their customers, as shown in Figure 4A-1. SPMWD receives up to 40,000 acft/yr of raw and treated water from the City of Corpus Christi according to their contract. The most typical contract between the City of Corpus Christi and its customers includes providing water at the greater amount supplied in previous years plus 10 percent. When projecting customer supplies (2010 to 2060), it was assumed that either: (1) supply increased each year by 10 percent, or (2) supply was equal to demand, whichever is less.

4A.5 Safe Yield Supply to Demands

The Coastal Bend Region adopted use of safe yield supply for the three largest wholesale water providers: City of Corpus Christi, SPMWD, and STWA and their customers. The safe yield supplies assume a reserve of 75,000 acft (i.e., 7 percent CCR/LCC/Lake Texana System storage) as a drought management strategy to plan for future droughts greater than the drought of record. Table 4A-23 shows the safe yield water supply for each Wholesale Water Provider, the amount of water supplied to each customer, and resulting water surplus or shortage after meeting customer needs. After meeting customer needs, the City of Corpus Christi has a surplus of 12,511 acft/yr in 2020. The City of Corpus Christi water supply for 2010 is 204,000 acft, which includes supplies from the CCR/LCC/Lake Texana System and a base amount of 41,840 acft/yr and up to 12,000 acft/yr on an interruptible basis from Lake Texana. This System supply diminishes to 200,000 acft by 2060 because of reservoir sedimentation.

The City of Corpus Christi, after meeting demands and/or contracts with its customers, has shortages from 2030 to 2060. The shortages are applied to Nueces County-Mining beginning in 2030 and Nueces County-Manufacturing beginning in 2040, as shown in Table 4A-19. SPMWD, authorized to receive 40,000 acft/yr of water from City of Corpus Christi, meets the demands of its customers and has a surplus through 2040. After 2040, SPMWD will need to obtain additional water supplies of 2,726 acft in 2050 increasing to 5,744 acft by 2060 to meet demands for Aransas County-Other and San Patricio County Manufacturing. STWA receives

Table 4A-23.
Surface Water Allocation/Wholesale

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Corpus Christi							
Safe Yield Supply (CCR/LCC Texana System)	**206,000**	**205,000**	**204,000**	**203,000**	**202,000**	**201,000**	**200,000**
City of Corpus Christi	55,629	61,953	68,212	73,592	78,422	82,961	86,962
Contract Sales							
Municipal							
Jim Wells County							
City of Alice	5,281	5,606	5,912	6,076	6,102	6,033	5,904
Bee County							
City of Beeville	2,529	2,619	2,691	2,722	2,699	2,683	2,618
San Patricio County							
City of Mathis	671	648	632	615	598	586	586
San Patricio MWD	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Live Oak County							
City of Three Rivers	3,363	3,363	3,363	3,363	3,363	3,363	3,363
Nueces County							
Nueces County WCID #4	977	1,913	2,884	3,729	4,460	5,124	5,655
County-Other[1,2]	116	116	116	116	116	116	116
Kleberg County							
South Texas Water Authority	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Non-Municipal							
Manufacturing (Nueces County)	38,791	45,373	49,047	52,119	55,119	57,704	61,765
Mining (Nueces County)[3]	1,189	1,375	1,453	1,494	1,534	1,572	1,612
Steam-Electric (Nueces County)[2]	8,799	7,316	14,312	16,733	19,683	23,280	27,664
Total Contract Sales	**159,629**	**172,901**	**191,489**	**203,570**	**215,161**	**226,658**	**239,505**
Surplus/Shortage (Nueces County – Mining and Manufacturing)	**46,371**	**32,099**	**12,511**	**(570)**	**(13,161)**	**(26,658)**	**(39,505)**

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Table 4A-23 continued

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
San Patricio Municipal Water District							
Total Surface Water Right	0	0	0	0	0	0	0
Contract Purchases from City of Corpus Christi	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**	**40,000**
Contract Sales							
Municipal							
Nueces County							
City of Aransas Pass	12	26	41	53	64	73	81
Port Aransas	1,601	2,606	3,655	4,558	5,355	6,068	6,637
San Patricio County							
City of Aransas Pass	1,210	1,405	1,615	1,828	2,016	2,201	2,386
City of Gregory	249	239	231	223	216	210	210
City of Ingleside	873	1,294	1,771	2,202	2,607	3,016	3,395
City of Ingleside on the Bay	74	92	112	130	148	164	181
City of Portland	1,976	2,399	2,869	3,290	3,716	4,106	4,498
City of Odem	319	330	347	361	372	389	408
City of Taft	559	586	619	648	672	703	736
County-Other[2,4]	975	1,033	1,103	1,163	1,209	1,274	1,345
Aransas County							
City of Aransas Pass	146	168	186	195	190	179	169
City of Fulton	261	307	346	365	359	336	318
City of Rockport	1,357	1,590	1,778	1,868	1,823	1,712	1,620
County-Other[2]	1,338	1,524	1,686	1,740	1,687	1,575	1,491
Non-Municipal							
Manufacturing (San Patricio County)	12,706	15,085	16,687	18,098	19,491	20,718	22,267
Total Contract Sales	**23,656**	**28,684**	**33,046**	**36,722**	**39,925**	**42,724**	**45,742**
Surplus/Shortage (Aransas County-Other and San Patricio County-Manufacturing)	**16,344**	**11,316**	**6,954**	**3,278**	**75**	**(2,724)**	**(5,742)**

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Table 4A-23 concluded

Wholesale Water Provider (Water User/County)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
South Texas Water Authority							
Total Surface Water Right	0	0	0	0	0	0	0
Contract Purchases	2,284	2,619	2,867	3,011	3,065	3,236	3,260
Contract Sales							
Municipal							
Nueces County							
City of Agua Dulce	115	112	110	107	105	103	103
City of Driscoll	97	122	148	171	191	208	224
City of Bishop	420	317	309	301	294	289	289
County-Other[2,5]	213	213	213	213	213	213	213
Kleberg County							
City of Kingsville	1,221	1,352	1,382	1,385	1,350	1,397	1,400
Ricardo WSC	218	503	705	834	912	1,026	1,031
Total Contract Sales	**2,284**	**2,619**	**2,867**	**3,011**	**3,065**	**3,236**	**3,260**
Surplus/Shortage	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Nueces County WCID #3							
Total Surface Water Right (firm yield)	3,665	3,665	3,665	3,665	3,665	3,665	3,665
Contract Sales							
Municipal							
Nueces County							
County-Other[2,6]	155	155	155	155	155	155	155
City of Robstown	2,153	2,110	2,067	2,024	1,982	1,953	1,953
River Acres WSC[7]	291	291	291	291	291	291	291
Total Contract Sales	**2,599**	**2,556**	**2,513**	**2,470**	**2,428**	**2,399**	**2,399**
Surplus/Shortage	**1,066**	**1,109**	**1,152**	**1,195**	**1,237**	**1,266**	**1,266**

[1] Includes Violet WSC.
[2] Wholesale water provider does not meet full demand (i.e. additional supply from groundwater)
[3] Assumed to include Koch industries, based on majority of mining demand occurring in San Antonio-Nueces River Basin.
[4] Includes Taft Southwest, Rincon WSC, and Seaboard WSC.
[5] Includes Coastal Bend Youth City, Nueces County WCID #5, Nueces WSC, and other rural water users.
[6] Includes City of San Pedro.
[7] Limited by contract. May opt to increase contract amount to cover needs.

water supplies to meet the demands of its customers, consistent with the terms of the present contracts, and have no projected shortages. Nueces WCID #3 receives dependable supply through run-of-river water rights and is able to meet contracts with its customers and have a surplus through 2060.

4A.6 Region Summary

When comparing total available supplies to total demands, the region shows a current surplus until after 2020. By the year 2030, a shortage of 358 acft exists and increases to a shortage of 46,084 acft by 2060 (Table 4A-24).

4A.6.1 Municipal and Industrial Summary

On a regional basis, Municipal and Industrial entities (Manufacturing, Steam-Electric, and Mining) show a surplus of 32,727 acft in 2010, although shortages of 409 acft are anticipated for remotely located Manufacturing entities and 1,801 acft for remotely located Mining entities. Due to increasing manufacturing demands, there are shortages of 2,414 acft by 2030 increasing to 49,129 acft by 2060. Shortages in supplies provided by the City of Corpus Christi via the CCR/LCC/Lake Texana System were accumulated in industrial (mining and/or manufacturing) demands in San Patricio and Nueces Counties, and Aransas County-Other.

Municipal demands account for approximately 49 percent of total demands in the region. Surface water accounts for approximately 88 percent of 2060 municipal supplies, with groundwater accounting for 12 percent. Although there is a region-wide municipal surplus, several cities and County-Others are experiencing near- and/or long-term shortages. These shortages are summarized in Table 4A-25.

Manufacturing demands account for 29 percent of total demands in 2060. The majority of these demands, 97 percent, are in Nueces and San Patricio Counties. Aransas, Bee, and Live Oak Counties make up the remaining 3 percent. Surface water supplies provide 95 percent of total manufacturing supplies in 2060; groundwater 5 percent. Region-wide there is a manufacturing supply deficit of 409 acft in 2010 increasing to 43,093 acft by 2060.

Table 4A-24.
Coastal Bend Region Summary
Population, Water Supply, and Water Demand Projections

Population Projection	2000	2010	2020	2030	2040	2050	2060
	541,184	617,143	693,940	758,427	810,650	853,954	885,665

	Supply and Demand by Type of Use	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal	Municipal Demand	99,950	111,495	122,861	132,063	139,425	146,036	151,474
	Municipal Existing Supply							
	Groundwater	17,684	18,641	19,387	19,758	19,838	19,701	19,414
	Surface water	131,470	127,791	118,760	115,018	122,387	127,681	133,596
	Total Existing Municipal Supply	149,154	146,432	138,147	134,776	142,225	147,382	153,010
	Municipal Surplus (Shortage)	49,204	34,937	15,286	2,713	2,800	1,346	1,536
Industrial	Manufacturing Demand	54,481	63,820	69,255	73,861	78,371	82,283	88,122
	Manufacturing Existing Supply							
	Groundwater	1,931	2,153	2,152	2,188	2,239	2,288	2,390
	Surface water	52,297	61,258	66,534	71,017	63,783	53,939	42,640
	Total Manufacturing Supply	54,228	63,411	68,686	73,205	66,022	56,227	45,030
	Manufacturing Surplus (Shortage)	(253)	(409)	(569)	(656)	(12,349)	(26,057)	(43,092)
	Steam-Electric Demand	8,799	7,316	14,312	16,733	19,683	23,280	27,664
	Steam-Electric Existing Supply							
	Groundwater	0	0	0	0	0	0	0
	Surface water	8,799	7,316	14,312	16,733	19,683	23,280	27,664
	Total Steam-Electric Supply	8,799	7,316	14,312	16,733	19,683	23,280	27,664
	Steam-Electric Surplus (Shortage)	0	0	0	0	0	0	0
	Mining Demand	11,897	15,150	16,524	16,640	17,490	18,347	19,114
	Mining Existing Supply							
	Groundwater	10,696	11,962	12,063	11,233	11,324	11,450	11,530
	Surface water	1,201	1,387	1,465	936	12	12	12
	Total Mining Supply	11,897	13,349	13,528	12,169	11,336	11,462	11,542
	Mining Surplus (Shortage)	0	(1,801)	(2,996)	(4,471)	(6,154)	(6,885)	(7,572)
Agriculture	Irrigation Demand	21,971	20,072	18,611	17,077	15,703	14,470	13,365
	Irrigation Existing Supply							
	Groundwater	19,359	17,754	16,550	15,244	14,069	13,011	12,058
	Surface water	4,352	4,352	4,352	4,352	4,352	4,352	4,352
	Total Irrigation Supply	23,711	22,106	20,902	19,596	18,421	17,363	16,410
	Irrigation Surplus (Shortage)	1,740	2,034	2,291	2,519	2,718	2,893	3,045
	Livestock Demand	8,838	8,838	8,838	8,838	8,838	8,838	8,838
	Livestock Existing Supply							
	Groundwater	1,258	1,258	1,258	1,258	1,258	1,258	1,258
	Surface water	7,580	7,580	7,580	7,580	7,580	7,580	7,580
	Total Livestock Supply	8,838	8,838	8,838	8,838	8,838	8,838	8,838
	Livestock Surplus (Shortage)	0	0	0	0	0	0	0
Total	Municipal & Industrial Demand	175,127	197,781	222,952	239,297	254,969	269,946	286,374
	Existing Municipal & Industrial Supply							
	Groundwater	30,311	32,756	33,602	33,179	33,401	33,439	33,334
	Surface water	193,767	197,752	201,071	203,704	205,865	204,911	203,911
	Total Municipal & Industrial Supply	224,078	230,508	234,673	236,883	239,266	238,350	237,245
	Municipal & Industrial Surplus (Shortage)	48,951	32,727	11,721	(2,414)	(15,703)	(31,596)	(49,129)
	Agriculture Demand	30,809	28,910	27,449	25,915	24,541	23,308	22,203
	Existing Agricultural Supply							
	Groundwater	20,617	19,012	17,808	16,502	15,327	14,269	13,316
	Surface water	11,932	11,932	11,932	11,932	11,932	11,932	11,932
	Total Agriculture Supply	32,549	30,944	29,740	28,434	27,259	26,201	25,248
	Agriculture Surplus (Shortage)	1,740	2,034	2,291	2,519	2,718	2,893	3,045
	Total Demand	205,936	226,691	250,401	265,212	279,510	293,254	308,577
	Total Supply							
	Groundwater	50,928	51,768	51,410	49,681	48,728	47,708	46,650
	Surface water	205,699	209,685	213,003	215,636	217,797	216,843	215,843
	Total Supply	256,627	261,453	264,413	265,317	266,525	264,551	262,493
	Total Surplus (Shortage)	50,691	34,762	14,012	105	(12,985)	(28,703)	(46,084)

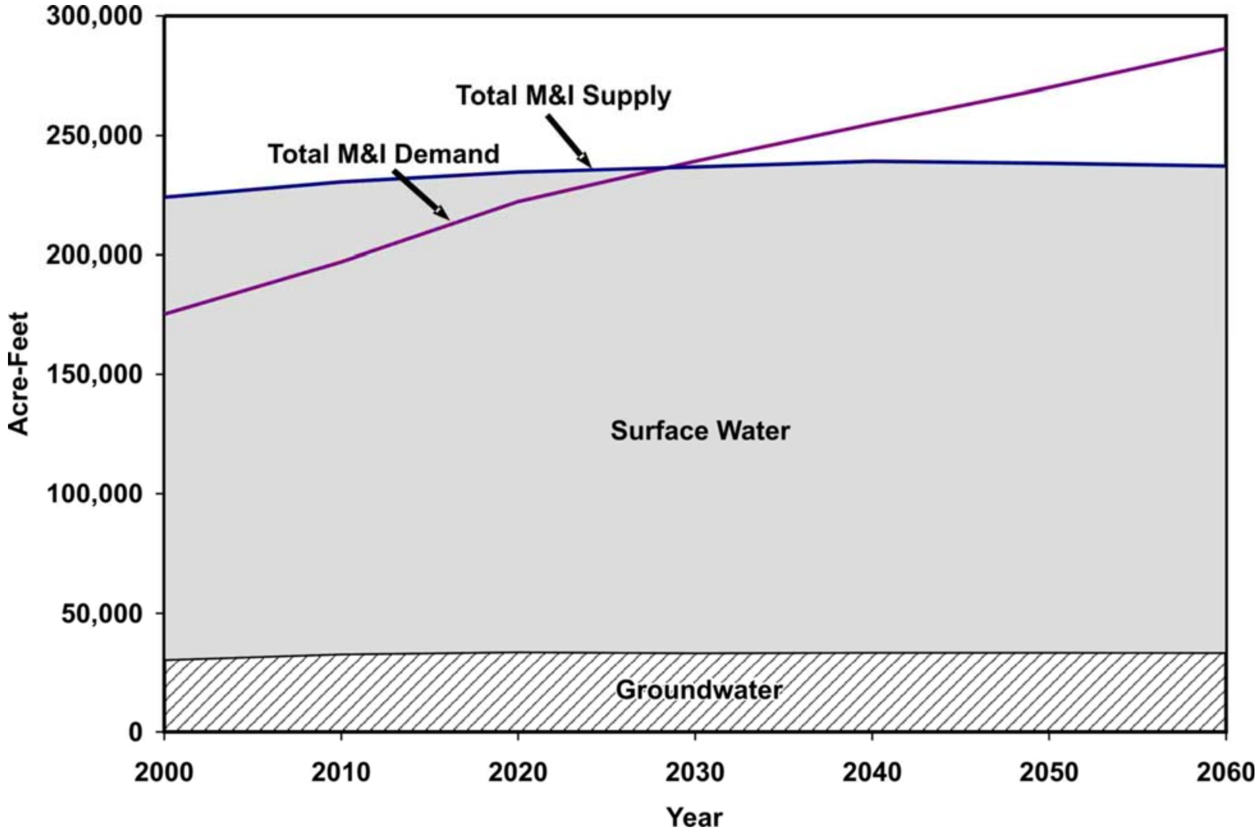


Figure 4A-3. Municipal and Industrial Supply and Demand

Table 4A-25.
Cities/County-Other with Projected Water Shortages

County/City	***Projected Shortages (acft)***		
	2000	***2030***	***2060***
Aransas County			
County-Other	—	—	(1,443)
Jim Wells County			
County-Other	(78)	(262)	(170)
Kleberg County			
County-Other	—	(81)	(155)
Live Oak County			
County-Other	—	(44)	—
Nueces County			
River Acres WSC	(23)	(355)	(590)
County-Other	(667)	—	—
San Patricio County			
Lake City	—	(11)	(37)

Nueces County shows manufacturing shortages beginning between 2030 and 2040; and San Patricio shows manufacturing shortages beginning between 2040 and 2050. In 2060, Nueces and San Patricio Counties have shortages of 37,893 acft and 4,299 acft, respectively (Table 4A-26). Aransas and Live Oak Counties show both near- and long-term manufacturing shortages from 2000 through 2060. Aransas County shows modest manufacturing shortages of 40 acft in 2000 increasing to 136 acft by 2060. Live Oak County-Manufacturing has shortages of 213 acft in 2000 and 764 acft by 2060.

Table 4A-26.
Manufacturing with Projected Water Shortages

County/City	***Projected Shortages (acft)***		
	2000	***2030***	***2060***
Aransas County	(40)	(97)	(136)
Live Oak County	(213)	(559)	(764)
Nueces County	—	—	(37,893)
San Patricio County	—	—	(4,299)

As for the remaining industrial demands, there are sufficient surface water supplies to meet the 2060 steam-electric demand of 27,664 acft, all of which is in Nueces County. The regional mining demand, 19,114 acft, accounts for only 6 percent of total demand in 2060. Region-wide there is insufficient groundwater to meet mining demands, with shortages increasing each decade from 1,801 in 2010 to 7,572 in 2060. Duval and Live Oak Counties show immediate and long-term shortages from 2010 to 2060; and Nueces County shows shortages beginning between 2020 and 2030 and increasing in 2060. Mining shortages are summarized in Table 4A-27.

Table 4A-27.
Mining with Projected Water Shortages

County/City	***Projected Shortages (acft)***		
	2000	***2030***	***2060***
Duval County	—	(2,973)	(4,205)
Live Oak County	—	(928)	(1,755)
Nueces County	—	(570)	(1,612)

4A.6.2 Agriculture Summary

Due to decreasing groundwater pumpage for irrigation and underutilized irrigation water rights in Nueces County, agriculture is showing a current and long-term surplus of 1,235 acft in 2010 to 3,004 acft in 2060. Irrigation demand decreases over the 55-year planning period and in 2060 represents 4 percent of total demand. Surface water supplies are 27 percent of total irrigation supplies with groundwater accounting for 73 percent of the total. Live Oak County uses both groundwater and surface water to meet its needs and projections show current and long-term shortages, as presented in Table 4A-28.

Table 4A-28.
Irrigation with Projected Water Shortages

County/City	Projected Shortages (acft)		
	2000	2030	2060
Live Oak County	(690)	(514)	(373)

Livestock demand remains constant at 8,838 acft over the 55-year planning period and in 2060 represents 3 percent of total demand. For each county, groundwater was allocated based on 1997 use. Surface water supplies were assumed to consist of local, on-farm sources and used to meet demands.

4A.6.3 Summary

Overall, the Coastal Bend Region has sufficient supplies to meet the demands of the six water user groups through 2020. However, as discussed in the previous section, various water user groups are showing shortages throughout the 55-year planning period. Water groups with shortages in 2030 and 2060 are presented in Figure 4A-4.

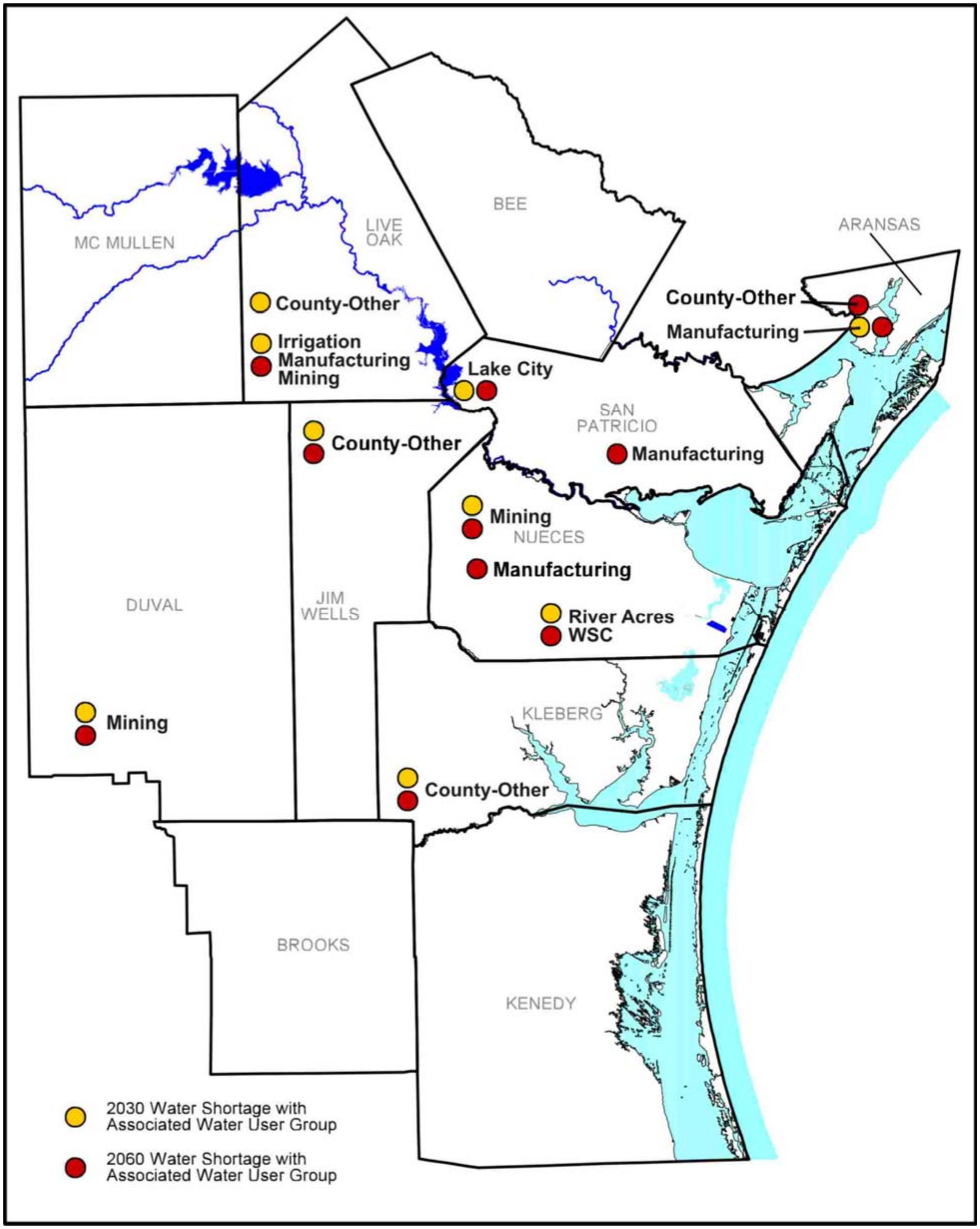


Figure 4A-4. Location and Type of Use for 2030 and 2060 Water Supply Shortages

Section 4B
Water Supply Plans

4B.1 Summary of Water Management Strategies

A total of 18 water management strategies were investigated during the development of the Coastal Bend Regional Water Plan. Many of these strategies include several water supply options within the main strategy. Strategies are summarized in Tables 4B.1-1 and 4B.1-2. The potentially feasible water management strategies selected by the CBRWPG for the 2006 Plan, are based on those identified in the 2001 Plan, in addition to new projects identified by Wholesale Water Providers and other water user groups. Results from studies since the 2001 Plan, such as new volumetric survey of Lake Corpus Christi, assisted in the selection process of potentially feasible water management strategies.

Table 4B.1-1 shows potential strategies for Wholesale Water Providers in Region N with shortages and Table 4B.1-2 shows potential strategies for other service areas. All strategies are compared with respect to four areas of concern: (1) additional water supply; (2) unit cost of treated water; (3) degree of water quality improvement; and (4) environmental issues and special concerns. A graphical comparison of how each significant strategy compares to the others with respect to unit cost and water supply quantity is shown in Figure 4B.1-1. A detailed description of the analysis of each strategy is included in Section 4C in Volume II of this report (refer to Sections 4C.1 through 4C.18). In these detailed descriptions, each strategy was evaluated with respect to ten impact categories, as required by TWDB rules. These categories are shown in Table 4B.1-3.

Recommended plans to meet the specific needs of the cities and other water user groups during the planning period (2000 through 2060) are presented in the following sections. In addition, proposed plans to meet long-term needs (2030 through 2060) are presented for the projected shortages in Nueces and San Patricio Counties. The water management strategies summarized in Tables 4B.1-1 and 4B.1-2 and discussed in detail in Section 4C (Volume II of this report) provided the options for building each plan to meet the specific shortages. The plans are organized by county and water user group in the following sections (Sections 4B.2 – 4B.12).

Table 4B.1-1. Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers

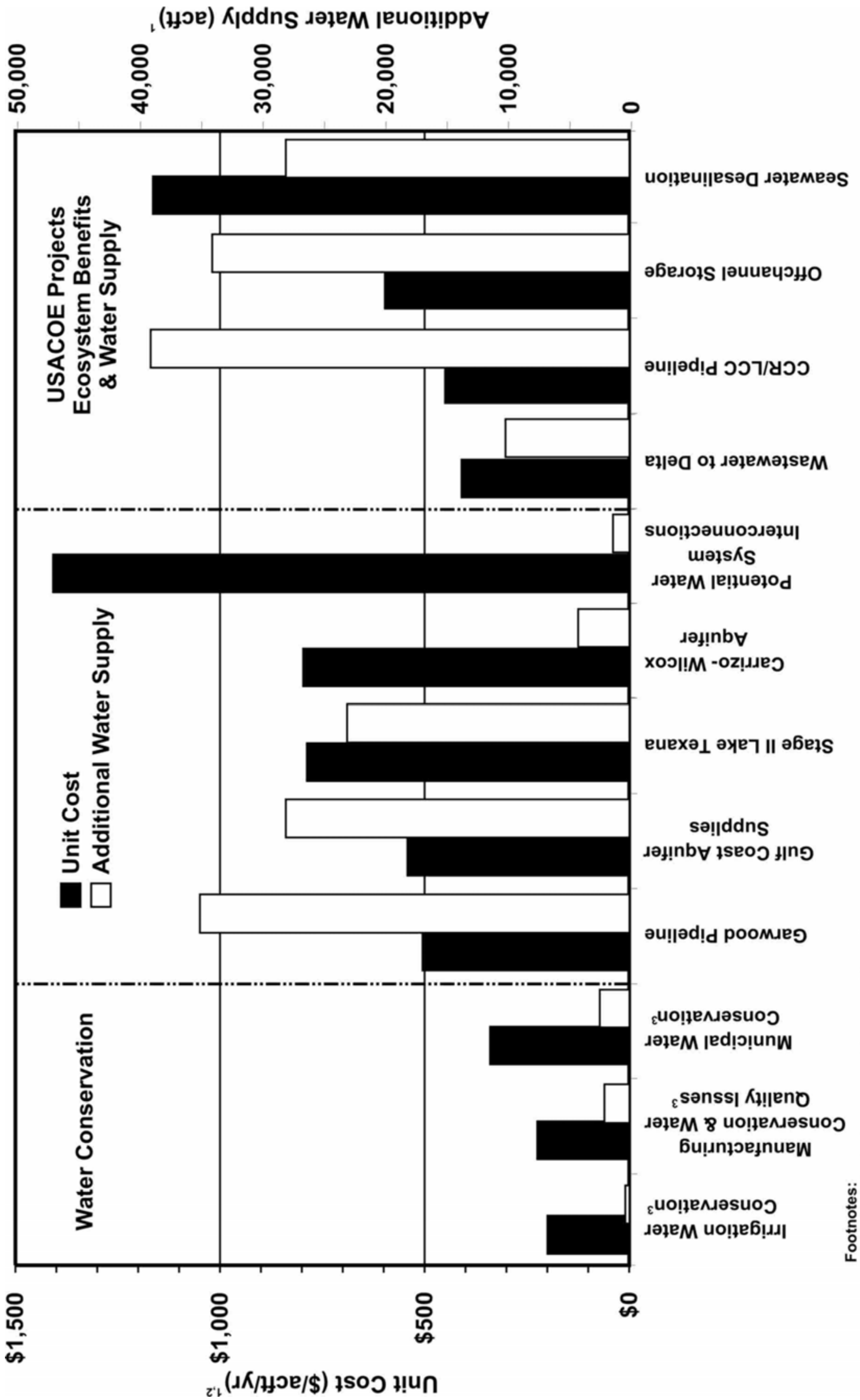
WMS ID	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 1,428	Variable; Regional Cost up to $803,457[1]	Variable	$69-$1,248	No Change	Possible reduction in return flows to bay and estuary.
N-3	**Manufacturing Water Conservation**						
N-3-1	Blending of Texana Water	up to 2,050	Not Applicable	Up to $461,250	$225 [2]	Significant Improvement	None
N-3-2	Outlet works to remove high TDS from Calallen Pool	150-730	$2,240,000	$343,250[2]	$470- $1,418 [2]	Significant Improvement	None
N-3-3	Intake Modifications	150-300	$5,884,000	$575,500[2]	$1,918- $3,612 [2]	Significant Improvement	None
N-3-4	Pipeline from LCC to Calallen	19,600-23,900	$122,100,000	$16,374,500[2]	$709- $795 [2]	Significant Improvement	Potentially significant environmental impacts/Construction and maintenance of pipeline corridors
N-4	**Mining Water Conservation**	up to 259	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	Variable	$1,500,000[4]	$500,000[4]	$725[4]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Groundwater supplies from Refugio, Bee, and/or San Patricio Counties	Variable	$45,642,000	$10,757,000[2]	$598 [2,3]	Some Degradation	Potential for increased freshwater inflows to estuary
N-8	**Multi-Year ASR along STWA Pipeline**	Negligible	Not Applicable[5]	Not Applicable[5]	-	No Change	Minor impacts
	Seasonal ASR in CC Distribution System	None	Variable				
N-10	**Pipeline from CCR to LCC**	39,500	$105,428,000	$17,671,500[2]	$447 [2]	No Change	Reduction in stream flows between CCR and LCC
N-11	**Off-channel Reservoir near Lake Corpus Christi**	34,000	$155,028,000	$20,301,000[2]	$597 [2]	No Change	Direct impact to 4,000 to 6,000 acres, depending on reservoir size
N-12	**Voluntary Redistribution and USACOE Nueces Feasibility Study**	Variable	$178,281,250[6]	Up to $30,549,725[7]	Variable	Variable	Possible cost reduction with federal participation. Ecosystem restoration benefits. Portion of projects may be used for additional inflows to Nueces Bay and Estuary.
N-13	**Stage II of Lake Texana**	23,000	$149,185,000	$18,132,000[2]	$788 [2]	No Change	Direct impact to 4,769 acres
N-14	**Garwood Pipeline**	35,000	$81,117,000	$17,679,000[2]	$505 [2]	No Change	Construction and maintenance of pipeline corridors and off-channel storage
N-17	**Desalination**						
	Desalination of Seawater[8]	28,000	$248,919,000	$37,561,000	$1,341	Significant Improvement	Brine from desalt plant requires disposal. Construction and maintenance of pipeline corridor
	Desalination of Combined Seawater and Brackish Groundwater	15,680	$84,420,000	$10,630,000	$678	Significant Improvement	Construction and maintenance of pipeline corridors. Potential lowering of groundwater levels

1 Assuming unit costs of $323 to $342 per acft.
2 Cost has been adjusted to include treatment. Cost for treatment is estimated at $225 per acft.
3 Cost based on 18,000 acft supply.
4 Unit costs for Allison Demonstration Project based on annual program costs for $500,000 per year and $225/acft for treatment.
5 ASR is not recommended as a viable water management strategy to provide water supply. Costs are not included.
6 Includes off-channel reservoir, CCR/LCC pipeline, and seawater desalination projects with cost reduction of 65 percent due to Federal participation.
7 Cost reduction of 65 percent due to Federal participation. Annual cost is for water supplied at 65 percent of project potential, with $225/acft added for treatment for supplies from Off-Channel Reservoir and CCR/LCC Pipeline.
8 Additional water supply is unlimited. Supply numbers and unit costs are shown for a 25 MGD facility.

Table 4B.1-2.
Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas

WMS	Water Management Strategy	Additional Water Supply (acft/yr)	Total Project Cost	Annual Cost	Unit Cost of Additional Treated Water ($ per acft/yr)	Degree of Water Quality Improvement	Environmental Issues/ Special Concerns
N-1	**Municipal Water Conservation**	up to 2,415	Variable; Regional Cost up to $803,457[1]	Variable	$69-$1,248	No Change	Possible reduction in return flows to bay and estuary.
N-2	**Irrigation Water Conservation**	up to 342	$836,400	$36,593 - $60,764	$69-$173	No Change	None
N-4	**Mining Water Conservation**	up to 2,343	Highly Variable	Highly Variable	Variable	No Change	None
N-5	**Reclaimed Wastewater Supplies**	Variable	$1,500,000[2]	$500,000[2]	$725[2]	No Change	Potential reduction of freshwater inflows to estuary/Construction and maintenance of pipeline corridors
N-7	**Gulf Coast Aquifer Supplies**						
	Drill additional well	Variable	Variable; up to $2,950,000[3]	Variable; up to $236,000[3]	Variable	Some Degradation	Minor impacts
	Brackish groundwater desalination	Variable	Variable; up to $6,471,000[4]	Variable; up to $1,437,000[4]	Variable	Significant Improvement	Brine from desalt plant requires disposal by evaporation, deep well injection, blending, or discharging to saltwater body.
N-12	**Voluntary Redistribution/ Reallocation**	Variable	Variable; as needed	Variable; as needed	$500[5]	Variable	None
N-18	**Potential System Interconnections**						
	Duval County	974-2,520	Up to $22,903,000	Up to $3,302,000	$824-$1,310	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Jim Wells County	246-1,434	Up to $8,233,000	Up to $1,346,000	$939-$1,512	Some Negative Impact	Construction and maintenance of pipeline corridor.
	Brooks County	2554	$12,318,000	$2,489,000	$975	Some Negative Impact	Construction and maintenance of pipeline corridor.
	San Patricio County	125-1,120	$1,915,000 to $2,385,000	$269,000 to $741,000	$662- $2,152	Some Negative Impact	Construction and maintenance of pipeline corridor.

[1]Assumes unit costs of $323 to $342/acft.
[2]Unit costs for Allison Demonstration Project based on annual prog ram costs of $500,000 per year and $225/acft for treatment.
[3]Costs based on drilling 11 wells for Duval County – Mining.
[4]Estimated cost for 3 MGD facility.
[5]Unit cost of $500 per acft assumed to be comparable to cost of Garwood water. Costs should be rev ised in the future, as rate study information becomes available.



Footnotes:
[1]Some strategies have more than one alternative.
[2]Costs include $225 for water treatment, except for municipal and irrigation water conservation.
[3]Costs and water supplies for Municipal, Manufacturing, and Irrigation Water Conservation are variable based on best management practice selected.

Figure 4B.1-1. Comparison of Unit Costs and Water Supply Quantities for Potential Water Management Strategies for Coastal Bend

Table 4B.1-3.
Summary of Impact Categories for Evaluation of Water Management Strategies

a.	Water Supply 1. Quantity 2. Reliability 3. Cost of Treated Water
b.	Environmental factors 1. Instream flows 2. Bay and Estuary Inflows 3. Wildlife Habitat 4. Wetlands 5. Threatened and Endangered Species 6. Cultural Resources 7. Water Quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents
c.	Impacts to State water resources
d.	Threats to agriculture and natural resources in region
e.	Recreational impacts
f.	Equitable comparison of strategies
g.	Interbasin transfers
h.	Third party social and economic impacts from voluntary redistribution of water
i.	Efficient use of existing water supplies and regional opportunities
j.	Effect on navigation

According to the TWDB,[1] regional planning is a reconnaissance-level effort and a detailed investigation of project impacts is beyond the scope and mandate of SB1. The impacts, costs, and benefit of large-scale projects such as reservoirs or major diversions would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Action, and any other applicable federal, state, or local regulations.

Drought Management is not a recommended water management strategy to meet projected water needs in Coastal Bend Region, in part because it cannot be demonstrated to be an

[1] TWDB Memo, "Texas Water Development Board Comments for the Coastal Bend Regional Water Planning Group (Region N) Initially Prepared Plan, Contract No. 2002-483-459," September 28, 2005.

economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Coastal Bend Region shows total losses[2] (Table 4B.1-4) due to unmet water needs (shortages) of $29,471 per acft/yr in 2010 increasing to $289,582 per acft/yr in 2060.

Table 4B.1-4
Projected Water Needs (Shortages) and Business, Personal Income, and Tax Losses from Unmet Water Needs in Coastal Bend Region

Year	*Projected Water Need (Shortage) (acft/yr)*	*Total Losses* ($millions/yr)*	*Cost per acft*
2010	3,404	100	$29,471
2020	4,691	153	$32,635
2030	6,394	224	$34,984
2040	19,794	1,714	$86,590
2050	35,796	5,309	$148,326
2060	53,431	15,473	$289,582

* Sum of business losses, personal income losses, and taxes lost (TWDB Table E-1)

Source: TWDB, "Socioeconomic Impacts of Unmet Water Needs in the Coastal Bend Water Planning Area", May 2005

Clearly, the cost for water to meet projected water needs is only a fraction of the total loss associated with business, personal income, and tax revenue losses from not having the quantities of water needed. For example, in 2010 business losses are $21,103 per acft of shortage, income losses are $6,369 per acft, and tax losses are $999 per acft,[3] while short-term costs of water for recommended water management strategies in the 2006 Regional Water Plan range from $69/acft/yr for Municipal Conservation (using more water efficient showerheads and aerators), up to $3,612/acft/yr[4] for modifying industrial intake structures near Calallen Pool.

The Water Conservation water management strategies recommended in the 2006 Regional Water Plan, together with the other water management strategies appear to the CBRWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration. The uncertainty and the cost associated therewith is not acceptable to the CBRWPG, thus Drought Management is not included as a recommended water management strategy. However, the CBRWPG recommends that entities with drought management plans implement their plans during droughts.

[2] Includes business production and sales impacts, personal income losses, and tax losses identified by TWDB.
[3] Calculated based on TWDB Table ES-1 and total projected regional water needs.
[4] Unit cost has been adjusted to include treatment. Cost for treatment is estimated at $225 per acft.

Socioeconomic impacts of unmet needs were evaluated by the TWDB and costs of unmet needs were provided to represent regional impacts of leaving water needs entirely unmet, representing a worst-case scenario. Costs of unmet needs are included in the water supply plan when recommended to meet shortages, such as for Live Oak County Mining and Duval County Mining. The draft TWDB report is presented in Appendix F. A summary of the plans for the Region's four Wholesale Water Providers is presented in Section 4B.13.

Additionally, future projects involving authorization from either the TCEQ and/or TWDB which are not specifically addressed in the plan are considered to be consistent with the plan under the following circumstances:

1. TWDB receives applications for financial assistance for many types of water supply projects, including water conservation, and when appropriate, wastewater reuse strategies. Other projects involve repairing, replacing, or expanding treatment plants, pump stations, pipelines and water storage facilities including ASR. The RWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even though not specifically recommended in the plan.
2. TCEQ considers water rights applications for various types of uses (e.g., recreation, navigation, irrigation, hydroelectric power, industrial, recharge, municipal and others). Many of these applications are for small amounts of water, some are temporary, and some are even non-consumptive. Because waters of the Nueces River Basin are fully appropriated to the City of Corpus Christi and others, any new water rights application for consumptive water use from this Basin will need to protect the existing water rights or provide appropriate mitigation to existing water right owners. Throughout the Coastal Bend Region the types of small projects that may arise are so unpredictable that the RWPG is of the opinion that each project should be considered by the TWDB and TNRCC on their merits, and that the Legislature foresaw this situation and provided appropriate language for each agency to deal with it.

(Note: The provision related to TCEQ is found in Texas Water Code §11.134. It provides that the Commission shall grant an application to appropriate surface water, including amendments, only if the proposed appropriator addresses a water supply need in a manner consistent with an approved regional water plan. TCEQ may waive this requirement if conditions warrant. For TWDB funding, Texas Water Code §16.053(j) states that after January 5, 2002 TWDB may provide financial assistance to a water supply project only after the Board determines that the needs to be addressed by the project will be addressed in a manner that is consistent with that appropriate regional water plan. The TWDB may waive this provision if conditions warrant.)

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4B.2 Aransas County Water Supply Plan

Table 4B.2-1 lists each water user group in Aransas County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.2-1.
Aransas County Surplus/(Shortage)

Water User Group	***Surplus/(Shortage)***[1]		***Comment***
	2030 (acft/yr)	***2060 (acft/yr)***	
City of Aransas Pass	0	0	Supply equals demand
City of Fulton	0	0	Supply equals demand
City of Rockport	0	0	Supply equals demand
County-Other	0	(1,443)	Projected shortages in 2050 and 2060 — see plan below
Manufacturing	(97)	(136)	Projected shortages from 2000 to 2060 — see plan below
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	none	none	No demands projected
Livestock	0	0	Supply equals demand

[1] From Tables 4A-1 and 4A-2, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.2.1 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces, and San Patricio Counties; consequently, its water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.2.2 City of Fulton

The City of Fulton has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Fulton and no changes in water supply are recommended.

4B.2.3 City of Rockport

The City of Rockport has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages in annual water supplies are projected for the City of Rockport and no changes in water supplies are recommended.

4B.2.4 County-Other

4B.2.4.1 Description

- Source: Groundwater – Gulf Coast Aquifer
  Surface Water – CCR/LCC/Texana System purchased from the SPMWD and run-of-river rights from San Antonio-Nueces River Basin
- Estimated Reliable Supply: 236 to 276 acft/yr (groundwater)
  49 to 1,740 acft/yr (surface water)
- System Description: Served by SPMWD and groundwater supplies with estimated well capacity of 295 acft/yr

4B.2.4.2 Options Considered

The function of the County-Other demand projection category is to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. The Aransas County-Other water user group has projected shortages of 1,527 acft/yr in 2050 and 1,443 acft/yr in 2060. Their shortages are attributed to shortages for SPMWD, based on customer needs exceeding existing maximum contracted supply of 40,000 acft from City of Corpus Christi. Table 4B.2-2 lists the water management strategy to meet customer needs (Aransas County-Other), references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Aransas County. The Water Management Strategies for SPMWD are discussed in Section 4B.12.12.

Table 4B.2-2.
Water Management Strategies Considered for Aransas County-Other

Option	***Yield (acft/yr)***	***Approximate Cost[1]***	
		Total	***Unit ($/acft)***
Increase contracted amount provided by Wholesale Water Providers	up to 1,527	N/A	$498-$550[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Unit cost based on development of water management strategies for wholesale water providers in Table 4B.12-5.
N/A — Not applicable; wholesale water provider will bear cost of project.

4B.2.4.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2050 and 2060 shortages for County-Other in Aransas County:

- Increase contracted amount provided by Wholesale Water Provider (San Patricio Municipal Water District)

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.2.4.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.2-3.

Table 4B.2-3.
Recommended Plan Costs by Decade for Aransas County-Other

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Projected Surplus/(Shortage) (acft/yr)	—	—	—	—	(1,527)	(1,443)
Increase Contracted Amount provided Wholesale Water Provider (San Patricio Municipal Water District)						
Supply From Plan Element (acft/yr)	—	—	—	—	1,527	1,443
Total Annual Cost ($/yr)	—	—	—	—	$760,500	$793,650
Total Unit Cost ($/acft)	—	—	—	—	$498	$550

[1]Unit cost based on development of water management strategies for wholesale water providers in Table 4B.11-7.

4B.2.5 Manufacturing

4B.2.5.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 195 acft/yr (groundwater)
- System Description: Various manufacturing operations

4B.2.5.2 Options Considered

The Aransas County manufacturing water user group has projected shortages of 72 acft/yr in 2010, 97 acft/yr in 2030, and 136 acft/yr in 2060. Their shortages are attributed to limited well capacity of 195 acft/yr estimated using the procedure in Section 4A.2.2. Table 4B.2-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Aransas County- Manufacturing.

Table 4B.2-4.
Water Management Strategies Considered for Aransas County-Manufacturing

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	200	$196,000[2]	$85[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-15 and $225 per acft for treatment costs. Cost estimates are based on size and depth of well(s) to meet needs.

4B.2.5.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 to 2060 shortages for Aransas County-Manufacturing:

- Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.2.5.4 Costs

The recommended Water Supply Plan, including anticipated costs, is summarized by decade in Table 4B.2-5.

Table 4B.2-5.
Recommended Plan Costs by Decade for Aransas County-Manufacturing

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(72)	(86)	(97)	(107)	(116)	(136)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)	200	200	200	200	200	200
Total Annual Cost ($/yr)	$17,000	$17,000	$17,000	$17,000	$17,000	$17,000
Total Unit Cost ($/acft)	$85	$85	$85	$85	$85	$85

4B.2.6 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.2.7 Mining

The mining water demands in Aransas County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining users and no changes in water supply are recommended.

4B.2.8 Irrigation

No irrigation demand exists or is projected for the county.

4B.2.9 Livestock

The livestock water demands in Aransas County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.3 Bee County Water Supply Plan

Table 4B.3-1 lists each water user group in Bee County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups have an adequate supply, as shown in Table 4B.3-1.

Table 4B.3-1.
Bee County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Beeville	0	0	Supply equals demand
El Oso WSC	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	0	0	Supply equals demand
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-3 and 4A-4, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.3.1 City of Beeville

The City of Beeville contracts with City of Corpus Christi to purchase raw water from the CCR/LCC System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Beeville and no changes in water supply are recommended.

4B.3.2 El Oso WSC

El Oso Water Supply Corporation is located in both Bee and Live Oak Counties; consequently, its water demand and supply values are split into tables for each county. The El Oso Water Supply Corporation receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for El Oso Water Supply Corporation and no changes in water supply are recommended.

4B.3.3 County-Other

County-Other demands are met with groundwater from the Gulf Coast Aquifer. No shortages are projected for County-Other entities and no changes in water supply are recommended.

4B.3.4 Manufacturing

There are small manufacturing water demands in Bee County. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for manufacturing and no changes in water supply are recommended.

4B.3.5 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.3.6 Mining

There are small mining water demands in Bee County. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.3.7 Irrigation

Irrigation demands in Bee County are declining over the planning period. These demands are met by groundwater from the Gulf Coast Aquifer and surface water supplies from run-of-river water rights in the San Antonio-Nueces Coastal Basin. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.3.8 Livestock

The livestock water demands in Bee County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.4 Brooks County Water Supply Plan

Table 4B.4-1 lists each water user group in Brooks County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups have an adequate supply, as shown in Table 4B.4-1.

Table 4B.4-1.
Brooks County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Falfurrias	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	No demands projected
Livestock	0	0	Supply equals demand

[1] From Tables 4A-5 and 4A-6, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.4.1 City of Falfurrias

The City of Falfurrias receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for the City of Falfurrias. The City of Falfurrias water demands increase over the planning period. In 2000 the City of Falfurrias has a per capita per day usage of 280 gallons per capita per day (gpcd) and an estimated usage of 265 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1).

4B.4.2 County-Other

The Brooks County-Other municipal users receive groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for Brooks County-Other and no changes in water supply are recommended.

4B.4.3 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.4.4 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.4.5 Mining

Mining demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.4.6 Irrigation

There are small irrigation water demands in Brooks County. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.4.7 Livestock

The livestock water demands in Brooks County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.5 Duval County Water Supply Plan

Table 4B.5-1 lists each water user group in Duval County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.5-1.
Duval County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Benavides	0	0	Supply equals demand
City of Freer	0	0	Supply equals demand
City of San Diego	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	(2,973)	(4,205)	Projected shortages for entire planning period— see plan below
Irrigation	0	0	No demands projected
Livestock	0	0	Supply equals demand

[1] From Tables 4A-7 and 4A-8, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.5.1 City of Benavides

The City of Benavides receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. No shortages are projected for the City of Benavides. Although projections indicate that Benavides' current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of Benavides requires groundwater desalination for their highest water demand over the planning period, a 0.6 MGD reverse osmosis membrane system would be sufficient. If no additional infrastructure is required, it is estimated then the total capital cost for a membrane water treatment plant will be $2,377,600, and total project cost will be $3,568,800. Total annual cost will be $464,200, resulting in a unit cost of $691 per acft, or $2.12 per 1,000 gallons, assuming full utilization of treatment plant.

4B.5.2 City of Freer

The City of Freer receives groundwater supplies from the Catahoula Tuff. No shortages are projected for the City of Freer. Although projections indicate that Freer's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of Freer requires groundwater desalination for their highest water demand over the planning period, a 1.2 MGD reverse osmosis membrane system would be sufficient. If no additional infrastructure is required, it is estimated then the total capital cost for a membrane water treatment plant will be $3,599,000, and total project cost will be $5,297,000. Total annual cost will be $739,000, resulting in a unit cost of $550 per acft, or $1.69 per 1,000 gallons, assuming full utilization of treatment plant.

4B.5.3 City of San Diego

The City of San Diego is in both Duval and Jim Well Counties; consequently, its water demand and supply values are split into tables for each county. The City of San Diego receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. The City of Alice has run a 16-inch water transmission line to Hwy 281 bypass, approximately 8 to 9 mines from the City of San Diego.[1] This pipeline could be extended to provide water supply from the City of Alice to San Diego.

No shortages are projected for the City of San Diego. Although projections indicate that San Diego's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality guidelines. If the City of San Diego requires groundwater desalination for their highest water demand over the planning period, a 1 MGD reverse osmosis membrane system would be

[1] Conservation with Carl Crull, July 2005.

sufficient. If no additional infrastructure is required, it is estimated that the total capital cost for a membrane WTP will be $3,280,000, and total project cost will be $4,844,000. Total annual cost will be $662,000, resulting in a unit cost of $591 per acft, or $1.81 per 1,000 gallons assuming full utilization of treatment plant.

4B.5.4 County-Other

Duval County-Other municipal users receive groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for the Duval County-Other. In 2000 Duval County Other has a per capita per day usage of 191 gallons per capita per day (gpcd) and an estimated usage of 178 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

4B.5.5 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.5.6 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.5.7 Mining

4B.5.7.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 4,122 to 4,348 acft/yr
- System Description: Various mining operations.

4B.5.7.2 Options Considered

The Duval County mining water user group has projected shortages of 1,738 acft/yr in 2010, 2,973 acft/yr in 2030, and 4,205 acft/yr in 2060. Their shortages are attributed to reducing pumping to meet drawdown constraints established by the CBRWPG. Table 4B.5-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Duval County-Mining.

Table 4B.5-2.
Water Management Strategies Considered for Duval County-Mining

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Mining Water Conservation (Section 4C.4)	147 to 1,283	N/A[2]	N/A[2]
No Action	—	N/A[3]	N/A[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Costs are unavailable for Mining Water Conservation Best Management Practices (Section 4C.4).
[3] Total economic impact of not meeting needs (i.e. "no action" alternative) not included in TWDB Report (see Appendix F). Annual impact of not meeting needs is presented by decade in Table 4B.5-3.
N/A = Not applicable.

4B.5.7.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to reduce the projected 2010 to 2060 shortages for Duval County-Mining:

- Mining Water Conservation (includes water reuse)
- No Action

Mining water conservation is only able to meet a portion of the projected shortage. The socioeconomic impact of not meeting mining needs will be considered for the final plan.

It is probable that Duval County mining users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional 11 wells to meet the projected shortages. The costs estimates take into consideration size and depth of wells.

In addition to the management strategy listed above, the RWPG supports strategies for reuse of existing supplies.

4B.5.7.4 Costs

For mining water conservation, the Water Conservation Implementation Task Force Guide includes a list of Best Management Practices for industries (included in Section 4C.4) but does not include specific costs. Therefore, no additional capital costs can be reasonably calculated for the mining water plan. The recommended Water Supply Plan, including anticipated supplies to meet shortages is summarized by decade in Table 4B.5-3.

Table 4B.5-3.
Recommended Plan Costs by Decade for Duval County-Mining

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	(1,738)	(2,518)	(2,973)	(3,386)	(3,809)	(4,205)
Mining Water Conservation						
Supply From Plan Element (acft/yr)	147	332	534	761	1,014	1,283
Annual Cost ($/yr)	N/A	N/A	N/A	N/A	N/A	N/A
Unit Cost ($/acft)	N/A	N/A	N/A	N/A	N/A	N/A
No Action						
Annual Cost ($/yr)[1]	$22,330,000	$30,010,000	$34,570,000	$36,840,000	$42,420,000	$46,250,000
[1] Includes lost output, lost income, and lost business taxes associated with not meeting needs.						

4B.5.8 Irrigation

Irrigation demands in Duval County are declining over the planning period. The county-wide decline in water use is likely due to expected reductions in irrigated land in the future, however this would imply a reversal of the trend observed in reported irrigated acreage from 1994 to 2000 (Section 4C.2). These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.5.9 Livestock

The livestock water demands in Duval County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.6 Jim Wells County Water Supply Plan

Table 4B.6-1 lists each water user group in Jim Wells County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.6-1.
Jim Wells County Surplus/(Shortage)

Water User Group	*Surplus/(Shortage)*[1]		*Comment*
	2030 (acft/yr)	*2060 (acft/yr)*	
City of Alice	0	0	Supply equals demand
City of Orange Grove	0	0	Supply equals demand
City of Premont	0	0	Supply equals demand
City of San Diego	0	0	Supply equals demand
County-Other	(262)	(170)	Projected shortages for entire planning period — see plan below
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-9 and 4A-10, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.6.1 City of Alice

The City of Alice has a contract to purchase water from the City of Corpus Christi via Lake Corpus Christi. The City also maintains a small reservoir in town, Lake Alice, which serves as temporary storage of waters from Lake Corpus Christi. This reservoir is fed naturally by a small watershed and has no effective firm yield. No shortages are projected for the City of Alice. In 2000 the City of Alice has a per capita per day usage of 248 gallons per capita per day (gpcd) and an estimated usage of 234 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1). The City of Alice is currently studying ways to reduce water use.

4B.6.2 City of Orange Grove

The City of Orange Grove's water supply is from the Gulf Coast Aquifer. No shortages are projected for the City of Orange Grove. In 2000 the City of Orange Grove has a per capita per day usage of 245 gallons per capita per day (gpcd) and an estimated usage of 230 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1).

4B.6.3 City of Premont

The City of Premont's water supply is from the Gulf Coast Aquifer. No shortages are projected for the City of Premont. In 2000 the City of Premont has a per capita per day usage of 260 gallons per capita per day (gpcd) and an estimated usage of 246 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060 (Section 4C.1).

4B.6.4 City of San Diego

The City of San Diego is in both Duval and Jim Well Counties; consequently, its water demand and supply values are split into tables for each county. The City of San Diego receives groundwater supplies from the Goliad Sands of the Gulf Coast Aquifer. The City of Alice has run a 16-inch water transmission line to Hwy 281 bypass, approximately 8 to 9 mines from the City of San Diego.[1] This pipeline could be extended to provide water supply from the City of Alice to San Diego.

No shortages are projected for the City of San Diego. Although projections indicate that San Diego's current wells will produce adequate supply to meet their anticipated demand, there is local concern that the quality of the water produced by the city's wells will decline to the point that advanced treatment will be necessary to stay in compliance with regulatory water quality

[1] Conservation with Carl Crull, July 2005.

guidelines. If the City of San Diego requires groundwater desalination for their highest water demand over the planning period, a 1 MGD reverse osmosis membrane system would be sufficient. If no additional infrastructure is required, it is estimated that the total capital cost for a membrane WTP will be $3,280,000, and total project cost will be $4,844,000. Total annual cost will be $662,000, resulting in a unit cost of $591 per acft, or $1.81 per 1,000 gallons assuming full utilization of treatment plant.

4B.6.5 County-Other

4B.6.5.1 Description

- Source: Groundwater - Gulf Coast Aquifer
- Estimated Reliable Supply: 1,944- 1,976 acft/yr
- System Description: Limited by well capacity in Nueces-Rio Grande River Basin.

4B.6.5.2 Options Considered

The function of the County-Other demand projection category is to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. Jim Wells County-Other users have projected shortages of 167 acft/yr in 2010, 262 acft/yr in 2030, and 170 acft/yr in 2060. Near-term (2010) and long-term shortages (2060) are about 8 percent of demand. Table 4B.6-2 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Jim Wells County Other shortages.

Table 5.6-2.
Water Management Strategies Considered for Jim Wells County-Other

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	565	$746,000[2]	$140[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-11, 0.6 MGD WTP, fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.6.5.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for the Jim Wells County-Other users:

- Gulf Coast Aquifer Supplies – Drill additional well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.6.5.4 Costs

Groundwater supplies for Jim Wells County-Other users are currently limited by well capacity. Two new wells would be required to meet the projected shortages for Jim Wells County-Other. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.6-3.

Table 4B.6-3.
Recommended Plan Costs by Decade for Jim Wells County-Other

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(167)	(238)	(262)	(241)	(210)	(170)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)	565	565	565	565	565	565
Total Annual Cost ($/yr)	$79,000	$79,000	$79,000	$79,000	$79,000	$79,000
Total Unit Cost ($/acft)	$140	$140	$140	$140	$140	$140

4B.6.6 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.6.7 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.6.8 Mining

Mining demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.6.9 Irrigation

Irrigation demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.6.10 Livestock

The livestock water demands in Jim Wells County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

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4B.7 Kenedy County Water Supply Plan

Table 4B.7-1 lists each water user group in Kenedy County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups have an adequate supply, as shown in Table 4B.7-1.

Table 4B.7-1. Kenedy County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
County-Other	0	0	Supply equals demand
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-11 and 4A-12, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.7.1 County-Other

County-Other demands are met with groundwater from the Gulf Coast Aquifer. No shortages are projected for County-Other entities and no changes in water supply are recommended.

4B.7.2 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.7.3 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.7.4 Mining

There are small mining water demands in Kenedy County. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.7.5 Irrigation

The irrigation demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.7.6 Livestock

The livestock water demands in Kenedy County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.8 Kleberg County Water Supply Plan

Table 4B.8-1 lists each water user group in Kleberg County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.8-1.
Kleberg County Surplus/(Shortage)

Water User Group	*Surplus/(Shortage)*[1]		*Comment*
	2030 (acft/yr)	*2060 (acft/yr)*	
City of Kingsville	0	0	Supply equals demand
Ricardo WSC	0	0	Supply equals demand
County-Other	(81)	(155)	Projected shortages in 2020 to 2060 — see plan below
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	0	0	Supply equals demand
Livestock	0	0	Supply equals demand

[1] From Tables 4A-13 and 4A-14, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.8.1 City of Kingsville

The City of Kingsville has a contract with the South Texas Water Authority (STWA) to purchase treated surface water from the CCR/LCC/Texana System. The City also has five wells with a combined capacity of 6.3 MGD (or 7,055 acft/yr) that pump groundwater from the Gulf Coast Aquifer. South Texas Water Authority provides water to the Ricardo Water Supply Corporation via a pass through agreement with the City of Kingsville. However, since the City of Kingsville does not meet its water needs with 100% surface water, the Ricardo WSC is receiving groundwater supplies from Kingsville's wells.[1] The current contract between the City and the STWA allows Kingsville to purchase as much as 10 percent above what it has purchased in the previous 12 months. This feature of the contract was used in 2020 and beyond to ensure sufficient water supplies to meet the City's needs through 2060. No shortages are projected for Kingsville and no changes in water supply are recommended.

[1] Correspondence from Carola Serrato, May 2005.

4B.8.2 Ricardo WSC

South Texas Water Authority provides water to the Ricardo Water Supply Corporation via a pass through agreement with the City of Kingsville. However, since the City of Kingsville does not meet its water needs with 100% surface water, the Ricardo WSC is receiving groundwater supplies from Kingsville's wells.[2] Ricardo WSC demands are met with surface water supplies and groundwater from the Gulf Coast Aquifer. No shortages are projected for Ricardo WSC and no changes in water supply are recommended.

4B.8.3 County-Other

4B.8.3.1 Description

- Source: Groundwater - Gulf Coast Aquifer
- Estimated Reliable Supply: 849 acft/yr (groundwater)
- System Description: Individual Wells

4B.8.3.2 Options Considered

County-Other demands in Kleberg County have shortages of 31 acft/yr in 2020 and increase to 155 acft/yr in 2060. Long-term shortages in 2060 are about 15 percent of demand. Table 4B.8-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Kleberg County.

Table 4B.8-2.
Water Management Strategies Considered for Kleberg County-Other

Option	***Yield (acft/yr)***	***Approximate Cost[1]***	
		Total	***Unit ($/acft)***
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)(Section 4C.7)	400	$447,000[2]	$123[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-12, 0.4 MGD water treatment plant, fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

[2] Correspondence from Carola Serrato, May 2005.

4B.8.3.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Kleberg County:

- Gulf Coast Aquifer Supplies- Drill additional well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.8.3.4 Costs

The function of the County-Other demand projection category is to capture the demands of single-family rural municipal demands as well as demands for small rural water supply systems. The recommended Water Supply Plan, including anticipated costs is summarized by decade in Table 4B.8-3.

Table 4B.8-3.
Recommended Plan Costs by Decade for Kleberg County-Other

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	(31)	(81)	(108)	(153)	(155)
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)	—	400	400	400	400	400
Total Annual Cost ($/yr)	—	$49,000	$49,000	$49,000	$49,000	$49,000
Total Unit Cost ($/acft)	—	$123	$123	$123	$123	$123

4B.8.4 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.8.5 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.8.6 Mining

Mining water demands in Kleberg County are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.8.7 Irrigation

Irrigation demands in Kleberg County are declining over the planning period. These demands are met by groundwater from the Gulf Coast Aquifer. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.8.8 Livestock

The livestock demands in Kleberg County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.9 Live Oak County Water Supply Plan

Table 4B.9-1 lists each water user group in Live Oak County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4B.9-1.
Live Oak County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
Choke Canyon WSC	2	4	Projected surplus — supplies and demands split between Live Oak and McMullen Counties
El Oso WSC	0	0	Supply equals demand
City of George West	0	0	Supply equals demand
McCoy WSC	2	14	Projected surplus
City of Three Rivers	3,271	3,463	Projected surplus
County-Other	(44)	0	Projected shortages in 2020, 2030, and 2040 — see plan below
Manufacturing	(559)	(764)	Projected shortages for entire planning period
Steam-Electric	none	none	No demands projected
Mining	(928)	(1,755)	Projected shortages for entire planning period
Irrigation	(514)	(373)	Projected shortages for entire planning period
Livestock	0	0	Supply equals demand

[1] From Tables 4A-15 and 4A-16, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.9.1 Choke Canyon WSC

Choke Canyon WSC has service areas in Live Oak and McMullen Counties, with a portion of their total water demand and supplies allocated to each county (Tables 4A-16 and 4A-18). In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Choke Canyon water supply demands are met with groundwater from the Gulf Coast Aquifer and surface water supplies from the City of Three Rivers. No shortages are projected for Choke Canyon WSC and no changes in water supply are recommended.

4B.9.2 El Oso WSC

El Oso Water Supply Corporation is located in both Bee and Live Oak Counties; consequently, its water demand and supply values are split into tables for each county. The El Oso Water Supply Corporation receives groundwater supplies from the Gulf Coast Aquifer. No shortages are projected for El Oso Water Supply Corporation and no changes in water supply are recommended.

4B.9.3 City of George West

The City of George West's demands are met with groundwater from the Gulf Coast Aquifer. No shortages are projected for George West. In 2000 the City of George West has a per capita per day usage of 227 gallons per capita per day (gpcd) and an estimated usage of 213 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

4B.9.4 McCoy WSC

McCoy WSC's demands are met with groundwater from the Carrizo-Wilcox Aquifer. No shortages are projected for McCoy WSC and no changes in water supply are recommended.

4B.9.5 City of Three Rivers

The City of Three Rivers' demands are met with surface water rights on the Nueces River. No shortages are projected for Three Rivers. In 2000 the City of Three Rivers has a per capita per day usage of 202 gallons per capita per day (gpcd) and an estimated usage of 188 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

Part of the City of Three River's surplus has been reallocated to Manufacturing use in the county (Table 4B.9-2).

Table 4B.9-2.
Reallocation of Surplus Supplies by Decade for City of Three Rivers

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Original Projected Surplus (acft/yr)	3,353	3,289	3,271	3,304	3,381	3,463
Reallocated Surplus (acft/yr)	337[1]	483[1]	559[1]	615[1]	657[1]	764[1]
Remaining Projected Surplus (acft/yr)	3,016	2,806	2,712	2,689	2,724	2,699

[1] Reallocated to Live Oak-Manufacturing users (Section 4B.9)

4B.9.6 County-Other

4B.9.6.1 Description

- Source: Groundwater - Gulf Coast Aquifer
- Estimated Reliable Supply: 764 acft per year
- System Description: Individual Wells and Small Water Supply Systems

4B.9.6.2 Options Considered

County-Other demand in Live Oak County has shortages of 32 acft/yr in 2020, 44 acft/yr in 2030, and 14 acft/yr in 2040. Projected groundwater demands decrease after 2030, and groundwater supplies are sufficient to meet projected demands in 2050 and 2060. Groundwater supplies are limited by the estimated well capacity, based on the procedure in Section 4A.2. Table 4B.9-3 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for County-Other in Live Oak County.

Table 4B.9-3.
Water Management Strategies Considered for Live Oak County-Other

Option	*Yield (acft/yr)*	*Approximate Cost[1]*	
		Total	*Unit ($/acft)*
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s) (Section 4C.7)	80	$240,000[2]	$300[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.7. Table 4C.7-5, 0.1 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.9.6.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Live Oak County:

- Gulf Coast Aquifer Supplies – Drill Additional Well(s).

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.6.4 Costs

The function of the County-Other demand projection category is to capture the demands of single family rural municipal demands as well as demands for small rural water supply systems. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-4.

Table 4B.9-4.
Recommended Plan Costs by Decade for Live Oak County-Other

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	—	(32)	(44)	(14)	—	—
Gulf Coast Aquifer Groundwater Supplies — Drill Additional Well(s)						
Supply From Plan Element (acft/yr)	—	80	80	80	80	80
Total Annual Cost ($/yr)	—	$24,000	$24,000	$24,000	$24,000	$24,000
Total Unit Cost ($/acft)	—	$300	$300	$300	$300	$300

4B.9.7 Manufacturing

4B.9.7.1 Description

- Source: Groundwater - Gulf Coast Aquifer and Nueces Basin run-of-the-river surface water rights for manufacturing use (owned by the City of Three Rivers)
- Estimated Reliable Supply: 800 acft/yr (surface water)
  630 to 809 acft/yr (groundwater)
- System Description: Individual Wells and various manufacturing operations

4B.9.7.2 Options Considered

Manufacturing demand in Live Oak County has shortages during the entire planning period and increase from 337 acft/yr in 2010 to 764 acft/yr in 2060. Groundwater supplies are limited by drawdown criteria established by the CBRWPG (Section 3). Table 4B.9-5 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Manufacturing in Live Oak County.

Table 4B.9-5.
Water Management Strategies Considered for Live Oak County-Manufacturing

Option	*Yield (acft/yr)*	*Approximate Cost[1]*	
		Total	*Unit ($/acft)*
Voluntary Redistribution of City of Three Rivers surplus (Section 4C.12)	337 to 764	N/A[2]	500[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Costs not applicable (see discussion in Section 4C.12.2).
[3] Unit cost of $500 per acft assumed to be comparable to cost of Garwood water. City of Three Rivers rates were requested. When available, these costs should be revised as appropriate.
N/A = Not applicable.

4B.9.7.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for County-Other in Live Oak County:

- Voluntary Redistribution of City of Three Rivers surplus.

It is probable that Live Oak manufacturing users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional two (2) wells to meet the projected shortages.

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.7.4 Costs

The recommended Water Supply Plan is summarized by decade in Table 4B.9-6. There are no costs associated for redistribution.

Table 4B.9-6.
Recommended Plan Costs by Decade for Live Oak-Manufacturing

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(337)	(483)	(559)	(615)	(657)	(764)
Voluntary Redistribution of City of Three Rivers surplus						
Supply From Plan Element (acft/yr)	337	483	559	615	657	764
Total Annual Cost ($/yr)	$168,500[1]	$241,500[1]	$279,500[1]	$307,500[1]	$328,500[1]	$382,000[1]
Total Unit Cost ($/acft)	$500[1]	$500[1]	$500[1]	$500[1]	$500[1]	$500[1]

[1] Unit cost of $500 per acft assumed to be comparable to cost of Garwood water. City of Three Rivers rates were requested. When available, these costs should be revised as appropriate.

4B.9.8 Steam-Electric

No steam-electric demand exists or is currently projected for the county.

4B.9.9 Mining

4B.9.9.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 3,105 to 3,841 acft/yr
- System Description: Various mining operations

4B.9.9.2 Options Considered

The mining supply in Live Oak County has shortages for the entire planning period and increase from 64 acft per year in 2010 to 1,755 acft per year in 2060. Groundwater supplies are limited by drawdown criteria established by the CBRWPG (Section 3). Table 4B.9-7 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Live Oak County mining shortages.

Table 4B.9-7.
Water Management Strategies Considered for Live Oak County-Mining

Option	***Yield (acft/yr)***	***Approximate Cost[1]***	
		Total	***Unit ($/acft)***
Mining Water Conservation (Section 4C.4)	97 to 801[2]	N/A[2]	N/A[2]
No Action	—	N/A[3]	N/A[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Yield based on 15 percent reduction in demand recommended by CBRWPG (Section 4C.4.2).
[3] Total economic impact of not meeting needs (i.e. "no action" alternative) not included in TWDB Report (see Appendix F). Annual impact of not meeting needs is presented by decade in Table 4B.5-3.
N/A = Not applicable.

4B.9.9.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected near-term and long-term shortages for Live Oak County mining:

- Mining Water Conservation (includes reuse)
- No Action

Mining water conservation is only able to meet a portion of the projected shortage. The socioeconomic impact of not meeting mining needs will be considered for the final plan.

It is probable that Live Oak mining users could avoid excessive drawdowns by spreading out the area of their wells, instead of concentrating them in a small area represented by a cluster of adjacent cells. This option is discussed in Section 4C.7.2, including costs to drill an additional 5 wells to meet the projected shortages. The costs estimates take into consideration size and depth of wells.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.9.4 Costs

For mining water conservation, the Water Conservation Implementation Task Force Guide includes a list of Best Management Practices for industries (included in Section 4C.4) but does not include specific costs. Therefore, no additional capital costs can be reasonably calculated for the mining water plan. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-8.

Table 4B.9-8.
Recommended Plan Costs by Decade for Live Oak County-Mining

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	(64)	(478)	(928)	(1,234)	(1,504)	(1,755)
Mining Water Conservation						
Supply From Plan Element (acft/yr)	97	216	344	485	639	801
Annual Cost ($/yr)	N/A	N/A	N/A	N/A	N/A	N/A
Unit Cost ($/acft)	N/A	N/A	N/A	N/A	N/A	N/A
No Action						
Annual Cost ($/yr)[1]	$2,030,000	$10,560,000	$19,330,000	$26,630,000	$32,150,000	$37,350,000

[1] Includes lost output, lost income, and lost business taxes associated with not meeting needs.
N/A = Not applicable.

4B.9.10 Irrigation

4B.9.10.1 Description

- Source: Groundwater - Gulf Coast Aquifer and Nueces Basin Run-of-River Water Rights for irrigation use in Live Oak County (owned by the City of Corpus Christi)
- Estimated Reliable Supply: 1,704 to 2,649 acft/yr (groundwater)
  200 acft/yr (surface water)
- System Description: Various on-farm irrigation systems

4B.9.10.2 Options Considered

The Irrigation supply in Live Oak County shows a projected shortage for the entire planning period. Due to projected water demand declines for irrigation users in Live Oak County, shortages decrease from 627 acft/yr in 2010 to 373 acft/yr in 2060. The county-wide decline in water use is likely due to expected reductions in irrigated land in the future, however this would imply a reversal of the trend observed in reported irrigated acreage from 1994 to 2000 (Section 4C.2). Shortages are approximately 19 percent and 16 percent of demand in 2010 and 2060, respectively. Groundwater supplies are limited by the approach used to calculate groundwater and surface water supplies based on 2000 use (Section 4A.2). Table 4B.9-9 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Live Oak County Irrigation shortages.

Table 4B.9-9.
Water Management Strategies Considered for Live Oak County-Irrigation

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Irrigation Conservation (Section 4C.2)	17 to 342[2]	$59,166/yr[2]	$173[2]
Gulf Coast Aquifer Supplies – Drill Additional Well(s) (Section 4C.7)	1,210	$805,000[3]	$64[3]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft per year) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Source of Cost Estimate: Section 4C.2. Irrigation Conservation presented for furrow irrigation as conservative cost estimate. LESA/LEPA are less expensive options.
[3] Source of Cost Estimate: Section 4C.7, Table 4C.7-8. Cost estimates are based on size and depth of well(s) to meet needs.

4B.9.10.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for Irrigation in Live Oak County:

- Irrigation Conservation (Furrow/LESA/LEPA);
- Gulf Coast Aquifer Supplies- Drill Additional Well(s)

Although irrigation demands are projected to decrease, the affects of irrigation conservation will not be significant in earlier decades. To meet near-term shortages drilling three additional wells will provide the additional water supply to meet projected shortages. Irrigation conservation savings are anticipated to increase from 17 acft/yr in 2010 to 342 acft/yr in 2060 (Section 4C.2). In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.9.10.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.9-10.

Table 4B.9-10.
Recommended Plan Costs by Decade for Live Oak County-Irrigation

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Projected Surplus/(Shortage) (acft/yr)	(627)	(569)	(514)	(464)	(416)	(373)
Irrigation Conservation						
Supply From Plan Element (acft/yr)	17	52	103	169	248	342
Annual Cost ($/yr)	$59,166	$59,166	$59,166	$59,166	$59,166	$59,166
Unit Cost ($/acft)	$173	$173	$173	$173	$173	$173
Gulf Coast Aquifer Supplies – Drill Additional Well(s)						
Supply From Plan Element (acft/yr)	1,210	1,210	1,210	1,210	1,210	1,210
Annual Cost ($/yr)	$78,000	$78,000	$78,000	$78,000	$78,000	$78,000
Unit Cost ($/acft)	$64	$64	$64	$64	$64	$64
Total Annual Cost ($/yr)	$137,166	$137,166	$137,166	$137,166	$137,166	$137,166
Total Unit Cost ($/acft)[1]	$128	$152	$185	$230	$289	$366

[1] Weighted average unit cost of the one or two management strategies that have associated total annual costs, based on projected supply needed.

4B.9.11 Livestock

The livestock demands in Live Oak County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.10 McMullen County Water Supply Plan

Table 4B.10-1 lists each water user group in McMullen County and their corresponding surplus or shortage in years 2030 and 2060. All water user groups have an adequate supply, as shown in Table 4B.10-1.

Table 4B.10-1.
McMullen County Surplus/(Shortage)

Water User Group	***Surplus/(Shortage)[1]***		***Comment***
	2030 (acft/yr)	***2060 (acft/yr)***	
Choke Canyon WSC	13	13	Projected surplus — supplies and demands split between Live Oak and McMullen Counties
County-Other	31	52	Projected surplus
Manufacturing	none	none	No demands projected
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	6	6	Projected surplus
Livestock	0	0	Supply equals demand

[1] From Tables 4A-17 and 4A-18, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.10.1 Choke Canyon WSC

Choke Canyon WSC has service areas in Live Oak and McMullen Counties, with a portion of their total water demand and supplies allocated to each county (Tables 4A-16 and 4A-18). In January 2004, Choke Canyon WSC was purchased by the City of Three Rivers. Choke Canyon water supply demands are met with groundwater from the Gulf Coast Aquifer and surface water supplies from the City of Three Rivers. No shortages are projected for Choke Canyon WSC and no changes in water supply are recommended.

4B.10.2 County-Other

County-Other demands are met with groundwater from the Carrizo-Wilcox, Queen City, and Sparta Aquifers. No shortages are projected for County-Other entities. In 2000 McMullen County-Other has a per capita per day usage of 201 gallons per capita per day (gpcd) and an estimated usage of 187 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

4B.10.3 Manufacturing

No manufacturing demand exists or is projected for the county.

4B.10.4 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.10.5 Mining

Mining demands in McMullen County show a small increase over the planning period. These demands are met by groundwater from the Carrizo-Wilcox Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.10.6 Irrigation

No irrigation demand exists or is projected for the county. The small surplus supply shown in Table 4B.10-1 indicates that there has been small irrigation use in the past in the county.

4B.10.7 Livestock

The livestock water demands in McMullen County are met by groundwater from the Carrizo-Wilcox, Gulf Coast, Queen City, and Sparta Aquifers. No shortages are projected for livestock and no changes in water supply are recommended.

4B.11 Nueces County Water Supply Plan

Table 4B.11-1 lists each water user group in Nueces County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections. Water supply plans are also presented for some entities that need pumping/conveyance facilities to utilize water from wholesale water providers.

Table 4B.11-1.
Nueces County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Agua Dulce	0	0	Supply equals demand
City of Aransas Pass	0	0	Supply equals demand
City of Bishop	0	0	Supply equals demand
City of Corpus Christi	0	0	Projected surplus through 2020, then supply equals demand
City of Driscoll	0	0	Supply equals demand
Nueces County WCID #4	0	0	Supply equals demand
City of Port Aransas	0	0	Supply equals demand
River Acres WSC	(355)	(590)	Projected shortage for entire planning period — see plan below
City of Robstown	0	0	Supply equals demand
County-Other	146	383	Projected shortage in 2010; Projected surplus from 2030 through 2060
Manufacturing	0	(37,893)	Projected shortage – see plan below
Steam-Electric	0	0	Supply equals demand
Mining	(570)	(1,612)	Projected shortage in 2030 and continuing through 2060 – see plan below
Irrigation	2,944	3,329	Projected Surplus
Livestock	0	0	Supply equals demand

[1] From Tables 4A-19 and 4A-20, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.11.1 City of Agua Dulce

The City of Agua Dulce has a contract with the South Texas Water Authority (STWA) to purchase treated surface water from the CCR/LCC/Texana System. No shortages are projected for the City of Agua Dulce and no changes in water supply are recommended.

4B.11.2 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces and San Patricio Counties; consequently, the water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water from the CCR/LCC/Texana System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.11.3 City of Bishop

The City of Bishop has a contract with STWA to purchase treated surface water. The current contract allows Bishop to purchase as much as 10 percent above what it has purchased in the previous 12 months. Additionally, the City pumps groundwater from the Gulf Coast Aquifer. No shortages are projected for the City of Bishop and no changes in water supply are recommended.

4B.11.4 City of Corpus Christi

The City of Corpus Christi meets its demands with its own water rights in the CCR/LCC System and through a contract with the Lavaca-Navidad River Authority (LNRA) that provides water from Lake Texana. Although no shortages are projected for the City's own municipal needs, the City also provides surface water to SPMWD, STWA, and manufacturing and steam-electric water user groups in Nueces and San Patricio Counties. The City's contract with LNRA expires in 2035; however, it is anticipated that this contract will be renewed when it expires. Therefore, water supply tables in Section 4 and in the water supply plans for Nueces County-Manufacturing (Section 4B.11.10) and San Patricio County-Manufacturing (Section 4B.12.11) include Lake Texana contract water as existing supply throughout the 60-year planning horizon.

In addition to these water supply sources, the City has a permit to divert up to 35,000 acft/yr of run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert and convey this water to the City. In the long-term (beyond 2030), the City will have to access this water—either directly or via a trade—to help offset the manufacturing shortages in Nueces and San Patricio Counties.

4B.11.5 City of Driscoll

The City of Driscoll has a contract with STWA to purchase treated surface water from the CCR/LCC/Texana System. No shortages are projected for the City of Driscoll and no changes in water supply are recommended.

4B.11.6 Nueces County WCID #4

The Nueces County WCID #4 has contracts with City of Corpus Christi and SPMWD to purchase treated surface water from the CCR/LCC/Texana System and serves the City of Port Aransas. Nueces County WCID #4 and Port Aransas water demands were separately identified by the TWDB. Water supplies for Nueces County WCID #4 are provided by City of Corpus Christi. Water supplies for Port Aransas are provided by SPMWD. No shortages are projected for the Nueces County WCID #4. In 2000 Nueces County WCID #4 has a per capita per day usage of 187 gallons per capita per day (gpcd) and an estimated usage of 177 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

4B.11.7 City of Port Aransas

The Nueces County WCID #4 has contracts with City of Corpus Christi and SPMWD to purchase treated surface water from the CCR/LCC System and serves the City of Port Aransas. Nueces County WCID #4 and Port Aransas water demands were separately identified by the TWDB. Water supplies for Nueces County WCID #4 are provided by City of Corpus Christi. Water supplies for Port Aransas are provided by SPMWD. No shortages are projected for Port Aransas. In 2000 the City of Port Aransas has a per capita per day usage of 424 gallons per capita per day (gpcd) and an estimated usage of 413 gpcd in 2060 (after built-in savings for low flow plumbing fixtures), based on TWDB water demand and population projections. A possible reason for the high usage is due to high influx of tourists. The CBRWPG recommends additional water conservation of 15 percent by 2060 for all municipal entities with reported use greater than 165 gpcd in 2060.

4B.11.8 River Acres WSC

4B.11.8.1 Description

- Source: Surface Water — Nueces River (via Nueces County WCID #3)
- Estimated Reliable Supply: 291 acft/yr (surface water)
- System Description: Small Water Supply Systems

4B.11.8.2 Options Considered

River Acres WSC in Nueces County has a shortage for the entire planning period and increases from 138 acft/yr in 2010 to 590 acft/yr in 2060. River Acres WSC receives surface water supplies from Nueces County WCID #3. Nueces County WCID #3 has projected surpluses sufficient to meet River Acres WSC needs (Section 4A.4). Table 4B.11-2 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for River Acres WSC.

Table 4B.11-2.
Water Management Strategies Considered for River Acres WSC

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Voluntary Redistribution- increase contracted amount from Nueces County WCID #3 (Section 4C.12)	138 to 590	$0[2]	$225[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Unit cost of $225 per acft is to treat water for municipal use.

4B.11.8.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 through 2060 shortages for River Acres WSC:

- Voluntary Redistribution- increase contracted amount from Nueces County WCID #3

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.8.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-3.

Table 4B.11-3.
Recommended Plan Costs by Decade for River Acres WSC

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(138)	(255)	(355)	(445)	(522)	(590)
Voluntary Redistribution – increase contracted amount from Nueces County WCID #3						
Supply From Plan Element (acft/yr)	138	255	355	445	522	590
Total Annual Cost ($/yr)	N/A	N/A	N/A	N/A	N/A	N/A
Total Unit Cost ($/acft)	$225	$225	$225	$225	$225	$225
N/A = Not applicable.						

4B.11.9 City of Robstown

The City of Robstown has a contract with the Nueces County WCID #3 to purchase treated surface water from the Nueces River. No shortages are projected for the City of Robstown and no changes in water supply are recommended.

4B.11.10 County-Other

4B.11.10.1 Description

- Source: Surface Water – CCR/LCC/Texana System (via Corpus Christi, & STWA)
  – Nueces River (via Nueces County WCID #3)
  Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 484 acft/yr (surface water)
  17 to 194 acft/yr (groundwater)
- System Description: Individual Wells and Small Water Supply Systems

4B.11.10.2 Options Considered

County-Other demand in Nueces County has a shortage of 261 acft/yr in 2010. The Nueces County-Other water demands may have been underestimated, as reflected by decreasing demands over the planning period which contradicts water demand trends for water supply corporations included in Nueces County-Other projections. These water demand projections should be reevaluated for future water planning efforts. There is a surplus projected from 2030 through 2060 to counterbalance low water demand estimates. Table 4B.11-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for Nueces County-Other.

Table 4B.11-4.
Water Management Strategies Considered for Nueces County-Other

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Increase contracted amount provided by Wholesale Water Providers	261	$0[2]	$225[2]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] Unit cost of $225 per acft is to treat water for municipal use.

4B.11.10.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected 2010 shortages for County-Other in Nueces County:

- Increase contracted amount provided by Wholesale Water Provider (City of Corpus Christi)

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.10.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-5.

Table 4B.11-5.
Recommended Plan Costs by Decade for Nueces County-Other

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(261)	—	—	—	—	—
Increase Contracted Amount provided Wholesale Water Provider (City of Corpus Christi)						
Supply From Plan Element (acft/yr)	261	—	—	—	—	—
Total Annual Cost ($/yr)	$58,725	—	—	—	—	—
Total Unit Cost ($/acft)	$225	—	—	—	—	—

4B.11.11 Manufacturing

4B.11.11.1 Description

The City of Corpus Christi provides the surface water for manufacturing in Nueces County from the CCR/LCC/Texana System. Additional manufacturing supplies are from the Gulf Coast Aquifer. The City also provides surface water for manufacturing in San Patricio County. *In the analysis that follows, the manufacturing needs of Nueces and San Patricio Counties are considered jointly*. A shortage in manufacturing supply occurs in 2040.

4B.11.11.2 Options Considered

Over 90 percent of the water supplied to Manufacturing users in Nueces and San Patricio Counties is from the CCR/LCC/Lake Texana System via Wholesale Water Providers (City of Corpus Christi and SPMWD). Beginning in 2040, shortages begin to appear and grow to a combined 42,192 acft/yr in 2060 (37,893 acft/yr in Nueces County and 4,299 acft/yr in San Patricio County). Table 4B.11-6 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for manufacturing in Nueces and San Patricio Counties.

Table 4B.11-6.
Water Management Strategies Considered for Manufacturing in Nueces and San Patricio Counties

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Manufacturing Conservation (Section 4C.3)	up to 2,050	N/A	N/A
Reclaimed Wastewater Supplies (Section 4C.5)	250	$1,500,000[2]	$725[2]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$45,642,000[3]	$598[3]
Garwood Pipeline (Section 4C.14)	35,000	$81,117,000[4]	$505[4]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)	23,000	$149,185,000[5]	$788[5]
Voluntary Redistribution and USCOE Nueces Feasibility Projects (Section 4C.12)	up to 62,205[6]	$178,281,250[6]	$348-$491[6]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] See Section 4C.5. Total cost provided by City for Allison Demonstration Project. Unit costs based on annual program costs of $500,000 per year and $225 per acft for treatment.
[3] Source of Cost Estimate: Section 4C.7, Table 4C.7-15. Unit cost includes $225/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.
[4] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $225/acft for treatment + $280/acft for raw water supply development.
[5] Source of Cost Estimate: Section 4C.13, Table 4C.13-6, cost of construction of the dam and delivery to Lake Texana. Unit cost = $225/acft for treatment + $563/acft for raw water supply development.
[6] Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. Source of Cost Estimate: Includes off-Channel Reservoir (Section 4C.11), CCR/LCC Pipeline (Section 4C.10), and Seawater Desalination Projects (Section 4C.17) with cost reduction of 65 percent due to Federal participation. Unit cost includes $225/acft for treatment of water associated with CCR/LCC Pipeline and Off-Channel Reservoir Project, and varies based on project implementation schedule.

4B.11.11.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2040 through 2060 shortages for manufacturing in Nueces and San Patricio Counties:

- Manufacturing Water Conservation
- Reclaimed Wastewater Supplies
- Gulf Coast Aquifer Groundwater Supplies
- Garwood Pipeline
- Stage II of Lake Texana
- Voluntary Redistribution and USCOE Nueces Feasibility Projects

The USCOE is currently studying six projects as part of the Nueces River Basin Feasibility Study to evaluate opportunities for flood damage reduction, ecosystem restoration, and/or benefit water supplies in South Texas. The six projects selected by the USCOE and participating sponsors for feasibility studies are: desalination facilities, wastewater diversion to the Nueces Delta, Cotulla Diversion Project, CCR/LCC Pipeline with Off Channel Storage, Recharge Enhancement Projects, and brush management opportunities.

Three of the six projects were considered in the cost estimate in Table 4B.11-7 (desalination, CCR/LCC Pipeline, and Off-Channel Storage). Costs to implement these projects could potentially be reduced through Federal participation as may be available through the USCOE Nueces River Basin Feasibility Study.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.11.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-7.

Table 4B.11-7. Potential Plan Costs by Decade for Manufacturing in Nueces and San Patricio Counties[1]

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage)[2] (acft/yr)	—	—	—	(11,627)	(25,283)	(42,192)
Manufacturing Water Conservation[3]						
Supply From Plan Element (acft/yr)	1,260	1,418	1,576	1,734	1,892	2,050
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Reclaimed Wastewater Supplies[4]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000
Unit Cost ($/acft)	$725	$725	$725	$725	$725	$725
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)	11,000	11,000	11,000	11,000	11,000	18,000
Annual Cost ($/yr)	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$10,757,000
Unit Cost ($/acft)	$598[5]	$598[5]	$598[5]	$598[5]	$598[5]	$598[5]
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	—	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	—	$17,679,000	$17,679,000	$17,679,000	$17,679,000
Unit Cost ($/acft)	—	—	$505	$505	$505	$505
Stage II of Lake Texana						
Supply From Plan Element (acft/yr)	—	—	—	—	—	23,000
Annual Cost ($/yr)	—	—	—	—	—	$18,132,000
Unit Cost ($/acft)	—	—	—	—	—	$788
Voluntary Redistribution and USCOE Nueces Feasibility Projects[6]						
Supply From Plan Element (acft/yr)	—	25,000	25,000	62,205	62,205	62,205
Annual Cost ($/yr)	—	$8,699,400	$8,699,400	$30,549,725	$30,549,725	$30,549,725
Unit Cost ($/acft)	—	$348	$348	$491	$491	$491
Total Annual Cost ($/yr)	$9,307,000	$18,006,400	$35,685,400	$57,535,725	$57,535,725	$77,242,725
Total Unit Cost ($/acft)	$540	$410	$455	$499	$498	$550

1 Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water.
2 Surplus/(Shortage) includes both Nueces and San Patricio Counties.
3 Water supply represents water saved by blending of Lake Texana water with Nueces River water.
4 Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $225/acft for treatment of additional yield.
5 Assumes full utilization of project. Unit cost based on 18,000 acft project + $225/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.
6 Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $225/acft added for treatment for supplies from Off-Channel and CCR/LCC Pipeline. Assumes implementation of CCR/LCC pipeline in 2020 with desalination plant and off-channel reservoir by 2040.

4B.11.12 Steam-Electric

The steam-electric users in Nueces County are provided water by City of Corpus Christi. No shortages are projected for steam-electric users and no changes in water supply are recommended.

4B.11.13 Mining

4B.11.13.1 Description of Supply

- Source: Groundwater – Gulf Coast Aquifer
  Surface water – CCR/LCC System via City of Corpus Christi and small Nueces River Basin run-of-river water rights for mining users in Nueces County
- Estimated Reliable Supply: 74 to 100 acft/yr (groundwater)
  12 to 1,465 acft/yr (surface water)
- System Description: Various mining operations

4B.11.13.2 Options Considered

The Nueces County mining water user group has shortages of 570 acft/yr in 2030 increasing to 1,612 acft/yr in 2060, respectively. Table 4B.11-8 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for mining in Nueces County.

Table 4B.11-8.
Water Management Strategies Considered for Mining in Nueces County

Option	**Yield (acft/yr)**	**Approximate Cost[1]**	
		Total	**Unit ($/acft)**
Manufacturing Conservation (Section 4C.3)	up to 2,050	N/A	N/A
Mining Conservation (Section 4C.4)	up to 259	N/A	N/A
Reclaimed Wastewater Supplies (Section 4C.5)	250	$1,500,000[2]	$725[2]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$45,642,000[3]	$598[3]
Garwood Pipeline (Section 4C.14)	35,000	$81,117,000[4]	$505[4]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)	23,000	$149,185,000[5]	$788[5]
Voluntary Redistribution and USCOE Nueces Feasibility Projects (Section 4C.12)	up to 62,205[6]	$178,281,250[6]	$348-$491[6]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.

[2] See Section 4C.5. Total cost provided by City for Allison Demonstration Project. Unit costs based on annual program costs of $500,000 per year and $225 per acft for treatment.

[3] Source of Cost Estimate: Section 4C.7, Table 4C.7-15. Unit cost includes $225/acft for treatment. Treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.

[4] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $225/acft for treatment + $280/acft for raw water supply development.

[5] Source of Cost Estimate: Section 4C.13, Table 4C.13-6, cost of construction of the dam and delivery to Lake Texana. Unit cost = $225/acft for treatment + $563/acft for raw water supply development.

[6] Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. Source of Cost Estimate: Includes off-Channel Reservoir (Section 4C.11), CCR/LCC Pipeline (Section 4C.10), and Seawater Desalination Projects (Section 4C.17) with cost reduction of 65 percent due to Federal participation. Unit cost includes $225/acft for treatment of water associated with CCR/LCC Pipeline and Off-Channel Reservoir Project, and varies based on project implementation schedule.

4B.11.13.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2030 through 2060 shortages for mining in Nueces County:

- Manufacturing Water Conservation
- Mining Water Conservation
- Reclaimed Wastewater Supplies

- Gulf Coast Aquifer Groundwater Supplies
- Garwood Pipeline
- Stage II of Lake Texana
- Voluntary Redistribution and USCOE Nueces Feasibility Projects

The USCOE is currently studying six projects as part of the Nueces River Basin Feasibility Study to evaluate opportunities for flood damage reduction, ecosystem restoration, and/or benefit water supplies in South Texas. The six projects selected by the USCOE and participating sponsors for feasibility studies are: desalination facilities, wastewater diversion to the Nueces Delta, Cotulla Diversion Project, CCR/LCC Pipeline with Off Channel Storage, Recharge Enhancement Projects, and brush management opportunities.

Three of the six projects were considered in the cost estimate in Table 4B.11-9 (desalination, CCR/LCC Pipeline, and Off-Channel Storage). Costs to implement these projects could potentially be reduced through Federal participation as may be available through the USCOE Nueces River Basin Feasibility Study.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.11.13.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.11-9.

4B.11.14 Irrigation

Irrigation demands in Nueces County are met with surface water supplies from Rio Grande-Nueces Basin run-of-river water supplies and Nueces County WCID #3 water permits from the Nueces River. There are no shortages in irrigation use in Nueces County and no changes in water supply are recommended.

4B.11.15 Livestock

The livestock demands in Nueces County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

Table 4B.11-9.
Potential Plan Costs by Decade for Mining in Nueces County[1]

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage)[2] (acft/yr)	—	—	(570)	(1,534)	(1,572)	(1,612)
Manufacturing Water Conservation[3]						
Supply From Plan Element (acft/yr)	1,260	1,418	1,576	1,734	1,892	2,050
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Mining Water Conservation[4]						
Supply From Plan Element (acft/yr)	—	—	60	123	189	259
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Reclaimed Wastewater Supplies[5]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000
Unit Cost ($/acft)	$725	$725	$725	$725	$725	$725
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)	11,000	11,000	11,000	11,000	11,000	18,000
Annual Cost ($/yr)	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$10,757,000
Unit Cost ($/acft)	$598[6]	$598[6]	$598[6]	$598[6]	$598[6]	$598[6]
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	—	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	—	$17,679,000	$17,679,000	$17,679,000	$17,679,000
Unit Cost ($/acft)	—	—	$505	$505	$505	$505
Stage II of Lake Texana						
Supply From Plan Element (acft/yr)	—	—	—	—	—	23,000
Annual Cost ($/yr)	—	—	—	—	—	$18,132,000
Unit Cost ($/acft)	—	—	—	—	—	$788
Voluntary Redistribution and USCOE Nueces Feasibility Projects[7]						
Supply From Plan Element (acft/yr)	—	25,000	25,000	62,205	62,205	62,205
Annual Cost ($/yr)	—	$8,699,400	$8,699,400	$30,549,725	$30,549,725	$30,549,725
Unit Cost ($/acft)	—	$348	$348	$491	$491	$491
Total Annual Cost ($/yr)	$9,307,000	$18,006,400	$35,685,400	$57,535,725	$57,535,725	$77,242,725
Total Unit Cost ($/acft)	$540	$410	$455	$499	$498	$550

1 Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water.
2 Surplus/(Shortage) includes both Nueces and San Patricio Counties.
3 Water supply represents water saved by blending of Lake Texana water with Nueces River water.
4 Water supply represents water saved by implementing best management practices to reduce demand by 15% (Section 4C.4).
5 Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $225/acft for treatment of additional yield.
6 Assumes full utilization of project. Unit cost based on 18,000 acft project + $225/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.
7 Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $225/acft added for treatment for supplies from Off-Channel and CCR/LCC Pipeline. Assumes implementation of CCR/LCC pipeline in 2020 with desalination plant and off-channel reservoir by 2040.

4B.12 San Patricio County Water Supply Plan

Table 4B.12-1 lists each water user group in San Patricio County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections. Water supply plans are also presented for some entities that need pumping/conveyance facilities to utilize their existing water resources, or to become a regional provider.

Table 4B.12-1.
San Patricio County Surplus/(Shortage)

Water User Group	Surplus/(Shortage)[1] 2030 (acft/yr)	Surplus/(Shortage)[1] 2060 (acft/yr)	Comment
City of Aransas Pass	0	0	Supply equals demand
City of Gregory	0	0	Supply equals demand
City of Ingleside	0	0	Supply equals demand
City of Ingleside on the Bay	0	0	Supply equals demand
Lake City	(11)	(37)	Projected shortage — see plan below
City of Mathis	0	0	Supply equals demand
City of Odem	0	0	Supply equals demand
City of Portland	0	0	Supply equals demand
City of Sinton	0	0	Supply equals demand
City of Taft	0	0	Supply equals demand
County-Other	0	0	Supply equals demand
Manufacturing	0	(4,299)	Projected shortage — see plan below
Steam-Electric	none	none	No demands projected
Mining	0	0	Supply equals demand
Irrigation	83	83	Projected surplus
Livestock	0	0	Supply equals demand

[1] From Tables 4A-21 and 4A-22, Section 4 – Comparison of Water Demands with Water Supplies to Determine Needs.

4B.12.1 City of Aransas Pass

The City of Aransas Pass is in Aransas, Nueces and San Patricio Counties, consequently, its water demand and supply values are split into the tables for each county. Aransas Pass contracts with the San Patricio Municipal Water District (SPMWD) to purchase treated water from the CCR/LCC/Texana System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Aransas Pass and no changes in water supply are recommended.

4B.12.2 City of Gregory

The City of Gregory has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Gregory and no changes in water supply are recommended.

4B.12.3 City of Ingleside

The City of Ingleside has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Ingleside and no changes in water supply are recommended.

4B.12.4 City of Ingleside on the Bay

The City of Ingleside on the Bay has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Ingleside on the Bay and no changes in water supply are recommended.

4B.12.5 Lake City

4B.12.5.1 Description

- Source: Groundwater – Gulf Coast Aquifer
- Estimated Reliable Supply: 88 acft/yr
- System Description: Limited by well capacity.

4B.12.5.2 Options Considered

Lake City users have projected shortages of 11 acft/yr in 2030 increasing to 37 acft/yr in 2060. Table 4B.12-2 lists the water management strategies, references to the report sections discussing the strategy, total project cost, and unit costs that were considered for meeting the Lake City's shortages.

Table 4B.12-2.
Water Management Strategies Considered for Lake City

Option	Yield (acft/yr)	Approximate Cost[1] Total	Unit ($/acft)
Gulf Coast Aquifer Supplies — Drill Additional Well (Section 4C.7)		$262,000	$300[2]

1 Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
2 Source of Cost Estimate: Section 4C.7. Table 4C.7-13, 0.07 MGD water treatment plant fully utilized. Cost estimates are based on size and depth of well(s) to meet needs.

4B.12.5.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages for the Lake City:

- Gulf Coast Aquifer Supplies- Drill one additional well.

In addition to the management strategy listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.12.5.4 Costs

Groundwater supplies for Lake City users are currently limited by well capacity. One new well would be required to meet the projected shortages for Lake City. The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 4B.12-3.

Table 4B.12-3.
Recommended Plan Costs by Decade for Lake City

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage) (acft/yr)	—	(1)	(11)	(19)	(28)	(37)
Gulf Coast Aquifer Supplies-Drill additional well						
Supply From Plan Element (acft/yr)	—	80	80	80	80	80
Total Annual Cost ($/yr)	—	$24,000	$24,000	$24,000	$24,000	$24,000
Total Unit Cost ($/acft)	—	$300	$300	$300	$300	$300

4B.12.6 City of Mathis

The City of Mathis has a contract with the City of Corpus Christi to purchase raw water from the CCR/LCC System. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Mathis and no changes in water supply are recommended.

4B.12.7 City of Odem

The City of Odem has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Odem and no changes in water supply are recommended.

4B.12.8 City of Portland

The City of Portland has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Portland and no changes in water supply are recommended.

4B.12.9 City of Sinton

The City of Sinton meets its demands with groundwater pumped from the Gulf Coast Aquifer. The City has three wells with a total capacity of 3.67 MGD, or 2,055 acft/yr. The City of Sinton is expected to only pump water needed to meet projected demands. No shortages are projected for the City of Sinton and no changes in water supply are recommended

4B.12.10 City of Taft

The City of Taft has a contract with the SPMWD to purchase treated water. The contract allows the City to purchase only the water that it needs. No shortages are projected for the City of Taft and no changes in water supply are recommended.

4B.12.11 County-Other

County-Other demands are met with surface water from the CCR/LCC/Texana System provided by the SPMWD and groundwater from the Gulf Coast Aquifer. No shortages are projected for County-Other entities and no changes in water supply are recommended.

4B.12.12 Manufacturing

4B.12.12.1 Description

The City of Corpus Christi provides the surface water for manufacturing in Nueces County from the CCR/LCC/Texana System. Additional manufacturing supplies are from the Gulf Coast Aquifer. The City also provides surface water for manufacturing in San Patricio County. *In the analysis that follows, the manufacturing needs of Nueces and San Patricio Counties are considered jointly*. A shortage in manufacturing supply occurs in 2040.

4B.12.12.2 Options Considered

Over 90 percent of the water supplied to Manufacturing users in Nueces and San Patricio Counties is from the CCR/LCC/Lake Texana System via Wholesale Water Providers (City of Corpus Christi and SPMWD). Beginning in 2040, shortages begin to appear and grow to a combined 42,192 acft/yr in 2060 (37,893 acft/yr in Nueces County and 4,299 acft/yr in San Patricio County). Table 4b.12-4 lists the water management strategies, references to the report section discussing the strategy, total project cost, and unit costs that were considered for meeting the shortage for manufacturing in Nueces and San Patricio Counties.

4B.12.12.3 Water Supply Plan

Working within the planning criteria established by the Coastal Bend RWPG and TWDB, the following water supply plan is one potential plan to meet the projected 2040 through 2060 shortages for manufacturing in Nueces and San Patricio Counties:

- Manufacturing Water Conservation
- Reclaimed Wastewater Supplies
- Gulf Coast Aquifer Groundwater Supplies
- Garwood Pipeline
- Stage II of Lake Texana
- Voluntary Redistribution and USCOE Nueces Feasibility Projects

The USCOE is currently studying six projects as part of the Nueces River Basin Feasibility Study to evaluate opportunities for flood damage reduction, ecosystem restoration, and/or benefit water supplies in South Texas. The six projects selected by the USCOE and participating sponsors for feasibility studies are: desalination facilities, wastewater diversion to the Nueces Delta, Cotulla Diversion Project, CCR/LCC Pipeline with Off Channel Storage, Recharge Enhancement Projects, and brush management opportunities.

Table 4B.12-4.
Water Management Strategies Considered for Manufacturing in Nueces and San Patricio Counties

Option	Yield (acft/yr)	Approximate Cost[1]	
		Total	Unit ($/acft)
Manufacturing Conservation (Section 4C.3)	up to 2,050	N/A	N/A
Reclaimed Wastewater Supplies (Section 4C.5)	250	$1,500,000[2]	$725[2]
Gulf Coast Aquifer Groundwater Supplies (Section 4C.7)	up to 18,000	$45,642,000[3]	$598[3]
Garwood Pipeline (Section 4C.14)	35,000	$81,117,000[5]	$505[5]
Stage II Lake Texana (Palmetto Bend) (Section 4C.13)	23,000	$149,185,000[4]	$788[4]
Voluntary Redistribution and USCOE Nueces Feasibility Projects (Section 4C.12)	up to 62,205[6]	$178,281,250[6]	$348-491[6]

[1] Unless otherwise noted, costs are Total Project Cost and Unit Cost ($/acft/yr) for treated water delivered to the water supply entity or entities. Unit cost is for full utilization of project capacity.
[2] See Section 4C.5. Total cost provided by City for Allison Demonstration Project. Unit costs based on annual program costs of $500,000 per year and $225 per acft for treatment.
[3] Source of Cost Estimate: Section 4C.7, Table 4C.7-15. Unit cost includes $225/acft for treatment.
[4] Source of Cost Estimate: Section 4C.13, Table 4C.13-6, cost of construction of the dam and delivery to Lake Texana. Unit cost = $225/acft for treatment + $563/acft for raw water supply development.
[5] Source of Cost Estimate: Section 4C.14, Table 4C.14-2. Unit cost = $225/acft for treatment + $280/acft for raw water supply development.
[6] Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. Source of Cost Estimate: Includes off-Channel Reservoir (Section 4C.11), CCR/LCC Pipeline (Section 4C.10), and Seawater Desalination Projects (Section 4C.17) with cost reduction of 65 percent due to Federal participation. Unit cost includes $225/acft for treatment of water associated with CCR/LCC Pipeline and Off-Channel Reservoir Project, and varies based on project implementation schedule.

Three of the six projects were considered in the cost estimate in Table 4B.12-5 (desalination, CCR/LCC Pipeline, and Off-Channel Storage). Costs to implement these projects could potentially be reduced through Federal participation as may be available through the USCOE Nueces River Basin Feasibility Study.

In addition to the management strategies listed above, the RWPG supports strategies for increased conservation and reuse of existing supplies.

4B.12.12.4 Costs

The recommended Water Supply Plan including anticipated costs is summarized by decade in Table 5.12-5.

Table 4B.12-5.
Potential Plan Costs by Decade for Manufacturing in Nueces and San Patricio Counties[1]

Plan Element	2010	2020	2030	2040	2050	2060
Projected Surplus/(Shortage)[2] (acft/yr)	—	—	—	(11,627)	(25,283)	(42,192)
Manufacturing Water Conservation[3]						
Supply From Plan Element (acft/yr)	1,260	1,418	1,576	1,734	1,892	2,050
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Reclaimed Wastewater Supplies[4]						
Supply From Plan Element (acft/yr)	250	250	250	250	250	250
Annual Cost ($/yr)	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000
Unit Cost ($/acft)	$725	$725	$725	$725	$725	$725
Gulf Coast Aquifer Groundwater Supplies						
Supply From Plan Element (acft/yr)	11,000	11,000	11,000	11,000	11,000	18,000
Annual Cost ($/yr)	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$9,182,000	$10,757,000
Unit Cost ($/acft)	$598[5]	$598[5]	$598[5]	$598[5]	$598[5]	$598[5]
Garwood Pipeline						
Supply From Plan Element (acft/yr)	—	—	35,000	35,000	35,000	35,000
Annual Cost ($/yr)	—	—	$17,679,000	$17,679,000	$17,679,000	$17,679,000
Unit Cost ($/acft)	—	—	$505	$505	$505	$505
Stage II of Lake Texana						
Supply From Plan Element (acft/yr)	—	—	—	—	—	23,000
Annual Cost ($/yr)	—	—	—	—	—	$18,132,000
Unit Cost ($/acft)	—	—	—	—	—	$788
Voluntary Redistribution and USCOE Nueces Feasibility Projects[6]						
Supply From Plan Element (acft/yr)	—	25,000	25,000	62,205	62,205	62,205
Annual Cost ($/yr)	—	$8,699,400	$8,699,400	$30,549,725	$30,549,725	$30,549,725
Unit Cost ($/acft)	—	$348	$348	$491	$491	$491
Total Annual Cost ($/yr)	$9,307,000	$18,006,400	$35,685,400	$57,535,725	$57,535,725	$77,242,725
Total Unit Cost ($/acft)	$540	$410	$455	$499	$498	$550

1 Supplies exceed shortages in case water growth patterns and demands exceed TWDB projections or supplies are reduced under the City's contract with LNRA for Lake Texana water.
2 Surplus/(Shortage) includes both Nueces and San Patricio Counties.
3 Water supply represents water saved by blending of Lake Texana water with Nueces River water.
4 Costs to maintain ongoing Nueces Delta studies are $500,000 per year (assumed cost associated with Allison Demonstration Project is 25 percent). Water supply for Allison Project based on ratio of yield recovered by a 2-MGD project as compared to an 8.8-MGD project (See Section 4C.5). Costs to supply Allison discharge to delta includes $225/acft for treatment of additional yield.
5 Assumes full utilization of project. Unit cost based on 18,000 acft project + $225/acft for treatment (See Section 4C.7) although treatment may not be required if separate pipeline is constructed so that groundwater would not be blended with water in Mary Rhodes pipeline.
6 Annual costs and unit cost are based on Federal funding participation of 65 percent. Water supplied is 65 percent of project potential, with 35 percent dedicated for ecosystem restoration. $225/acft added for treatment for supplies from Off-Channel and CCR/LCC Pipeline. Assumes implementation of CCR/LCC pipeline in 2020 with desalination plant and off-channel reservoir by 2040.

4B.12.13 Steam-Electric

No steam-electric demand exists or is projected for the county.

4B.12.14 Mining

The mining demands in San Patricio County are met by groundwater from Gulf Coast Aquifer. No shortages are projected for mining and no changes in water supply are recommended.

4B.12.15 Irrigation

The irrigation demands in San Patricio County are met by groundwater from Gulf Coast Aquifer and small San Antonio-Nueces Basin run-of-river water rights. No shortages are projected for irrigation and no changes in water supply are recommended.

4B.12.16 Livestock

The livestock water demands in San Patricio County are met by groundwater from the Gulf Coast Aquifer and surface water from local on-farm sources. No shortages are projected for livestock and no changes in water supply are recommended.

4B.13 Wholesale Water Provider Water Supply Plans

Table 4B.13-1 lists each Wholesale Water Provider and their corresponding surplus or shortage in years 2030 and 2060. For each Wholesale Water Provider with a projected shortage, a water supply plan has been developed.

Table 4B.13-1.
Wholesale Water Provider Surplus/(Shortage)

Water User Group	*Surplus/(Shortage)*[1] 2030 (acft/yr)	*Surplus/(Shortage)*[1] 2060 (acft/yr)	*Comment*
City of Corpus Christi	(570)	(39,505)	Projected shortage — see plan below
San Patricio MWD	3,278	(5,742)	Projected shortage — see plan below
South Texas Water Authority	0	0	Supply equals demand
Nueces County WCID #3	1,195	1,266	Projected surplus

[1] Surplus/(Shortage) for each Wholesale Water Provider calculated by taking total surface water availability less municipal retail and wholesale demands, and/or steam-electric demands, and/or manufacturing demands (Table 4A-23).

4B.13.1 City of Corpus Christi

As the primary provider of surface water to the Coastal Bend Region, the City of Corpus Christi is the major Wholesale Water Provider in the region. Corpus Christi has 200,000 acft in available safe yield supply in 2060 through its own water right in the CCR/LCC System and a contract with LNRA from Lake Texana. This availability constitutes 93 percent of the total surface water availability in the region. Additionally, the City has a permit to divert up to 35,000 acft/yr run-of-river water under its interbasin transfer permit on the Colorado River (via the Garwood Irrigation Co.). While the City owns the water right on the Colorado River, it does not have the facilities to divert and convey this water to the City; therefore, the 35,000 acft is not included in the existing surface water availability in the region.

The City provides treated and raw water from the CCR/LCC/Texana System to the water user groups and other entities shown in Table 4B.13-2.

Table 4B.13-2.
Purchasers of Water from the City of Corpus Christi

Water User Group / Entity	***County***
San Patricio MWD	San Patricio
South Texas Water Authority	Kleberg, Nueces
City of Alice	Jim Wells
City of Beeville	Bee
City of Mathis	San Patricio
City of Three Rivers	Live Oak
Nueces County WCID #4	Nueces
Nueces County-Other	Nueces
Steam-Electric	Nueces
Manufacturing	Nueces
Mining	Nueces

A comparison of Corpus Christi's demand and supply is presented in Section 4A.5 and is an analysis of the City's retail municipal demands and supplies available to meet those demands. The shortage listed in Table 4B.13-1 reflects the entire City's demands—both municipal retail and wholesale, as well as steam-electric and manufacturing demands. The shortage begins in 2030 and is due to large manufacturing and mining demands in Nueces and San Patricio County. For a list of the water management strategies available to meet these shortages, refer to the water supply plan for manufacturing in Nueces and San Patricio Counties in Section 4B.11.11.

The City has surpluses of 32,099 acft/yr in 2010, 12,511 acft/yr in 2020, and 12,511 acft in 2030 (Table 4A-23). Part of the City of Corpus Christi's surplus has been reallocated to Nueces County-Other use (see Table 4B.11-3).

Table 4B.13-3.
Reallocation of Surplus Supplies by Decade for City of Corpus Christi (as Wholesale Water Provider)[1]

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Original Projected Surplus (acft/yr)	32,099	—	—	—	—	—
Reallocated Surplus (acft/yr)	261[1]	—	—	—	—	—
Remaining Projected Surplus (acft/yr)	31,838	—	—	—	—	—
[1] Reallocated to Nueces County-Other users (Section 4B.11)						

4B.13.2 San Patricio Municipal Water District

The San Patricio Municipal Water District (SPMWD) is the second largest Wholesale Water Provider in the region. SPMWD has a contract with the City of Corpus Christi to purchase water from both the CCR/LCC System and Lake Texana. SPMWD treats this water and provides it to the water user groups and other entities shown in Table 4B.13-4.

Table 4B.13-4.
Purchasers of Water from San Patricio MWD

Water User Group / Entity	*County*
City of Aransas Pass	Aransas, Nueces, San Patricio
City of Gregory	San Patricio
City of Ingleside	San Patricio
City of Ingleside on the Bay	San Patricio
City of Odem	San Patricio
City of Portland	San Patricio
City of Rockport	Aransas
City of Taft	San Patricio
Port Aransas	Nueces
County-Other	Aransas, San Patricio
City of Fulton	Aransas
Manufacturing	San Patricio

The shortage listed in Table 4B.13-1 reflects all of SPMWD's demands—both municipal retail and wholesale, as well as manufacturing demands. The shortage begins in 2050 and is due to large manufacturing demands in San Patricio County and Aransas County-Other demands. For the water management strategies available to meet these shortages, refer to the water supply plan for manufacturing in Nueces and San Patricio Counties in Section 4B.11.1 and 4B.12.12.

4B.13.3 South Texas Water Authority

The South Texas Water Authority (STWA) is the third largest Wholesale Water Provider in the region. STWA has a contract with the City of Corpus Christi to purchase treated water from both the CCR/LCC System and Lake Texana. STWA provides this water to the water user groups and other entities shown in Table 4B.13-5.

Table 4B.13-5.
Purchasers of Water from South Texas Water Authority

Water User Group / Entity	*County*
City of Agua Dulce	Nueces
City of Driscoll	Nueces
City of Bishop	Nueces
Nueces County-Other[1]	Nueces
City of Kingsville	Kleberg
Ricardo WSC	Kleberg

[1] Includes Coastal Bend Youth City, Nueces County WCID #5, Nueces WSC, and other rural water users.

There are no shortages listed in Table 4B.13-1 for South Texas Water Authority.

4B.13.4 Nueces County WCID #3

The Nueces County WCID #3 is the smallest Wholesale Water Provider in the region. Nueces County WCID #3 receives a firm yield of 3,665 acft/yr from its Nueces Basin run-of-river rights. Nueces County WCID #3 provides this water to the water user groups and other entities shown in Table 4B.13-6.

Table 4B.13-6.
Purchasers of Water from Nueces County WCID #3

Water User Group / Entity	*County*
City of Robstown	Nueces
River Acres WSC	Nueces
Nueces County-Other	Nueces

After meeting customer demands, Nueces County WCID #3 shows surpluses of 1,109 acft in 2010 increasing to 1,266 acft by 2060. Part of the Nueces County WCID #3 surplus has been reallocated to River Acres WSC (Table 4B.13-7).

Table 4B.13-7.
Reallocation of Surplus Supplies by Decade for
Nueces County WCID #3 (as Wholesale Water Provider)[1]

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Original Projected Surplus (acft/yr)	1,109	1,152	1,195	1,237	1,266	1,266
Reallocated Surplus (acft/yr)	138[1]	255[1]	355[1]	445[1]	522[1]	590[1]
Remaining Projected Surplus (acft/yr)	971	897	840	792	744	676

[1] Reallocated to River Acres WSC (Section 4B.11.8)

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Section 5
Impacts of Water Management Strategies on Key Parameters of Water Quality [31 TAC § 357.7(a)12] and Impacts of Moving Water from Rural and Agricultural Areas [31 TAC § 357.7(a)8(G)]

The new guidelines for 2006 Regional Water Plans include describing major impacts of recommended water management strategies on key parameters of water quality identified by the regional water planning group and consideration of third party social and economic impacts associated with voluntary redistribution of water from rural and agricultural areas.

5.1 Impacts of Water Management Strategies on Key Parameters of Water Quality

In January 2005, the Coastal Bend Region identified key parameters of water quality to consider for water management strategies. The selection of key water quality parameters is based on current water quality concerns identified in the Nueces River Authority's Basin Highlights Report, water user concerns expressed during Regional Water Planning Group meetings, and water quality studies conducted for water management strategies included in the 2001 Plan and other regional studies. The Coastal Bend Region identified water quality parameters for six water management strategies, as shown in Figures 5-1 and 5-2.

The major impacts of recommended water management strategies on these key parameters of water quality are described in greater detail in the respective water management strategy summary (Section 4C). These identified water quality concerns present challenges that may need to be overcome before the water management strategy can be used as a water supply. For water quality parameters that cannot be fully addressed due to lack of available information or inconclusive water quality studies, the water management summary write-ups include recommendations for further studies prior to implementing as a water management strategy.

5.2 Voluntary Redistribution of Water and Impacts of Moving Water from Rural and Agricultural Areas

Several opportunities for voluntary redistribution exist for the Coastal Bend Region, including: (1) reallocating surface water through utilization of unused supply and sales of existing water rights, (2) trading and transferring surface water rights with the South Central

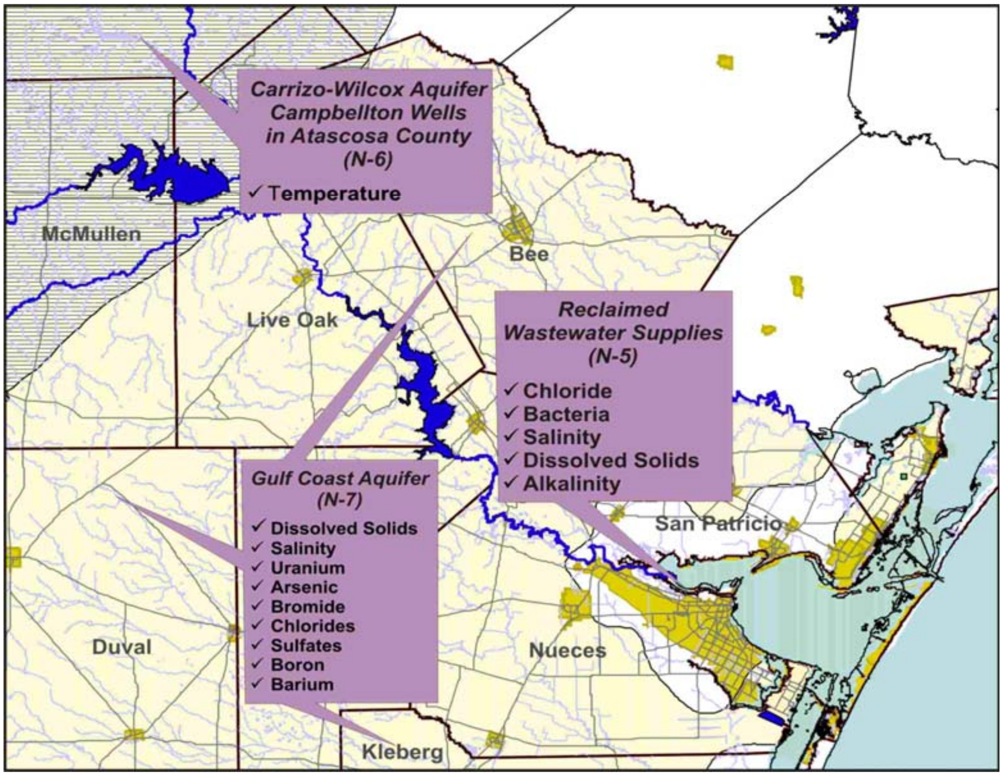

Figure 5-1. Water Quality Parameters to Consider for Water Management Strategies

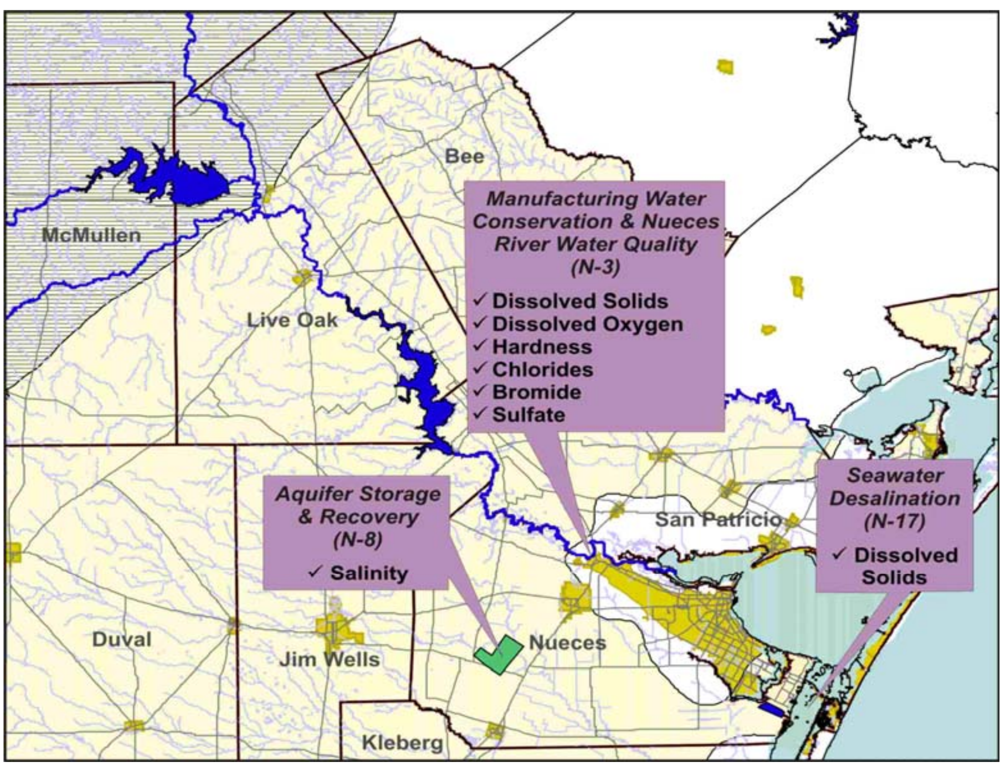

Figure 5-2. Water Quality Parameters to Consider for Water Management Strategies

Texas Region (Region L), and (3) regional water supply opportunities associated with projects included in the U.S. Army Corps of Engineers (USACOE) Nueces Feasibility Study.

Reallocation of unutilized surface water supply was recommended to meet both near-term and long-term shortages for Live Oak-Manufacturing and River Acres WSC. The 2006 Plan recommends the City of Three Rivers provide additional water to meet water needs for Live Oak-Manufacturing. The City of Three Rivers currently provides water to manufacturing users in Live Oak County and would likely require an a contract modification to increase water supplied from City of Three Rivers. Similarly, Nueces County WCID #3 currently provides water to River Acres WSC. Nueces County WCID #3 has unutilized surface water supply that could be provided to River Acres WSC to meet their needs and would likely require a contract modification. The impacts of voluntary redistribution of un-utilized surface water supply are expected to have minimal or no impacts on third party users or rural and agricultural areas.

The South Central Texas Regional Water Plan considers a pipeline from Choke Canyon Reservoir to provide water to the South Central Texas Region in exchange for a desalination facility near the City of Corpus Christi. This water management strategy is not expected to be recommended in the 2006 South Central Texas Regional Water Plan.

The Corps of Engineers is currently studying six projects as part of the Nueces River Basin Feasibility Study: recharge enhancement on the Upper Nueces; brush management; desalination; wastewater diversion to Nueces Delta; Cotulla Diversion Project; and CCR/LCC Pipeline with off-channel storage. The Feasibility Study will evaluate opportunities for flood mitigation, ecosystem restoration, water quality enhancements, and water supply benefits. The third party social and economic impacts resulting from voluntary redistribution will be considered in the Feasibility Study.

The water management strategies recommended to meet water needs (Section 4B) do not include transferring water needed by rural and agricultural users and, therefore, are not considered to impact them. As discussed above, voluntary redistributions of unutilized surface water supplies for some rural and agricultural users are recommended and included in Section 4B – Water Supply Plans.

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Section 6
Water Conservation and Drought Management Recommendations [31 TAC §357.7(a)(11)]

The 2006 Coastal Bend Regional Water Plan (2006 Plan) includes water conservation and drought management recommendations pursuant to 31 Texas Administrative Code 357.7(a)11 and Texas Water Code 11.085. The guidelines require water user groups that obtain water from inter-basin transfers consider conservation as a water management strategy. The City of Corpus Christi (City) benefits from an interbasin transfer and contract with the Lavaca-Navidad River Authority (LNRA) to divert up to 53,840 acft/yr from Lake Texana in the Lavaca-Navidad River Basin, which includes a base contract of 41,840 acft/year and 12,000 acft/year on an interruptible basis. Although not considered as a current water supply, the City has a permit to divert up to 35,000 acft/year from the Colorado River Basin according to a purchase agreement with the Garwood Irrigation Company. The City's Water Conservation Plan (1999) addresses their goals and plan to conserve water. The City's Drought Contingency Plan (2001) identifies factors used to initiate a drought response and actions to be taken as part of the response (Table 3-9). Both City Plans are included in Appendix E, along with the Coastal Bend Region Water Conservation Plan (from 2001 Plan).

The TCEQ provides guidance for Water Conservation and Drought Contingency Plans in 30 Texas Administrative Code Chapter 288, which requires entities applying for new water rights or an amendment to existing water right to prepare and implement a water conservation/drought contingency plan to be submitted with their application. Furthermore, 30 TAC Chapter 288, requires "specific, quantified five and ten year targets for water savings to be included in all water conservation plans to be submitted to the TCEQ no later than May 1, 2005." Due to timing constraints, the water conservation target savings for entities in the Coastal Bend Region will not be included in the 2006 Plan. These targets should be included in future water planning efforts.

6.1 Water Conservation

The Coastal Bend Region has considered water conservation and drought management measures for each water user group with a need (projected water shortage) in accordance with

Regional Water Planning Guidelines. The Coastal Bend Region recommends water conservation for municipal and non-municipal entities.

6.1.1 Municipal Water Conservation

The City of Corpus Christi, largest municipal water user in the Coastal Bend Region, has demonstrated significant water savings attributable to water conservation efforts over the last decade. The City of Corpus Christi currently uses less water than comparable cities in the Central Texas region and is currently among the lowest in the state, for all climatological regions. The City's municipal water use was nearly 220 gallons per capita per day (gpcd) in 1990 and was reduced to 179 gpcd by 2000, a decrease of 41 gpcd in 10 years (or 19 percent). According to TWDB water use projections, the City of Corpus Christi water use is anticipated to decline to 165 gpcd by 2060.

The Coastal Bend Region encourages all municipal entities in the Coastal Bend Region to conserve water, regardless of per capita consumption. In September 2004, the Coastal Bend Region recommended that water entities, with and without shortages, exceeding 165 gallons per capita per day reduce consumption by 15 percent by 2060 by using Best Management Practices (BMPs) provided by the Water Conservation Implementation Task Force. By reducing water use by 15 percent in addition to anticipated savings built into the TWDB projections for replacement of existing plumbing fixtures, the Coastal Bend Region is expected to reduce average consumption from 155 gpcd in 2000 to 137 gpcd by 2060 (a decrease of 12 percent). Assuming 100 percent participation in water conservation efforts for entities with greater than 165 gpcd, the anticipated regional savings is expected to increase from 104 acft/yr in Year 2010 to 2,415 acft/yr by Year 2060. A discussion of municipal conservation water savings, program costs, and unit costs for the Coastal Bend Region are included in Section 4C.1.

6.1.2 Non-municipal Water Conservation

In March 2005, the Coastal Bend Region recommended water conservation for industrial (manufacturing/mining) and irrigation users. The Coastal Bend Region recommended that manufacturing users continue to pursue opportunities to improve water quality, thereby reducing water consumption. Manufacturing entities can improve water quality through outlet works and intake modifications to reduce total dissolved solids as described in Section 4C.3. The Planning Group also recommended a 15 percent reduction in water demand for irrigation and mining entities with projected water needs that may be achieved using Best Management Practices (BMPs) identified by the Water Conservation Implementation Task Force.

There are four counties within the Coastal Bend Region with projected irrigation needs: Brooks, Duval, Jim Wells, and Live Oak. The total water savings for these four counties after 15 percent water demand reduction is 1,214 acft/yr, as shown in Table 6-1. There are multiple irrigation BMPs that irrigators can select from to attain this water savings, including furrow diking, low elevation spray applications (LESA), and low energy precision application (LEPA). The costs of these BMPs range from $50 to $530 per acft water saved with a savings potential of 1,300 to 3,320 acft with 100 percent participation. A more detailed description of irrigation BMPs, costs, and water savings for the Coastal Bend Region are included in Section 4C.2.

Table 6-1.
Irrigation Water Conservation Savings

Counties with Irrigation Needs	***Irrigation Shortages in 2060 (acft/yr)***		***Water Savings in 2060 (acft/yr)***
	Before Conservation	***After Conservation (Reducing Demand By 15 Percent)***	
Brooks	(4)	0	4
Duval	(3,138)	(2,528)	610
Jim Wells	(379)	(121)	258
Live Oak	(1,597)	(1,255)	342
Total	**(5,118)**	**(3,904)**	**1,214**

There are six counties in the Coastal Bend Region with projected mining needs: Aransas, Brooks, Duval, Jim Wells, Live Oak, and Nueces. The total water savings for these six counties after 15 percent water demand reduction is 2,475 acft/yr as shown in Table 6-2. There are multiple industrial BMPs identified by the Water Conservation Implementation Task Force, however data to quantify savings and costs is unavailable. The Coastal Bend Region recognizes that conservation savings and costs to implement mining BMPs are facility specific and assumes that mining users will implement those strategies that are practical, cost effective, and provide good water savings potential. A more detailed description of suggested mining BMPs for the Coastal Bend Region is included in Section 4C.4.

Table 6-2.
Mining Water Conservation Savings

Counties with Mining Needs	Irrigation Shortages in 2060 (acft/yr)		Water Savings in 2060 (acft/yr)
	Before Conservation	After Conservation (Reducing Demand By 15 Percent)	
Aransas	(43)	(21)	22
Brooks	(39)	(11)	22
Duval	(6,745)	(5,462)	1,283
Jim Wells	(126)	(44)	82
Live Oak	(2,944)	(2,143)	801
Nueces	(1,646)	(1,387)	259
Total	**(11,543)**	**(9,068)**	**2,475**

6.2 Drought Management

All water supply entities and some major water right holders are required by Senate Bill 1 regulations to submit for approval to the Texas Commission for Environmental Quality (TCEQ) a Drought Contingency and Water Conservation Plan. These plans must detail the entities' plans to reduce water demand at times when the demand threatens the total capacity of the water supply delivery system or overall supplies are low (like during a drought). In accordance with 31 Texas Administrative Code 357.7(a)1, the 2006 Plan identifies: 1) factors to consider in determining whether to initiate a drought response; and 2) actions to be taken as part of the response, for each water source as summarized in Tables 3-9 and 3-10.

The City's Drought Management Plan considers combined storage of the CCR/LCC System in determining whether to initiate a drought response. The City issues drought response measures based on 50 percent-40 percent-30 percent storage of CCR/LCC System, as described in Table 3-9. Through water purchase agreements, the customers of the City of Corpus Christi (including wholesale water providers) are responsible to impose similar drought measures. Supplies from the CCR/LCC System are determined on the basis of minimum year availability and safe yield, respectively. Hence, the surface water supplies available to the three largest Coastal Bend wholesale water providers (City of Corpus Christi, San Patricio Municipal Water District, and South Texas Water Authority) are dependable during drought and have included drought provisions in the event that a future drought is greater in severity than the worst drought of record as discussed in Section 7.

Supplies from other surface water sources, such as run-of-river water rights for Nueces County WCID#3, the fourth wholesale water provider, are determined from analyses using TCEQ's Nueces River Water Availability Model and are dependable during drought.

The Nueces River Authority has on file, drought management plans for the following Coastal Bend region entities:

Wholesale Water Providers	**Date of Management Plan**
City of Corpus Christi	November 2005 (Amended)
San Patricio Muncipal Water District	May 2005 (Amended)
South Texas Water Authority	April 2005
Surface Water Users	**Date of Management Plan**
City of Alice	May 1996
City of Beeville	February 2000
Nueces WCID #3	January 2001 (Amended)
Nueces WSC	September 2000
City of Portland	June 2000
River Acres WSC	November 2000
City of Rockport	April 2002 (Amended)
Copano Heights Water Company	October 2005 (Amended)
Groundwater Users	**Date of Management Plan**
Aransas County MUD #1	June 2005
Blueberry Hills Water Works, LLC	January 2005
El Oso WCD	March 2000
Escondido Creek Estates	August 2000
Utility Development & Research, Inc.	August 2000
Utility Board of Falfurrias	August 1999
McCoy WSC	August 2000
McMullen County WCID #2	December 2002
City of Orange Grove	September 2000
Pettis MUD	Date not available
San Diego MUD #1	June 2000

Groundwater Users (continued)	**Date of Management Plan**
Freer WCID	September 2000
Both Groundwater/Surface Water Users	**Date of Management Plan**
Choke Canyon Water System	August 2000
City of Kingsville	May 2002
Ricardo WSC	August 2000

The Nueces River Authority also has on file, the Lavaca-Navidad River Authority Drought Contingency Plan, revised August 24, 2005.

Section 7
Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources [31 TAC §357.7(a)(13) and §357.7(2)(C)

The 2006 Coastal Bend Regional Water Plan (2006 Plan) is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources and is developed based on guidance principles outlined in the Texas Administrative Code Chapter 358-State Water Planning Guidelines. The 2006 Plan was produced with an understanding of the importance of orderly development, management, and conservation of water resources and is consistent with all laws applicable to water use for the state and regional water planning areas. Furthermore, the plan was developed according to principles governing surface water and groundwater rights. The 2001 TCEQ Agreed Order governing freshwater pass-throughs to the Nueces Estuary was strictly adhered to for current surface water supply projects and future water management strategies. For groundwater, the 2006 Plan also recognized principles for groundwater use in Texas and the authority of groundwater conservation districts within the Coastal Bend Region. The rules of groundwater conservation districts in the region and regional drawdown constraints developed by the Coastal Bend Groundwater Advisory Panel were followed when determining groundwater availability. The CBRWPG recognizes the need to protect groundwater quality and recommends routine water quality monitoring near in situ uranium mining and deep well injection operations.

The 2006 Plan identifies actions and policies necessary to meet the Coastal Bend Region's near and long-term water needs by developing and recommending water management strategies to meet their needs with reasonable cost, good water quality, and sufficient protection of agricultural and natural resources of the state. The Coastal Bend Region recommended water management strategies that considered public interest of the state, wholesale water providers, protection of existing water rights, and opportunities that encourage voluntary transfers of water resources while balancing economic, social, and ecological viability. When needs could not be met economically with water management strategies, a socioeconomic impact analysis was performed to estimate the economic loss associated with not meeting these needs (Appendix F).

The 2006 Plan considered environmental information resulting from site-specific studies and ongoing water development projects when evaluating water management strategies. Cumulative effects of water management strategies on Nueces River instream flows and inflows to the Nueces estuary were considered, as summarized in Appendix L. A list of endangered and threatened species in the Coastal Bend Region for each county was obtained from the U.S. Fish and Wildlife Service and these possible habitats were considered for each water management strategy (Section 4C). The 2001 Agreed Order includes operational procedures for Choke Canyon Reservoir and Lake Corpus Christi and requires passage of inflows to the Nueces Bay and Estuary based on maximum harvest studies and inflow recommendations to maintain the health of the Nueces Estuary.

Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region.

The 2006 Plan consists of initiatives to respond to drought conditions, such as the City of Corpus Christi Drought Management Plan, which included modifying the operation of the CCR/LCC System during drought conditions as required by the Agreed Order to conserve water. As a further drought protection provision, the Coastal Bend Region adopted use of safe yield analyses for purposes of determining water supply. The use of safe yield analyses anticipates that a future drought may occur that is greater in severity than the worst drought of record and reserves a certain amount of water in storage (i.e., 7 percent of CCR/LCC System) for such an event. Use of safe yield for the major water supplies in the Nueces River Basin is justified based on previous droughts in the basin over the past 70 years. Figure 7-1 shows how 3-year average annual inflows for the major reservoir system have been reduced for each of the past four significant droughts.

The Coastal Bend Region conducted numerous meetings during the 2006 planning cycle, with meetings open to the public and decisions based on accurate, objective, and reliable information. The Region coordinated water planning and management activities with local, regional, state, and federal agencies and participated in interregional meetings with the South Central Texas Region (Region L) to identify common needs and worked together with Region L to develop interregional strategies in an open, equitable, and efficient manner. The Coastal Bend Region considered recommendations of stream segments with unique ecological value by Texas Parks and Wildlife and sites of unique value for reservoirs. At this time, the Coastal Bend Region recommends that no stream segments or reservoir sites with unique ecological value be designated. The Planning Group developed policy recommendations for the 2006 Plan including protection of water quality, consideration of environmental issues, interbasin transfers, groundwater management, request for additional studies for water supply projects (such as desalination), and continued funding for regional water planning efforts.

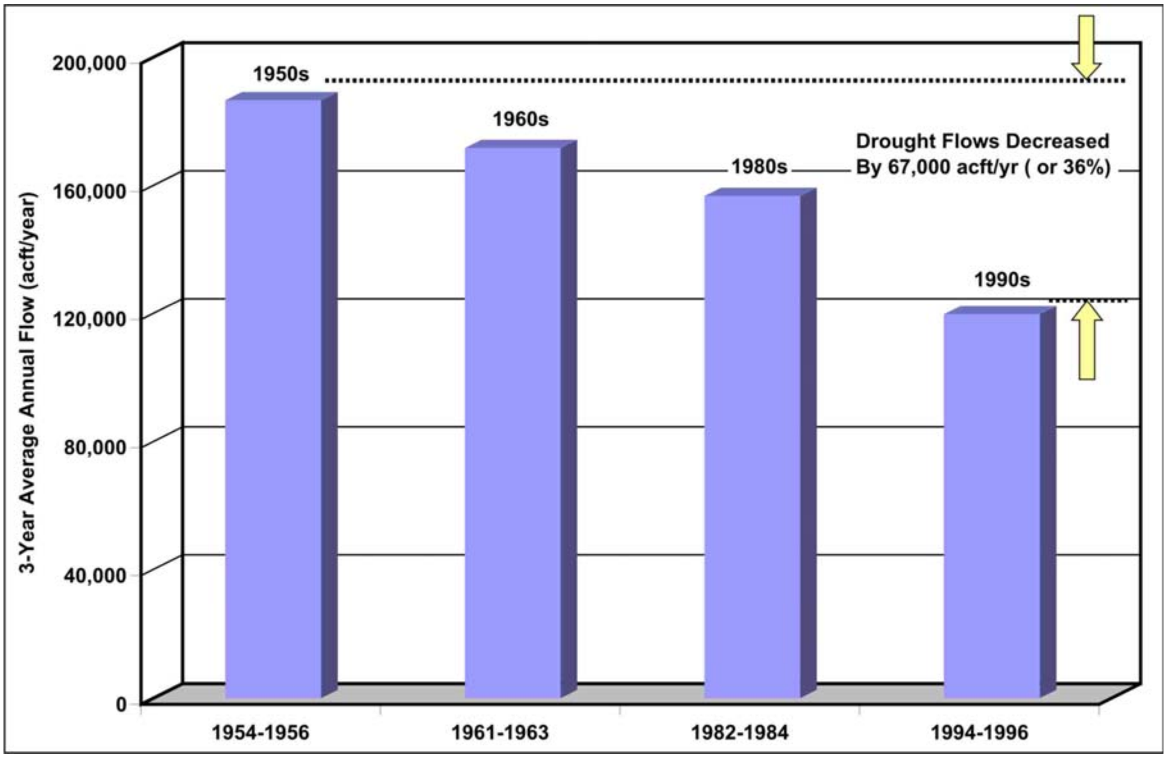

Figure 7-1. 3-Year Reservoir Inflows

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Section 8
Legislative Recommendations, Unique Stream Segments, and Reservoir Sites [31 TAC §357.7(a)(8-9); 31 TAC §357.8; 31 TAC §357.8]

Each of the 16 regional water planning groups may make recommendations to the TWDB regarding legislative and regional policy recommendations; identification of unique ecological stream segments; and identification of sites uniquely suited for reservoirs. The Coastal Bend RWPG selected a subcommittee to consider legislative and regional policy recommendations, which were adopted by the Coastal Bend Region. The following are the Coastal Bend Region's recommendations regarding these matters.

8.1 Legislative and Regional Policy Recommendations

Under the authority of Senate Bill 1, the Coastal Bend RWPG has developed the following legislative and regional policy recommendations.

General Policy Statement

I. The Texas Legislature is urged to declare that: i) all water resources of the State are hydrologically inter-related and should be managed on a "conjunctive use" basis, wherever possible; ii) existing water supplies should be more efficiently and effectively used through improved conservation and system operating policies; and iii) water re-use should be promoted, wherever practical, taking into account appropriate provisions for protection of downstream water rights, domestic and livestock uses, and environmental flows.

Interbasin Transfers

I. The Texas Legislature is urged to repeal the "Junior Rights" provision and the additional application requirements for interbasin transfers that were included in Senate Bill 1.

Desalination

I. The Texas Legislature is urged to direct TCEQ to investigate the current regulatory status of the "concentrate" or "reject water" produced during the desalination of brackish ground water, brackish surface water and seawater in industrial and municipal treatment processes and compare these to reject water requirements for the oil and gas industry and arrive at a common set of standards for the disposal of these waste products so that safe, economical methods of disposal will be available to encourage the application of these technologies in Texas.

II. The Texas Legislature is urged to direct TCEQ to work with TWDB and TPWD to develop information on the potential environmental impacts of concentrate discharges from seawater desalination facilities and to facilitate the permitting of these discharges into tidal waters where site specific information shows that no environment damage would occur.

III. Texas Legislature is urged to amend state laws governing the procurement of professional services by public agencies in order to allow municipalities, water districts, river authorities and other public entities to utilize alternatives to the traditional "Design-Bid-Build" methods for public work projects, including desalination facilities. For example, most large-scale desalination facilities built in the past 10 years are constructed using "Build-Own-Operate-Transfer" method, allowing for a cost-effective transfer of project risks to the private sector.[1]

Groundwater Management

I. The Texas Legislature is urged to encourage a regional approach to the management of groundwater resources wherever feasible, while also recognizing and encouraging local decision-making related to groundwater resource allocation issues.

II. TWDB, TCEQ, and the Texas Railroad Commission are urged to expand and intensify their activities in collecting, managing, and disseminating information on groundwater conditions and aquifer characteristics throughout Texas.

III. TWDB is urged to continue funding for updates to the groundwater availability models, specifically the Central Gulf Coast GAM covering the Coastal Bend Region.

IV. The Texas Railroad Commission is urged to cooperate with TWDB and TCEQ to encourage oil and gas well drillers to furnish e-logs, well logs, and other information that might be available on shallow, groundwater bearing formations to facilitate the better identification of aquifer characteristics.

V. The Texas Legislature is urged to appropriate additional funds for TWDB to continue and expand their statewide groundwater data program and to appropriate new funds, through regional institutions such as Texas A&M University – Corpus Christi and Texas A&M University –Kingsville, for a regional research center to support research, data collection, monitoring, modeling, and outreach related to groundwater management activities in the Coastal Bend region of Texas.

VI. The Texas Legislature is urged to make funds available through regional water planning groups and groundwater management districts to educate the citizens of Texas about groundwater issues, as well as the powers and benefits of groundwater management districts.

[1] "Large-Scale Seawater Desalination and Alternative Project Delivery", Design-Build DATELINE, February 2005.

VII. TCEQ is urged to amend rules and regulations to require routine water quality monitoring, by a non-partisan third-party, of mining operations and enforcement of water quality standards, including in situ mining and those with deep well injection practices.

VIII. The Texas Legislature is urged to prohibit in-situ mining in aquifers that serve as drinking water sources for residents and livestock.

Surface Water Management

I. The Texas Legislature is urged to provide funding for the development of periodic updates to surface water availability models, (WAMs), with specific consideration to updating the Nueces River Basin WAM though new drought period (Through December 2003.)

Regional Water Resources Data Collection and Information Management

I. The Texas Legislature is urged to provide SB1 planning funds, through the Coastal Bend RWPG to a regional institution, to support regional water resources data collection and activities to develop and maintain a "Regional Water Resources Information Management System" for the Coastal Bend area.

Role of the Coastal Bend RWPG

I. The Coastal Bend RWPG should play a role in facilitating public information/public education activities that promote a wider understanding of state and regional water issues and the importance of long-range regional water planning.

II. The Texas Legislature is urged to continue funding the TWDB to provide support for state mandated regional water planning group activities.

III. Public entities in the Coastal Bend Water Planning Region are urged to provide their share of continued funding for the administrative support activities that facilitate the Coastal Bend RWPG activities.

8.2 Identification of River and Stream Segments Meeting Criteria for Unique Ecological Value

The Coastal Bend Region considered TPWD's recommendations regarding the identification of river and stream segments which meet criteria for unique ecological value (Appendix G). In January 2005, the Coastal Bend Region recommended that no river or stream segments within the Coastal Bend Region be identified at this time.

8.3 Identification of Sites Uniquely Suited for Reservoirs

No sites uniquely suited for reservoirs were identified by the Coastal Bend Region.

8.4 Additional Recommendations

The following additional recommendations are under consideration by the Coastal Bend RWPG:

- Studies of the interaction of groundwater and surface water along the Lower Nueces River should be continued to identify alternatives to improve water quality to entities diverting water from this stream segment.

- Studies of the potential to develop a large-scale, multiyear ASR system in the Gulf Coast Aquifer should be continued to help drought-proof the Region.

- Options that will maximize the benefits of using treated wastewater to enhance the productivity of the Nueces Estuary should continue to be evaluated. This would allow other water now used for this purpose to be conserved. For example, continue studies of a methodology using a multiplier system for granting credits (exceeding 1:1 ratio) under the Agreed Order for treated wastewater flows to the Nueces Delta to enhance biological productivity of the Nueces Bay and Estuary.

- Studies of desalination options to further reduce the cost of using seawater and/or brackish groundwater should be continued.

- Studies addressing the potential for saltwater contamination from various sources, such as over pumping of water wells or improperly plugged and abandoned oil and gas wells, that adversely affect local groundwater supplies should be undertaken. Funding should be provided to address known problems and/or enforce responsible parties to properly plug abandoned wells, including oil, gas, and water wells.

- Studies should be undertaken to analyze the effects/costs of new EPA Safe Drinking Water Act requirements regarding the treatment of problematic constituents in groundwater on users in the Coastal Bend Region.

- Feasibility studies should be undertaken to optimize and reduce, if possible, the costs of water system interconnects for the cities of San Diego, Freer, Benavides, Premont, and Falfurrias to improve the quantity and quality of potable water available to these cities. Additionally, an evaluation should be undertaken of the feasibility of a regional desalination facility for the treatment of poor quality groundwater to improve the quality of potable water to these cities.

- Feasibility studies should be undertaken to identify opportunities/costs to develop regional groundwater systems that could utilize poor quality groundwater in conjunction with a desalination treatment plant to more effectively manage groundwater resources within the Coastal Bend Region.

- A detailed inventory of irrigation systems, crops, and acreage should be undertaken to more accurately estimate irrigation demands in the region.

- Environmental studies of the segments of the Frio and Nueces Rivers downstream of Choke Canyon Reservoir and upstream of Lake Corpus Christi should be undertaken to fully evaluate the potential impacts of reduced instream flows, including groundwater recharge, associated with the option to construct a pipeline between the two reservoirs.

- The Coastal Bend Region should work with Region P on environmental studies associated with the potential construction of Stage II of Lake Texana.

- The Coastal Bend Region should perform environmental field studies of potentially unique stream segments and potential unique reservoir sites on the Aransas River and Copano Creek provided additional clarification is provided by the Texas Legislature regarding the repercussions of identifying a stream segment as unique.

- Support studies to closely monitor discharges from sand and gravel operations in the Lower Nueces River.

- Support studies of construction and implementation of pilot desalination plant to quantify and qualify impacts of operating a desalination facility in the Coastal Bend Region.

- The City of Corpus Christi is opposed to indirect reuse of water associated with the City of Austin's proposal for indirect reuse to be reclaimed downstream by new customers.

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Section 9
Water Infrastructure Funding Recommendations
[31 TAC §357.7(a)(14)]

9.1 Introduction

Senate Bill 2 (77th Texas Legislature) requires that an Infrastructure Financing Report (IFR) be included in the 2006 regional water plan. In order to meet this requirement, each regional water planning group (RWPG) is required to examine the funding needed to implement the water management strategies and projects identified and recommended in the region's January 2006 regional water plan.

9.2 Objectives of the Infrastructure Financing Report

The primary objectives of the Infrastructure Financing Report are as follows:

- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

9.3 Methods and Procedures

For the Coastal Bend Regional Water Planning Area, municipal water user groups having water needs and recommended water management strategies in the regional plan with an associated capital cost were surveyed using the questionnaire provided by the TWDB, included in Appendix M.[1] For individual cities the survey was mailed to either the mayor or the assistant (city) manager.

The surveys were mailed via first class U.S. Mail, along with supporting documentation that summarized the water management strategies included in the regional plan for that entity. Follow-up phone calls and emails were conducted with cities who did not respond by the initial deadline.

9.4 Survey Responses

The Coastal Bend RWPG mailed three survey packages — one to the City of Corpus Christi, one to San Patricio Municipal Water District; and one to the City of Lake City.

[1] Based on TWDB guidance, surveys were sent to wholesale water provider if their customers showed shortages.

Responses were received from the City of Corpus Christi and SPMWD. Copies of the completed surveys and related documentation are included in Appendix M. As shown in Table 9-1, the two responses represent about 99.7 percent of the estimated capital costs of water management strategies included in the Coastal Bend Regional Water Plan. Of those responding, for which total capital costs are $54 million[2], the survey shows that approximately $49 million (90 percent of the total capital costs) would be financed through bonds. Approximately $5 million (9.7 percent of the total capital costs) would be financed through State Government programs. According to SPMWD, the only project that would be funded and completed by the District would be the Gulf Coast Aquifer supply, and all other projects will be funded through water rates with the City of Corpus Christi providing initial funding. It is also important to note that it is unclear how the remaining 0.3 percent of the capital costs ($186,000 for those who did not respond to the survey) would be financed. Table 9-2 provides a brief summary of responses from all utilities that provided written comments.

With respect to the role of the State in financing the recommended water supply projects, significant State participation is required in order to provide adequate funding for the implementation of water management strategies in the plan.

[2] The total water supplied by all water management strategies exceeds projected water needs and it is anticipated that not all water management strategies will be implemented. Total cost is based on average unit cost of strategies ($621/acft) and amount of water needed to meet projected water demands.

Table 9-1.
Summary of Survey Responses for Coastal Bend Region (Region N)

Name of Political Subdivision	Recommended Project/Strategy	Implementation Date	Total Capital Cost to be paid by Political Subdivision	ID # from DB07	Planning on Implementing the recommended Strategy? (Y/N)	If 'no' explaination of how they will meet future water needs.	% Cash Reserves	% Bonds	% Bank Loans	[illegible]	% Government Programs - State	% Other	TOTAL % (should be 100%)	Name of Contact Person	Title	Phone
City of Corpus Christi	Reclaimed Wastewater Supplies;	Current	$54,285,504[a]	N5	Y			90%			10%		100%	Ronald Massey	Assistant City Manager Public Works/Utility	361-826-3217
	Gulf Coast Aquifer Supplies;	By 2010		N7	Y											
	Garwood Pipeline;	By 2030		N14	Y											
	Voluntary Redistribution and USCOE Nueces Feasibility Projects;	By 2020; full implementation by 2040		N12	Y											
	Stage II Lake Texana	By 2060		N13	Y											
San Patricio Municipal Water District	Reclaimed Wastewater Supplies;	Current	$54,285,504[a]	N5	N[b]	Indirect participation in project (see note).								Don Roach	Assistant Manager	361-643-6521
	Gulf Coast Aquifer Supplies;	By 2010		N7	Y			100%					100%			
	Garwood Pipeline;	By 2030		N14	N[b]	Indirect participation in project (see note).										
	Voluntary Redistribution and USCOE Nueces Feasibility Projects;	By 2020; full implementation by 2040		N12	N[b]	Indirect participation in project (see note).										
	Stage II Lake Texana	By 2060		N13	N[b]	Indirect participation in project (see note).										
DID NOT RESPOND																
Lake City	Drill Additional Well- Gulf Coast Aquifer Supplies	By 2020	$186,000	N7												

[a] The total water supplied by all water management strategies exceeds projected water needs and it is anticipated that not all water management strategies will be implemented. Total cost is based on average unit cost of strategies and amount of water needed to meet projected water demands.
[b] Note: Although SPMWD may receive water supply from recommended projects, these projects would be funded through water rates from all raw water customers with the

Table 9-2.
Survey Responses — Comments and Proposed Options
Coastal Bend Regional Water Planning Area

City of Corpus Christi	The total cost of capital improvements was discounted 10% to account for State Participation Program portion of funding Texana Stage II.
San Patricio Municipal Water District	Only the Gulf Coast Aquifer supply project would be funded and completed by the District. If project moves forward, funding would come from private bond placement.

Section 10
Plan Adoption
[31 TAC §357.11-12]

10.1 Public Involvement Program

The public involvement program was incorporated at the onset of the Coastal Bend Regional Water Planning Group (CBRWPG) water planning process in order to maximize the opportunity for public review and input into the process of developing the water plan as well as critique the Initially Prepared Regional Water Plan.

The public involvement program included:

- An opportunity at all RWPG meetings for the public to comment on any aspect of the plan or planning process;
- Quarterly newsletters (see Appendix G):
  - 1. Fall 2004 (October 2004)
  - 2. Winter 2005 (March 2005)
  - 3. Summer 2005 (June 2005)
- Public Hearing for Initially Prepared Plan:
  July 14, 2005
  Johnny Calderon County Building
  710 Main Street, Robstown, Texas 78380
- Press releases and notices of public meetings; and
- Dedicated website for Coastal Bend RWPG information.

10.2 Coordination with City of Corpus Christi and San Patricio Municipal Water District

An informational meeting with City of Corpus Christi and San Patricio Municipal Water District was held on February 2, 2005 to evaluate projected water demands, supplies, and discuss their plans for future water supply projects for the CBRWPG water management planning process.

Representatives from water supply entities within the CBRWPG were also regularly notified of all CBRWPG meetings and public informational meetings.

10.3 Coastal Bend Regional Water Planning Group Meetings

The CBRWPG met approximately monthly or bimonthly since the inception of the planning process in order to facilitate and direct the water planning of the region. The following is a summary of the meetings:

Coastal Bend RWPG Meetings	
April 12, 2001	July 10, 2003
June 14, 2001	September 11, 2003
July 19, 2001	January 8, 2004
September 13, 2001	March 11, 2004
October 1, 2001	March 31, 2004
November 8, 2001	May 13, 2004
December 13, 2001	July 8, 2004
January 17, 2002	September 9, 2004
February 21, 2002	November 18, 2004
March 28, 2002	January 13, 2005
April 18, 2002	February 10, 2005
May 16, 2002	March 10, 2005
July 18, 2002	May 12, 2005
September 19, 2002	July 14, 2005
November 14, 2002	October 27, 2005
February 13, 2003	December 8, 2005
May 8, 2003	

The CBRWPG also designated several subcommittees in order to expedite more specific work efforts and further increase the effectiveness and timeliness of the planning process. The following summarizes these committee and subcommittee meetings.

Administrative Review Committee

- May 10, 2001

Nominations Committee Meeting

- February 21, 2002
- February 13, 2003

Public Meeting on Infrastructure Financing Report

- April 18, 2002

Executive Committee Meetings

- May 16, 2002
- July 18, 2002
- September 19, 2002
- September 11, 2003
- March 11, 2004
- January 13, 2005

Subcommittee to Review/ Revise Coastal Bend RWPG bylaws

- February 4, 2005

Subcommittee to Review Water Conservation Implementation Task Force BMPs

- March 8, 2004

Subcommittee on Policy Recommendations

- February 10, 2005
- March 10, 2005

The CBRWPG approved responses to the comments received on the Initially Prepared Plan and approved the Final Plan on December 8, 2005. The comments received on the Coastal Bend Initially Prepared Plan with approved responses are included in Appendix N.

10.4 Regional Water Planning Group Chairs Conference Calls and Meetings

The Texas Water Development Board had several meetings with Regional Water Planning Group chairs to provide guidance and respond to issues regarding the planning process:

Conference Calls

- March 13, 2003
- April 5, 2004
- August 31, 2004

Chairs Meeting

- July 15, 2003
- January 26, 2005

10.5 Coordination with Other Regions

A Joint Executive Committee Meeting between the Coastal Bend RWPG and the South Central Texas RWPG was held in an effort to share information regarding water supply and water management strategies.

August 12, 2004 at 1:00 pm.
Beeville Country Club
Hwy 181 North
Beeville, Texas 78104

Appendix A
List of References for In-Depth Description of the Region (from 2001 Plan)

Regional Water Studies:

Data for Regional Planning Group "N". Texas Water Development Board Water Resources Planning Division, Water Uses Section, 1997.

Trans-Texas Water Program. City of Corpus Christi, Port of Corpus Christi Authority, Corpus Christi Board of Trade, Texas Water Development Board, Lavaca-Navidad River Authority, September 1995.

Regional Water Supply Study: Duval and Jim Wells Counties, Texas. Nueces River Authority, Texas Water Development Board, October, 1996.

Regional Water Task Force: Final Report. Regional Water Conference. Coastal Bend Alliance of Mayors, Corpus Christi Area Economic Development Corporation, Port of Corpus Christi - Board of Trade, Dr. Manuel L. Ibanez, President, Texas A&I University, June 30, 1990.

Regional Water Planning Study: Cost update for Palmetto Bend, Stage 2 and Yield Enhancement Alternative for Lake Texana and Palmetto Bend, Stage 2. Lavaca-Navidad River Authority, Alamo Conservation and Reuse District, City of Corpus Christi, May 1991.

Northshore Regional Wastewater Reuse Water Supply and Flood Control Planning Study. San Patricio Municipal Water District, Texas Water Development Board, October 1994.

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Bureau of Economic Analysis: http://www.bea.doc.gov/

Environmental Protection Agency - Office of Water: http://www.epa.gov/watrhome/

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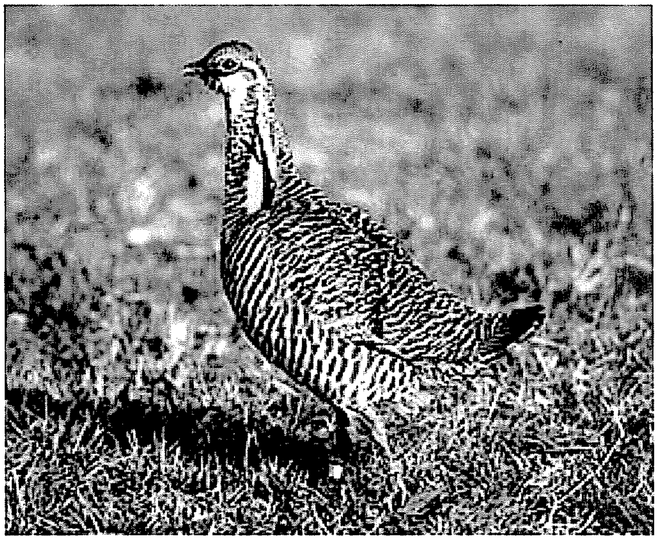
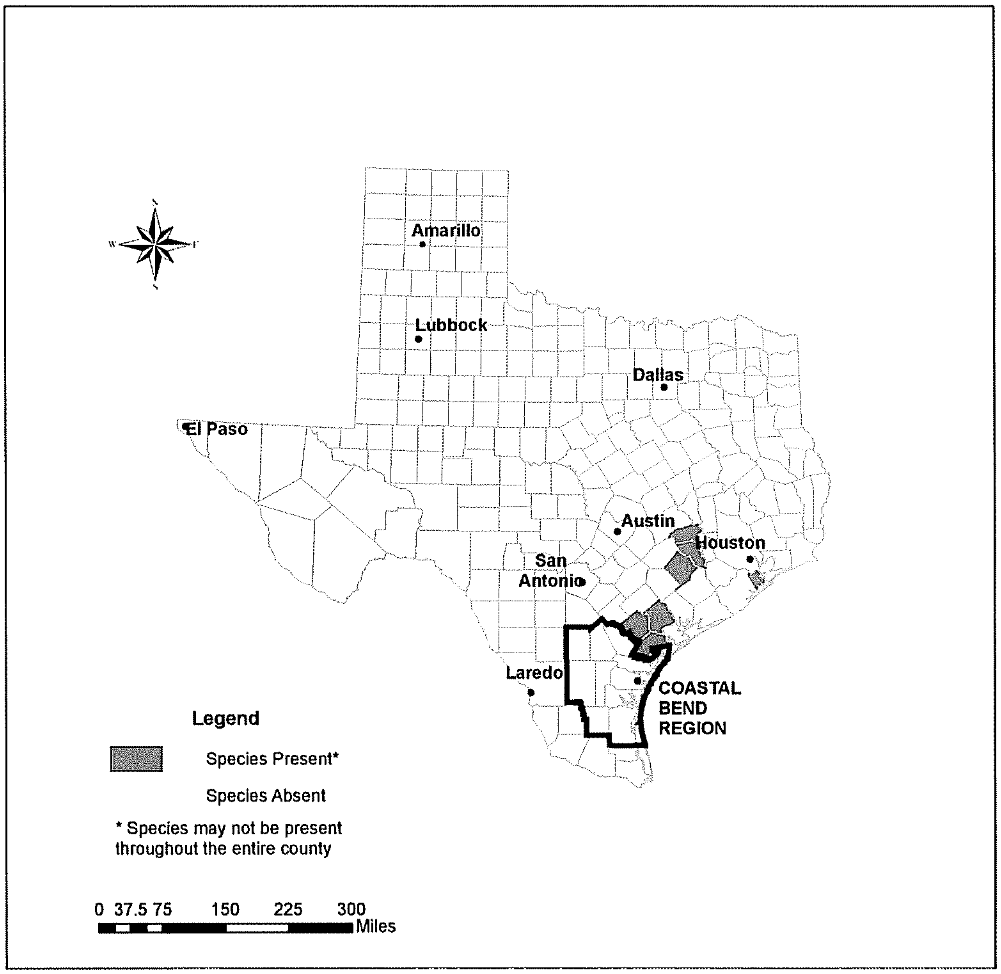
Appendix B
Endangered, Threatened, and Rare Species by County

Attwater's greater prairie-chicken

Scientific Name: Tympanuchus cupido attwateri

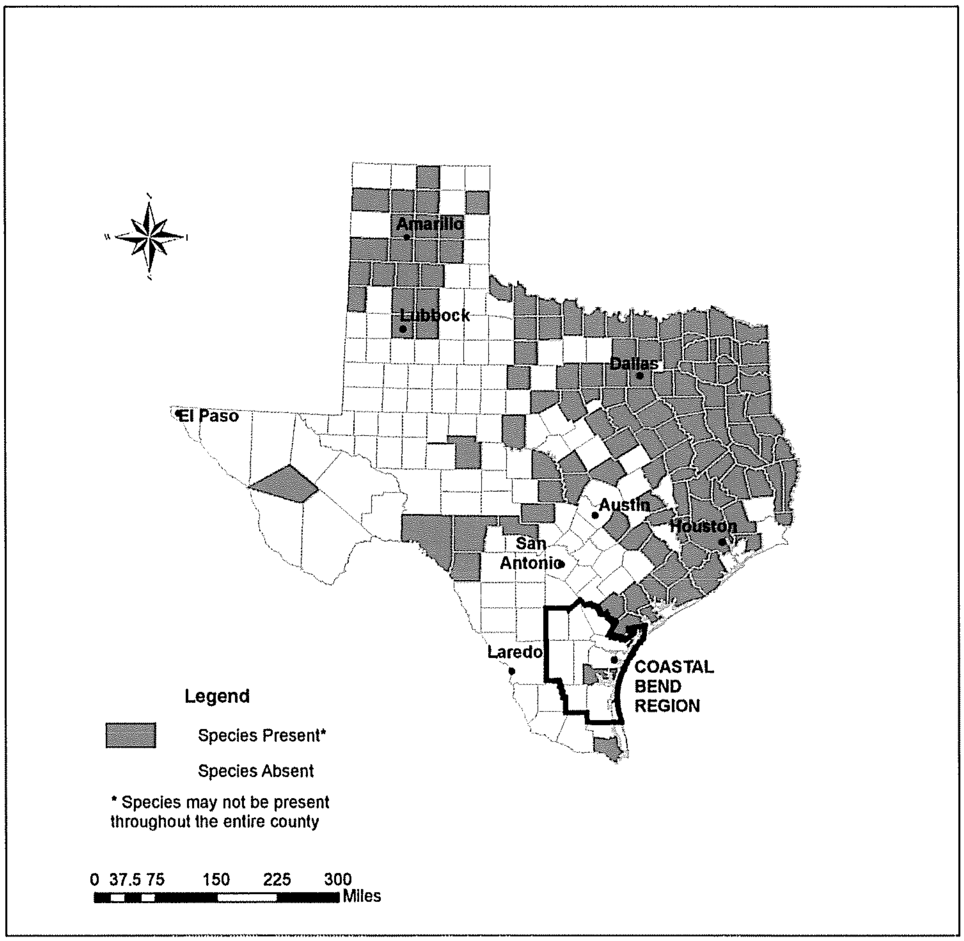




Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Bald Eagle

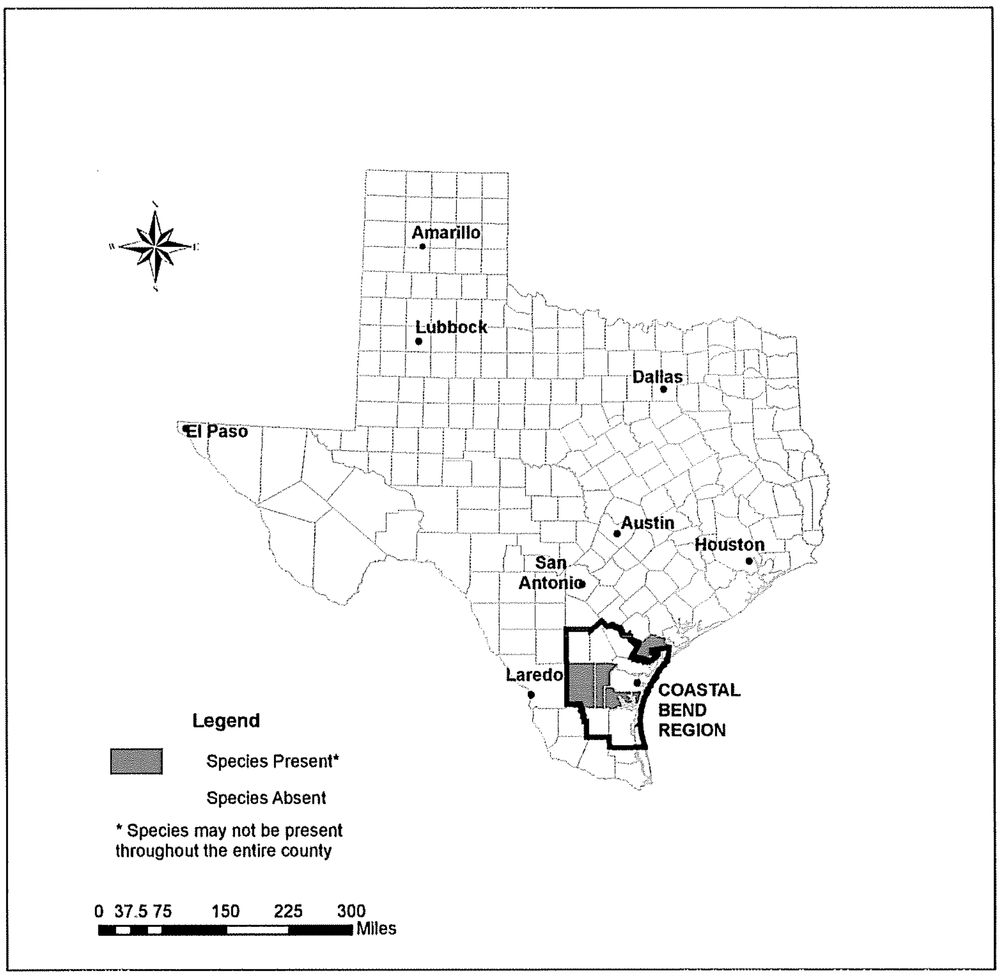
Scientific Name: Haliaeetus leucocephalus



Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Black Lace Cactus

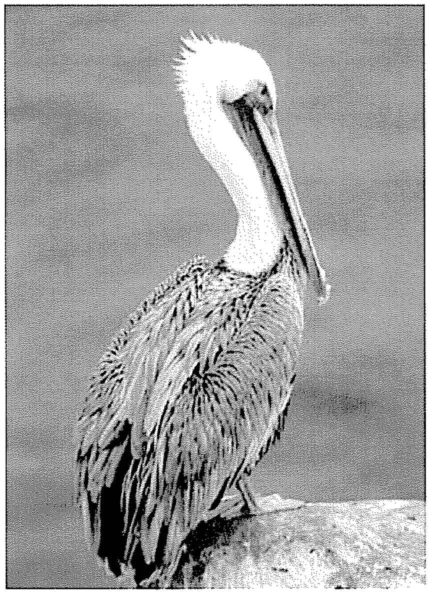
Scientific Name: Echinocereus reichenbachii var. albertii

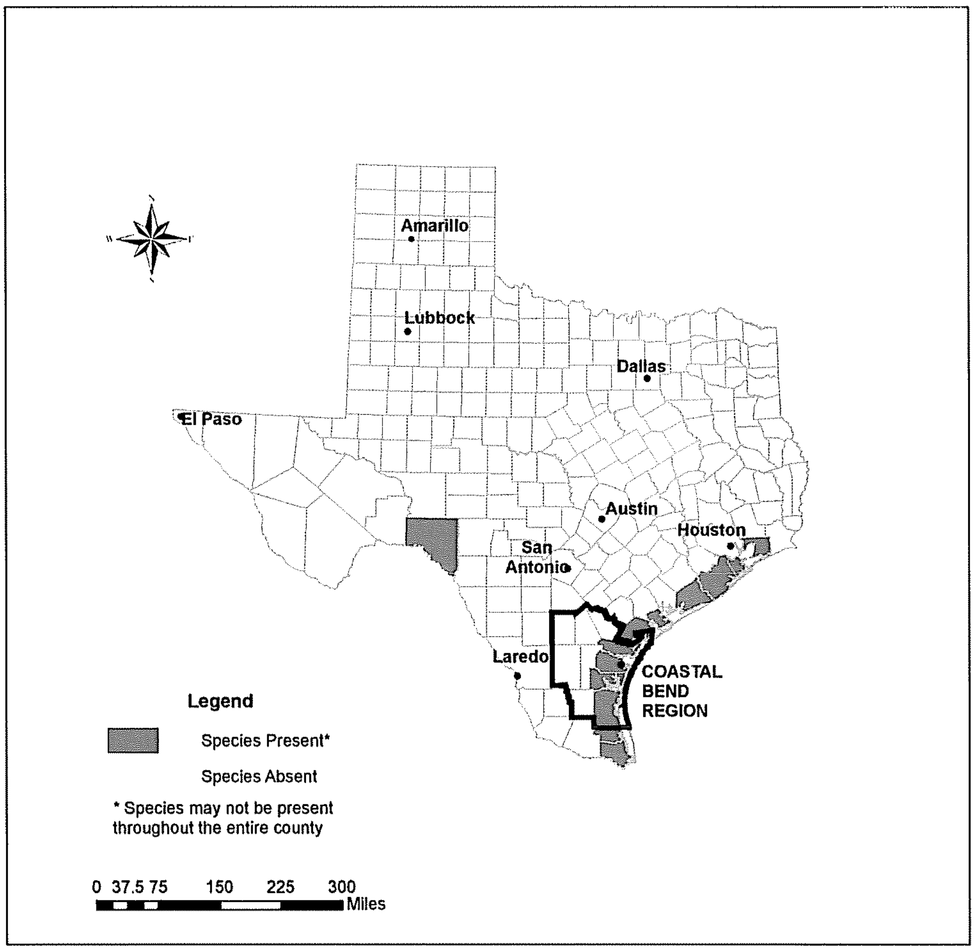


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Brown Pelican

Scientific Name: Pelecanus occidentalis

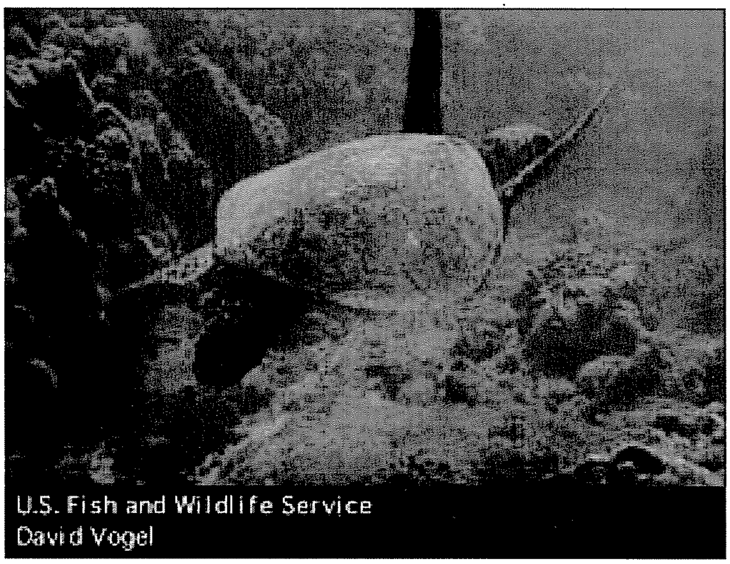


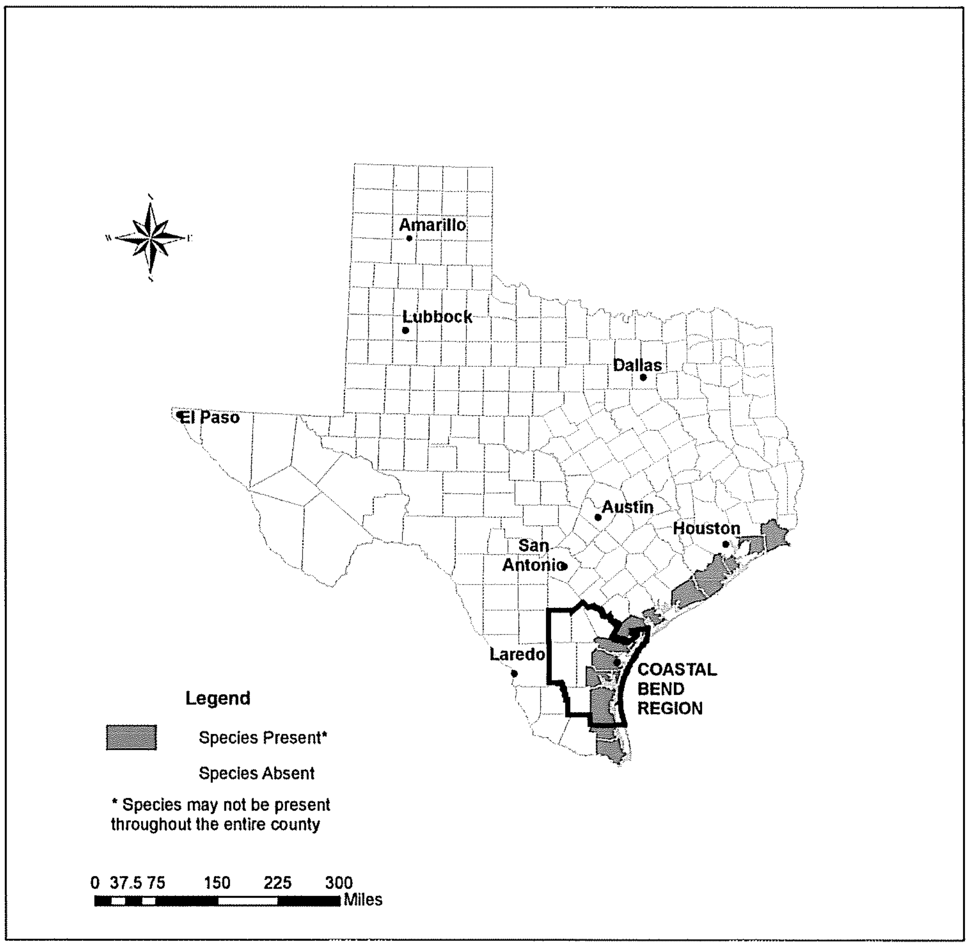


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Green Sea Turtle

Scientific Name: Chelonia mydas

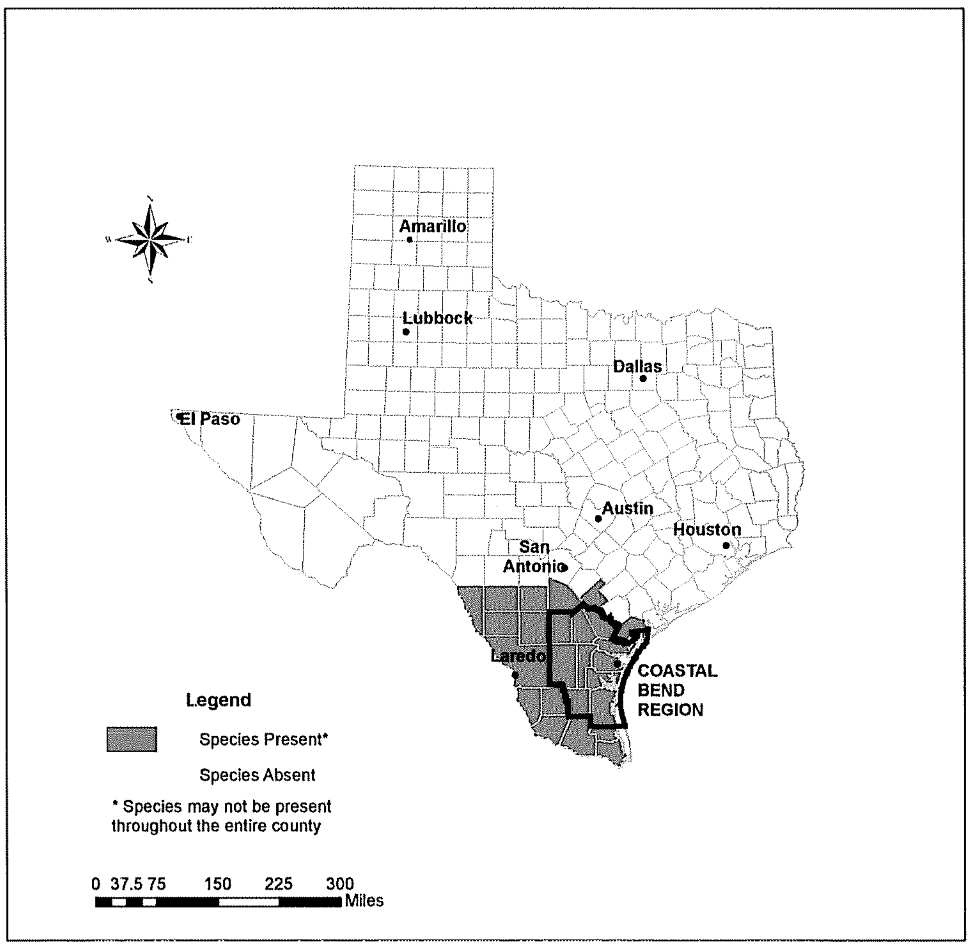




Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Gulf Coast Jaguarundi

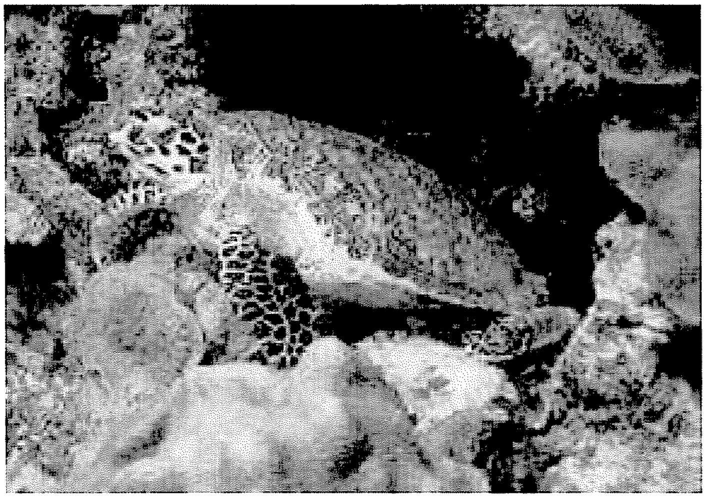
Scientific Name: Herpailurus (=Felis) yagouaroundi cacomitli

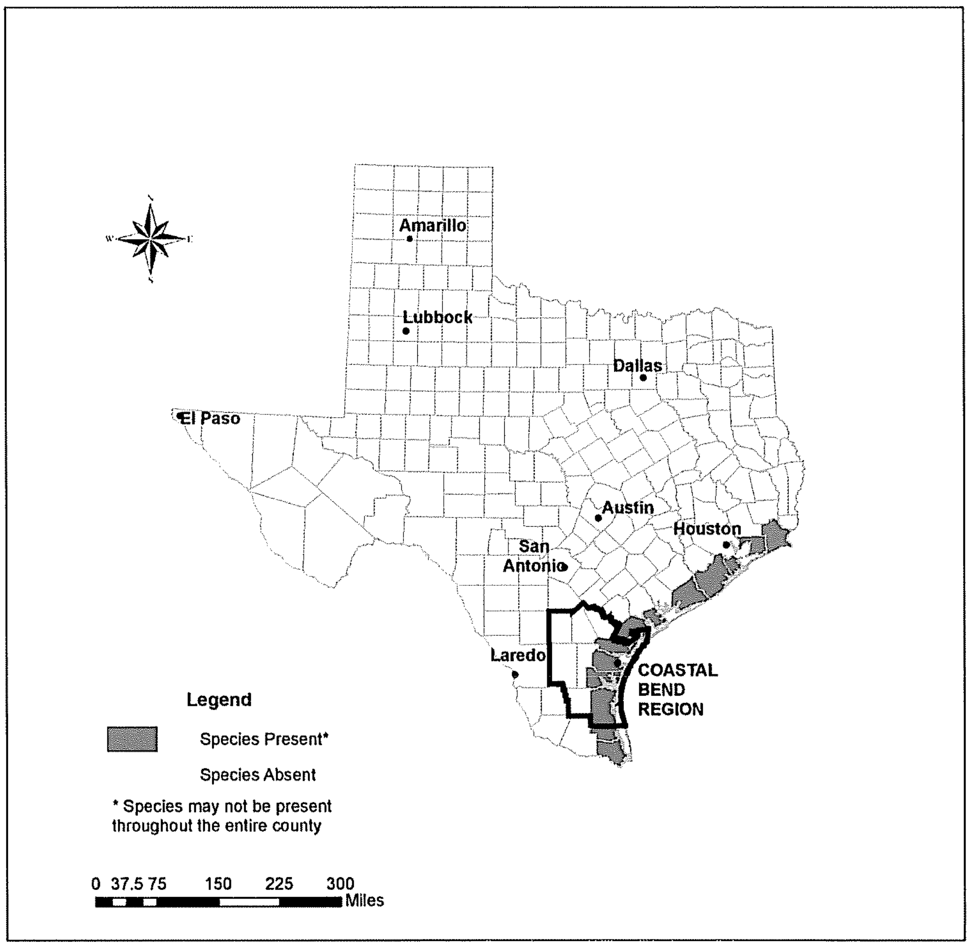


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Hawksbill Sea Turtle

Scientific Name: Eretmochelys imbricate

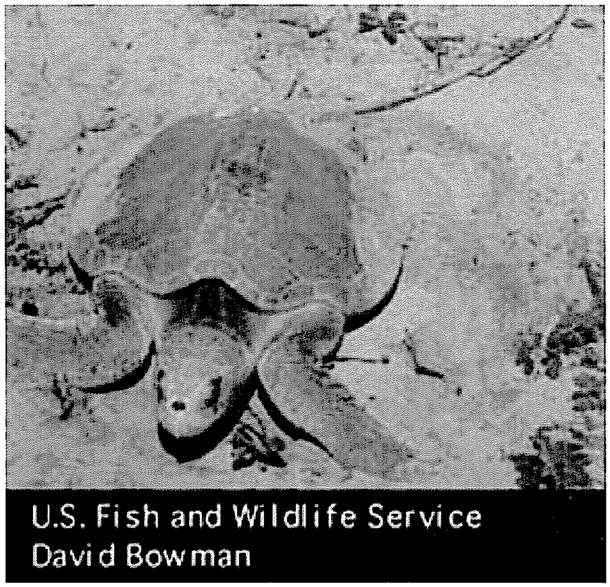


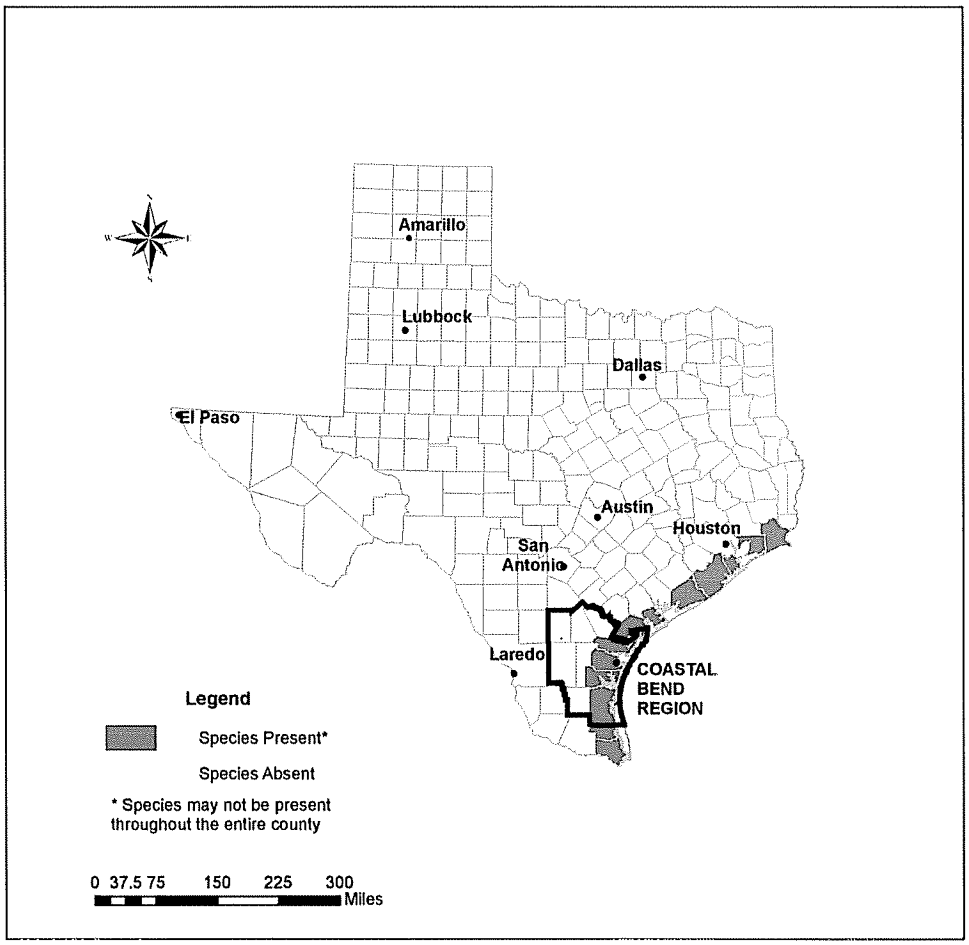


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Kemp's Ridley Sea Turtle

Scientific Name: Lepidochelys kempii

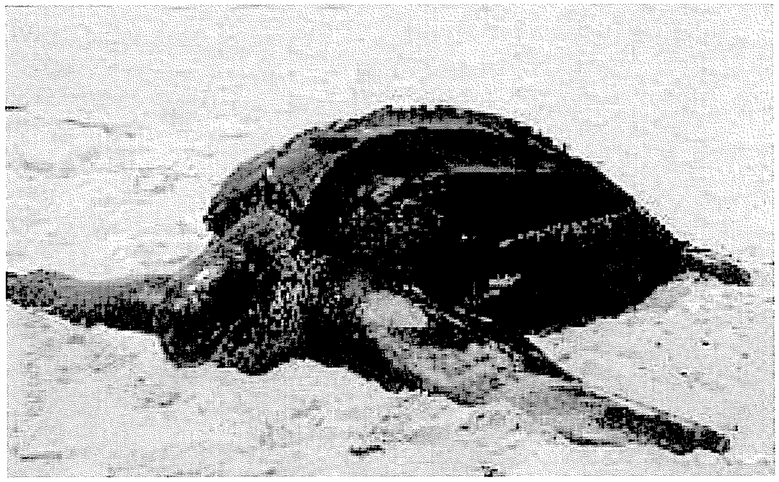


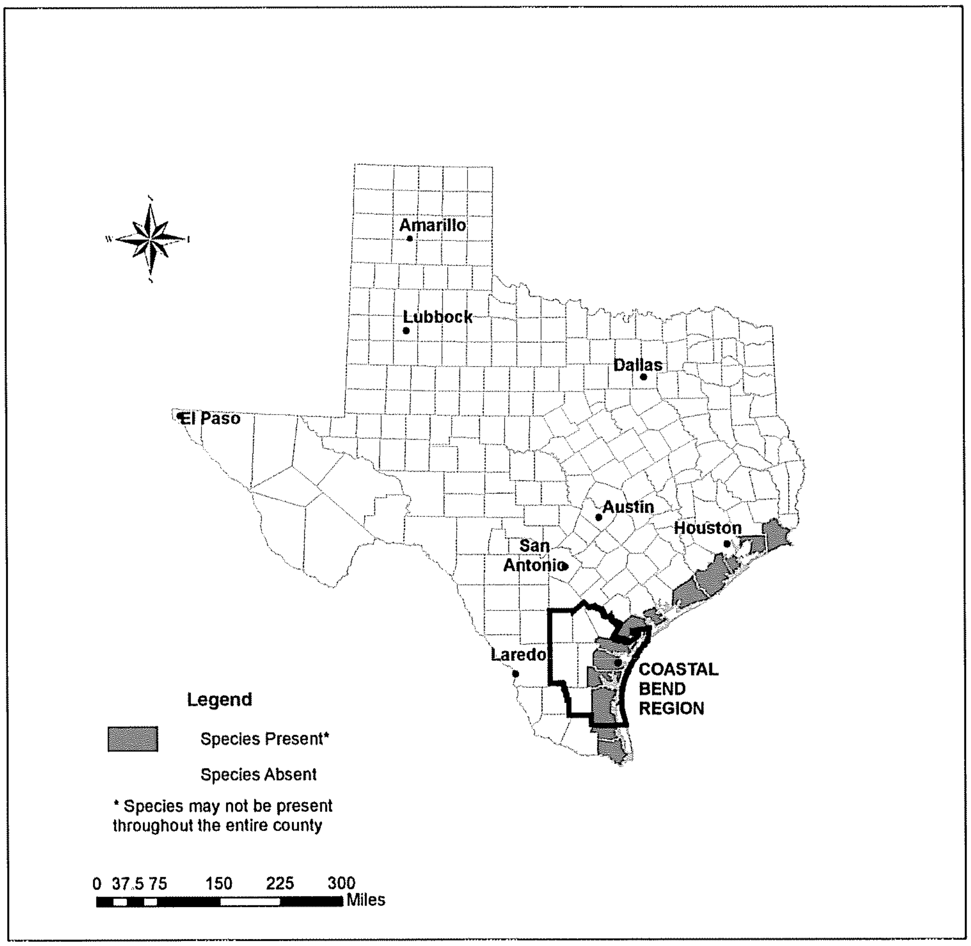


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Leatherback Sea Turtle

Scientific Name: Dermochelys coriacea

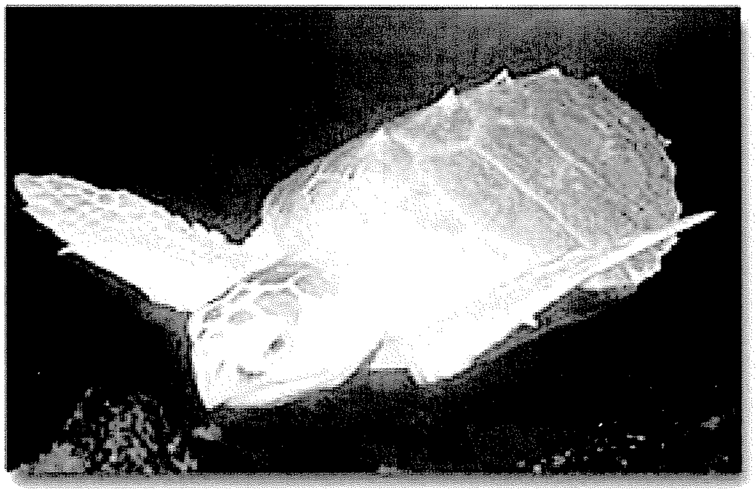




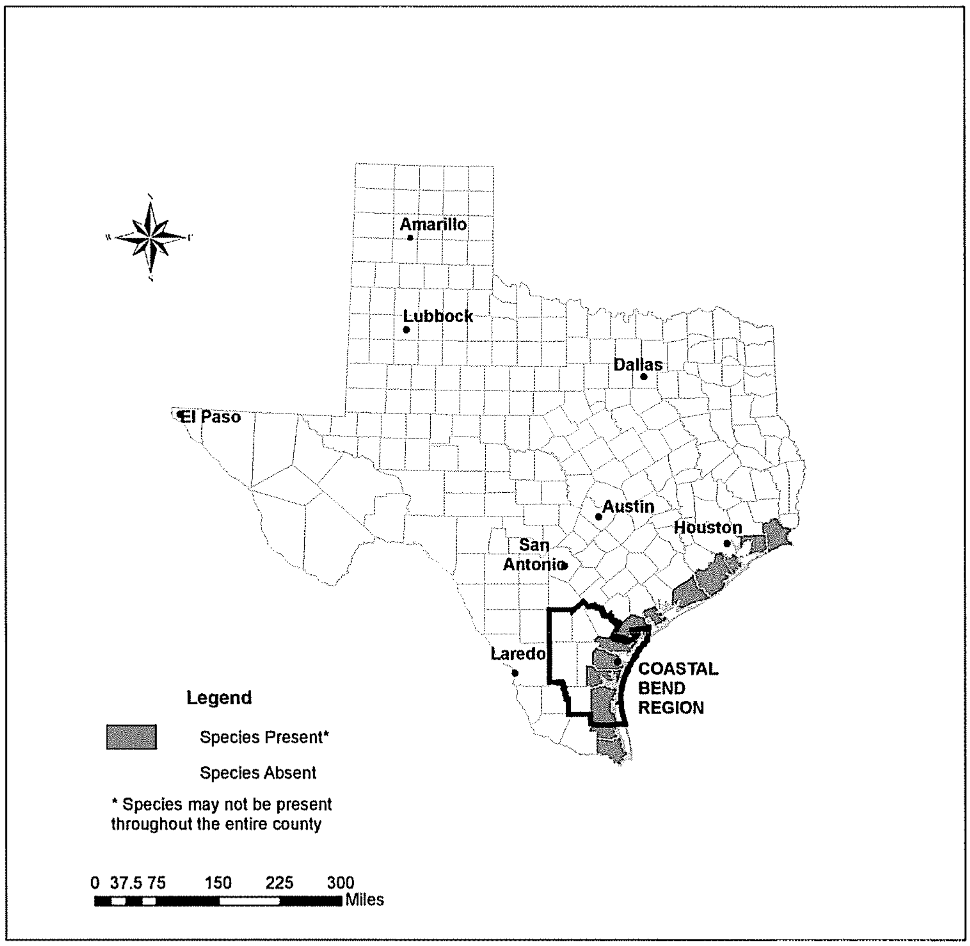
Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Loggerhead Sea Turtle

Scientific Name: Caretta caretta



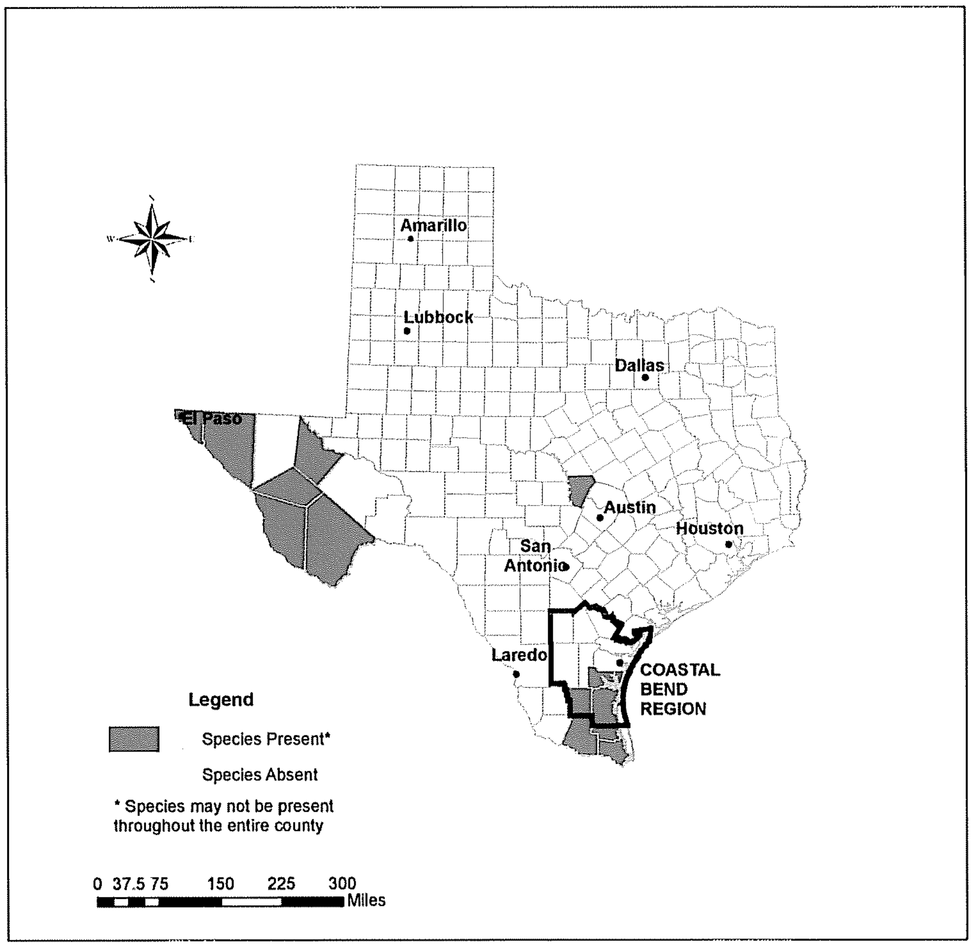
County Distribution Map



Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Northern Aplomado Falcon

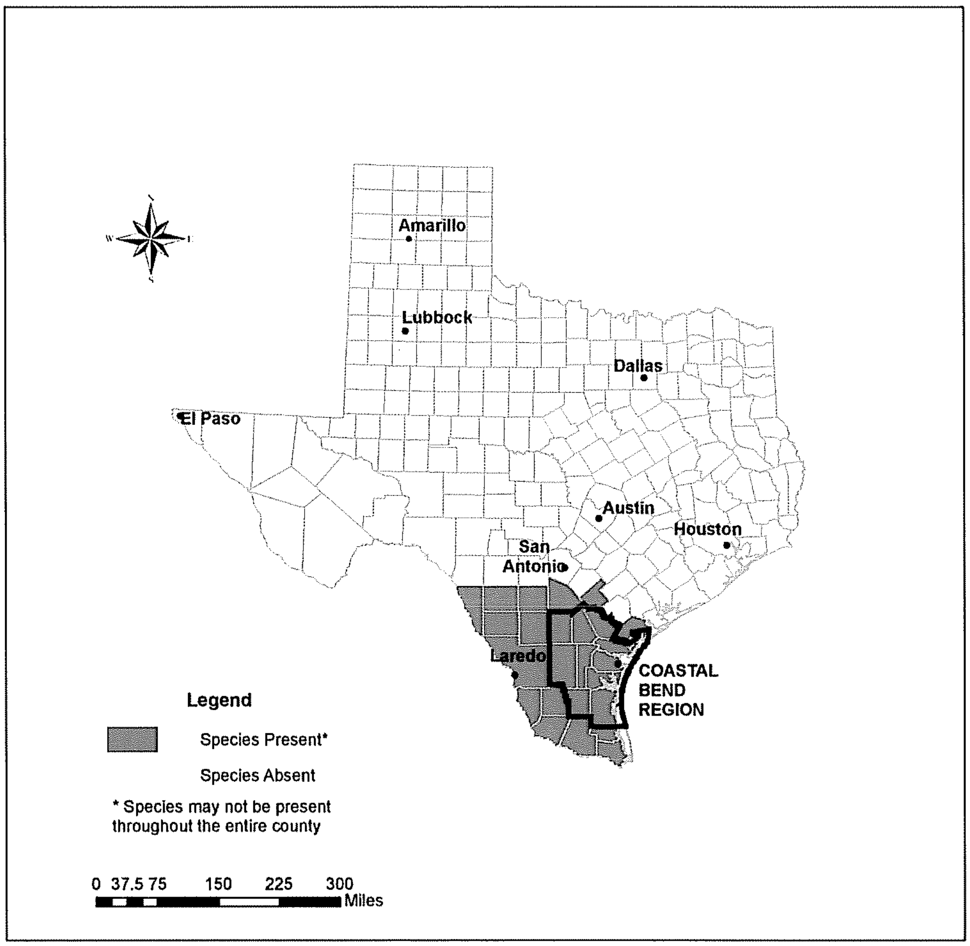
Scientific Name: Falco femoralis septentrionalis



Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Ocelot

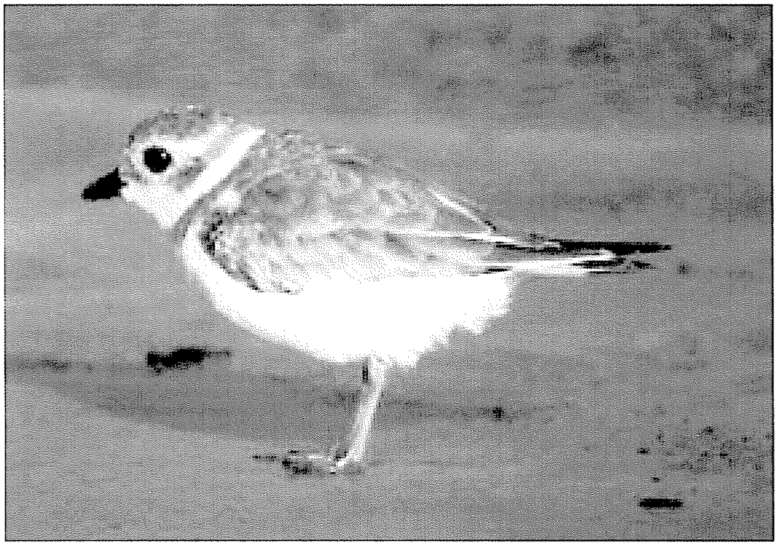
Scientific Name: Leopardus (=Felis) pardalis

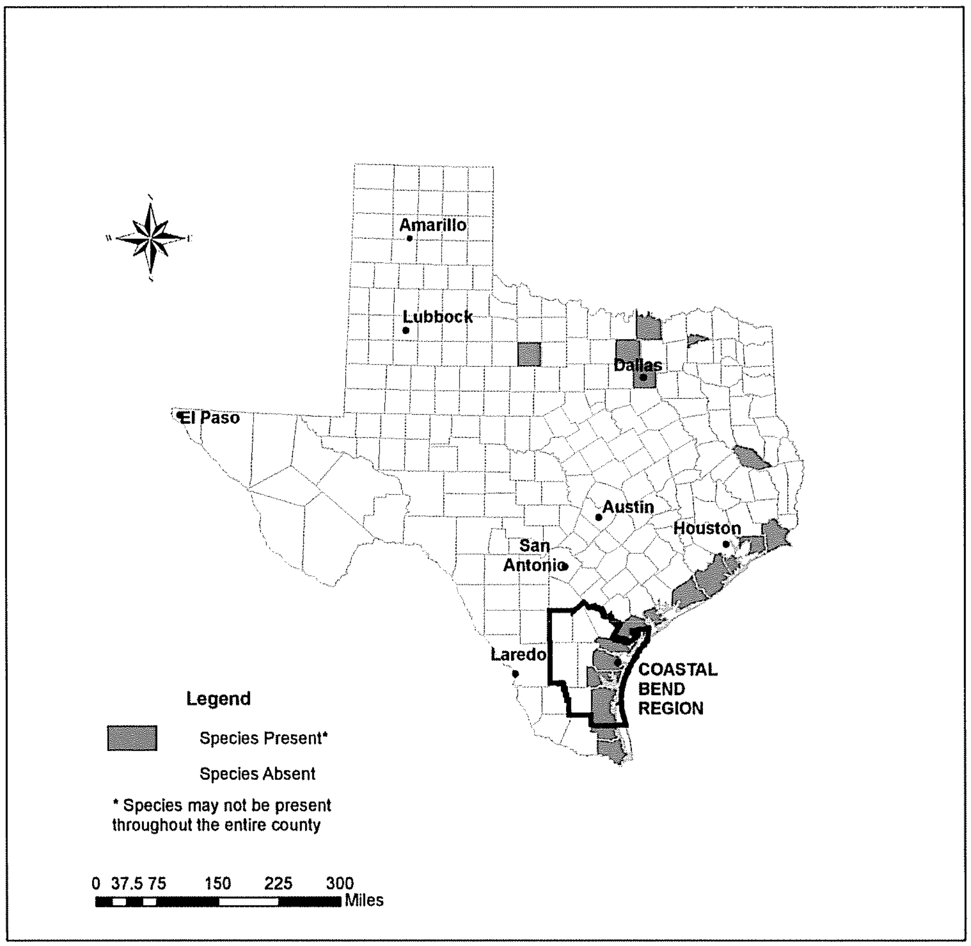


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Piping Plover

Scientific Name: Charadrius melodus

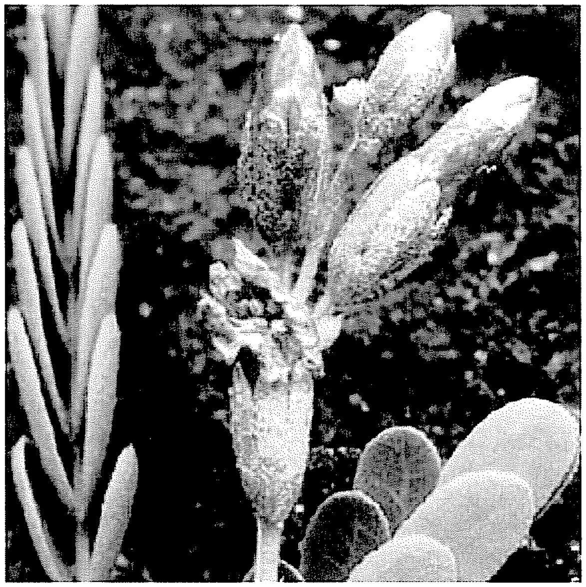


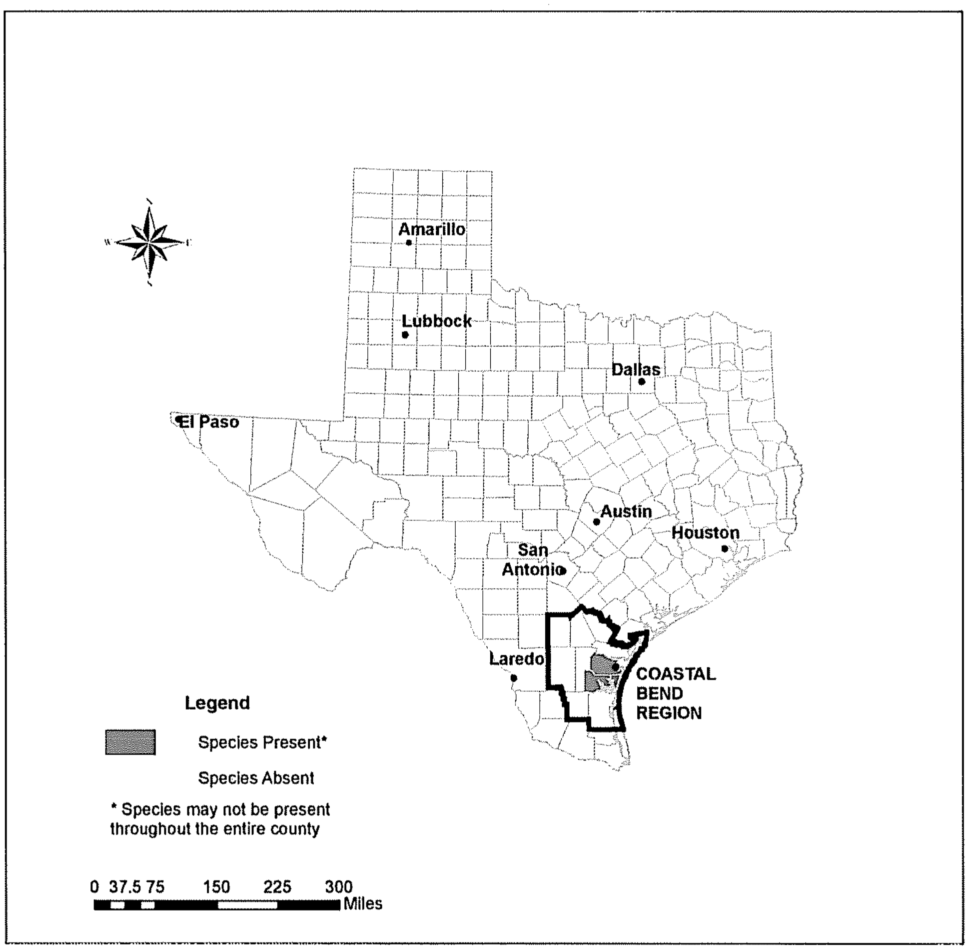


Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Slender Rush-pea

Scientific Name: Hoffmannseggia tenella

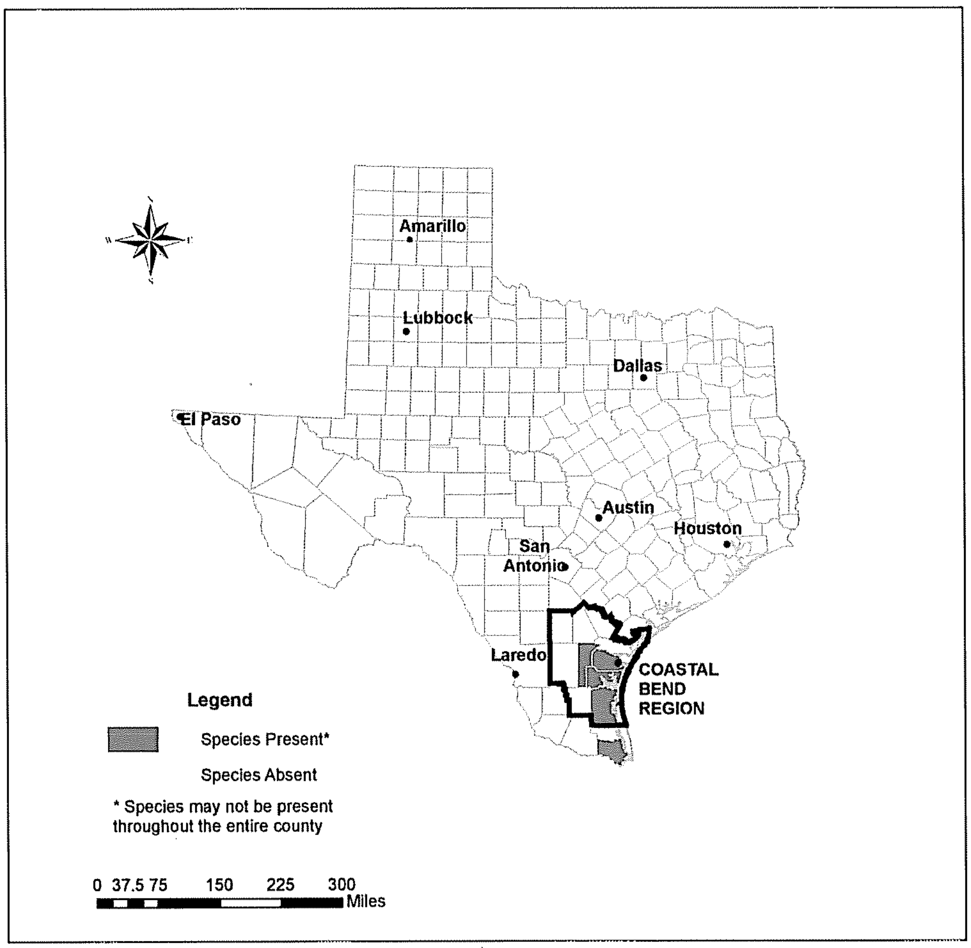




Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

South Texas Ambrosia

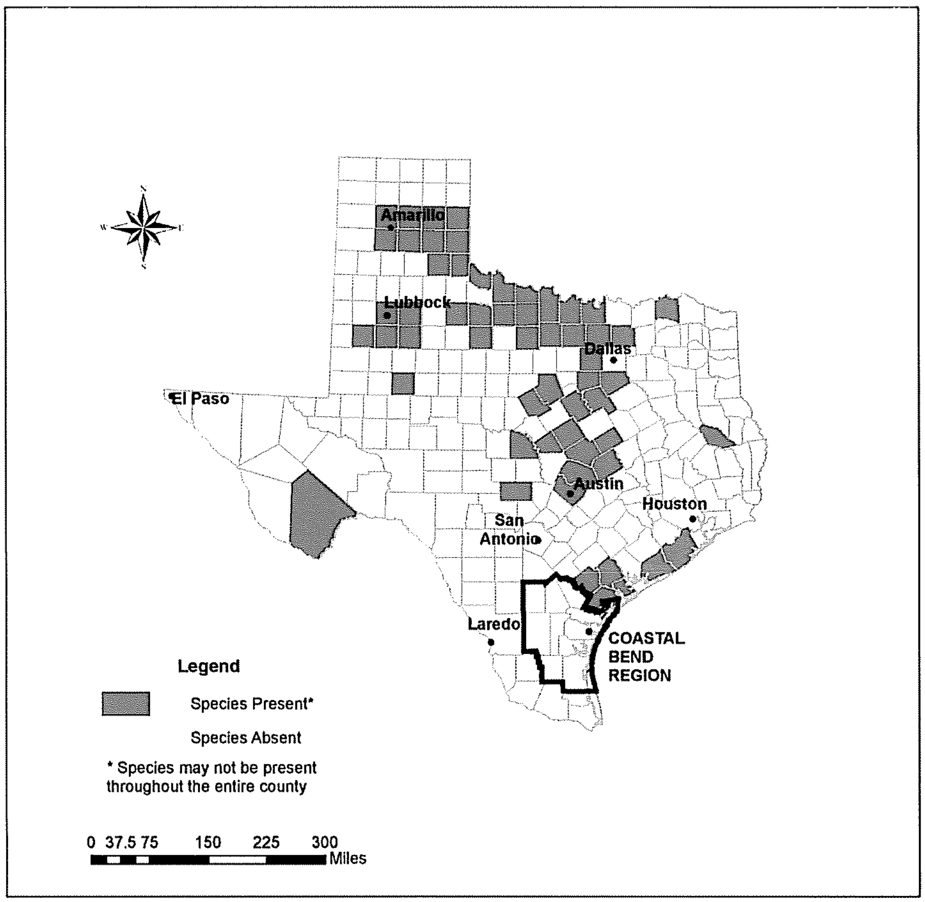
Scientific Name: Ambrosia cheiranthifolia



Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Whooping Crane

Scientific Name: Grus americana



Source: Southwest Region Ecological Services , Texas Fish and Wildlife.

Appendix C

Population, Water Use, and Supply/Demand Projection Summary Graphs

Contents

Appendix C.1

City and County-Other Figures with Population, Per Capita Water Demand, and Municipal Water Demand/Supply Projections

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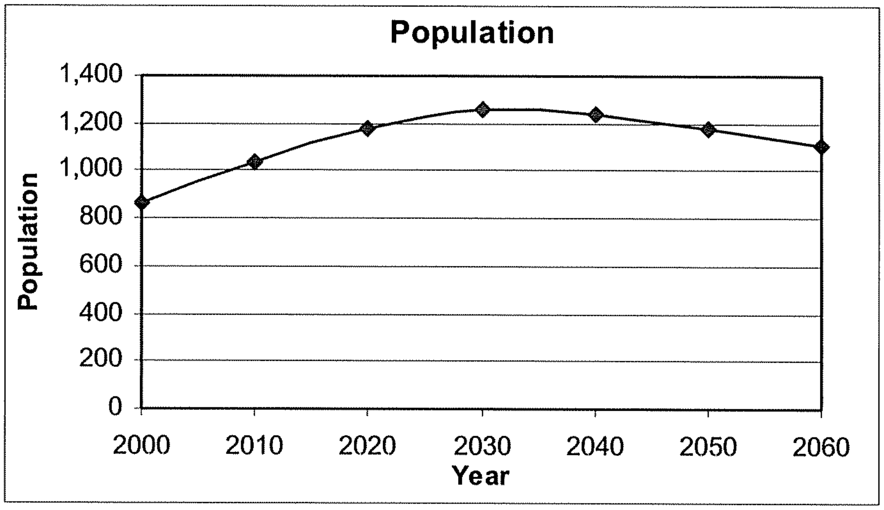
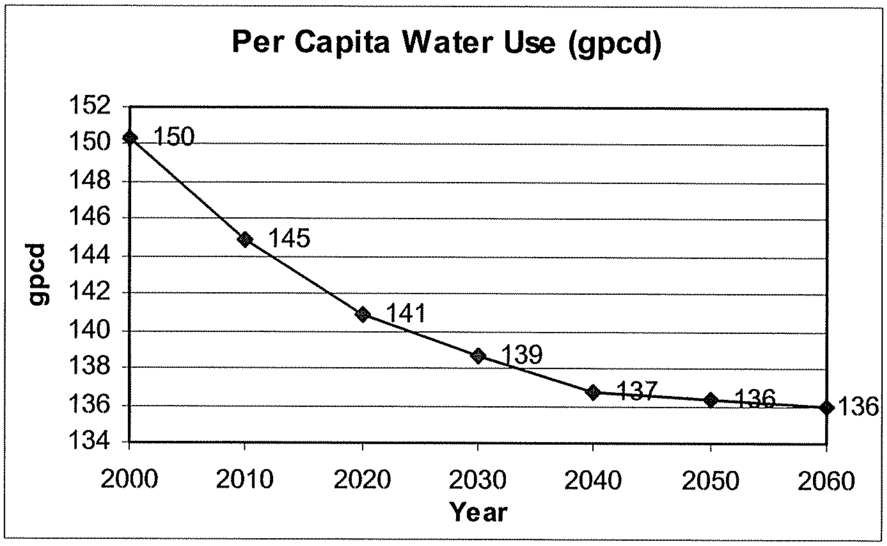
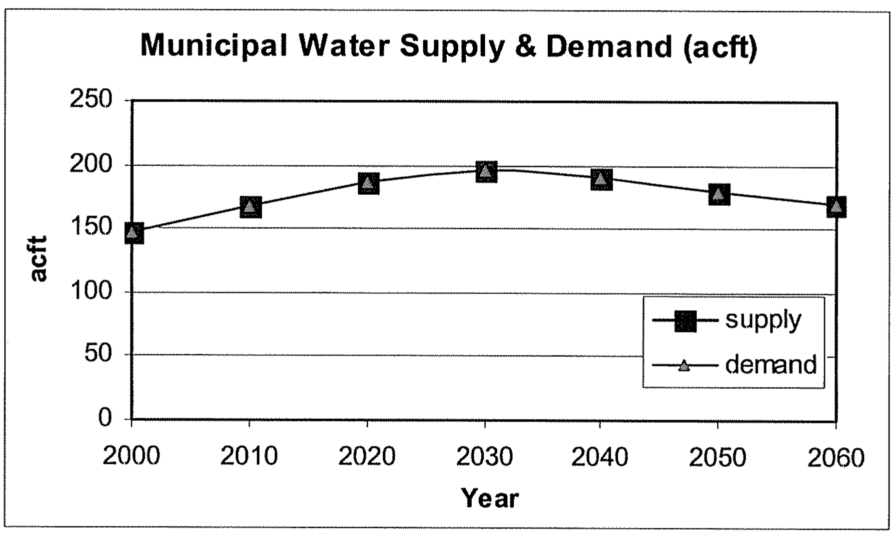
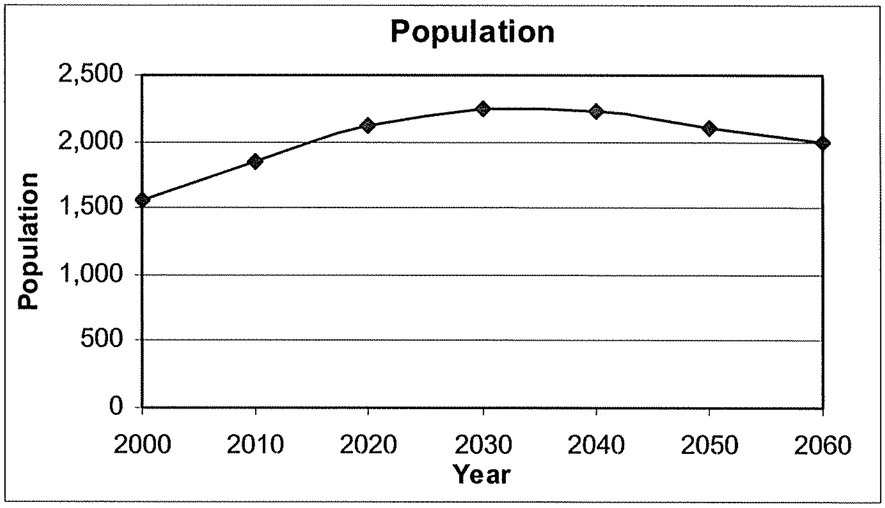
City of Aransas Pass — Aransas County

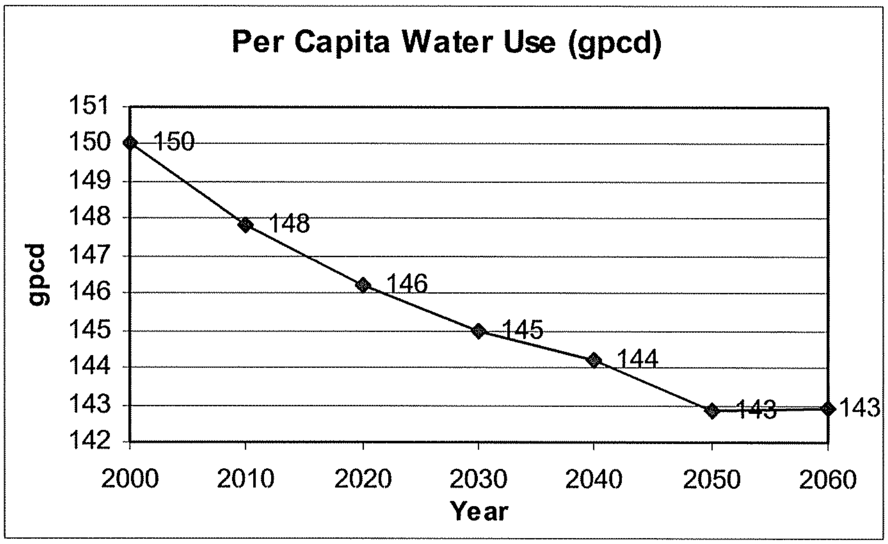


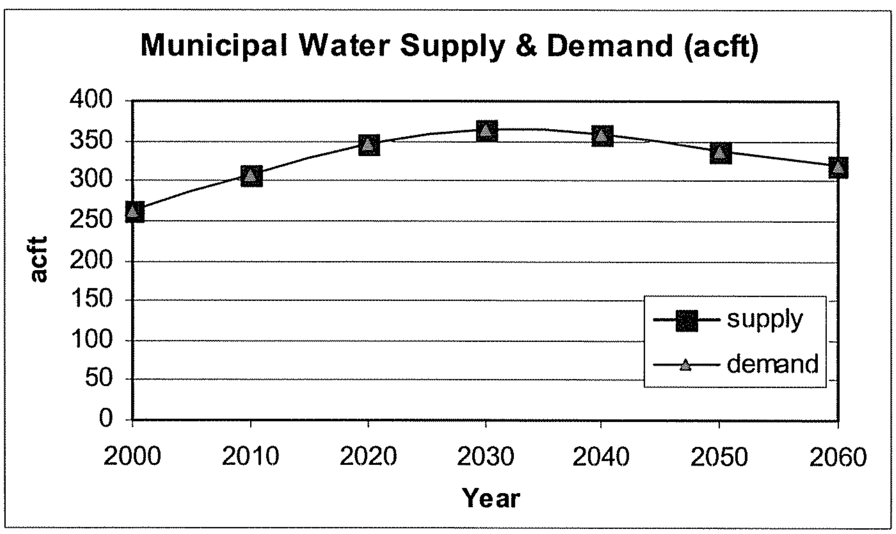




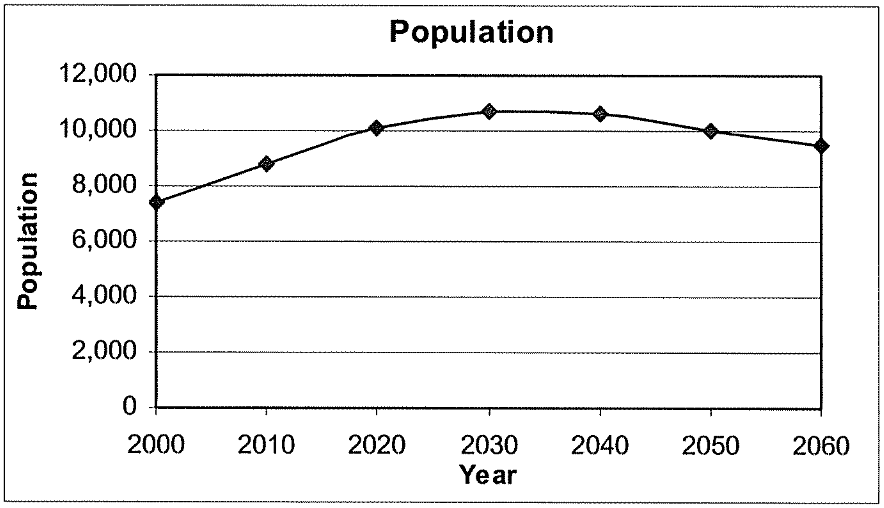
City of Fulton — Aransas County

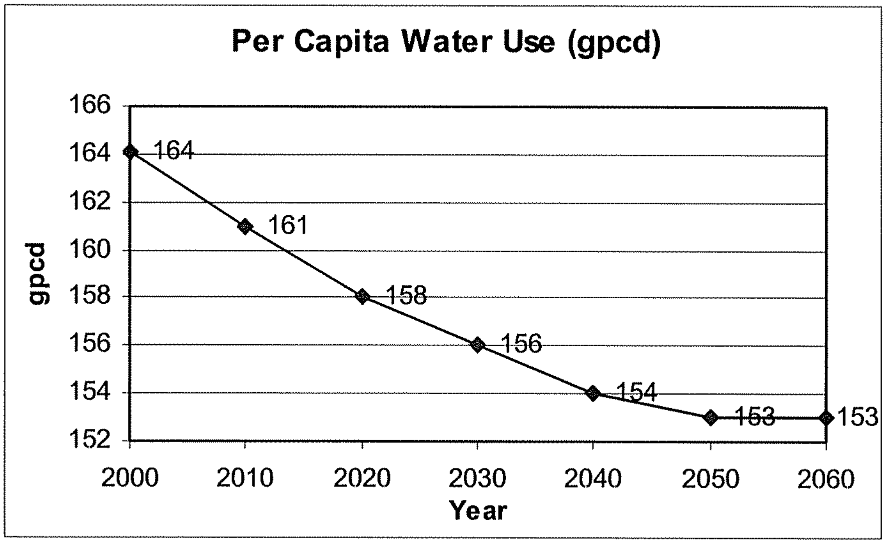


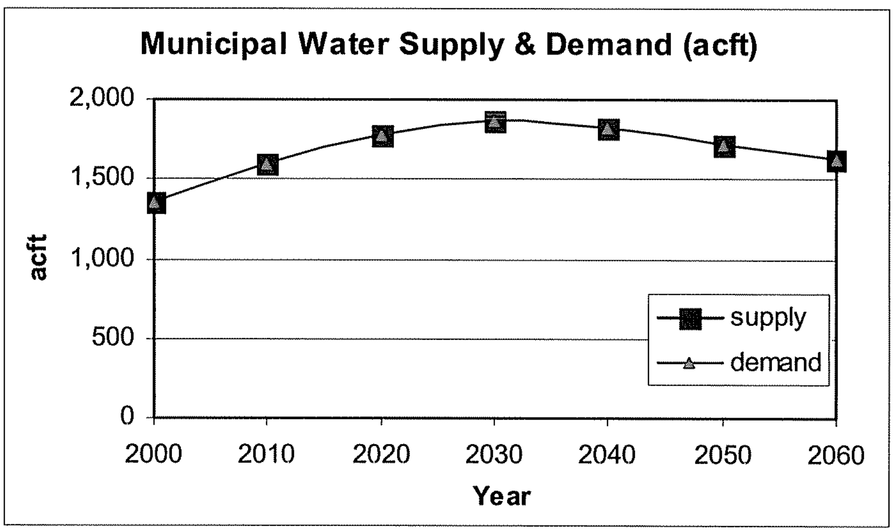




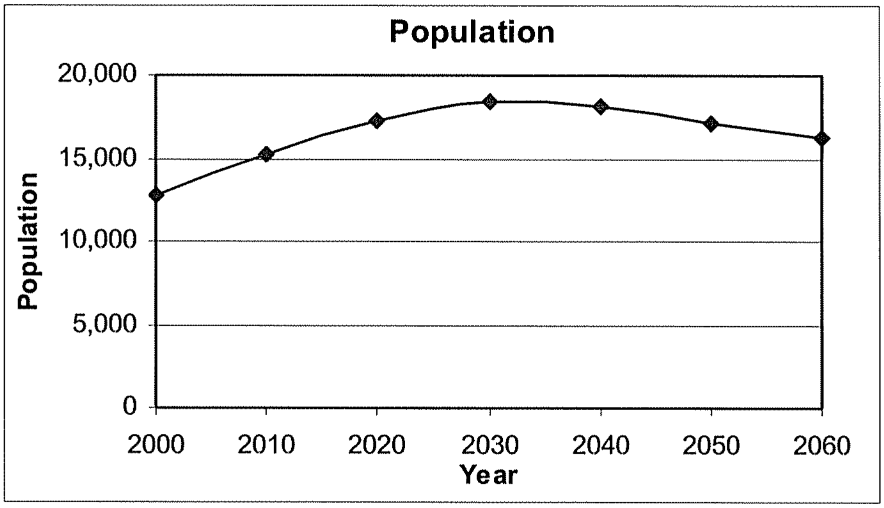
City of Rockport — Aransas County

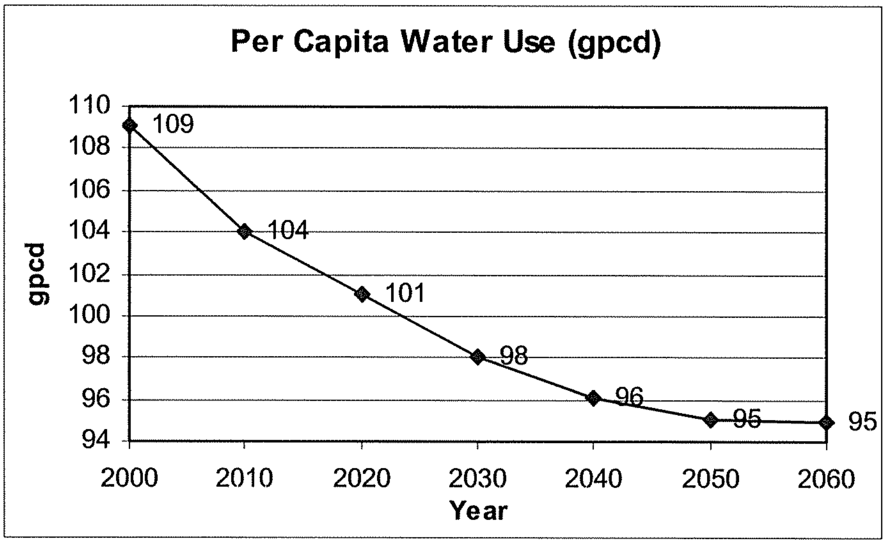


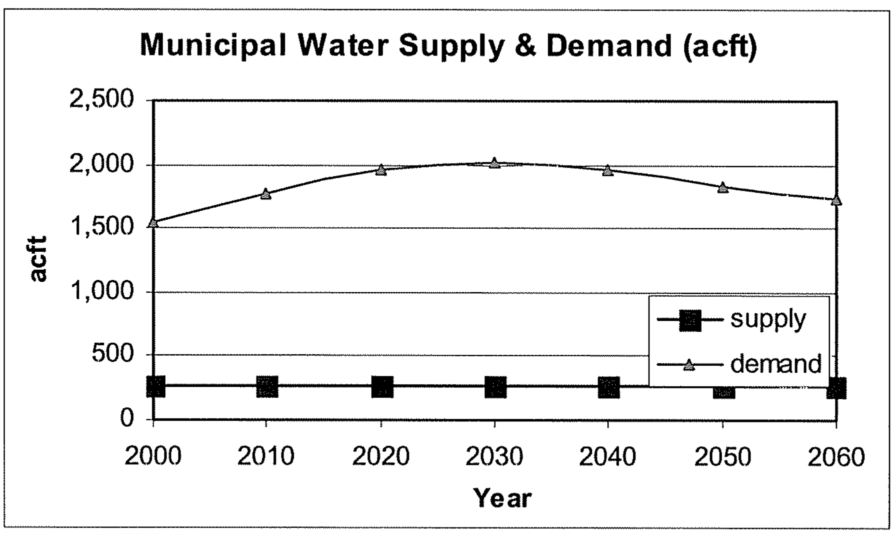




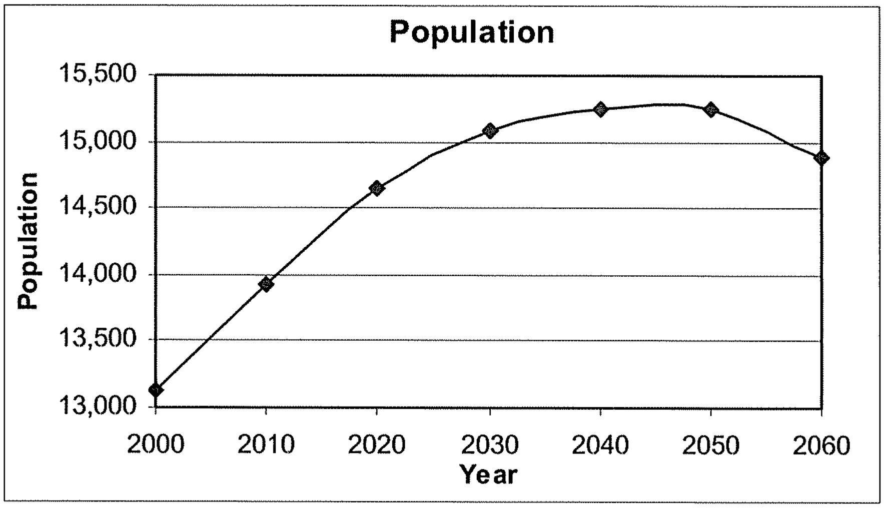
County-Other — Aransas County

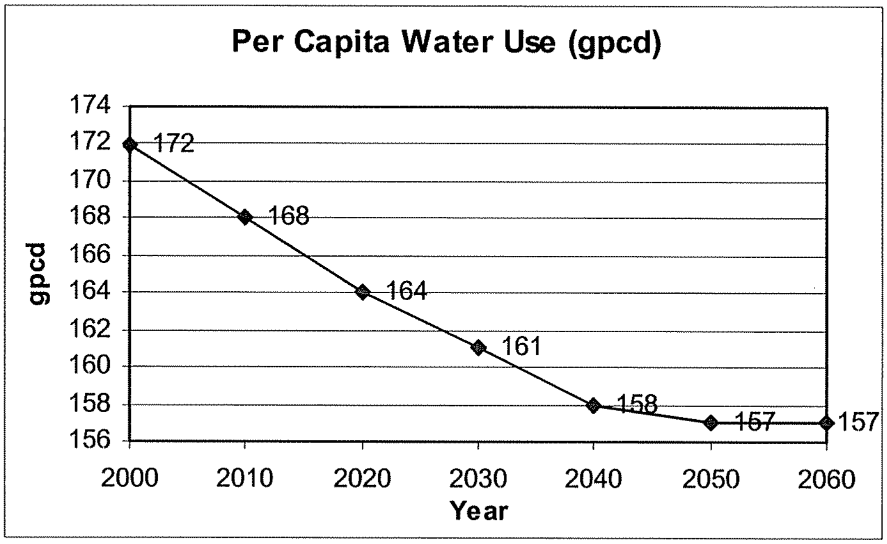


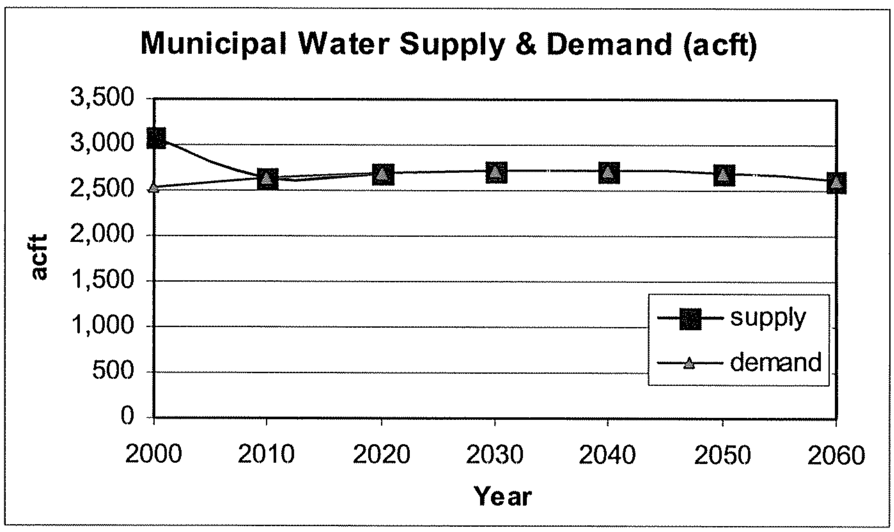




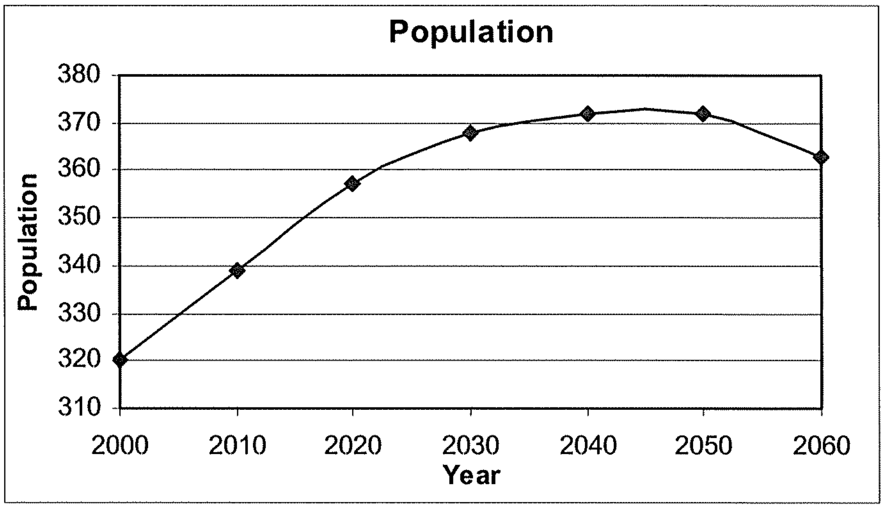
City of Beeville — Bee County

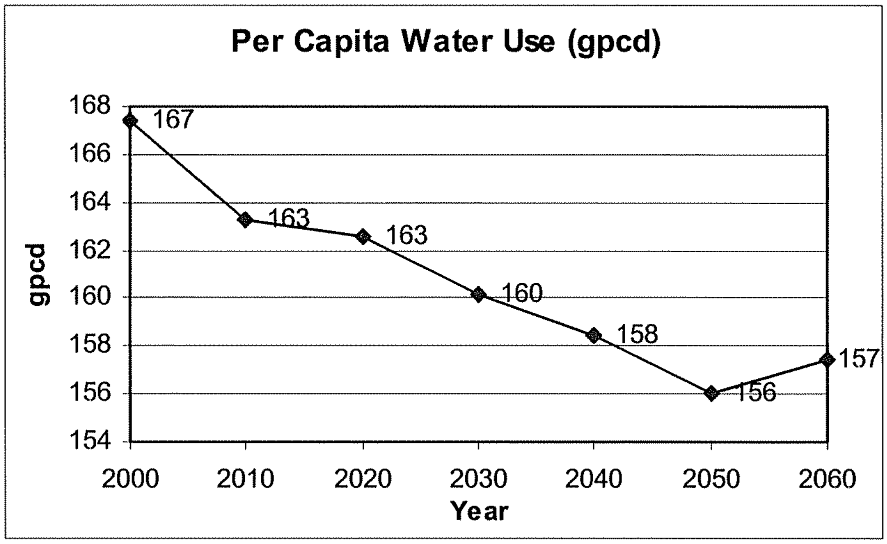


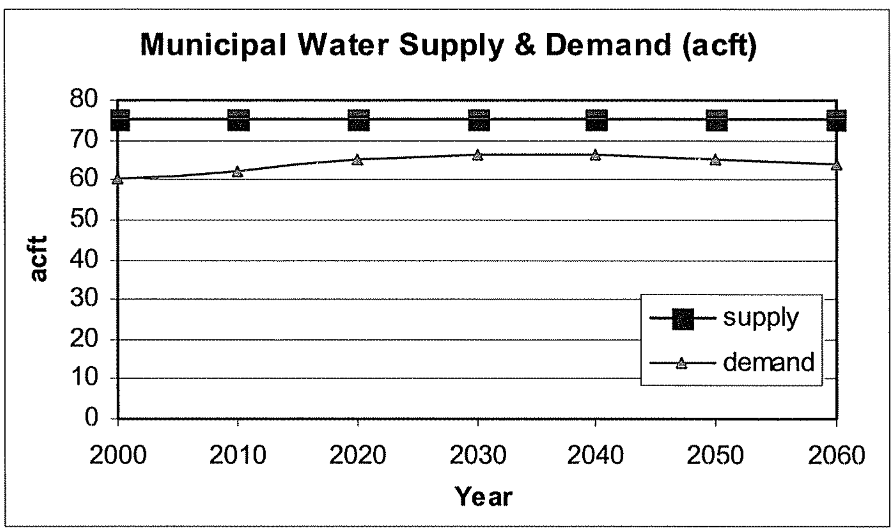




El Oso WSC — Bee County







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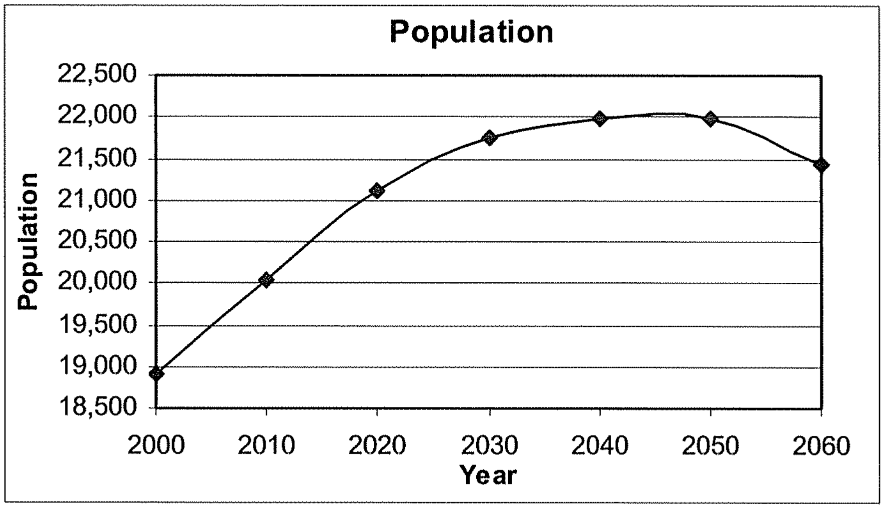
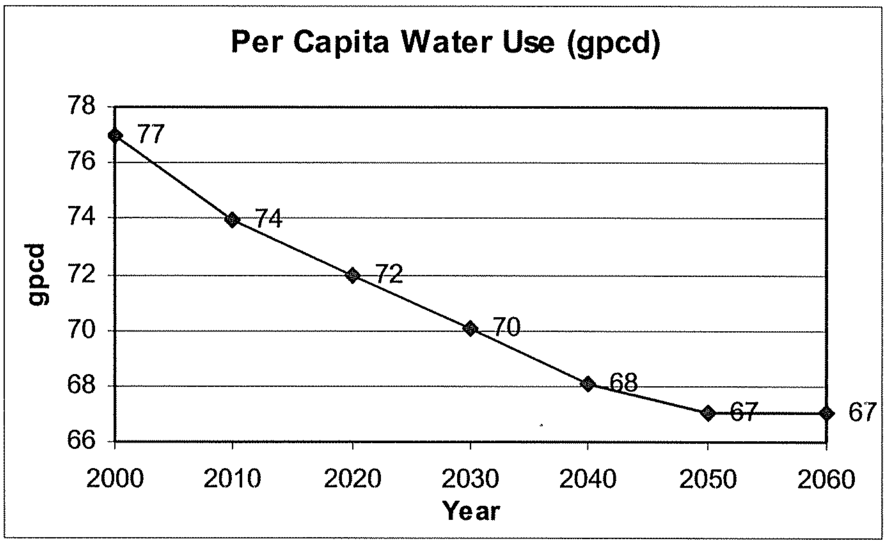
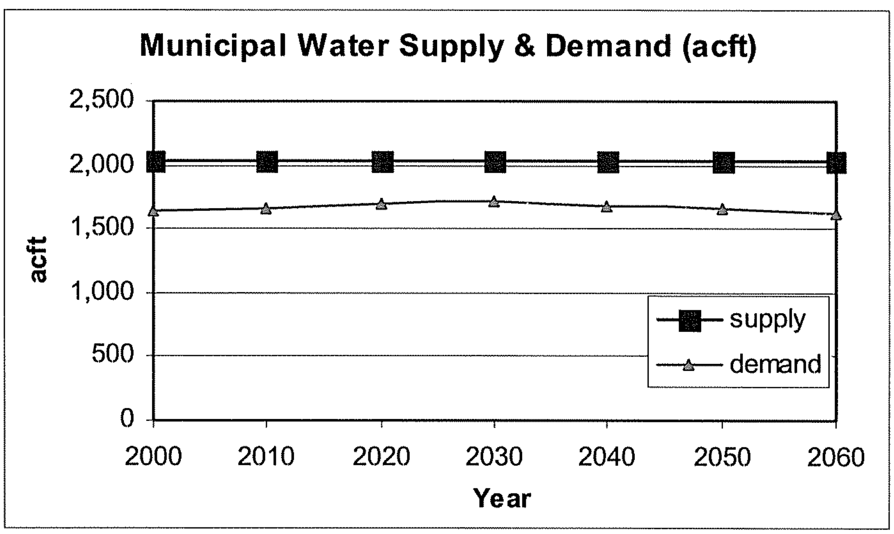
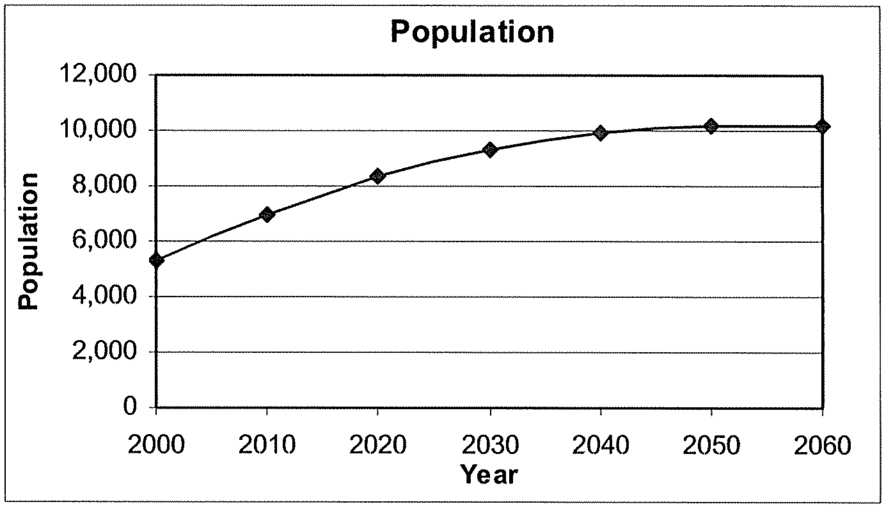
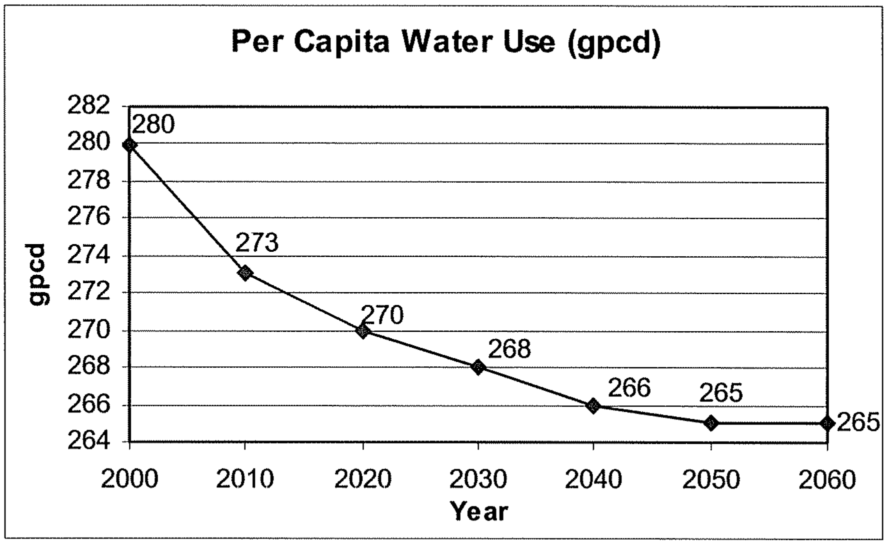


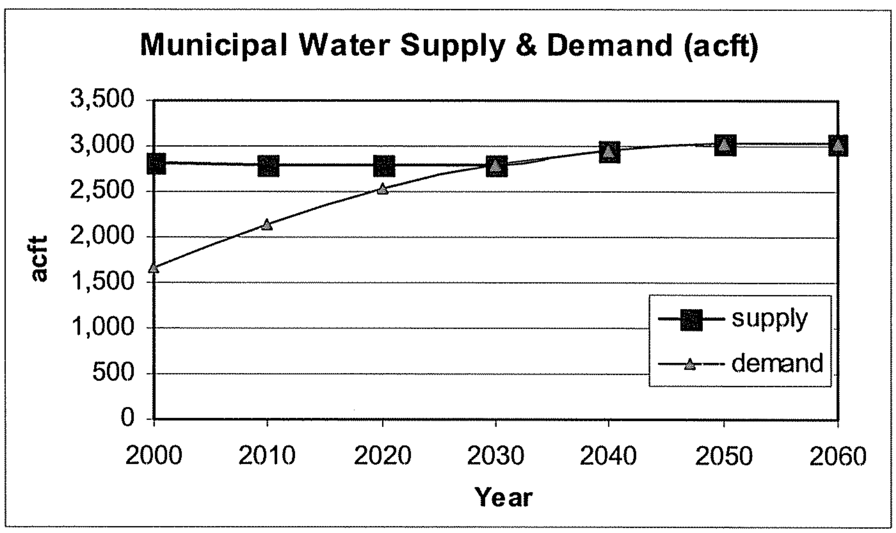




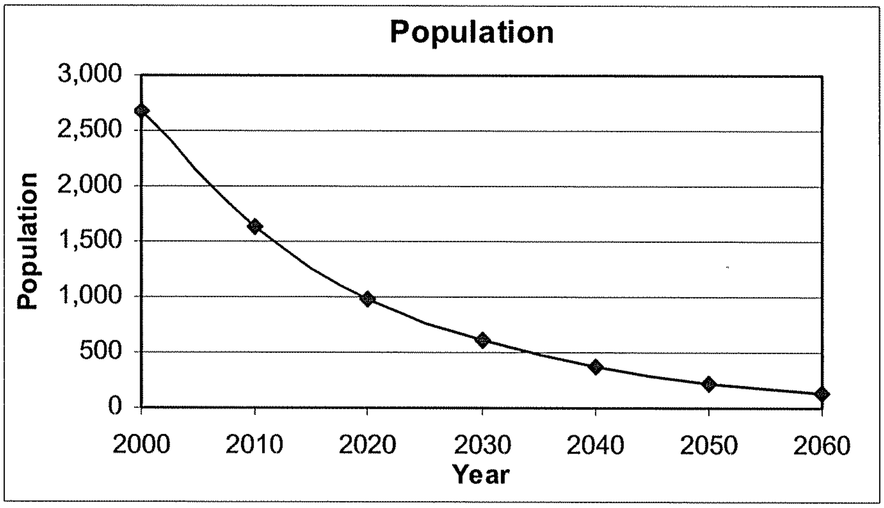
City of Falfurrias — Brooks County

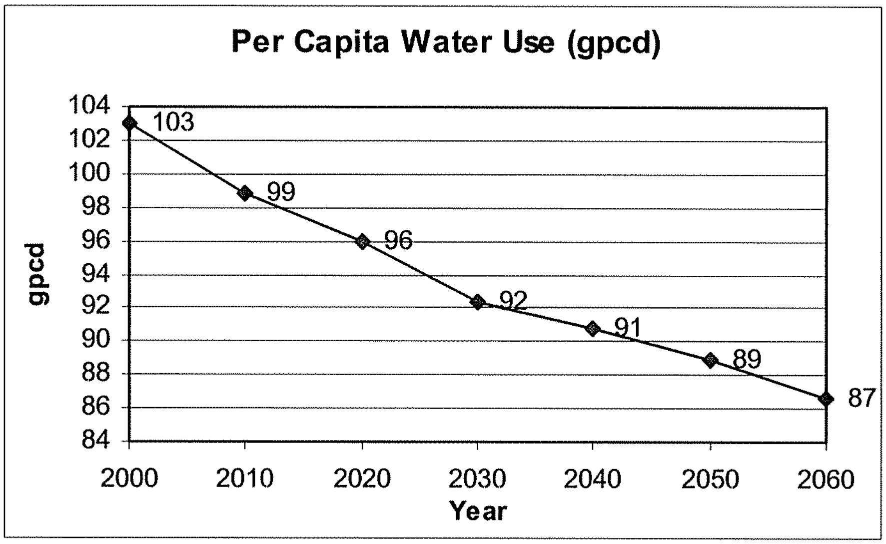


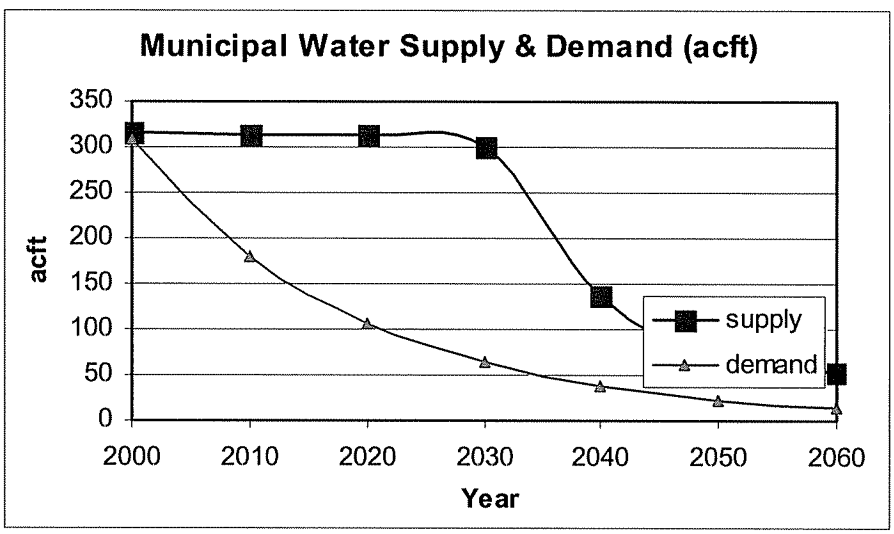




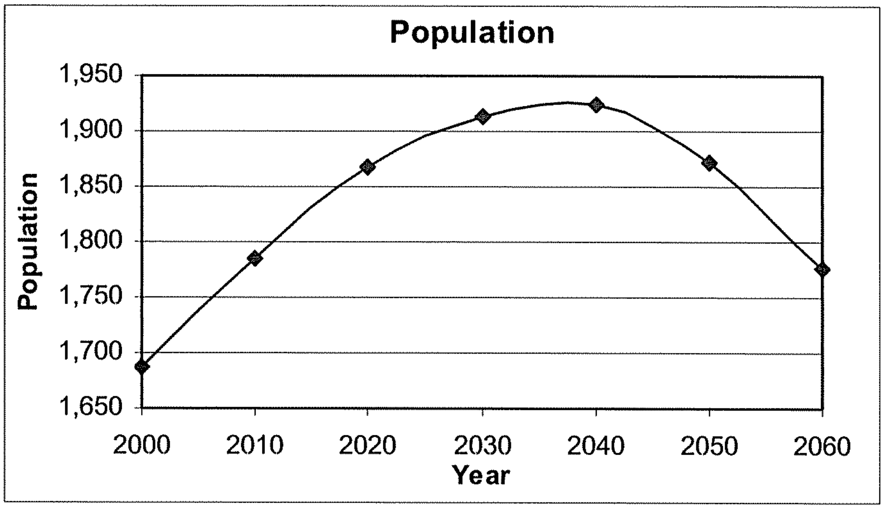
County-Other — Brooks County

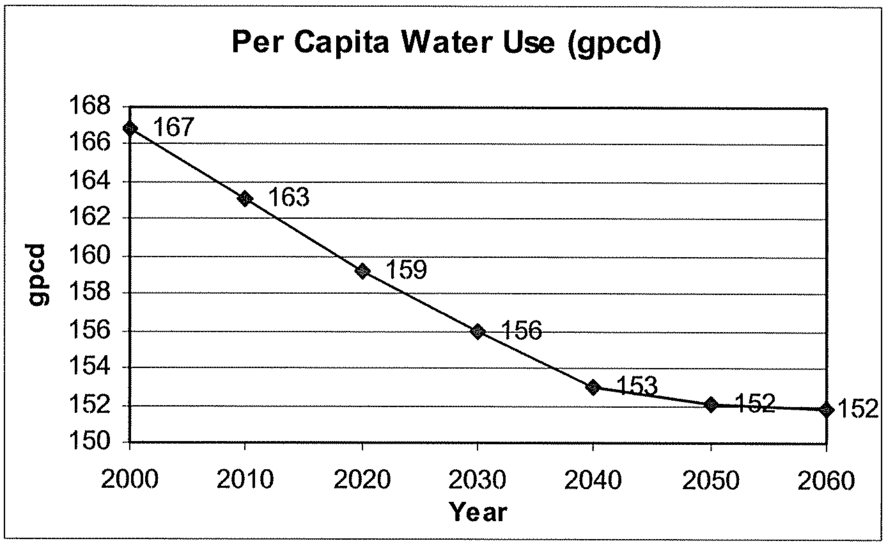


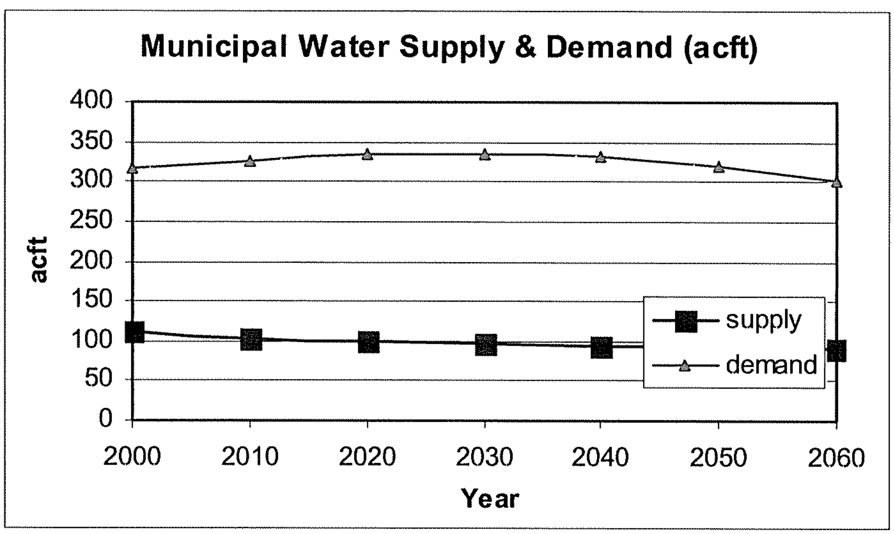




City of Benavides — Duval County







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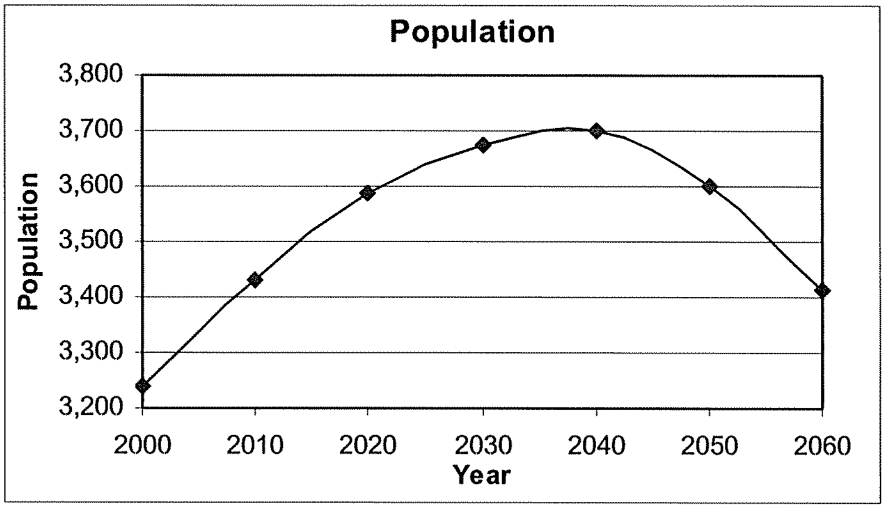
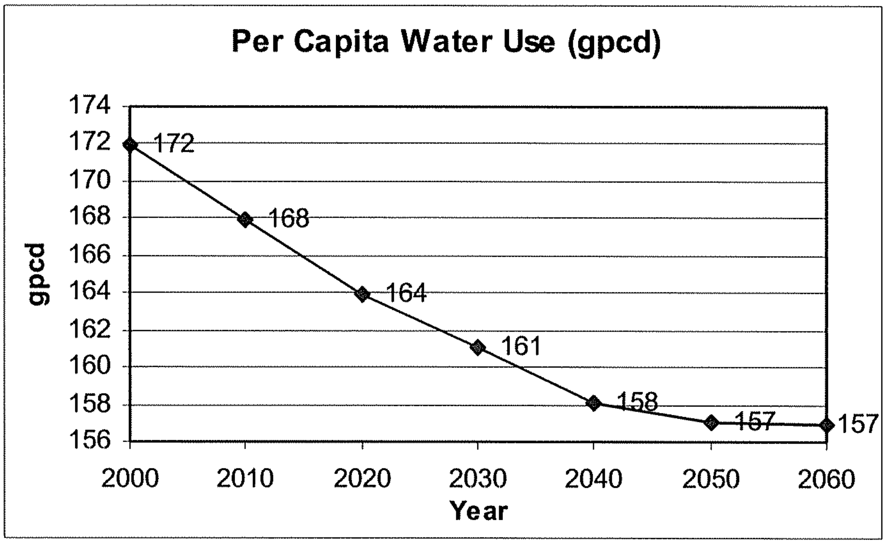
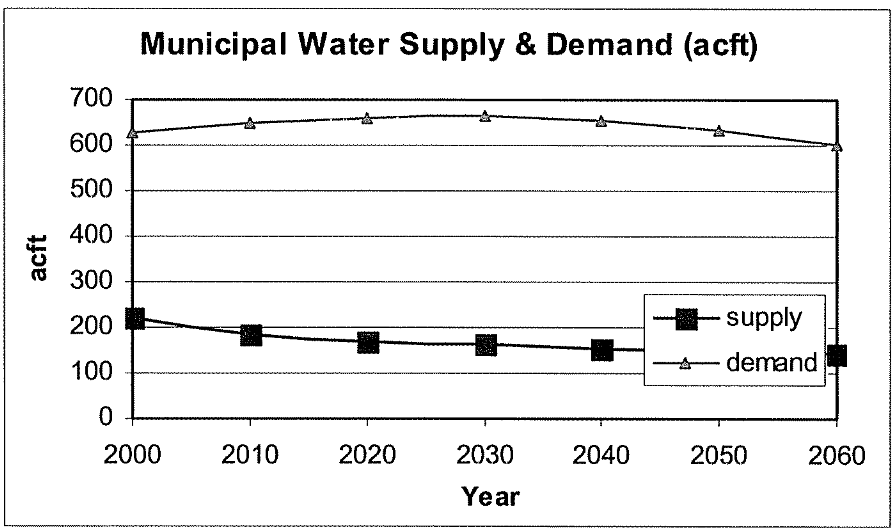
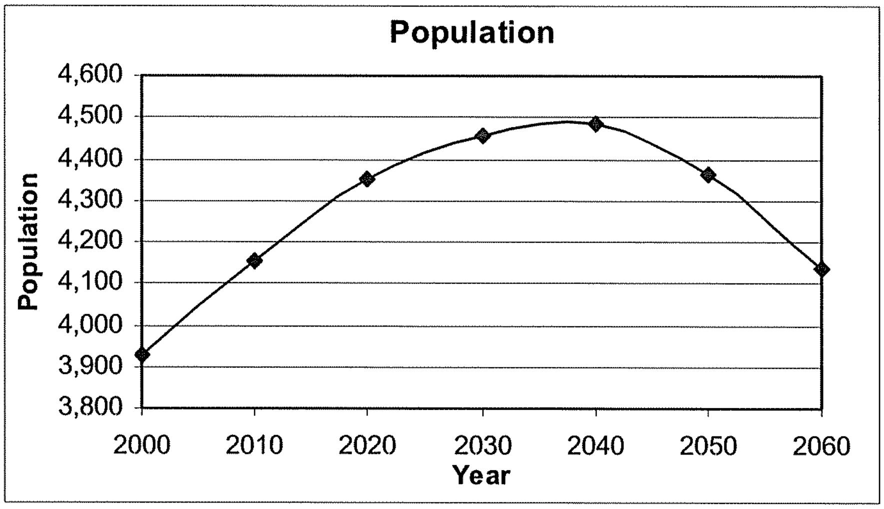
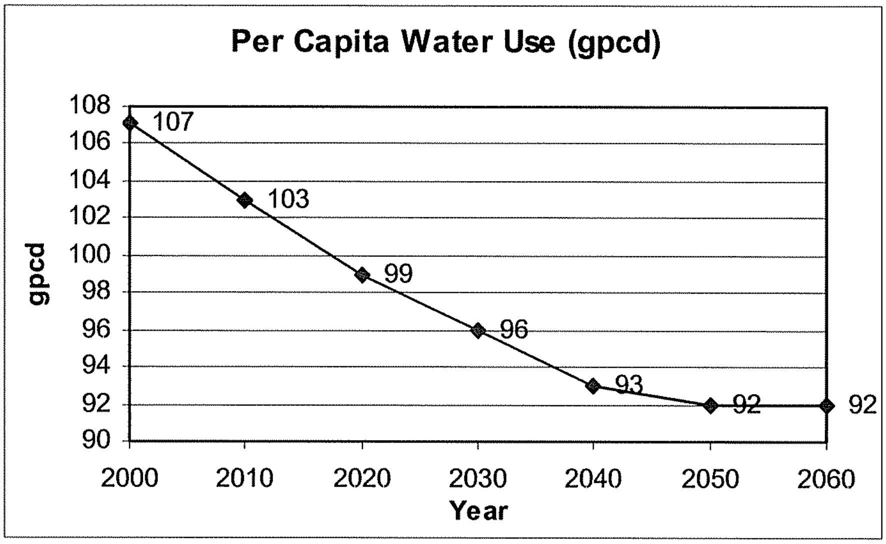


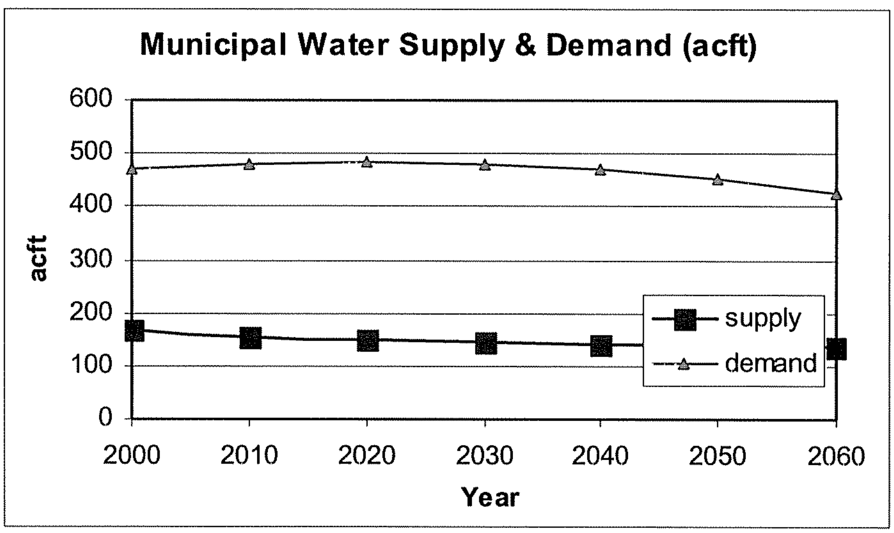




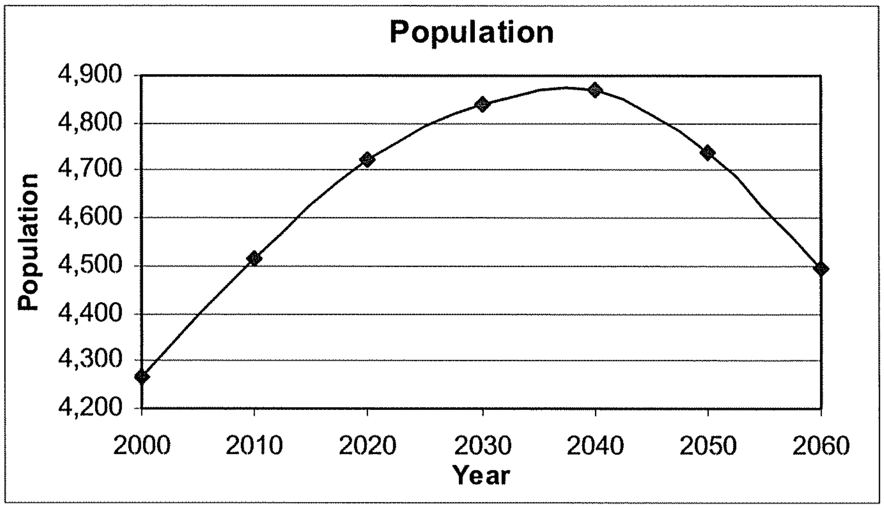
City of San Diego — Duval County

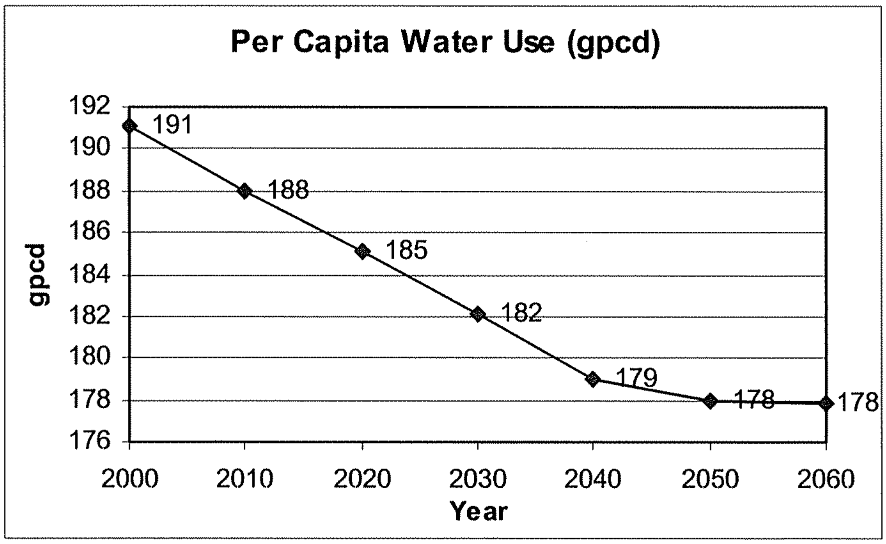


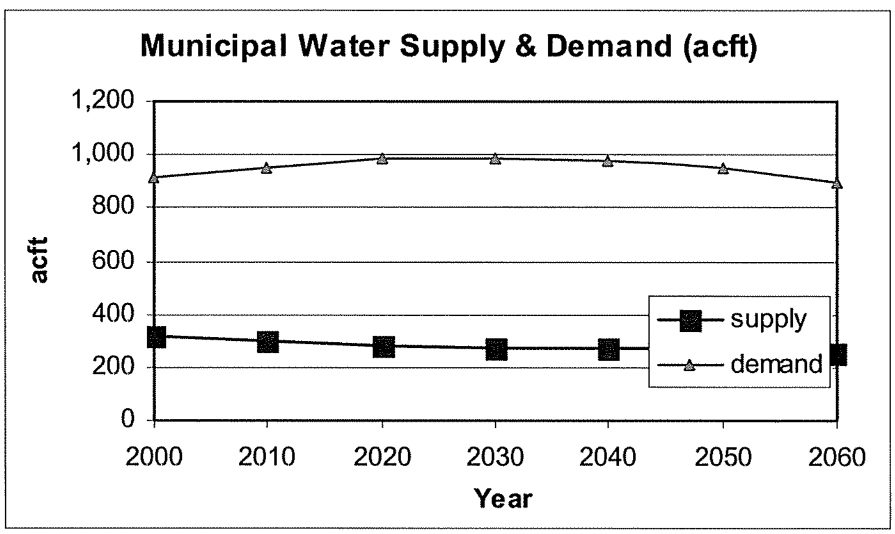




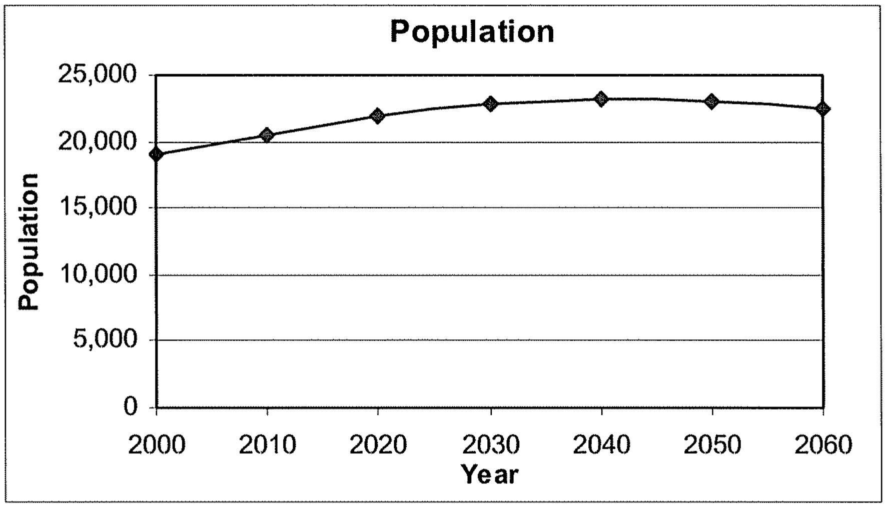
County-Other — Duval County

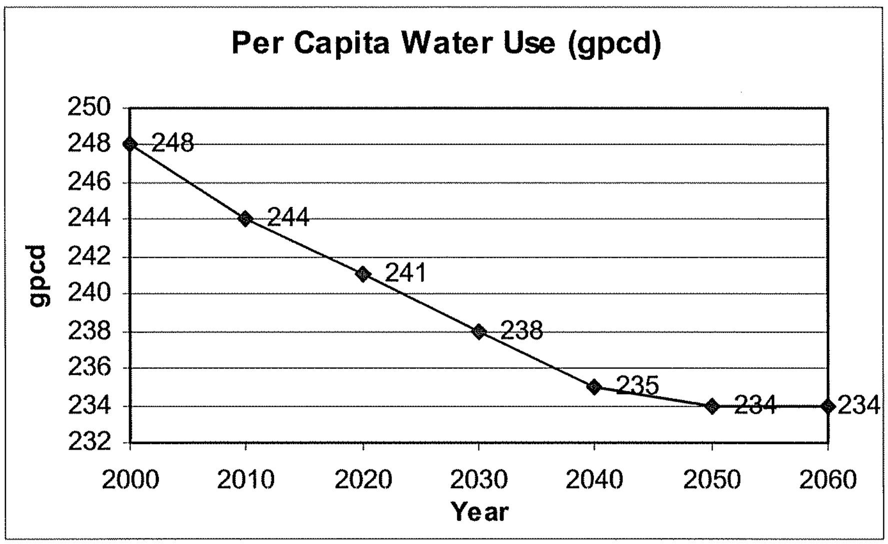


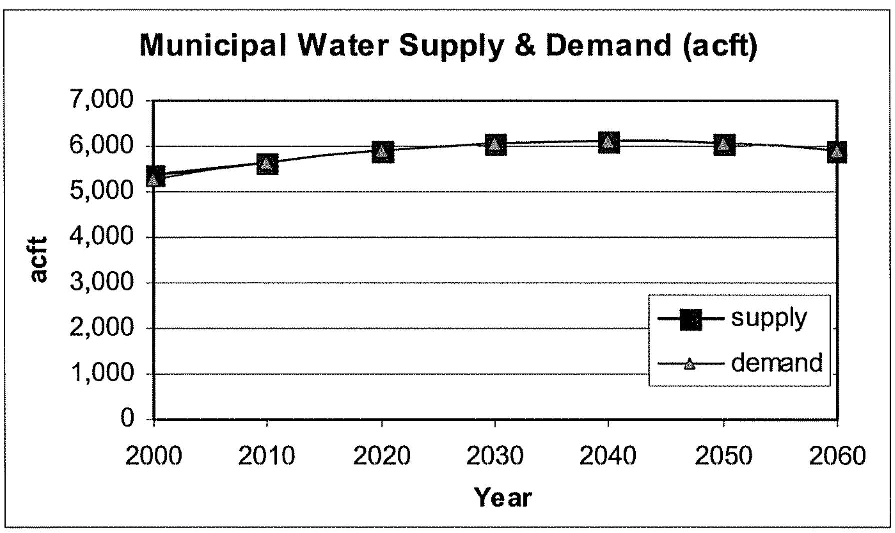




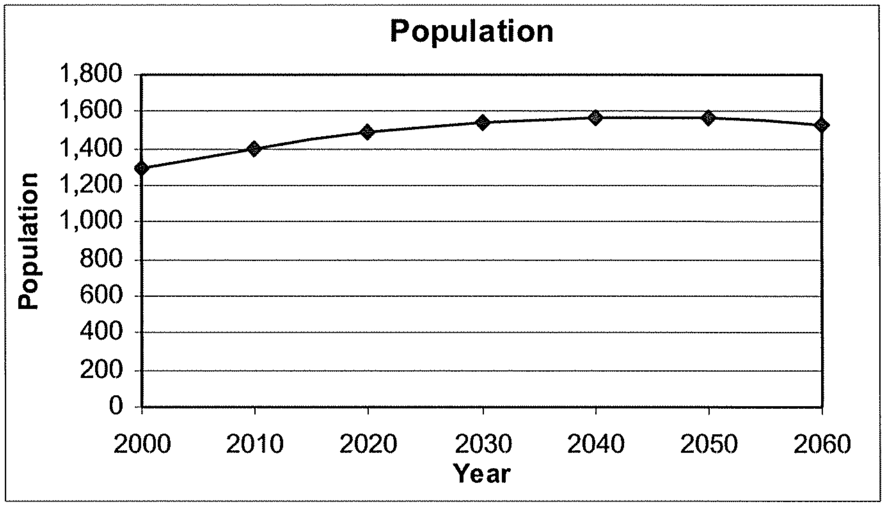
City of Alice — Jim Wells County

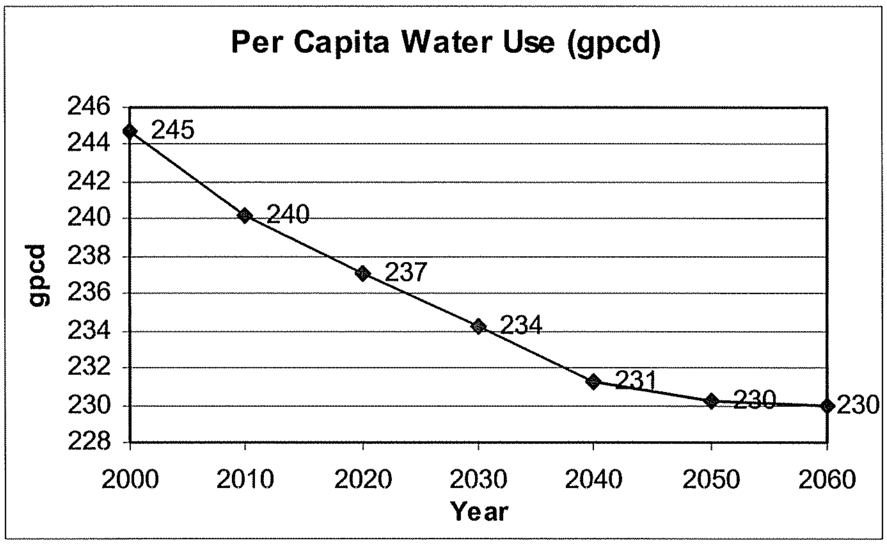


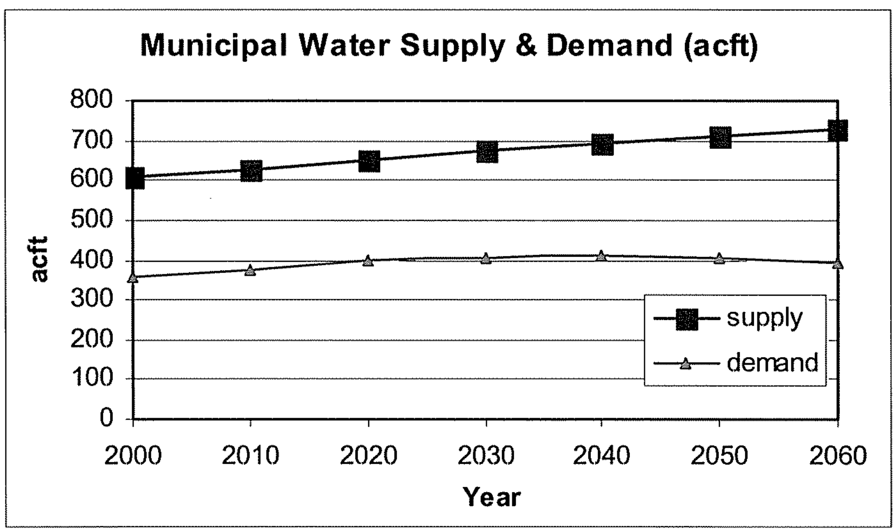




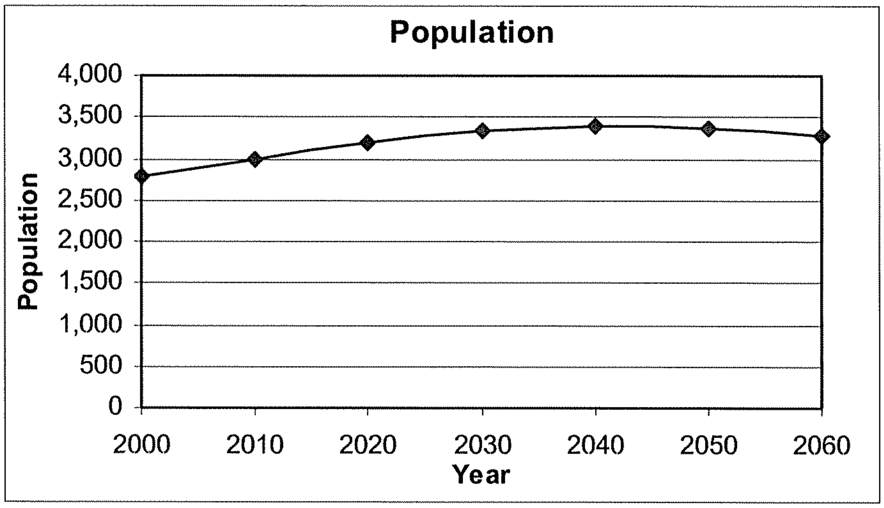
City of Orange Grove — Jim Wells County

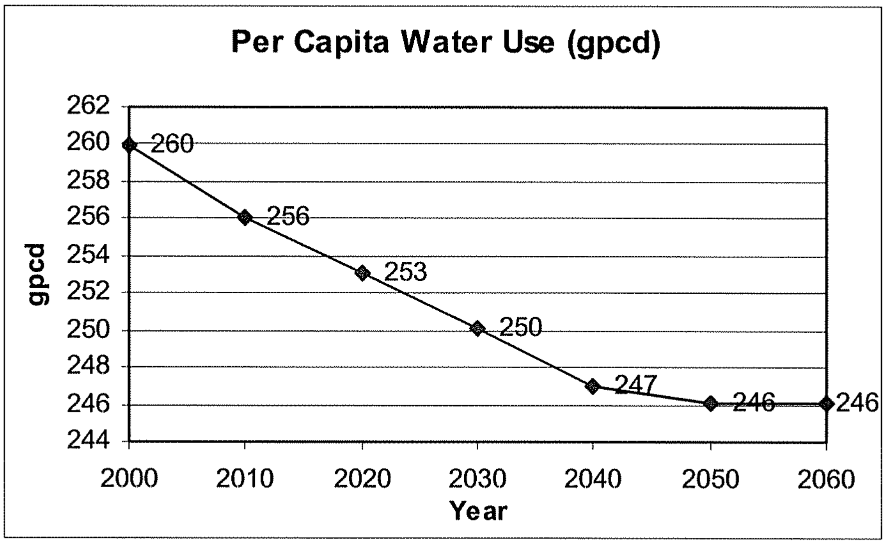


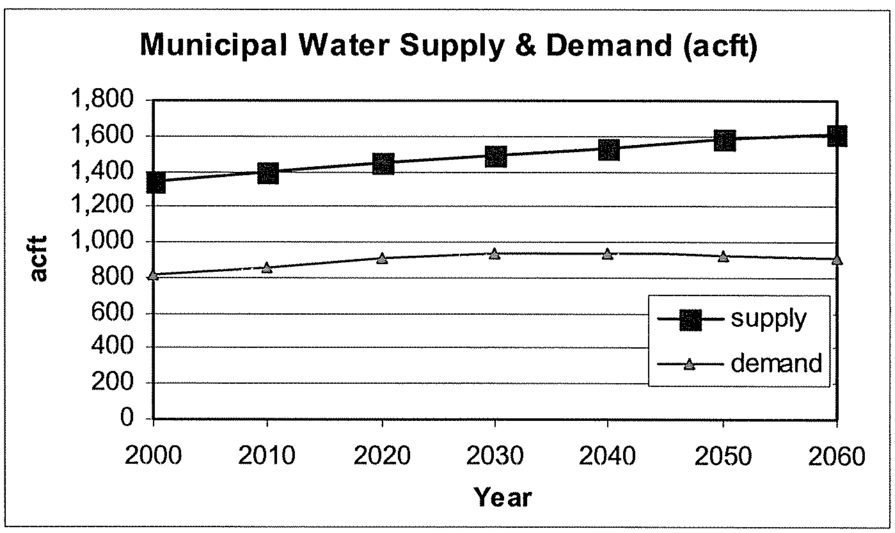




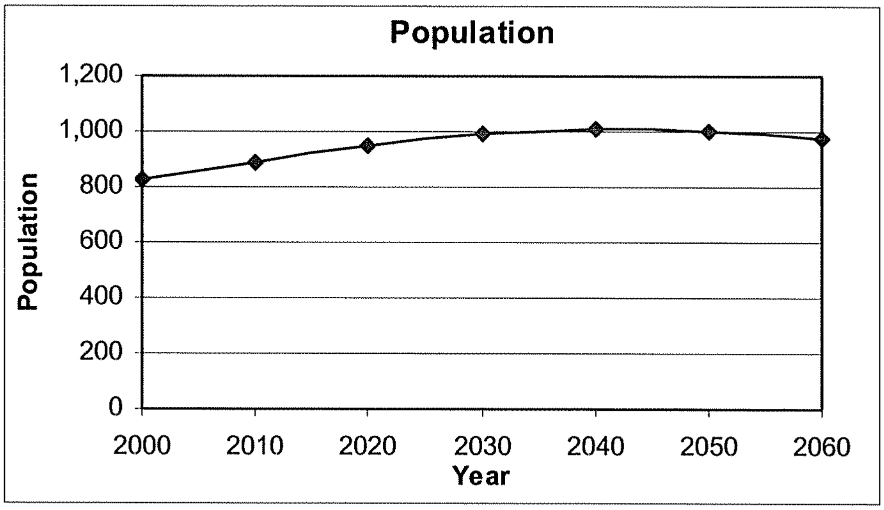
City of Premont — Jim Wells County

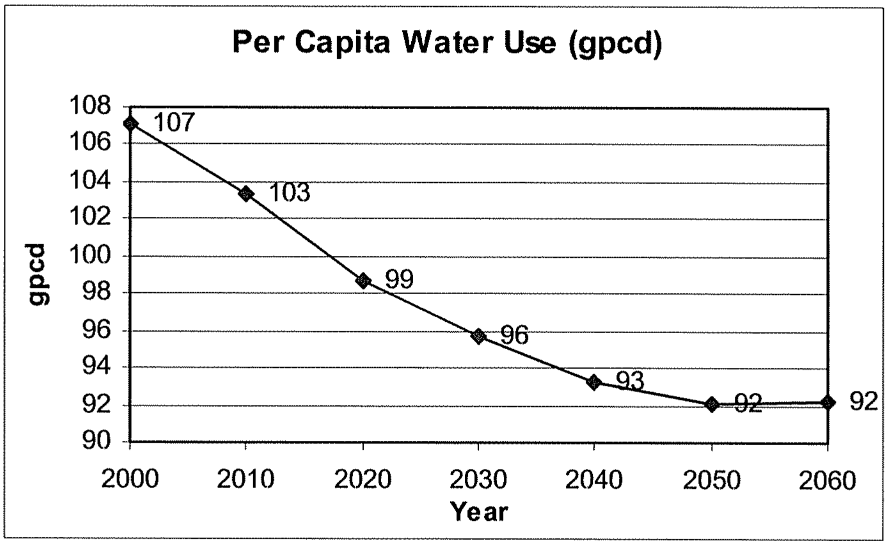


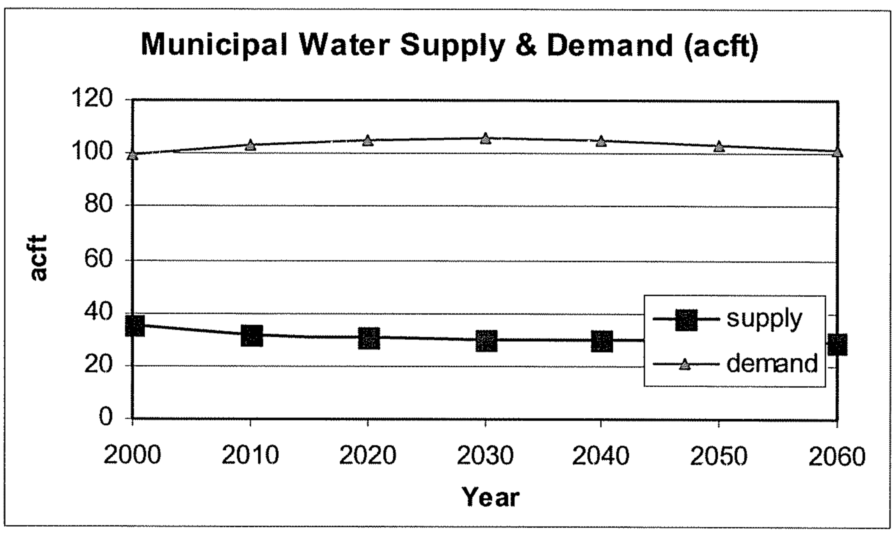




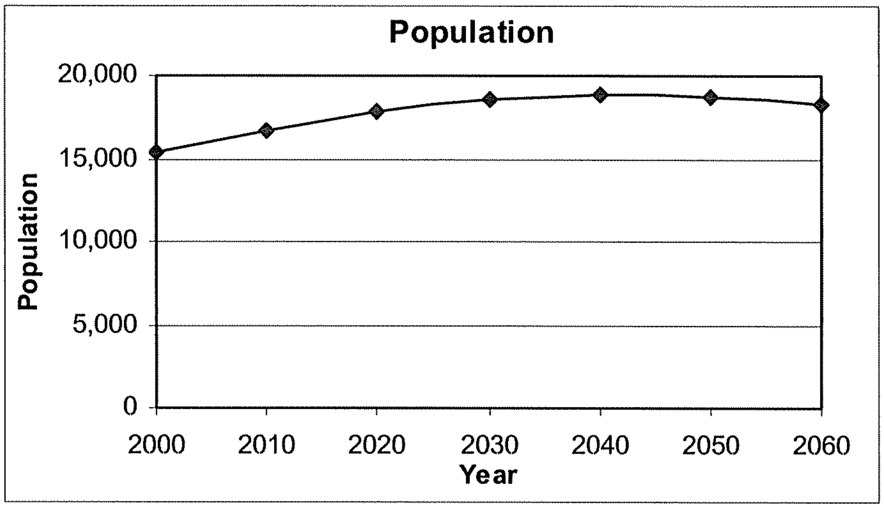
City of San Diego — Jim Wells County

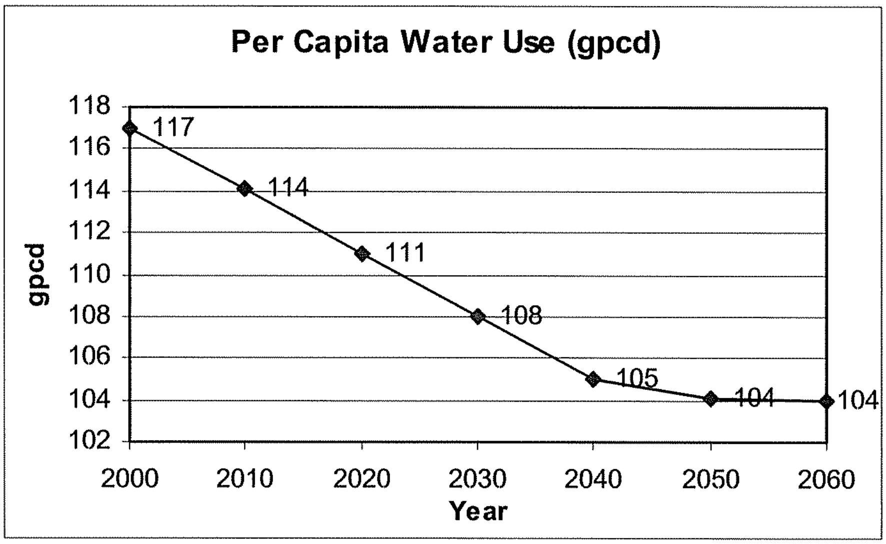


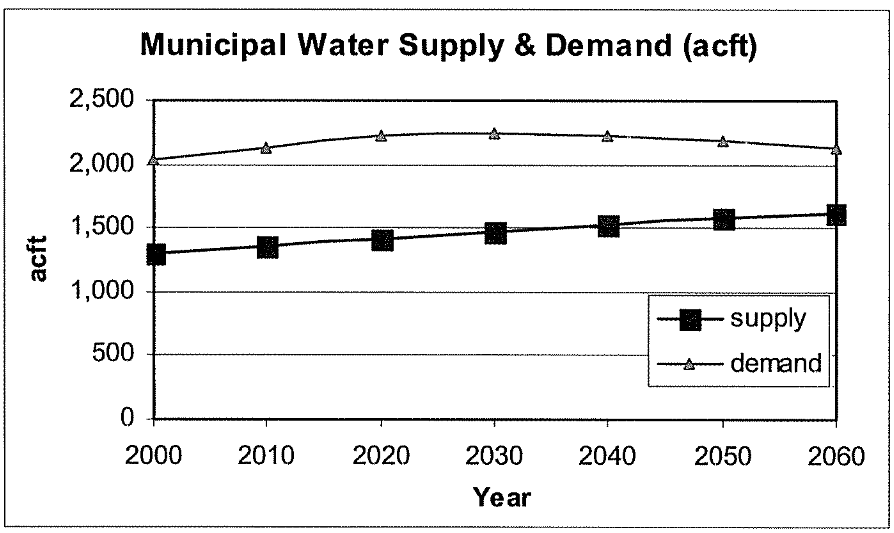




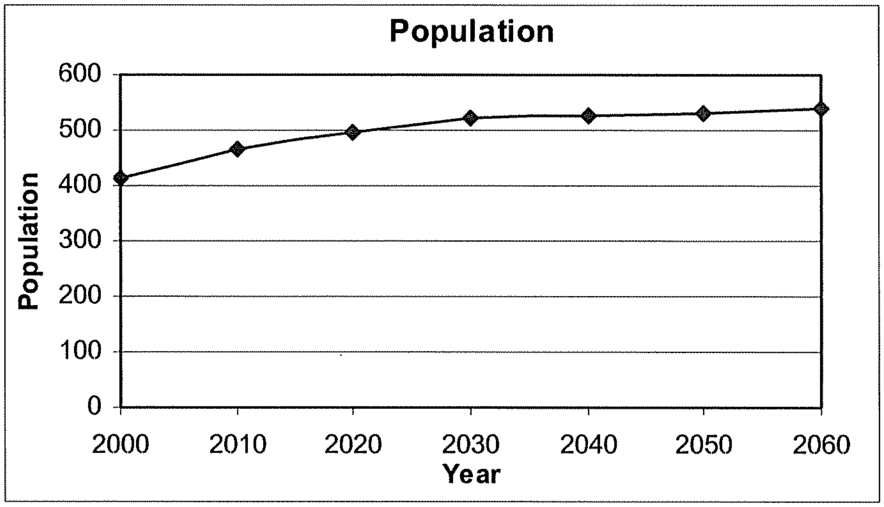
County-Other — Jim Wells County

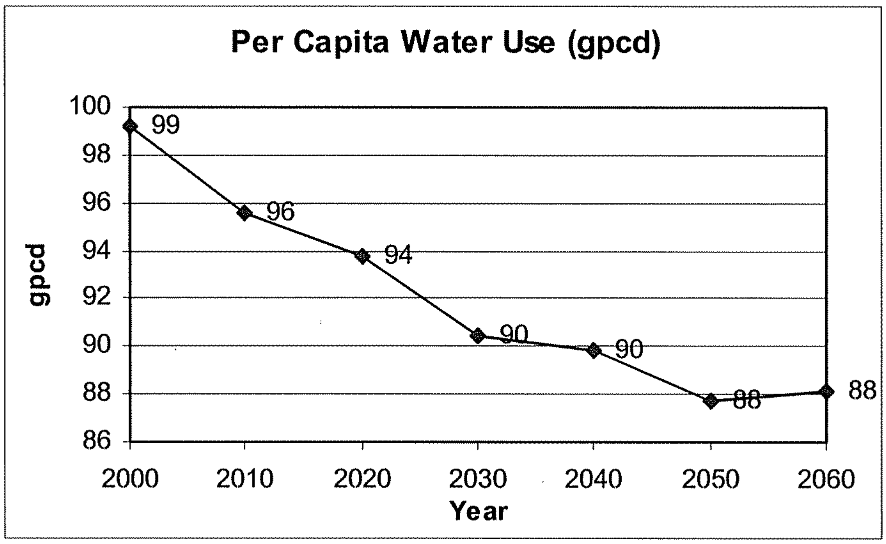


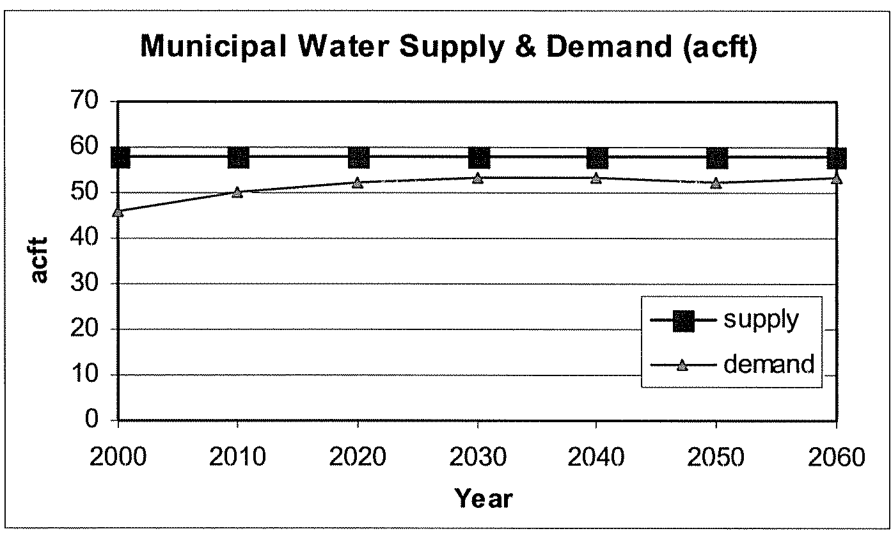




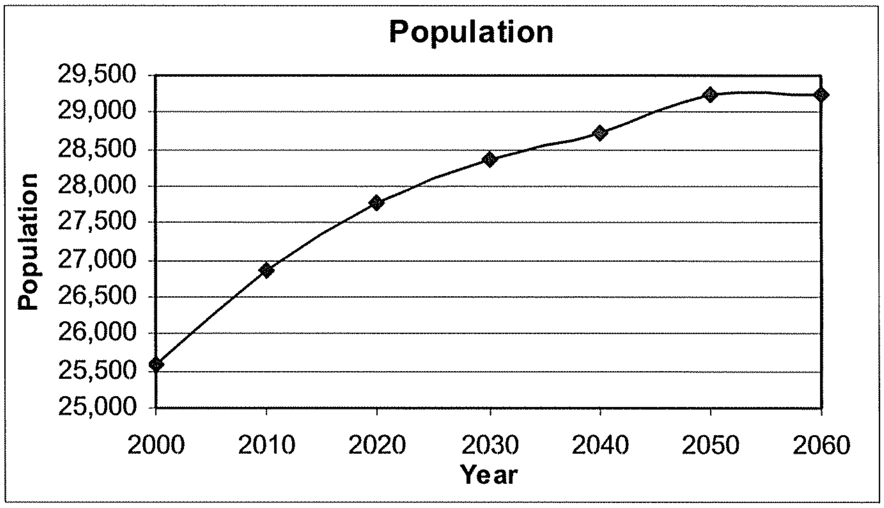
County-Other — Kenedy County

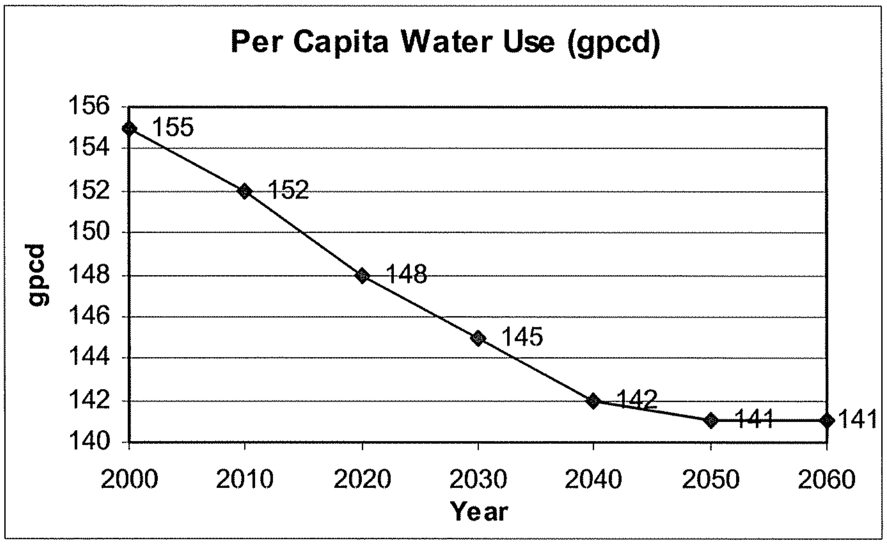


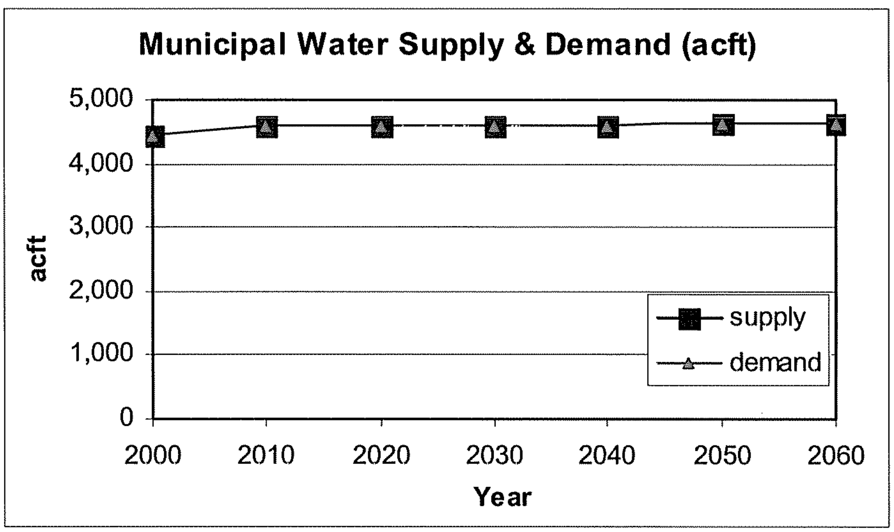




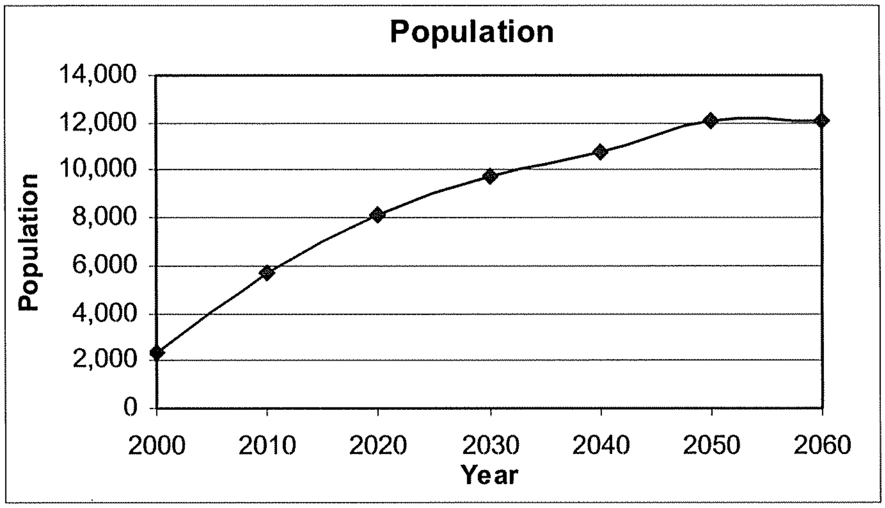
City of Kingsville — Kleberg County

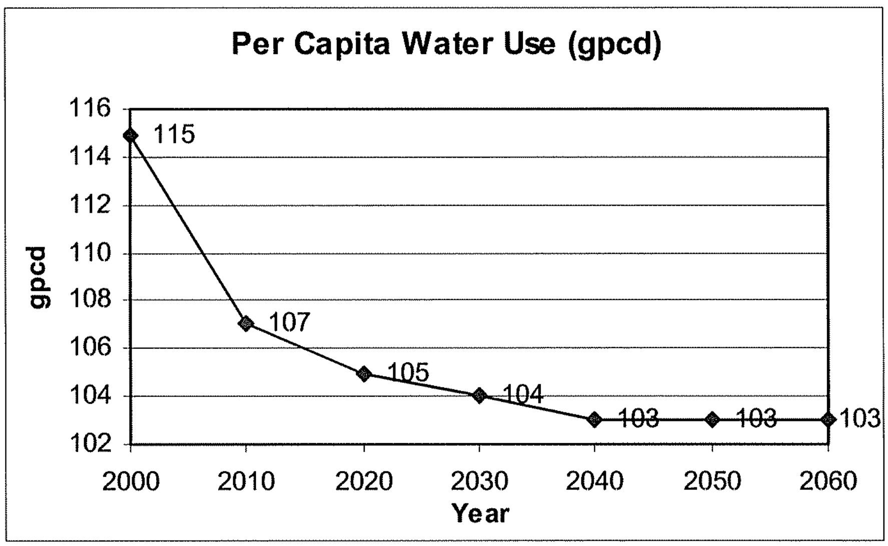


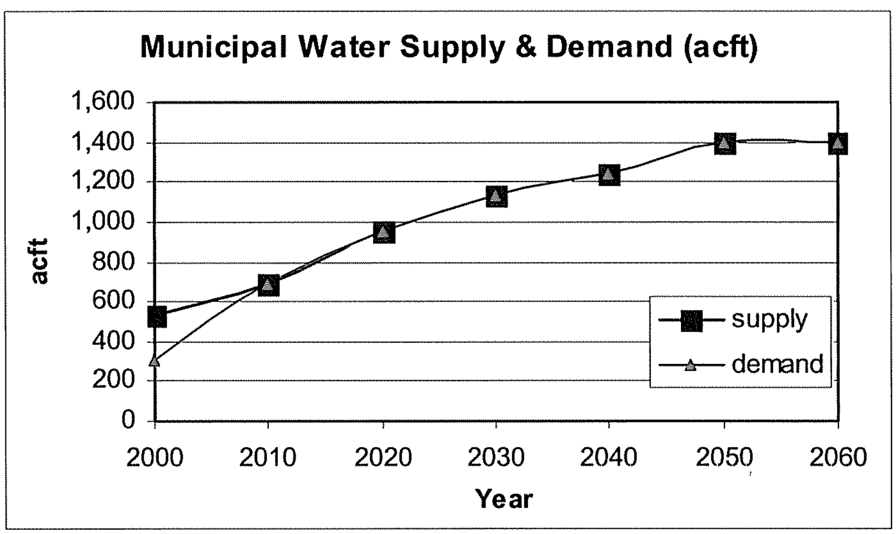




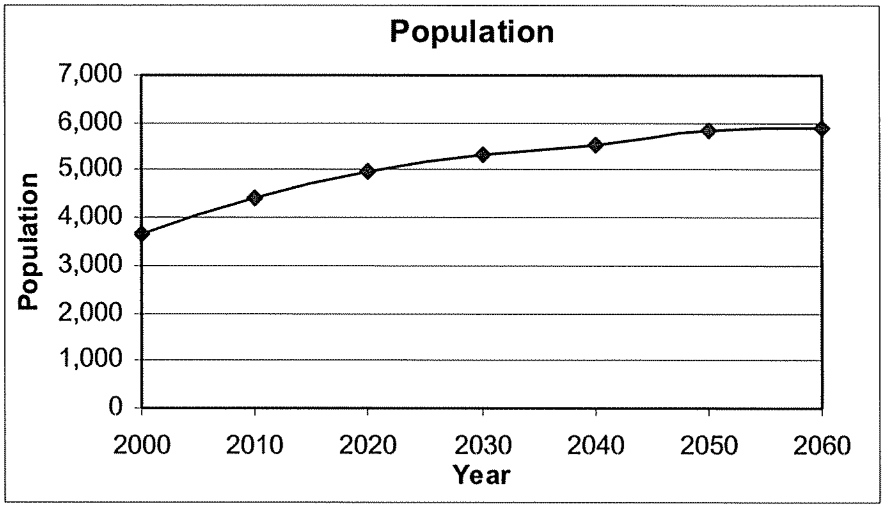
Ricardo WSC — Kleberg County

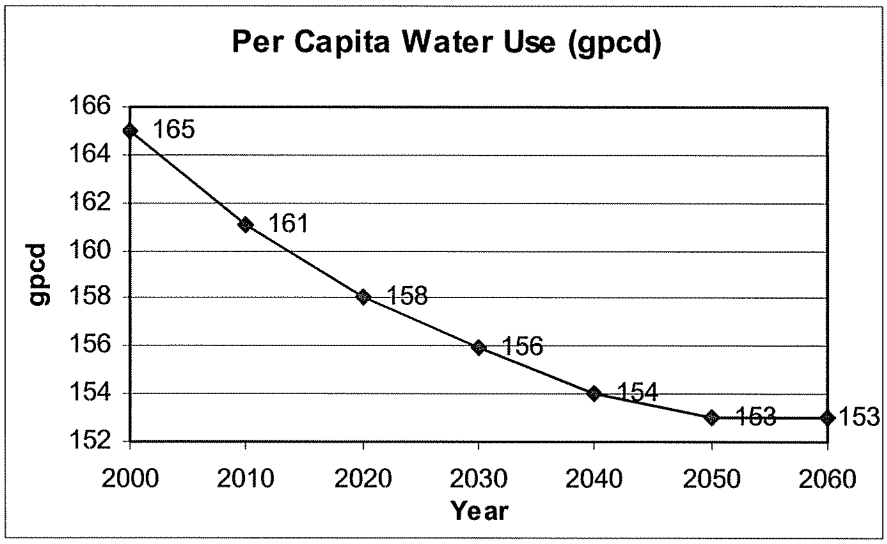


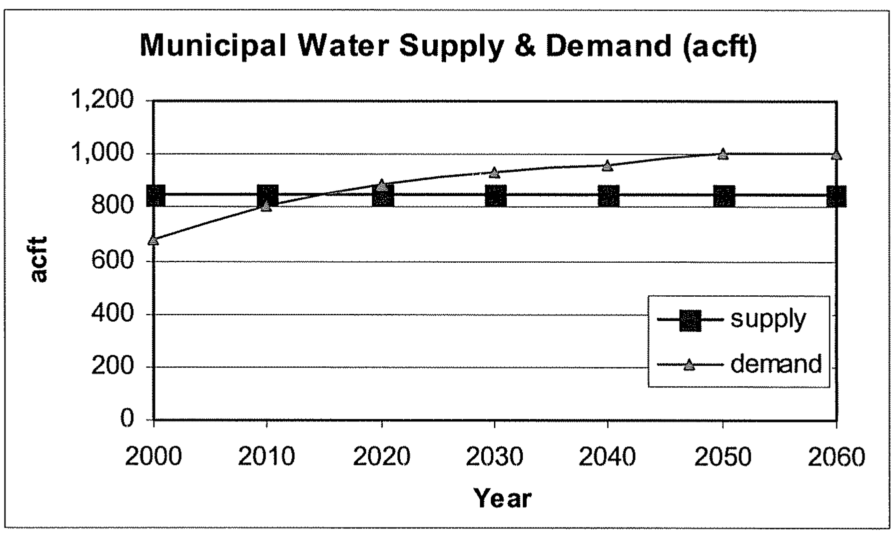




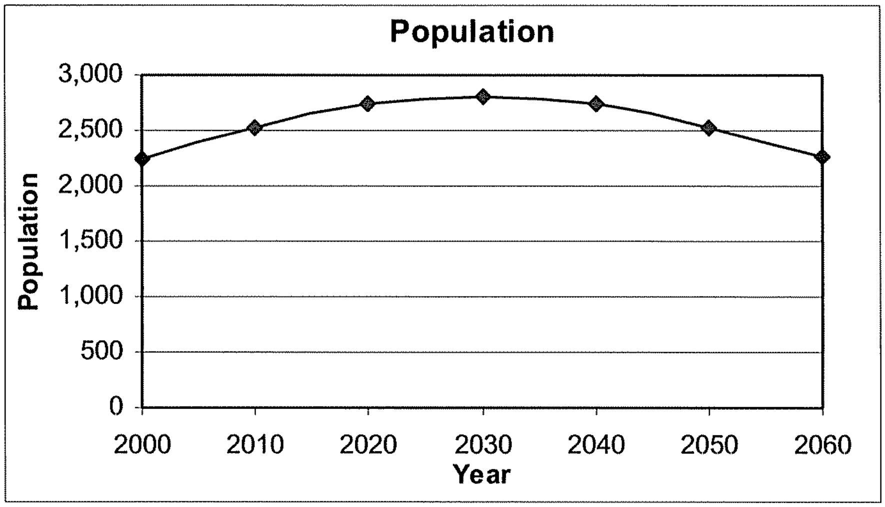
County-Other — Kleberg County

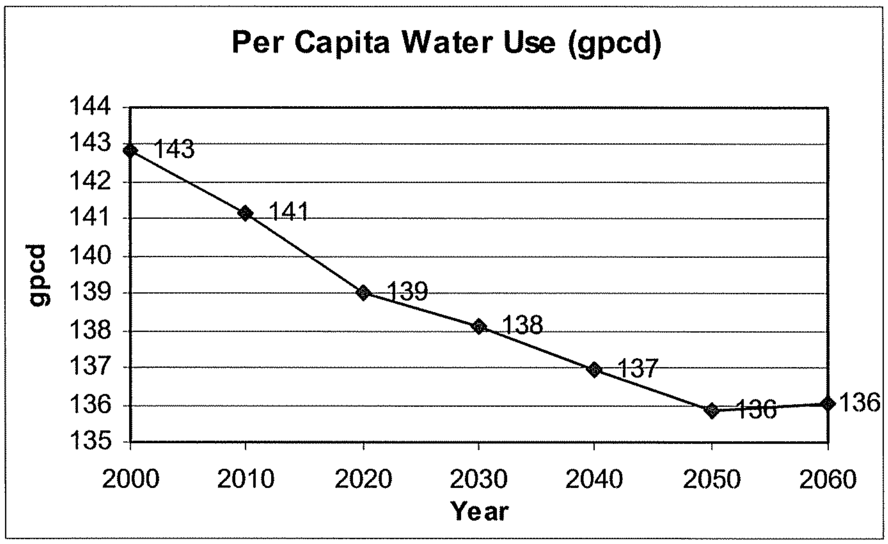


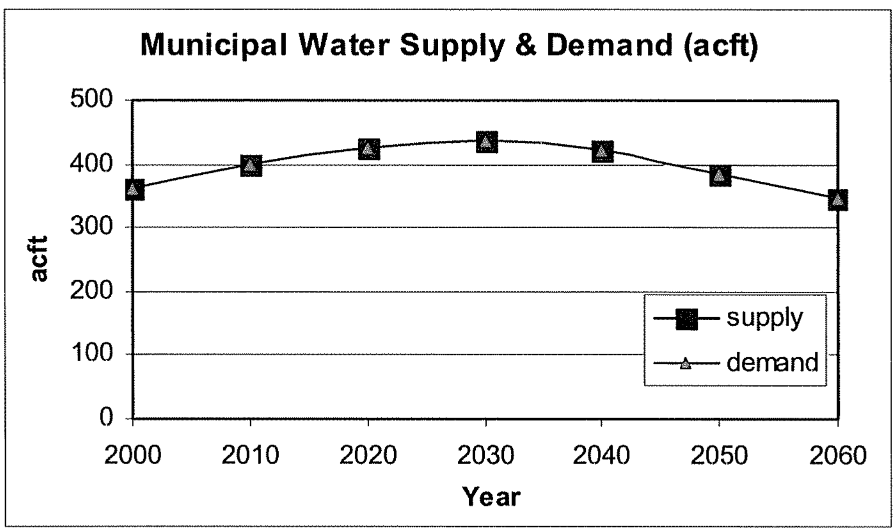




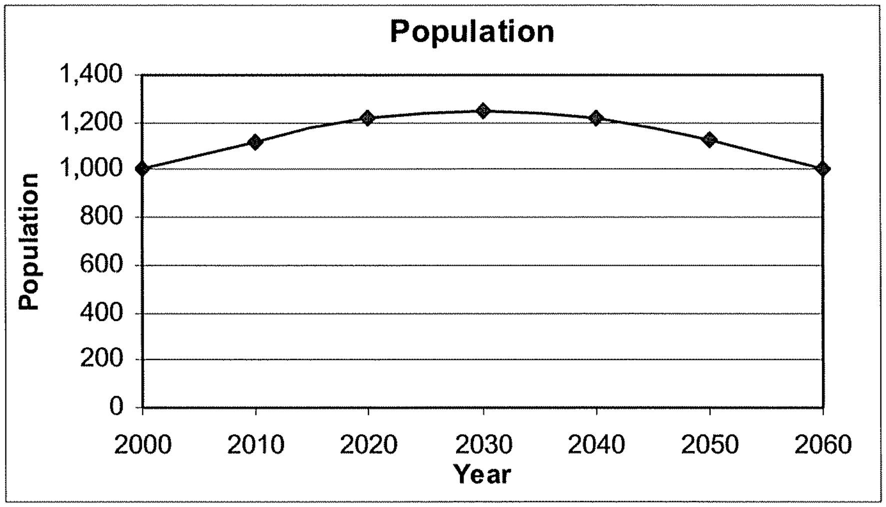
Choke Canyon WSC — Live Oak County

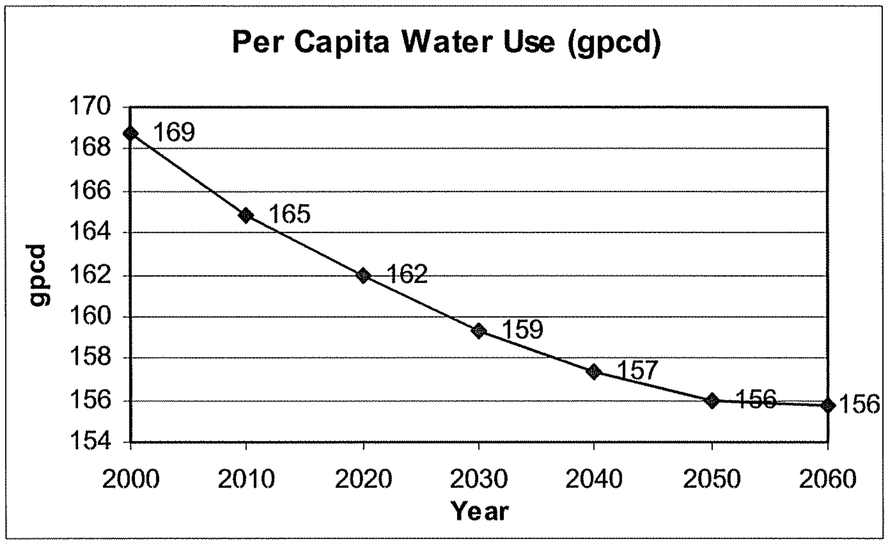


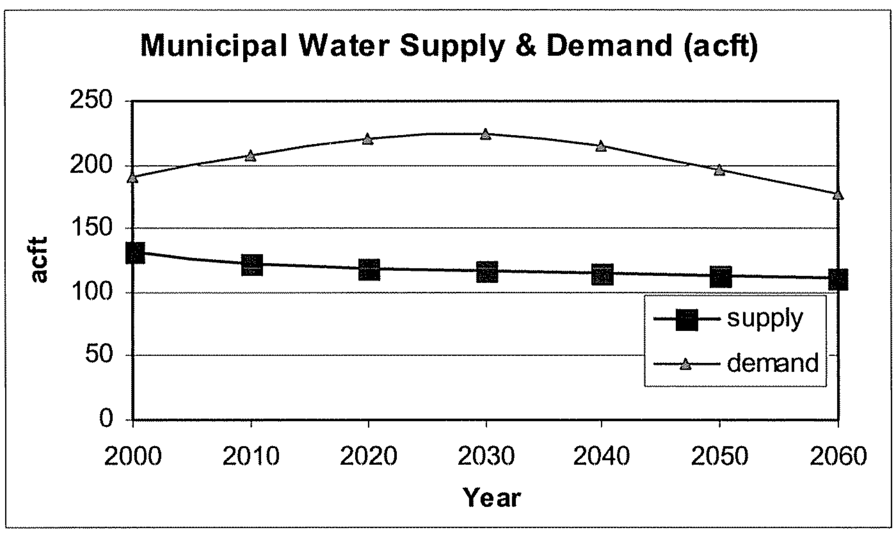




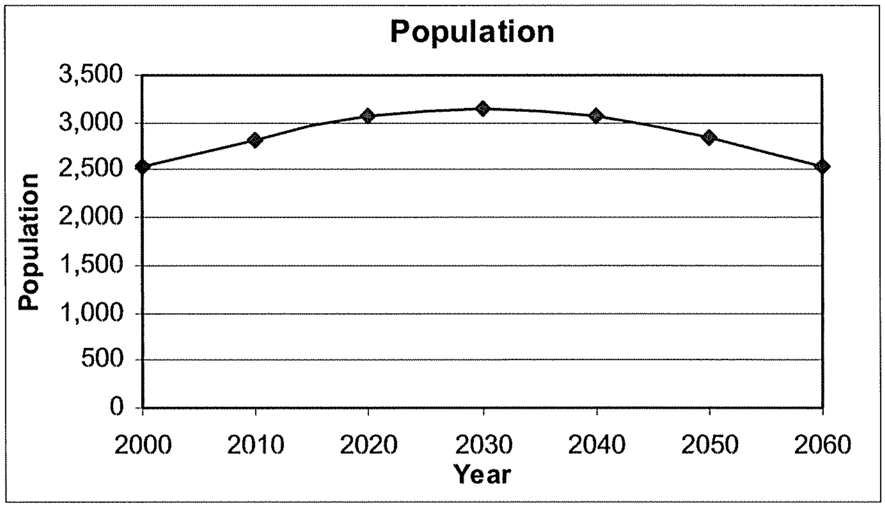
El Oso WSC — Live Oak County

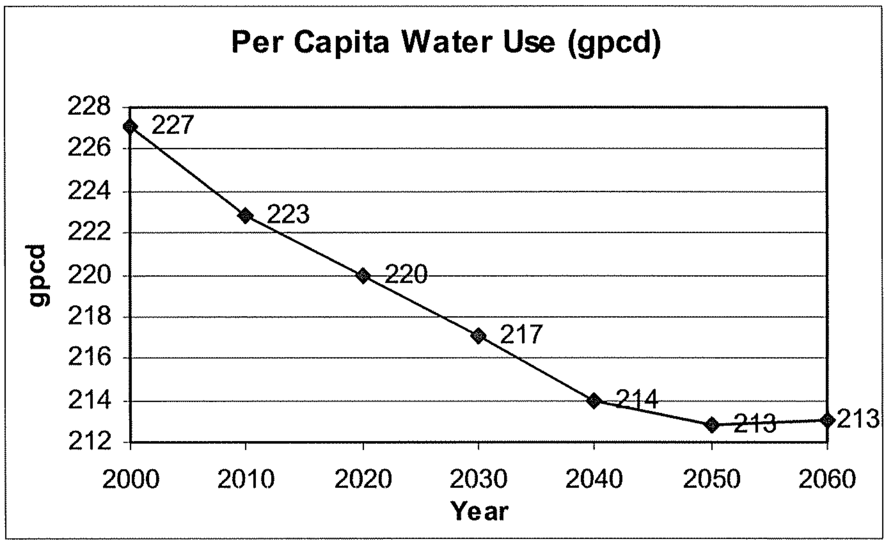


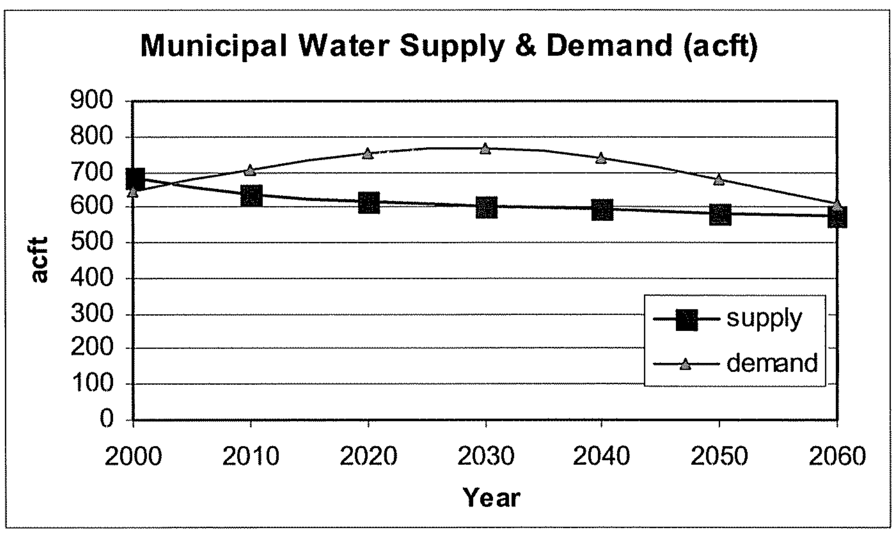




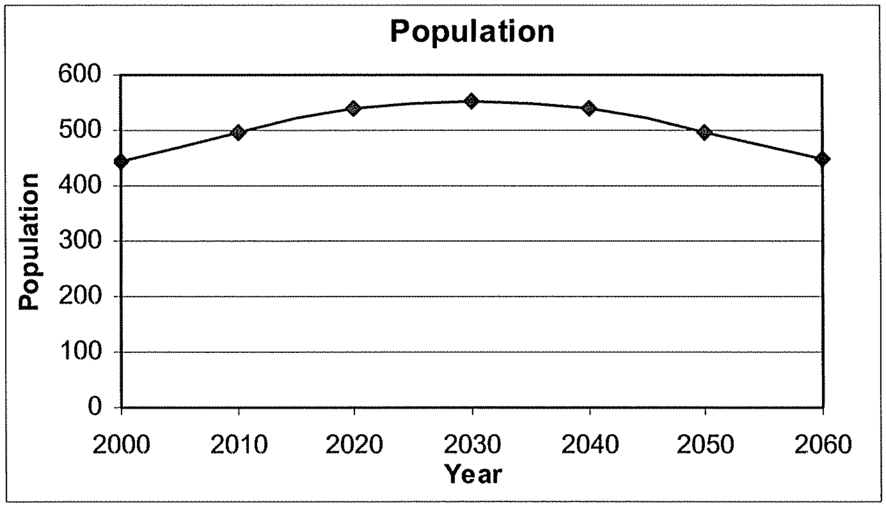
City of George West — Live Oak County

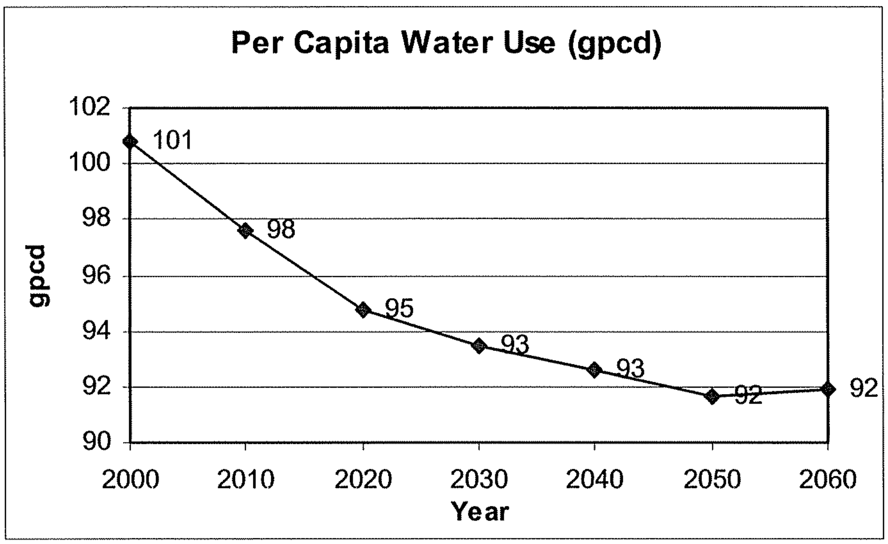


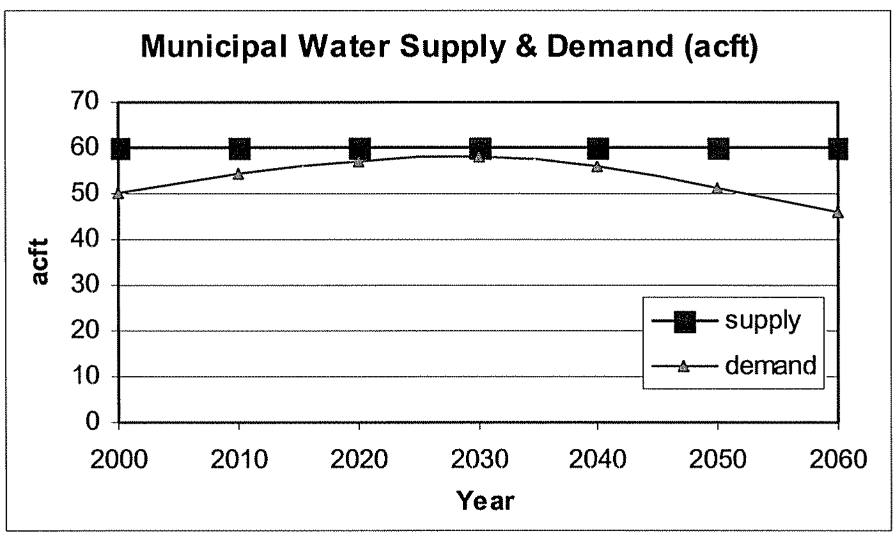




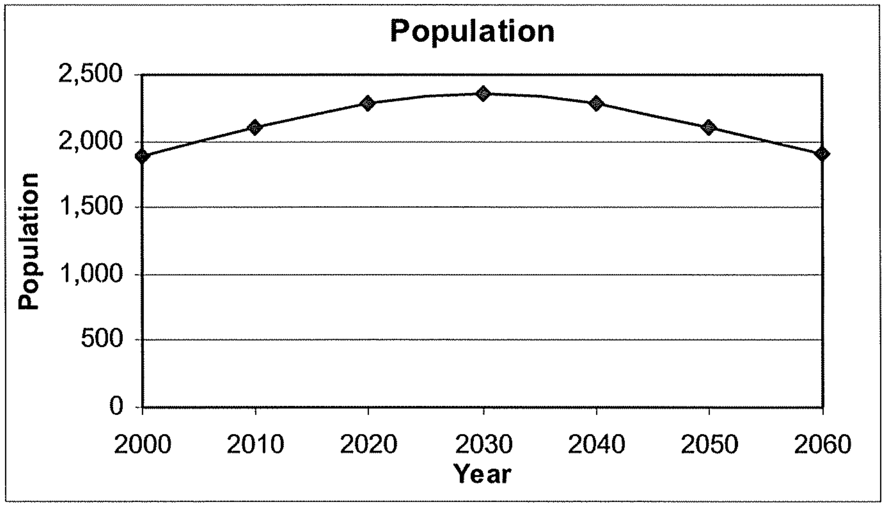
McCoy WSC — Live Oak County

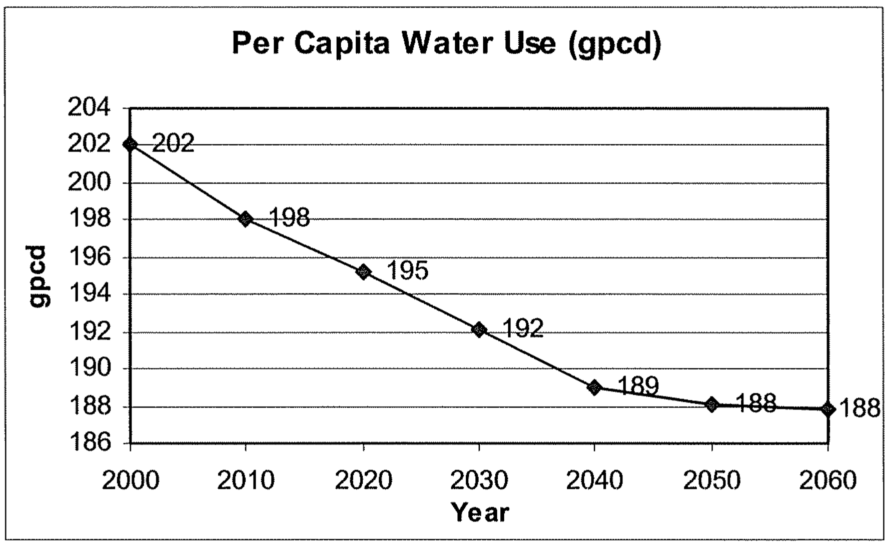


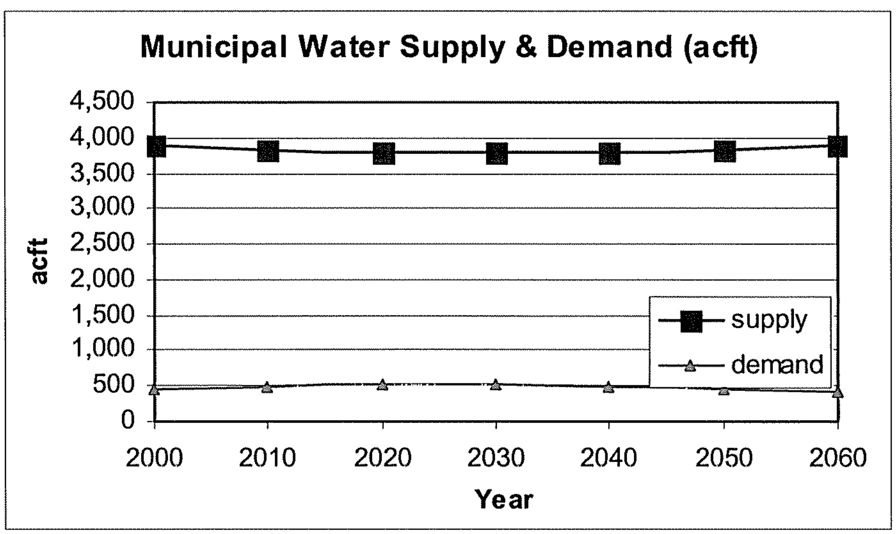




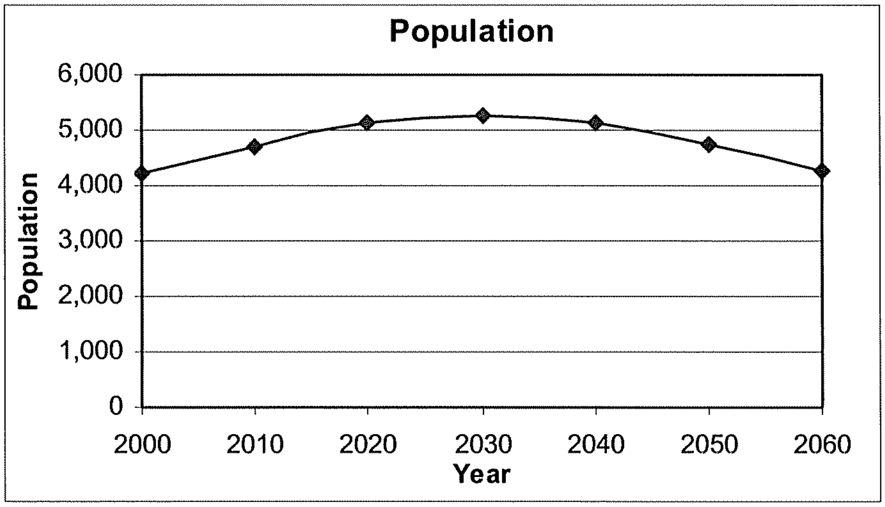
City of Three Rivers — Live Oak County

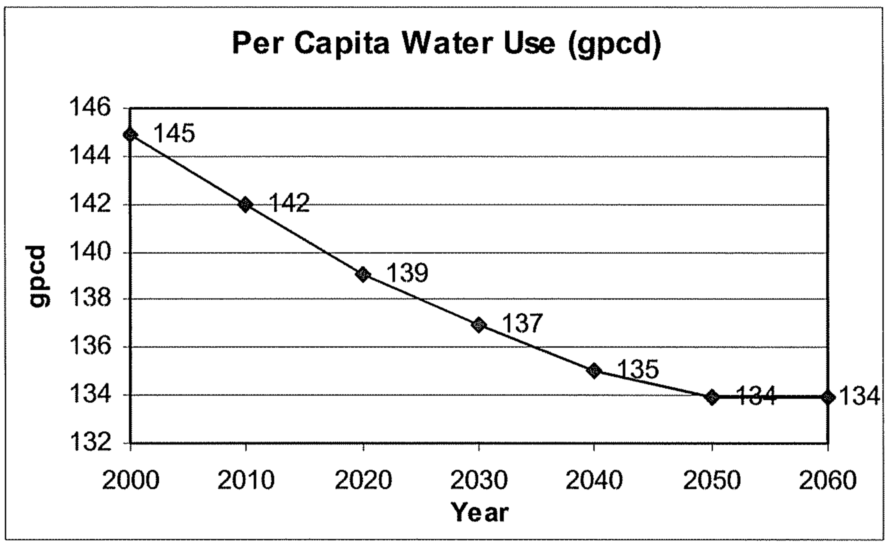


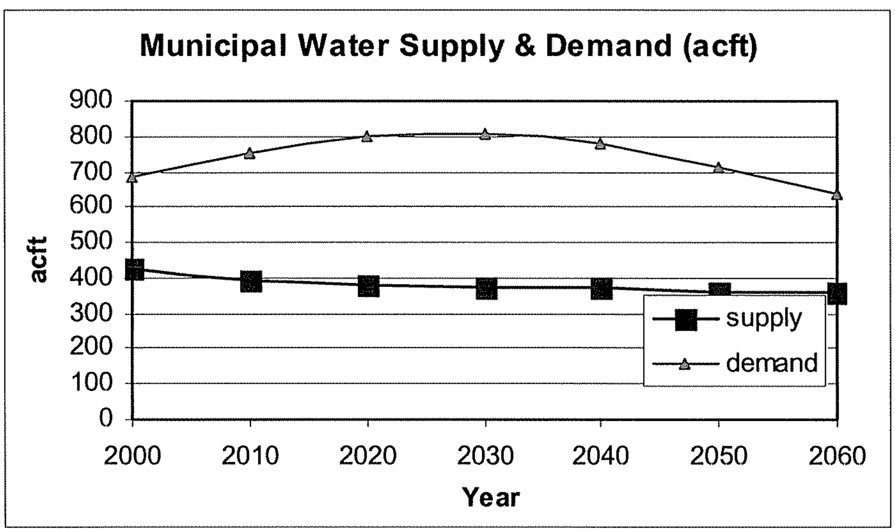




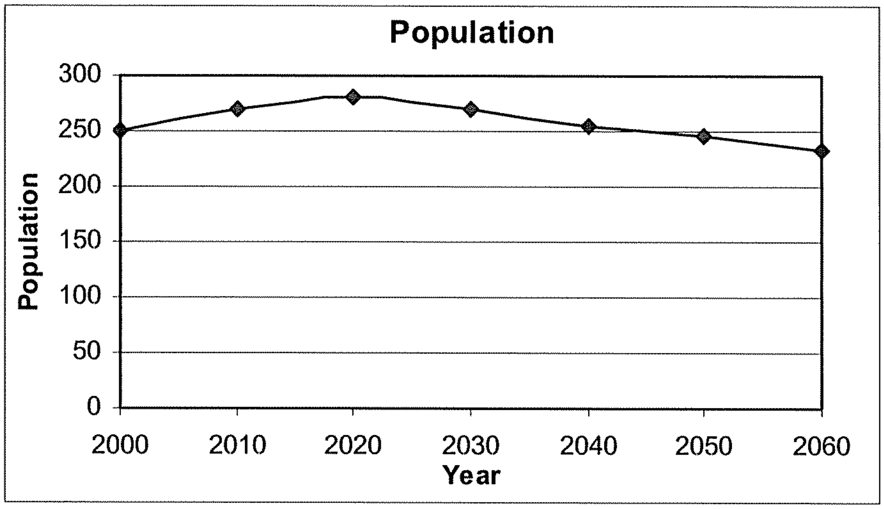
County-Other — Live Oak County

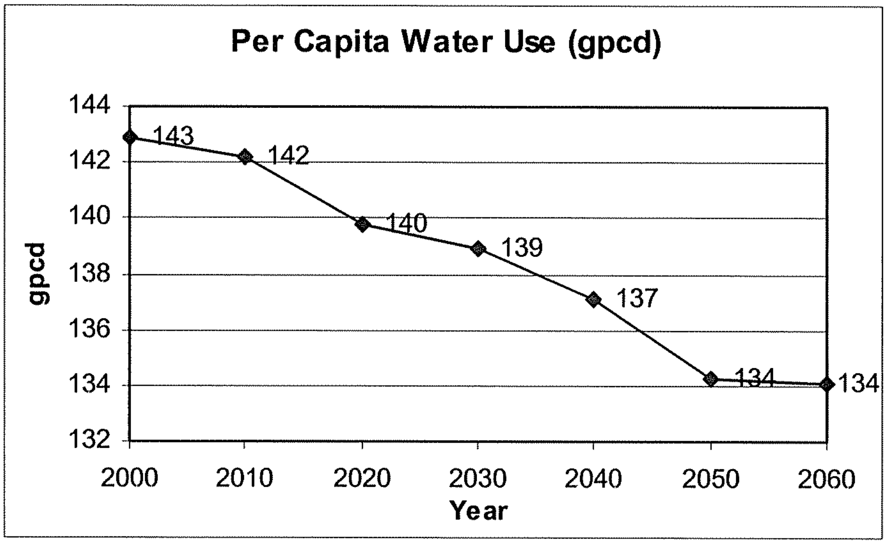


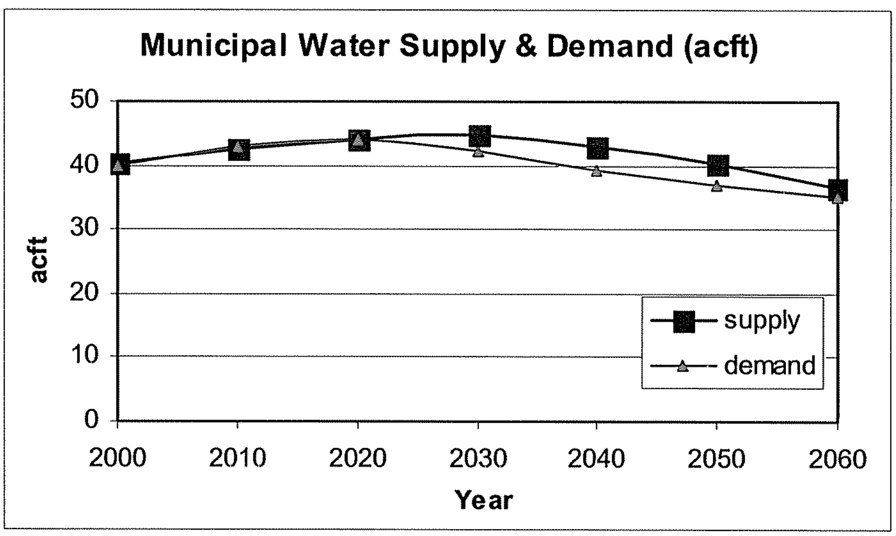




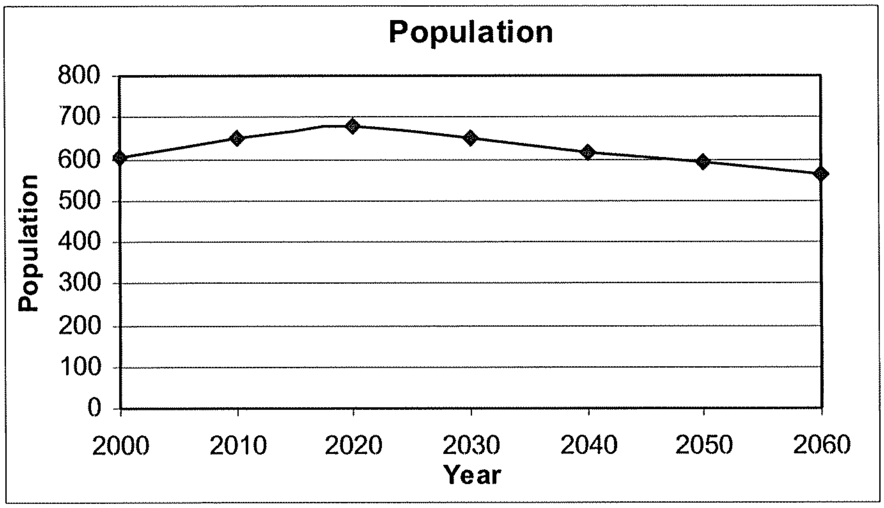
Choke Canyon WSC — McMullen County

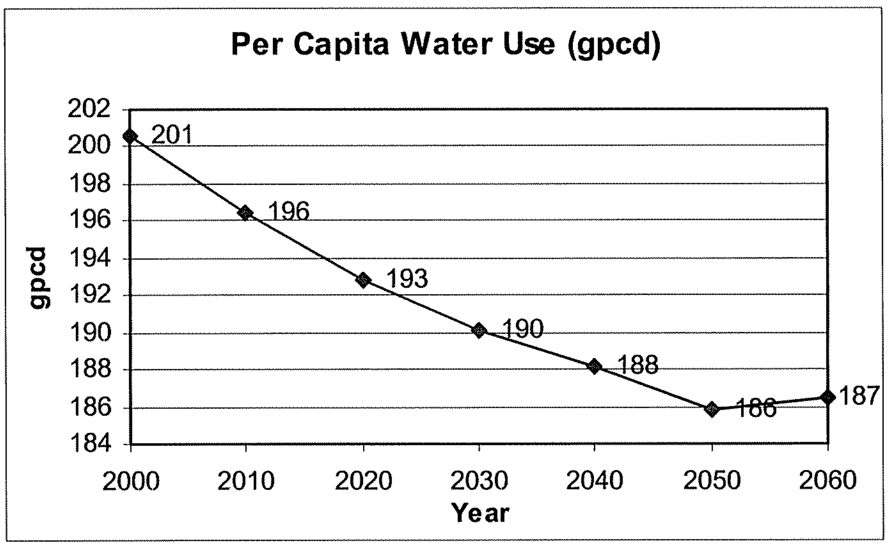


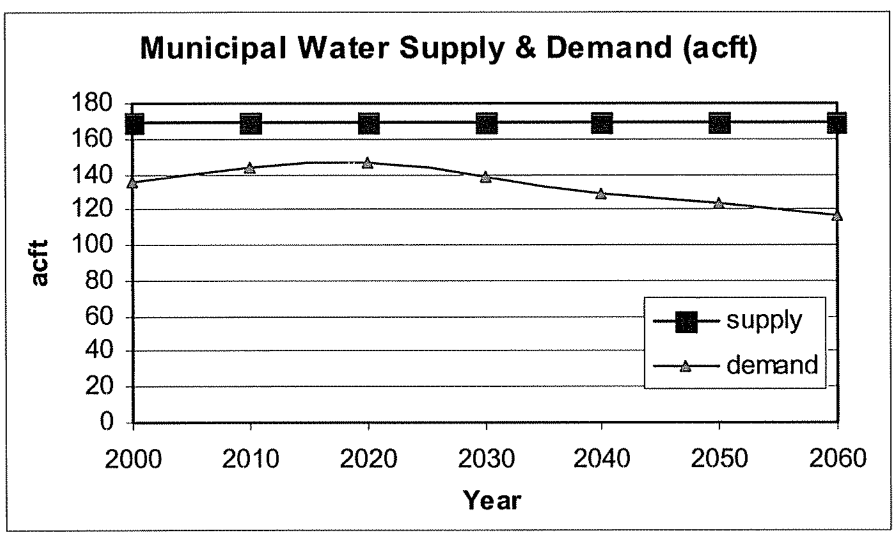




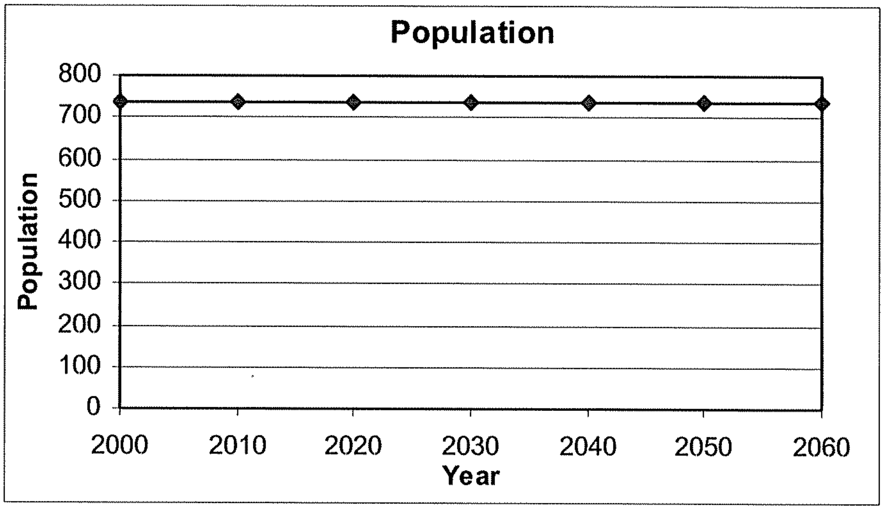
County-Other — McMullen County

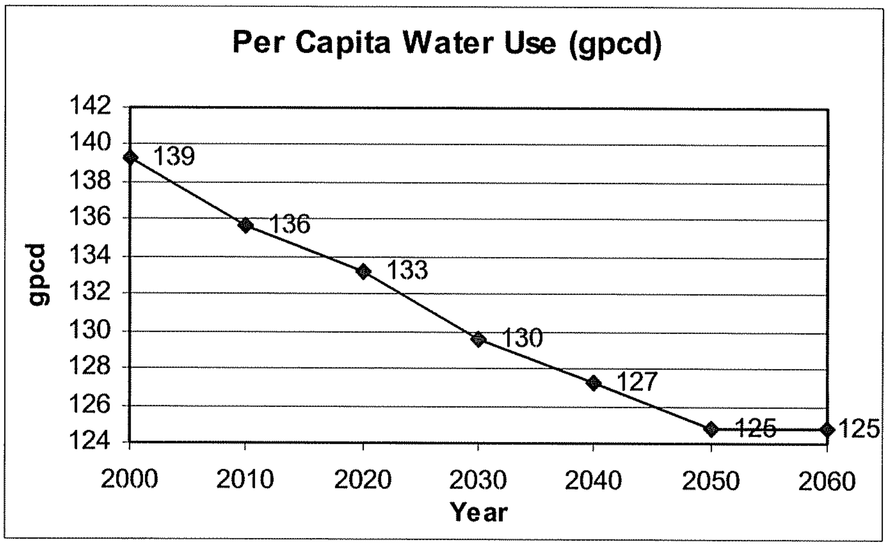


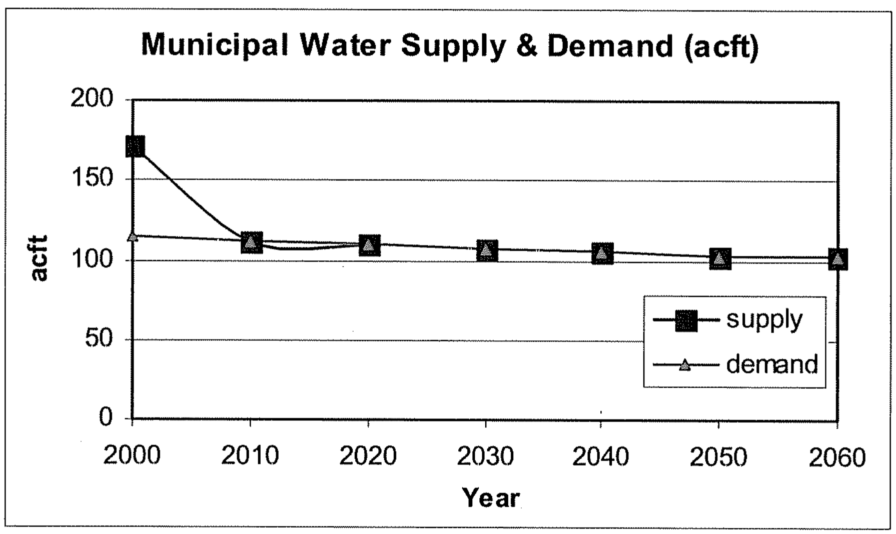




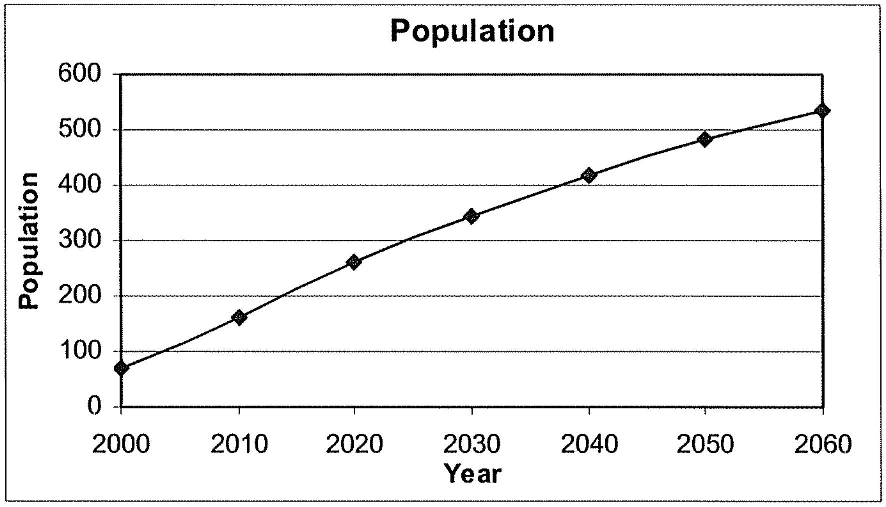
City of Agua Dulce — Nueces County

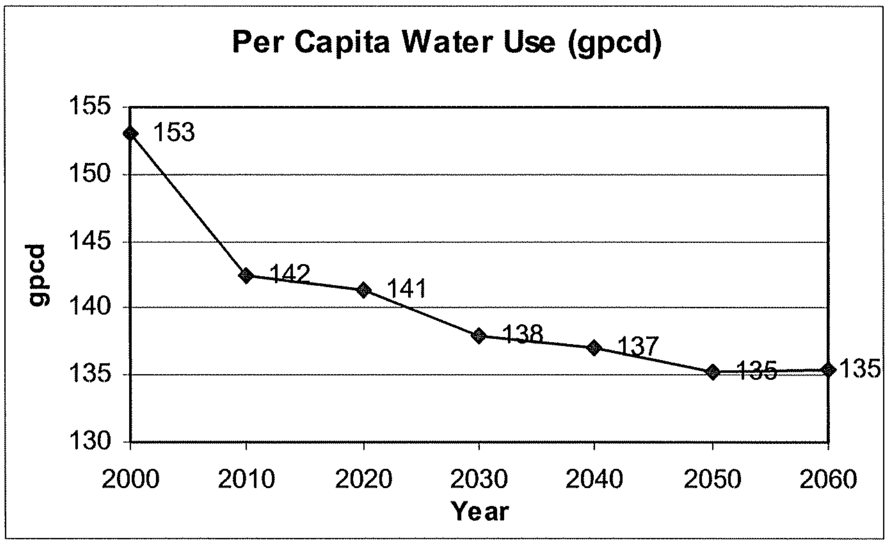


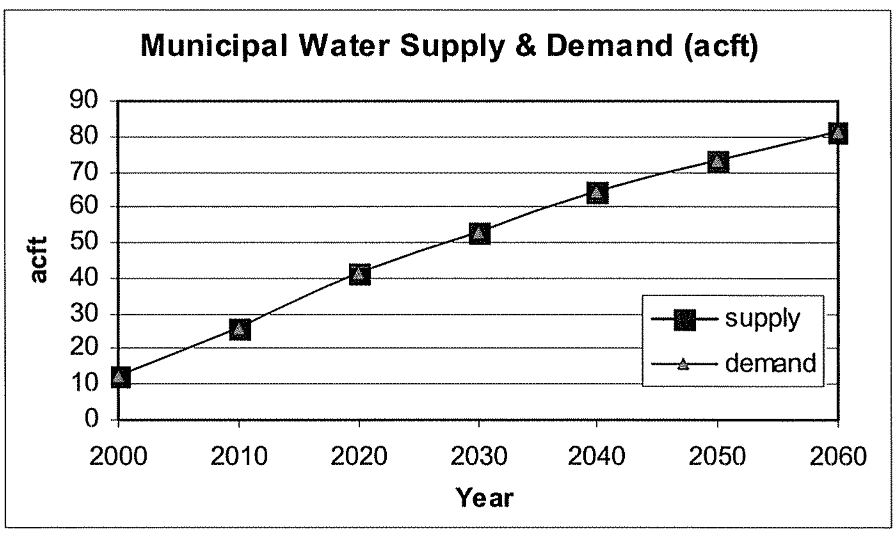




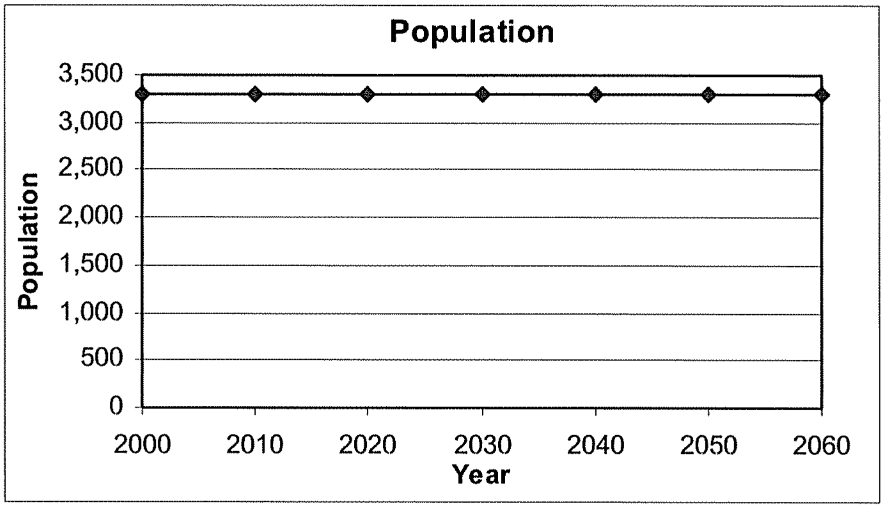
City of Aransas Pass — Nueces County

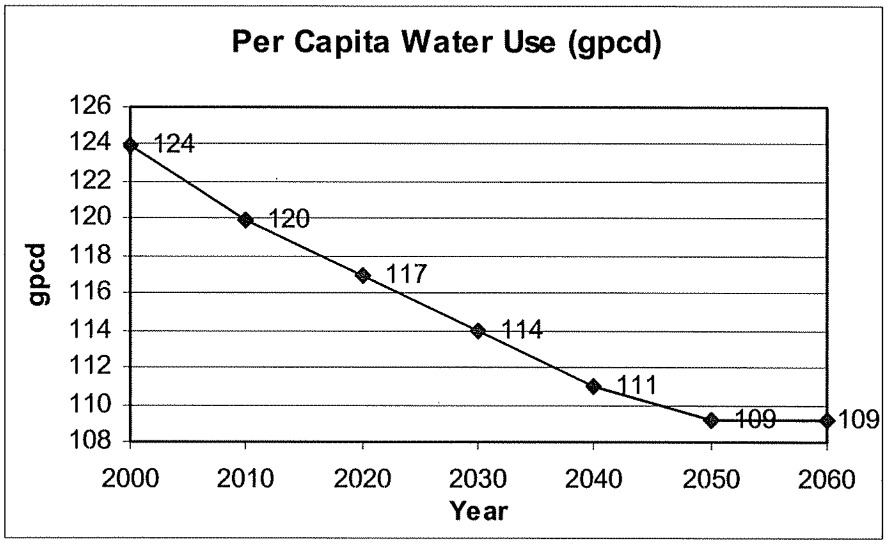


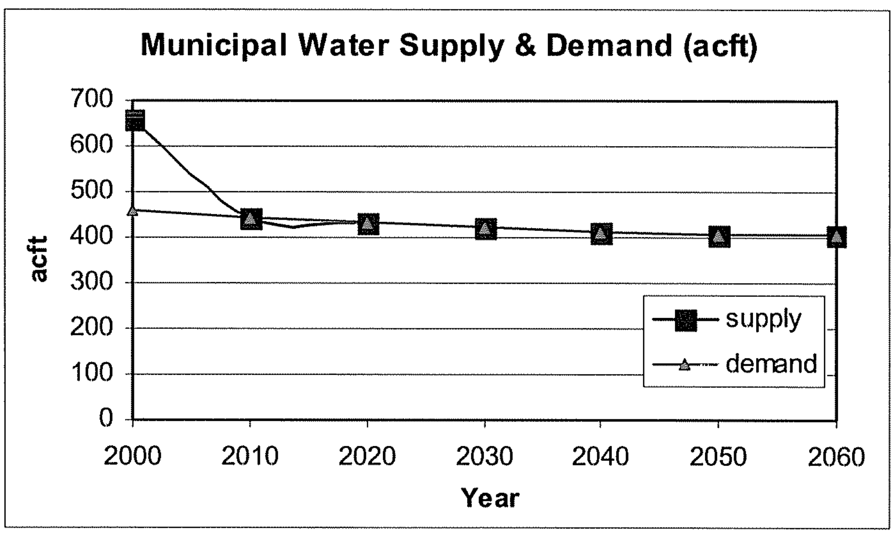




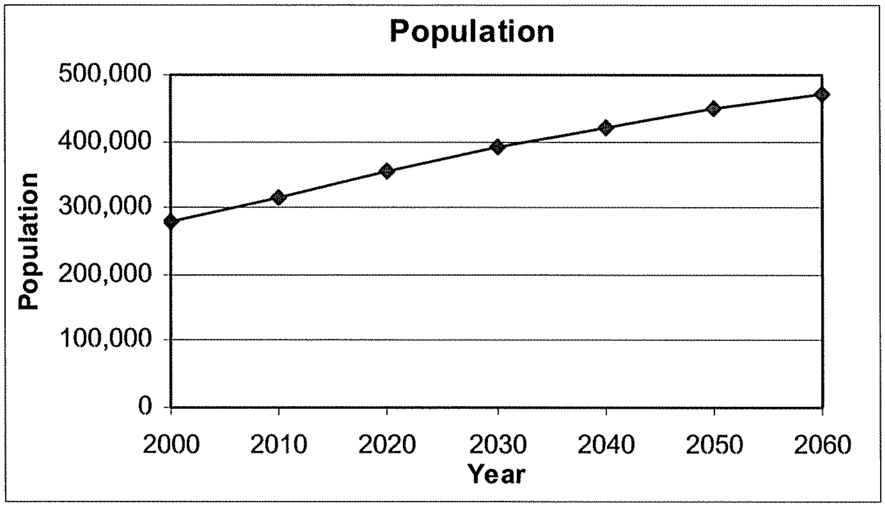
City of Bishop — Nueces County

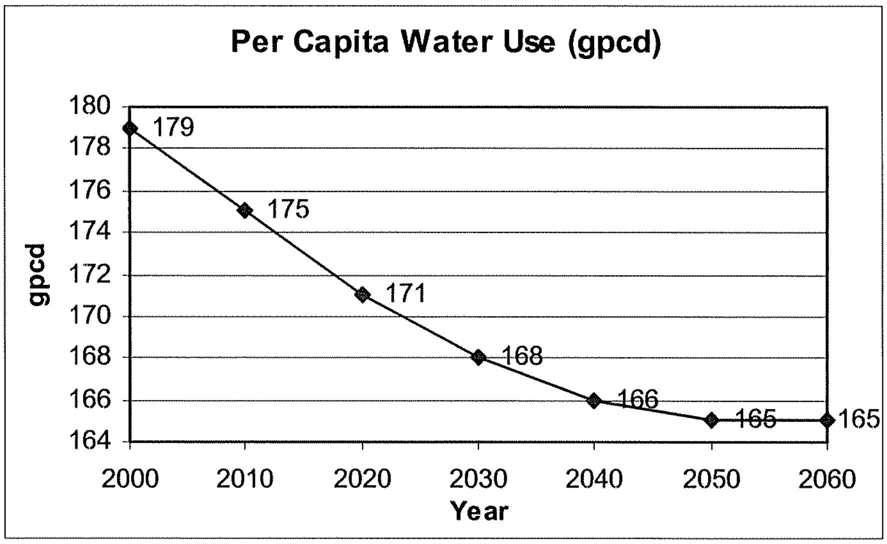


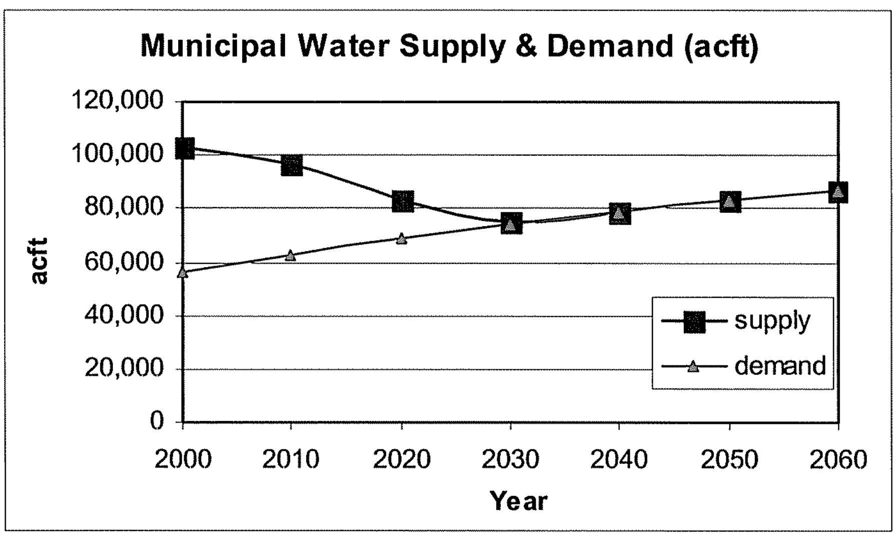




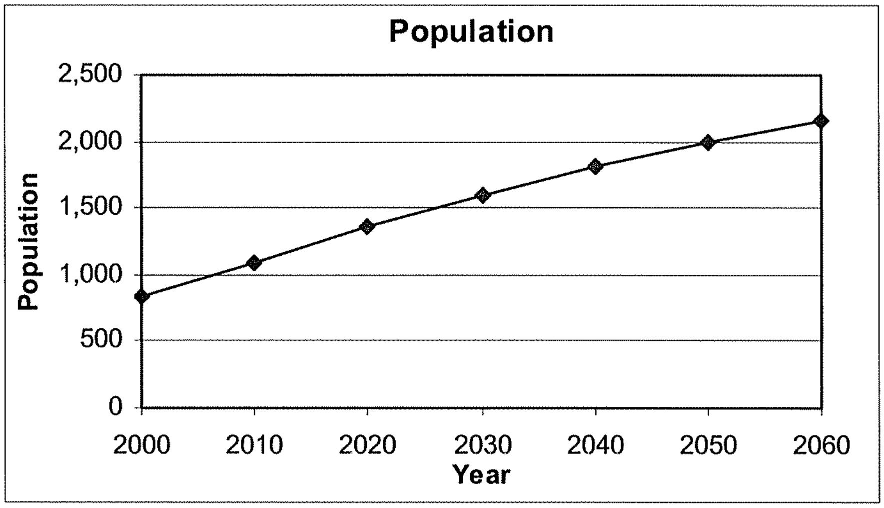
City of Corpus Christi — Nueces County

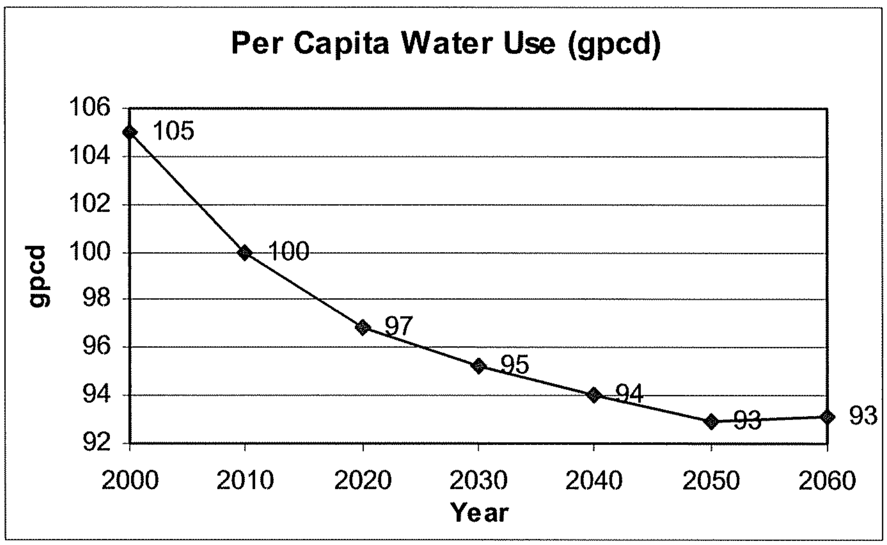


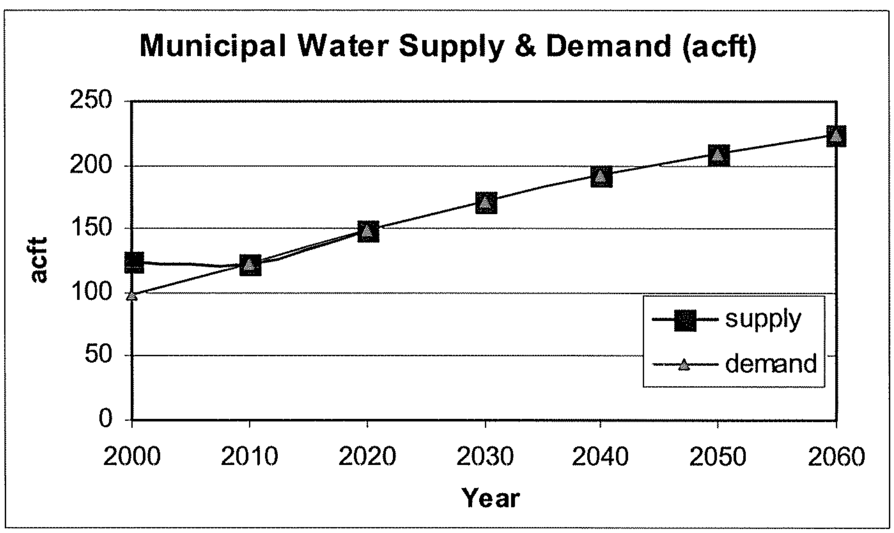




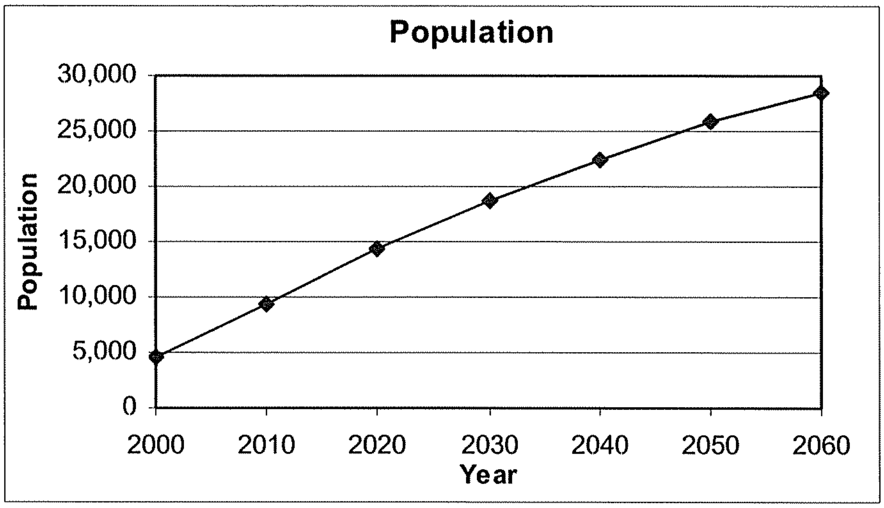
City of Driscoll — Nueces County

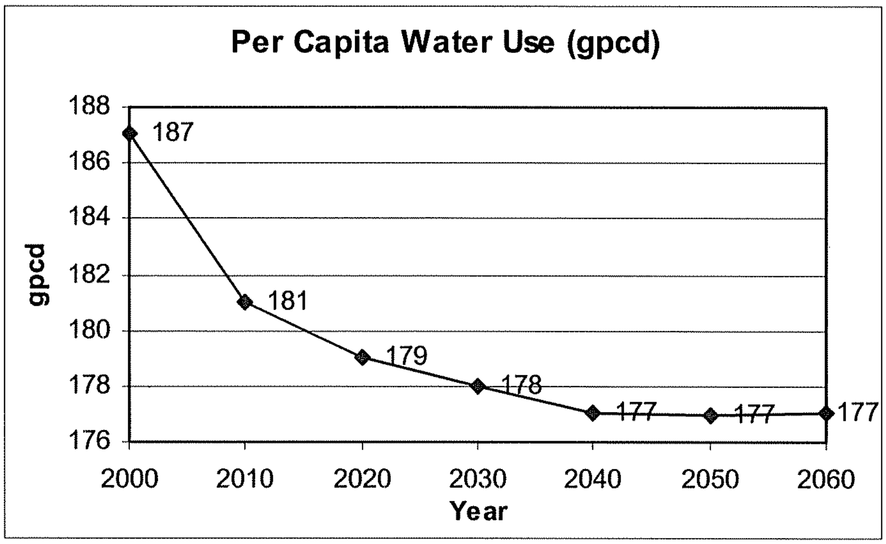


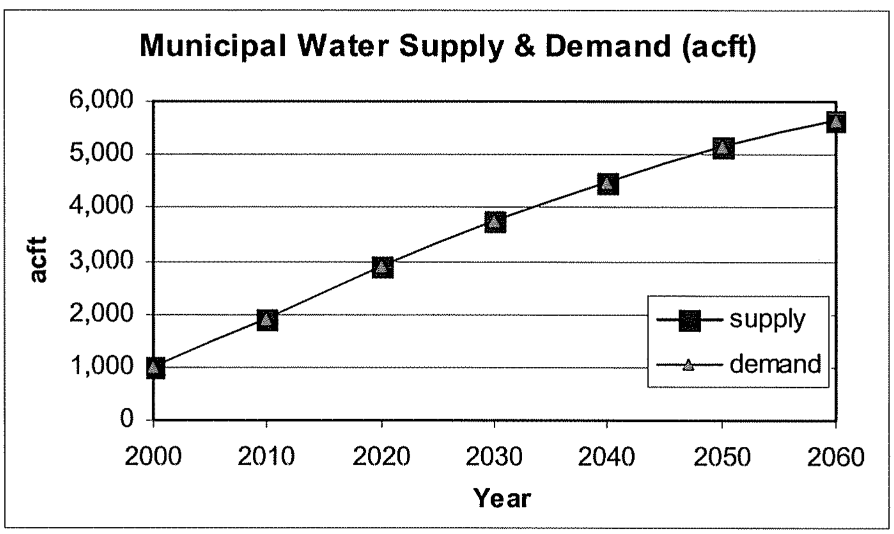




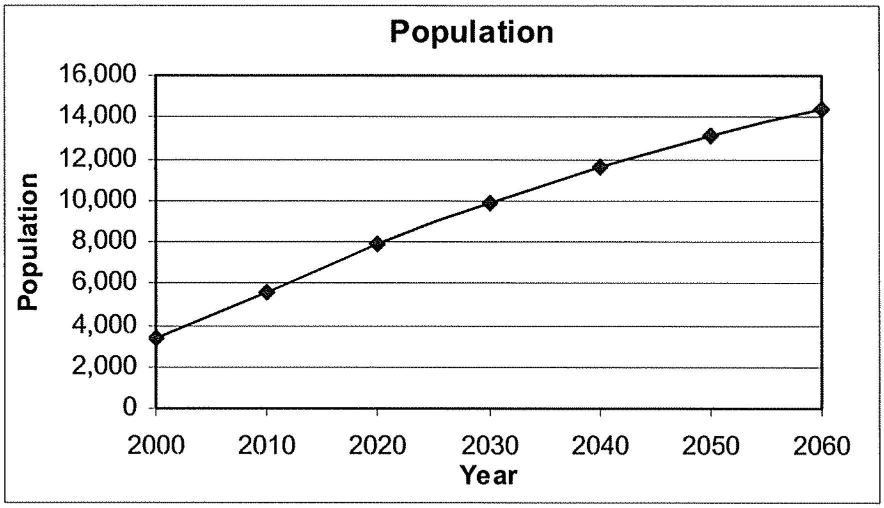
Nueces County WCID #4 — Nueces County

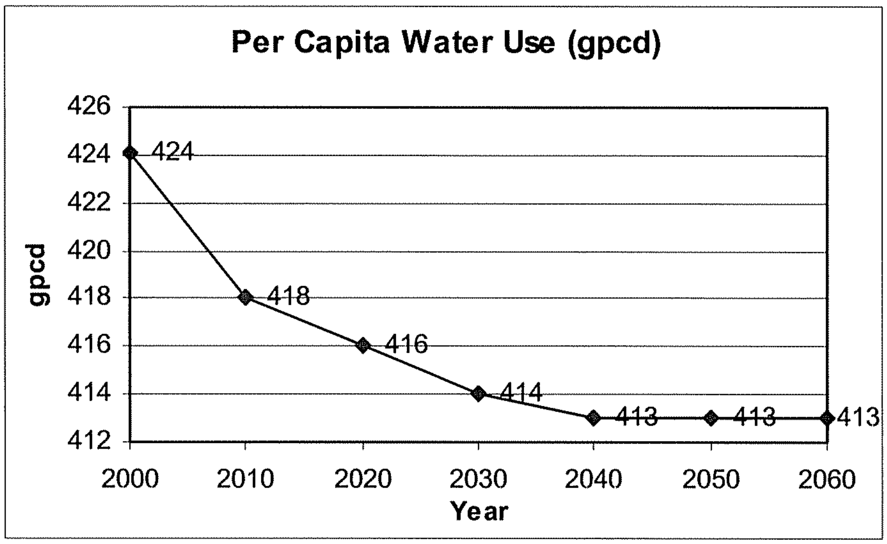


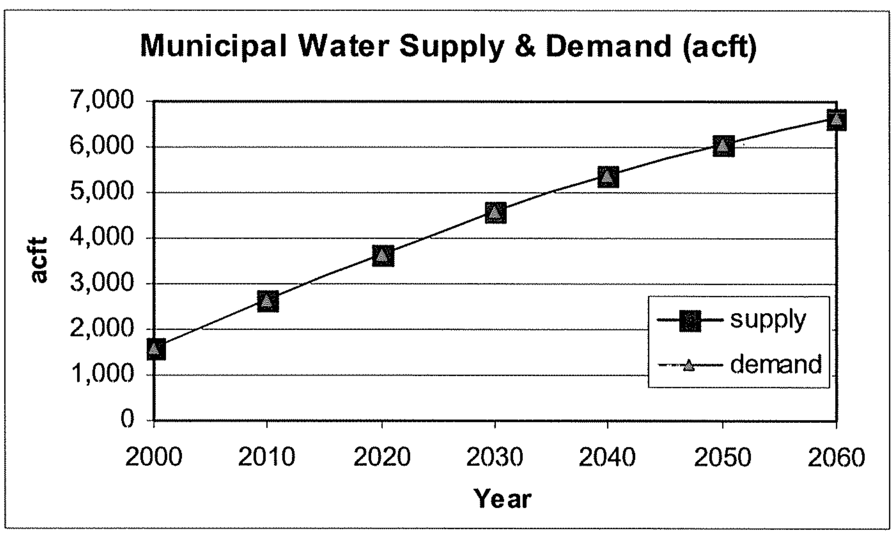




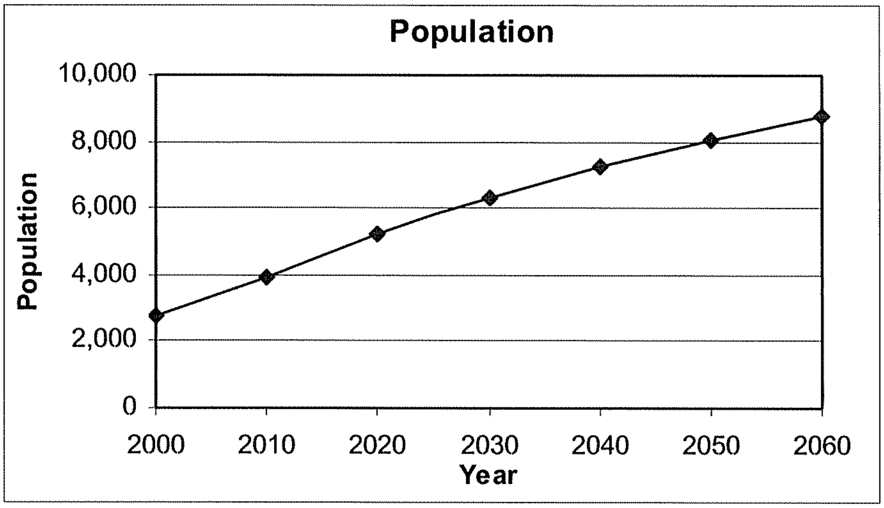
City of Port Aransas — Nueces County

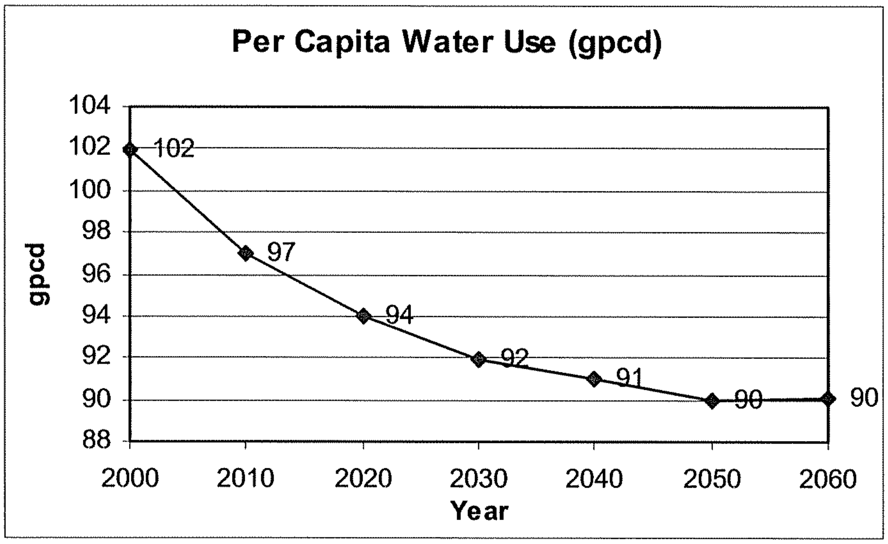


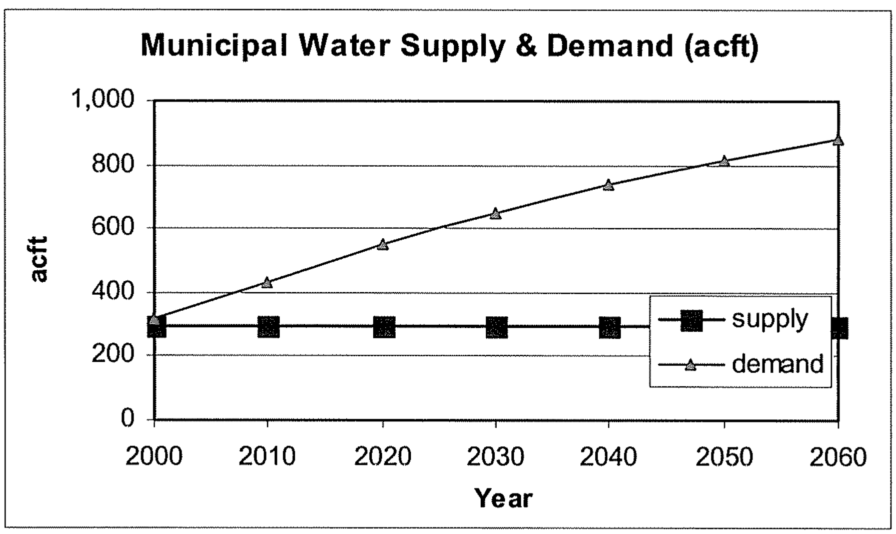




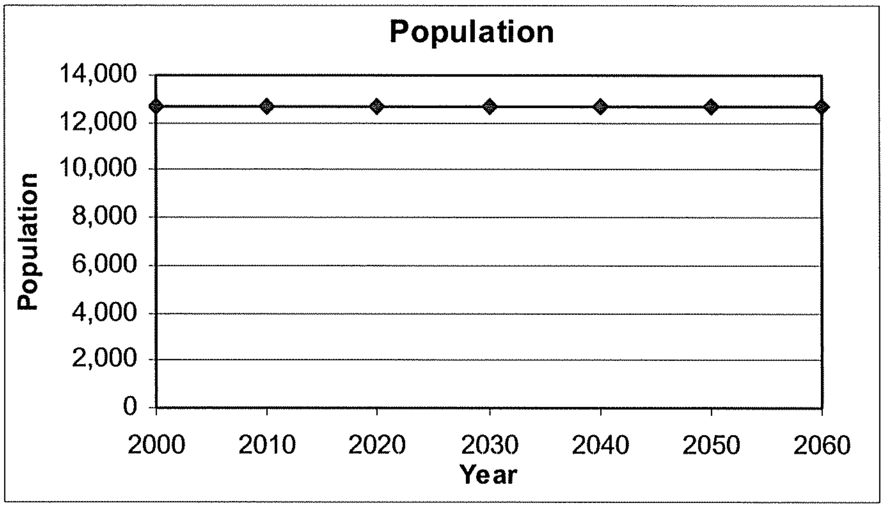
River Acres WSC — Nueces County

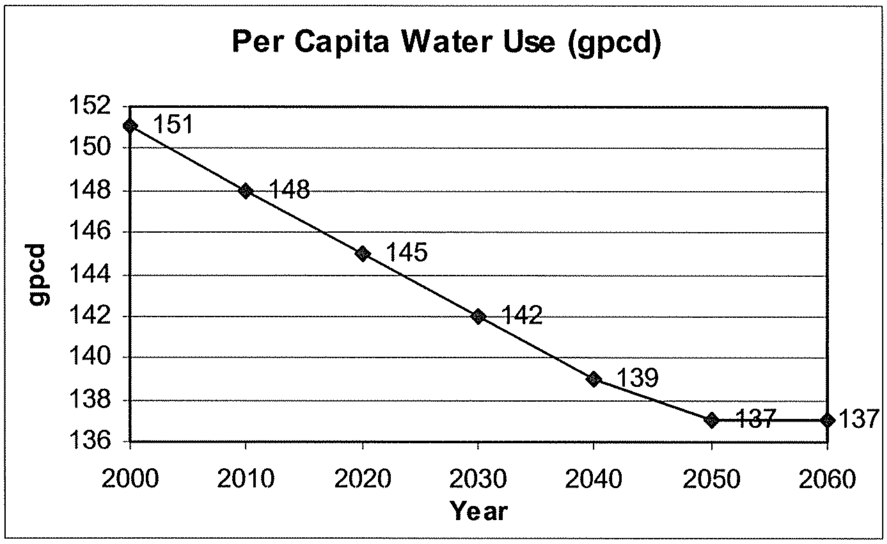


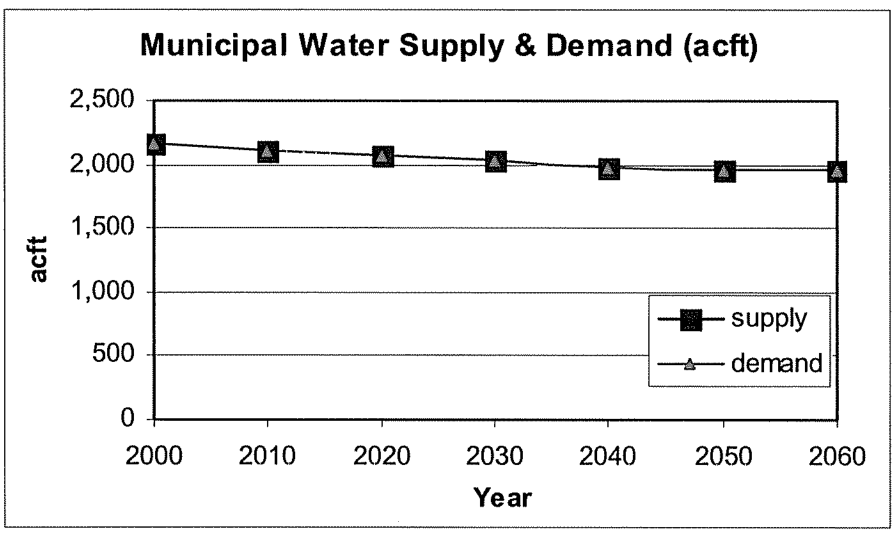




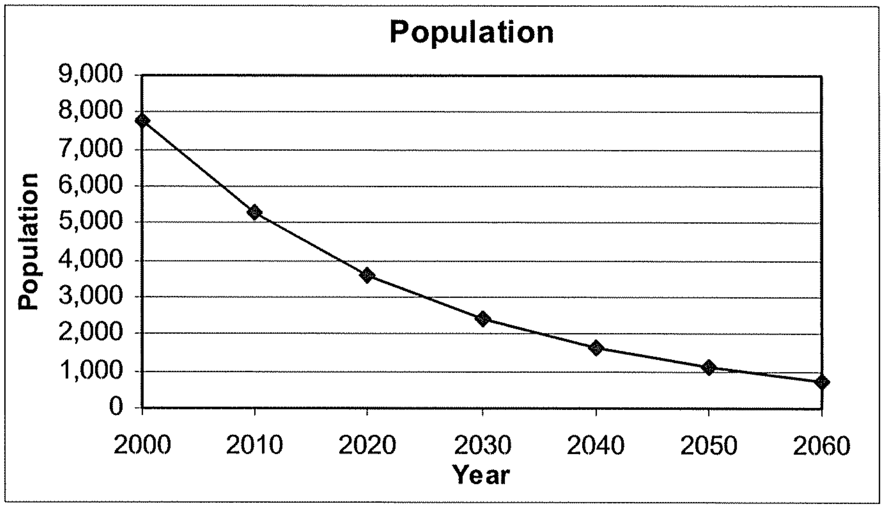
City of Robstown — Nueces County

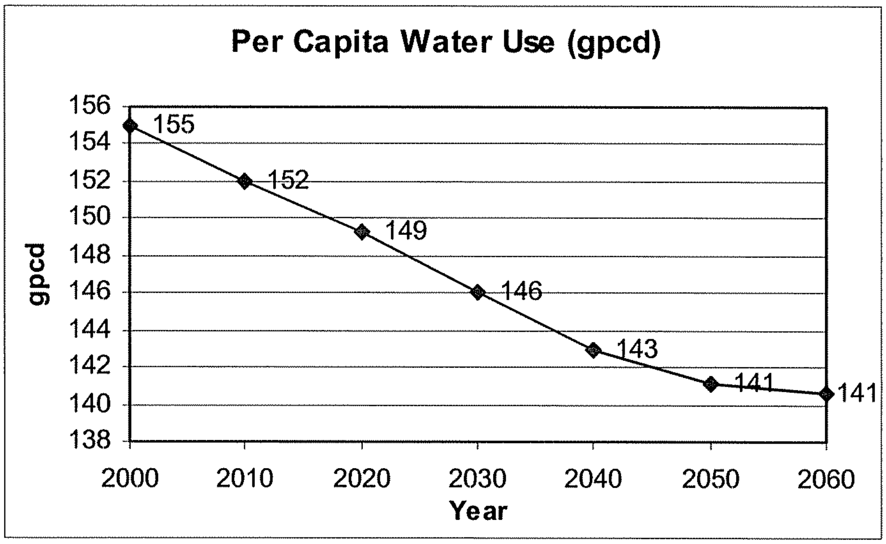


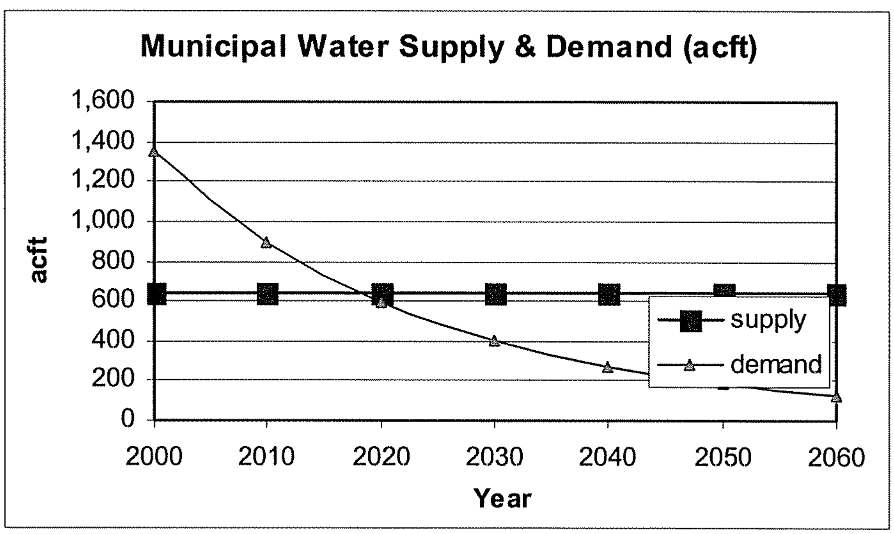




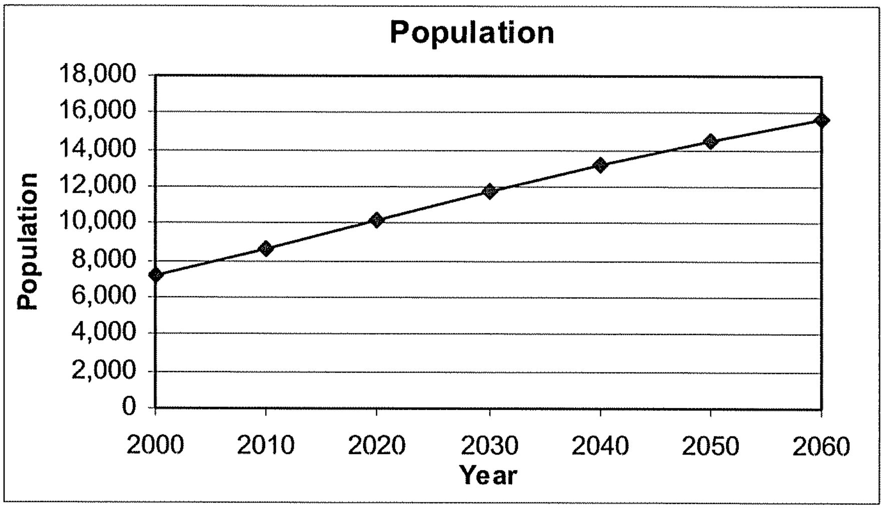
County-Other — Nueces County

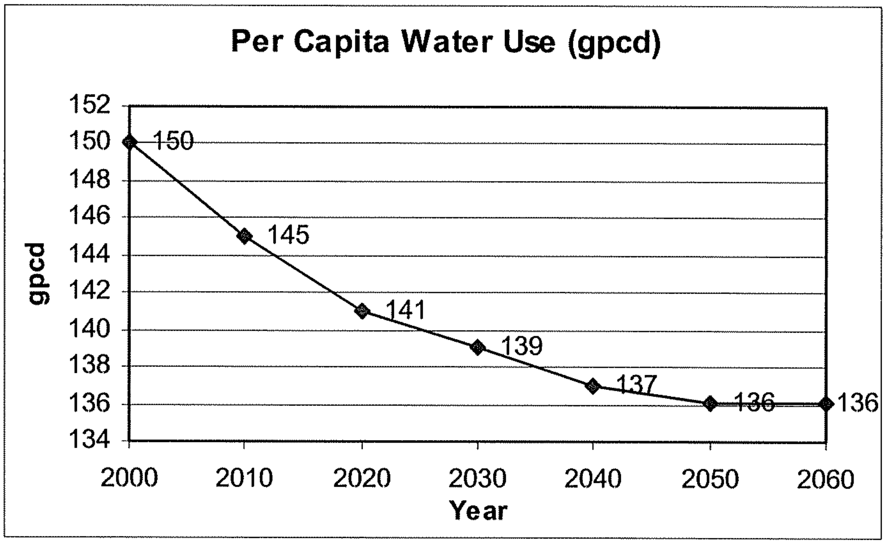


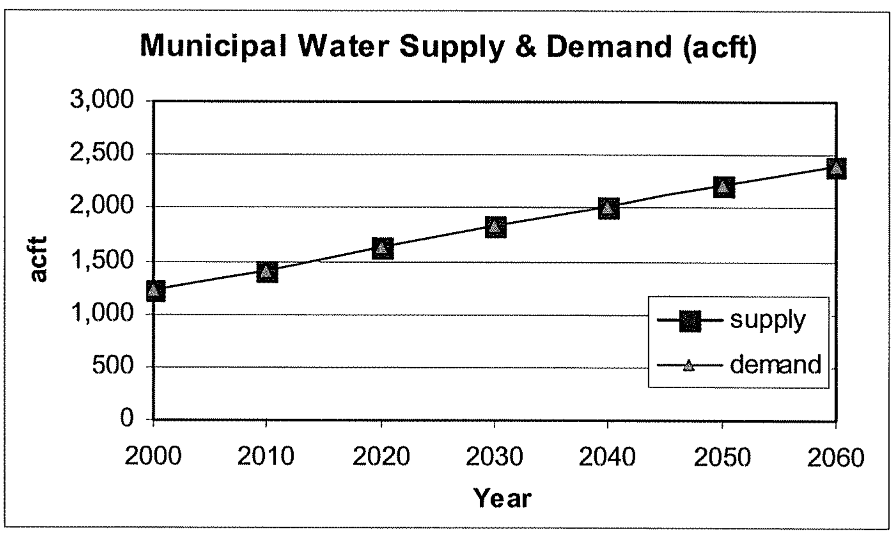




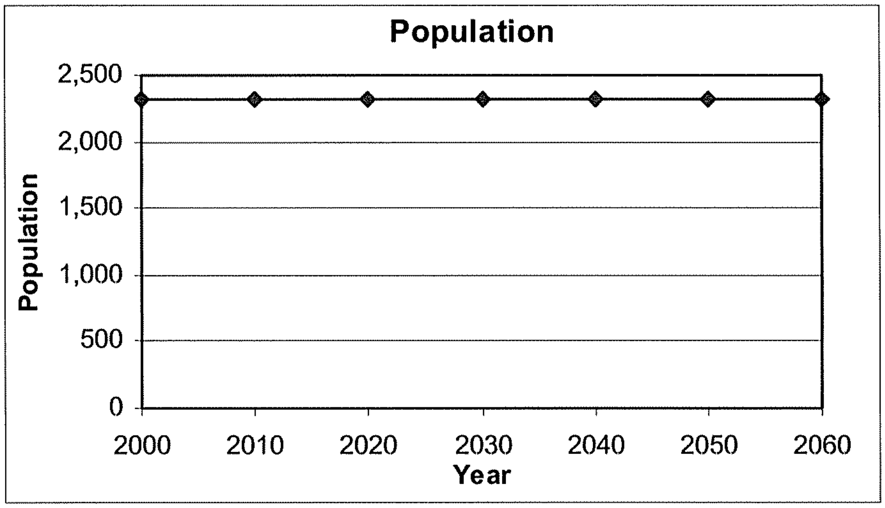
City of Aransas Pass — San Patricio County

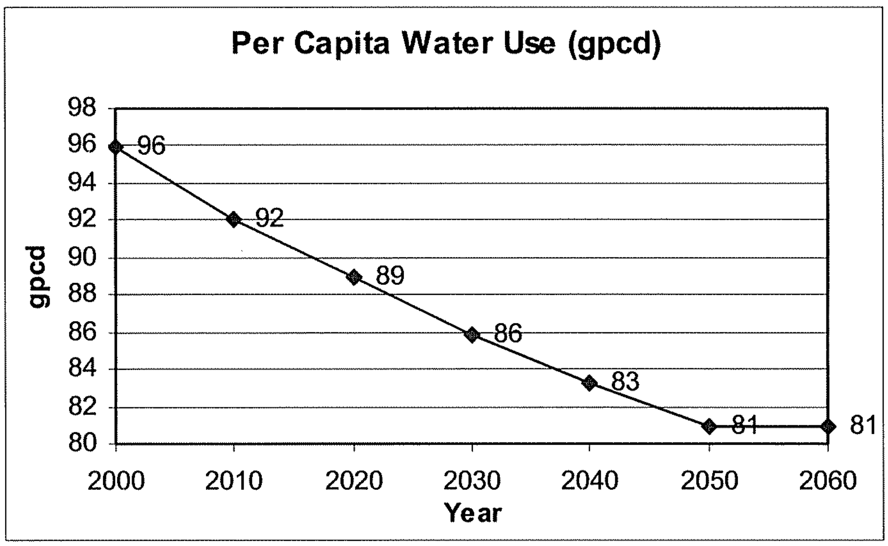


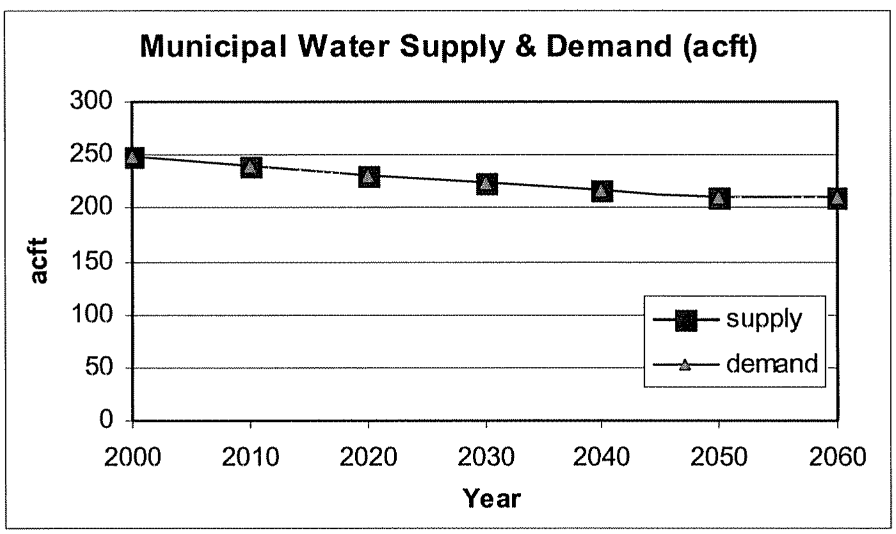




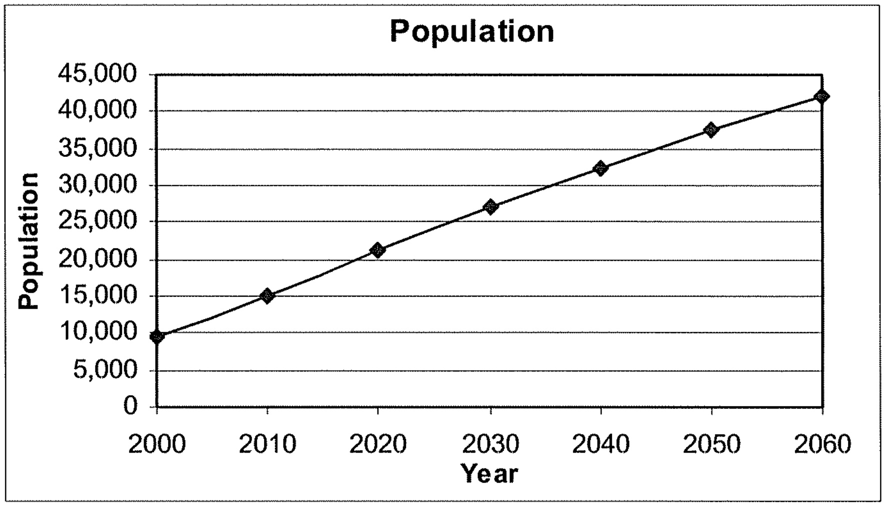
City of Gregory — San Patricio County

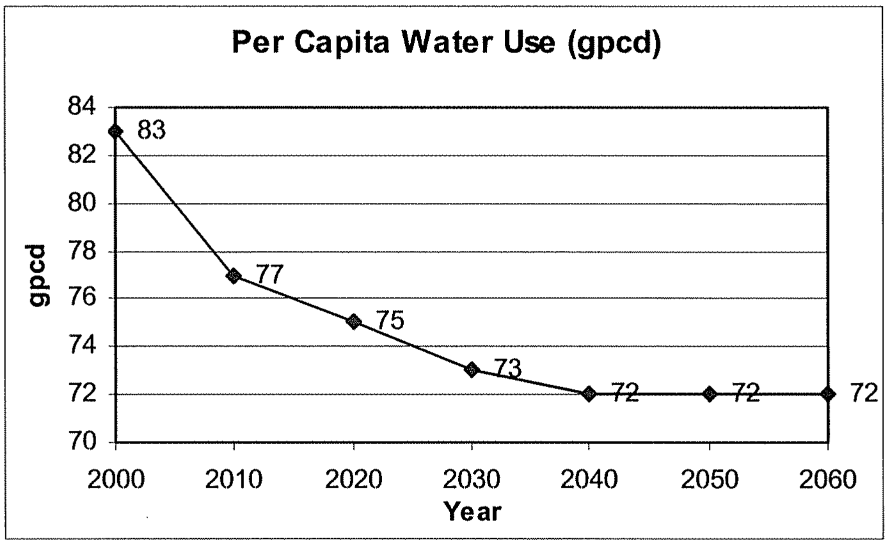


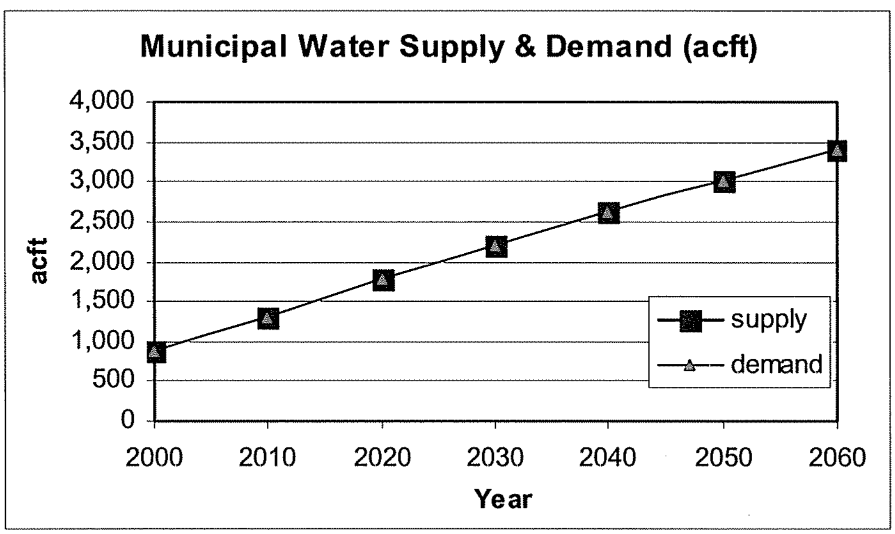




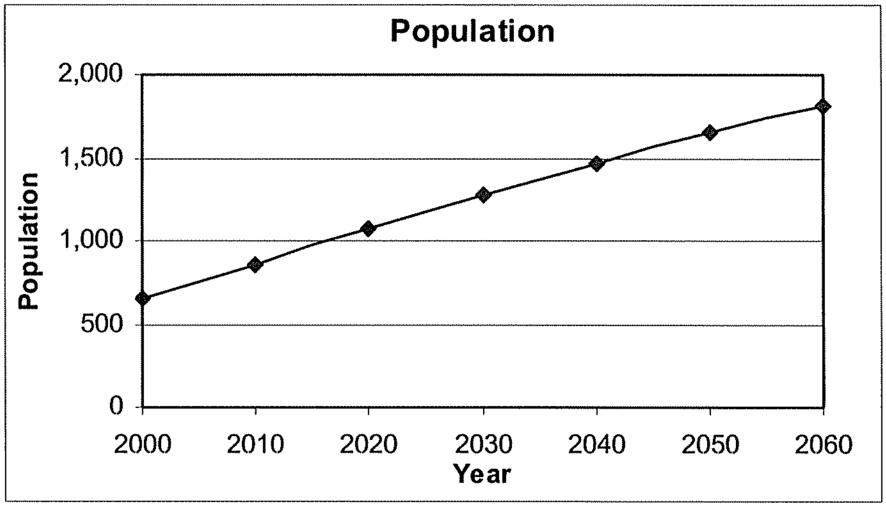
City of Ingleside — San Patricio County

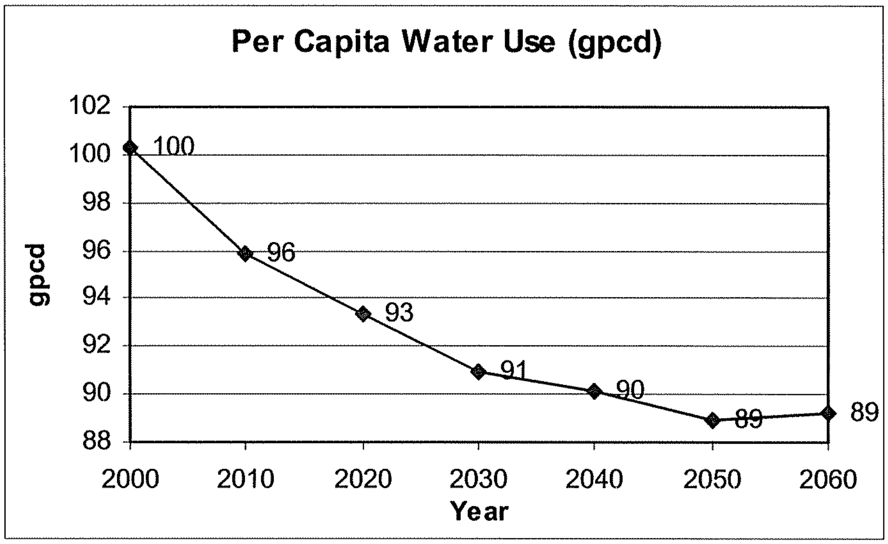


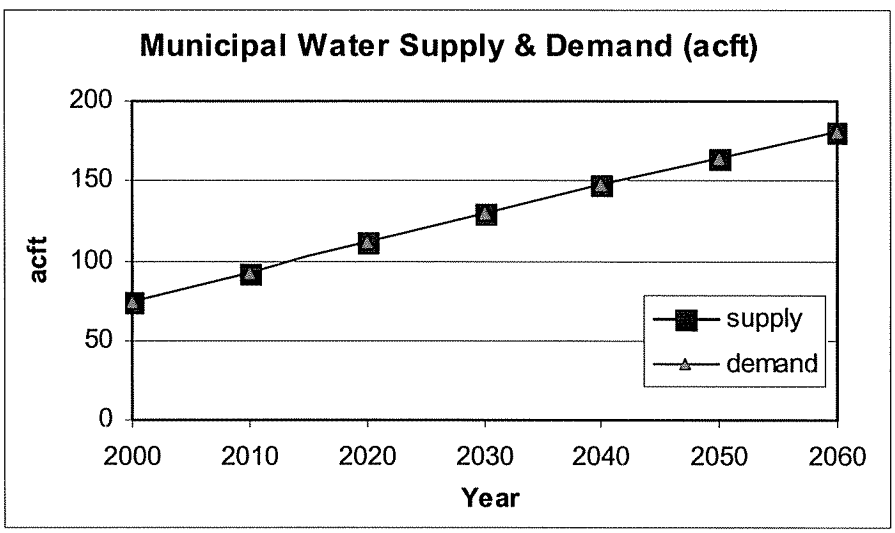




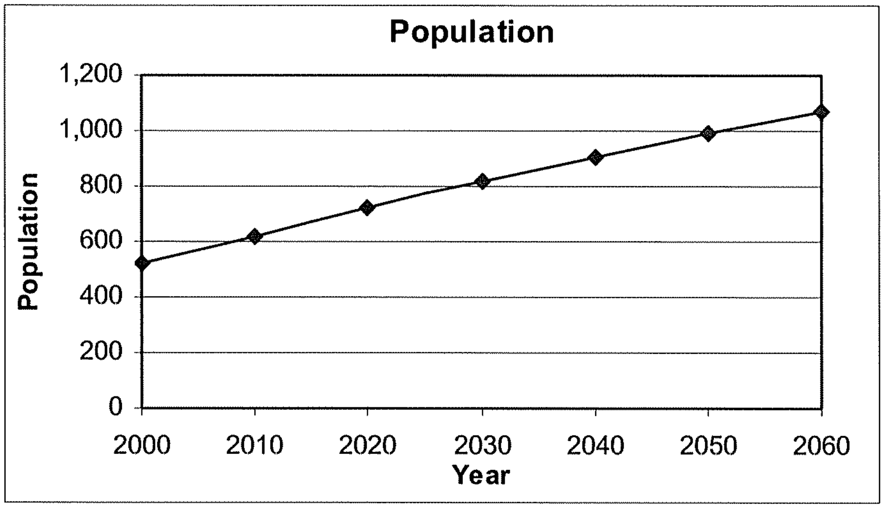
City of Ingleside On the Bay — San Patricio County

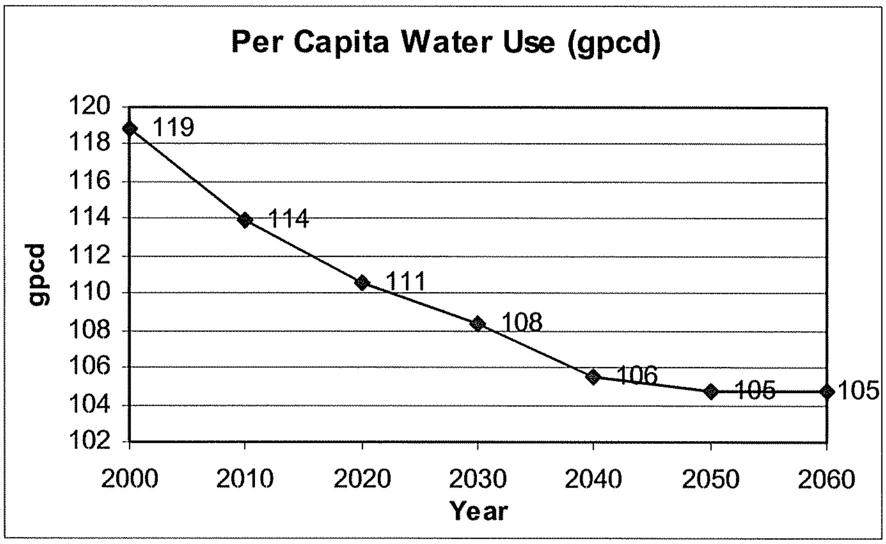


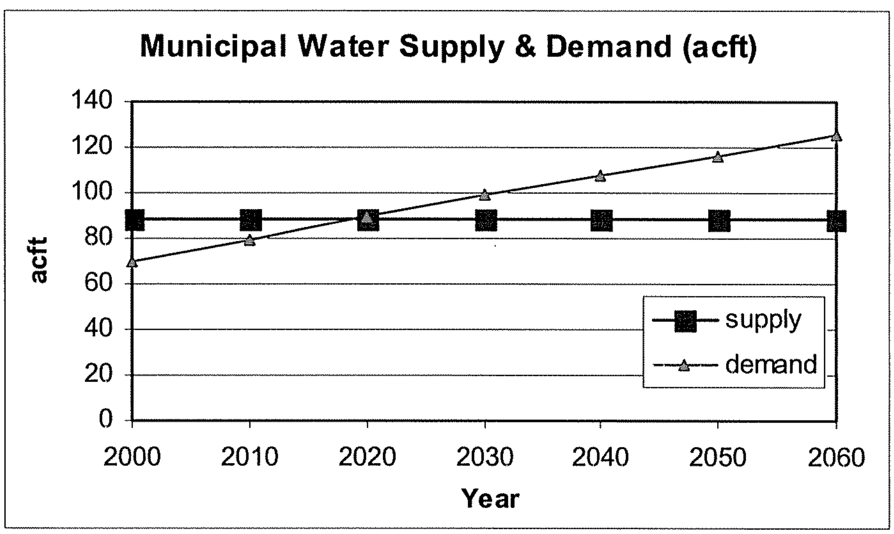




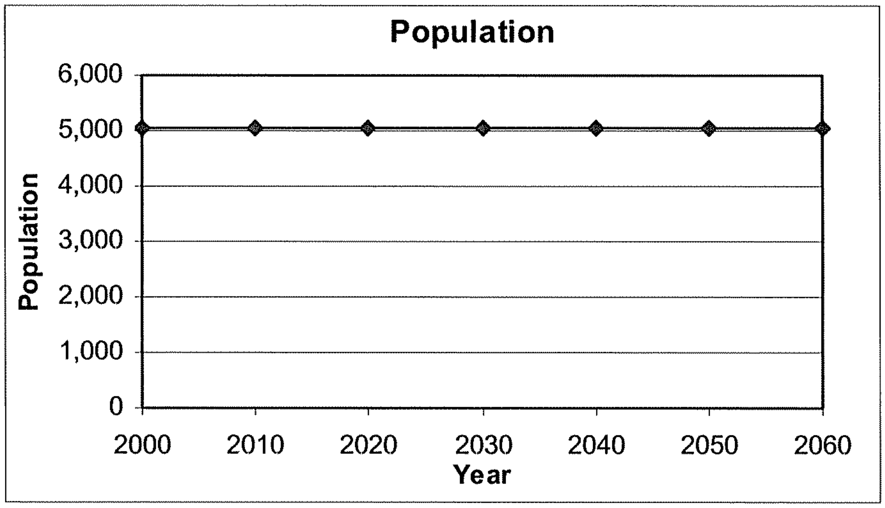
Lake City — San Patricio County

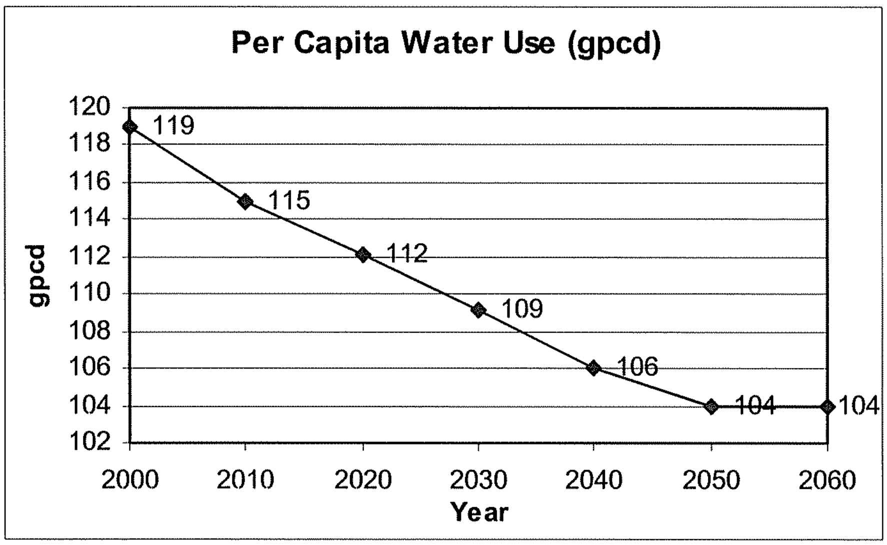


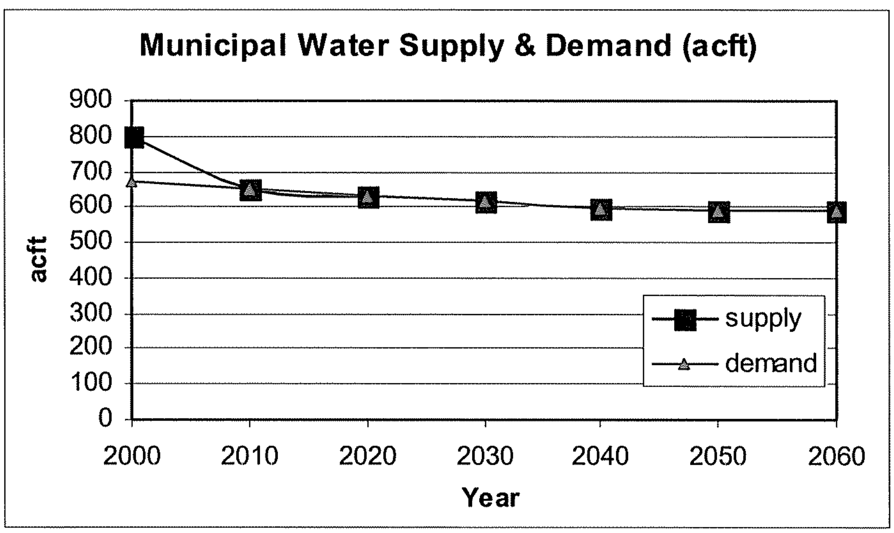




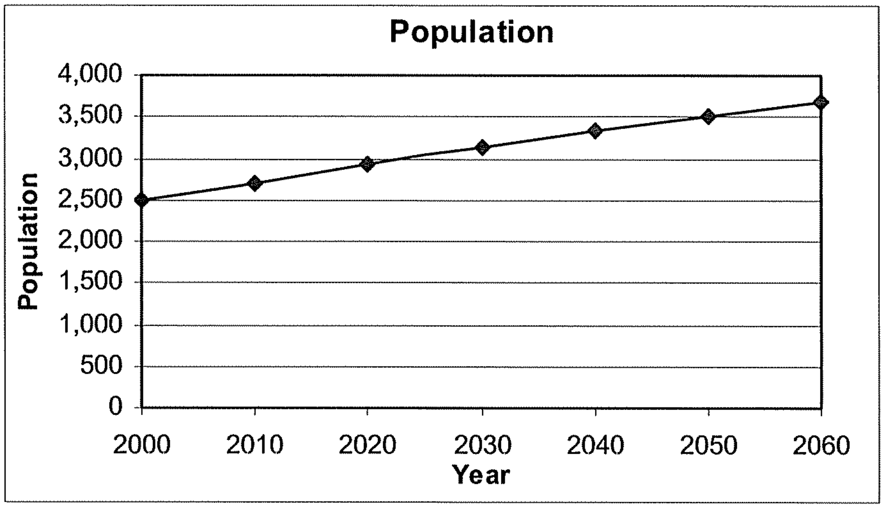
City of Mathis — San Patricio County

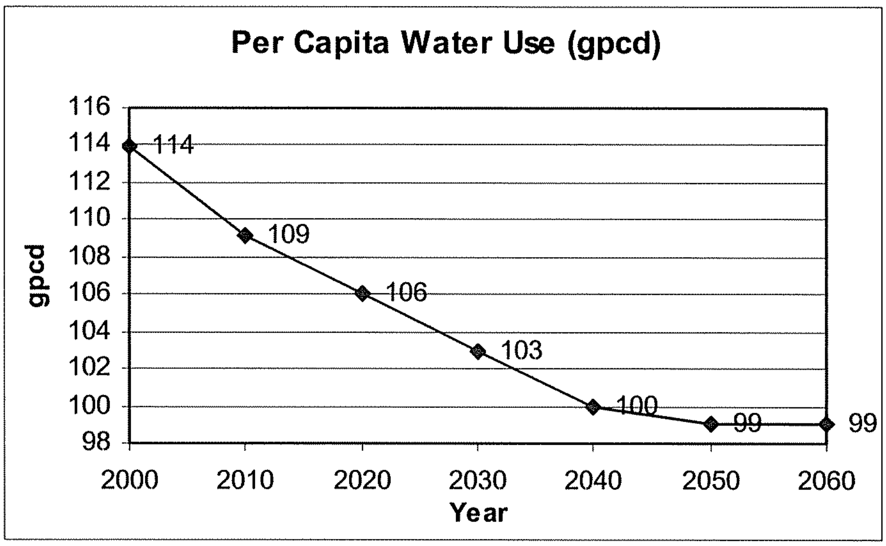


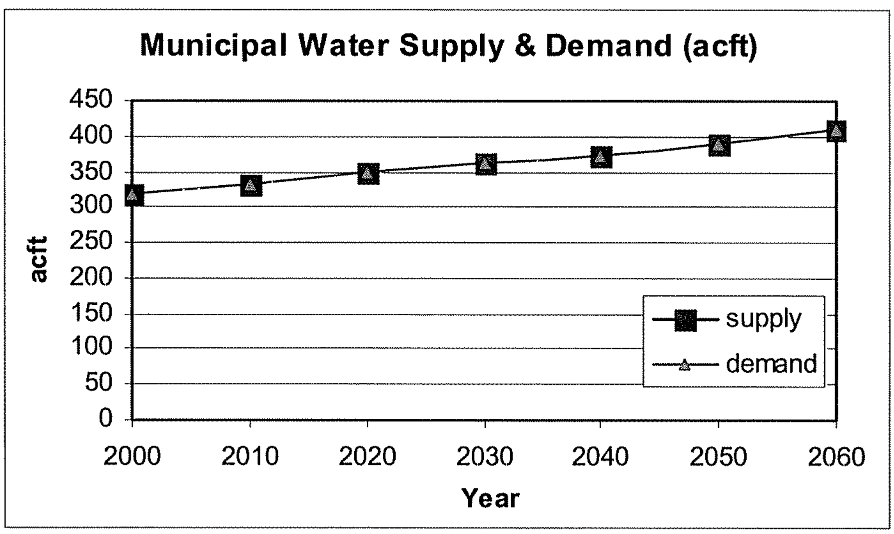




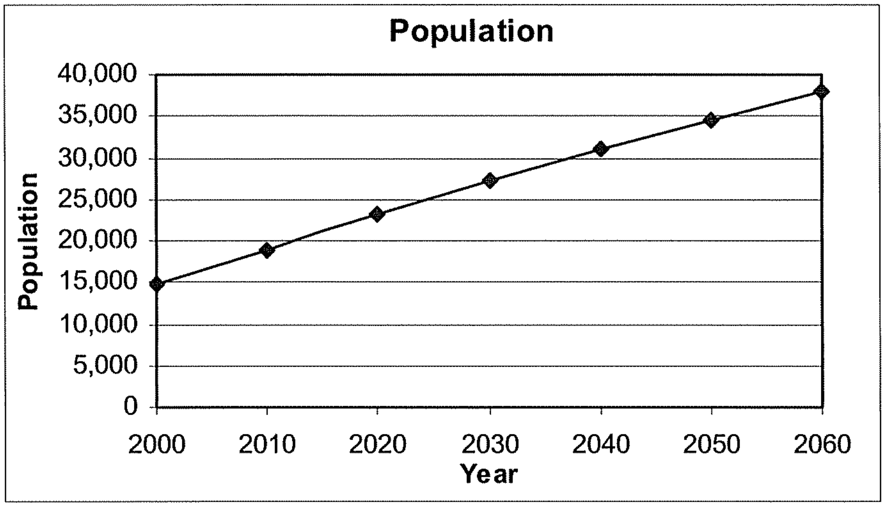
City of Odem — San Patricio County

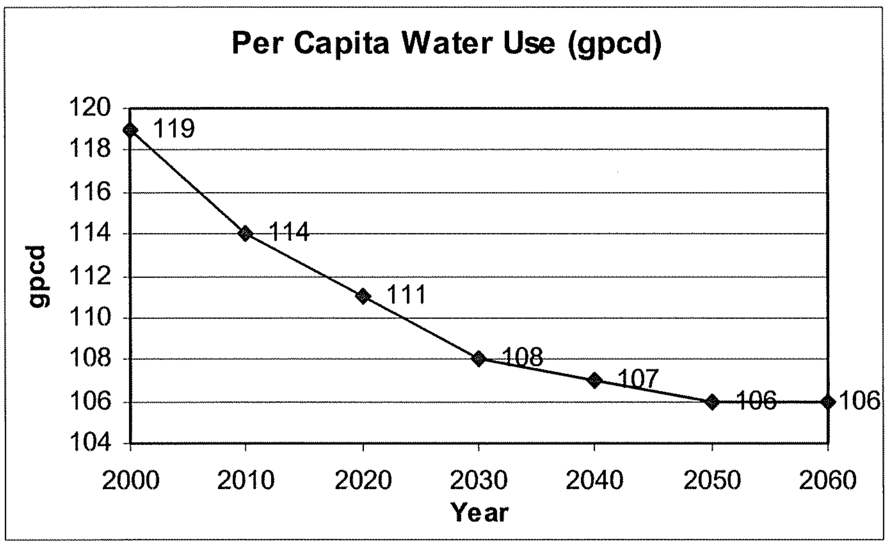


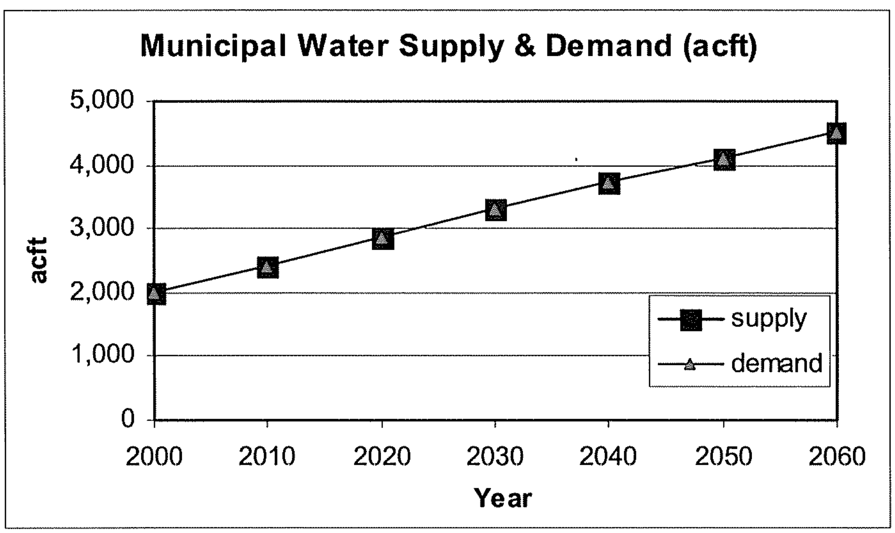




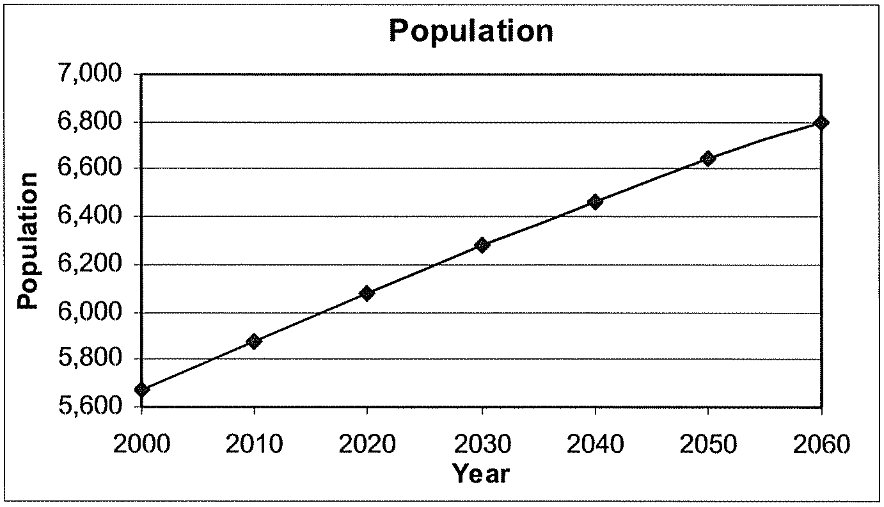
City of Portland — San Patricio County

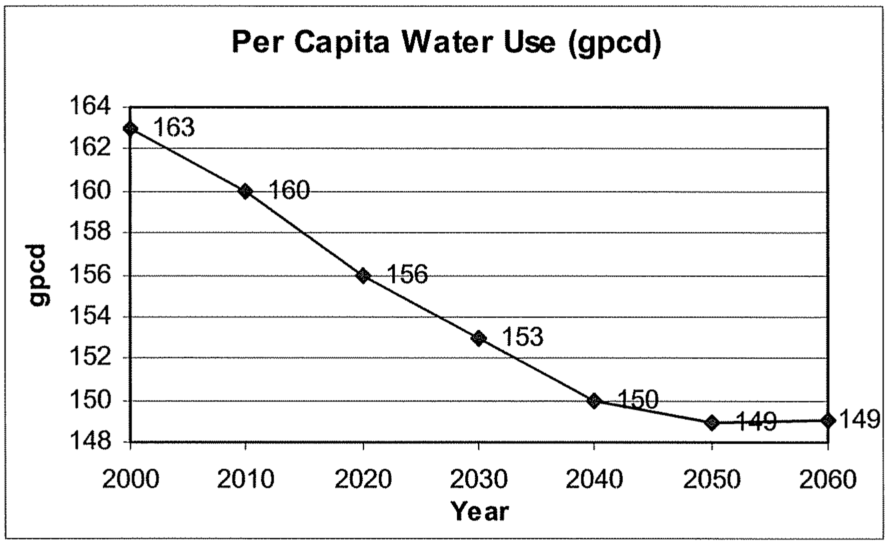


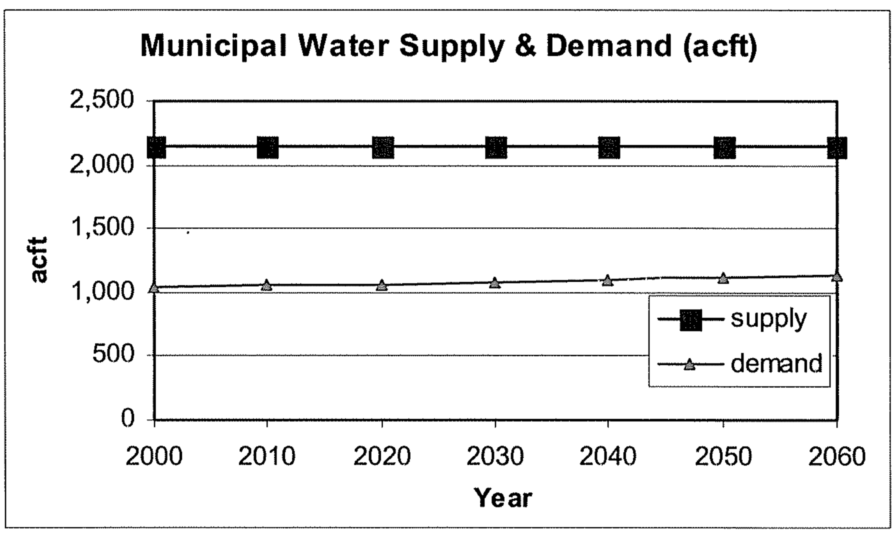




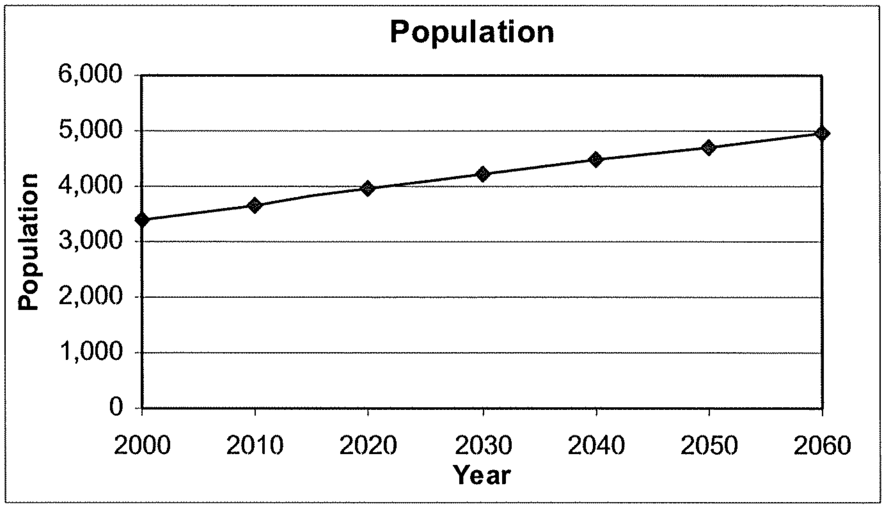
City of Sinton — San Patricio County

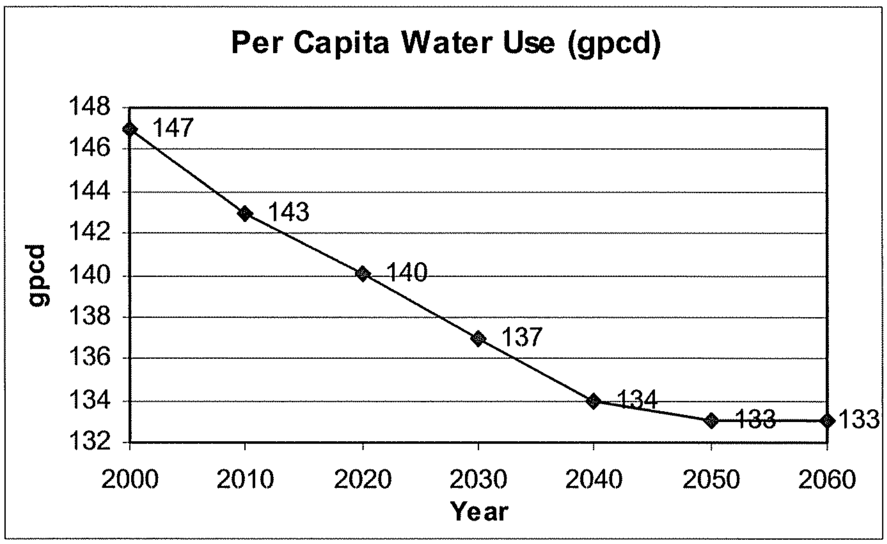


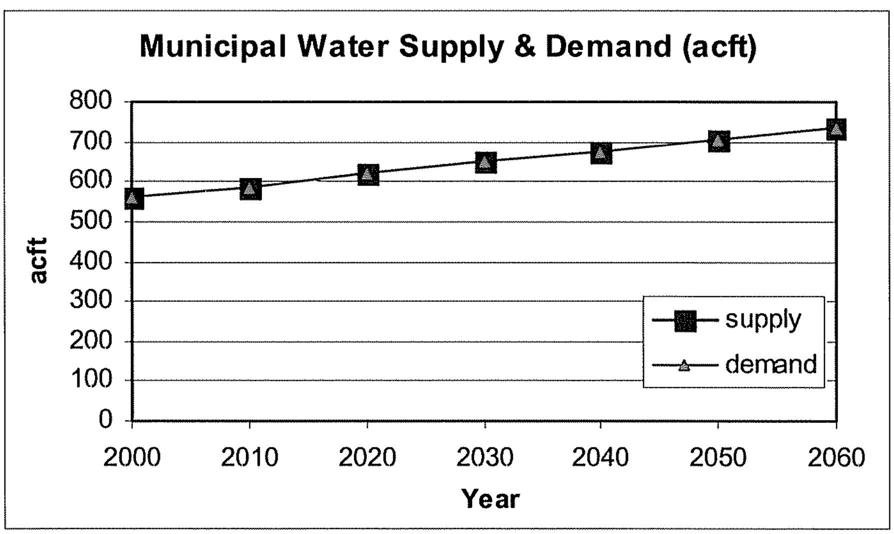




City of Taft — San Patricio County







Appendix C.2

Other Water Uses Figures (Manufacturing, Mining, Irrigation, and Livestock for each County)

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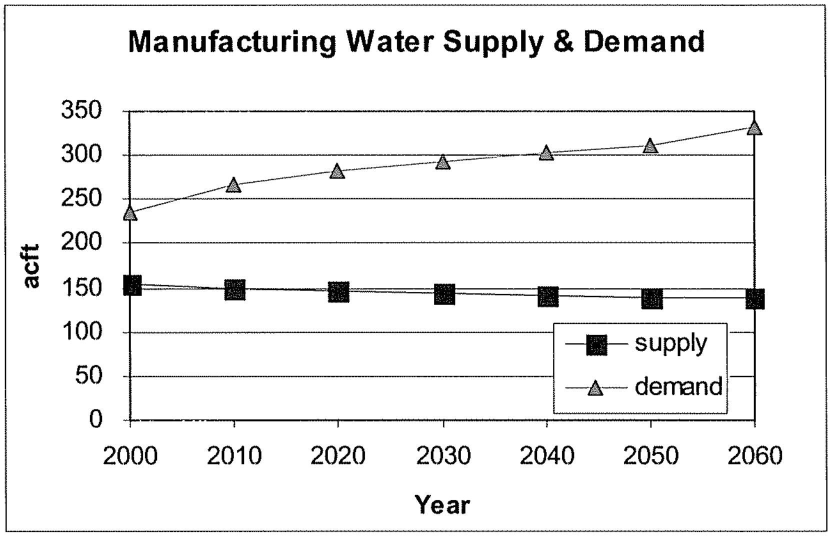
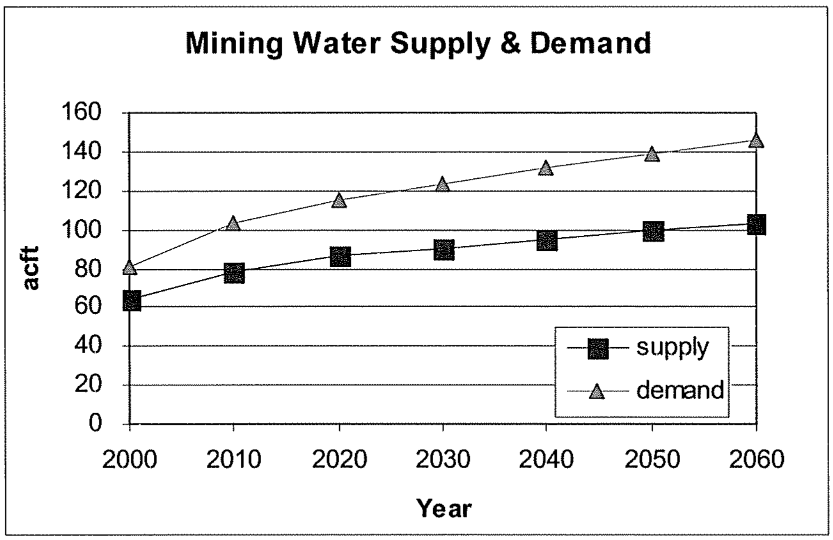
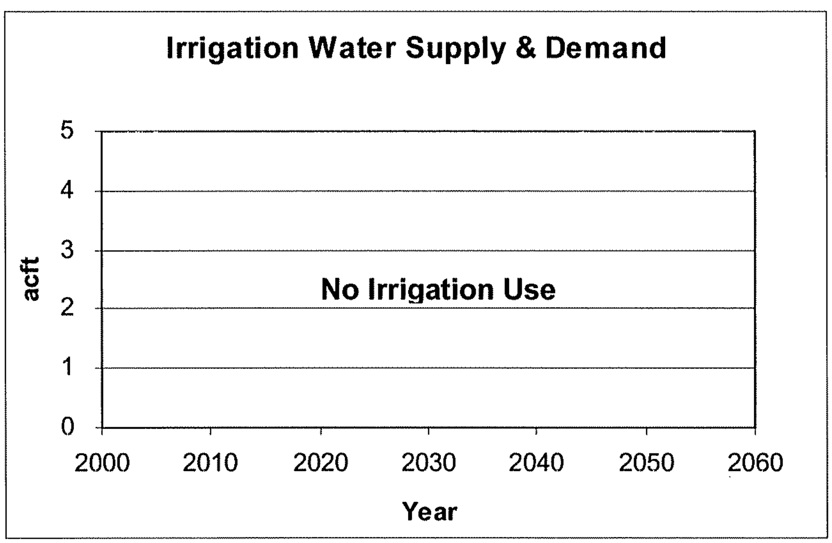
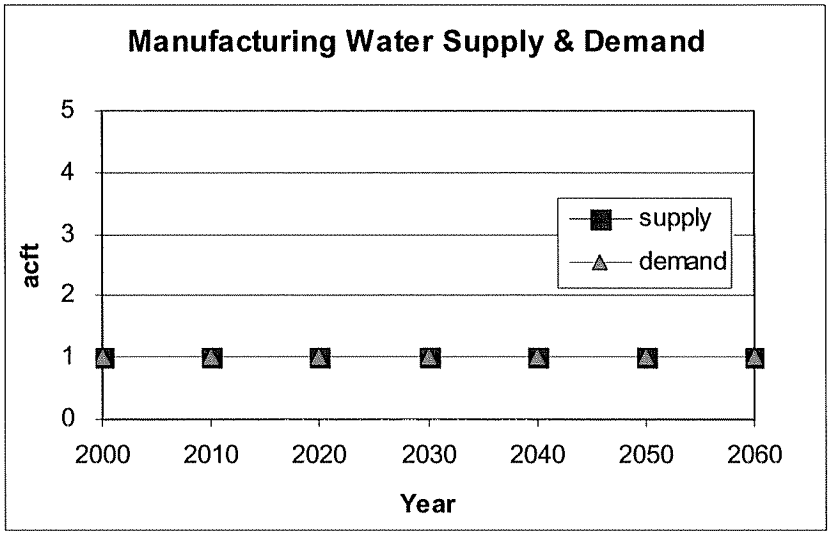
Aransas County

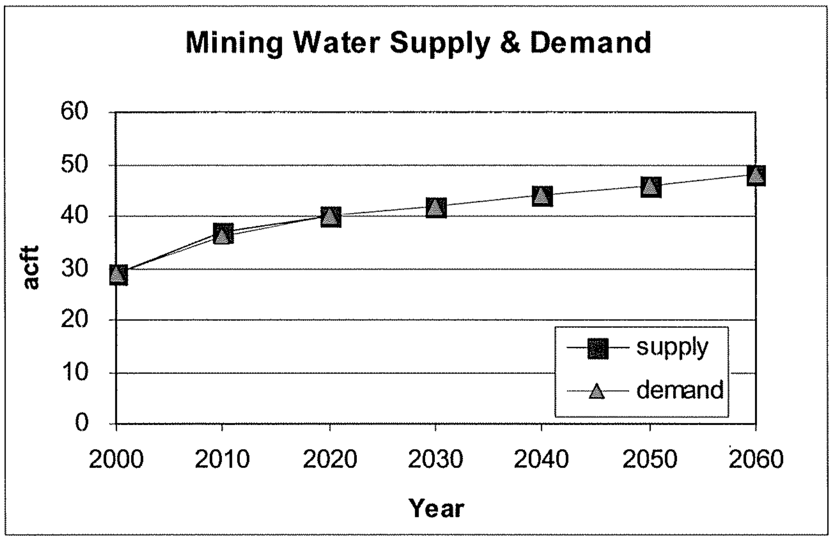


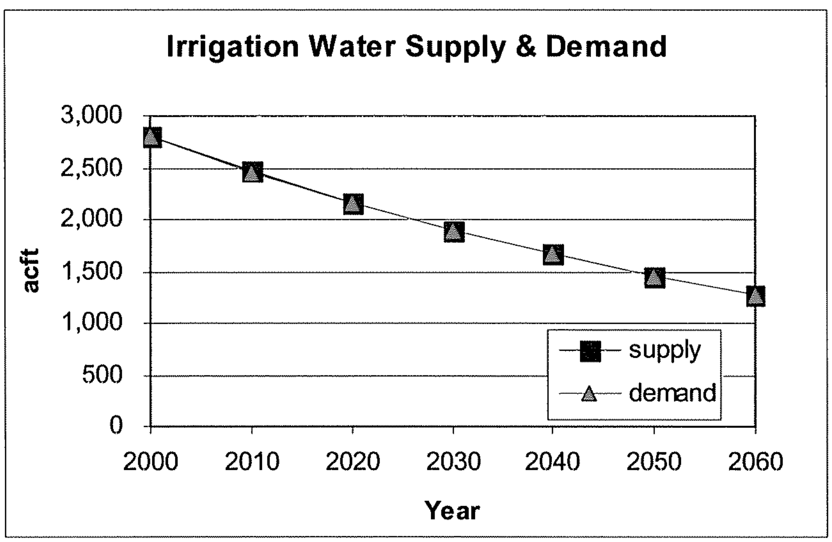




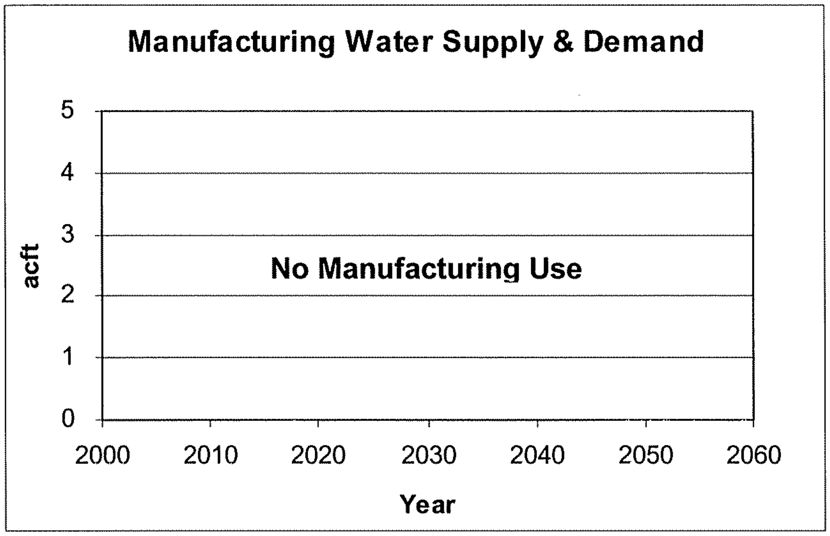
Bee County

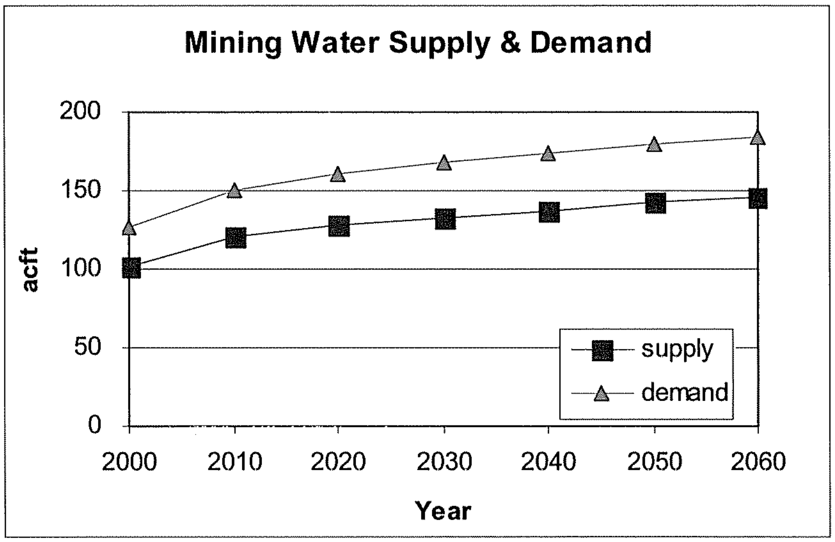

Manufacturing Water Supply & Demand
acft
5
4
3
2
1
0
supply
demand
2000
2010
2020
2030
2040
2050
2060
Year

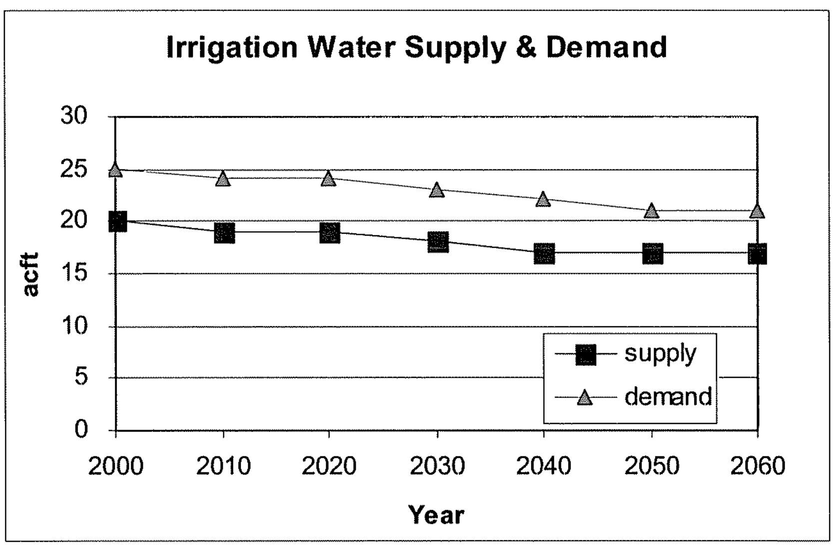

Mining Water Supply & Demand
acft
60
50
40
30
20
10
0
supply
demand
2000
2010
2020
2030
2040
2050
2060
Year


Irrigation Water Supply & Demand
acft
3,000
2,500
2,000
1,500
1,000
500
0
supply
demand
2000
2010
2020
2030
2040
2050
2060
Year

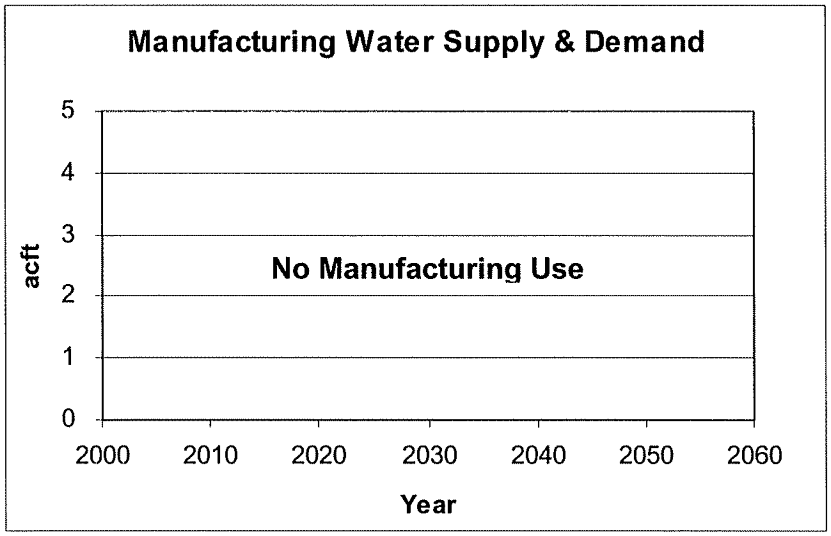
Brooks County

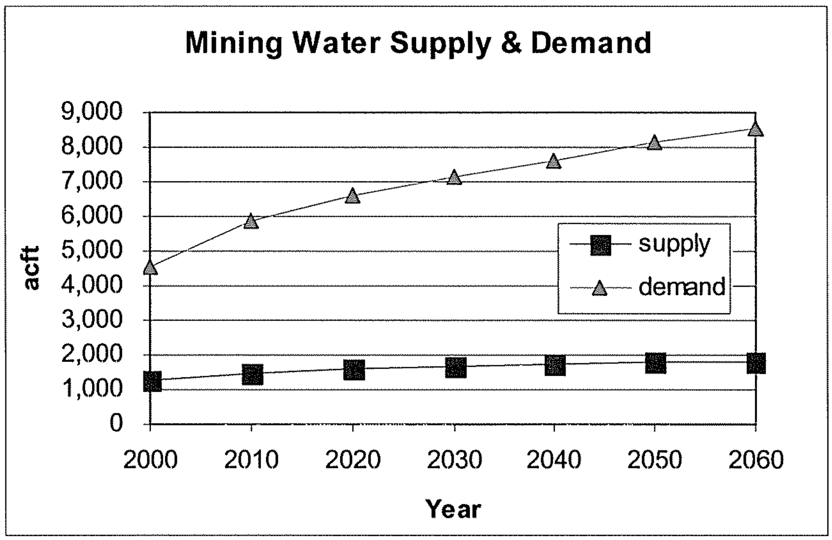


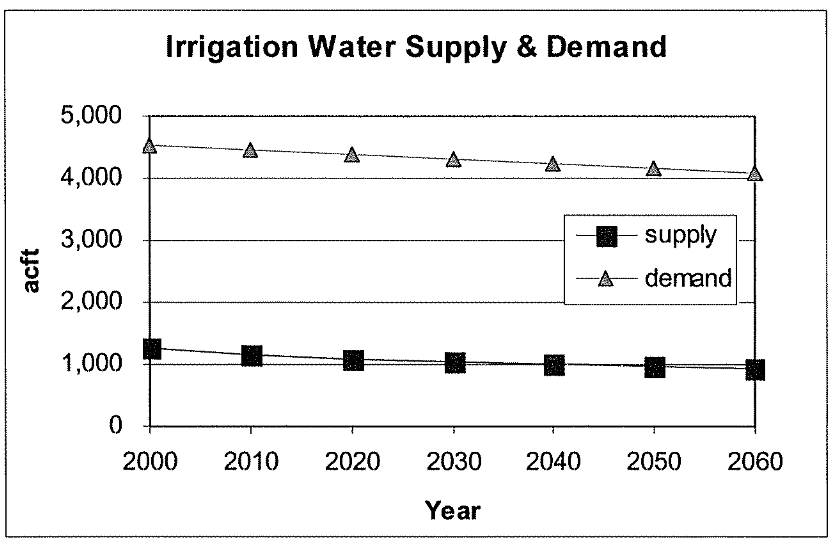




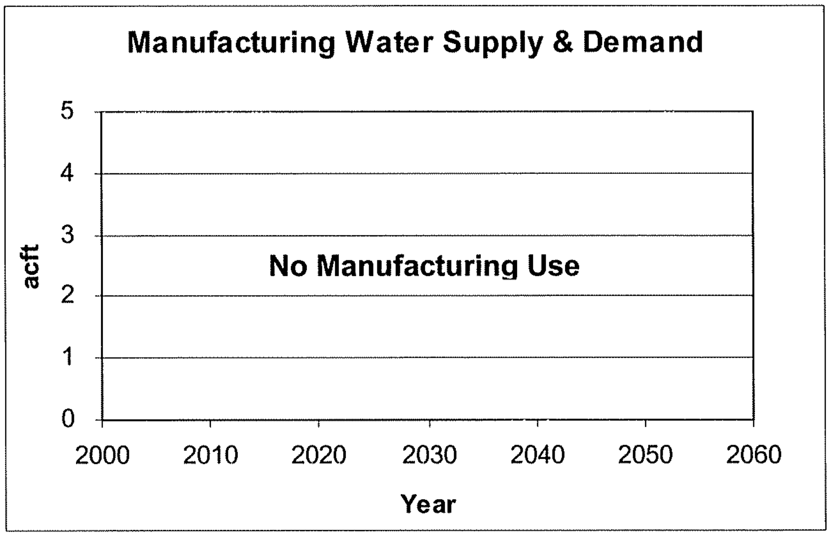
Duval County

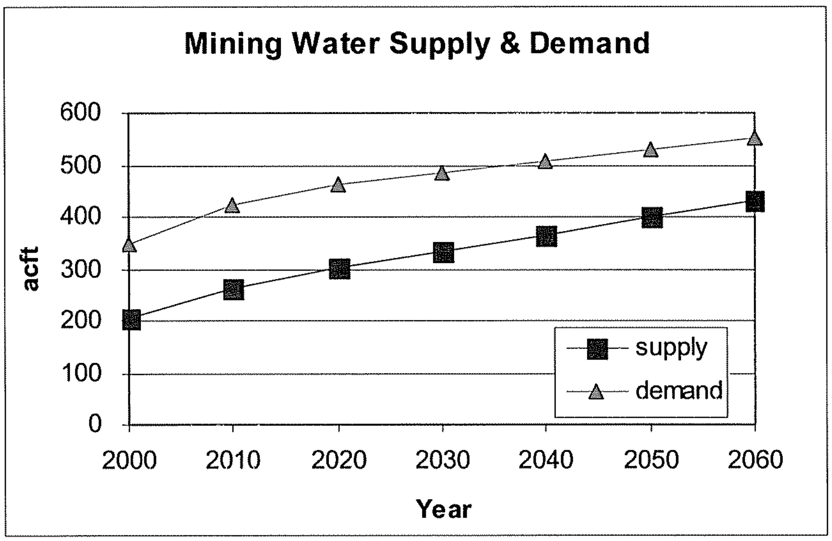


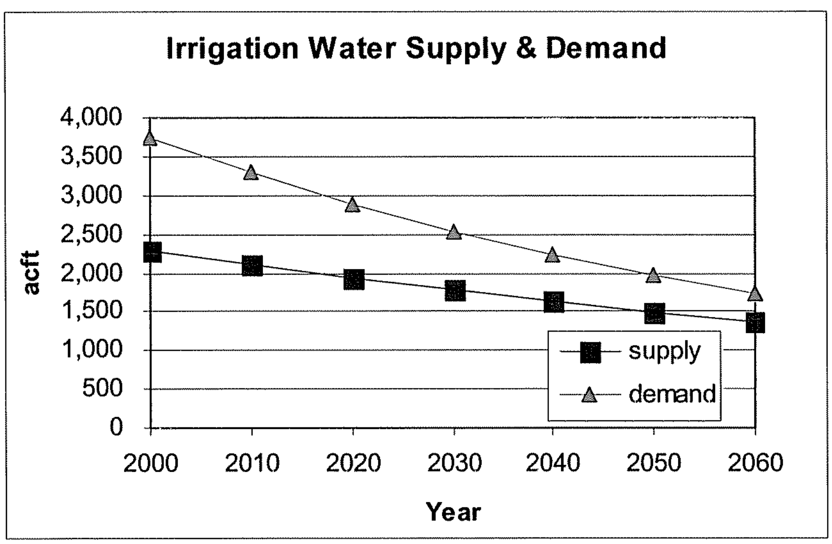




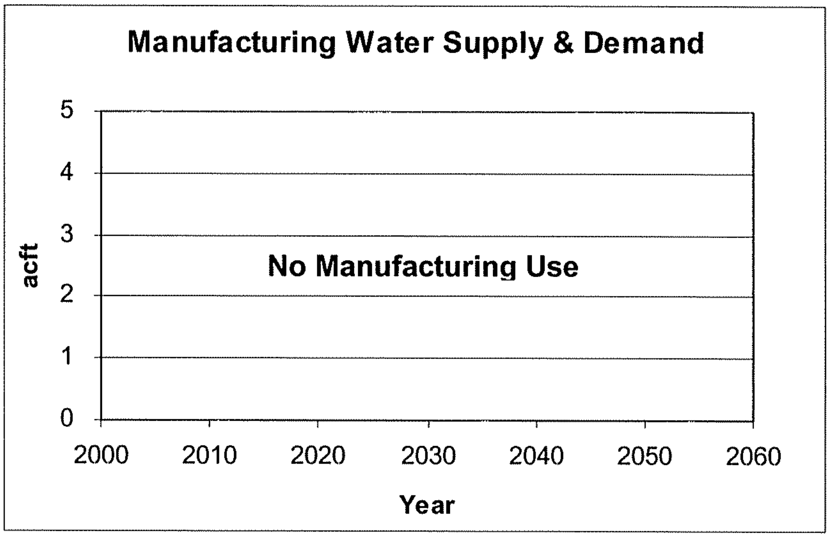
Jim Wells County

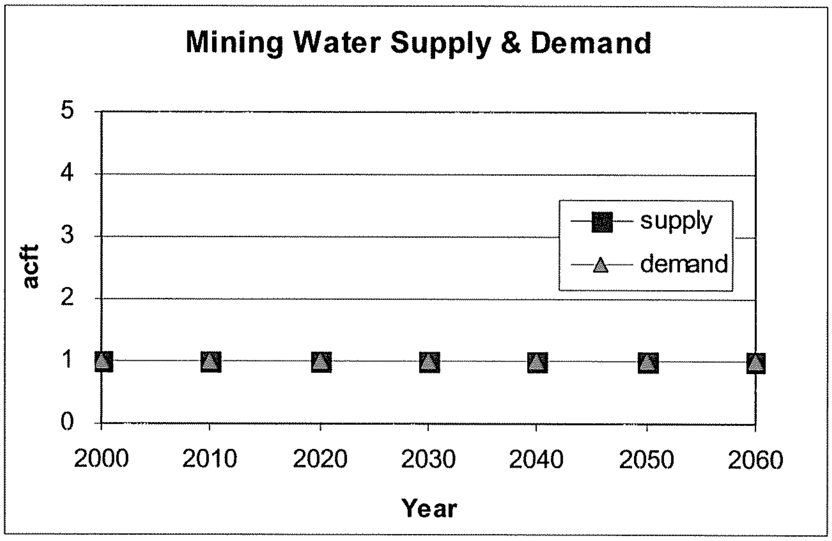


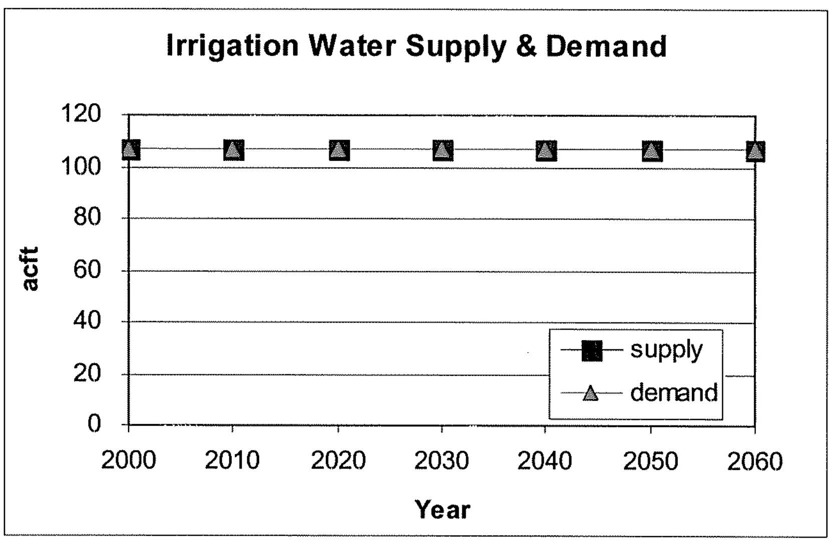




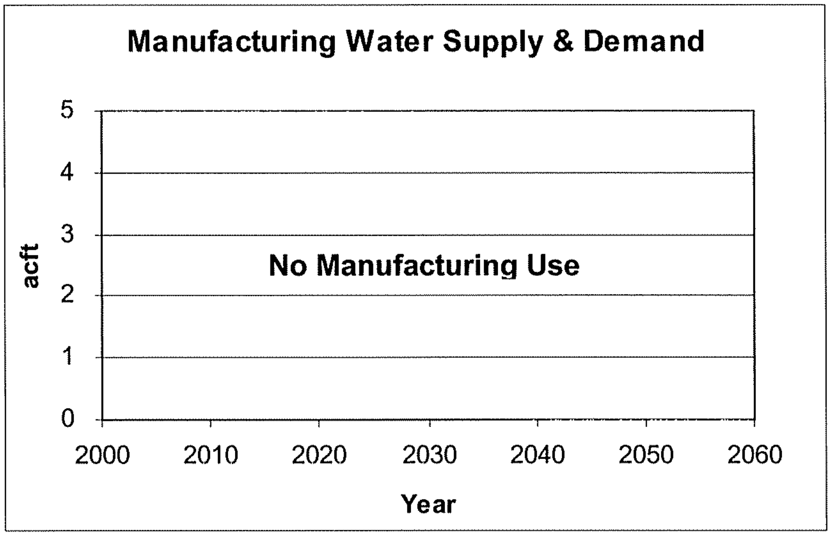
Kenedy County

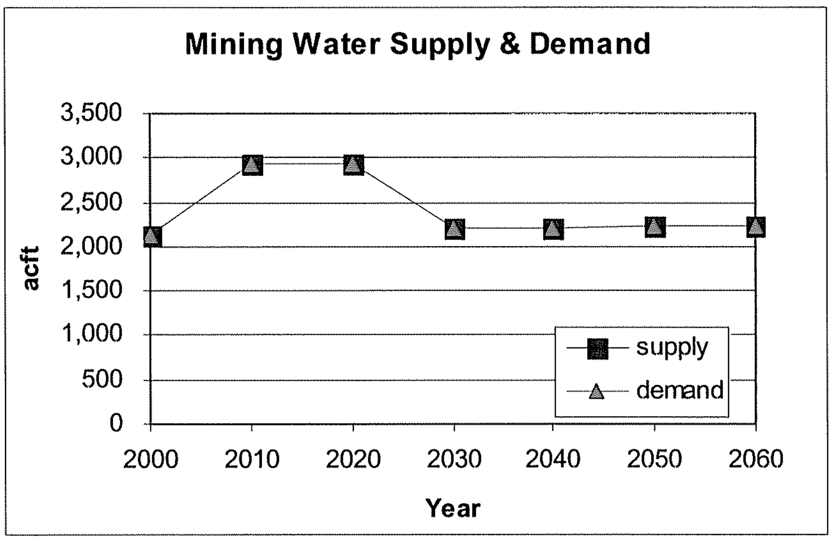


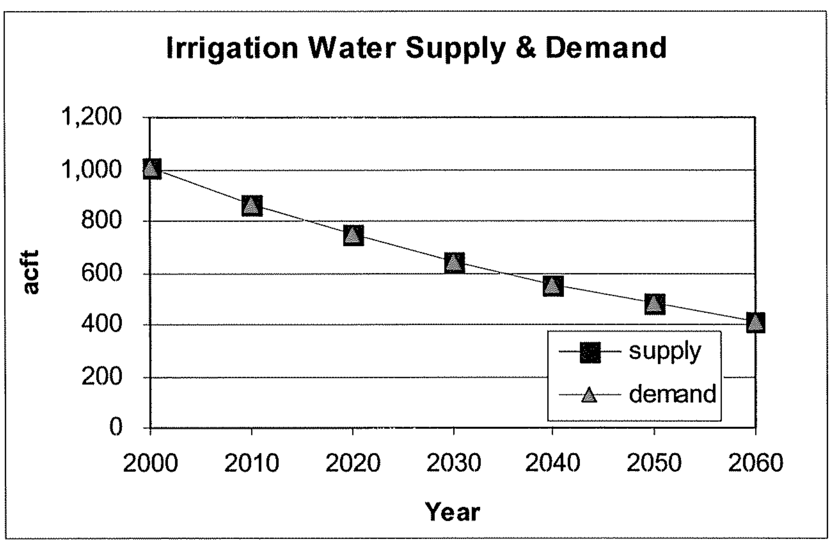




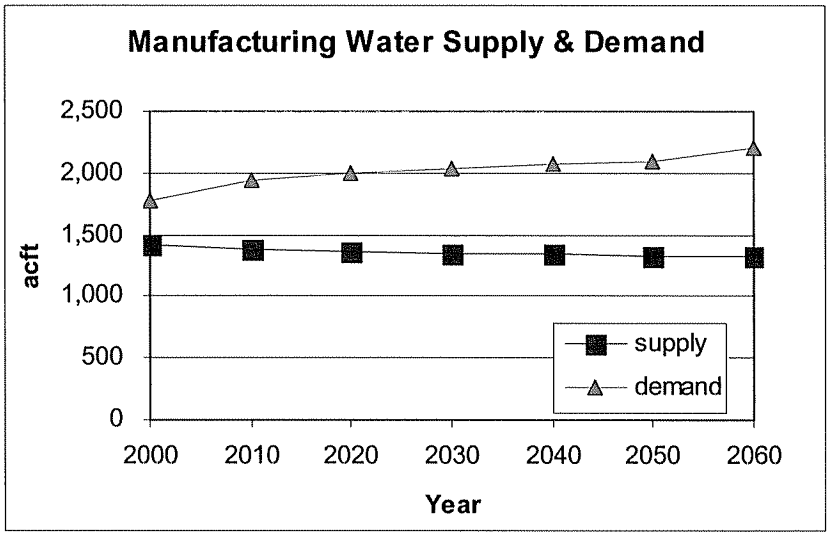
Kleberg County

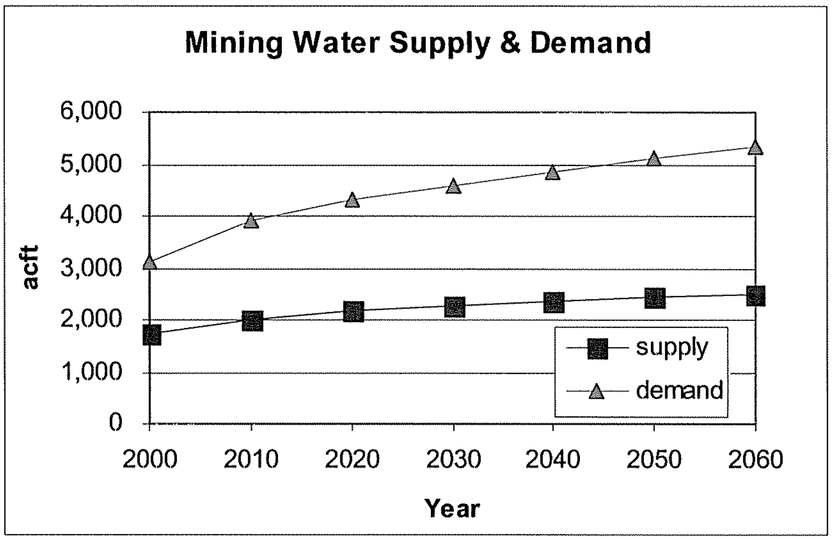


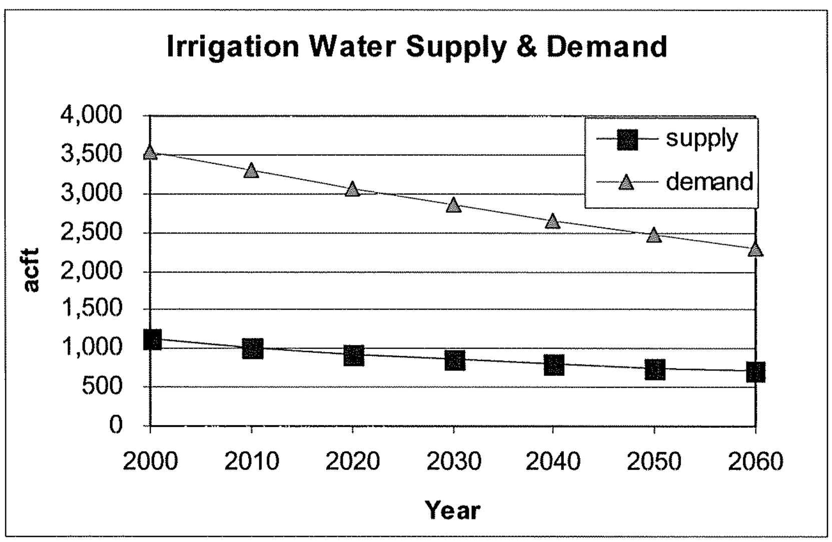




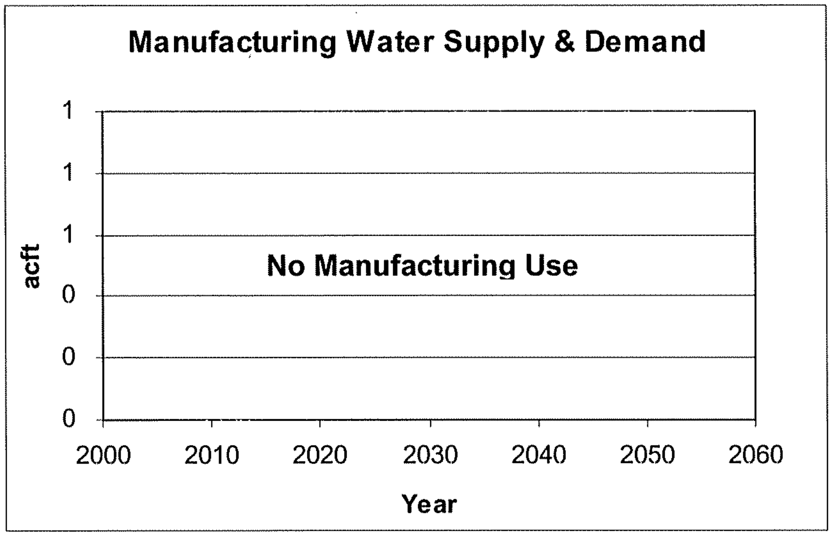
Live Oak County

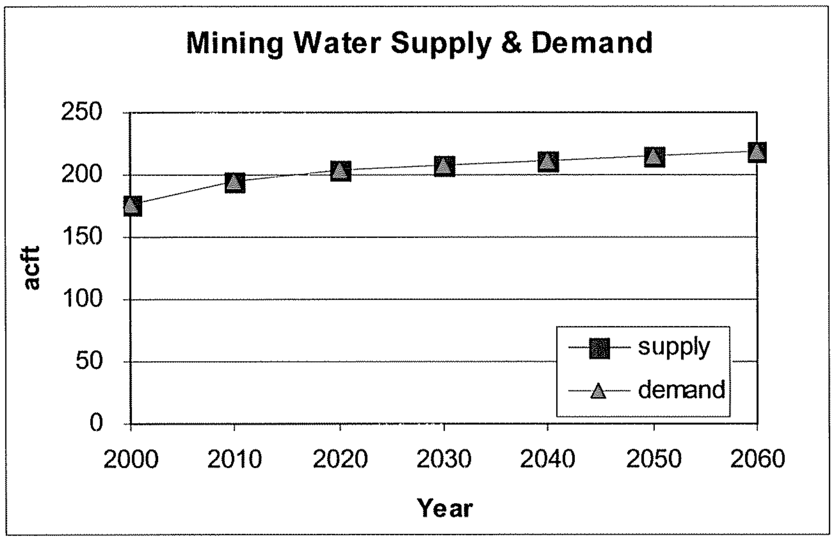


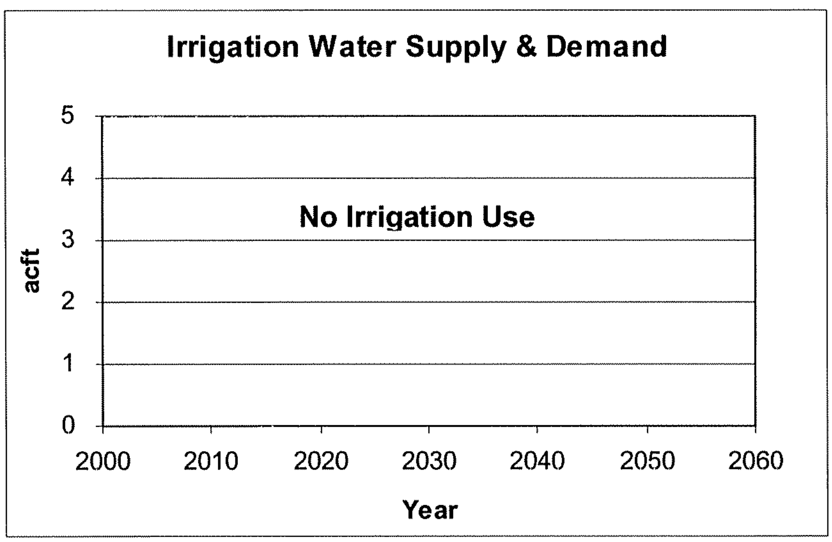




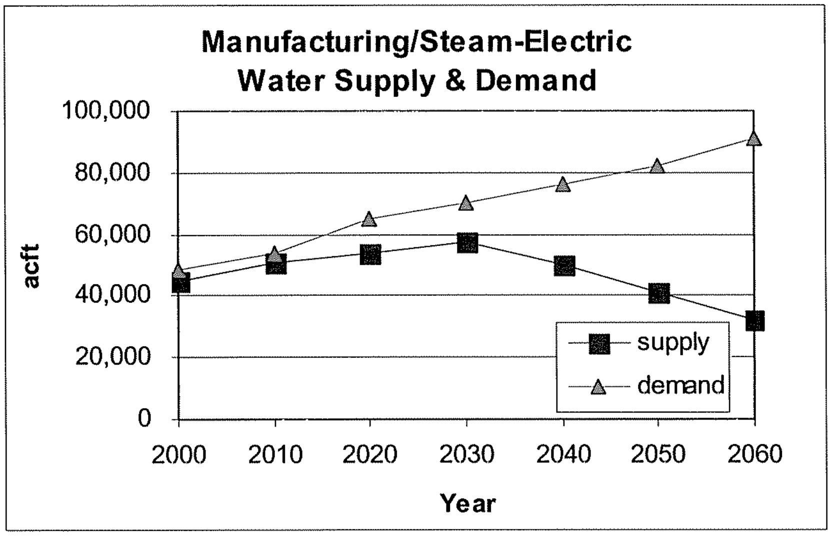
McMullen County

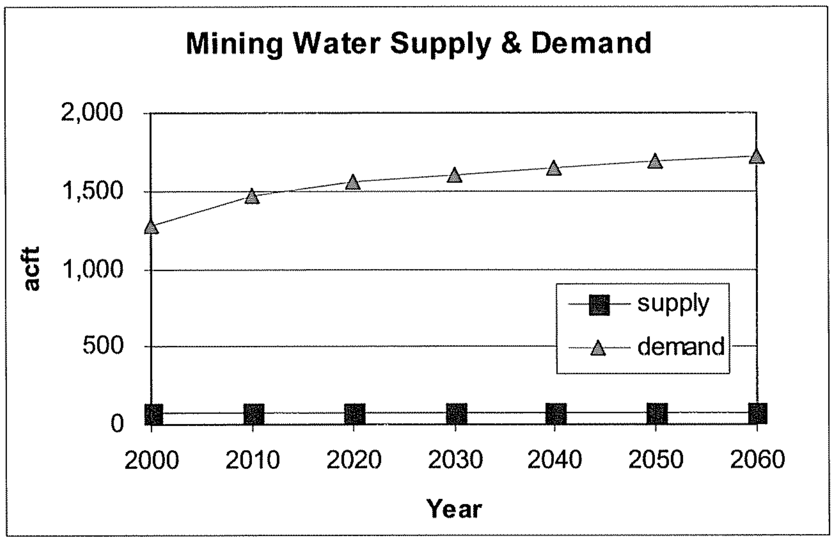


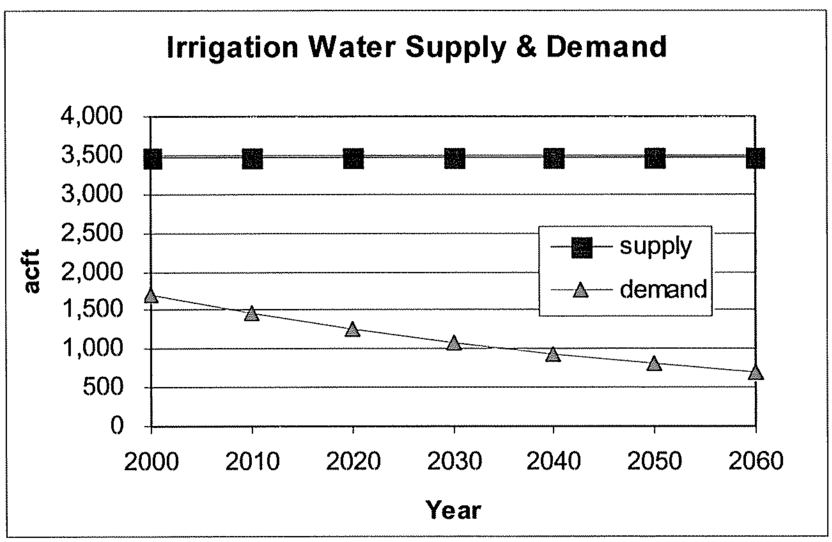




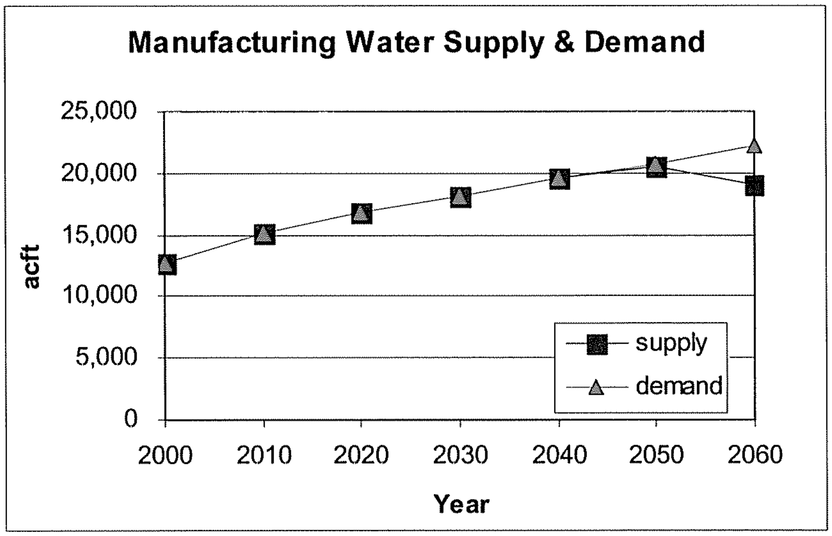
Nueces County

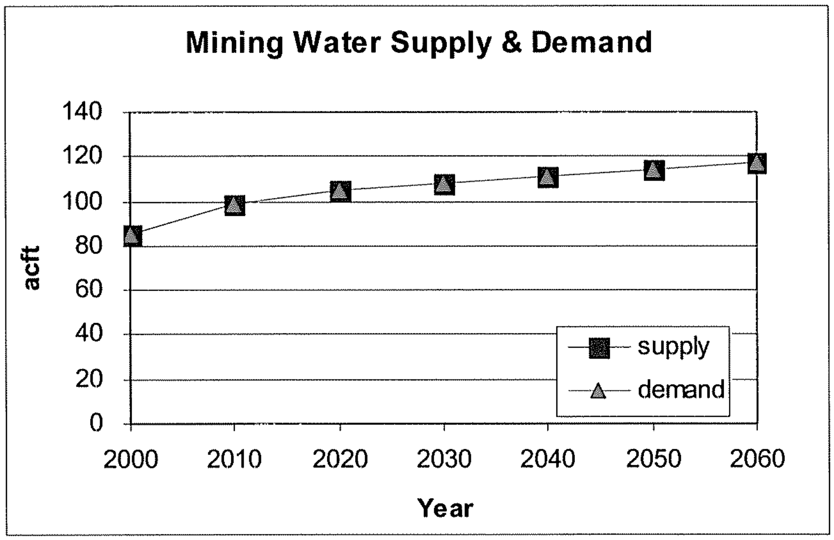


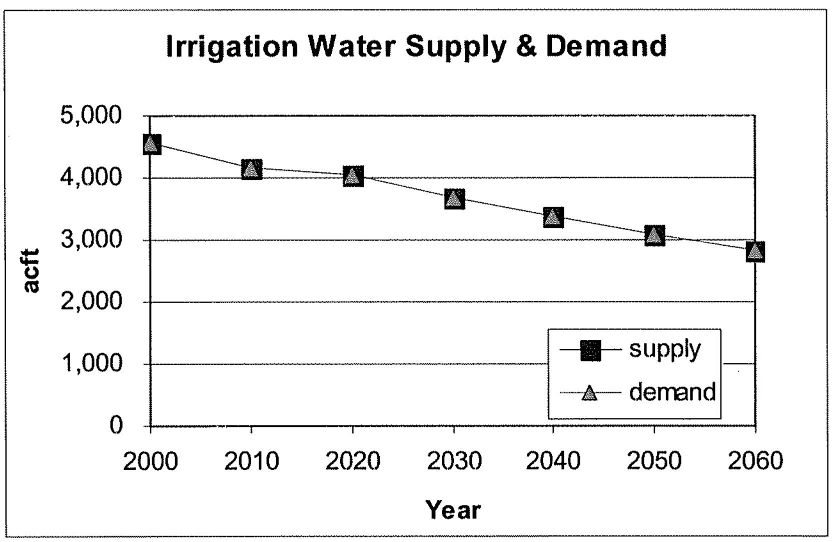




San Patricio County







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Appendix C.3

Updates to Municipal Population and Water Demand Projections since 2001 Plan (by County)

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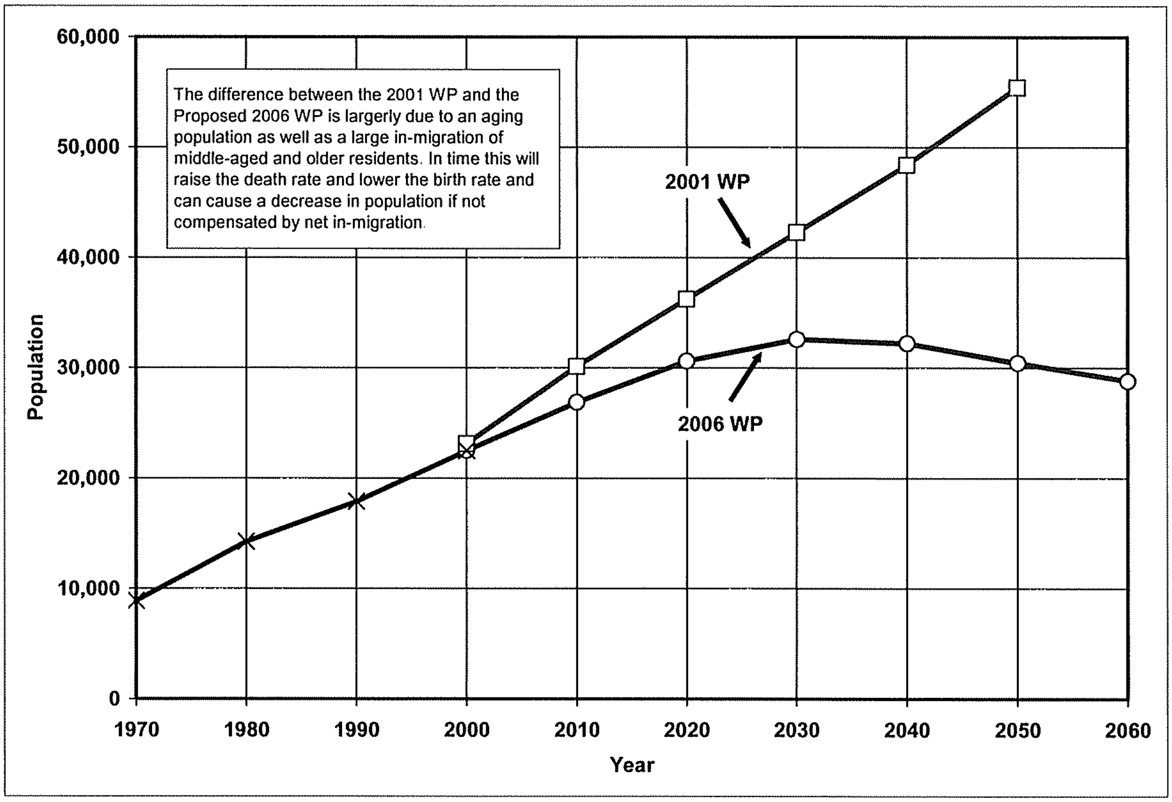
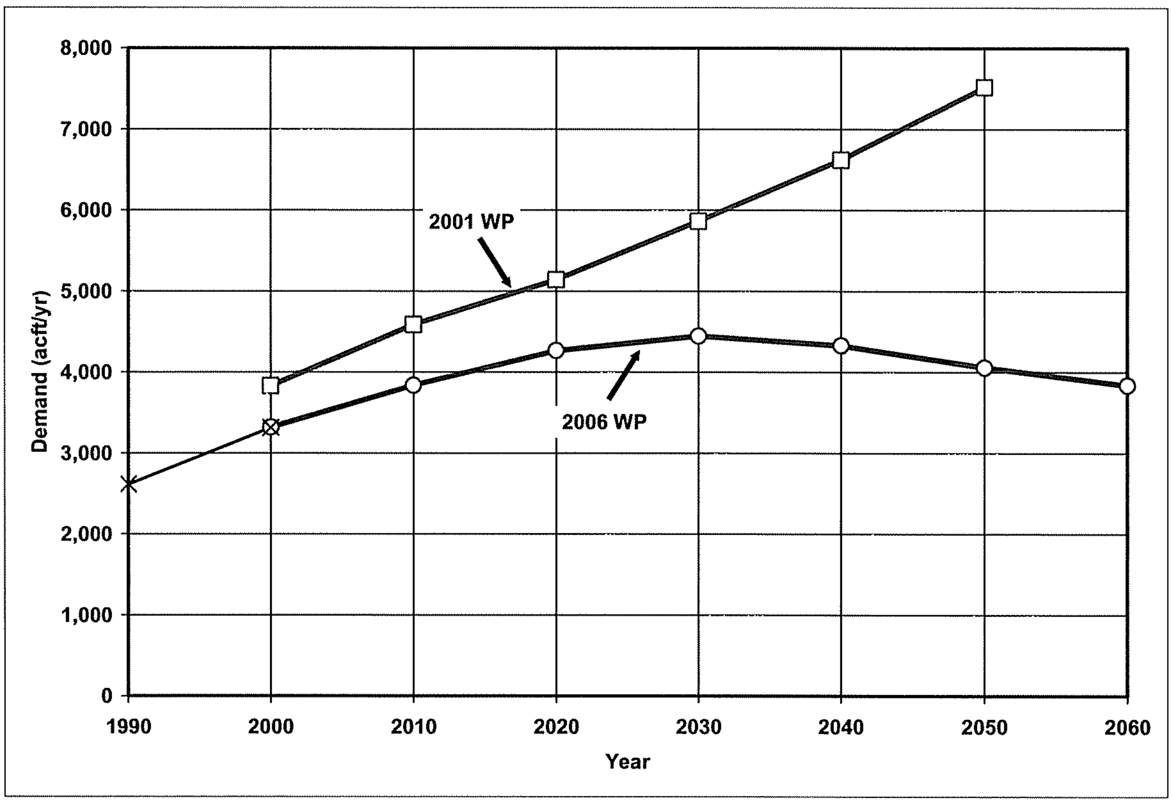
Aransas County

Population

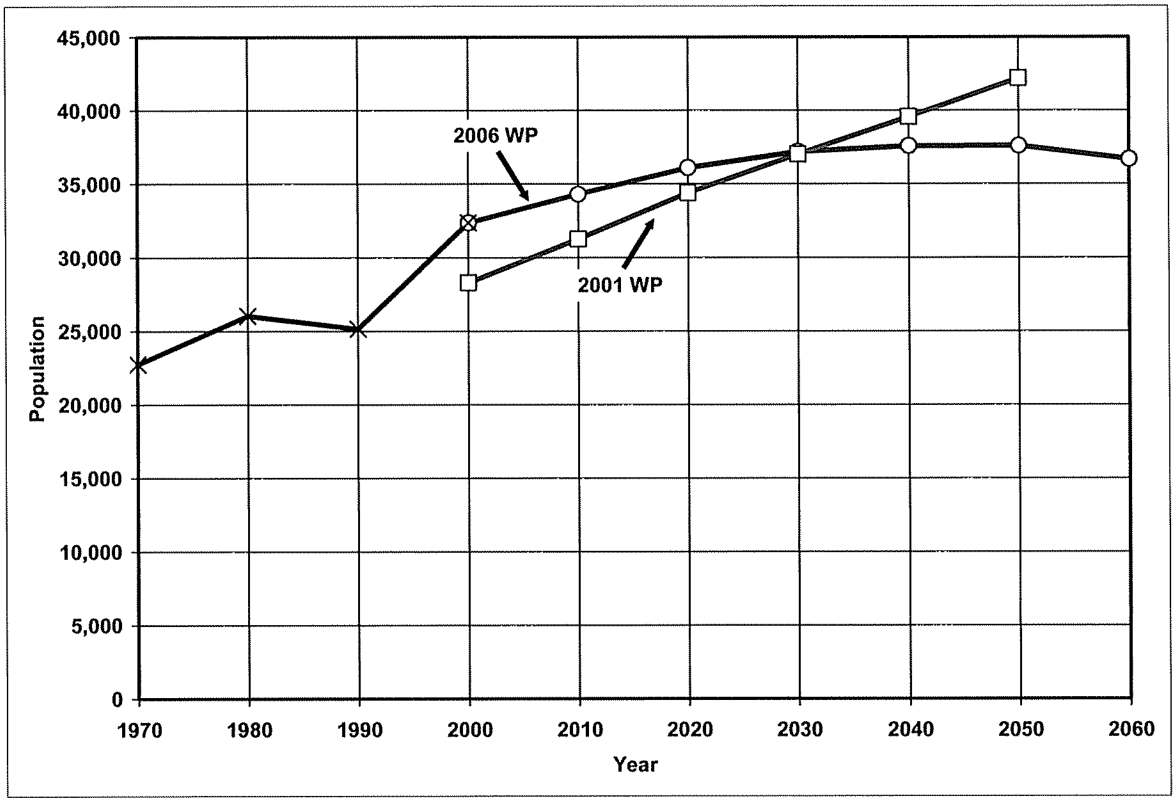


Water Demand

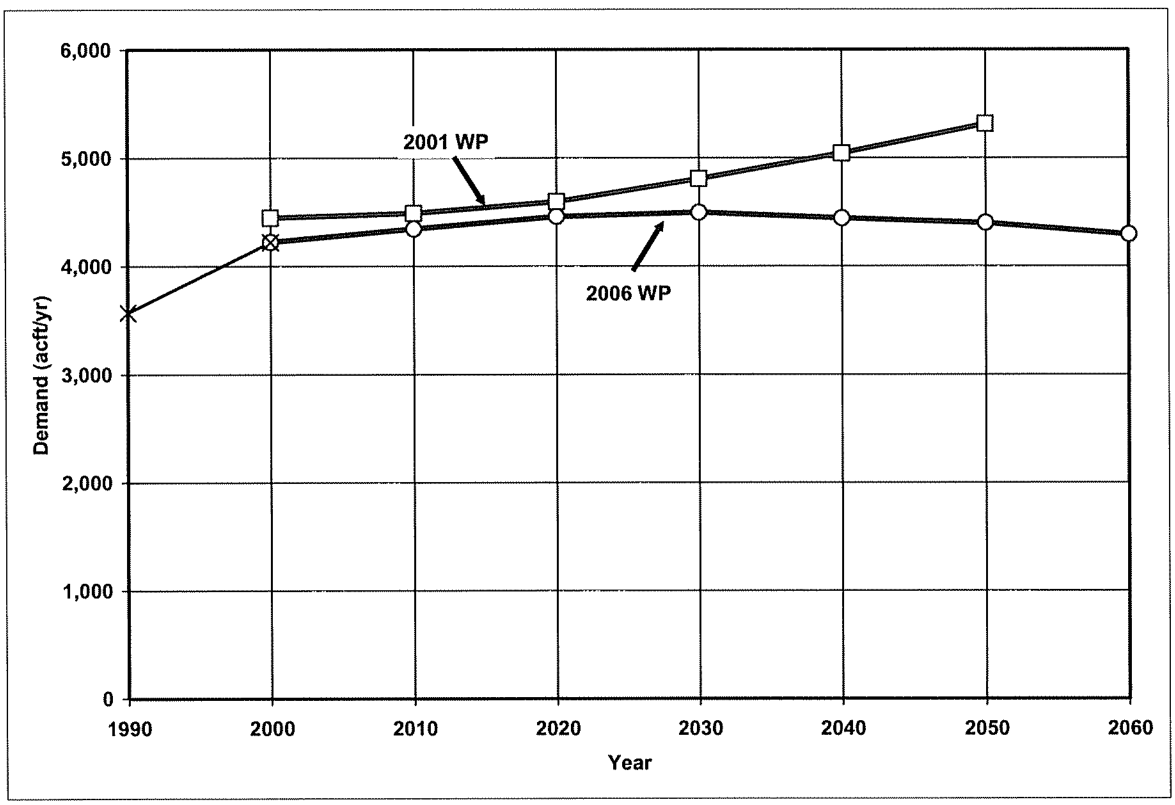


Bee County

Population

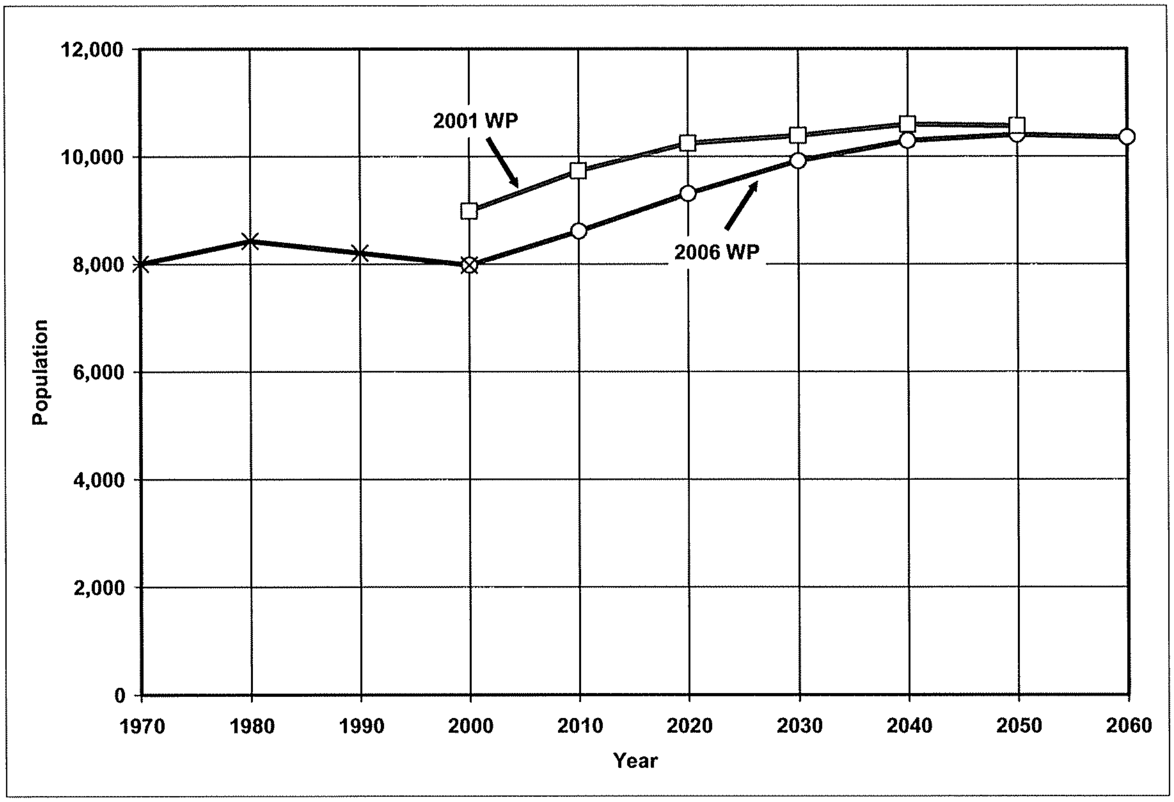


Water Demand

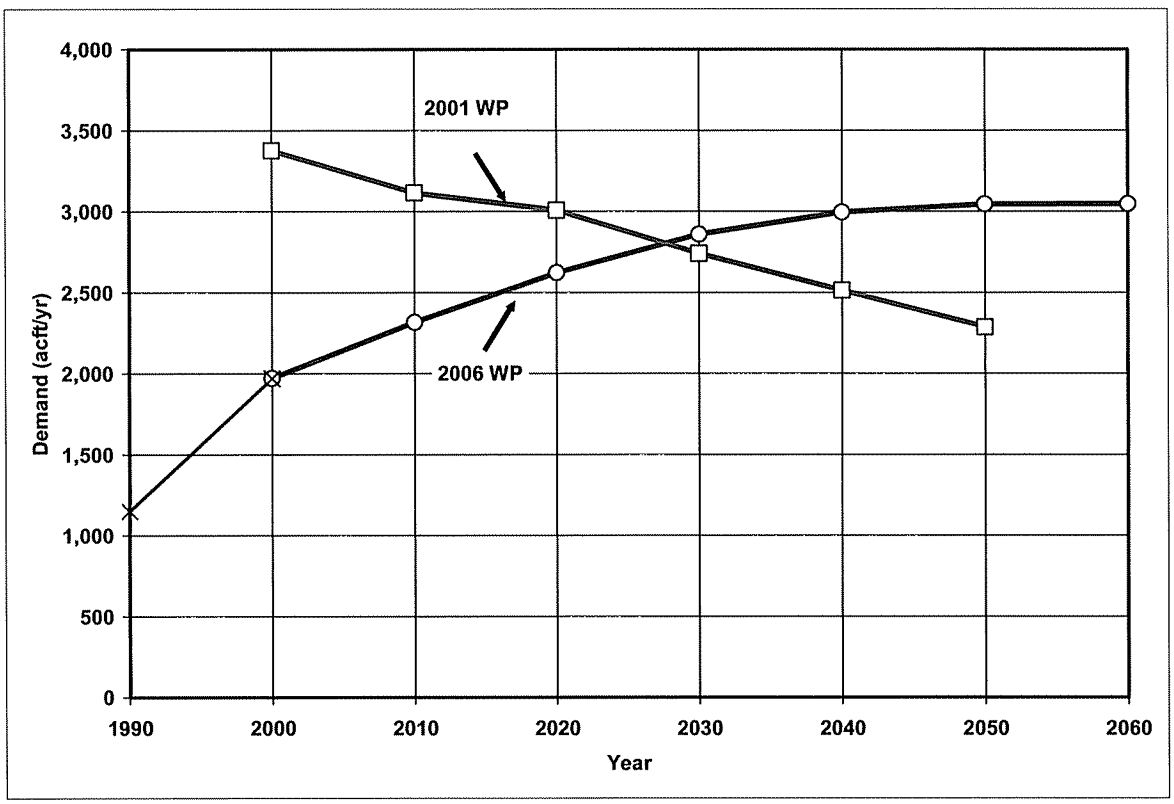


Brooks County

Population

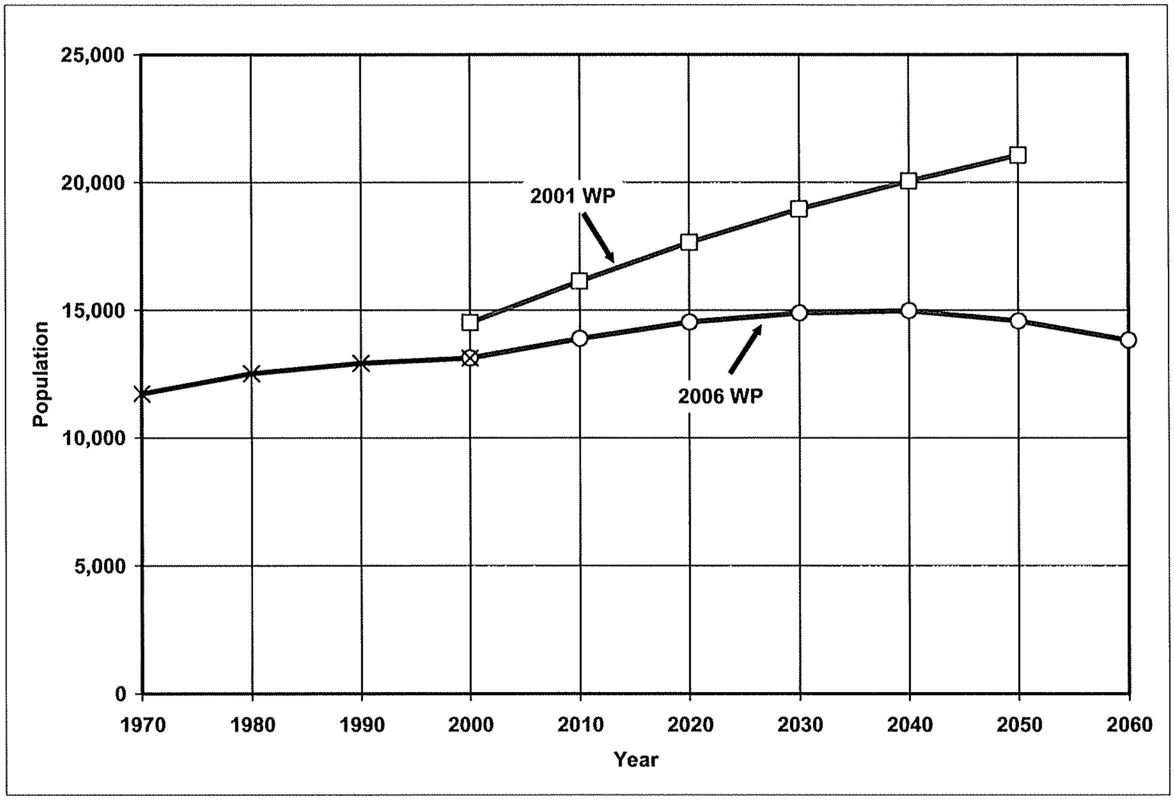


Water Demand

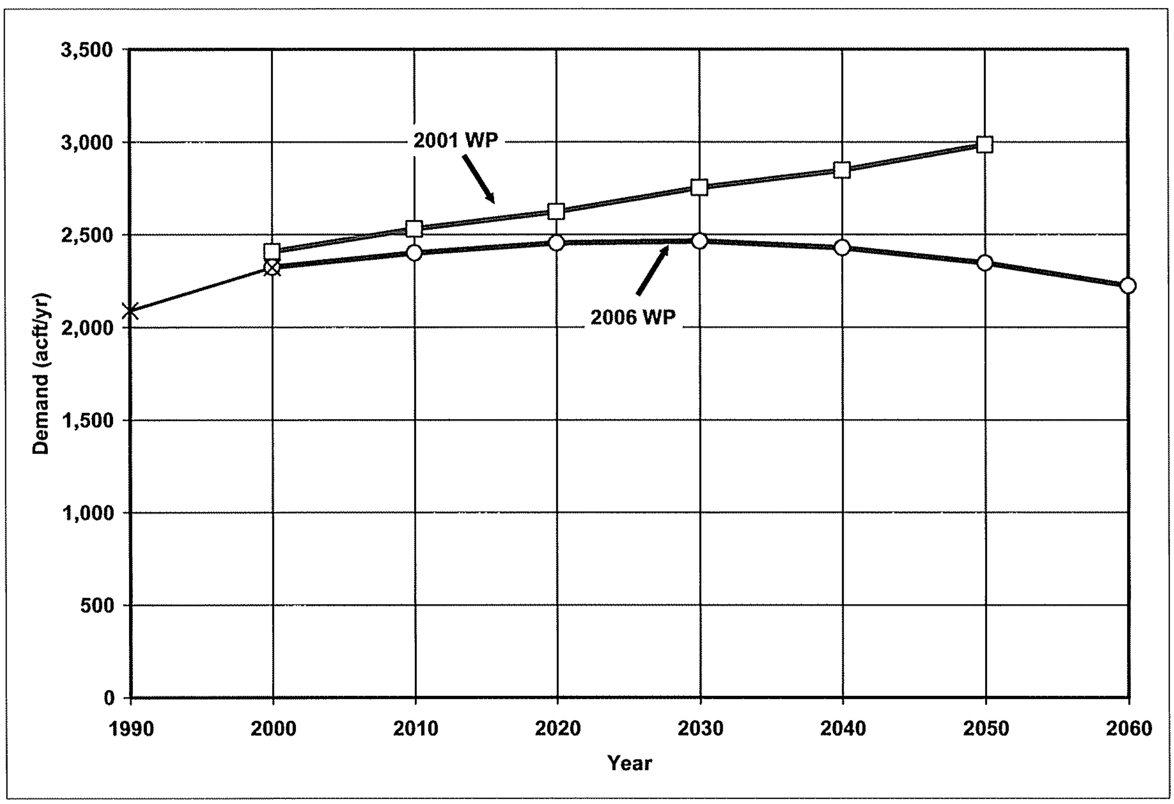


Duval County

Population

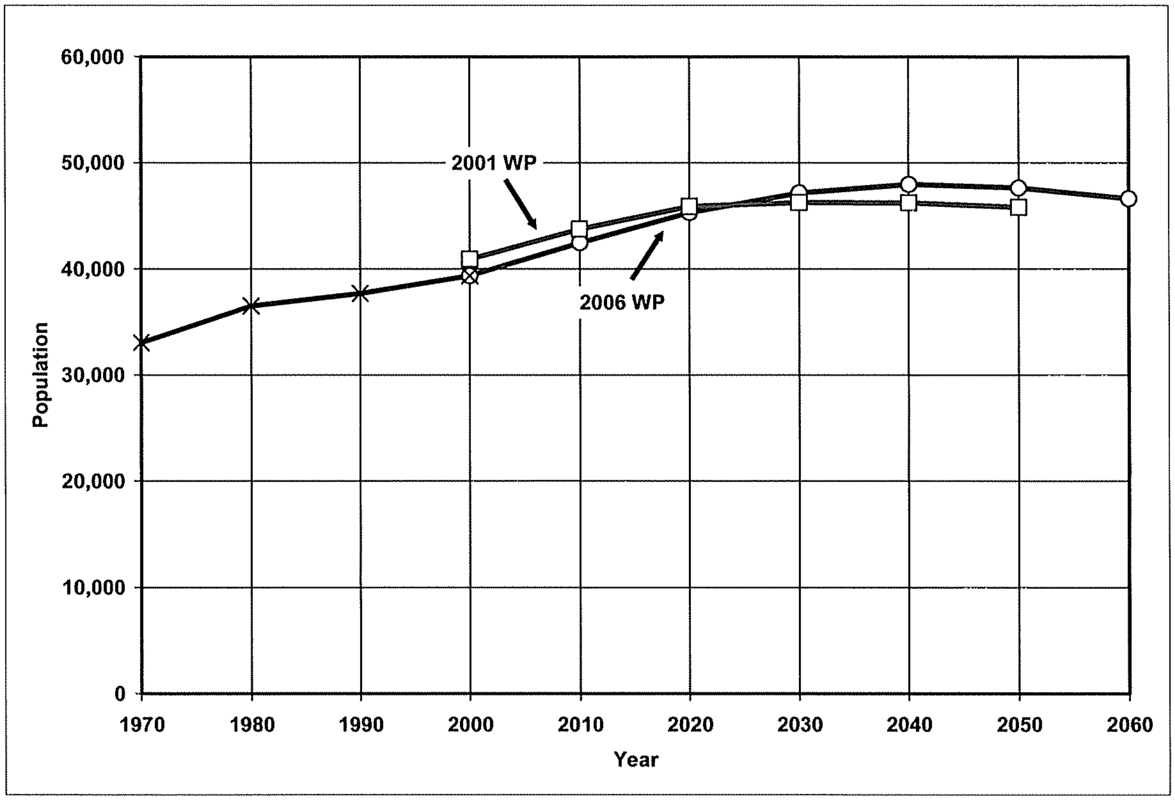


Water Demand

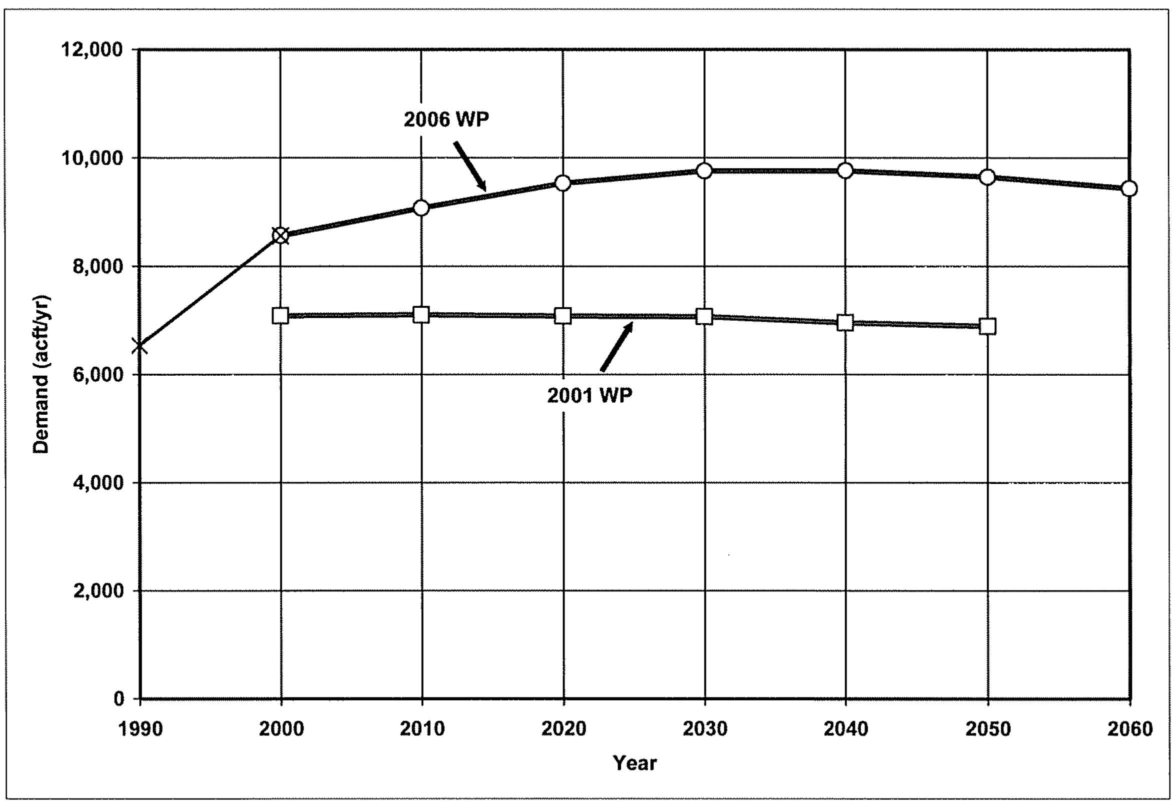


Jim Wells County

Population

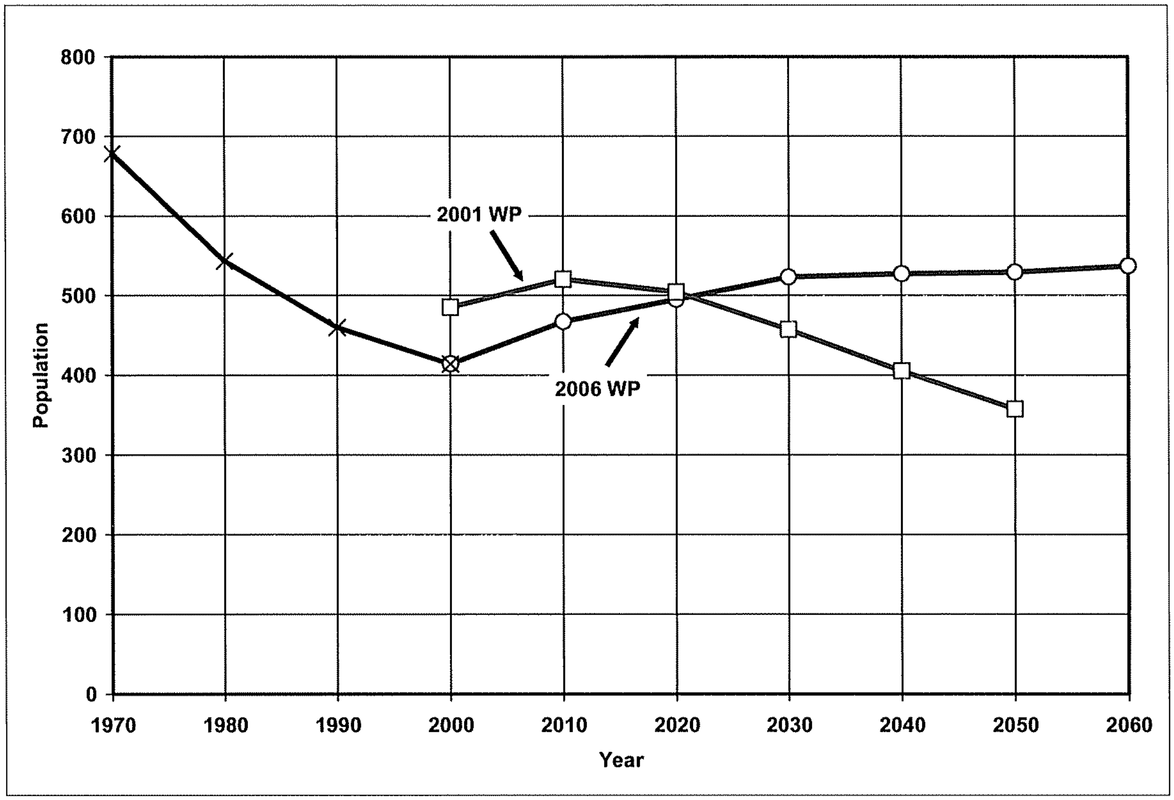


Water Demand

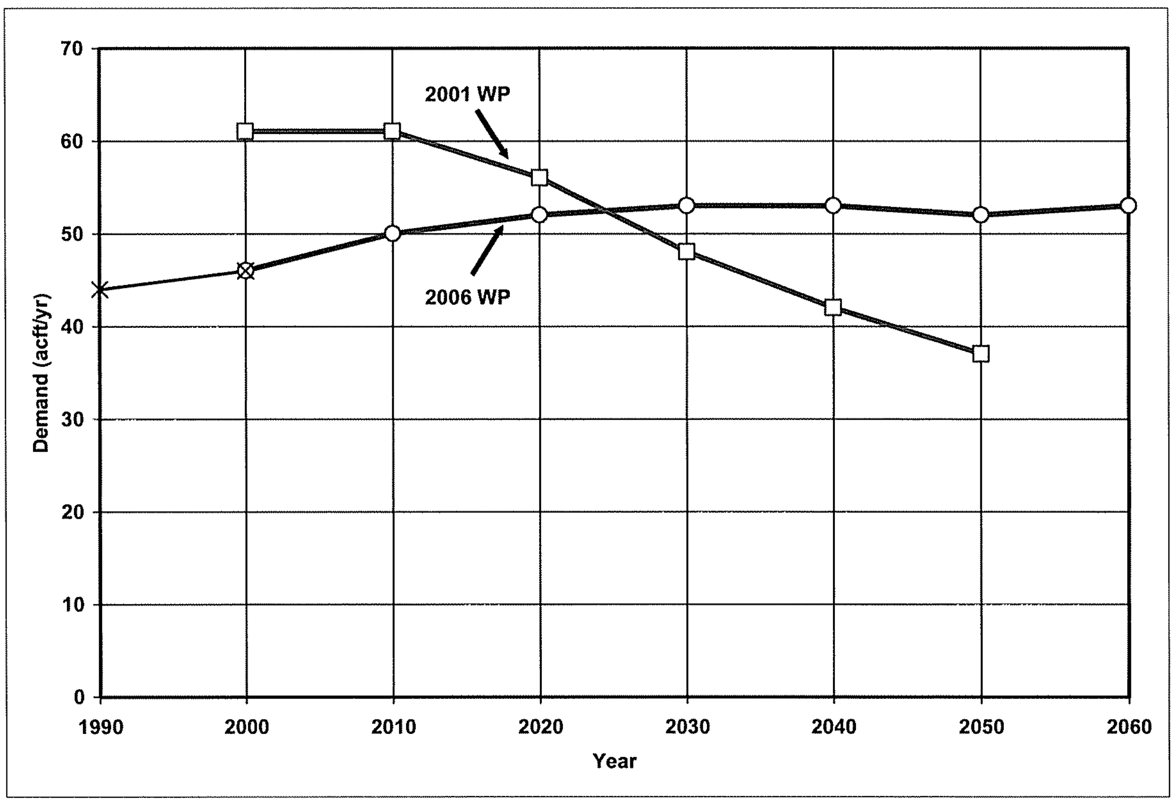


Kenedy County

Population

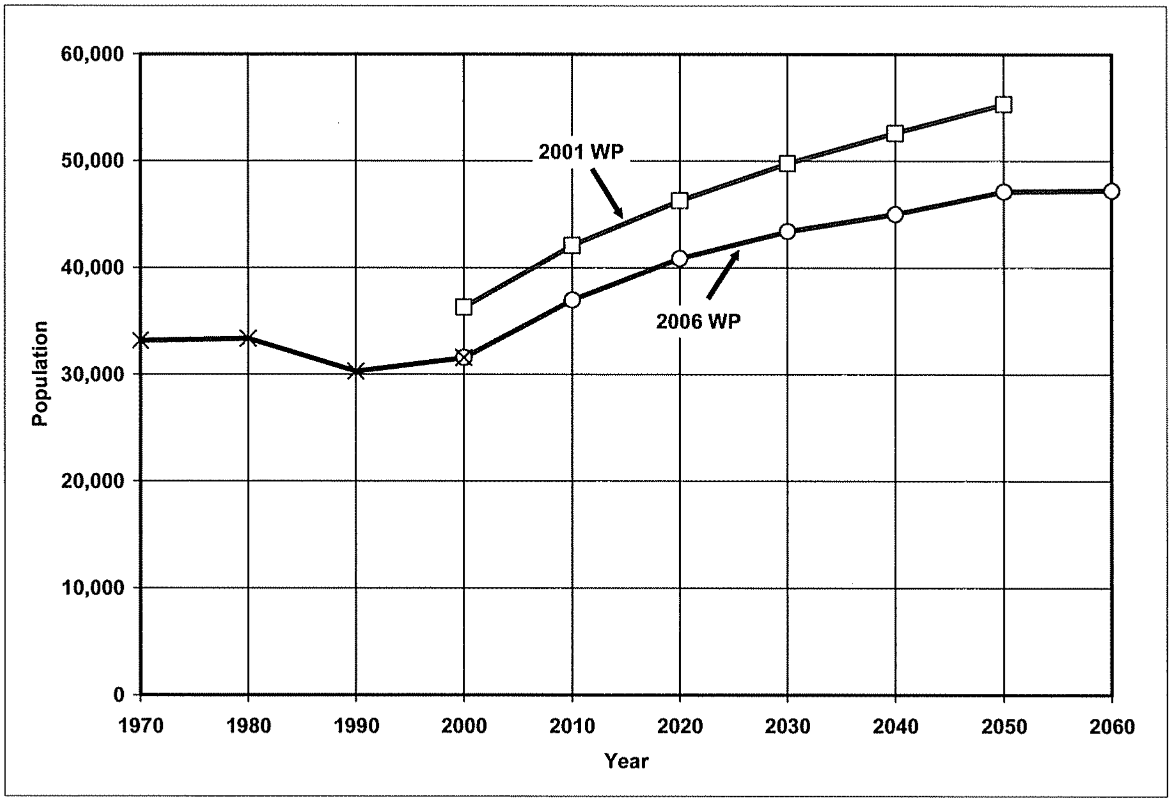


Water Demand

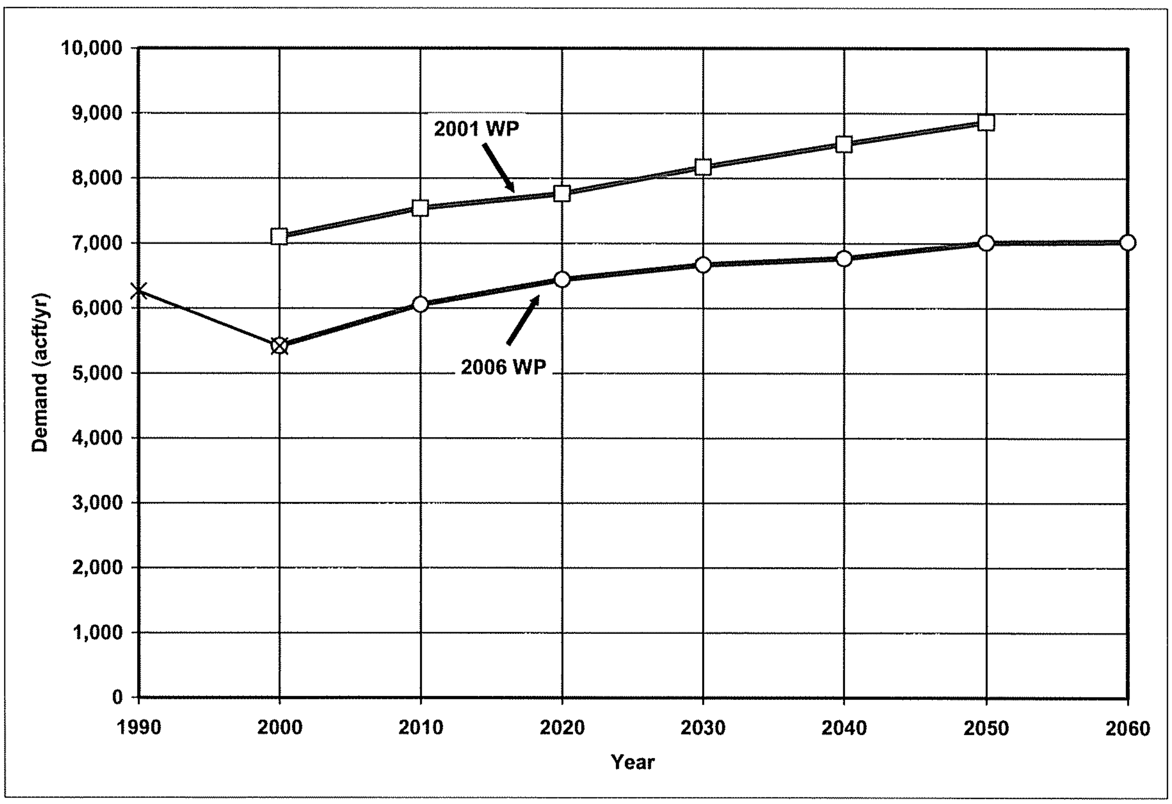


Kleberg County

Population

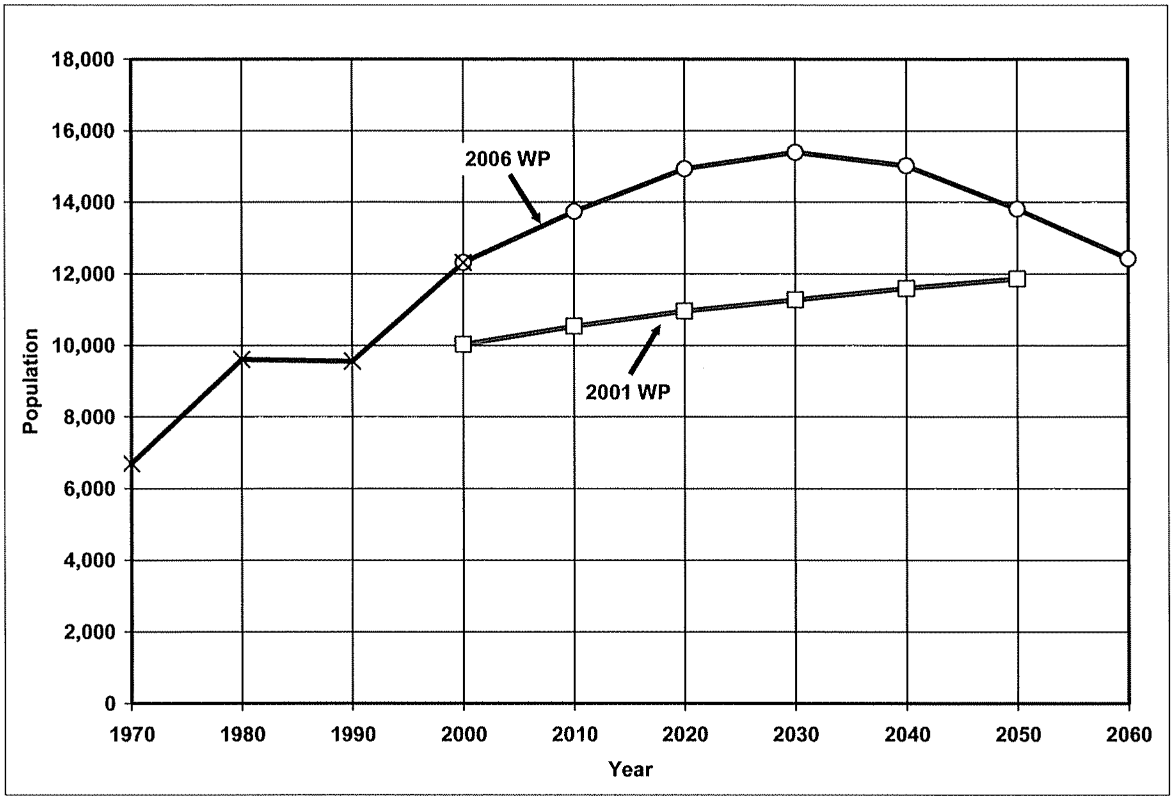


Water Demand

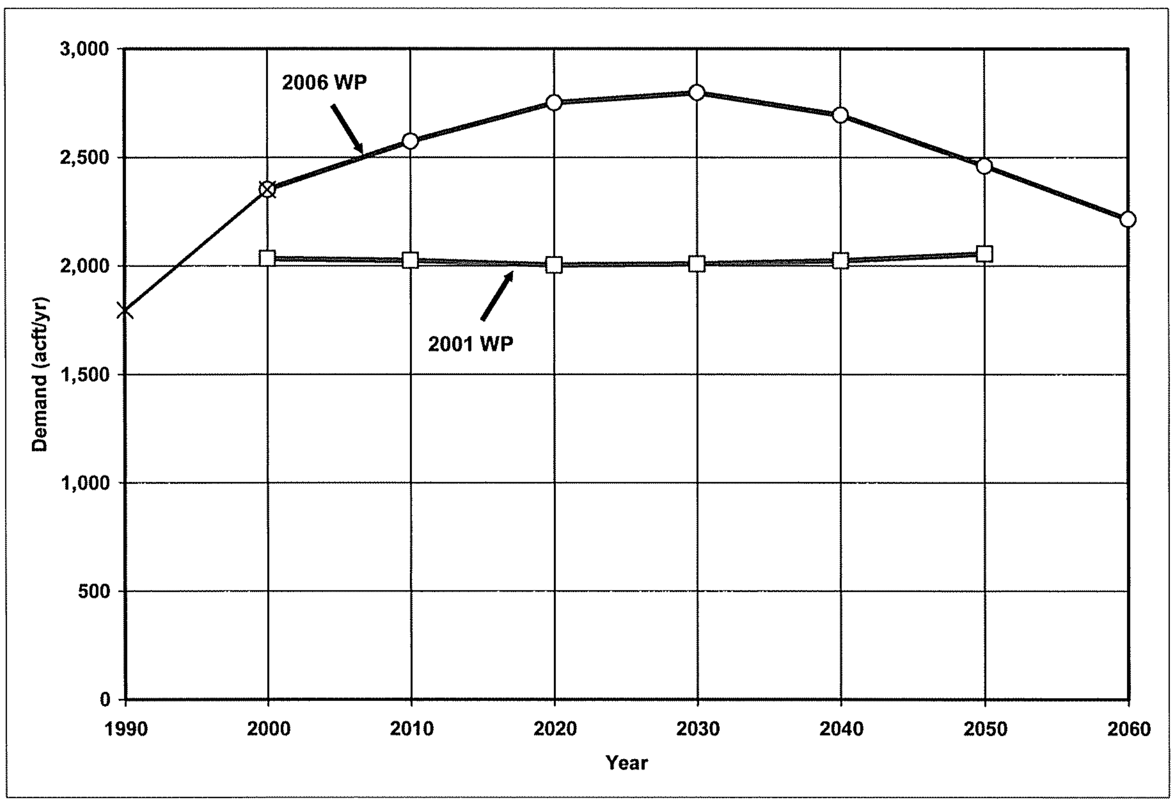


Live Oak County

Population

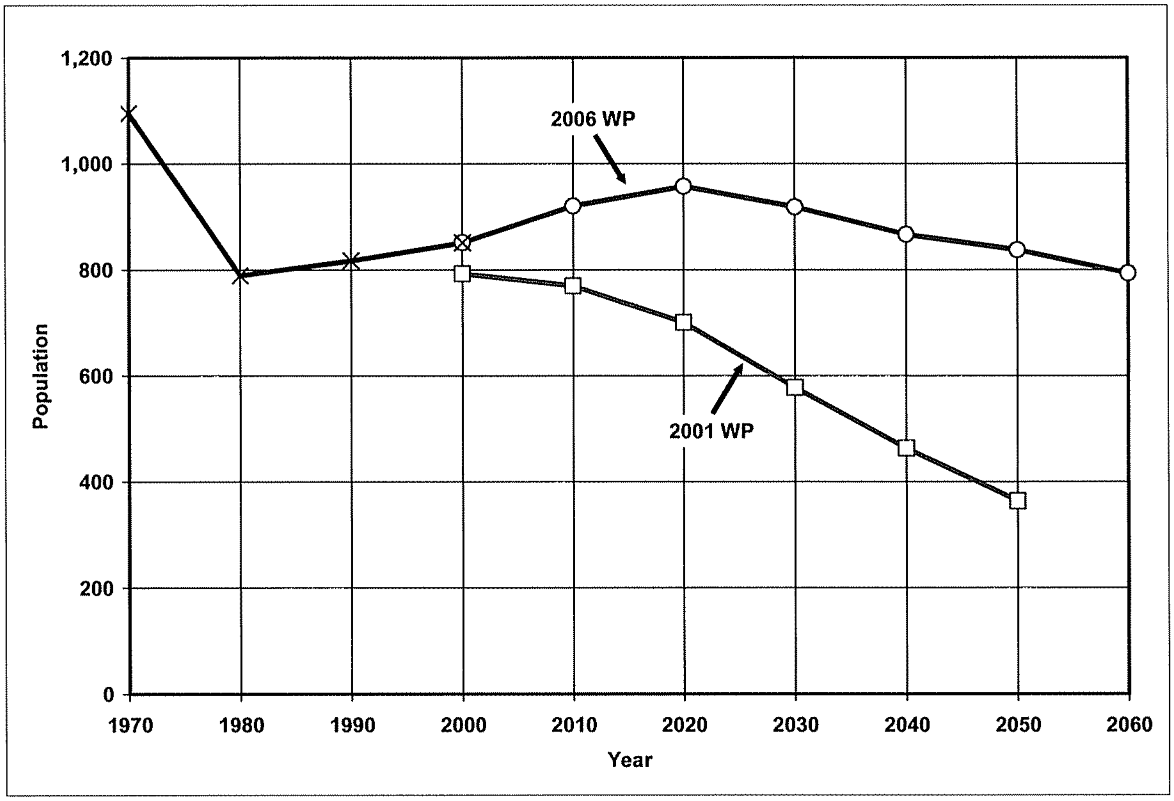


Water Demand

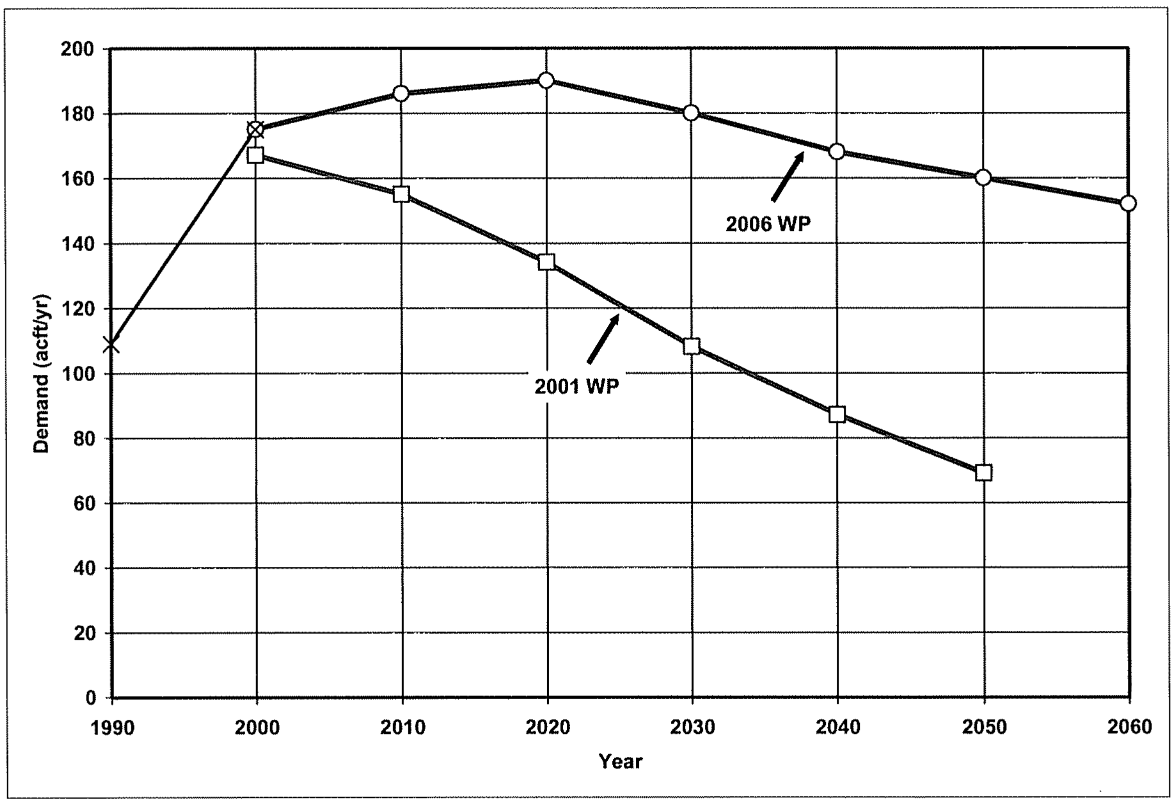


McMullen County

Population

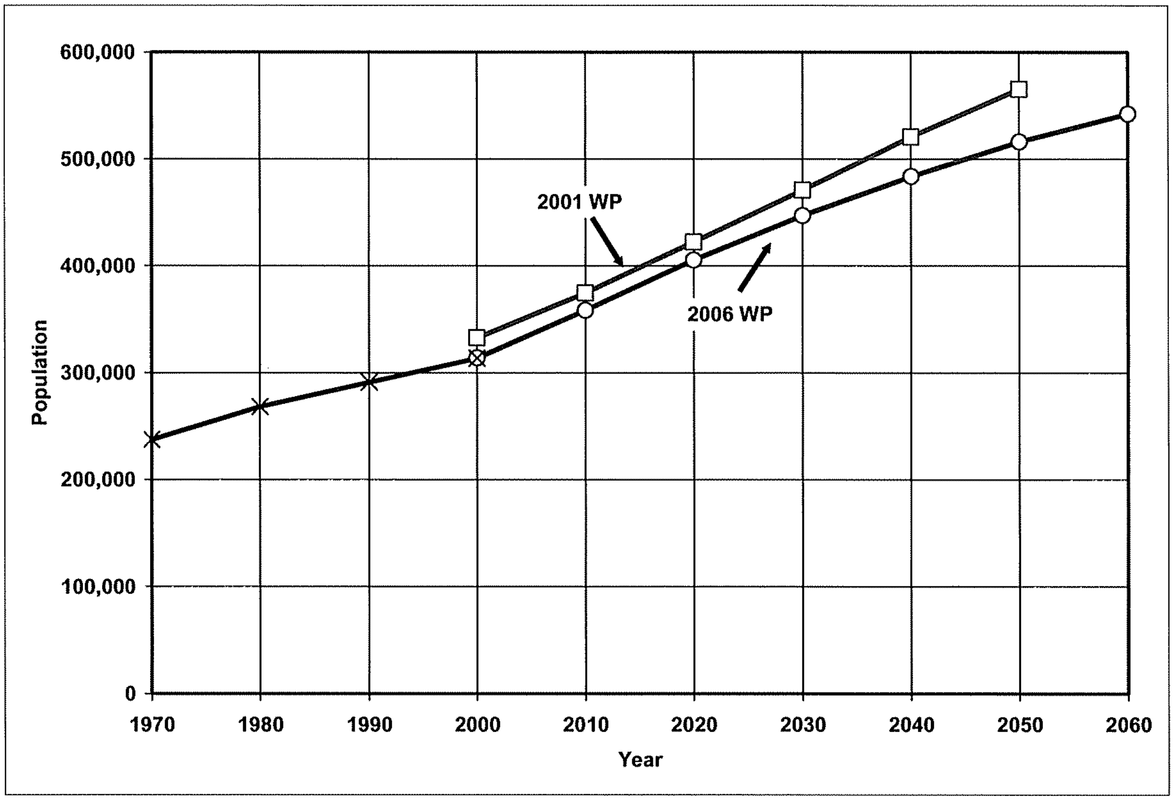


Water Demand

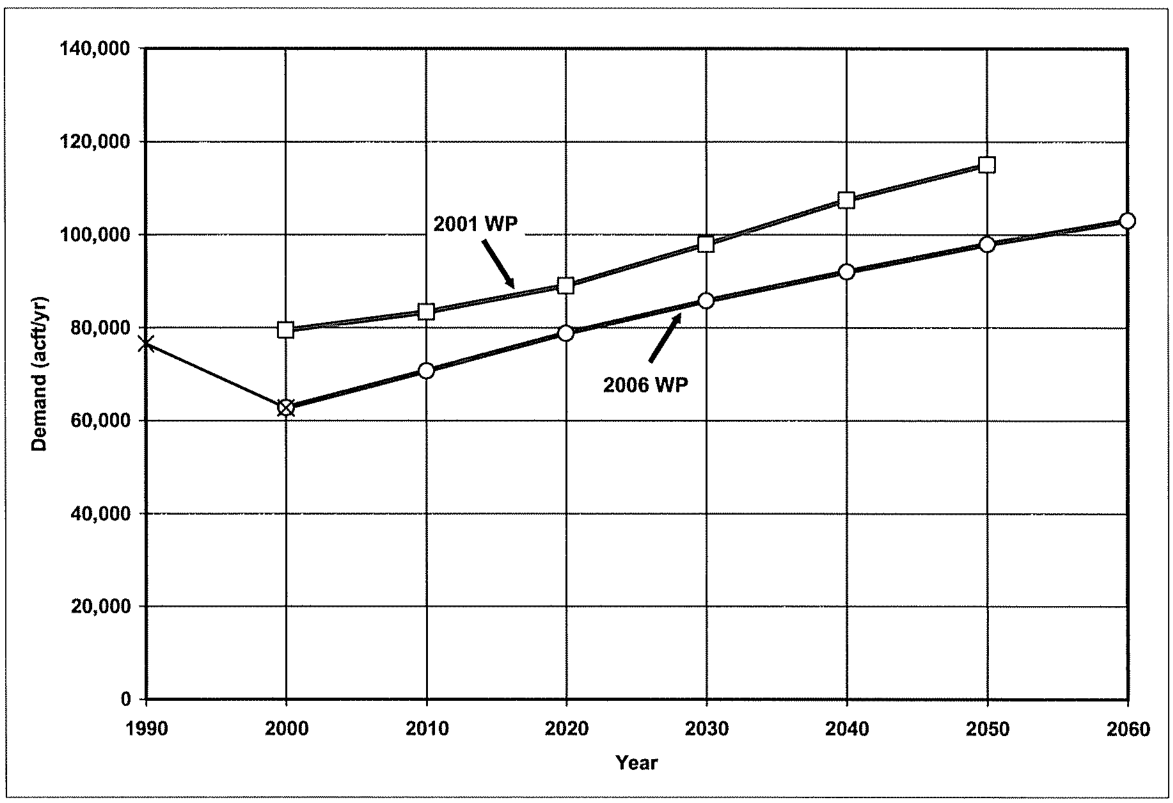


Nueces County

Population

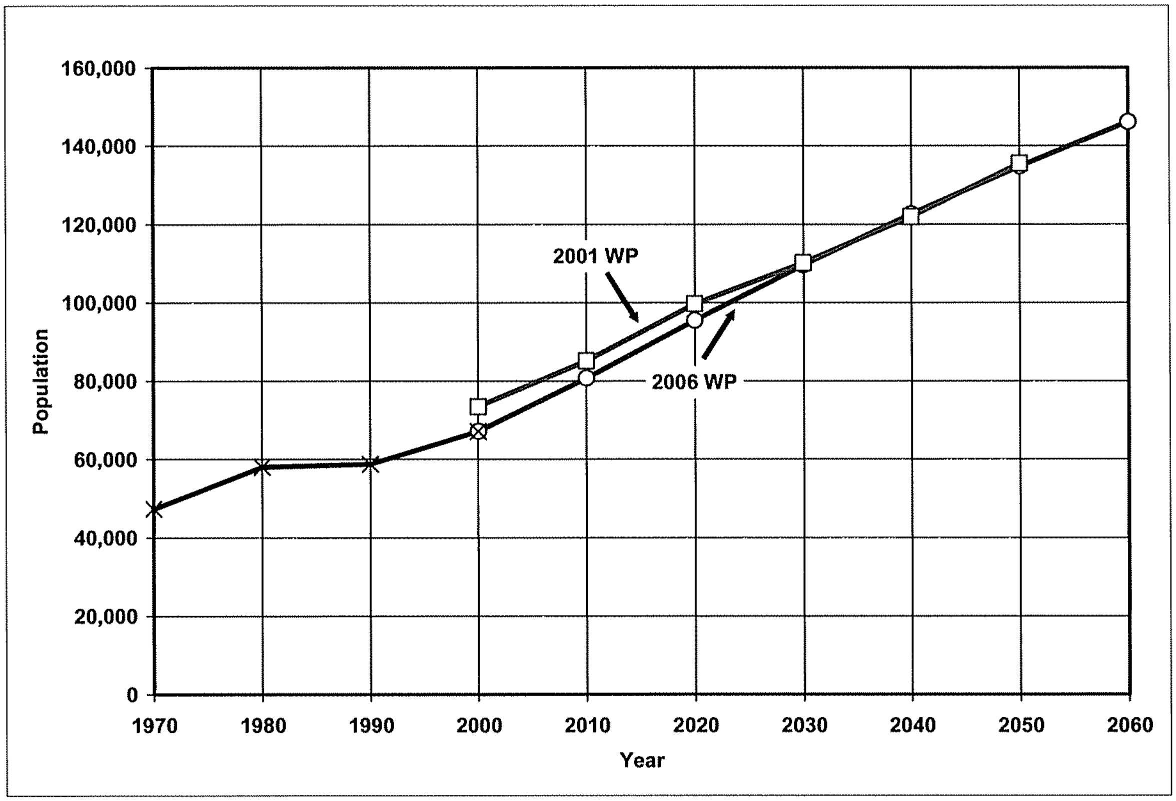


Water Demand

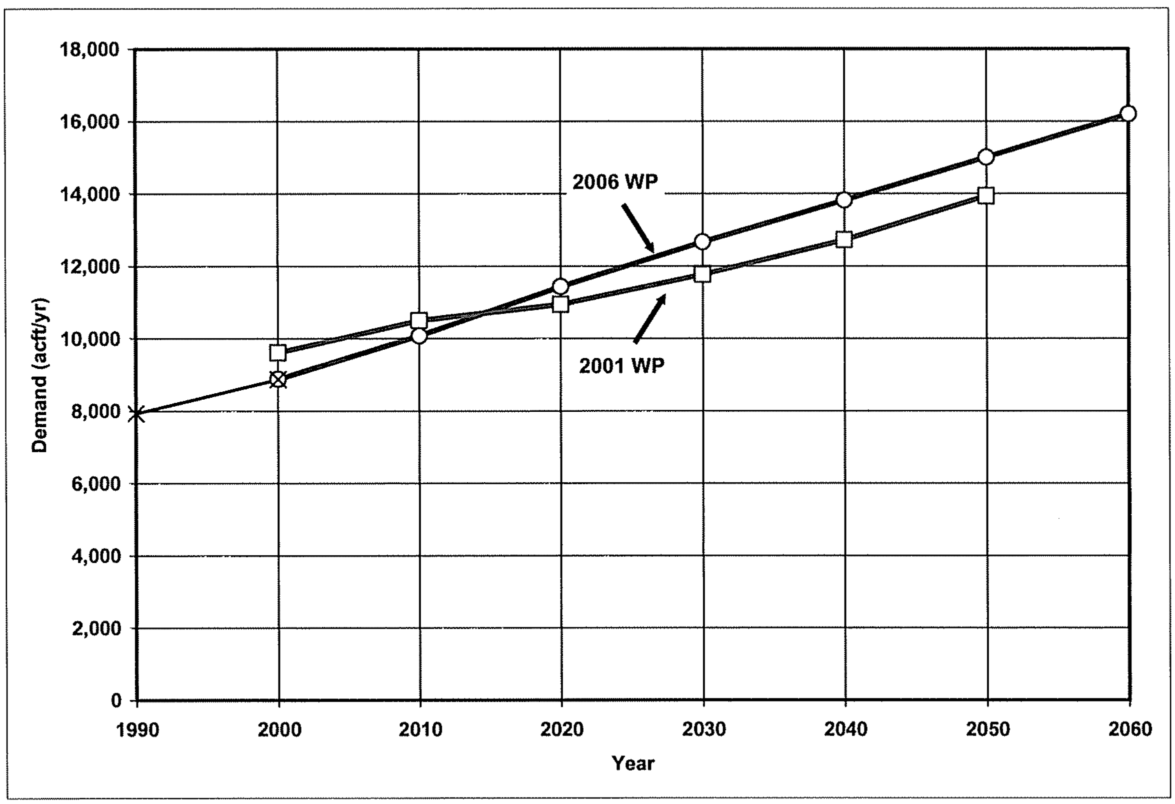


San Patricio County

Population

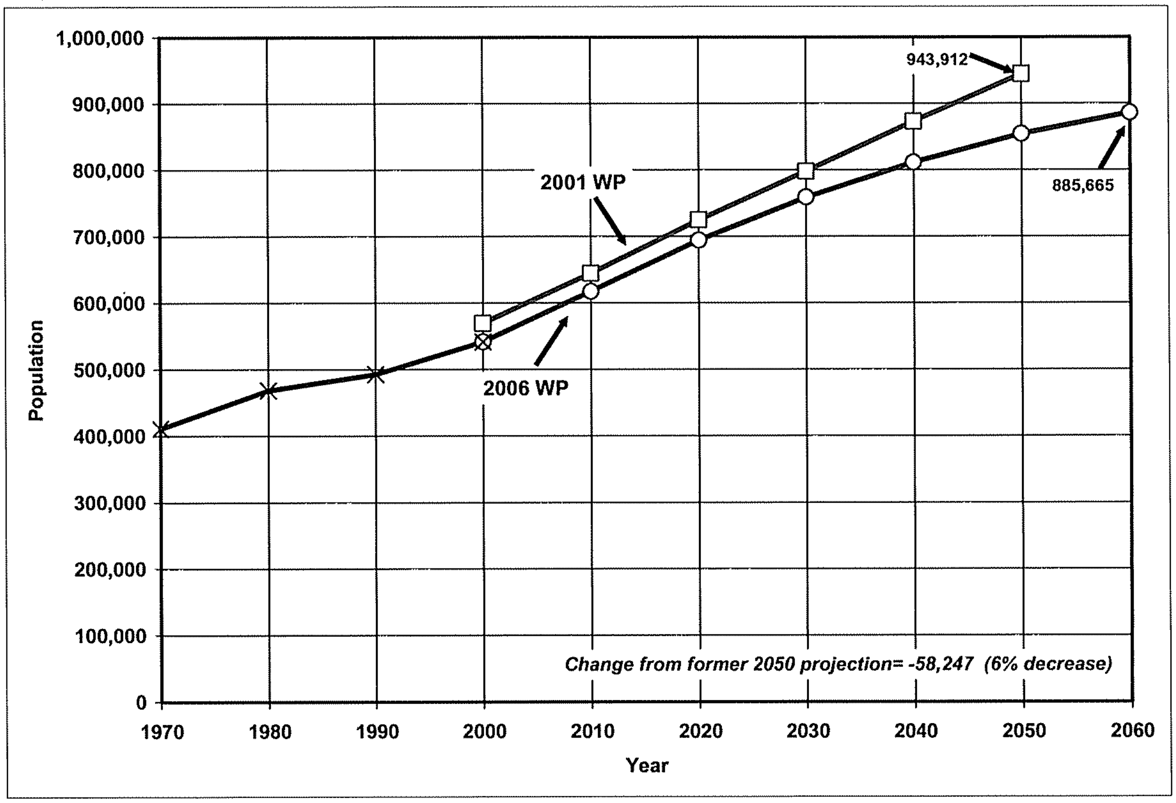


Water Demand

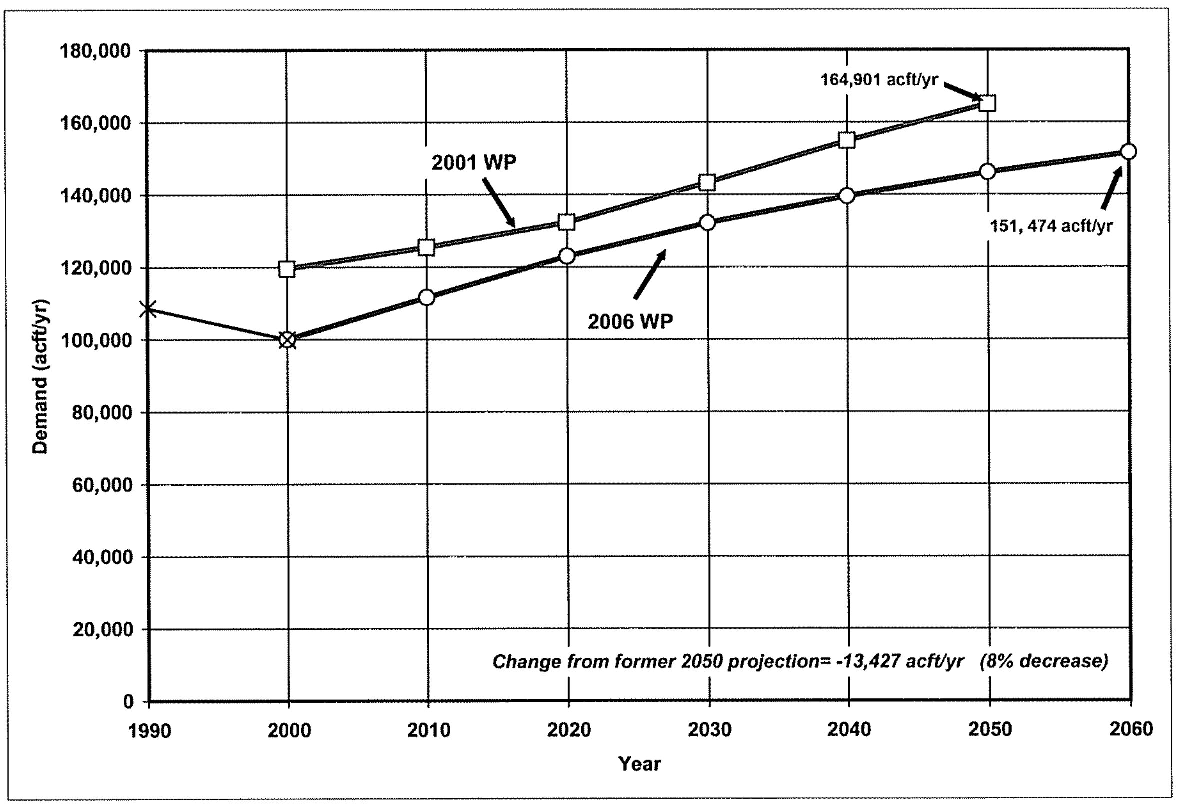


Region Totals

Population



Water Demand



Appendix C.4

Updates to Non-Municipal Water Demand Projections (Manufacturing, Mining, Irrigation, and Livestock) since 2001 Plan (by County)

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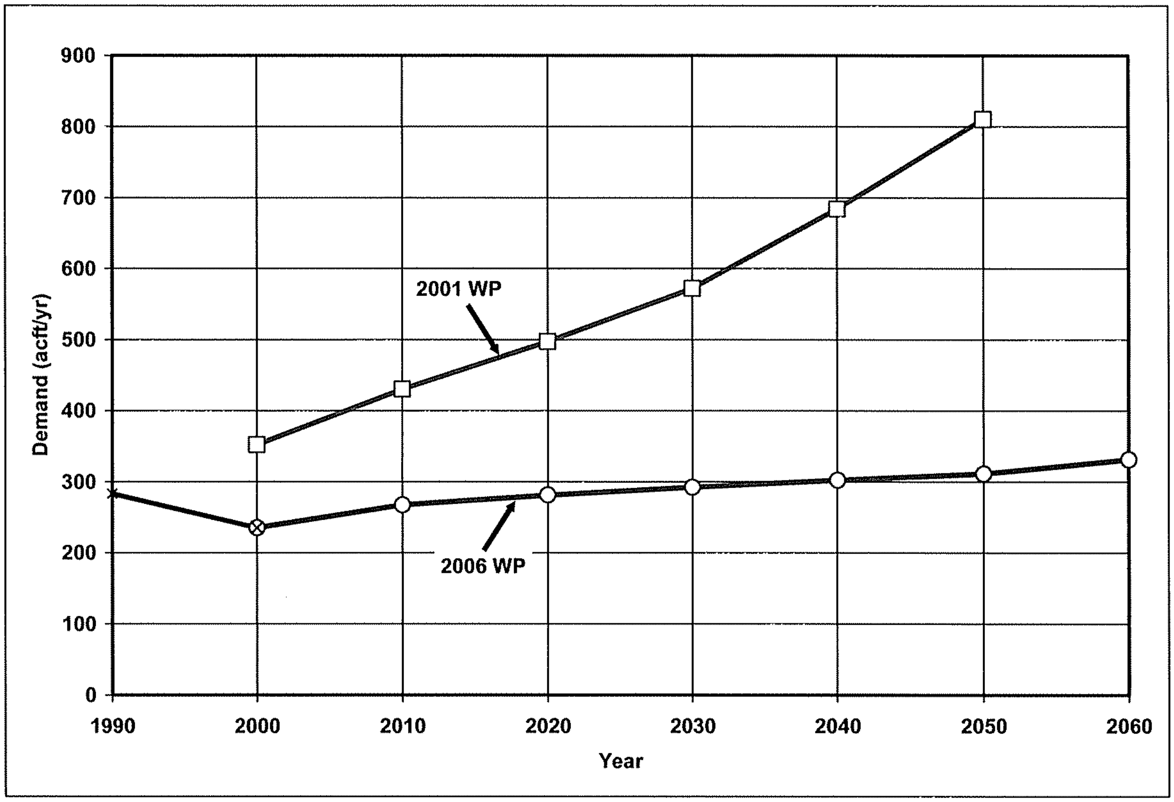
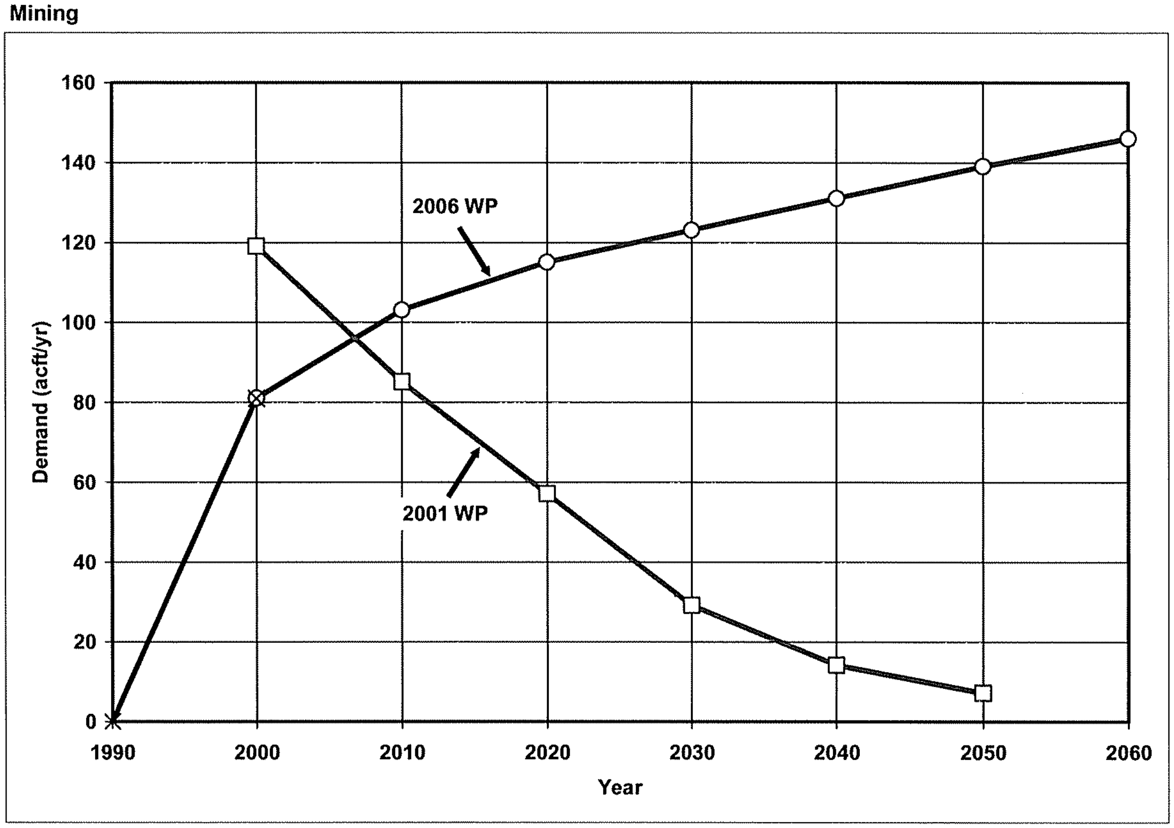
Aransas County

Manufacturing

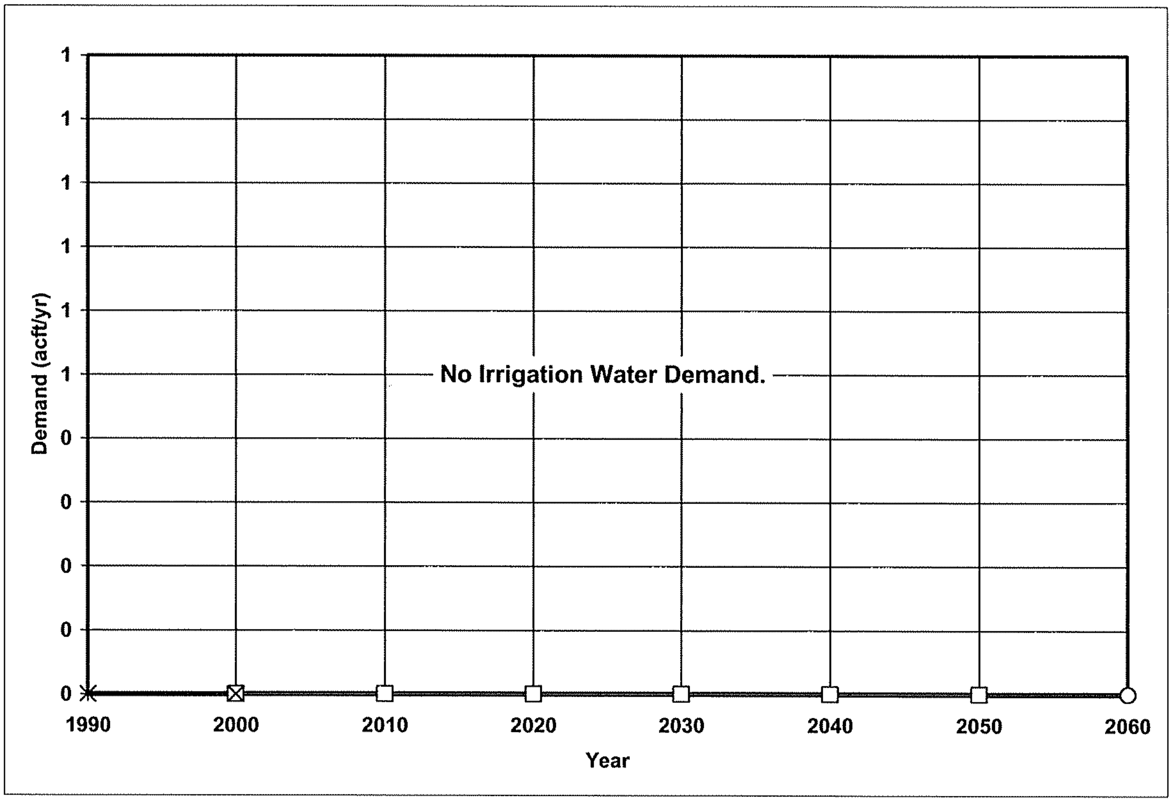


Mining

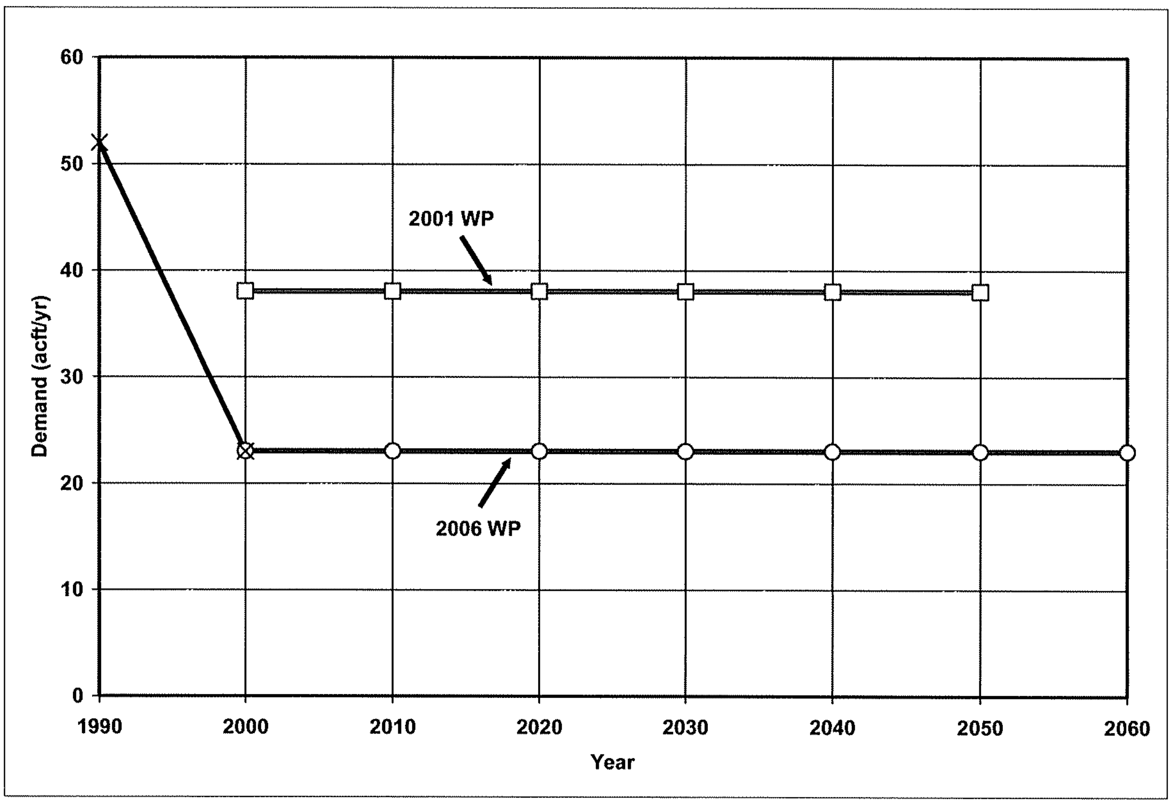


Aransas County (Continued)

Irrigation

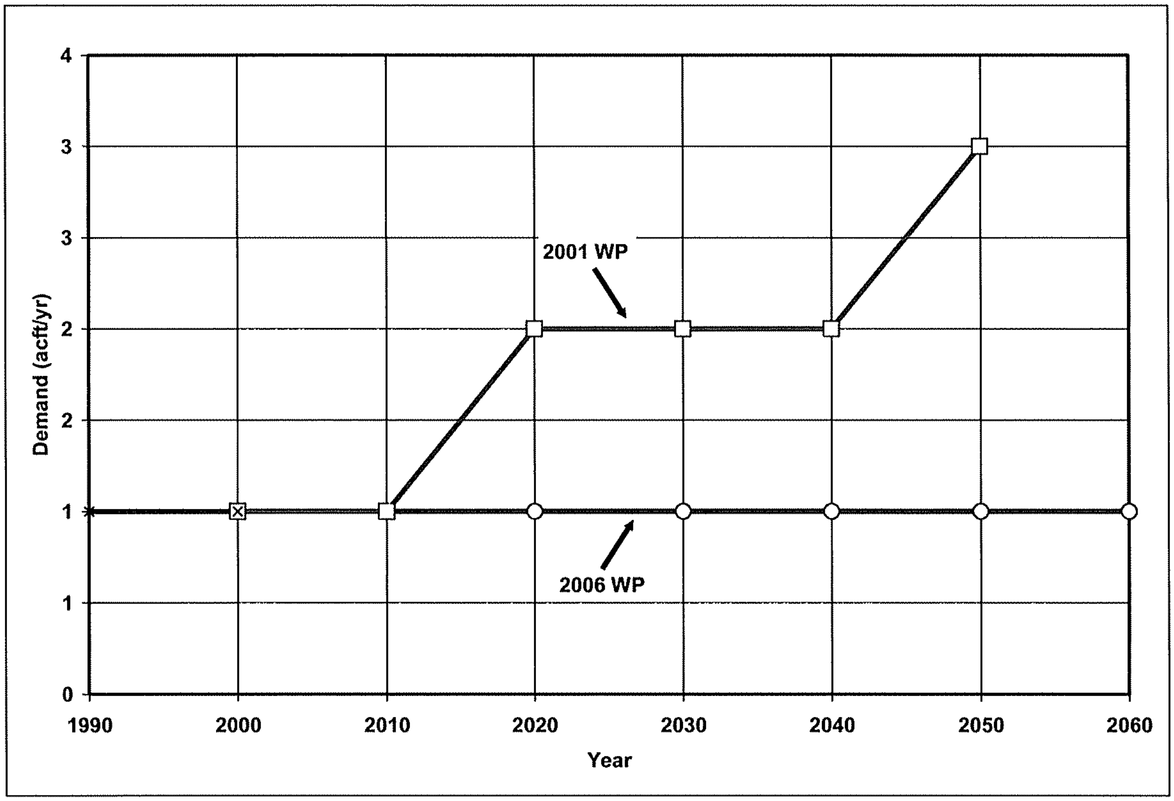


Livestock

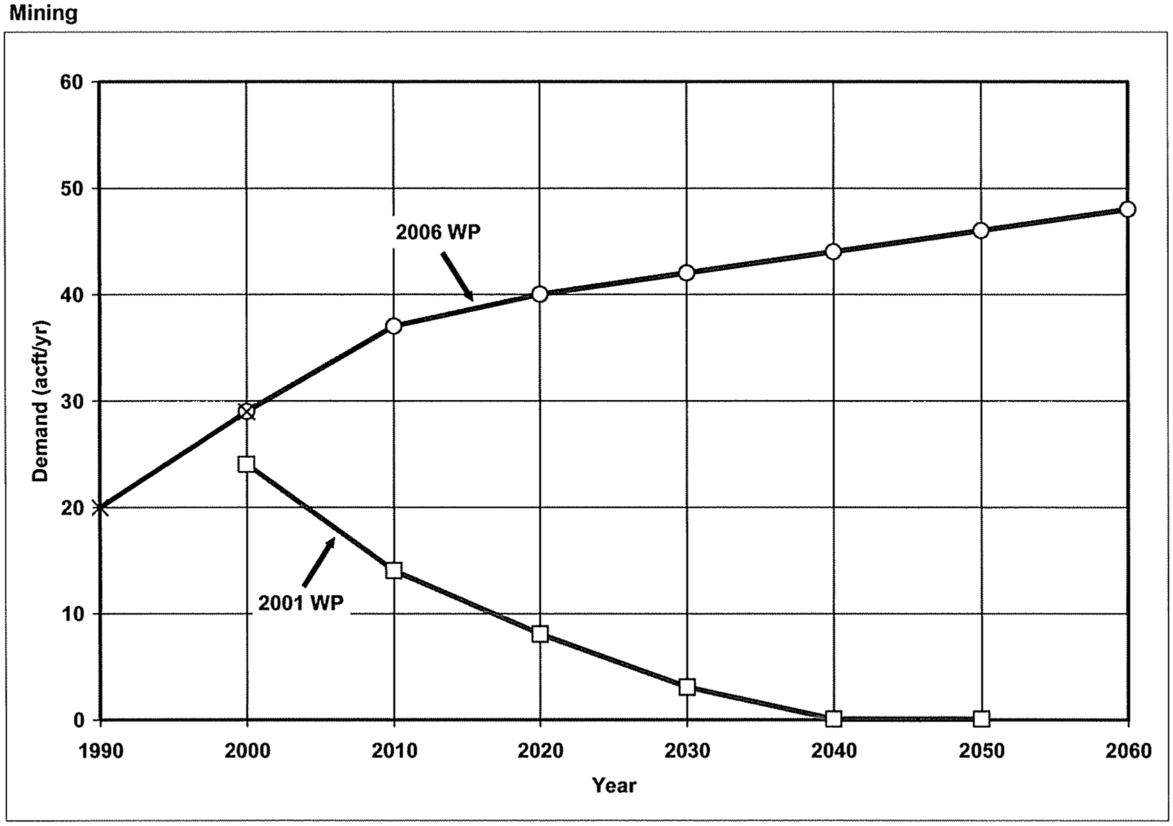


Bee County

Manufacturing

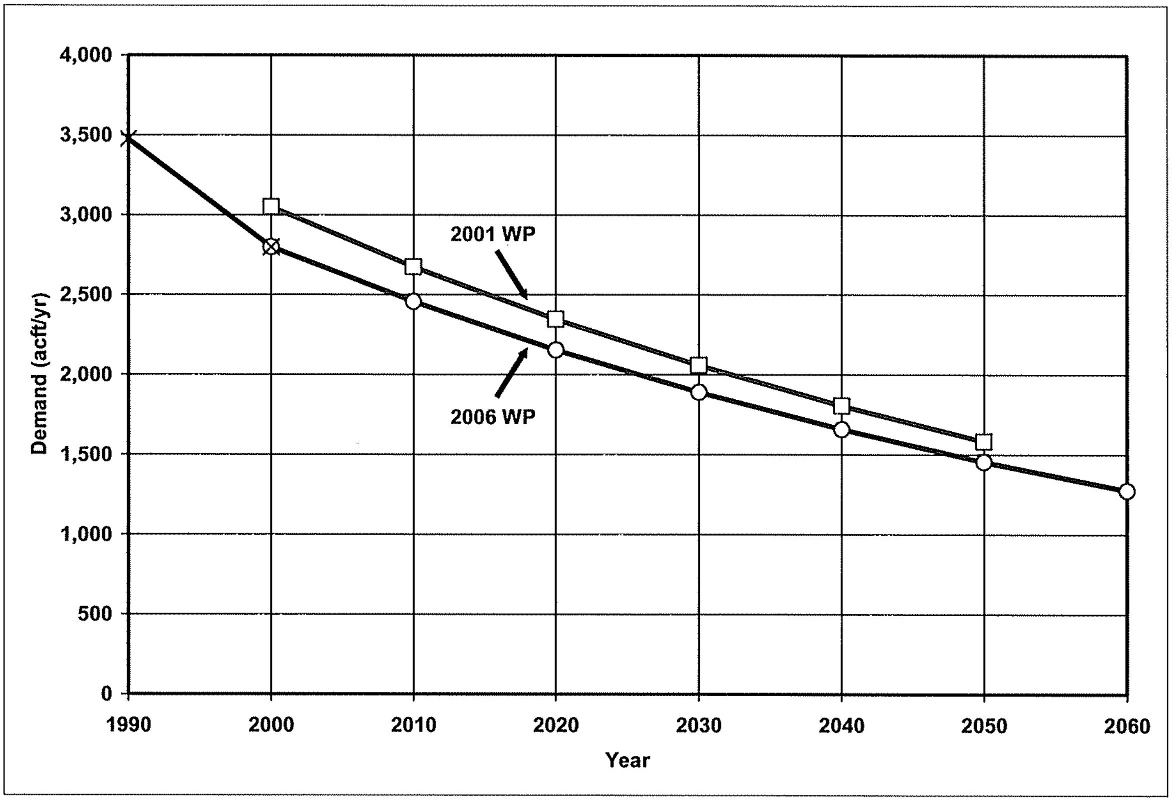


Mining

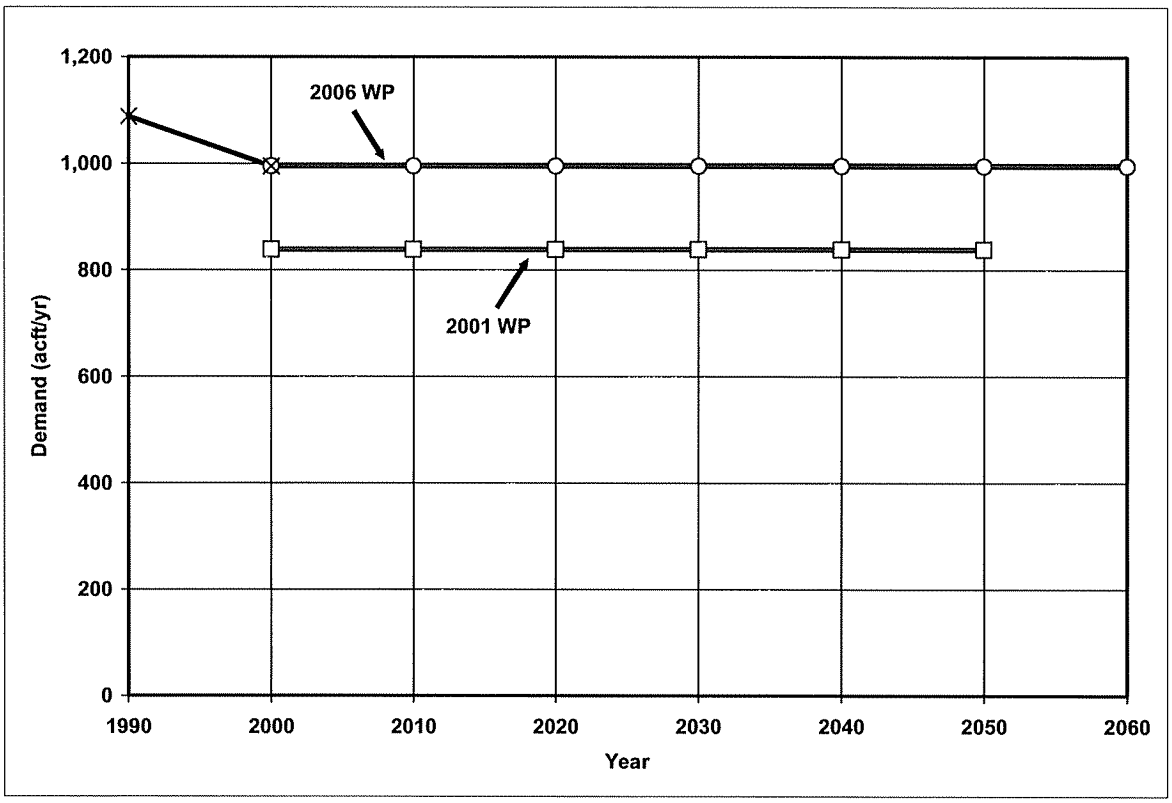


Bee County (Continued)

Irrigation

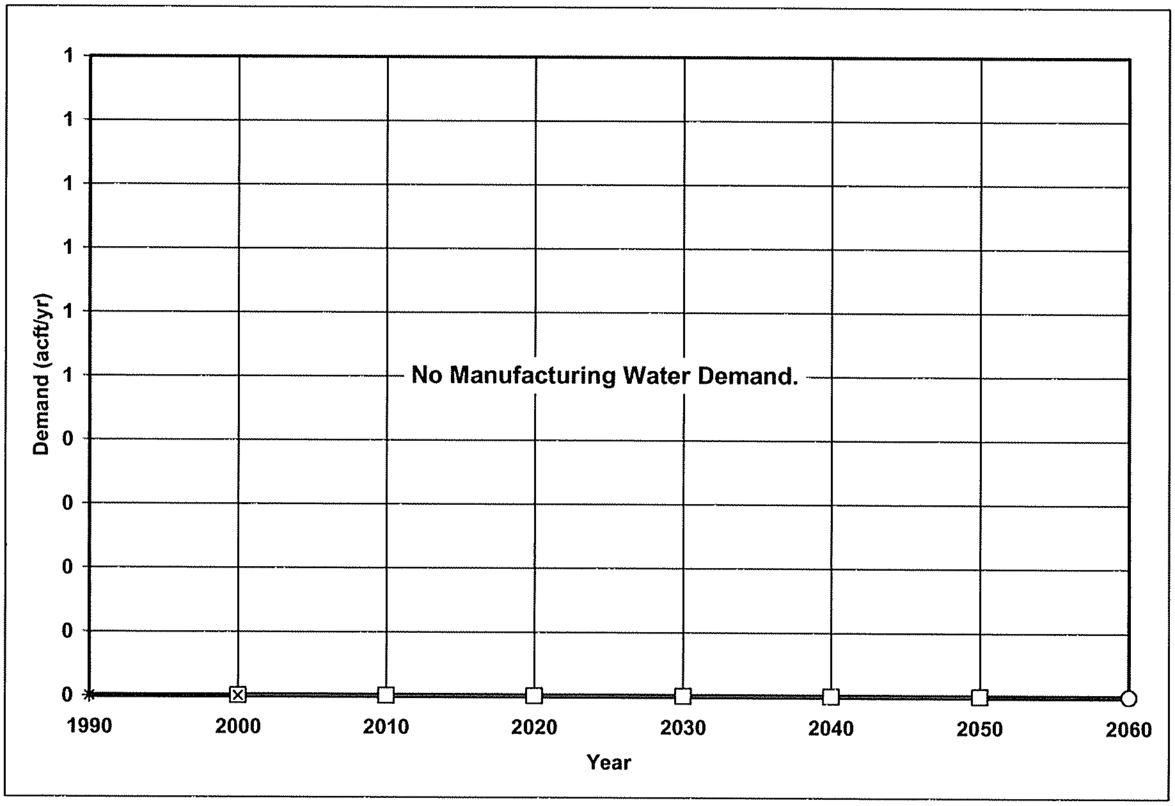


Livestock

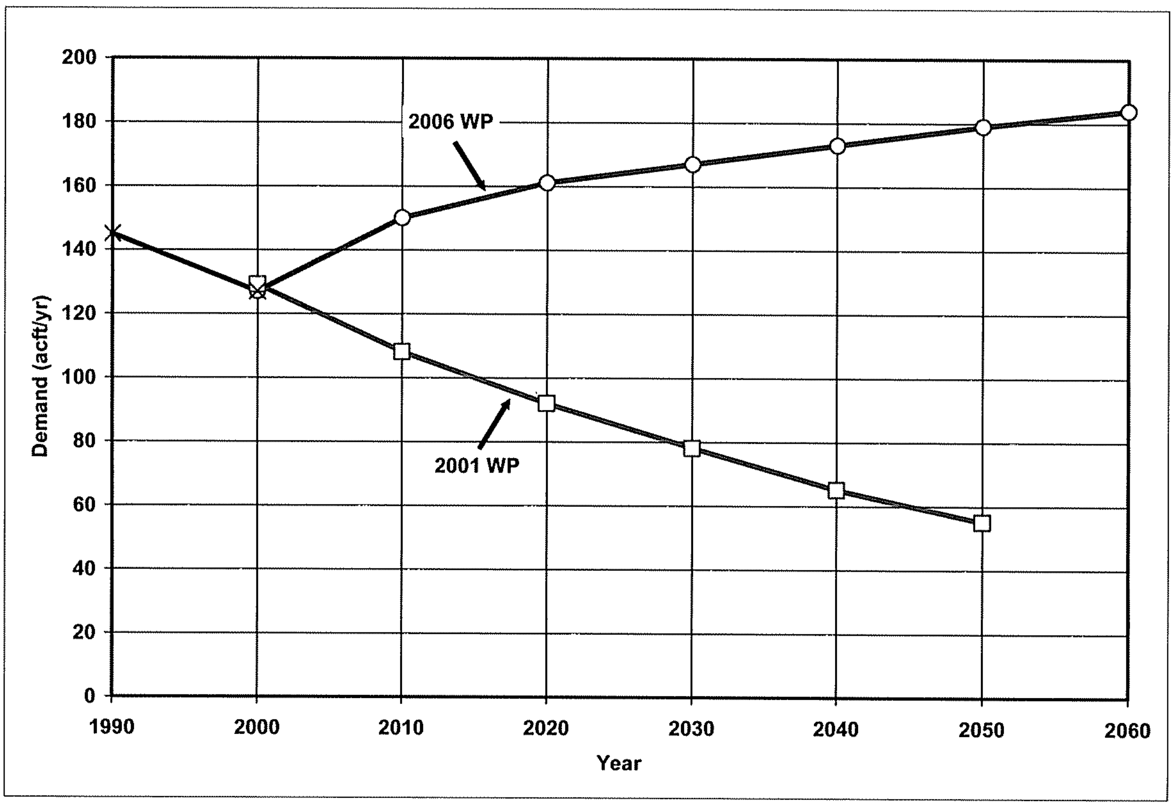


Brooks County

Manufacturing

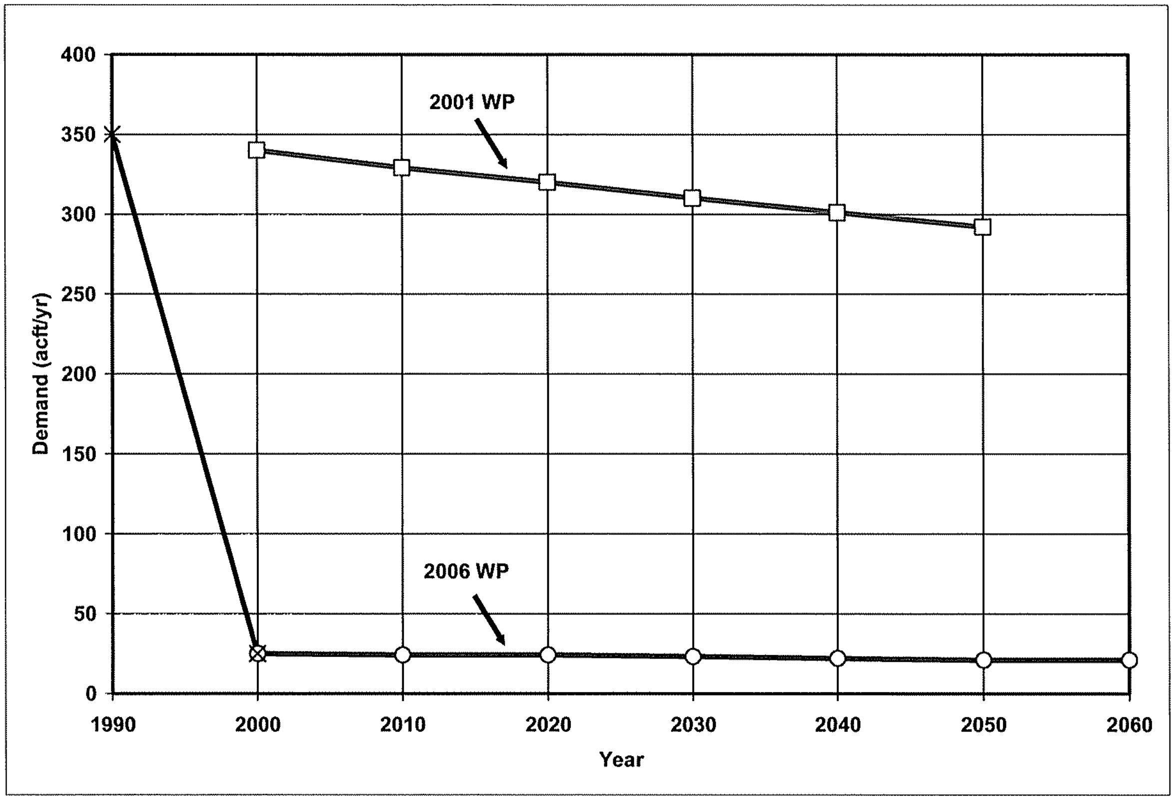


Mining

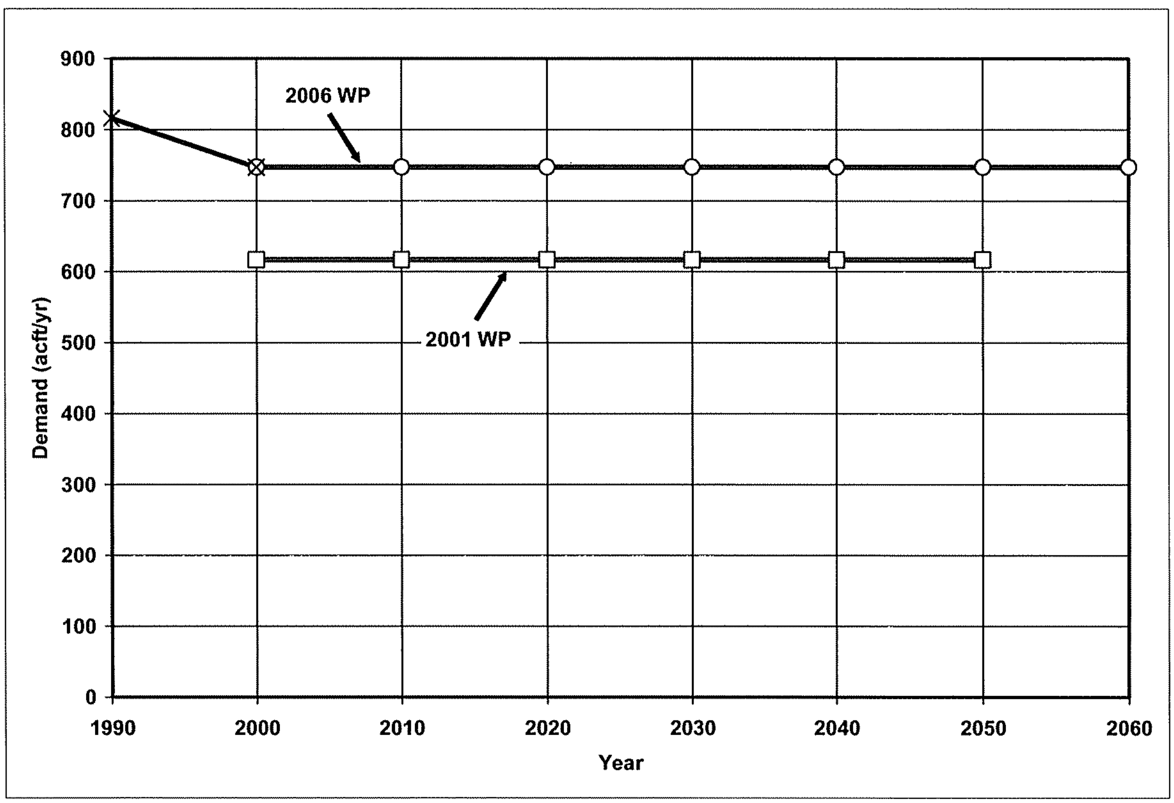


Brooks County (Continued)

Irrigation

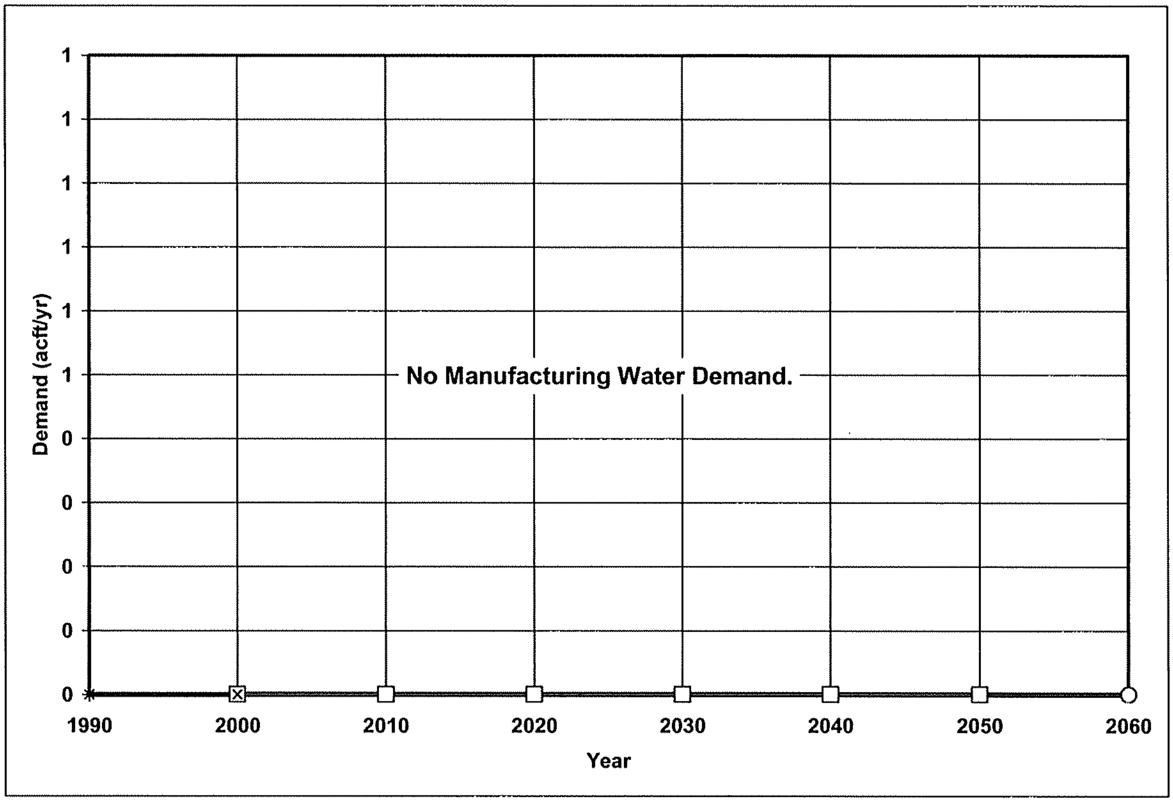


Livestock

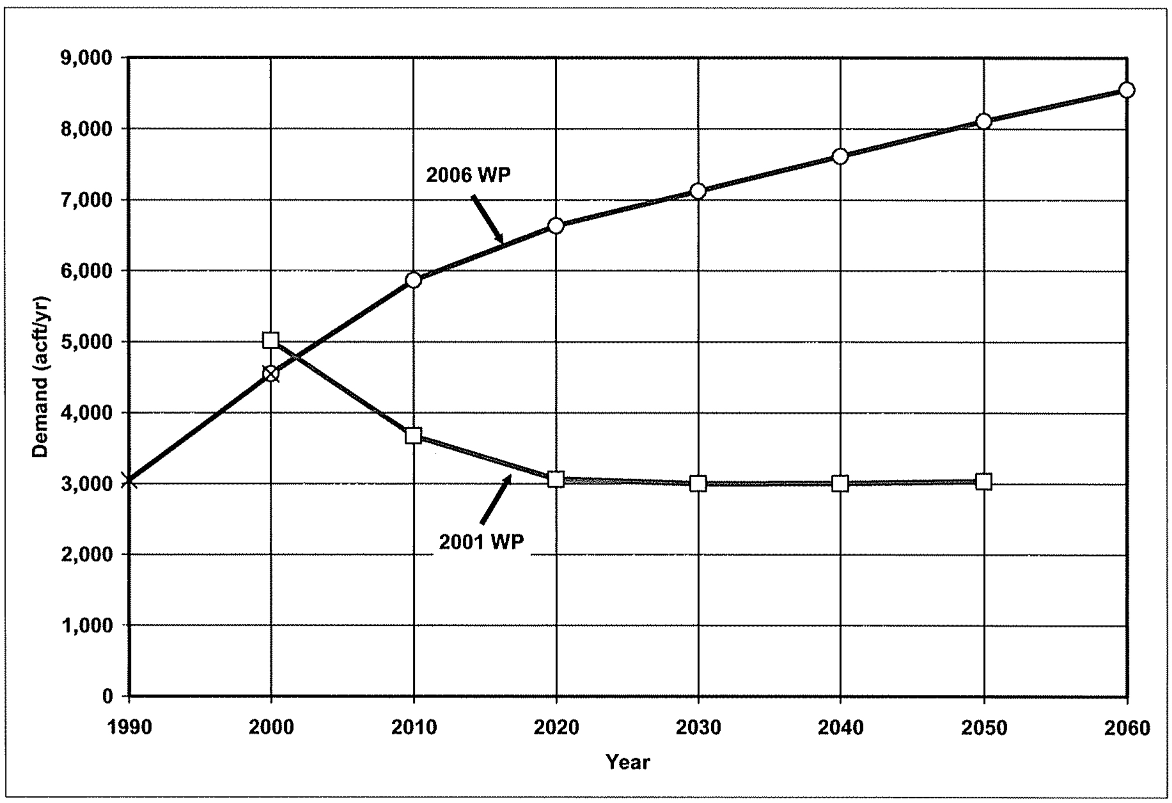


Duval County

Manufacturing

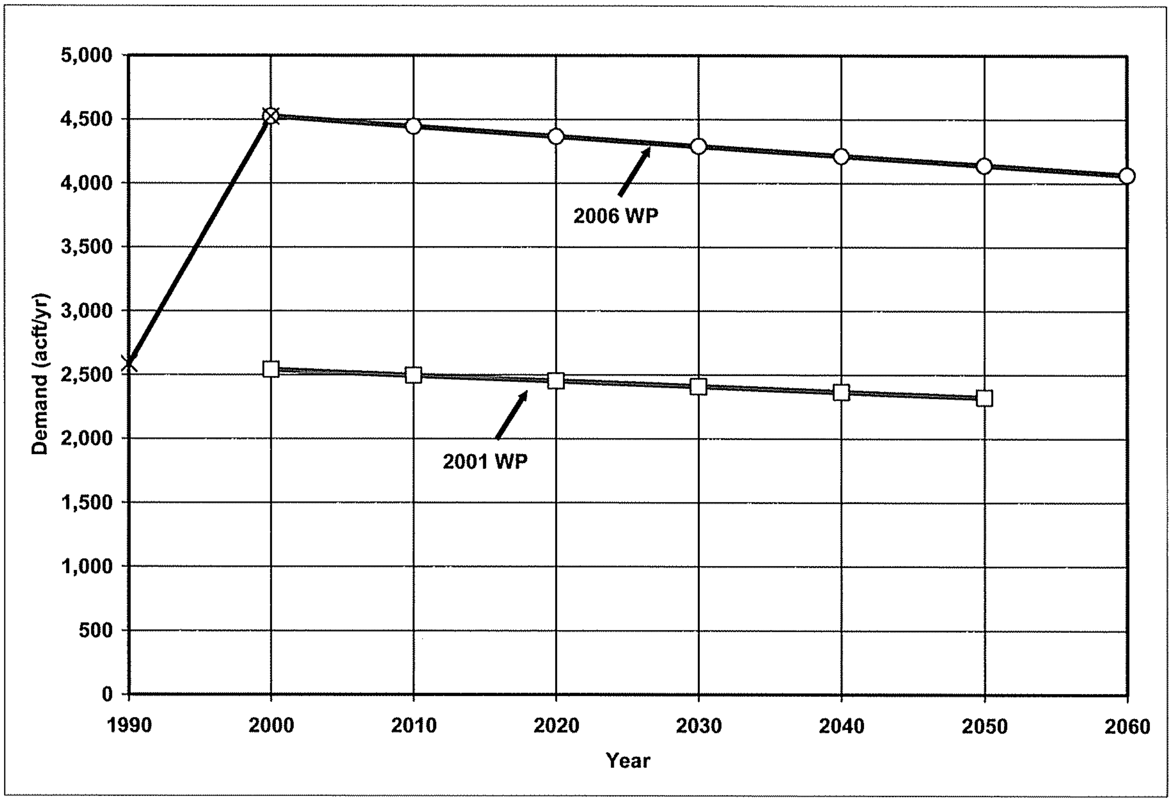


Mining

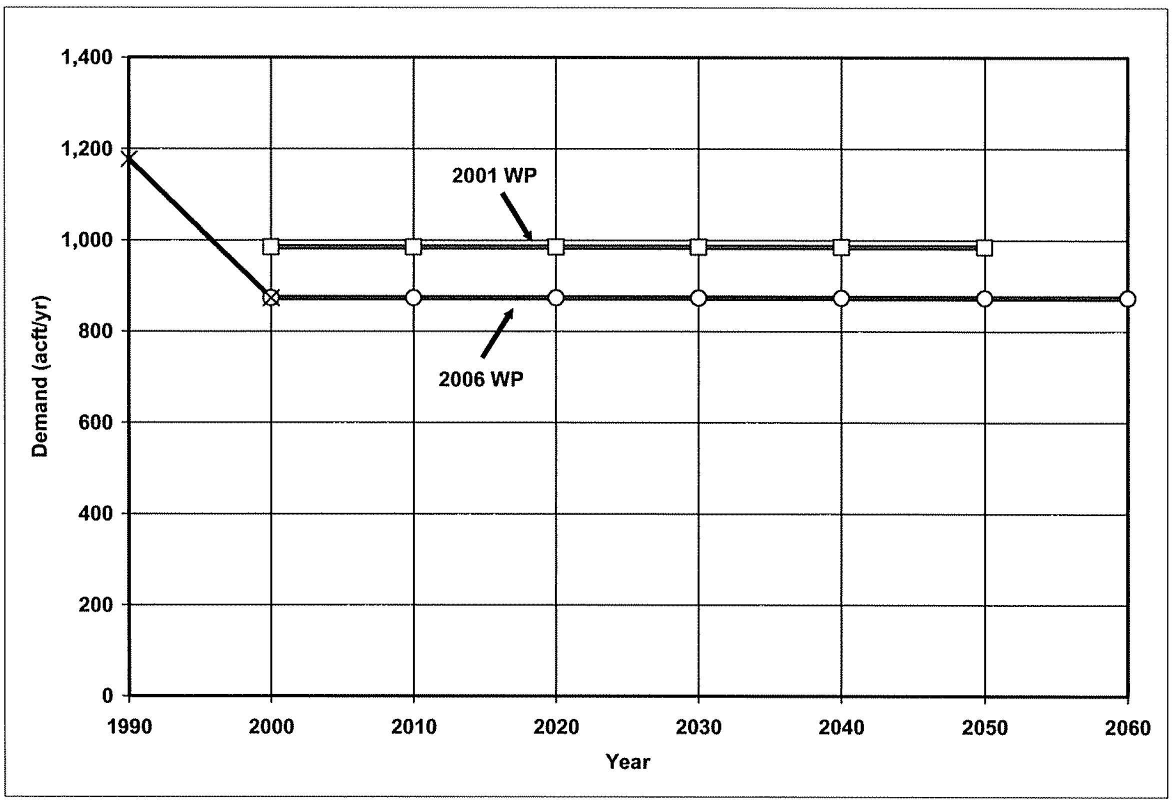


Duval County (Continued)

Irrigation

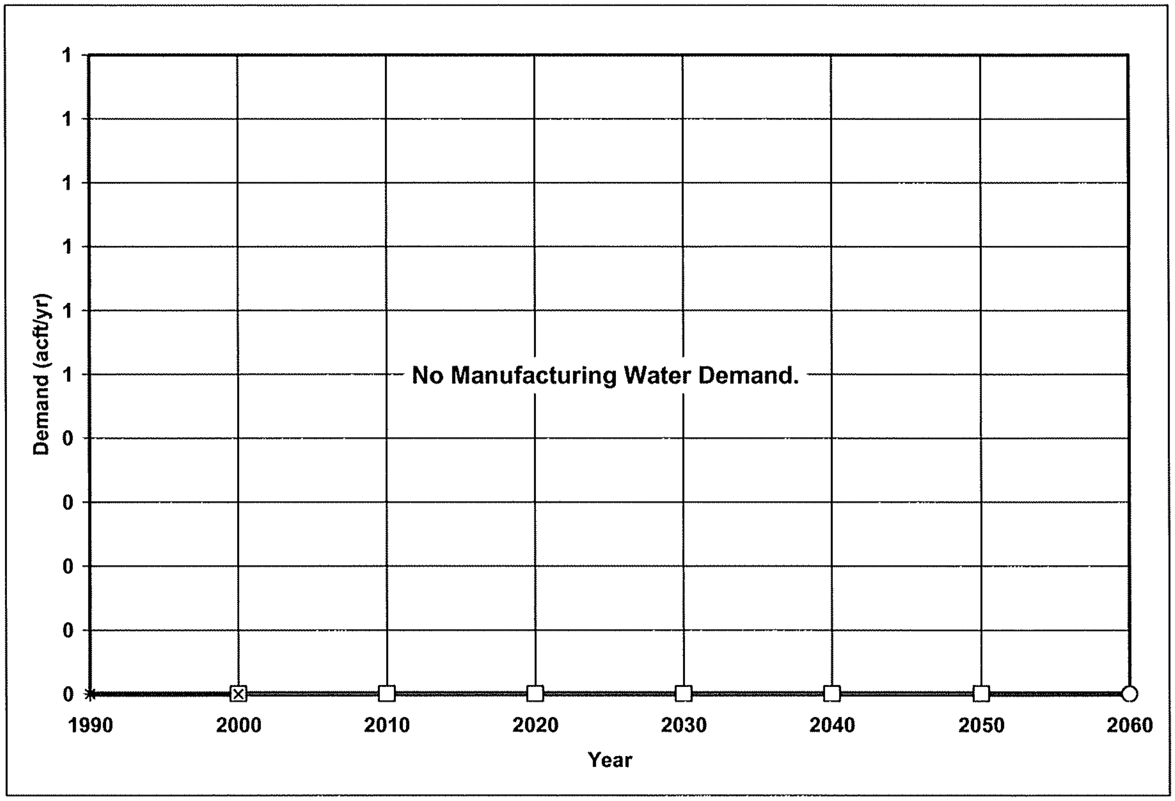


Livestock

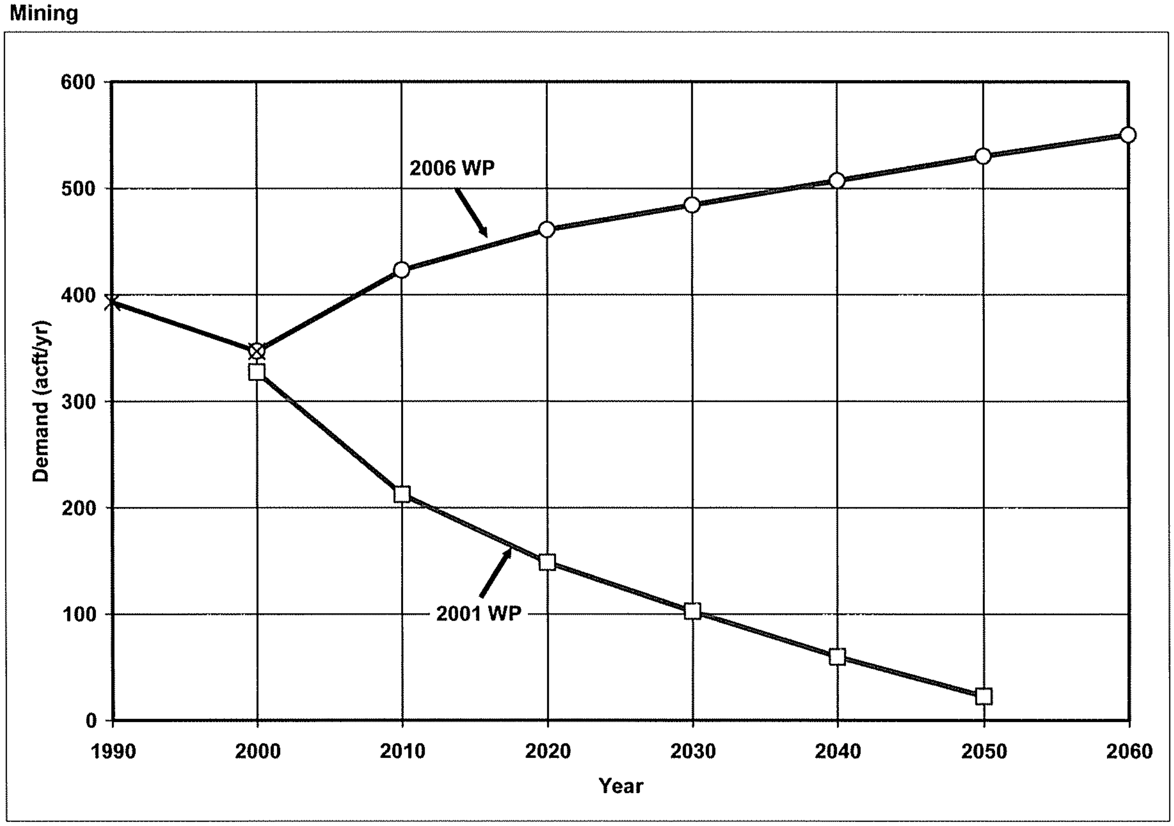


Jim Wells County

Manufacturing

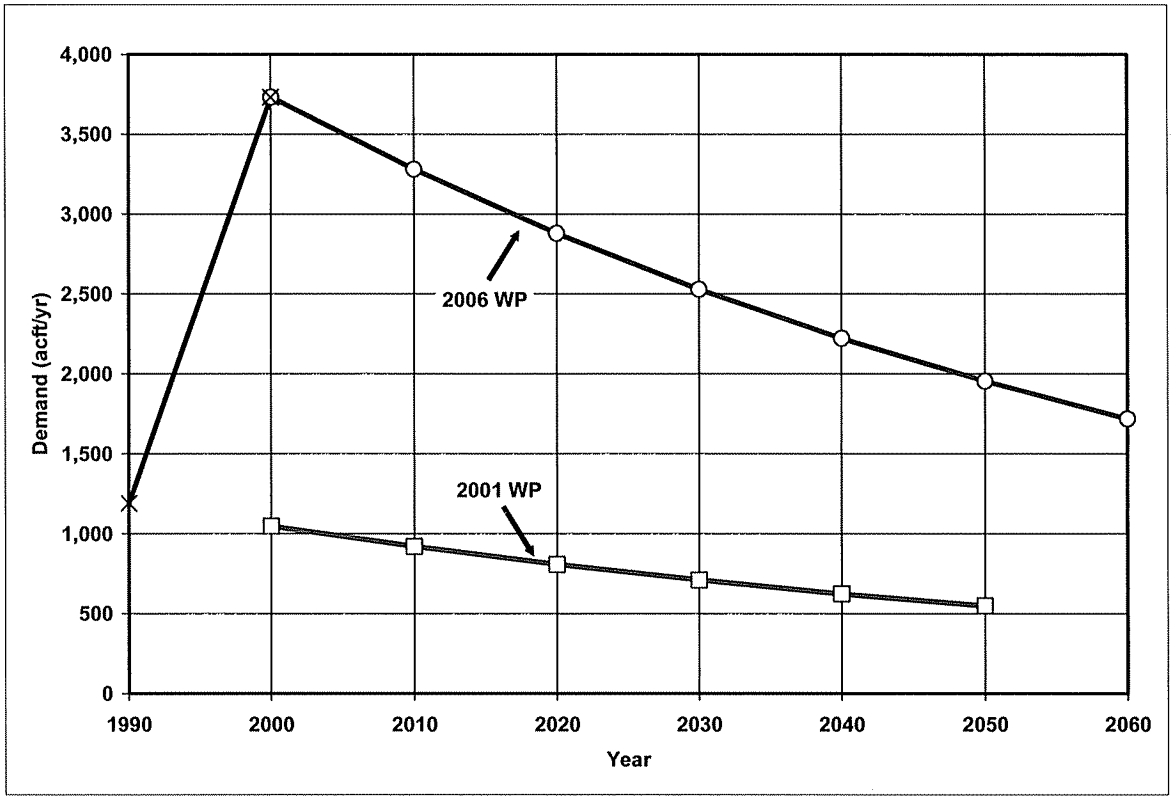


Mining

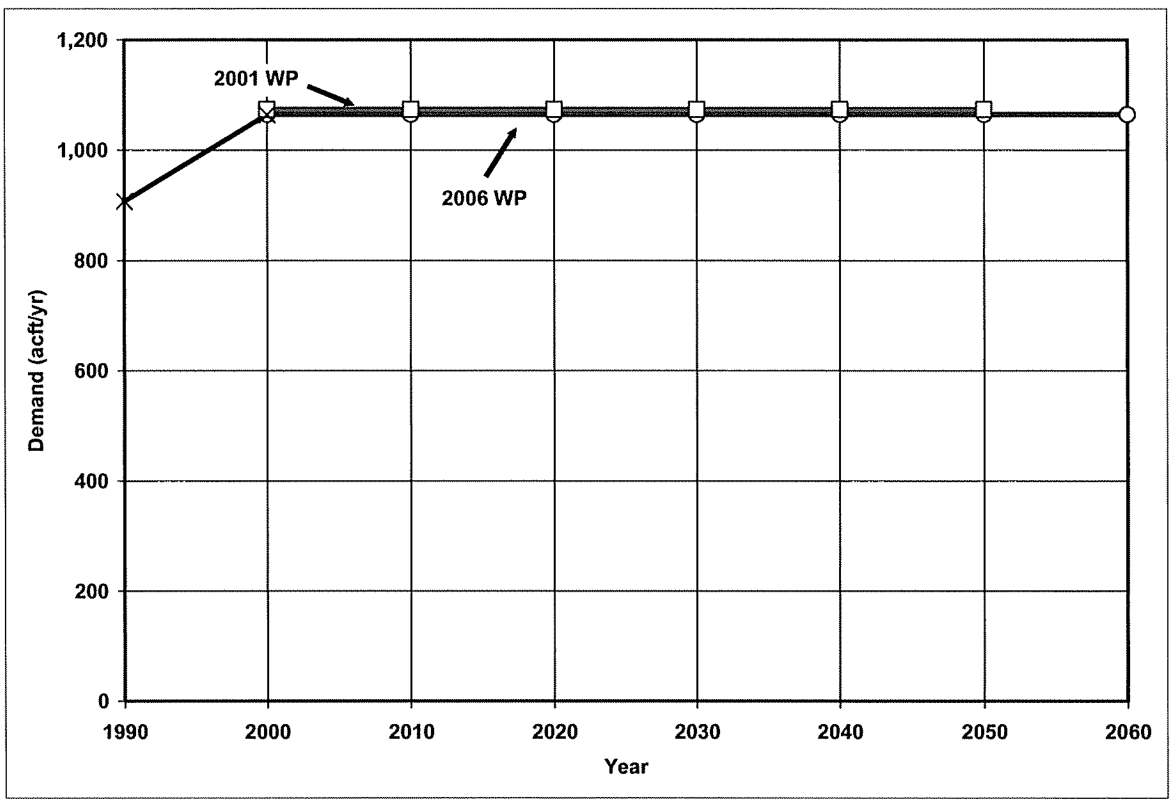


Jim Wells County (Continued)

Irrigation

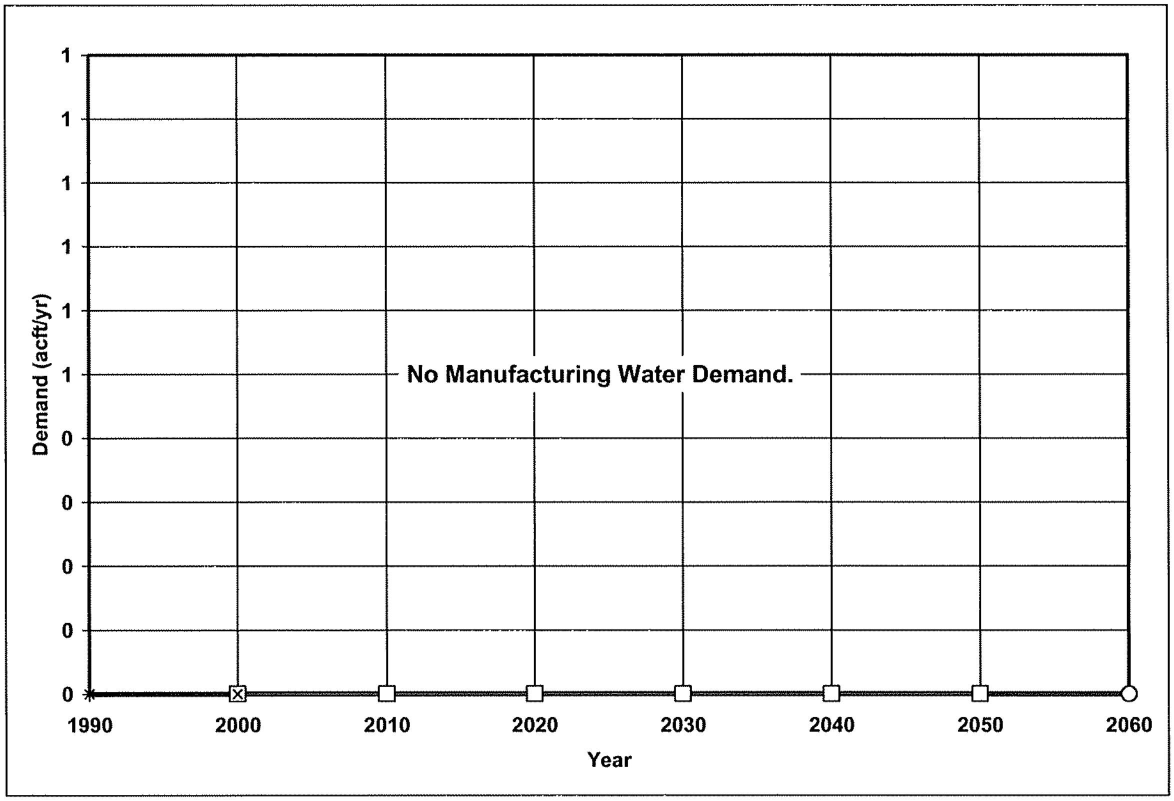


Livestock

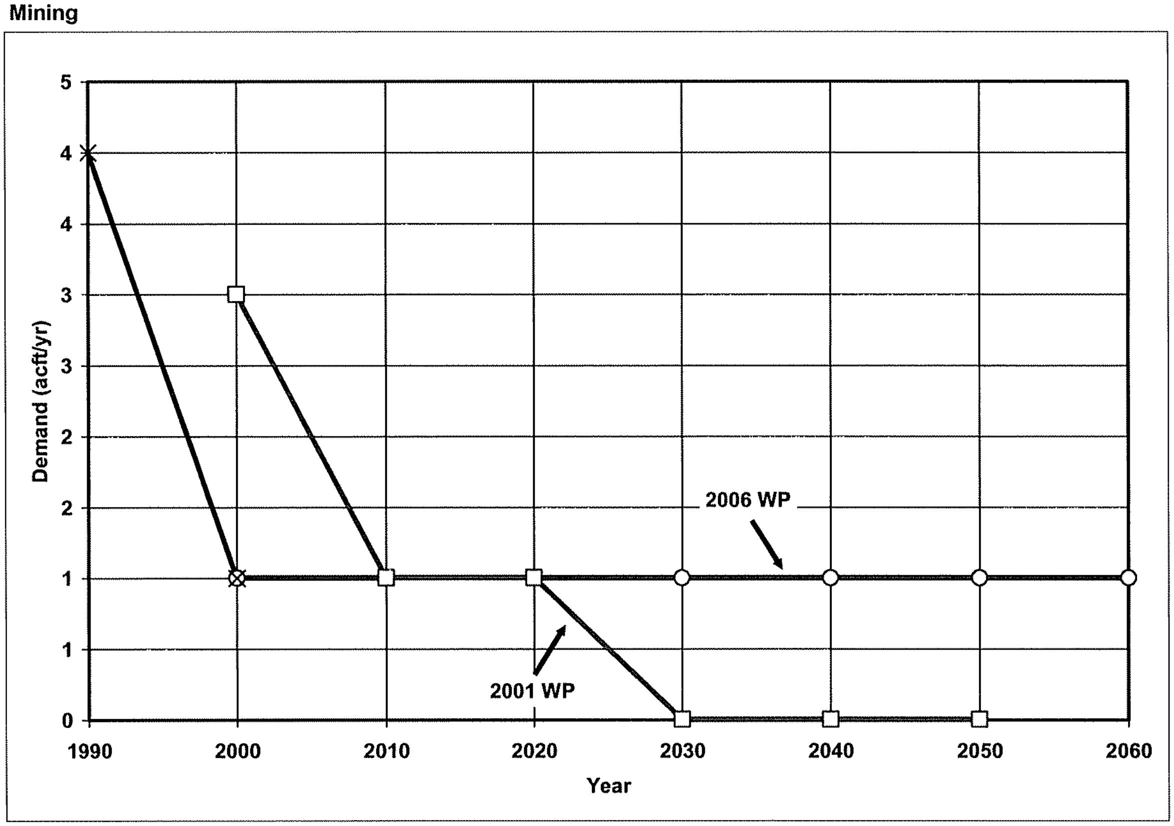


Kenedy County

Manufacturing

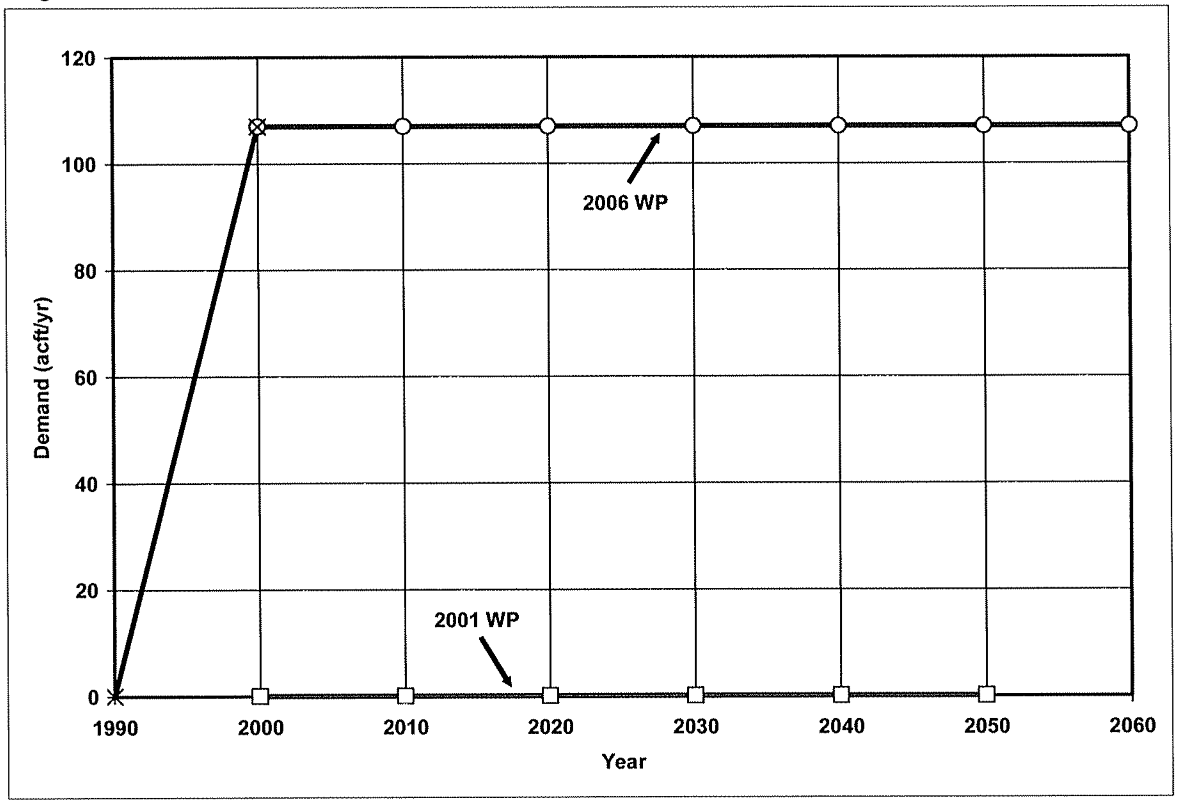


Mining

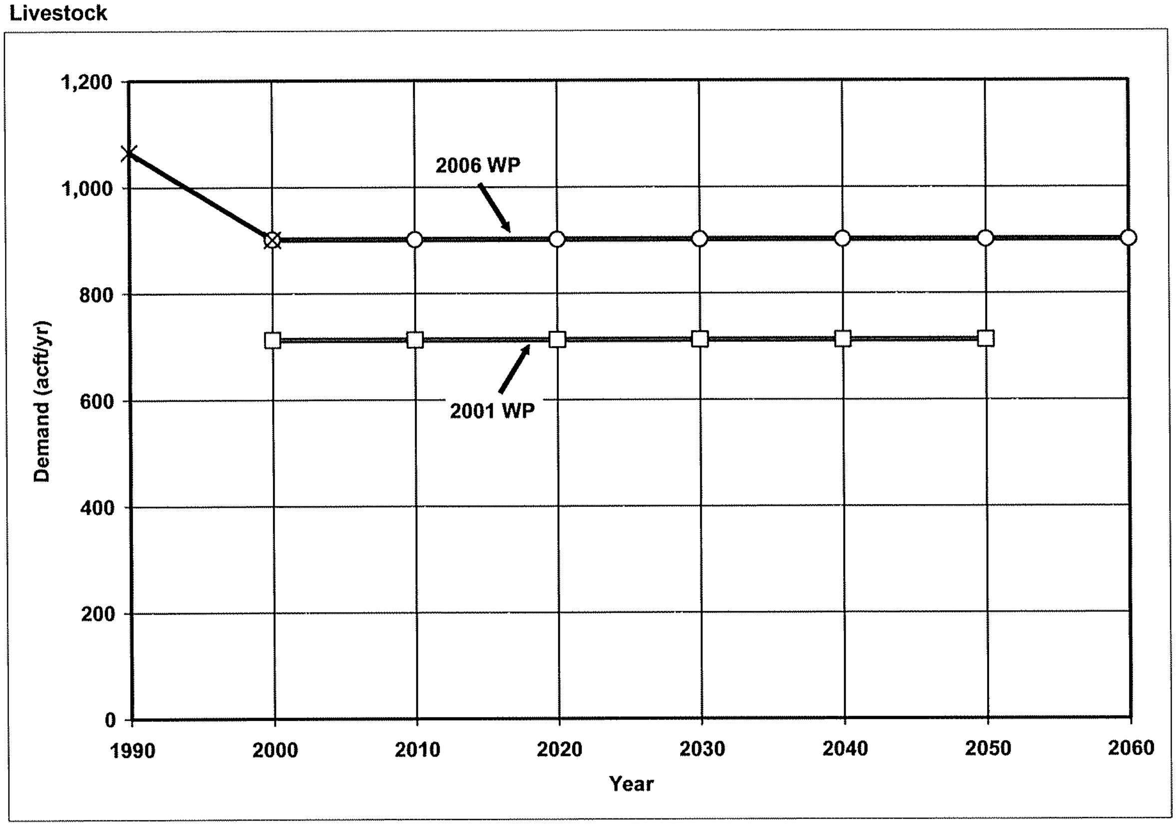


Kenedy County (Continued)

Irrigation

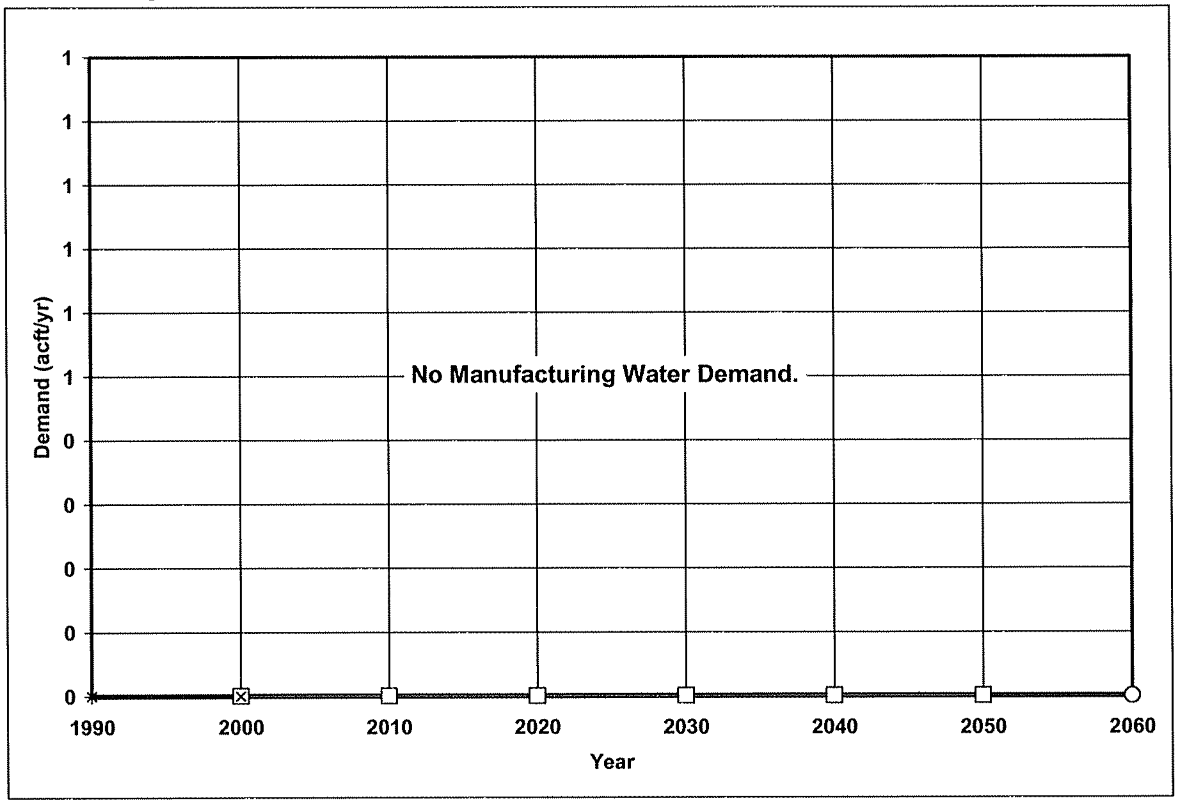


Livestock

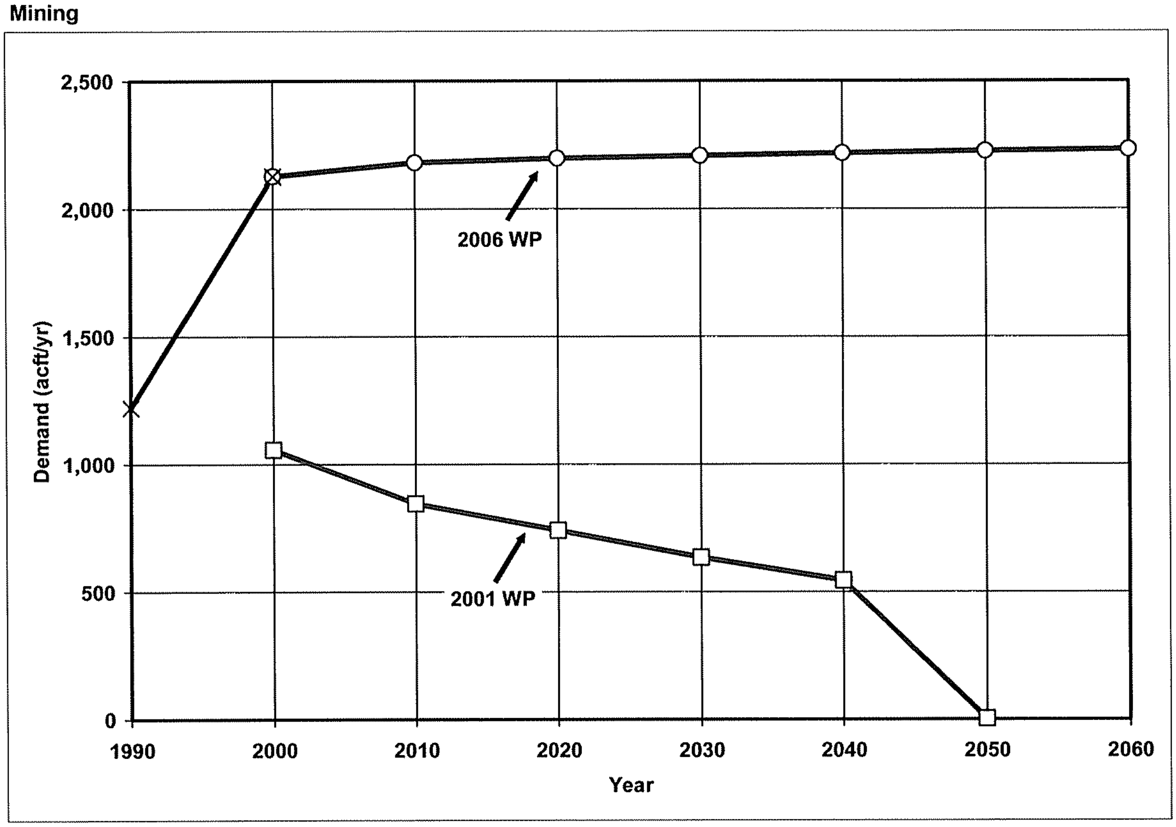


Kleberg County

Manufacturing

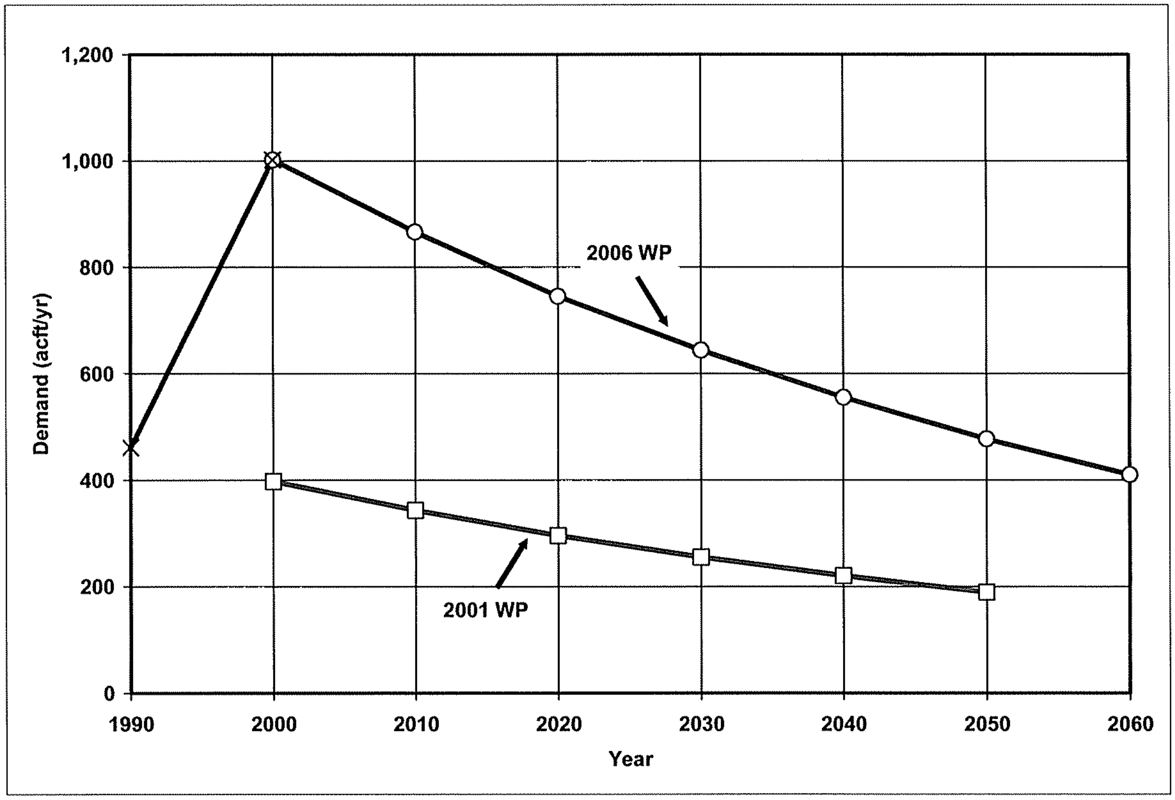


Mining

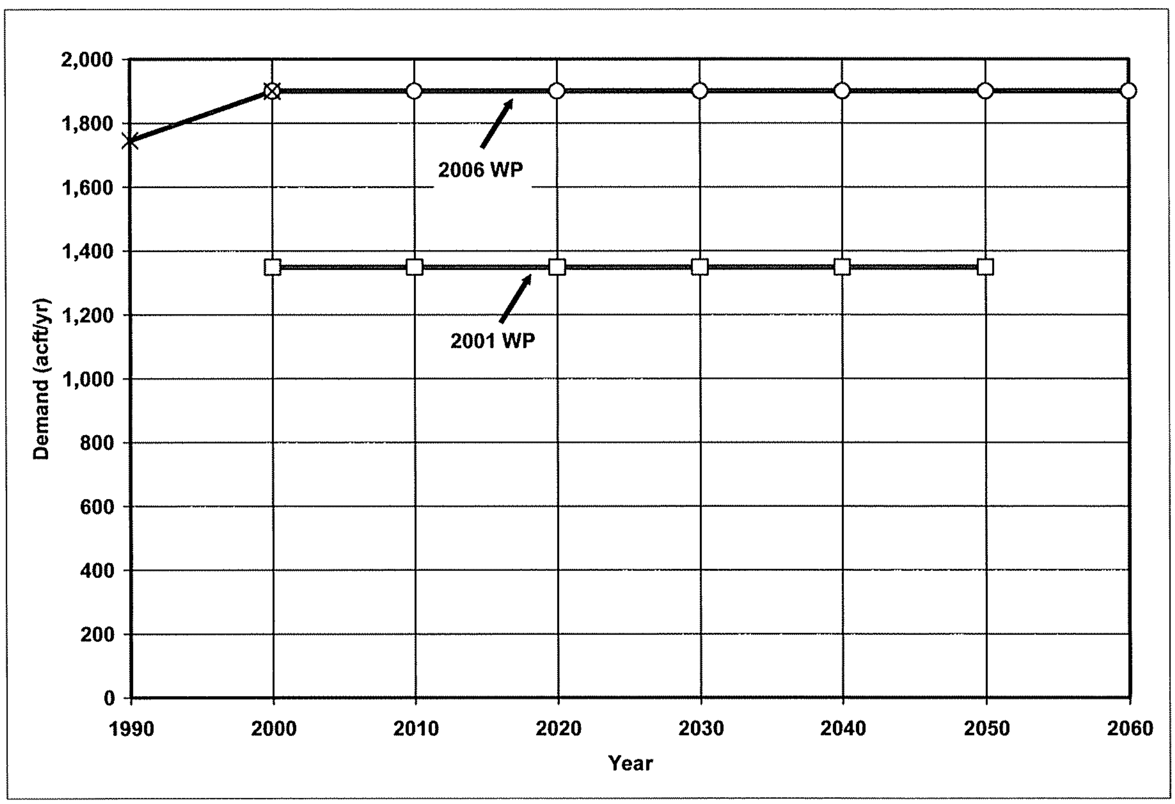


Kleberg County (Continued)

Irrigation

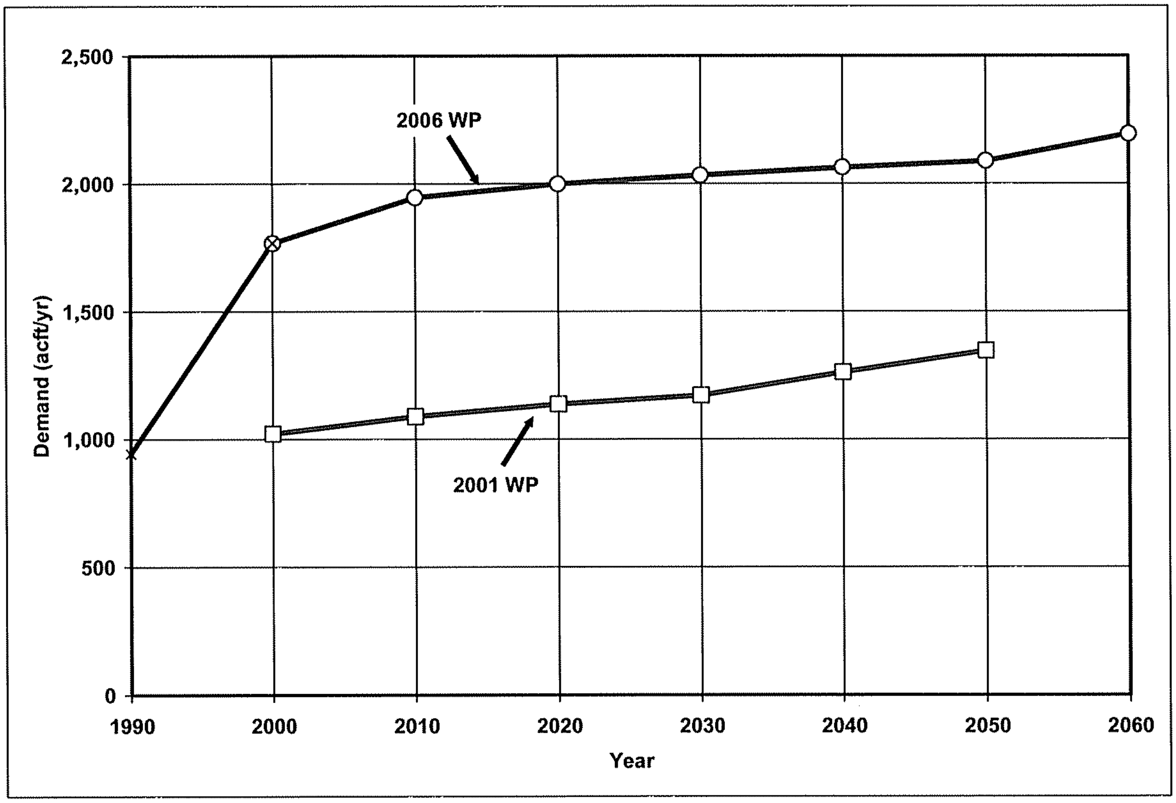


Livestock

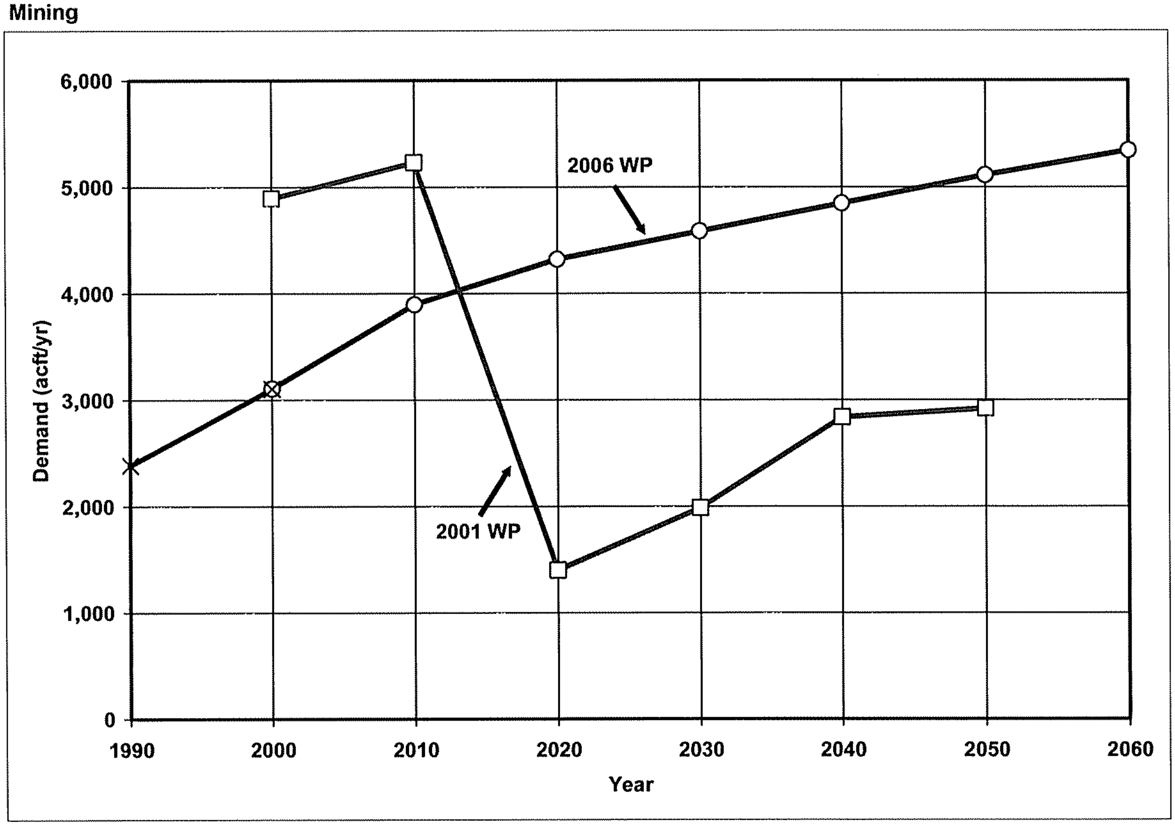


Live Oak County

Manufacturing

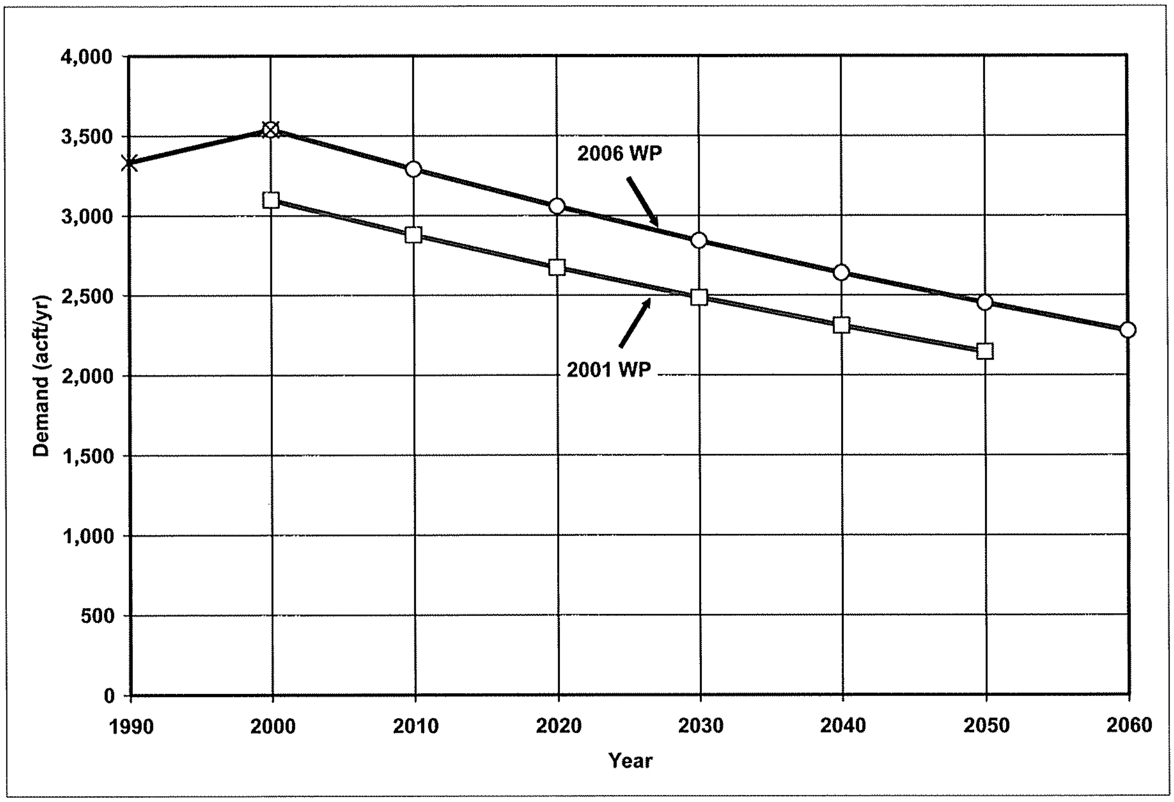


Mining

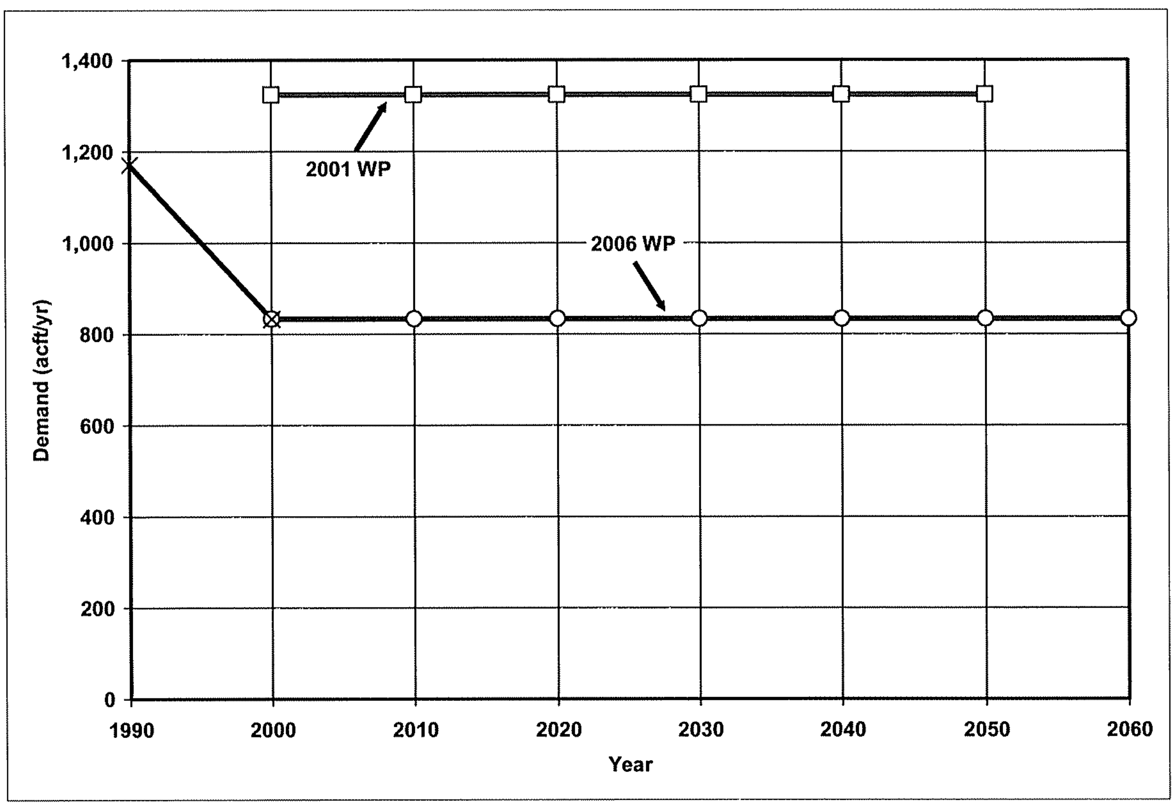


Live Oak County (Continued)

Irrigation

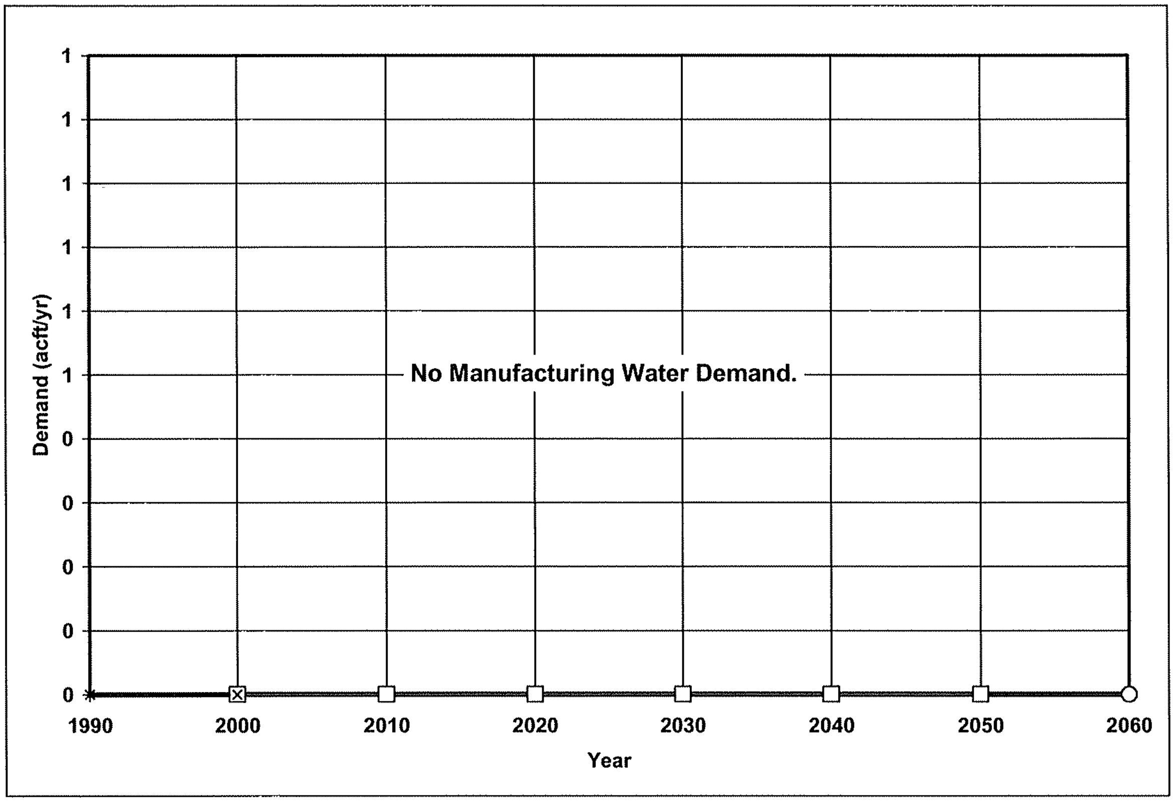


Livestock

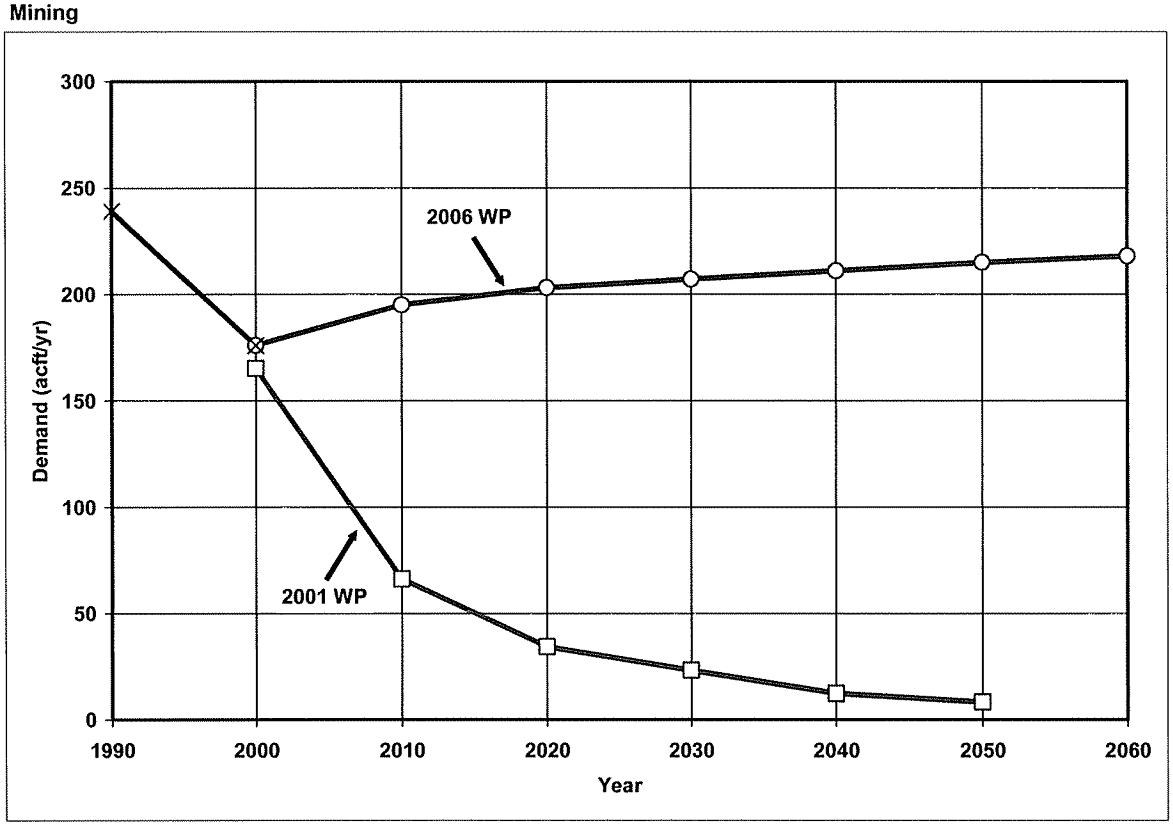


McMullen County

Manufacturing

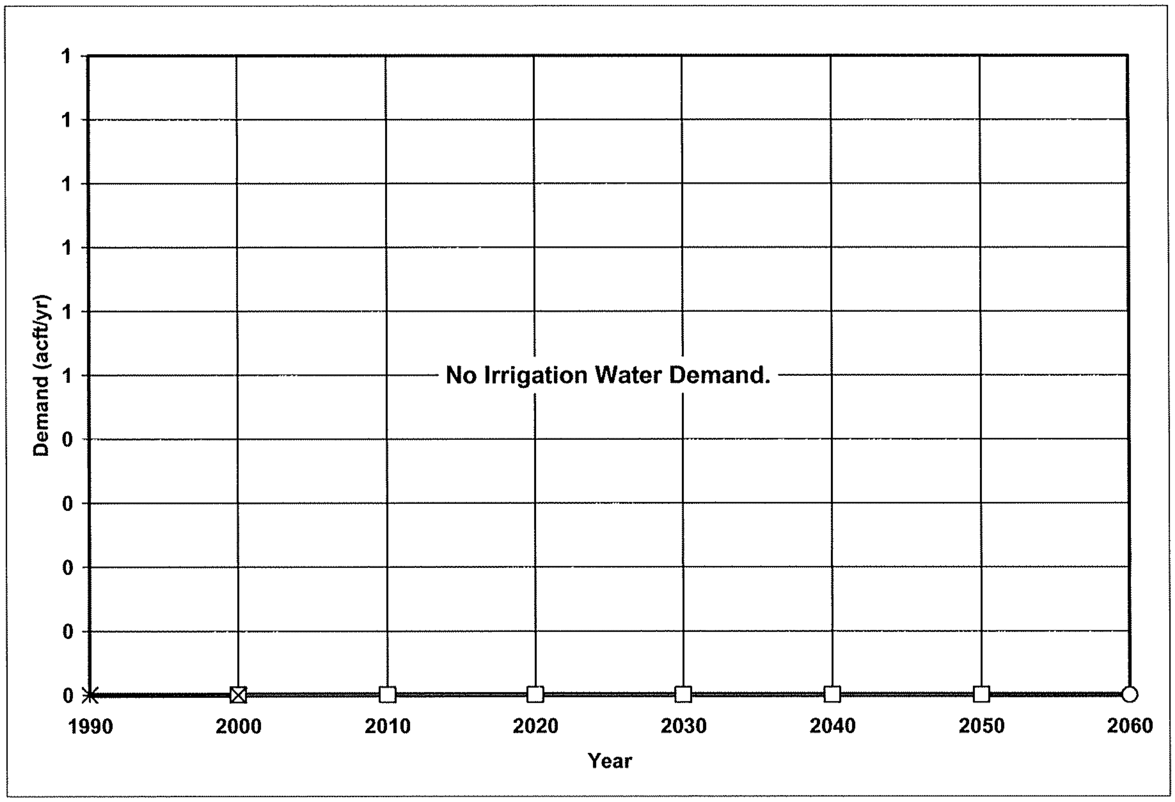


Mining

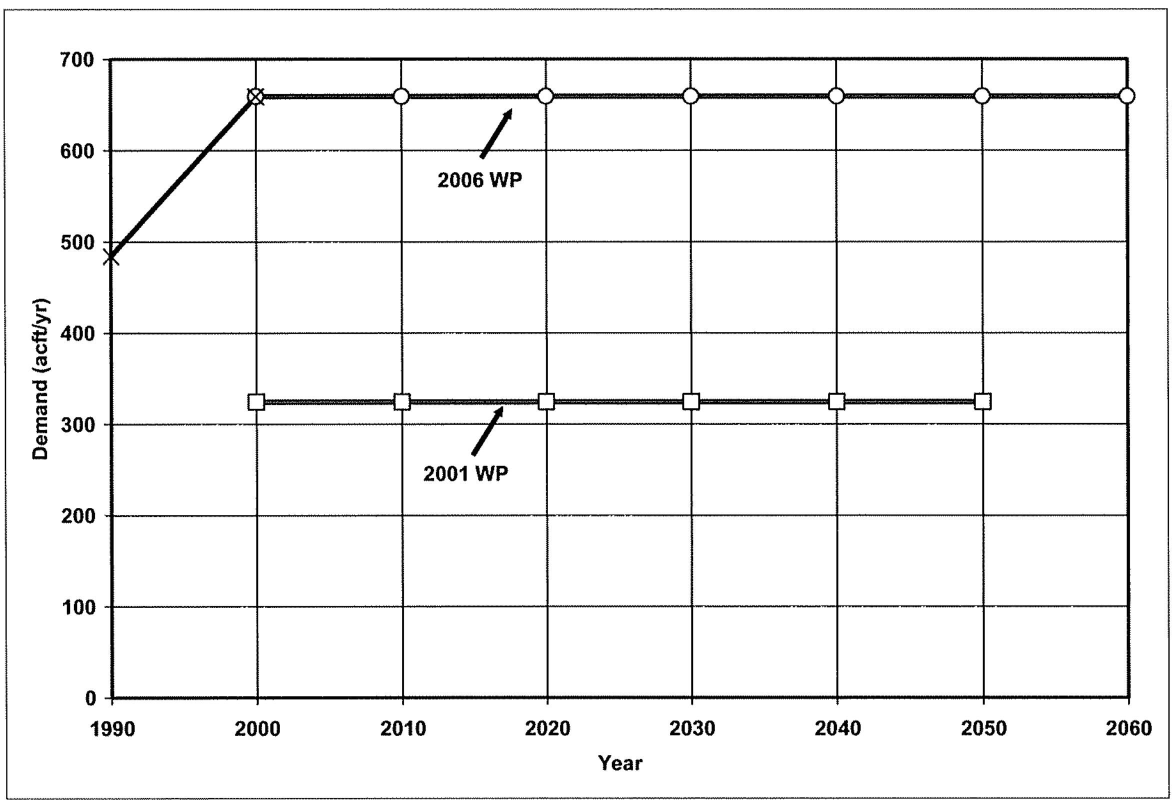


McMullen County (Continued)

Irrigation

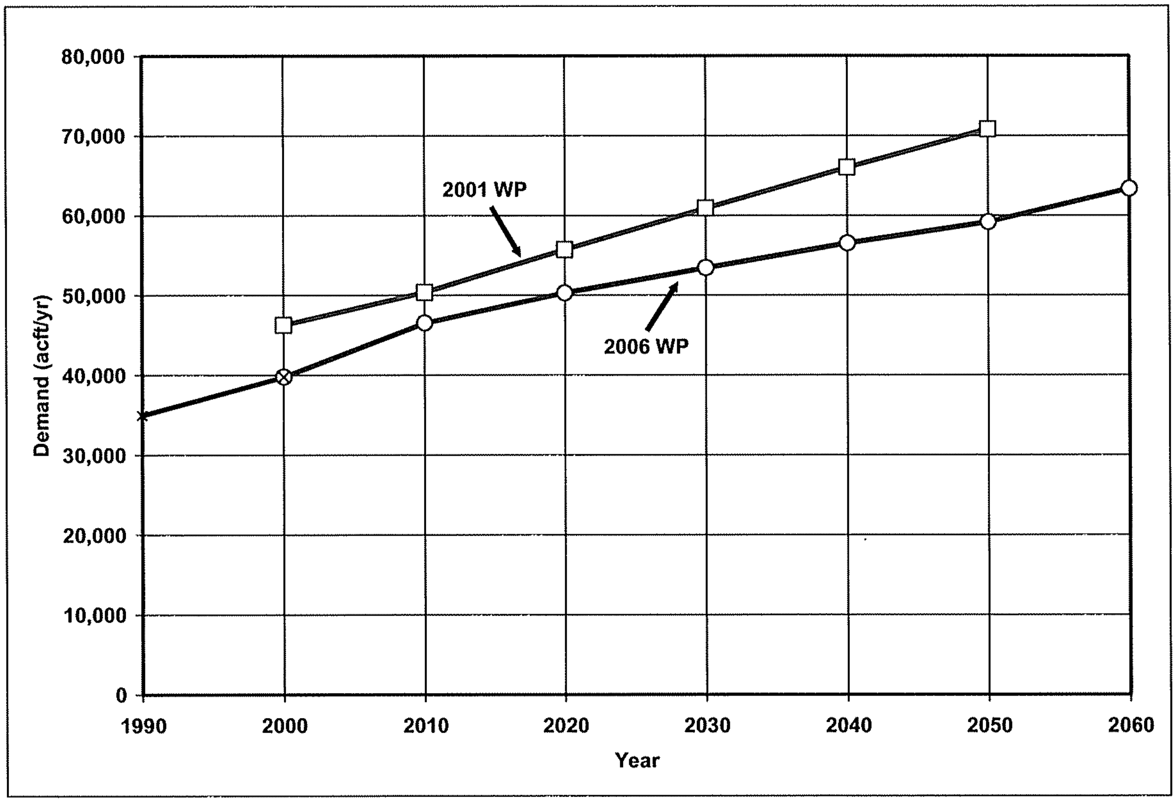


Livestock

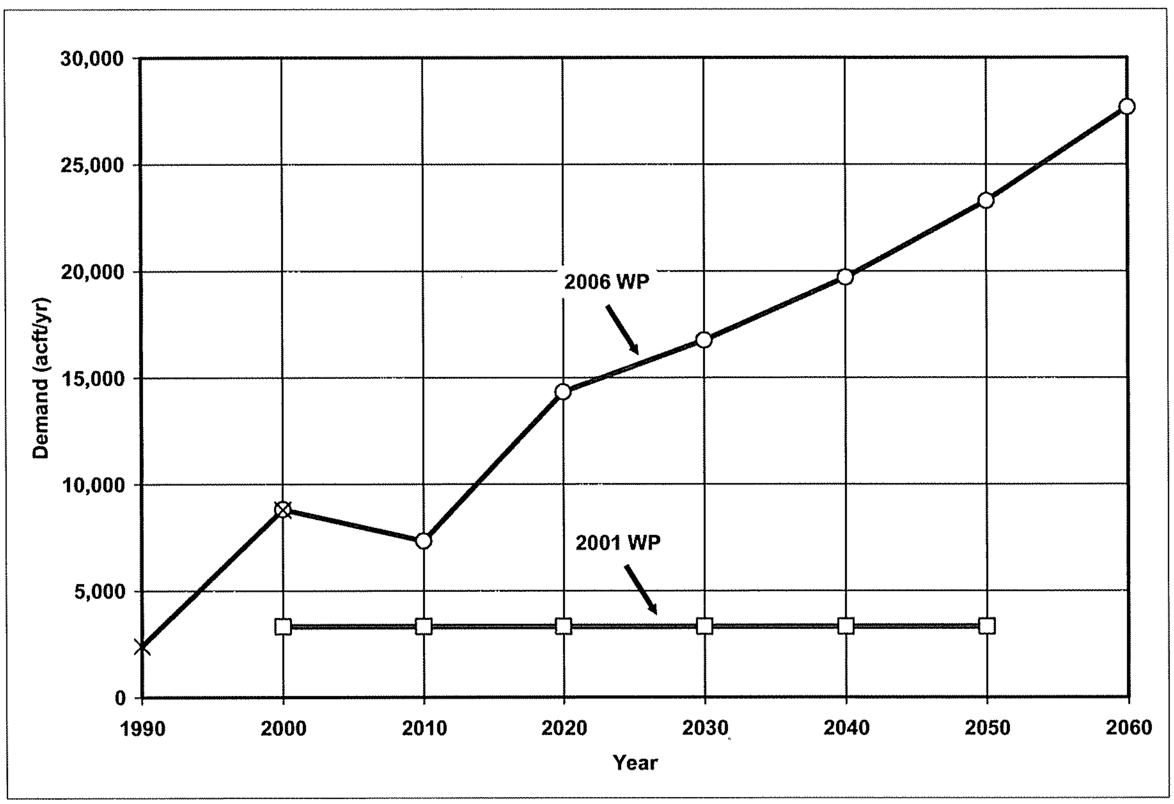


Nueces County

Manufacturing

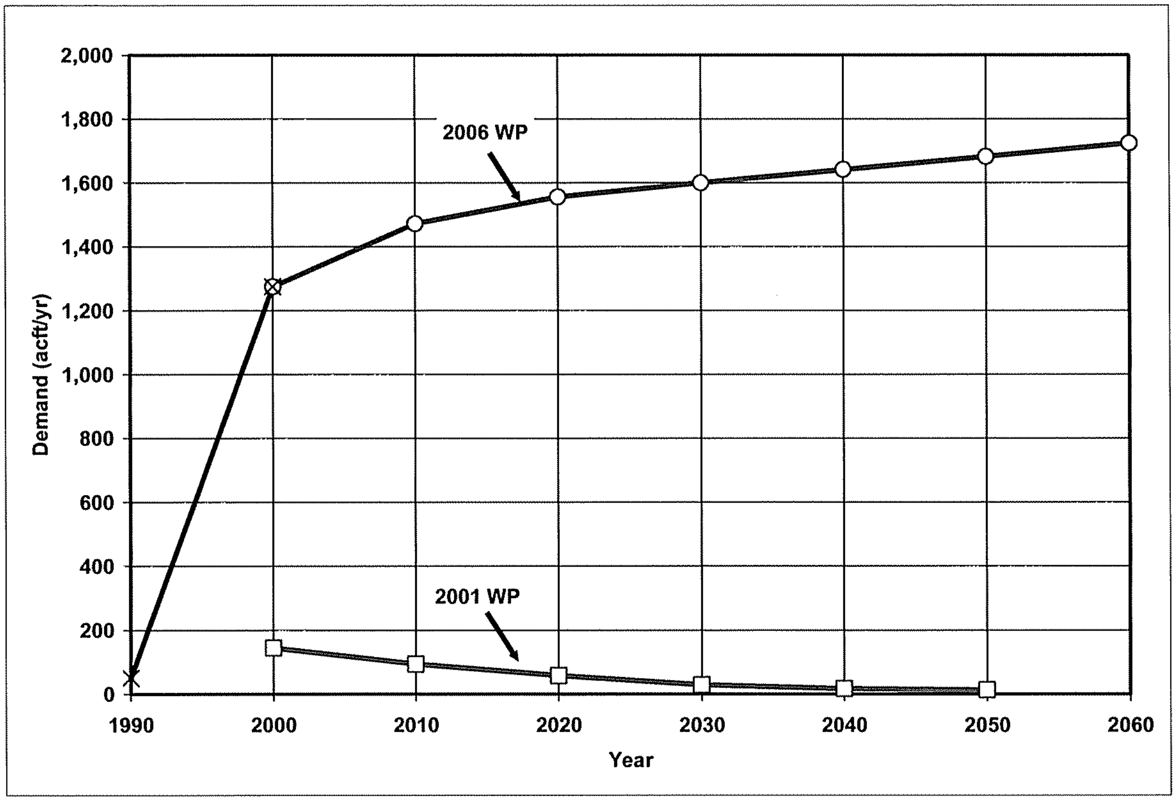


Steam-Electric

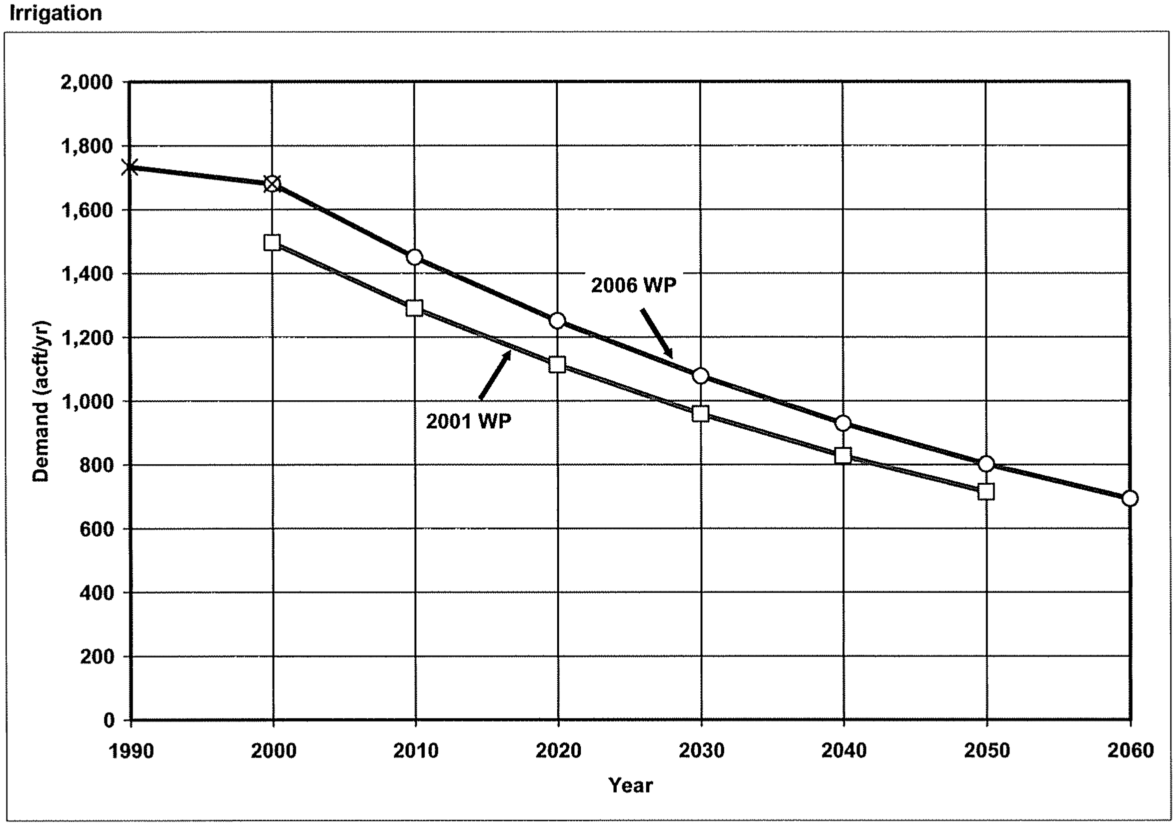


Nueces County (Continued)

Mining

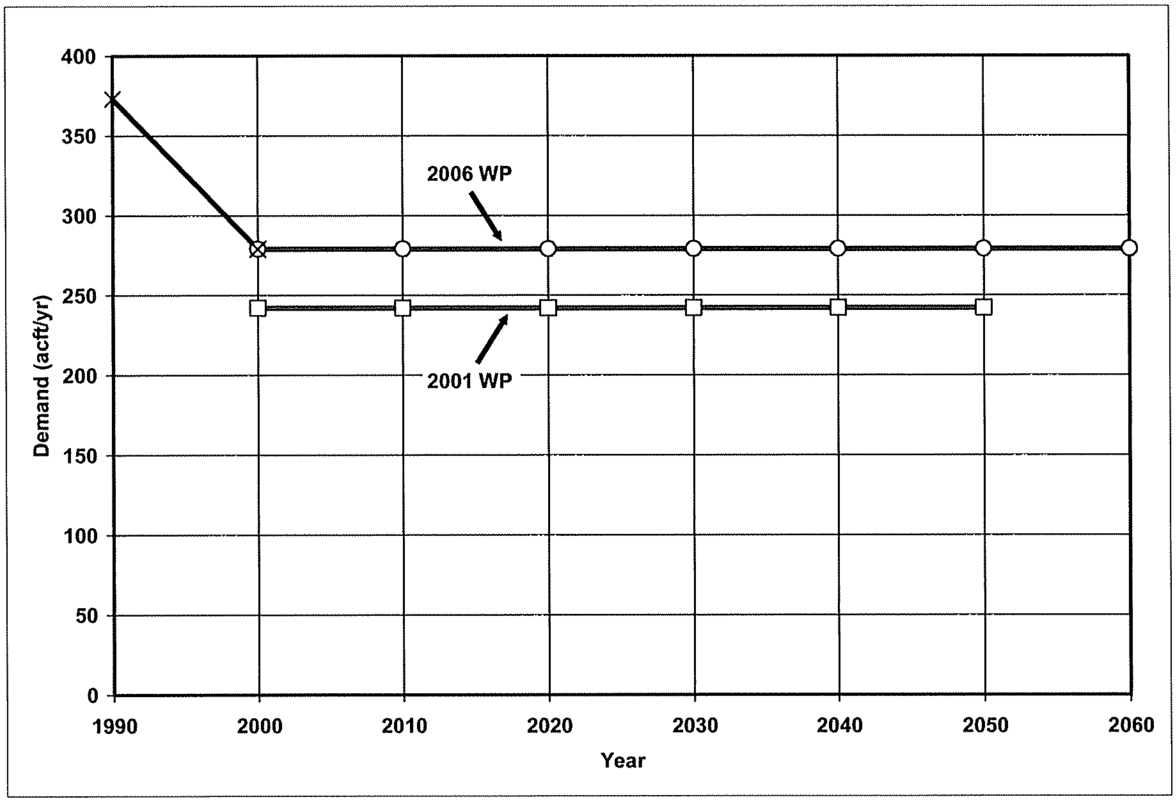


Irrigation



Nueces County (Continued)

Livestock



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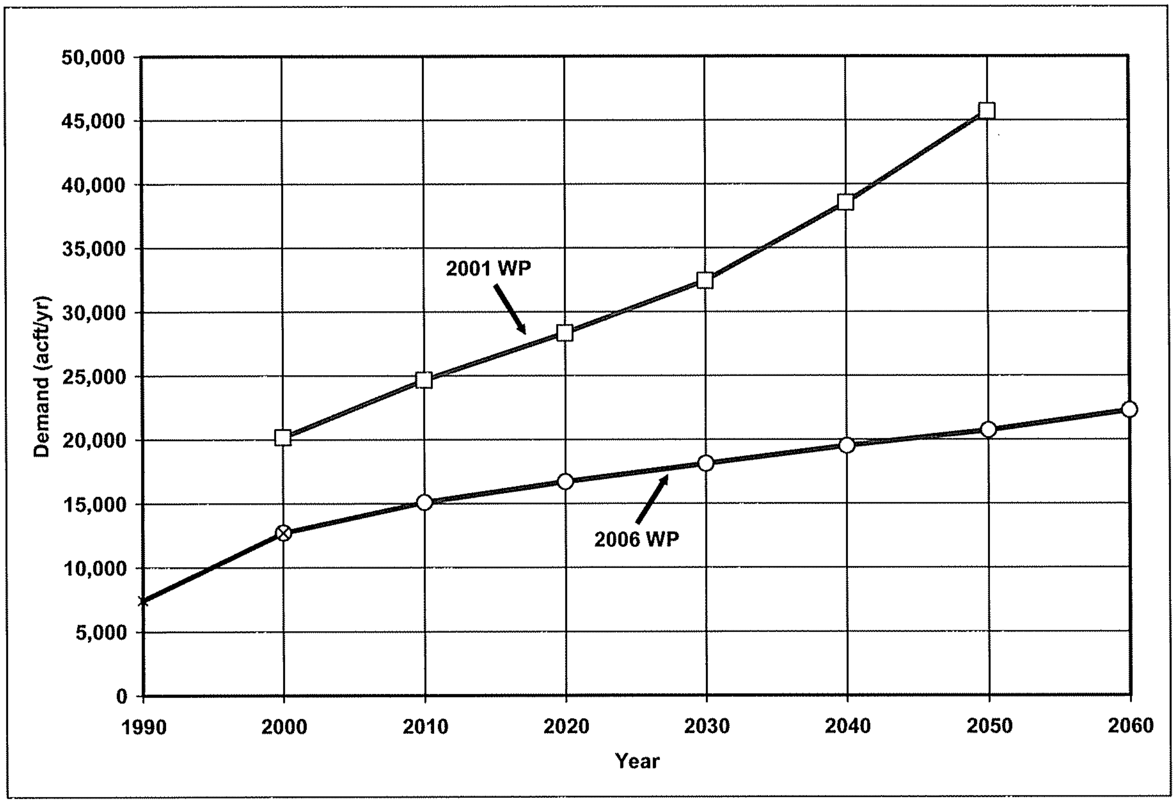
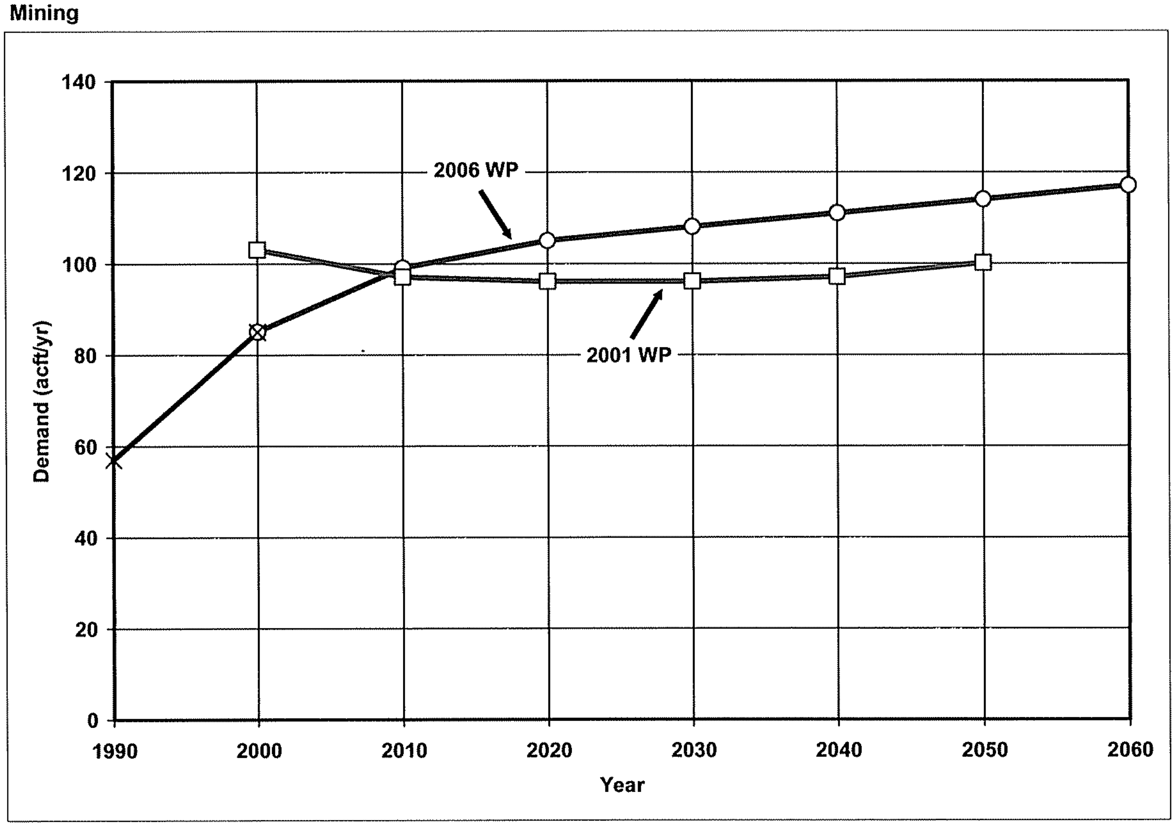
San Patricio County

Manufacturing

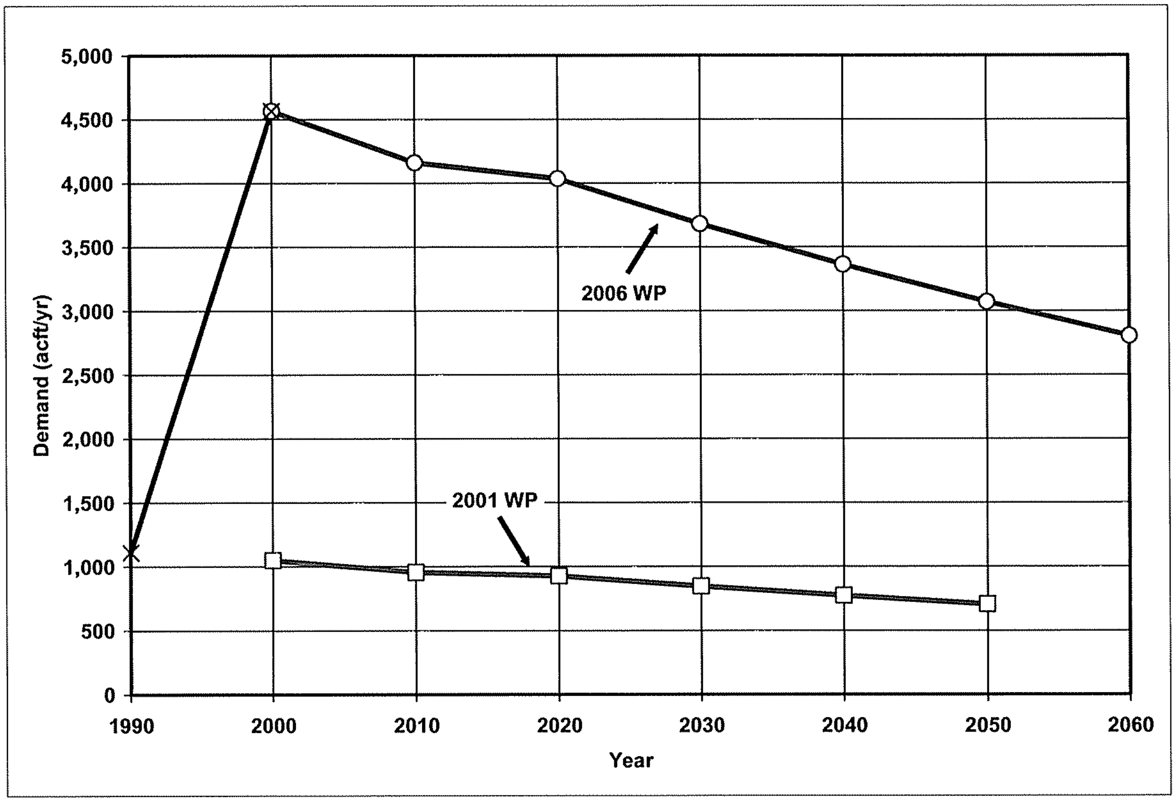


Mining

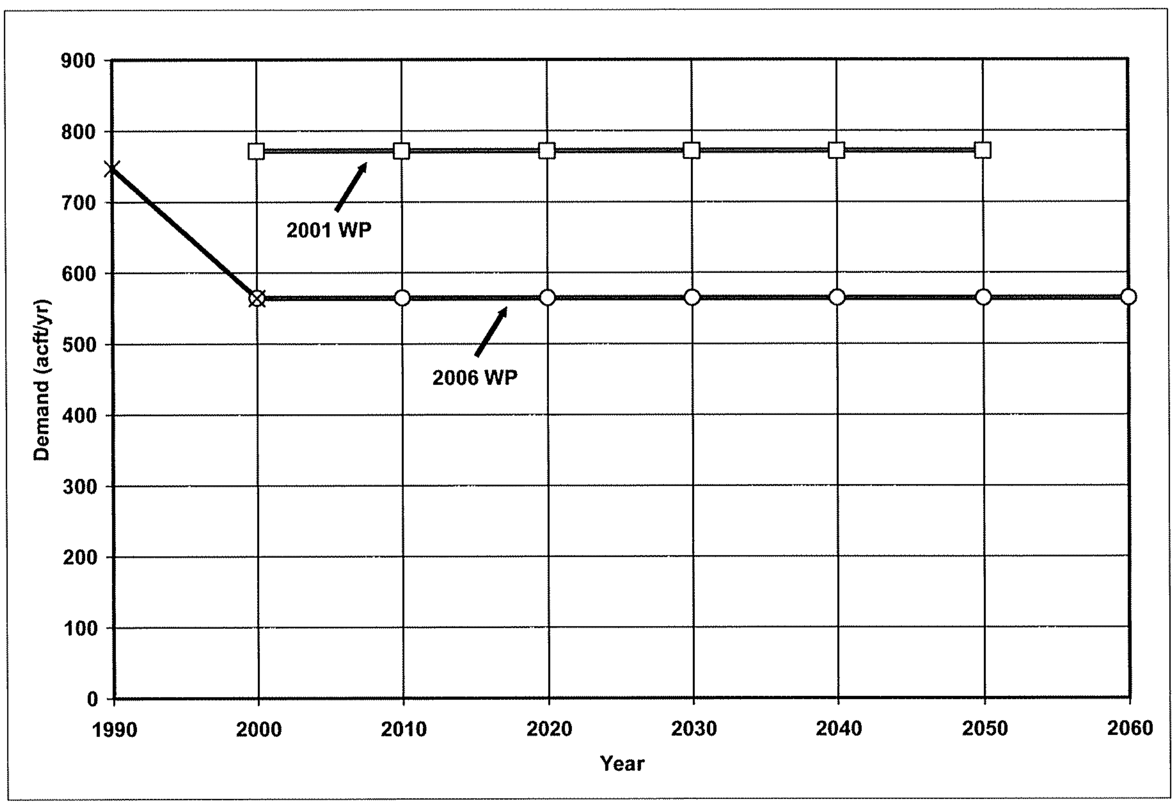


San Patricio County (Continued)

Irrigation

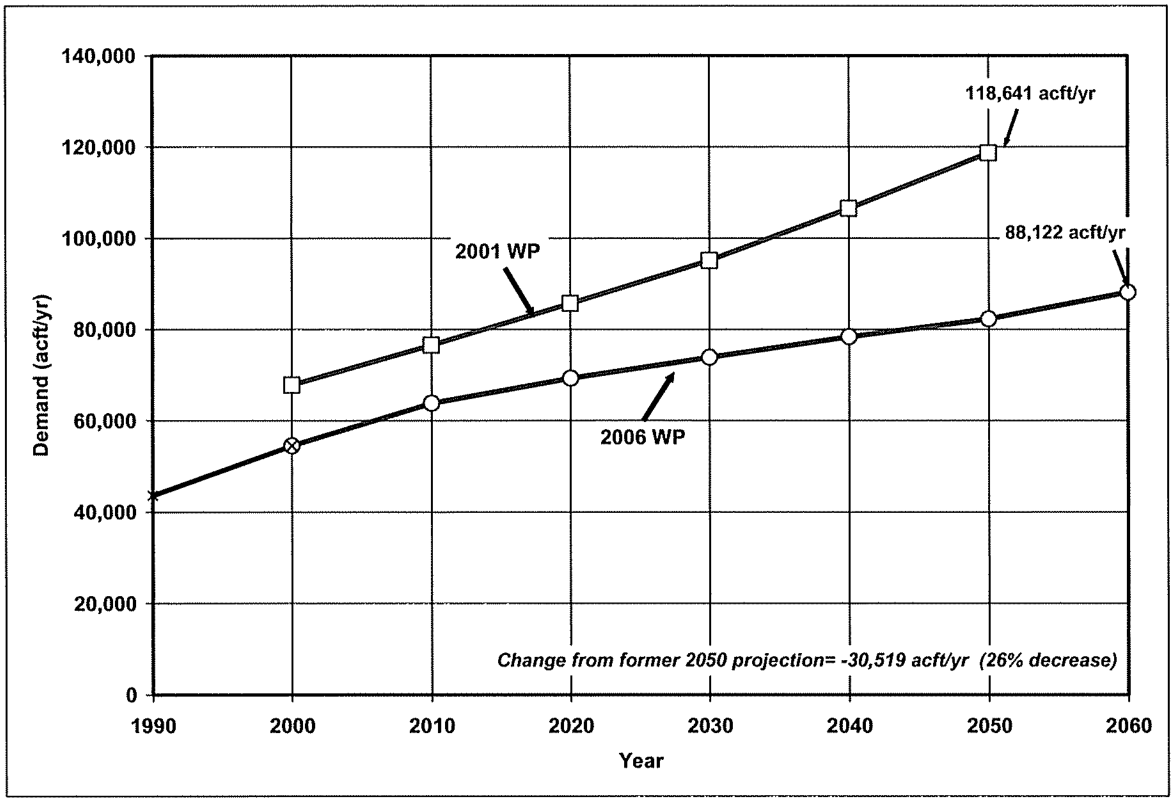


Livestock

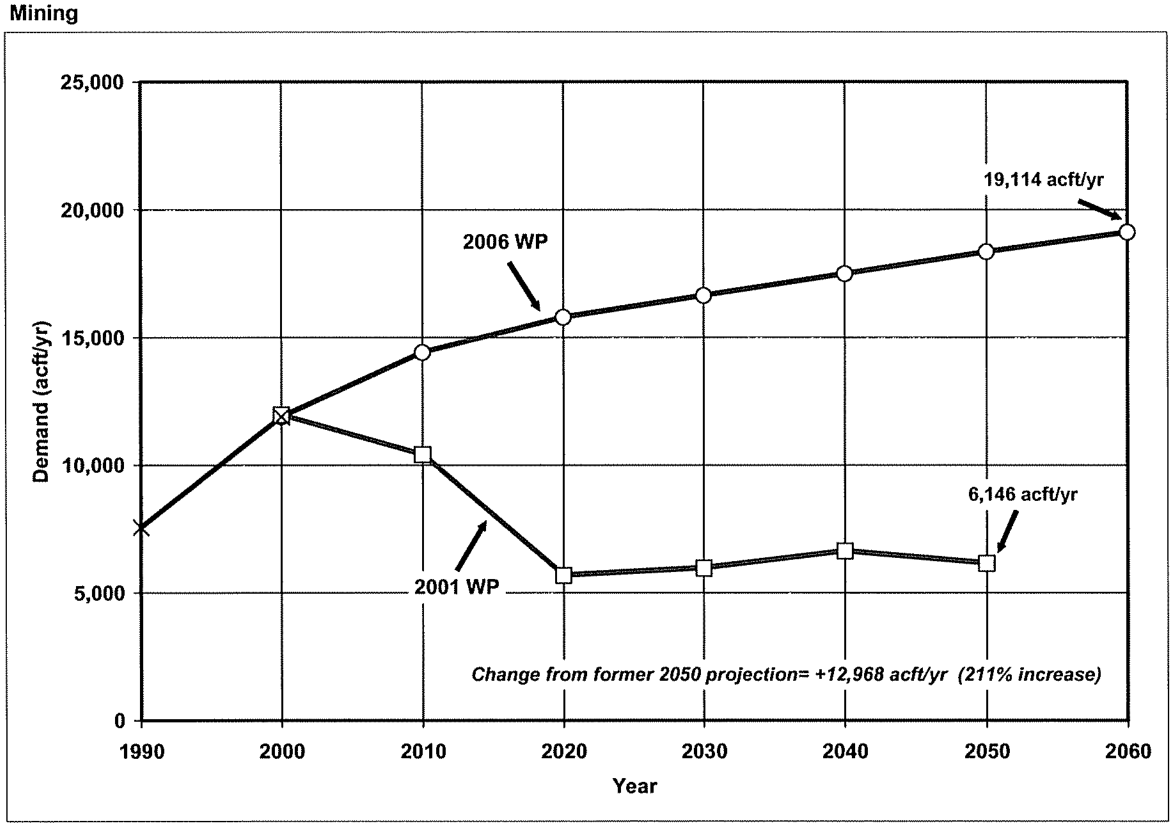


Region Totals

Manufacturing

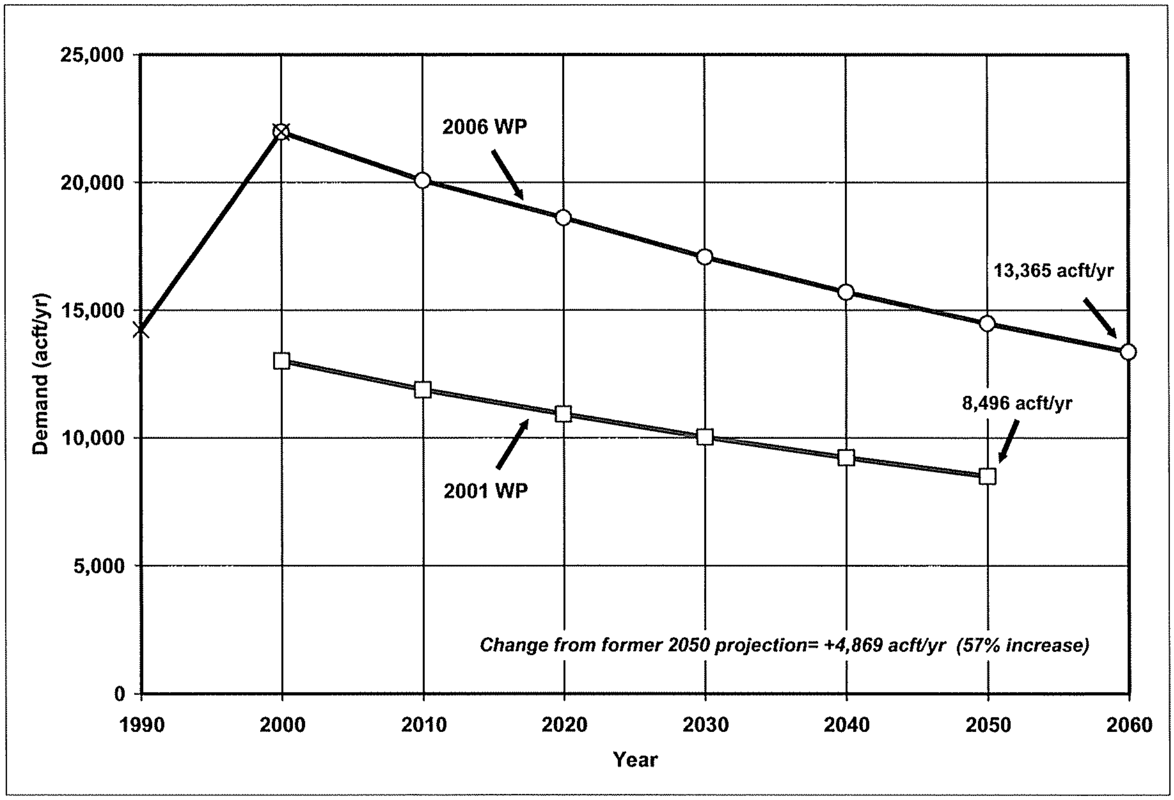


Mining



Region Totals (Continued)

Irrigation



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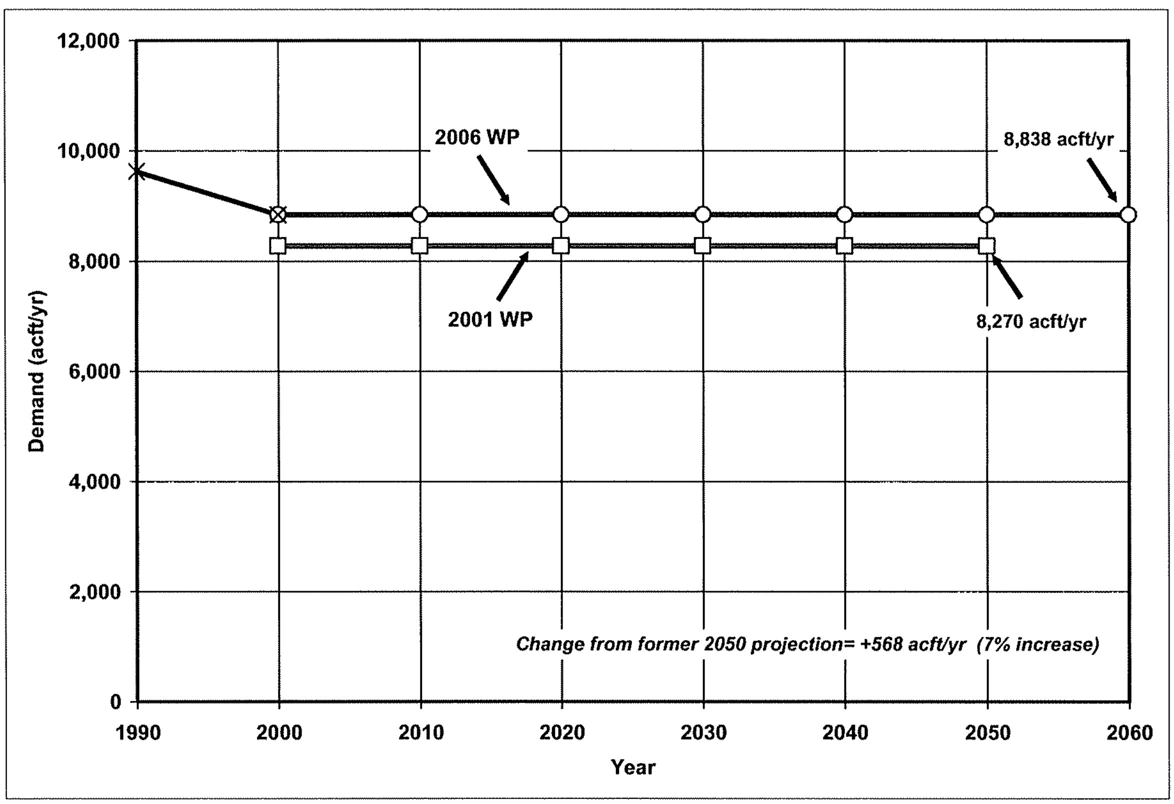

Appendix D

Projected Groundwater Availability through 2060 using the Central Gulf Coast Groundwater Availability Model

Description of the Central Gulf Coast Aquifer

The Gulf Coast Aquifer underlies all or parts of eleven counties within the Coastal Bend Region and yields moderate to large amounts of fresh to slightly saline water. The Gulf Coast Aquifer, extending from Northern Mexico to Florida, is comprised of four water-bearing formations: Catahoula, Jasper, Evangeline, and Chicot. The Evangeline and Chicot Aquifers are the uppermost water-bearing formations, are the most productive and, consequently, are the formations utilized most commonly. The Evangeline Aquifer of the Gulf Coast Aquifer System features the highly transmissive Goliad Sands. The Chicot Aquifer is comprised of many different geologic formations, including the Beaumont and Lissie Formations, which are predominant in the Coastal Bend area. The Catahoula and Jasper are comparatively thin formations that are not extensively developed.

Description of the Central Gulf Coast Groundwater Availability Model

The Texas Water Development Board (TWDB) has sponsored the development of Groundwater Availability Models (GAMs) for all major and minor aquifers in the state of Texas. The GAM that was utilized to support the Coastal Bend Regional Water Planning activities is the Central Gulf Coast GAM (CGCGAM), which extends from Wharton and Colorado Counties in the northeast to Hidalgo and Starr Counties in the southwest. The model has four layers which thicken and dip toward the Gulf of Mexico. Layer 1 represents the Chicot Aquifer, Layer 2 represents the Evangeline Aquifer, Layer 3 represents the Burkeville confining unit, and Layer 4 represents the Jasper Aquifer (Figure D-1). The Catahoula Formation is not represented in the GAM Model.

Due to technical problems encountered by the TWDB and the GAM contractors during the development of the CGCGAM, there are currently two differing versions of the model available from TWDB. Each version is appropriate for evaluating predictive scenarios with different purposes. The two versions of the CGCGAM are called the Partially-Penetrating version[1] and the best-calibrated, Fully-Penetrating version.[2] These are the best models currently available to use as tools to calculate the regional effects of local and project pumping on the Gulf

[1] Chowdhury, A., Wade, S., Mace, R., and Ridgeway, C., *Groundwater Availability of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999*, Texas Water Development Board, September 27, 2004.
[2] Chowdhury, A., *GAM run 05-04*, Texas Water Development Board, January 23, 2005.

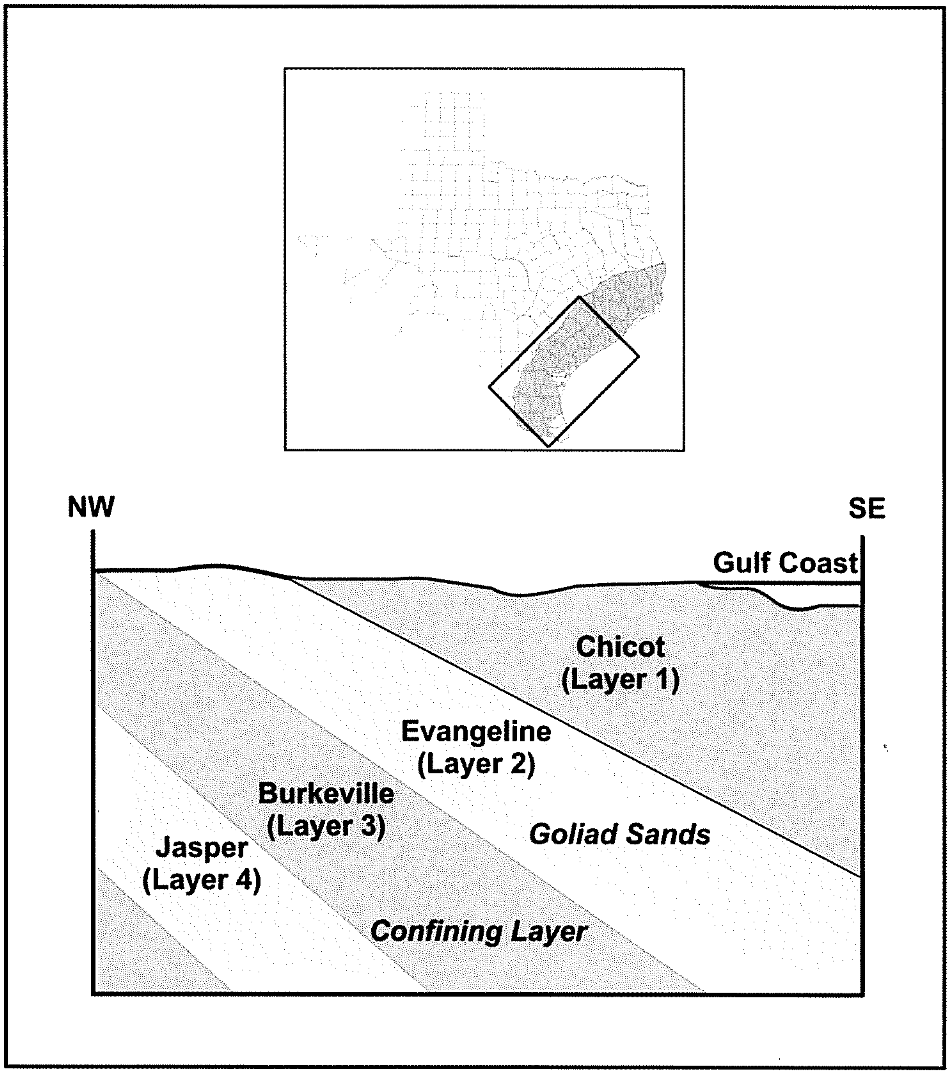

Figure D-1. Central Gulf Coast Groundwater Availability Model Boundaries and Layers

Coast Aquifer. These models are essentially identical for most aquifer parameters, with one important difference. They differ in the representation of the hydraulic conductivity (and therefore transmissivity, which is hydraulic conductivity multiplied by thickness) of Layer 2, the Evangeline Aquifer. The hydraulic conductivity differences between the models are shown in Figure D-2. Use of the Partially-Penetrating model is appropriate when modeling local groundwater demands in which existing wells in the Evangeline Aquifer are screened only in the upper portion of the aquifer; in other words, the wells only partially penetrate the aquifer. Use of the Fully-Penetrating model is appropriate when modeling major project groundwater demands in which wells are expected to fully penetrate the entire thickness of the aquifer. The Central Gulf Coast Aquifer was modeled with local groundwater demands and project-related groundwater demands for each water user group using the two publicly-released versions of the CGCGAM. The cumulative effects are the sum of the drawdowns calculated in two models.

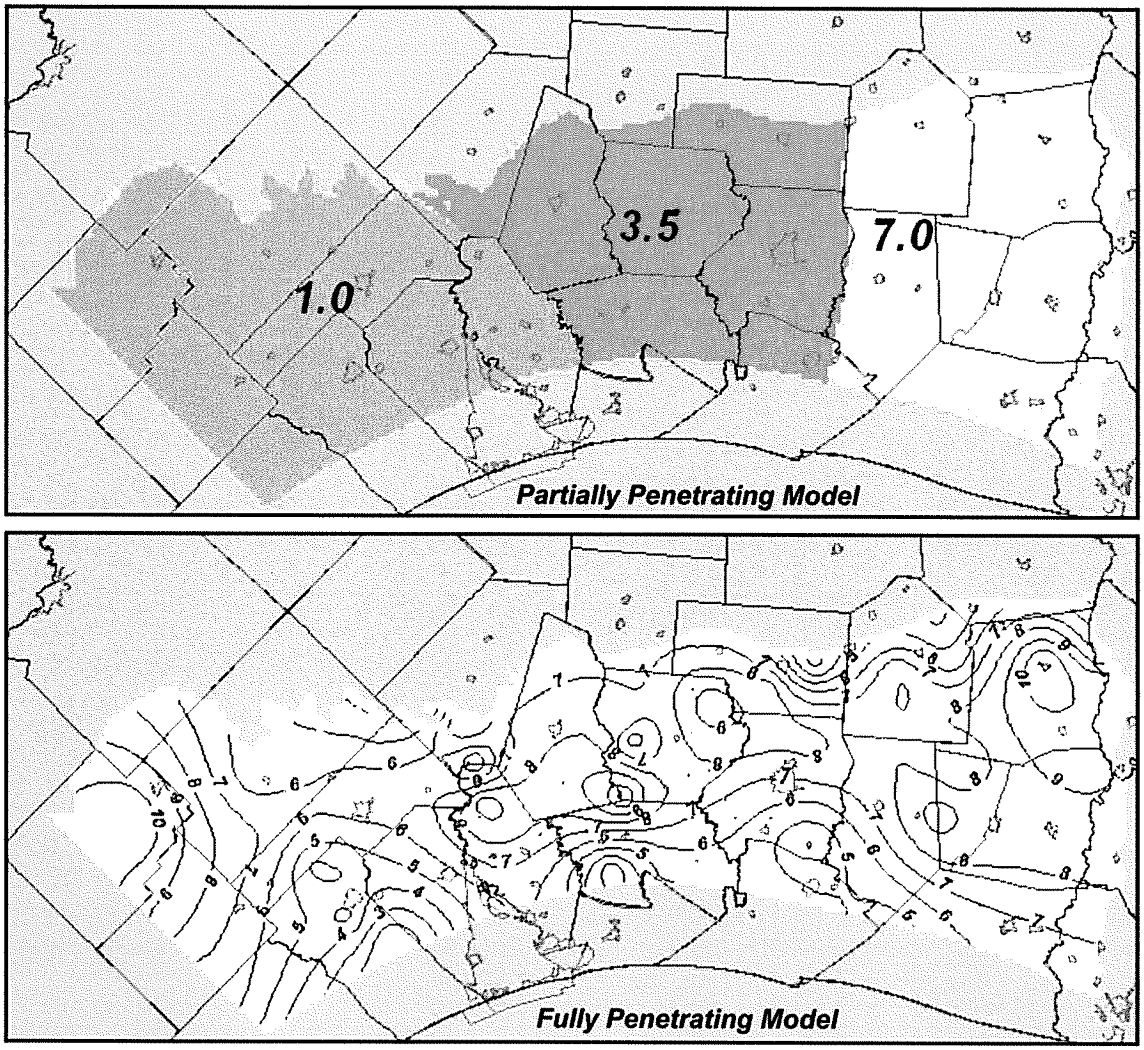

Figure D-2. Evangeline Aquifer Hydraulic Conductivity in the Partially-Penetrating Model (a) and the Fully-Penetrating Model (b) (ft/day)

The TWDB released a steady-state (pre-development) and a historical transient (1980 to 1999) version of the CGCGAM, reflective of the partially-penetrating conceptual approach. The historical transient model contained a variable time series of values for recharge, streamflow, pumping, and evapotranspiration. For predictive analysis, a clearer assessment can be made of the effects of pumpage if the other time-variant parameters are held at a constant value. For this reason, the predictive CGCGAM Model used by HDR to evaluate regional effects of pumping in Region N for both the Partially-Penetrating version and the Fully-Penetrating version used these constant value parameters from the TWDB steady-state model. The predictive simulations represent the period from 2000 to 2060 with 61 annual stress periods. The steady-state recharge values were used in the predictive models; however, they were modified to include a 6-year drought, with recharge based on the percentage of reported annual precipitation as a portion of average annual precipitation during the drought of record in 1951 to 1956 in the region.[3] The storage and specific yield values from the historical transient model were used in the predictive models. The final heads from the TWDB historical transient model, representative of conditions in the year 1999, were used as the initial starting heads for the Partially-Penetrating model so that the historical pumping would be represented prior to starting the predictive simulation. The TWDB steady-state model (with the fully-penetrating hydraulic conductivity) heads were used as the initial starting heads for the Fully-Penetrating model; thus, these simulations only calculate drawdown estimates specifically associated with the described development projects.

Since there are two versions of the CGCGAM, the Partially-Penetrating version and the Fully-Penetrating version, there will be drawdown results and output from both models. In order to calculate total drawdown effects of the aquifer system from both models, the drawdown from each simulation was added to calculate total drawdown, as shown in Figure D-3.

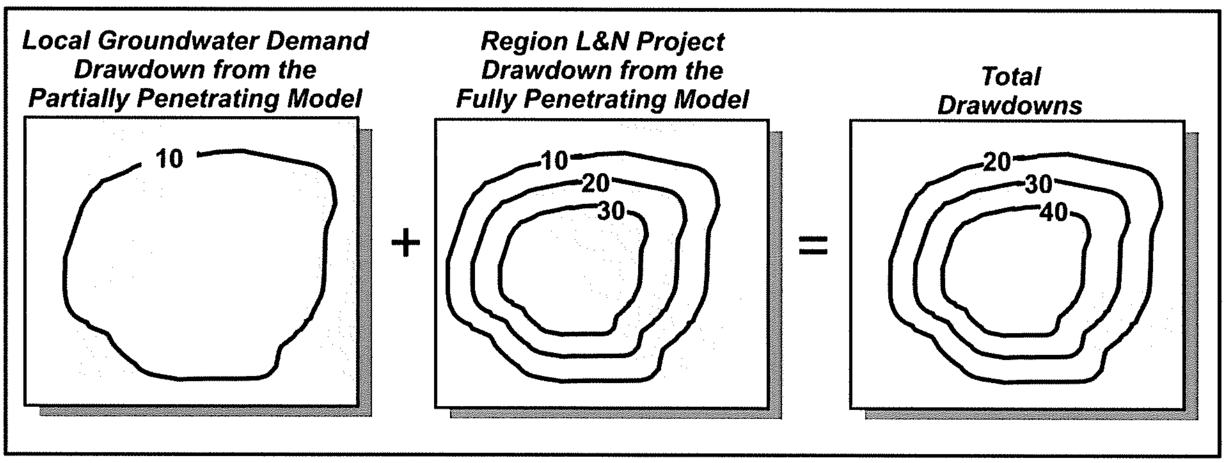

Figure D-3: Calculating Total Drawdown

[3] Chowdhury, personal communication, 2005.

Description of the CGCGAM Predictive Pumpage Data Sets

The Central Gulf Coast Model covers six Regional Water Planning Group boundaries as shown in Figure D-4. Predictive pumping data for Regions M, P, K, and H were obtained from the TWDB and are consistent with the 2002 Regional Water Plan. The 2002 pumping dataset includes water management strategies per the 2002 Regional Water Plan. Pumping data in Regions N and Region L were updated to reflect the 2006 Regional Water Plan.

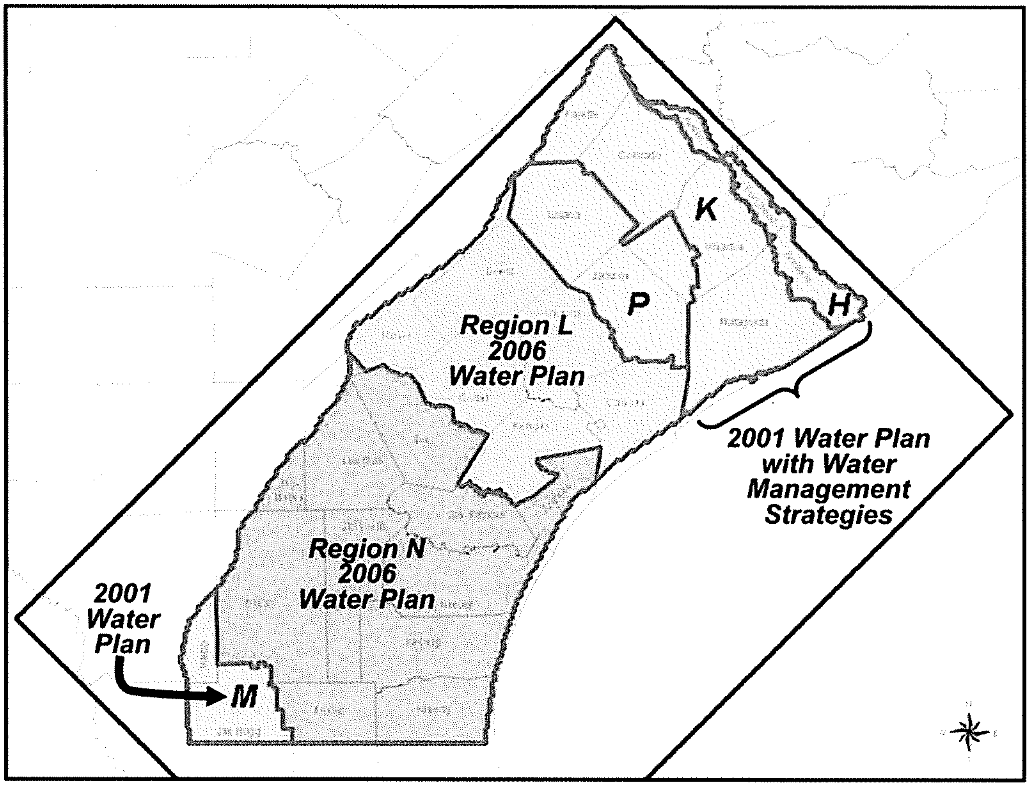

Figure D-4: Groundwater Pumping Data Sources for the Partially Penetrating Model

Region N and Region L developed estimates of total pumpage by county for each of the defined water user groups (municipal, irrigation, manufacturing, steam-electric, livestock, and rural/county-other). The method used to distribute the 2006 Region L and Region N ground water pumpage data to cells in the partially-penetrating model included apportioning the pumping between *point-source* and *diffuse* use types. Point source use types include pumping that can be attributed to a particular location. The TWDB has identified locations of municipalities, mines, power plants, and manufacturing facilities and the utilized aquifers. The point source pumping data was distributed to these identified locations and aquifers in the partially-penetrating model.

In general, diffuse use types include irrigation, livestock, rural, and any point source pumping use type with a demand of less than 250 acft/yr. A methodology for assigning a spatial distribution to diffuse pumping has been developed by the TWDB,[4] and was used to assign pumpage in the historical transient version of the CGCGAM. When developing the predictive pumpage data sets, HDR maintained the spatial distribution of diffuse pumpage in each county that was represented for the year 1999, which was the final year of the historical transient simulation.

The predictive annual pumping per county for local supply in Region N that was used in the Partially-Penetrating model is presented in Table D-1. Figures D-5 through D-15 display the 1981 to 1999 historical and predictive annual pumping per county and aquifer for Aransas, Bee, Brooks, Duval, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen, Nueces, and San Patricio Counties, respectively. Drawdown from 2000 to 2060 was calculated by the CGCGAM. After the groundwater demands for local supply were simulated, the resulting water levels were compared to water levels simulated in the steady-state version of the CGCGAM which are representative of pre-development conditions. If drawdown from pre-development conditions exceeded any of the criteria, these locations are noted. Drawdown for the Chicot and Evangeline Aquifers are presented in Figures D-16 and D-17. A more detailed discussion of CGCGAM modeling results is included in Section 4C.7.

All counties in the Coastal Bend Region show a consistent trend through the planning period, either increasing or decreasing with time. Exceptions to this trend exist in Region L pumpage. The City of Victoria is pursuing a strategy to switch from groundwater to surface water supply, and is simulated to have variable groundwater demand in the predictive simulations based on surface water availability modeling. The annual pumping for local supply in Goliad County (Region L) is predicted to increase from 1,920 acre-ft/yr in 2000 to 2,501 acre-ft/yr in 2060. The annual pumping for local supply in Refugio County (Region L) is expected to decline from 2,358 acre-ft/yr in 2000 to 1,690 acre-ft/yr by 2060.[5] Graphs that include the projected pumping trend by aquifer for each Region L county can be found in the Region L Plan.

[4] GAM Technical Memo 02-02, Cindy Ridgeway, TWDB, August 1, 2002.
[5] HDR, South Central Texas Regional Water Initially Prepared Plan, June 2005.

Table D-1.
Predictive Annual Pumping per County for Local Supply used for the Partially-Penetrating Model

County	2000	2010	2020	2030	2040	2050	2060
Live Oak	8,700	9,499	9,882	10,025	10,080	10,060	10,051
Bee	4,327	4,058	3,832	3,602	3,364	3,157	2,956
San Patricio	6,683	6,370	6,332	6,059	5,804	5,603	5,440
McMullen	34	34	34	34	34	34	34
Duval	10,855	12,147	12,877	13,296	13,683	14,046	14,328
Jim Wells	8,858	8,967	8,909	8,741	8,529	8,323	8,110
Nueces	1,586	1,690	1,738	1,783	1,836	1,887	1,983
Kleberg	8,129	9,124	9,200	8,470	8,413	8,472	8,419
Brooks	2,197	2,564	2,881	3,122	3,264	3,318	3,325
Kenedy	244	248	250	251	251	250	251
Aransas	530	614	665	693	702	702	715

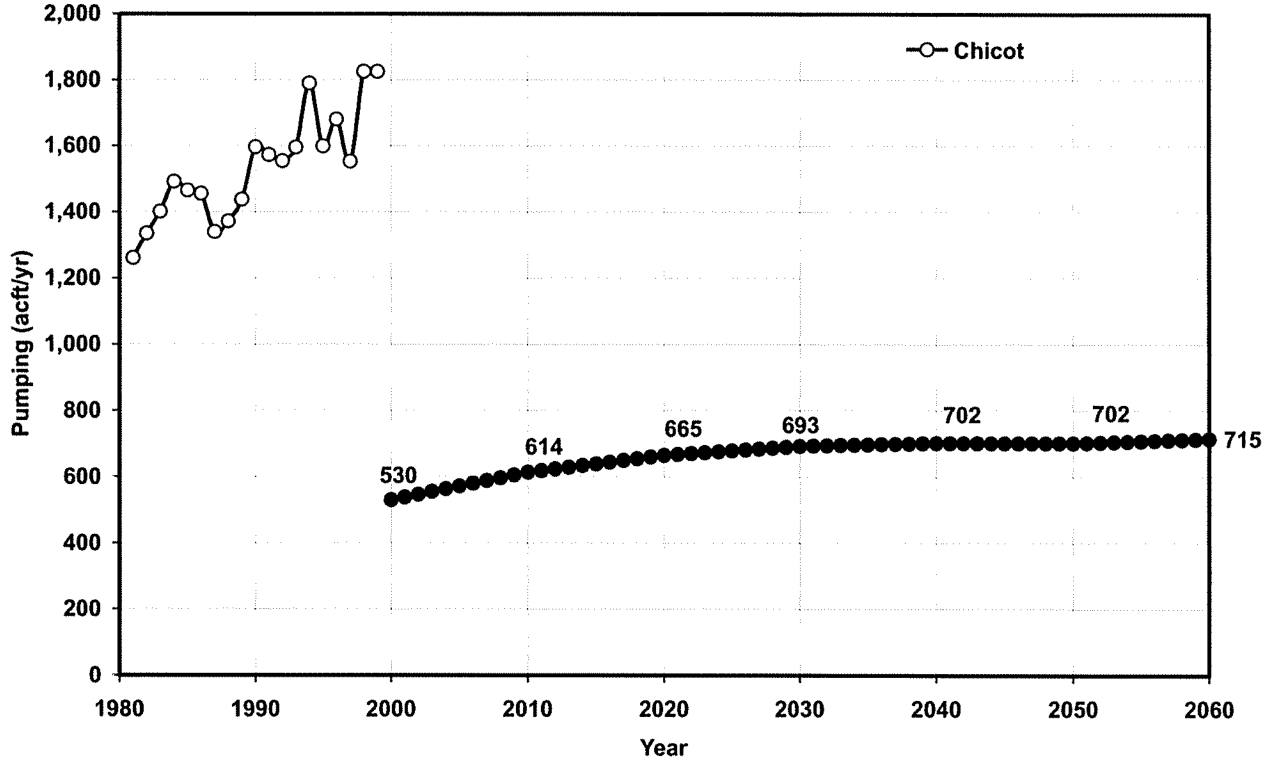

Figure D-7: Partially-Penetrating Model Historical and Predictive Pumping in Aransas County

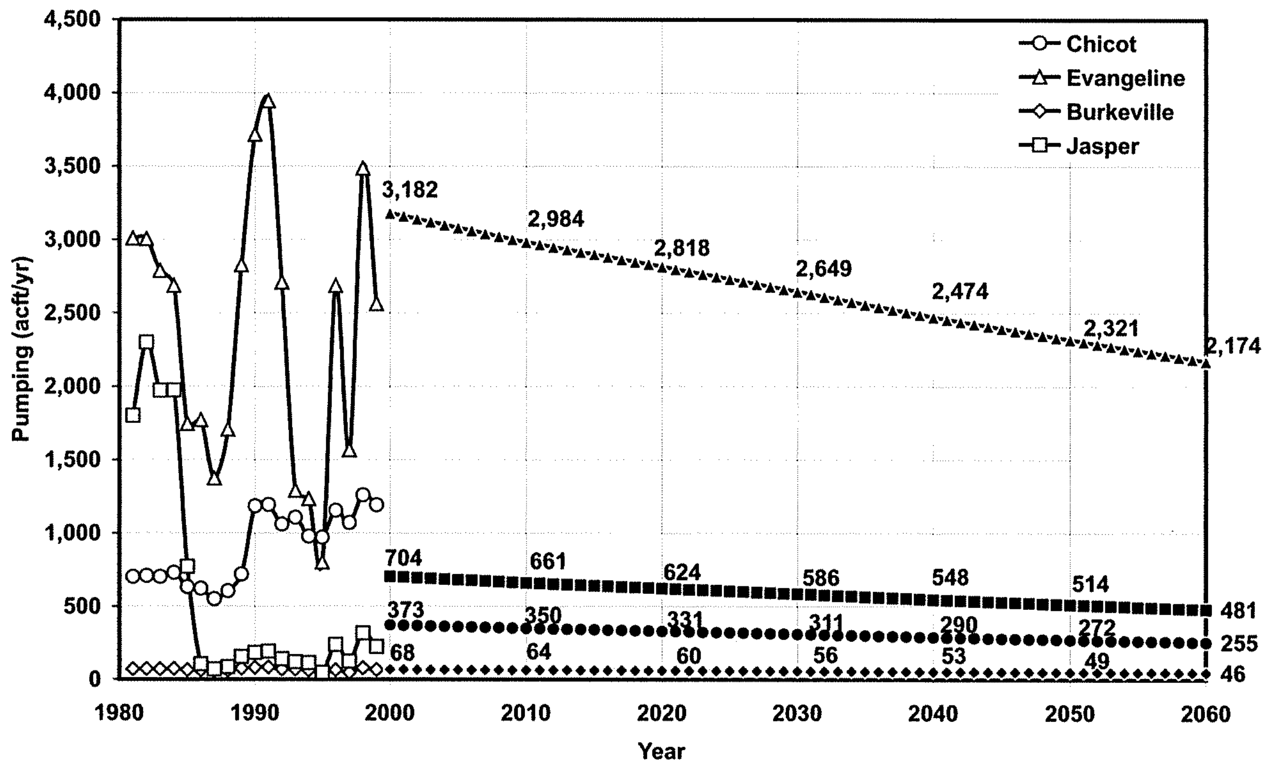

Figure D-6: Local Supply Historical and Predictive Pumping in Bee County

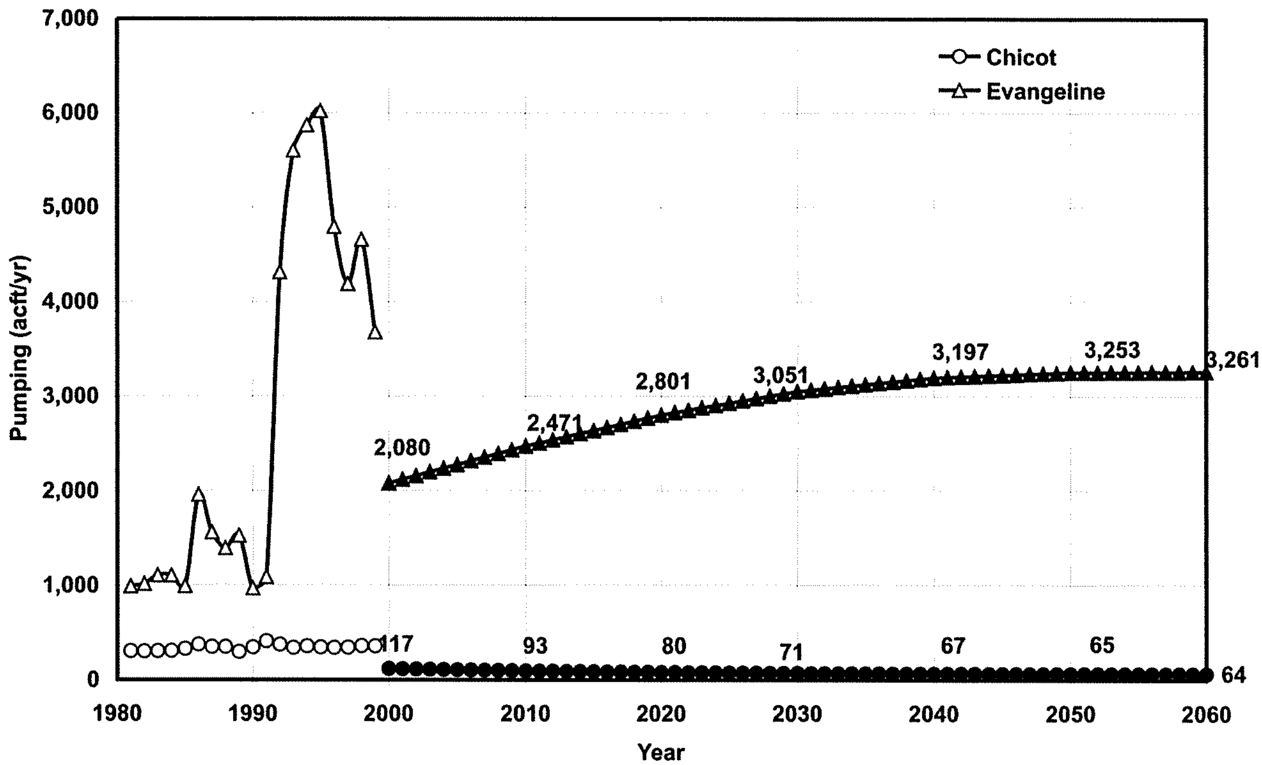

Figure D-7: Local Supply Historical and Predictive Pumping in Brooks County

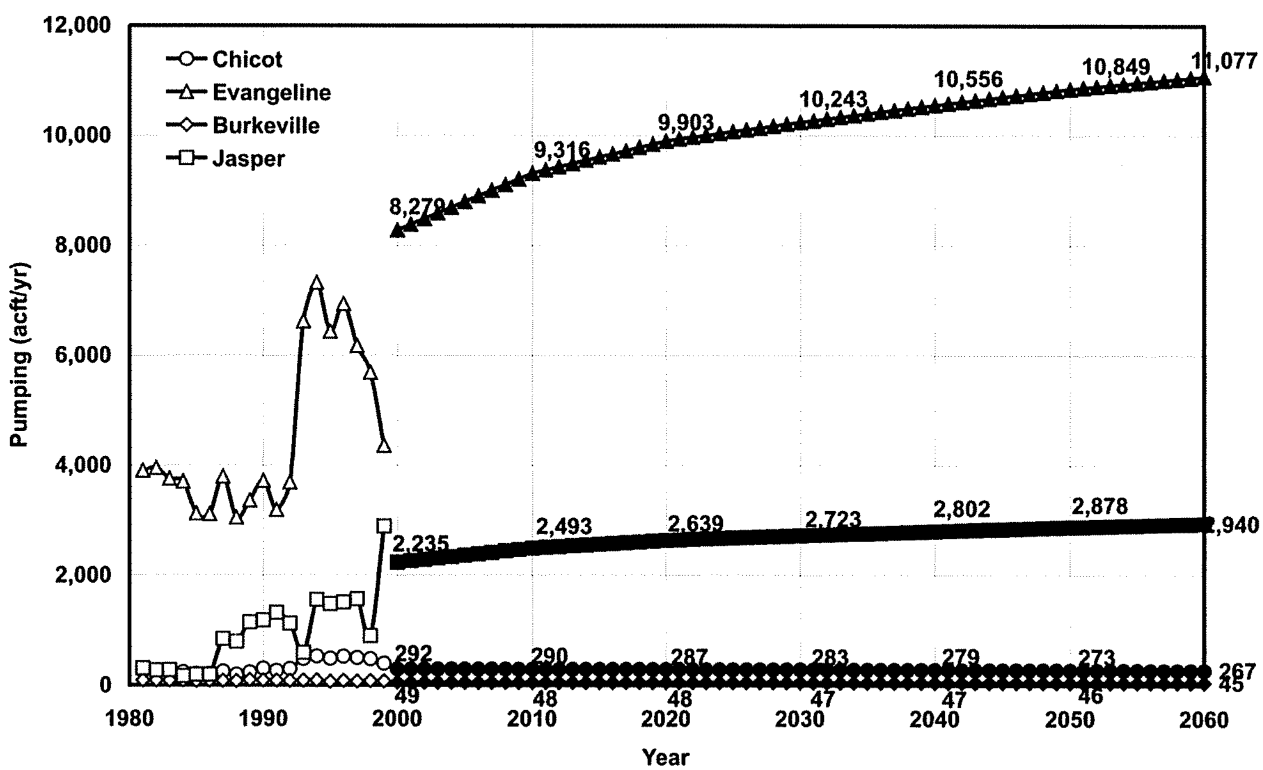

Figure D-8: Local Supply Historical and Predictive Pumping in Duval County

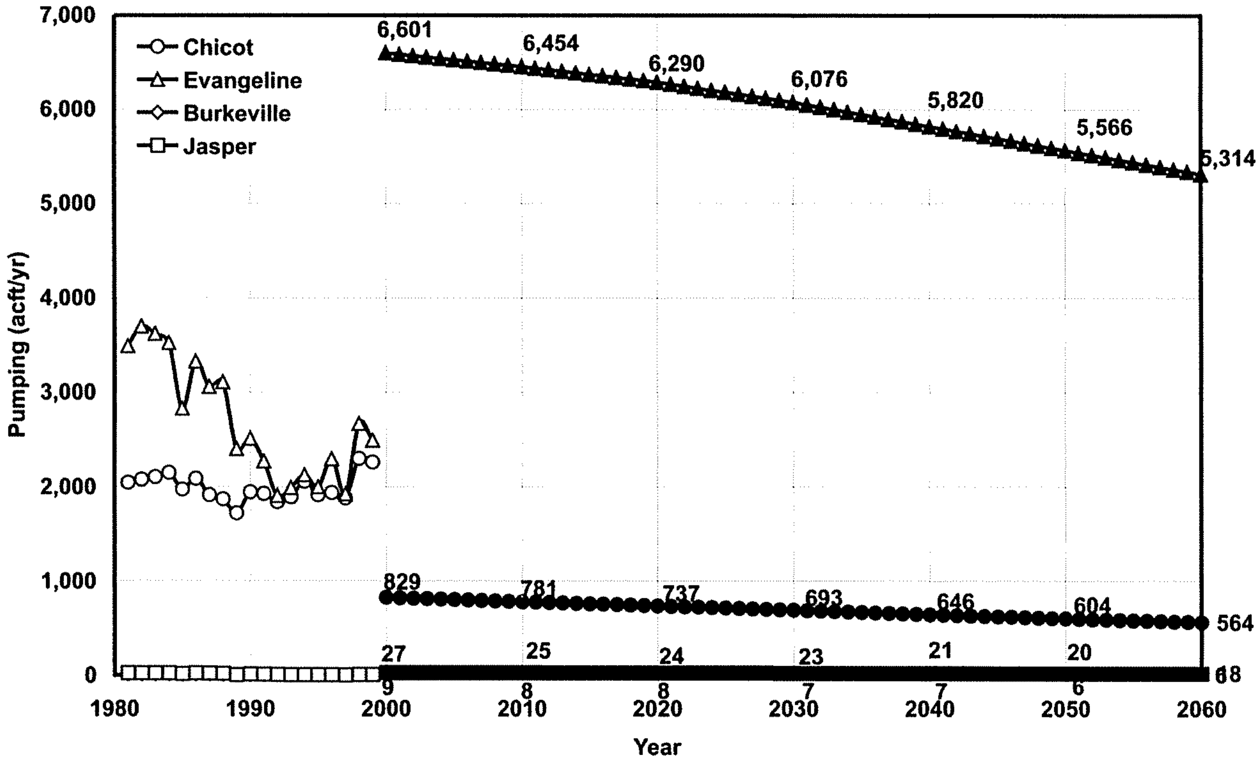

Figure D-9: Local Supply Historical and Predictive Pumping in Jim Wells County

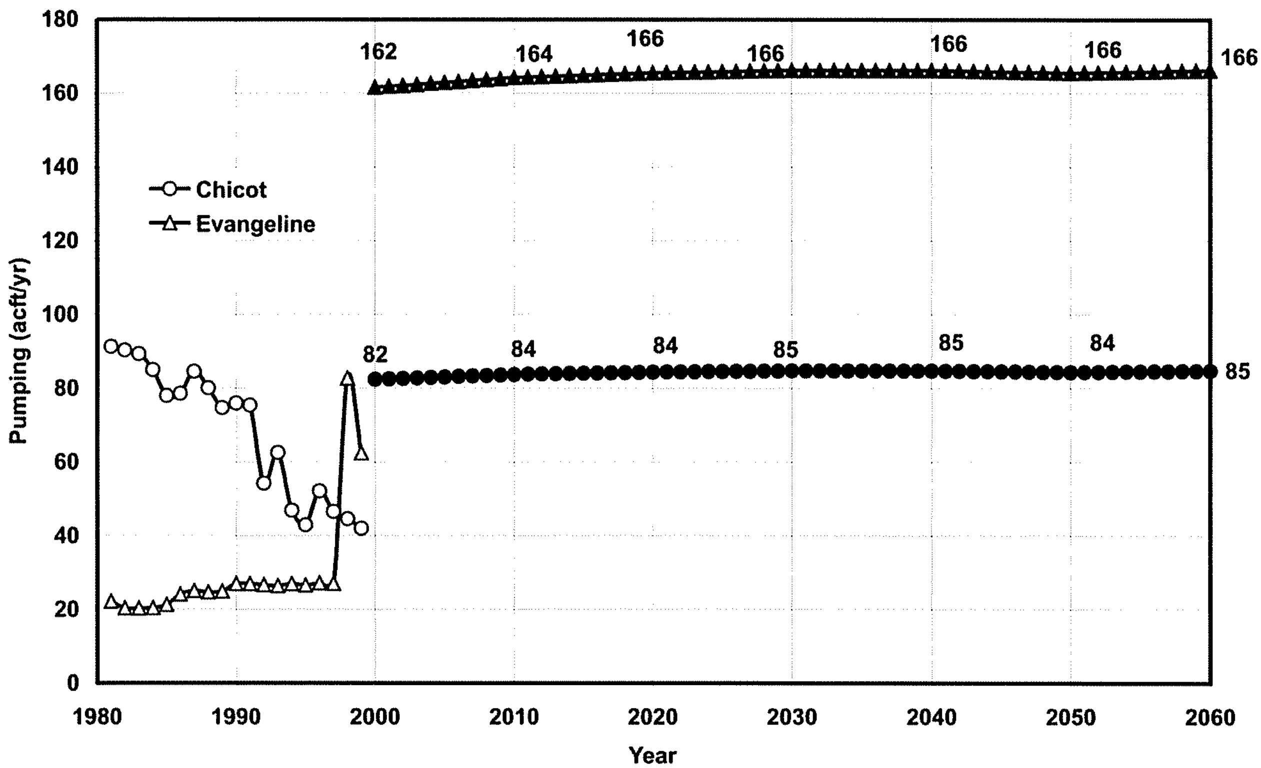

Figure D-10: Local Supply Historical and Predictive Pumping in Kenedy County

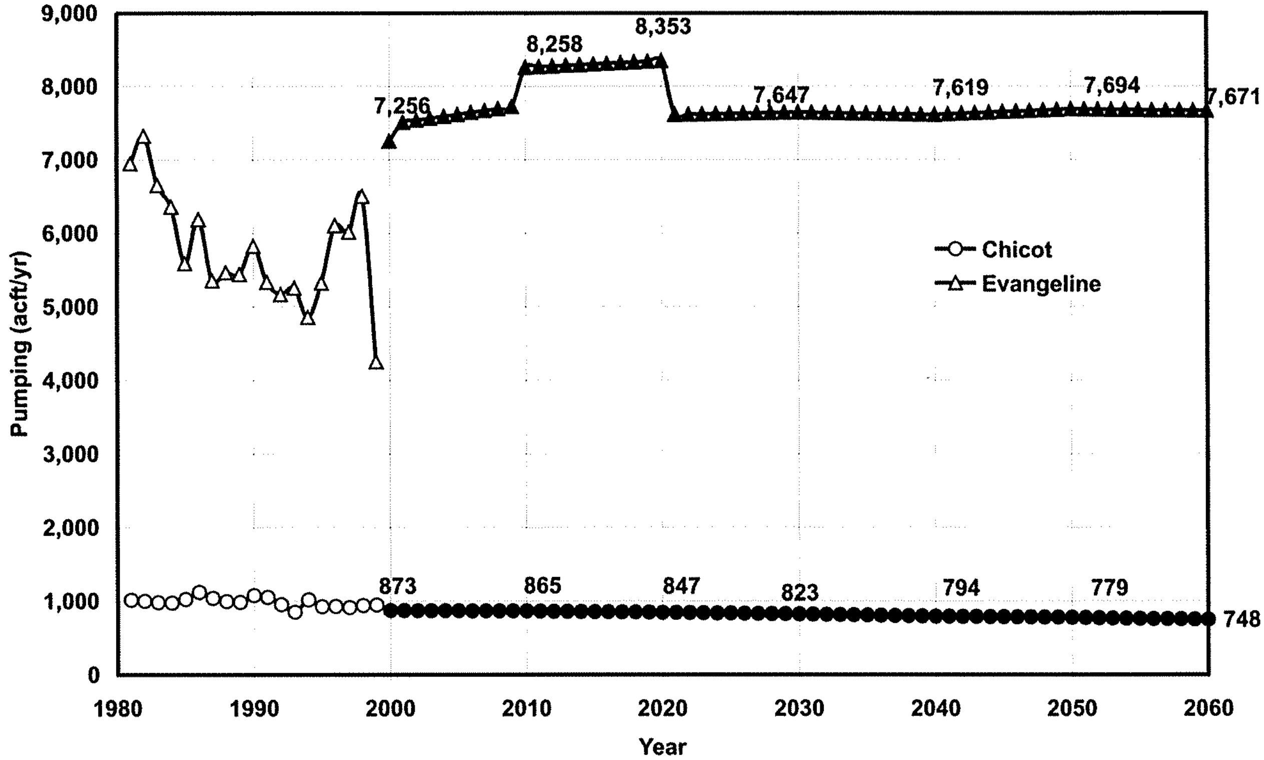

Figure D-11: Local Supply Historical and Predictive Pumping in Kleberg County

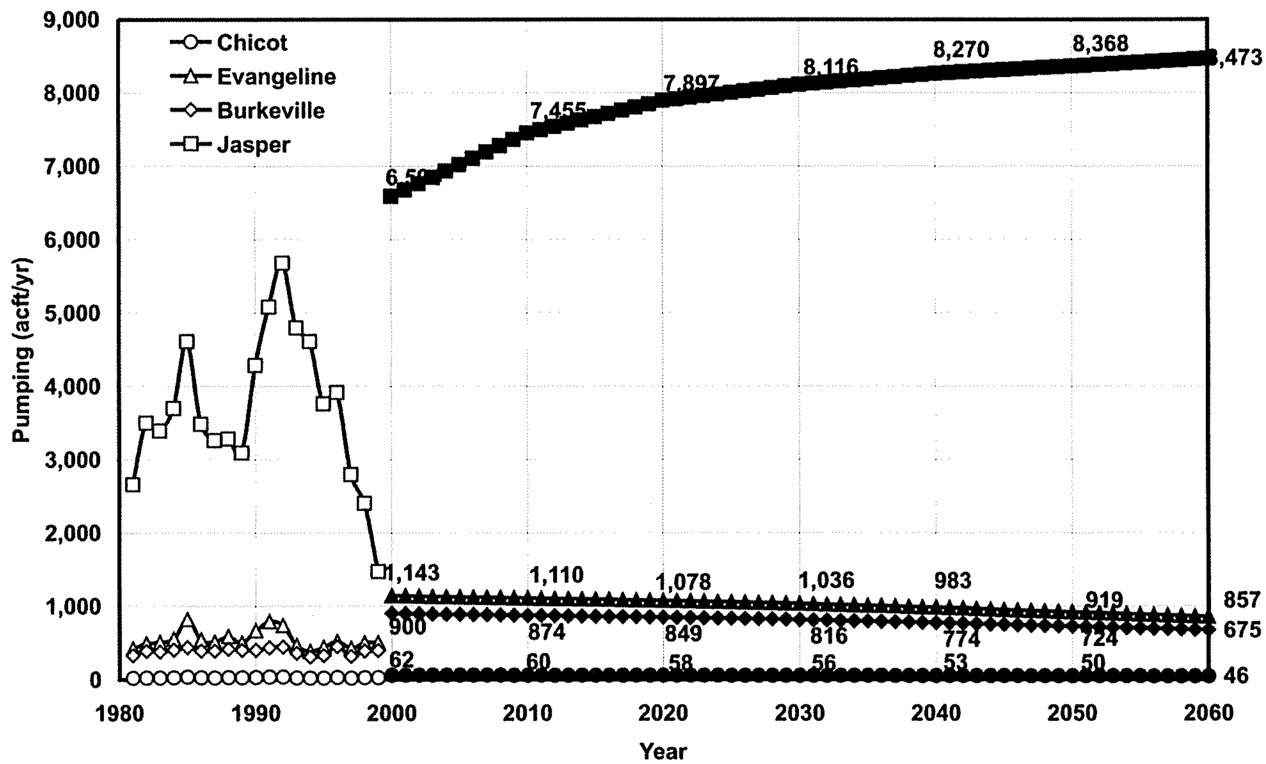

Figure D-12: Local Supply Historical and Predictive Pumping in Live Oak County

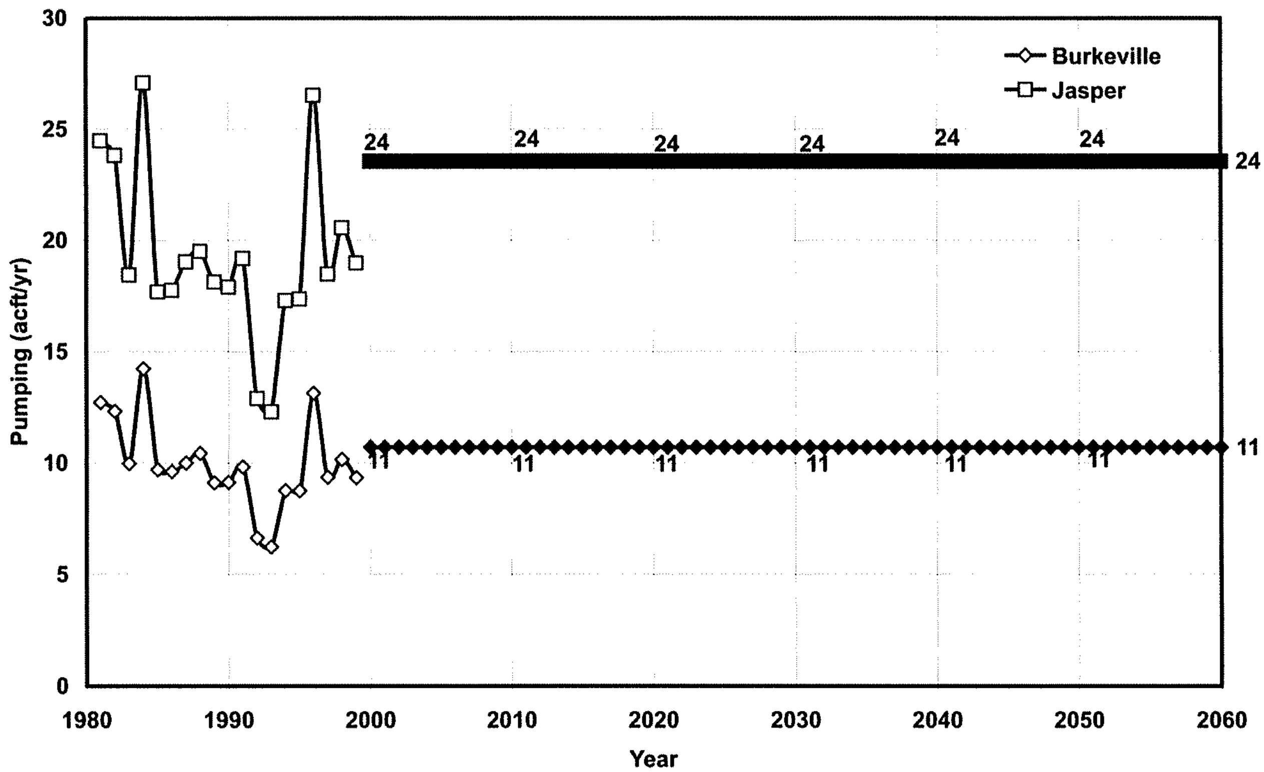

Figure D-13: Local Supply Historical and Predictive Pumping in McMullen County

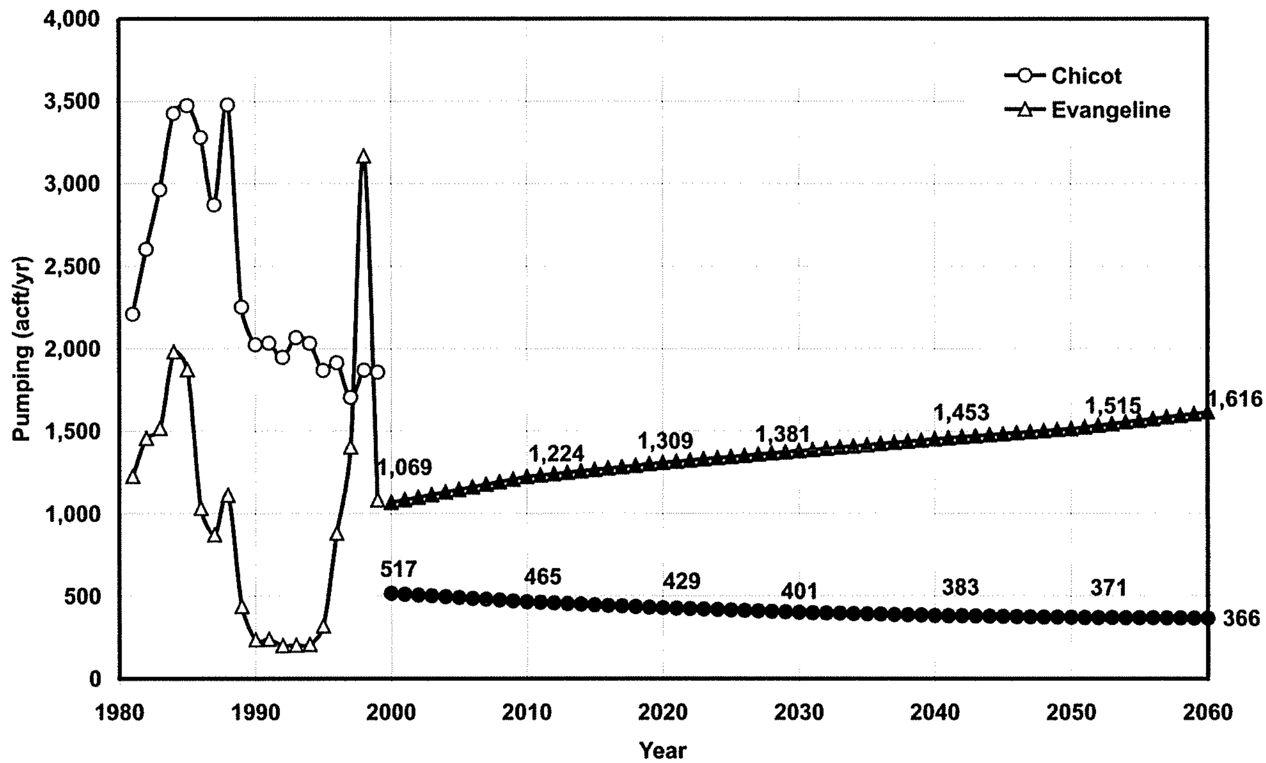

Figure D-14: Local Supply Historical and Predictive Pumping in Nueces County

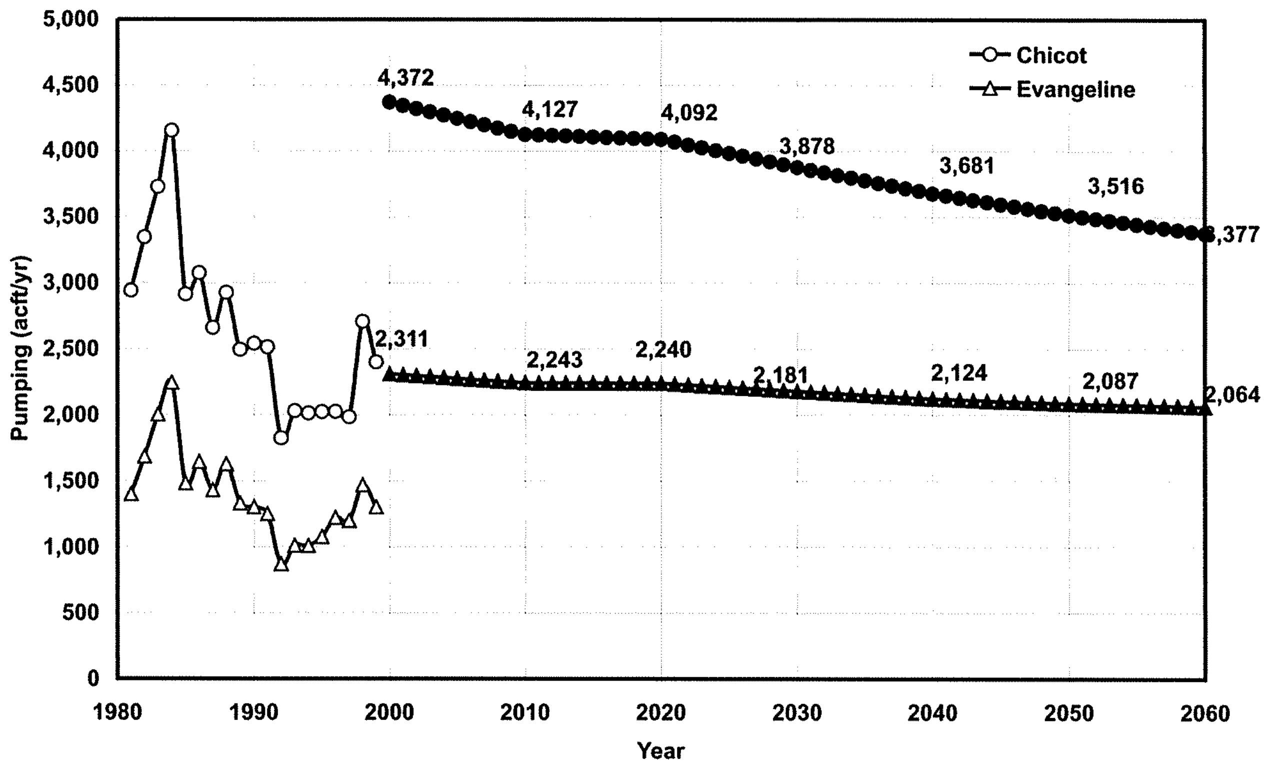

Figure D-15: Local Supply Historical and Predictive Pumping in San Patricio County

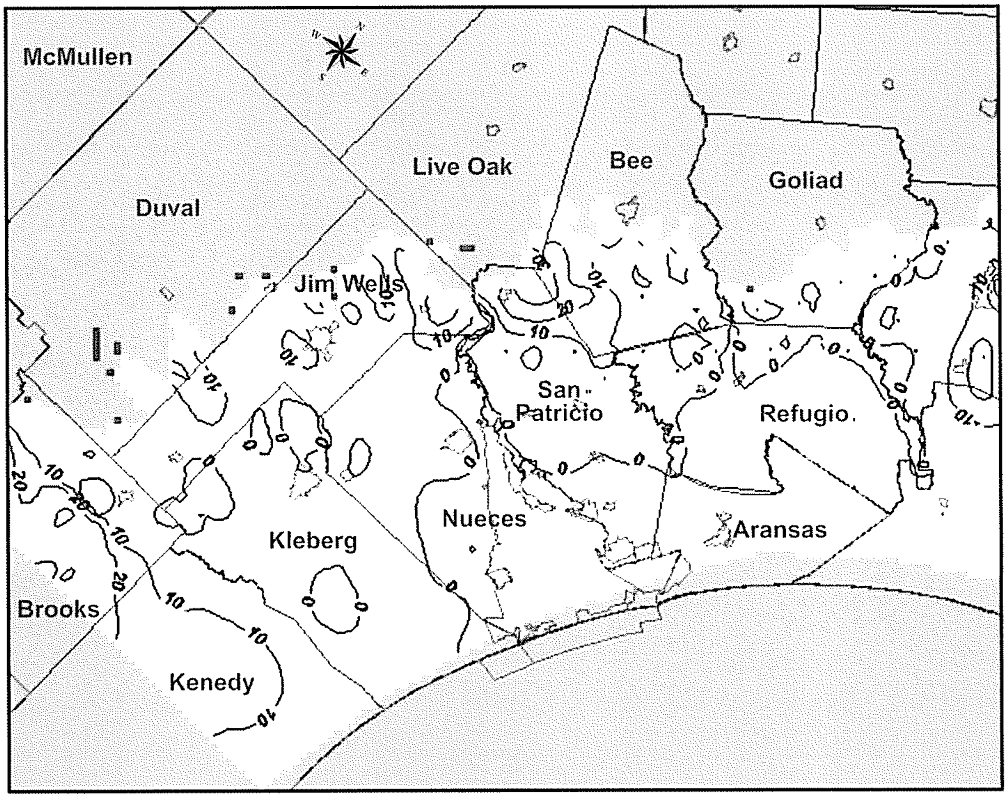

Figure D-16. 2000 to 2060 Chicot Drawdown

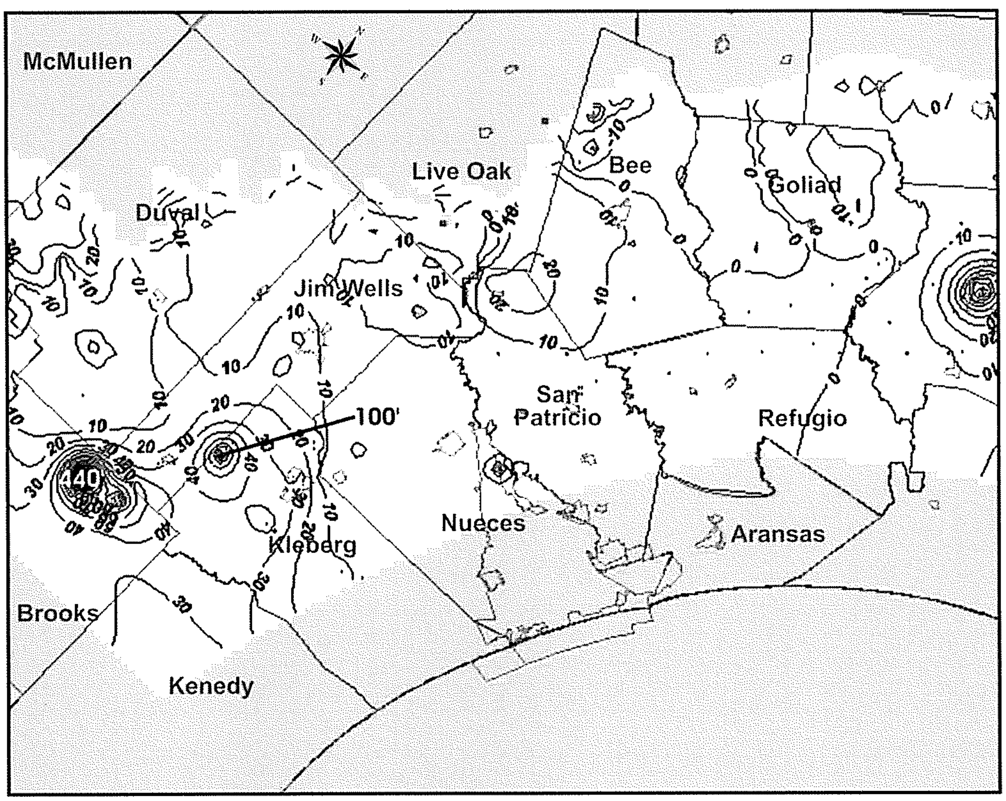

Figure D-17. 2000 to 2060 Evangeline Drawdown

Fully-Penetrating Predictive Model Pumping

In addition to projected pumpage to meet local demand, several groundwater export projects have been proposed for the Gulf Coast Aquifer in Region N as well as in the neighboring South Central Texas Water Planning Region (Region L). These projects include the Lower Guadalupe Water Supply Project (LGWSP), the San Patricio Municipal Water District Well Field, and the City of Corpus Christi Well Field. The project locations are shown in Figure D-18. Since these project wells will fully penetrate the Evangeline Aquifer, these well fields were modeled using the Fully-Penetrating model; local groundwater pumping demand was not included in the Fully-Penetrating model. The following are brief descriptions of the proposed simulated projects.

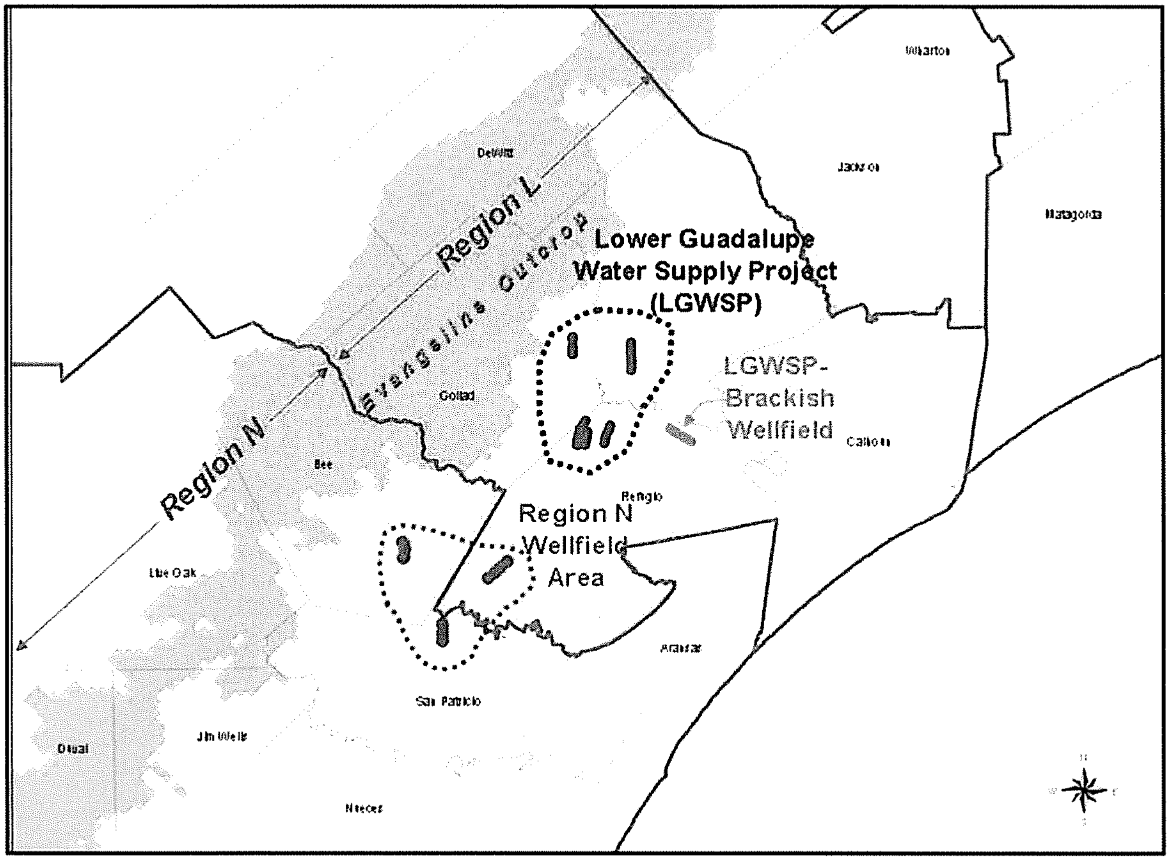

Figure D-18. Proposed Project Locations in the Evangeline Aquifer

Region N Project Pumping

Region N projects were also modeled in the Fully-Penetrating model. The San Patricio well field project includes two well fields in Bee and San Patricio Counties, each producing 5,500 acft/yr for a total of 11,000 acft/yr at a constant annual rate starting in 2010. The Bee County well field has three 1,100-gpm wells and the San Patricio County well field has four 850-gpm wells.

The City of Corpus Christi project is located in Refugio County and does not come online until 2056. Pumping is 500 acft/yr in 2056 and increases to 7,000 acft/yr in 2060. This well field includes four 1,000-gpm wells.

All Region L and Region N project pumping using the Fully-Penetrating model is shown in Figure D-19.

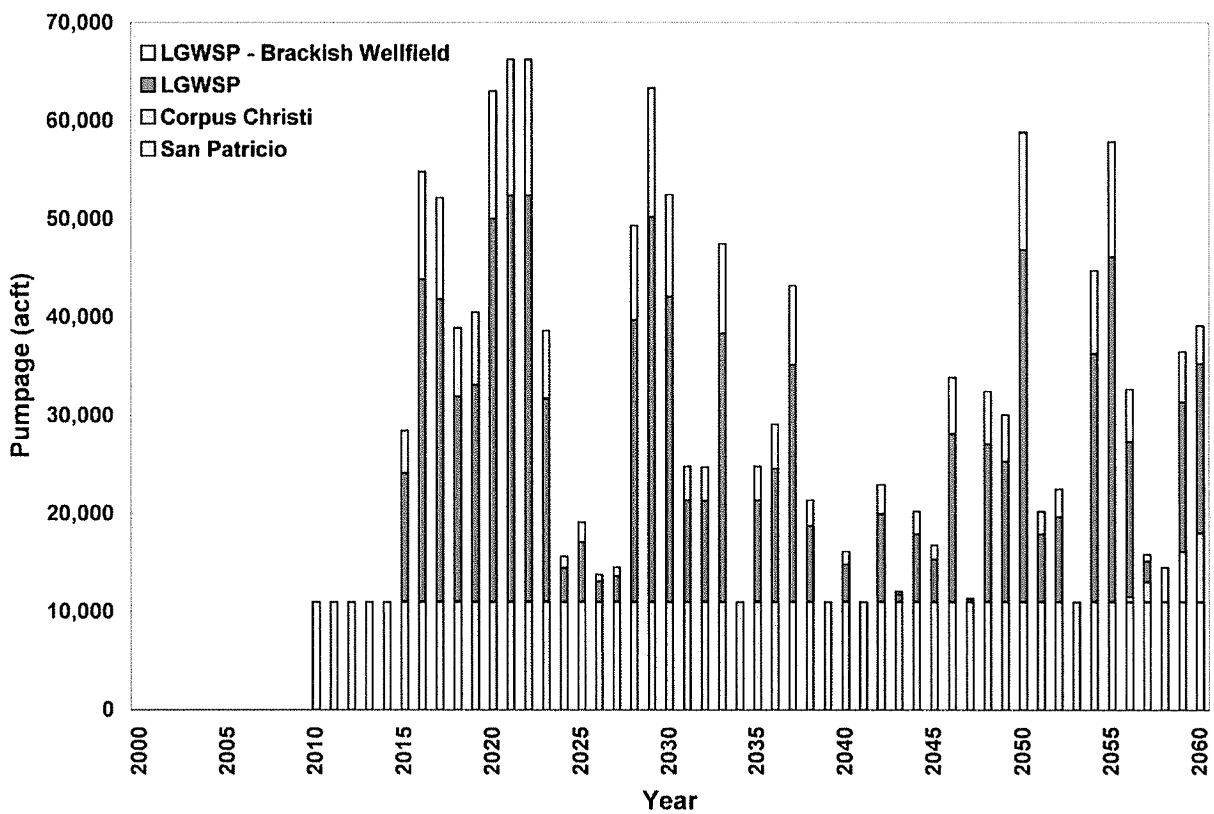

Figure D-19. Fully-Penetrating Model Predictive Pumping per Project

Lower Guadalupe Water Supply Project Pumping

LGWSP includes three well fields in the Region L counties of Victoria, Goliad, and Refugio. This project is envisioned as a conjunctive use project in which surface water flows from the Guadalupe River would be used when available, and groundwater would be used to supplement this source, which is reduced in times of drought. The projected groundwater use is dependent upon surface water availability calculated using the Guadalupe-San Antonio River Basin Water Availability Model (GSA WAM). Groundwater would be pumped at a variable annual rate starting in 2015 depending on modeled surface water availability for each year. Water would be cumulatively pumped from the three well fields at an average rate of 15,529 acft/yr and at a maximum of 41,400 acft/yr during the drought of record. In Refugio County, 61 percent of the total LGWSP pumping was proportioned to sixteen 1,000-gpm wells spaced approximately 3,000-feet apart. In Victoria County, 24 percent of the total LGWSP pumping was proportioned to seven 1,000-gpm wells spaced at approximately 3,000 feet. In Goliad County, the remaining 15 percent of the total LGWSP pumping was proportioned to five 800-gpm wells spaced approximately 2,500 feet apart.[6] The LGWSP pumping per year, per county well field is shown on Table D-2. Sixty-one percent of the total LGWSP pumping was proportioned to sixteen 1,000 gpm wells spaced approximately 3,000-feet apart in Refugio County. Twenty-four percent of pumping was proportioned to seven, 1,000 gpm wells spaced approximately 3,000-feet apart in Victoria County. Fifteen percent of pumping was proportioned to five, 800 gpm wells spaced approximately 2,500-feet apart in Goliad County.

The brackish well field in Refugio County was also modeled using the Fully-Penetrating model. The average pumping rate in this well field is 5,191 acft/yr and at a maximum of 13,840 acft/yr during the drought of record. The pumping was proportioned to seven, 1,000 gpm wells spaced approximately 3,000-feet apart.

[6] HDR, South Central Texas Regional Water Initially Prepared Plan, June 2005.

Table D-2.
Fully Penetrating Model Lower Guadalupe Water Supply Project Pumping Per County Well Field (2000-2060) (acft)

Year	Goliad	Refugio	Victoria	Total	Refugio (Brackish Well Field)	Total (Including Brackish Well Field)
2000	0	0	0	**0**	0	**0**
2001	0	0	0	**0**	0	**0**
2002	0	0	0	**0**	0	**0**
2003	0	0	0	**0**	0	**0**
2004	0	0	0	**0**	0	**0**
2005	0	0	0	**0**	0	**0**
2006	0	0	0	**0**	0	**0**
2007	0	0	0	**0**	0	**0**
2008	0	0	0	**0**	0	**0**
2009	0	0	0	**0**	0	**0**
2010	0	0	0	**0**	0	**0**
2011	0	0	0	**0**	0	**0**
2012	0	0	0	**0**	0	**0**
2013	0	0	0	**0**	0	**0**
2014	0	0	0	**0**	0	**0**
2015	1,964	7,986	3,142	**13,092**	4,377	**17,469**
2016	4,926	20,034	7,882	**32,842**	10,979	**43,821**
2017	4,623	18,801	7,397	**30,822**	10,304	**41,126**
2018	3,136	12,753	5,018	**20,907**	6,989	**27,896**
2019	3,315	13,482	5,304	**22,102**	7,389	**29,491**
2020	5,852	23,798	9,363	**39,012**	13,042	**52,054**
2021	6,210	25,254	9,936	**41,400**	13,840	**55,240**
2022	6,210	25,254	9,936	**41,400**	13,840	**55,240**
2023	3,105	12,627	4,968	**20,700**	6,920	**27,620**
2024	518	2,105	828	**3,450**	1,153	**4,603**
2025	908	3,692	1,453	**6,053**	2,024	**8,077**
2026	313	1,272	501	**2,086**	697	**2,783**
2027	391	1,592	626	**2,610**	872	**3,482**
2028	4,308	17,520	6,893	**28,721**	9,601	**38,322**
2029	5,882	23,922	9,412	**39,217**	13,110	**52,327**
2030	4,663	18,963	7,461	**31,087**	10,393	**41,480**
2031	1,553	6,314	2,484	**10,350**	3,460	**13,810**
2032	1,545	6,283	2,472	**10,300**	3,443	**13,743**

Page 1 of 2

Table D-2 continued

Year	*Goliad*	*Refugio*	*Victoria*	*Total*	*Refugio (Brackish Well Field)*	*Total (Including Brackish Well Field)*
2033	4,102	16,680	6,563	**27,344**	9,141	**36,485**
2034	0	0	0	**0**	0	**0**
2035	1,553	6,314	2,484	**10,350**	3,460	**13,810**
2036	2,036	8,279	3,257	**13,573**	4,537	**18,110**
2037	3,623	14,732	5,796	**24,150**	8,073	**32,223**
2038	1,163	4,731	1,861	**7,756**	2,593	**10,349**
2039	0	0	0	**0**	0	**0**
2040	576	2,343	922	**3,840**	1,284	**5,124**
2041	0	0	0	**0**	0	**0**
2042	1,342	5,457	2,147	**8,945**	2,990	**11,936**
2043	115	468	184	**767**	256	**1,023**
2044	1,035	4,209	1,656	**6,900**	2,307	**9,207**
2045	651	2,649	1,042	**4,343**	1,452	**5,795**
2046	2,570	10,450	4,112	**17,131**	5,727	**22,859**
2047	40	164	65	**269**	90	**359**
2048	2,411	9,806	3,858	**16,076**	5,374	**21,450**
2049	2,146	8,728	3,434	**14,309**	4,784	**19,092**
2050	5,380	21,879	8,608	**35,868**	11,991	**47,859**
2051	1,035	4,209	1,656	**6,900**	2,307	**9,207**
2052	1,296	5,269	2,073	**8,638**	2,888	**11,526**
2053	0	0	0	**0**	0	**0**
2054	3,797	15,442	6,075	**25,314**	8,463	**33,777**
2055	5,274	21,448	8,439	**35,161**	11,755	**46,916**
2056	2,379	9,676	3,807	**15,862**	5,303	**21,165**
2057	321	1,307	514	**2,142**	716	**2,858**
2058	0	0	0	**0**	0	**0**
2059	2,294	9,330	3,671	**15,295**	5,113	**20,408**
2060	2,588	10,523	4,140	**17,250**	5,767	**23,017**
2015-2060 Average	**2,329**	**9,473**	**3,727**	**15,529**	**5,191**	**20,720**

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Appendix E

Model Water Conservation and Drought Contingency Plans for the Coastal Bend Region

Contents

Appendix E.1

Texas Commission on Environmental Quality

Model
Municipal Water Conservation Plan

Utility Profile and Water Conservation Plan Requirements for Municipal Water Use by Public Water Suppliers

Web Sites for Information:
www.tceq.state.tx.us/waterconservation/waterconservationplanforms
www.twdb.state.tx.us/assistance/conservation/Municipal/Plans/CPlans.asp
www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

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Texas Commission on Environmental Quality

UTILITY PROFILE & WATER CONSERVATION PLAN REQUIREMENTS FOR MUNICIPAL WATER USE BY PUBLIC WATER SUPPLIERS

This form is provided to assist entities in water conservation plan development for municipal water use by a retail public water supplier. Information from this form should be included within a water conservation plan for municipal use. If you need assistance in completing this form or in developing your plan, please contact the conservation staff of the Resource Protection Team in the Water Supply Division at (512) 239-4691.

Name of Entity: ______________________________

Address & Zip: ______________________________

Telephone Number: ____________________ **Fax:** ______________

Form Completed By: ______________________________

Title: ______________________________

Signature: ____________________ **Date:** ______________

Name and Phone Number of Person/Department responsible for implementing a water conservation program: ______________________________

UTILITY PROFILE

I. POPULATION AND CUSTOMER DATA

A. Population and Service Area Data

1. Attach a copy of your service-area map and, if applicable, a copy of your Certificate of Convenience and Necessity (CCN).

2. Service area size (square miles): ______________

3. Current population of service area: ______________________

4. Current population served:

   a. water ______________________
   b. wastewater ______________________

5. Population served by water utility for the previous five years:

Year	Population
________	________
________	________
________	________
________	________
________	________

6. Projected population for service area in the following decades:

Year	Population
2010	________
2020	________
2030	________
2040	________
2050	________

7. List source/method for the calculation of current and projected population:

____
____
____
____

B. Active Connections

1. Current number of active connections. Check whether multi-family service is counted as Residential _____ or Commercial _____

Treated water users:	Metered	Not-metered	Total
Residential	________	________	______
Commercial	________	________	______
Industrial	________	________	______
Other	________	________	______

2. List the net number of new connections per year for most recent three years:

Year	________	________	________
Residential	________	________	________
Commercial	________	________	________
Industrial	________	________	________
Other	________	________	________

C. High Volume Customers

List annual water use for the five highest volume customers
(indicate if treated or raw water delivery)

	Customer	Use (1,000gal./yr.)	Treated/Raw Water
(1)	____________	____________	____________
(2)	____________	____________	____________
(3)	____________	____________	____________
(4)	____________	____________	____________
(5)	____________	____________	____________

II. WATER USE DATA FOR SERVICE AREA

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):
Please indicate : Diverted Water ____________________
Treated Water ____________________

Year	________	________	________	________	________
January	________	________	________	________	________
February	________	________	________	________	________
March	________	________	________	________	________

April	______	______	______	______	______
May	______	______	______	______	______
June	______	______	______	______	______
July	______	______	______	______	______
August	______	______	______	______	______
September	______	______	______	______	______
October	______	______	______	______	______
November	______	______	______	______	______
December	______	______	______	______	______
Total	______	______	______	______	______

Indicate how the above figures were determined (e.g., from a master meter located at the point of a diversion from the source or located at a point where raw water enters the treatment plant, or from water sales).

____

____

____

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

Year	Residential	Commercial	Industrial	Wholesale	Other	Total Sold
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______
____	______	______	______	______	____	______

3. List previous five years records for water loss (the difference between water diverted (or treated) and water delivered (or sold))

Year	Amount (gal.)	%
____	__________	____
____	__________	____
____	__________	____
____	__________	____
____	__________	____

4. Municipal water use for previous five years:

Year	Population	Total Water Diverted or Pumped for Treatment (1,000 gal.)
	______________	________________
	______________	________________
	______________	________________
	______________	________________
	______________	________________

B. Projected Water Demands

If applicable, attach projected water supply demands for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirement from such growth.

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

	Source	Amount Authorized
Surface Water:	______________________________	____________ acre-feet
Groundwater:	______________________________	____________ acre-feet
Contracts:	______________________________	____________ acre-feet
Other:	______________________________	____________ acre-feet

B. Treatment and Distribution System

1. Design daily capacity of system: _______________ MGD

2. Storage Capacity: Elevated ________ MGD, Ground _______ MGD

3. If surface water, do you recycle filter backwash to the head of the plant? Yes ______ No ______. If yes, approximately ________ MGD.

4. Please attach a description of the water system. Include the number of

treatment plants, wells, and storage tanks. If possible, include a sketch of the system layout.

IV. WASTEWATER SYSTEM DATA

A. Wastewater System Data

1. Design capacity of wastewater treatment plant(s): ___________ MGD

2. Is treated effluent used for irrigation on-site _____, off-site _____, plant washdown _____, or chlorination/dechlorination ______?
   If yes, approximately ________ gallons per month.

3. Briefly describe the wastewater system(s) of the area serviced by the water utility. Describe how treated wastewater is disposed of. Where applicable, identify treatment plant(s) with the TCEQ name and number, the operator, owner, and, if wastewater is discharged, the receiving stream. If possible, attach a sketch or map which locates the plant(s) and discharge points or disposal sites.

B. Wastewater Data for Service Area

1. Percent of water service area served by wastewater system: ______%

2. Monthly volume treated for previous three years (in 1,000 gallons):

Year			
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			
Total			

REQUIREMENTS FOR WATER CONSERVATION PLANS FOR MUNICIPAL WATER USE BY PUBLIC WATER SUPPLIERS

In addition to the utility profile, a water conservation plan for municipal use by a public water supplier must include, at a minimum, additional information as required by Title 30, Texas Administrative Code, §288.2. Note: If the water conservation plan does not provide information for each requirement, an explanation must be included as to why the requirement is not applicable.

Specific, Quantified 5 & 10-Year Targets

The water conservation plan must include specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for ***municipal use in gallons per capita per day*** (see Appendix A). Note that the goals established by a public water supplier under this subparagraph are not enforceable.

Metering Devices

The water conservation plan must include a statement about the water supplier's metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply.

Universal Metering

The water conservation plan must include and a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement.

Unaccounted-For Water Use

The water conservation plan must include measures to determine and control unaccounted-for uses of water (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.).

Continuing Public Education & Information

The water conservation plan must include a description of the program of continuing public education and information regarding water conservation by the water supplier.

Non-Promotional Water Rate Structure

The water supplier must have a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water. This rate structure must be listed in the water conservation plan.

Reservoir Systems Operations Plan

The water conservation plan must include a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies.

Enforcement Procedure & Plan Adoption

The water conservation plan must include a means of implementation and enforcement which shall be evidenced by 1) a copy of the ordinance, resolution, or tariff indicating **official adoption** of the water conservation plan by the water supplier; and 2) a description of the authority by which the water supplier will implement and enforce the conservation plan.

Coordination with the Regional Water Planning Group(s)

The water conservation plan must include documentation of coordination with the regional water planning group(s) for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

Example statement to be included within the water conservation plan:

The service area of the ____________ (name of water supplier) is located within the ___________ (name of regional water planning area or areas) and ___________ (name of water supplier) has provided a copy of this water conservation plan to the ____________ (name of regional water planning group or groups).

Additional Requirements:

required of suppliers serving population of 5,000 or more or a projected population of 5,000 or more within ten years)

1. **Program for Leak Detection, Repair, and Water Loss Accounting**

   The plan must include a description of the program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted-for uses of water.

2. **Record Management System**

   The plan must include a record management system to record water pumped, water deliveries, water sales, and water losses which allows for the desegregation of water sales and uses into the following user classes (residential; commercial; public and institutional; and industrial.

Plan Review and Update

Beginning May 1, 2005, a public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. The revised plan must also include an implementation report.

Best Management Practices Guide

On November 2004, the Texas Water Development Board's (TWDB) Report 362 was completed by the Water Conservation Implementation Task Force. Report 362 is the Water Conservation Best Management Practices (BMP) Guide. The BMP Guide is a voluntary list of management practices that water users may implement in addition to the required components of Title 30, Texas Administrative Code, Chapter 288. The BMP Guide is available on the TWDB's website at the link below or by calling (512) 463-7847.

http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

Appendix A

Definitions of Commonly Used Terms

Conservation – Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

Industrial use – The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, commercial fish production, and the development of power by means other than hydroelectric, but does not include agricultural use.

Irrigation – The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system.

Municipal per capita water use – The sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by actual population served.

Municipal use – The use of potable water within or outside a municipality and its environs whether supplied by a person, privately owned utility, political subdivision, or other entity as well as the use of sewage effluent for certain purposes, including the use of treated water for domestic purposes, fighting fires, sprinkling streets, flushing sewers and drains, watering parks and parkways, and recreational purposes, including public and private swimming pools, the use of potable water in industrial and commercial enterprises supplied by a municipal distribution system without special construction to meet its demands, and for the watering of lawns and family gardens.

Municipal use in gallons per capita per day – The total average daily amount of water diverted or pumped for treatment for potable use by a public water supply system. The calculation is made by dividing the water diverted or pumped for treatment for potable use by population served. Indirect reuse volumes shall be credited against total diversion volumes for the purpose of calculating gallons per capita per day for targets and goals.

Pollution – The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Public water supplier – An individual or entity that supplies water to the public for human consumption.

Regional water planning group – A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

Retail public water supplier – An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

Reuse – The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

Water conservation plan – A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

Water loss - The difference between water diverted or treated and water delivered (sold). Water loss can result from:

1. inaccurate or incomplete record keeping;
2. meter error;
3. unmetered uses such as firefighting, line flushing, and water for public buildings and water treatment plants;
4. leaks; and
5. water theft and unauthorized use.

Wholesale public water supplier – An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

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Appendix E.2

Texas Commission on Environmental Quality

Model
Municipal Drought Contingency Plan

Drought Contingency Plan Requirements for
Municipal Retail Public Water Suppliers

Web Site for Information:
www.tnrcc.state.tx.us/permitting/waterperm/wrpa/contingency.html

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DROUGHT CONTINGENCY PLAN
FOR THE
(name of retail public water supplier)
(date)

Section I: Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the __________________ (name of water supplier) hereby adopts the following regulations and restrictions on the delivery and consumption of water through an ordinance/or resolution (see Appendix C for an example).

Water uses regulated or prohibited under this Drought Contingency Plan (the Plan) are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply condition are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section XI of this Plan.

Section II: Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by the _____________ (name of water supplier) by means of _______________ (describe methods used to inform the public about the preparation of the plan and provide opportunities for input; for example, scheduling and providing public notice of a public meeting to accept input on the Plan).

Section III: Public Education

The _________ (name of water supplier) will periodically provide the public with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of _________________ (describe methods to be used to provide information to the public about the Plan; for example, public events, press releases or utility bill inserts).

Section IV: Coordination with Regional Water Planning Groups

The service area of the ____________ (name of water supplier) is located within the ___________ (name of regional water planning area or areas) and __________ (name of water supplier) has provided a copy of this Plan to the ___________ (name of regional water planning group or groups).

Section V: Authorization

The __________________ (designated official; for example, the mayor, city manager, utility director, general manager, etc.), or his/her designee is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The ______________, (designated official) or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by the __________________ (name of supplier). The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Definitions

For the purposes of this Plan, the following definitions shall apply:

Aesthetic water use: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Commercial and institutional water use: water use which is integral to the operations of commercial and non-profit establishments and governmental entities such as retail establishments, hotels and motels, restaurants, and office buildings.

Conservation: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses.

Customer: any person, company, or organization using water supplied by _________________ (name of water supplier).

Domestic water use: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

Even number address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

Industrial water use: the use of water in processes designed to convert materials of lower value into forms having greater usability and value.

Landscape irrigation use: water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, and rights-of-way and medians.

Non-essential water use: water uses that are not essential nor required for the protection of public, health, safety, and welfare, including:

(a) irrigation of landscape areas, including parks, athletic fields, and golf courses, except otherwise provided under this Plan;
(b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;

(c) use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
(d) use of water to wash down buildings or structures for purposes other than immediate fire protection;
(e) flushing gutters or permitting water to run or accumulate in any gutter or street;
(f) use of water to fill, refill, or add to any indoor or outdoor swimming pools or jacuzzi-type pools;
(g) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic life;
(h) failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and
(i) use of water from hydrants for construction purposes or any other purposes other than fire fighting.

Odd numbered address: street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9.

Section VIII: Criteria for Initiation and Termination of Drought Response Stages

The ____________ (designated official) or his/her designee shall monitor water supply and/or demand conditions on a _____ (*e.g., daily, weekly, monthly*) basis and shall determine when conditions warrant initiation or termination of each stage of the Plan, that is, when the specified "triggers" are reached.

The triggering criteria described below are based on ______________________________________
____
(*provide a brief description of the rationale for the triggering criteria; for example, triggering criteria / trigger levels based on a statistical analysis of the vulnerability of the water source under drought of record conditions, or based on known system capacity limits*).

Stage 1 Triggers – MILD Water Shortage Conditions

Requirements for initiation
Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain water uses, defined in Section VII–Definitions, when

____
(*describe triggering criteria / trigger levels; see examples below*).

> *Following are examples of the types of triggering criteria that might be used in one or more successive stages of a drought contingency plan. One or a combination of such criteria must be defined for each drought response stage, but usually not all will apply. Select those appropriate to your system:*
>
> *Example 1:* *Annually, beginning on May 1 through September 30.*
>
> *Example 2:* *When the water supply available to the ____________ (name of water supplier) is equal to or less than _______ (acre-feet, percentage of storage, etc.).*

Example 3: *When, pursuant to requirements specified in the _____________(name of water supplier) wholesale water purchase contract with ____________ (name of wholesale water supplier), notification is received requesting initiation of Stage 1 of the Drought Contingency Plan.*

Example 4: *When flows in the _______ (name of stream or river) are equal to or less than ____cubic feet per second.*

Example 5: *When the static water level in the ____________ (name of water supplier) well(s) is equal to or less than _____ feet above/below mean sea level.*

Example 6: *When the specific capacity of the __________________ (name of water supplier) well(s) is equal to or less than _____ percent of the well's original specific capacity.*

Example 7: *When total daily water demand equals or exceeds ______ million gallons for ___consecutive days of ____ million gallons on a single day (e.g., based on the "safe" operating capacity of water supply facilities).*

Example 8: *Continually falling treated water reservoir levels which do not refill above __ percent overnight (e.g., based on an evaluation of minimum treated water storage required to avoid system outage).*

The public water supplier may devise other triggering criteria which are tailored to its system.

Requirements for termination
Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g. 3) consecutive days.

Stage 2 Triggers -- MODERATE Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses provided in Section IX of this Plan when ____________ (*describe triggering criteria; see examples in Stage 1*).

Requirements for termination
Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 2, Stage 1 becomes operative.

Stage 3 Triggers – SEVERE Water Shortage Conditions

Requirements for initiation

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when ___________ (*describe triggering criteria; see examples in Stage 1*).

Requirements for termination
Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 3, Stage 2 becomes operative.

Stage 4 Triggers -- CRITICAL Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when ___________ (*describe triggering criteria; see examples in Stage 1*).

Requirements for termination
Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days. Upon termination of Stage 4, Stage 3 becomes operative.

Stage 5 Triggers -- EMERGENCY Water Shortage Conditions

Requirements for initiation
Customers shall be required to comply with the requirements and restrictions for Stage 5 of this Plan when ___________ (designated official), or his/her designee, determines that a water supply emergency exists based on:

1. Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; **or**

2. Natural or man-made contamination of the water supply source(s).

Requirements for termination
Stage 5 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days.

Stage 6 Triggers -- WATER ALLOCATION

Requirements for initiation
Customers shall be required to comply with the water allocation plan prescribed in Section IX of this Plan and comply with the requirements and restrictions for Stage 5 of this Plan when ________________________ (*describe triggering criteria, see examples in Stage 1*).

Requirements for termination - Water allocation may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ (e.g., 3) consecutive days.

> *Note: The inclusion of WATER ALLOCATION as part of a drought contingency plan may not be required in all cases. For example, for a given water supplier, an analysis of water supply availability under drought of record conditions may indicate that there is essentially no risk of water supply shortage. Hence, a drought contingency plan for such a water supplier might only address facility capacity limitations and emergency conditions (e.g., supply source contamination and system capacity limitations).*

Section IX: Drought Response Stages

The _________ (designated official), or his/her designee, shall monitor water supply and/or demand conditions on a daily basis and, in accordance with the triggering criteria set forth in Section VIII of this Plan, shall determine that a mild, moderate, severe, critical, emergency or water shortage condition exists and shall implement the following notification procedures:

Notification

Notification of the Public:
The ____________ (designated official) or his/ here designee shall notify the public by means of:

Examples:
publication in a newspaper of general circulation,
direct mail to each customer,
public service announcements,
signs posted in public places
take-home fliers at schools.

Additional Notification:
The ___________ (designated official) or his/ her designee shall notify directly, or cause to be notified directly, the following individuals and entities:

Examples:
Mayor / Chairman and members of the City Council / Utility Board
Fire Chief(s)
City and/or County Emergency Management Coordinator(s)
County Judge & Commissioner(s)
State Disaster District / Department of Public Safety
TCEQ *(required when* mandatory *restrictions are imposed)*
Major water users
Critical water users, i.e. hospitals
Parks / street superintendents & public facilities managers

Note: The plan should specify direct notice only as appropriate to respective drought stages.

Stage 1 Response -- MILD Water Shortage Conditions

Target: Achieve a voluntary ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, activation and use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Voluntary Water Use Restrictions for Reducing Demand :

(a) Water customers are requested to voluntarily limit the irrigation of landscaped areas to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and to irrigate landscapes only between the hours of midnight and 10:00 a.m. and 8:00 p.m to midnight on designated watering days.

(b) All operations of the ______________ (name of water supplier) shall adhere to water use restrictions prescribed for Stage 2 of the Plan.

(c) Water customers are requested to practice water conservation and to minimize or discontinue water use for non-essential purposes.

Stage 2 Response -- MODERATE Water Shortage Conditions

Target: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

Water Use Restrictions for Demand Reduction:
Under threat of penalty for violation, the following water use restrictions shall apply to all persons:

(a) Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems shall be limited to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9), and irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 a.m. and between 8:00 p.m. and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at anytime if it is by means of a hand-held hose, a faucet filled bucket or watering can of five (5) gallons or less, or drip irrigation system.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight. Such washing, when allowed, shall be done with a hand-held bucket or a hand-held hose equipped with a positive shutoff nozzle for quick rises. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public is contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

(c) Use of water to fill, refill, or add to any indoor or outdoor swimming pools, wading pools, or jacuzzi-type pools is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight.

(d) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(e) Use of water from hydrants shall be limited to fire fighting, related activities, or other activities necessary to maintain public health, safety, and welfare, except that use of water from designated fire hydrants for construction purposes may be allowed under special permit from the ___________________ (name of water supplier).

(f) Use of water for the irrigation of golf course greens, tees, and fairways is prohibited except on designated watering days between the hours 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight. However, if the golf course utilizes a water source other than that provided by the _______________ (name of water supplier), the facility shall not be subject to these regulations.

(g) All restaurants are prohibited from serving water to patrons except upon request of the patron.

(h) The following uses of water are defined as non-essential and are prohibited:

1. wash down of any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
2. use of water to wash down buildings or structures for purposes other than immediate fire protection;
3. use of water for dust control;
4. flushing gutters or permitting water to run or accumulate in any gutter or street; and
5. failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s).

Stage 3 Response -- SEVERE Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Demand Reduction</u>:
All requirements of Stage 2 shall remain in effect during Stage 3 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 12:00 midnight and 10:00 a.m. and between 8 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, drip irrigation, or permanently installed automatic sprinkler system only. The use of hose-end sprinklers is prohibited at all times.

(b) The watering of golf course tees is prohibited unless the golf course utilizes a water source other than that provided by the ____________________ (name of water supplier).

(c) The use of water for construction purposes from designated fire hydrants under special permit is to be discontinued.

Stage 4 Response -- CRITICAL Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Reducing Demand:</u>. All requirements of Stage 2 and 3 shall remain in effect during Stage 4 except:

(a) Irrigation of landscaped areas shall be limited to designated watering days between the hours of 6:00 a.m. and 10:00 a.m. and between 8:00 p.m. and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, or drip irrigation only. The use of hose-end sprinklers or permanently installed automatic sprinkler systems are prohibited at all times.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle not occurring on the premises of a commercial car wash and commercial service stations and not in the immediate interest of public health, safety, and welfare is prohibited. Further, such vehicle washing at commercial car washes and commercial service stations shall occur only between the hours of 6:00 a.m. and 10:00 a.m. and between 6:00 p.m. and 10 p.m.

(c) The filling, refilling, or adding of water to swimming pools, wading pools, and jacuzzi-type pools is prohibited.

(d) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(e) No application for new, additional, expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or water service facilities of any kind shall be approved, and time limits for approval of such applications are hereby suspended for such time as this drought response stage or a higher-numbered stage shall be in effect.

Stage 5 Response -- EMERGENCY Water Shortage Conditions

<u>Target</u>: Achieve a ___ percent reduction in __________ (e.g., total water use, daily water demand, etc.).

<u>Best Management Practices for Supply Management</u>:

Describe measures, if any, to be implemented directly by ____________ (name of water supplier) to manage limited water supplies and/or reduce water demand. Examples include: reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas; use of an alternative supply source(s); use of reclaimed water for non-potable purposes.

<u>Water Use Restrictions for Reducing Demand</u>. All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 except:

(a) Irrigation of landscaped areas is absolutely prohibited.

(b) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is absolutely prohibited.

Stage 6 Response -- WATER ALLOCATION

In the event that water shortage conditions threaten public health, safety, and welfare, the ___________ (designated official) is hereby authorized to allocate water according to the following water allocation plan:

Single-Family Residential Customers

The allocation to residential water customers residing in a single-family dwelling shall be as follows:

Persons per Household	Gallons per Month
1 or 2	6,000
3 or 4	7,000
5 or 6	8,000
7 or 8	9,000
9 or 10	10,000
11 or more	12,000

"Household" means the residential premises served by the customer's meter. "Persons per household" includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period. It shall be assumed that a particular customer's household is comprised of two (2) persons unless the customer notifies the ___________ (name of water supplier) of a greater number of persons per household on a form prescribed by the _________ (designated official). The _________ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every residential customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ___________ (name of water supplier) offices to complete and sign the form claiming more than two (2) persons per household. New customers may claim more persons per household at the time of applying for water service on the form prescribed by the __________ (designated official). When the number of persons per household increases so as to place the customer in a different allocation category, the customer may notify the _________ (name of water supplier) on such form and the change will be implemented in the next practicable billing period. If the number of persons in a household is reduced, the customer shall notify the _________(name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) persons per household, the _________ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the ___________ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than $________.

Residential water customers shall pay the following surcharges:

$____ for the first 1,000 gallons over allocation.
$____ for the second 1,000 gallons over allocation.
$____ for the third 1,000 gallons over allocation.

$____ for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

Master-Metered Multi-Family Residential Customers

The allocation to a customer billed from a master meter which jointly measures water to multiple permanent residential dwelling units (e.g., apartments, mobile homes) shall be allocated 6,000 gallons per month for each dwelling unit. It shall be assumed that such a customer's meter serves two dwelling units unless the customer notifies the ____________ (name of water supplier) of a greater number on a form prescribed by the __________ (designated official). The _________ (designated official) shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every such customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ____________ (name of water supplier) offices to complete and sign the form claiming more than two (2) dwellings. A dwelling unit may be claimed under this provision whether it is occupied or not. New customers may claim more dwelling units at the time of applying for water service on the form prescribed by the __________ (designated official). If the number of dwelling units served by a master meter is reduced, the customer shall notify the _________(name of water supplier) in writing within two (2) days. In prescribing the method for claiming more than two (2) dwelling units, the _________ (designated official) shall adopt methods to insure the accuracy of the claim. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units served by a master meter or fails to timely notify the ____________ (name of water supplier) of a reduction in the number of person in a household shall be fined not less than $________. Customers billed from a master meter under this provision shall pay the following monthly surcharges:

$____ for 1,000 gallons over allocation up through 1,000 gallons for each dwelling unit.
$____, thereafter, for each additional 1,000 gallons over allocation up through a second 1,000 gallons for each dwelling unit.
$____, thereafter, for each additional 1,000 gallons over allocation up through a third 1,000 gallons for each dwelling unit.
$____, thereafter for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

Commercial Customers

A monthly water allocation shall be established by the __________ (designated official), or his/her designee, for each nonresidential commercial customer other than an industrial customer who uses water for processing purposes. The non-residential customer's allocation shall be approximately __ (e.g. 75%) percent of the customer's usage for corresponding month's billing period for the previous 12 months. If the customer's billing history is shorter than 12 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists. Provided, however, a customer, __ percent of whose monthly usage is less than ____ gallons, shall be allocated ____ gallons. The _________ (designated official) shall give his/her best effort to see that notice of each non-residential customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ____________ (name of water supplier) to determine the allocation. Upon request of the customer or at the initiative of the ___________ (designated official), the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the customer's normal water usage, (2) one nonresidential customer agrees to transfer part of its allocation to another nonresidential customer, or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the ___________ (designated official or alternatively, a special water allocation review committee). Nonresidential commercial customers shall pay the following surcharges:

Customers whose allocation is _____ gallons through ______ gallons per month:

$____ per thousand gallons for the first 1,000 gallons over allocation.
$____ per thousand gallons for the second 1,000 gallons over allocation.
$____ per thousand gallons for the third 1,000 gallons over allocation.
$____ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is ______ gallons per month or more:

___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.
___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
___ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Industrial Customers

A monthly water allocation shall be established by the __________ (designated official), or his/her designee, for each industrial customer, which uses water for processing purposes. The industrial customer's allocation shall be approximately __ (e.g., 90%) percent of the customer's water usage baseline. Ninety (90) days after the initial imposition of the allocation for industrial customers, the industrial customer's allocation shall be further reduced to __ (e.g., 85%) percent of the customer's water usage baseline. The industrial customer's water use baseline will be computed on the average water use for the ______ month period ending prior to the date of implementation of Stage 2 of the Plan. If the industrial water customer's billing history is shorter than ___ months, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists. The _________ (designated official) shall give his/her best effort to see that notice of each industrial customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ____________ (name of water supplier) to determine the allocation, and the allocation shall be fully effective notwithstanding the lack of receipt of written notice. Upon request of the customer or at the initiative of the ___________ (designated official), the allocation may be reduced or increased, (1) if the designated period does not accurately reflect the customer's normal water use because the customer had shutdown a major processing unit for repair or overhaul during the period, (2) the customer has added or is in the process of adding significant additional processing capacity, (3) the customer has shutdown or significantly reduced the production of a major processing unit, (4) the customer has previously implemented significant permanent water conservation measures such that the ability to further reduce water use is limited, (5) the customer agrees to transfer part of its allocation to another industrial customer, or (6) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the ___________ (designated official or alternatively, a special water allocation review committee). Industrial customers shall pay the following surcharges:

Customers whose allocation is _____ gallons through _______ gallons per month:

$____ per thousand gallons for the first 1,000 gallons over allocation.
$____ per thousand gallons for the second 1,000 gallons over allocation.
$____ per thousand gallons for the third 1,000 gallons over allocation.
$____ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is ______ gallons per month or more:

___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation.
___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation.

___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation.
___ times the block rate for each 1,000 gallons more than 15 percent above allocation.

The surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Section X: Enforcement

(a) No person shall knowingly or intentionally allow the use of water from the _________________ (name of water supplier) for residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this Plan, or in an amount in excess of that permitted by the drought response stage in effect at the time pursuant to action taken by _____________(designated official), or his/her designee, in accordance with provisions of this

Plan.

(b) Any person who violates this Plan is guilty of a misdemeanor and, upon conviction shall be punished by a fine of not less than _______ dollars ($__) and not more than ______ dollars ($__). Each day that one or more of the provisions in this Plan is violated shall constitute a separate offense. If a person is convicted of three or more distinct violations of this Plan, the _____________ (designated official) shall, upon due notice to the customer, be authorized to discontinue water service to the premises where such violations occur. Services discontinued under such circumstances shall be restored only upon payment of a re-connection charge, hereby established at $______, and any other costs incurred by the ___________________ (name of water supplier) in discontinuing service. In addition, suitable assurance must be given to the ________________ (designated official) that the same action shall not be repeated while the Plan is in effect. Compliance with this plan may also be sought through injunctive relief in the district court.

(c) Any person, including a person classified as a water customer of the ______________ (name of water supplier), in apparent control of the property where a violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on the person's property shall constitute a rebuttable presumption that the person in apparent control of the property committed the violation, but any such person shall have the right to show that he/she did not commit the violation. Parents shall be presumed to be responsible for violations of their minor children and proof that a violation, committed by a child, occurred on property within the parents' control shall constitute a rebuttable presumption that the parent committed the violation, but any such parent may be excused if he/she proves that he/she had previously directed the child not to use the water as it was used in violation of this Plan and that the parent could not have reasonably known of the violation.

(d) Any employee of the _______________ (name of water supplier), police officer, or other _____ employee designated by the ___________ (designated official), may issue a citation to a person he/she reasonably believes to be in violation of this Ordinance. The citation shall be prepared in duplicate and shall contain the name and address of the alleged violator, if known, the offense charged, and shall direct him/her to appear in the _____________ (e.g., municipal court) on the date shown on the citation for which the date shall not be less than 3 days nor more than 5 days from the date the citation was issued. The alleged violator shall be served a copy of the citation. Service of the citation shall be complete upon delivery of the citation to the alleged violator, to an agent or employee of a violator, or to a person over 14 years of age who is a member of the violator's immediate family or is a resident of the violator's residence. The alleged violator shall appear in _________ (e.g., municipal court) to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in __________ (e.g., municipal court), a warrant for his/her arrest may be issued. A summons to appear may be issued in lieu of an arrest warrant. These cases shall be expedited and given preferential setting in __________ (e.g., municipal court) before all other cases.

Section XI: Variances

The ________________ (designated official), or his/her designee, may, in writing, grant temporary variance for existing water uses otherwise prohibited under this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Ordinance shall file a petition for variance with the ________________ (name of water supplier) within 5 days after the Plan or a particular drought response stage has been invoked. All petitions for variances shall be reviewed by the __________ (designated official), or his/her designee, and shall include the following:

(a) Name and address of the petitioner(s).
(b) Purpose of water use.
(c) Specific provision(s) of the Plan from which the petitioner is requesting relief.
(d) Detailed statement as to how the specific provision of the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
(e) Description of the relief requested.
(f) Period of time for which the variance is sought.
(g) Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.
(h) Other pertinent information.

Variances granted by the __________________ (name of water supplier) shall be subject to the following conditions, unless waived or modified by the ____________ (designated official) or his/her designee:

(a) Variances granted shall include a timetable for compliance.
(b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

EXAMPLE ORDINANCE FOR ADOPTION OF A DROUGHT CONTINGENCY PLAN

ORDINANCE NO. __________

AN ORDINANCE OF THE CITY OF ____________________, TEXAS, ADOPTING A DROUGHT CONTINGENCY PLAN; ESTABLISHING CRITERIA FOR THE INITIATION AND TERMINATION OF DROUGHT RESPONSE STAGES; ESTABLISHING RESTRICTIONS ON CERTAIN WATER USES; ESTABLISHING PENALTIES FOR THE VIOLATION OF AND PROVISIONS FOR ENFORCEMENT OF THESE RESTRICTIONS; ESTABLISHING PROCEDURES FOR GRANTING VARIANCES; AND PROVIDING SEVERABILITY AND AN EFFECTIVE DATE.

WHEREAS, the City of _________________, Texas recognizes that the amount of water available to the City and its water utility customers is limited and subject to depletion during periods of extended drought;

WHEREAS, the City recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes;

WHEREAS, Section 11.1272 of the Texas Water Code and applicable rules of the Texas Commission on Environmental Quality require all public water supply systems in Texas to prepare a drought contingency plan; and

WHEREAS, as authorized under law, and in the best interests of the citizens of _____________, Texas, the ________________ (governing body) deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies during drought and other water supply emergencies;

NOW THEREFORE, BE IT ORDAINED BY THE CITY OF ____________, TEXAS:

SECTION 1.

That the City of ____________, Texas Drought Contingency Plan attached hereto as Exhibit "A" and made part hereof for all purposes be, and the same is hereby, adopted as the official policy of the City.

SECTION 2.

That all ordinances that are in conflict with the provisions of this ordinance be, and the same are hereby, repealed and all other ordinances of the City not in conflict with the provisions of this ordinance shall remain in full force and effect.

SECTION 3.

Should any paragraph, sentence, subdivision, clause, phrase, or section of this ordinance be adjudged or held to be unconstitutional, illegal or invalid, the same shall not affect the validity of this ordinance as a whole or any part or provision thereof, other than the part so declared to be invalid, illegal or unconstitutional.

SECTION 4.

This ordinance shall take effect immediately from and after its passage and the publication of the caption, as the law in such cases provides.

DULY PASSED BY THE CITY OF _______________, TEXAS, on the ___________ day of ______________, 20__.

APPROVED:

____
MAYOR

ATTESTED TO:

____
CITY SECRETARY

APPROVED AS TO FORM:

____
CITY ATTORNEY

EXAMPLE RESOLUTION FOR ADOPTION OF A DROUGHT CONTINGENCY PLAN

RESOLUTION NO. _________

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE __________________ (name of water supplier) ADOPTING A DROUGHT CONTINGENCY PLAN.

WHEREAS, the Board recognizes that the amount of water available to the ____________ (name of water supplier) and its water utility customers is limited and subject to depletion during periods of extended drought;

WHEREAS, the Board recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes;

WHEREAS, Section 11.1272 of the Texas Water Code and applicable rules of the Texas Commission on Environmental Quality require all public water supply systems in Texas to prepare a drought contingency plan; and

WHEREAS, as authorized under law, and in the best interests of the customers of the ________________(name of water supply system), the Board deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies during drought and other water supply emergencies;

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE _________________ (name of water supplier):

SECTION 1. That the Drought Contingency Plan attached hereto as Exhibit "A" and made part hereof for all purposes be, and the same is hereby, adopted as the official policy of the ________________ (name of water supplier).

SECTION 2. That the _______________ (e.g., general manager) is hereby directed to implement, administer, and enforce the Drought Contingency Plan.

SECTION 3. That this resolution shall take effect immediately upon its passage.

DULY PASSED BY THE BOARD OF DIRECTORS OF THE _______________, ON THIS __ day of _____________, 20__.

____
President, Board of Directors

ATTESTED TO:

____
Secretary, Board of Directors

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Appendix E.3

Lavaca-Navidad River Authority Drought Contingency Plan

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LAVACA-NAVIDAD RIVER AUTHORITY

Drought Contingency Plan

As Revised August 24, 2005

LNRA

MANAGE CONSERVE PROTECT

LAVACA-NAVIDAD RIVER AUTHORITY

DROUGHT CONTINGENCY PLAN

MAY 2005

(Revised August 24, 2005)

DROUGHT CONTINGENCY PLAN

1.0 INTRODUCTION

Droughts and other uncontrollable circumstances can disrupt the normal availability of water supplies from either ground or surface sources. During drought periods, consumer demand is typically 15 to 25 percent higher than under normal conditions. Limitations on the supply of either ground or surface water, or on facilities to pump, treat, store, or distribute water can also present a public water supply utility with an emergency demand management situation.

The Drought Contingency Plan (DCP) establishes temporary methods designed to be used as long as the emergency exists. The purpose of the DCP is to specify how LNRA will contract and supply stored water supplies during a repetition of the critical drought of record. Consistent with Texas Commission on Environmental Quality (TCEQ) regulations, the LNRA has recommended that, as appropriate, its wholesale water customers consider adoption of drought contingency measures to be implemented in response to LNRA trigger conditions. As a provision of their respective water supply contracts, all LNRA customers have drought contingency plans on file with the TCEQ.

LNRA's DCP includes the following measures:

a. Trigger conditions signaling the start of an emergency period;
b. Designation of drought contingency measures;
c. Public information and education; and
d. Notification actions for drought termination

2.0 TRIGGERING CONDITIONS

As a wholesale water supply utility and a water resource manager, the LNRA will initiate drought contingency measures upon occurrence of the following conditions:

<u>Condition One:</u>	Compromised Reservoir Condition One Reservoir elevation is at or below elevation 43.00 msl
<u>Condition Two:</u>	Compromised Reservoir Condition Two Reservoir elevation is at or below elevation 40.15 msl
<u>Condition Three:</u>	Severe Local Drought Condition -- Compromised Groundwater Supply Reduction of local groundwater supplies to critical levels.

3.0 DROUGHT CONTINGENCY MEASURES

The following actions should be taken when trigger conditions are met. As a wholesale water supplier, the LNRA continuously monitors Lake Texana water levels and communicates with local communities as to the condition of water supplies in the Lavaca River Basin.

Condition One: Compromised Reservoir Condition One

A trigger condition has been established by an agreement between the LNRA and specified water rights permit holders upstream of Lake Texana using surface water for irrigation purposes. Trigger condition one impacts permit holders upstream of Lake Texana who divert water for irrigation purposes. Diversions for irrigation purposes are limited to times that Lake Texana is at or above elevation 43.00 msl. Prior to any initiating diversions, permittees must confirm the level of Lake Texana with either the LNRA or the TCEQ Watermaster. Diversions must cease within 24 hours following the time when the reservoir level drops below elevation 43.00 msl. The goal for water use reduction under Condition One is a 3% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition One, LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of reservoir condition.
b. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and upstream water rights permit holders.
c Through the news media, the public should be advised of the trigger condition situation. Include in the information to the public a recommendation that water users look for ways to conserve water.

Resumption of normal operation and termination of Condition One should occur when reservoir levels are equal to or greater than elevation 43.00 msl.

Condition Two: Compromised Reservoir Condition Two

A trigger condition has been established by an agreement between LNRA, Texas Parks and Wildlife Department and Texas Water Development Board, whereby upon Lake Texana reaches elevation 40.15 or roughly 78% of the reservoir capacity, LNRA may reduce the volume of freshwater releases to bays and estuaries to 5 cubic feet per second. The goal for water use reduction under Condition Two is a 5% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition Two, the LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of reservoir condition.
b. Inform public, giving notice of reservoir condition to the customers served by the LNRA system and include in the information recommendations for water conservation.

Resumption of normal operation and termination of Condition Two should occur when reservoir levels are equal to or greater than elevation 40.15 msl.

Condition Three: Severe Local Drought Condition- Compromised Groundwater Supply

All communities in the Lavaca River Basin use groundwater as their primary water supply source. Lowering of groundwater supplies to critical levels in these communities will impact the health and safety of the public. The water sales contract between the LNRA and the City of Corpus Christi allows for the return of 10,400 acre-feet for meeting the needs of Jackson County. The goal for water use reduction under Condition Three is a 7% percent reduction of the use that would have occurred in the absence of drought contingency measures.

Upon reaching Condition Three, the LNRA will implement the following relevant actions:

a. Notify the TCEQ Watermaster of the compromised condition.
b. The affected community(s) should continue implementation of relevant DCP and water conservation actions
c. Upon authorization by the TCEQ Watermaster, the LNRA will enact contractual provisions and assist the affected community as appropriate
d. Certain industrial and commercial water uses which are not essential to the health and safety of the community should be prohibited; and
e. Through the news media, the public should be advised daily of the trigger conditions.

4.0 INFORMATION AND EDUCATION

Once trigger conditions have been reached for the LNRA system, LNRA will notify the TCEQ Watermaster and its customers, whereby customers should notify the public within their jurisdictions of conditions and measures to be taken. The process for notifying the public should include:

a. Posting the Notice of Drought conditions at City Hall, County Courthouse, Post Office, Public Library, Senior Citizens Center, and Major Supermarkets;
b. Copy of notice to newspapers and hold press conferences; and
c. Copy of notice to local radio and television stations.

5.0 TERMINATION NOTIFICATION

Termination of the drought contingency measures should take place when the trigger conditions that initiated the drought contingency measures have subsided, and an emergency situation no longer exists. LNRA will notify the TCEQ Watermaster and its customers. Customers should notify the public within their jurisdiction of termination of the drought contingency measures in the same manner they were informed of initiation of the drought contingency measures through the city officials in charge.

6.0 LNRA ENVIRONMENTAL ASSURANCE PROGRAM

LNRA participates in the TCEQ sponsored Texas Clean Rivers Program, conducting water quality assessments of the Lavaca River Basin. The purpose of the water quality assessment is to identify issues affecting water quality in the Lavaca River Basin, and to develop solution techniques for improving water quality. The assessment program is divided into two phases. LNRA's Clean Rivers Program involves collecting, reviewing, and analyzing past and present water quality data, addressing public opinion, and identifying areas of potential pollution. The program has required the implementation of a comprehensive data management system, the establishment of a water quality monitoring network, and the identification of specific water quality concerns throughout the Lavaca River Basin. LNRA is providing water quality and water conservation information to citizens throughout the Lavaca River Basin as a means of public education. The LNRA Clean Rivers Program will assist in the protection of the water resources in the Lavaca River Basin.

7.0 PUBLIC INVOLVEMENT AND CUSTOMER COORDINATION

LNRA's wholesale water supply contracts are based on allocations from firm yield and are governed by and are enforceable in all respects in accordance with the laws of the State of Texas.

LNRA's water customers are required to prepare and submit Water Conservation and/or Drought Contingency Plans to the TCEQ. LNRA works closely and coordinates with its customers and recommends that each develop plans consistent with LNRA's DCP and conditions as established herein.

As a means of actively informing the public and to provide opportunity for input in the preparation of the DCP, and to inform LNRA's customers of the plan, information concerning drought management will be provided to the customers and the public by means of annual customer meetings, public board meetings, mail, telephone, and the news media, as appropriate.

8.0 PRO RATA WATER ALLOCATION

In the event that a) the triggering criteria specified herein have been met and b) the General Manager, or his designee, deems it necessary, LNRA, in coordination with the South Texas Watermaster, will allocate water supplies on a pro rata basis in accordance with Texas Water Code, § 11.039.

9.0 ENFORCEMENT

This DCP and all plans developed hereunder are incorporated by reference into all LNRA water supply contracts. Violation of this DCP is a violation of the contract and will be treated as such.

10.0 VARIANCES

The General Manager, or his designee, may grant a temporary variance to the pro rata water allocation policies provided by this DCP if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

a. Compliance with this DCP cannot be technically accomplished during the duration of the water supply shortage or other conditions for which the DCP is in effect.

b. Alternative methods can be implemented which will achieve the same level of reduction in water use.

11.0 PLAN UPDATE

LNRA shall review and update, as appropriate, this DCP at least every five (5) years, based on new or updated information, such as adoption or revision of a regional water plan.

APPENDIX A

Texas Administrative Code, Section 288.22

APPENDIX A

Texas Commission on Environmental Quality Rules on Drought Contingency Plans for Wholesale Water Suppliers

TITLE 30	ENVIRONMENTAL QUALITY
PART 1	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
CHAPTER 288	WATER CONSERVATION PLANS, DROUGHT CONTINGENCY PLANS, GUIDELINES AND REQUIREMENTS
SUBCHAPTER B	DROUGHT CONTINGENCY PLANS
RULE § 288.22	**Drought Contingency Plans for Wholesale Water Suppliers**

(a) A drought contingency plan for a wholesale water supplier must include the following minimum elements.

(1) Preparation of the plan shall include provisions to actively inform the public and to affirmatively provide opportunity for user input in the preparation of the plan and for informing wholesale customers about the plan. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(2) The drought contingency plan must document coordination with the regional water planning groups for the service area of the wholesale public water supplier to ensure consistency with the appropriate approved regional water plans.

(3) The drought contingency plan must include a description of the information to be monitored by the water supplier and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(4) The drought contingency plan must include a minimum of three drought or emergency response stages providing for the implementation of measures in response to water supply conditions during a repeat of the drought-of-record.

(5) The drought contingency plan must include the procedures to be followed for the initiation or termination of drought response stages, including procedures for notification of wholesale customers regarding the initiation or termination of drought response stages.

(6) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this paragraph are not enforceable.

(7) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(A) A pro rata curtailment of water deliveries to or diversions by wholesale water customers as provided in Texas Water Code, § 11.039; and

(B) utilization of alternative water sources with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(8) The drought contingency plan must include a provision in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, § 11.039.

(9) The drought contingency plan must include procedures for granting variances to the plan.

(10) The drought contingency plan must include procedures for the enforcement of any mandatory water use restrictions including specification of penalties (e.g., liquidated damages, water rate surcharges, discontinuation of service) for violations of such restrictions.

(b) The wholesale public water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The wholesale public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as adoption or revision of the regional water plan.

Source Note: The provisions of this § 288.22 adopted to be effective February 21, 1999, 24 TexReg 949; amended to be effective April 27, 2000, 25 TexReg 3544; amended to be effective October 7, 2004, 29 TexReg 9384.

APPENDIX B

Letter to Customers

APPENDIX B
Example Letter to Wholesale Water Customers

Date

[Customer]
[Address]

Dear [Customer]:

The Lavaca-Navidad River Authority has prepared a draft Drought Contingency Plan which, when adopted by the Board of Directors of the Lavaca-Navidad River Authority, will be used by the Authority as a component of its Water Management Plan. As a wholesale water customer of the Authority, we are seeking your input and comments on the draft Drought Contingency Plan. I have enclosed a copy of the Plan for your review.

Public comments regarding the draft Drought Contingency Plan may be made at the Public Meeting to be held by the Lavaca-Navidad River Authority Board of Directors on April 20, 2005. Written comments on the draft Drought Contingency Plan will be accepted through close of business on Tuesday, April 19, 2005.

We appreciate your input and interest in the water resources in the Lavaca River Basin.

Sincerely,

Patrick Brzozowski
General Manager
Lavaca-Navidad River Authority

APPENDIX C

Letter to Regional Water Planning Groups

APPENDIX C
Example Letter to Regional Water Planning Groups
[Planning Groups P and N]

Date

[Chairman]
Chair, Region__ Water Planning Group
[Address]

Dear [Chairman]:

Enclosed please find a copy of the draft Drought Contingency Plan for the Lavaca-Navidad River Authority. I am submitting a copy of this plan to the Region __ Water Planning Group in accordance with the Texas Water Development Board and Texas Commission on Environmental Quality rules.

Please review the draft plan for consistency with the approved Regional Water Plan. Public comments regarding the draft Drought Contingency Plan may be made at the Public Meeting to be held by the Lavaca-Navidad River Authority Board of Directors on April 20, 2005. Written comments on the draft Drought Contingency Plan will be accepted through close of business on Tuesday, April 19, 2005.

Sincerely,

Patrick Brzozowski
General Manager
Lavaca-Navidad River Authority

APPENDIX D

Texas Water Code, Section 11.039

APPENDIX D

Texas Water Code Section 11.039

§ 11.039. Distribution of Water During Shortage

(a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.

(b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:

(1) the amount of water to which each customer may be entitled; or

(2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.

(c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.

Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977.

Amended by Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.

APPENDIX E

Board Resolution to Adopt the Drought Contingency Plan

Lavaca-Navidad River Authority
Resolution No. 2005-002
Board Resolution Adopting the Drought Contingency Plan

Resolution Adopting a Drought Contingency Plan for the Lavaca-Navidad River Authority, Authorizing Submittal of the Drought Contingency Plan to the Texas Commission on Environmental Quality and the Texas Water Development Board for Approval, and Authorizing Incorporation of Provisions into All Water Sales Contracts used by the Lavaca-Navidad River Authority

BE IT RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that a Drought Contingency Plan attached hereto as Exhibit A, prepared in conformance with the requirements of the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB) is hereby adopted;

BE IT FURTHER RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that the General Manager is directed to submit the adopted Lavaca-Navidad River Authority Drought Contingency Plan to TCEQ and TWDB and for their approval; and

BE IT FURTHER RESOLVED by the Board of Directors of the Lavaca-Navidad River Authority that the General Manager, in accordance with state law, is directed to incorporate provisions into all water sales contracts used by the Lavaca-Navidad River Authority to require purchasers of water from the Lavaca-Navidad River Authority to implement water conservation and demand reduction measures in accordance with the adopted Lavaca-Navidad River Authority Drought Contingency Plan.

Passed and approved this 20th day of April, 2005.

Vée Strauss, President
Board of Directors
Lavaca-Navidad River Authority

ATTEST:

Willard Ulbricht, Secretary-Treasurer
Board of Directors
Lavaca-Navidad River Authority

Appendix E.4

City of Corpus Christi Water Conservation and Drought Contingency Plan (Amended November 15, 2005)

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City of Corpus Christi
Water Conservation and
Drought Contingency Plan
2005

Adopted April 26, 2005
Amended November 15, 2005

Prepared by

Chris Brown Consulting
in cooperation with the

City of Corpus Christi
Water Department

Executive Summary

The City of Corpus Christi has had a nationally recognized water conservation program for the past 16 years. Beginning in 1988, the City's Water Department assigned duties to a conservation coordinator, which has led to the development of award-winning programs like Xeriscape to Go, an educational brochure and website, and It's Up to Me and to You, a school-age program including the environmental mascot, Toby Globy. These efforts have resulted in measurable water savings. Total water consumption per person has dropped from 259 gallons per day in 1988 to 218 gallons per day in 2004.

The City has also worked with its wholesale customers to promote water conservation and to coordinate efforts during times of water shortage as in the mid-1990s. This document contains all of the provisions required in TAC Chapter 288 for municipal water providers, wholesale providers, and for a drought contingency plan. The document is divided into chapters that contain the major elements essential to each of the regulatory requirements, and appendices that contain legal ordinances enacting the Drought Contingency and Conservation Plan and water rates, as well as the utility profile and reservoir operations plan.

Chapter One summarizes the reservoir operating systems that supply the City of Corpus Christi and its wholesale customers with raw and treated water. Chapter Two presents the demand profiles and quantifiable targets and goals for the City, indicating that water use is tracked by customer class, and that the City has related its metered data to its conservation aims. For example, the City's largest retail customer class is single-family residential at 89 percent of customers, while the largest customer class by consumption per connection is industrial at 21 million gallons per month. The City is projecting a 1 percent per year drop in per capita consumption over the next 10 years, and has a goal to keep system water loss below 10 percent.

Chapter Three includes the 10 conservation best management practices that make up the City's Conservation Program. Mandatory elements, like metering, systems water audits, and conservation pricing are addressed, as well as voluntary practices like park conservation and water reuse. The City's conservation program is best known for its educational initiatives including efforts which target both adults and children. The Xeriscape Learning Center and Design Garden at the Museum of Science and History has attracted interest from horticultural and conservation specialists from around the state and the nation, as well as serving as a resource for school children and adults in Corpus Christi.

Chapter Four includes the provision addressing the wholesale customers, including a summary of contractual requirements to conserve during water shortages, and targets and goals section for wholesale customers. Chapter Five includes a summary of the drought plan provisions which were enacted by ordinance in 2001, and the water use reduction targets for the drought plan.

Chapter 1
Introduction

The City of Corpus Christi Water Department serves nearly 500,000 citizens of Corpus Christi and the Coastal Bend. Its mission is to effectively manage the City's water supply, production, and distribution system in order to meet water supply needs and to provide safe drinking water that meets state and federal regulations; to review the design and construction of water facilities to ensure the adequacy of the water system to meet projected growth requirements; and to identify and meet consumer needs and expectations.

The City of Corpus Christi Water Department supplies water for municipal and industrial use in a seven-county service area covering 140 square miles. Major raw water customers include Alice Water Authority, Beeville Water Supply District, City of Mathis, San Patricio Municipal Water District, Celanese, and Flint Hills Resources. Treated water customers include Nueces County Water Improvement District No. 4 (Port Aransas), San Patricio Municipal Water District, South Texas Water Authority, and the Violet Water Supply Corporation. The primary supply of water comes from surface water resources. The Frio River supplies water to Choke Canyon Reservoir. Lake Corpus Christi receives inflow from Choke Canyon Reservoir, the Atascosa and the Nueces Rivers, all within the Nueces River Basin. Water drawn from Lake Texana is pumped through the Mary Rhodes Pipeline and enters the O. N. Stevens Water Treatment Plant.

Lake Corpus Christi has a capacity of 242,241 acre-feet of water. Wesley Seale Dam was dedicated April 26, 1958. Choke Canyon Reservoir has the capacity of 695,271 acre-feet of water. The United States Bureau of Reclamation financed, designed, and built the reservoir, which was dedicated on June 8, 1982. The City operates and maintains the facility.

During 1993 to 1996, Nueces River Basin stream flows were the lowest recorded — even lower than the much-remembered 1950s Drought. The Regional Water Supply Task Force determined that additional water resources were needed for the Coastal Bend. In 1993, the City entered into a contract with the Lavaca-Navidad River Authority to purchase 41,840 acre-feet of water per year. The City of Corpus Christi, along with the Nueces River Authority, the Port of Corpus Christi and the Lavaca-Navidad River Authority worked together to deliver water via a new pipeline from Lake Texana. The 101-mile-long pipeline was named for the late Mary Rhodes, mayor of Corpus Christi from 1991 to 1997, in recognition of her special contribution to the development of water resources for the residents and industries of the Coastal Bend. Water is pumped through a 64-inch pipeline from Lake Texana near Edna, Texas. The pipeline came on line in September 1998. Approximately 50 percent to 70 percent of the water delivered to homes in Corpus Christi comes from Lake Texana.

Another Water Department function includes operation of the O. N. Stevens Water Treatment Plant. The City diverts raw water from the Nueces River and Lake Texana into the plant to be treated to Texas Commission on Environmental Quality (TCEQ) drinking water standards. Water is drawn from the Nueces River, and passes through screens to remove large floating objects. The water is pumped from the Nueces River to the treatment plant junction box, where it is blended with Lake Texana water. From there, the water is treated to remove suspended particles and disinfected for human consumption. Large master pumps help to distribute water into the City and to its wholesale water customers.

Approximately 28 billion gallons of water are treated each year. The O. N. Stevens Water Treatment Plant has a rated capacity of 167 million gallons per day, well above the peak summer demand of 110 million gallons per day. The Water Department operates five pumping stations and four elevated storage tanks, and maintains 1,600 miles of pipeline.

The Water Department operates in full compliance with all state and federal requirements. The Water Department also maintains a water laboratory and water maintenance activity that oversees the repair and replacement of transmission and service water lines.

To meet the demand of a growing community, the City has taken steps to assure a future water supply. In 1999, the City purchased senior water rights to 35,000 acre-feet of water per year in the Colorado River. This water will be transported to Corpus Christi via a pipeline that will be constructed in the future from the Colorado River to the Mary Rhodes Pipeline at Lake Texana.

The City is also exploring the feasibility of desalination — the process of removing salt from seawater — and is currently working on three independent desalination initiatives. In 2003, the City was one of three sites awarded a $500,000 state grant to conduct a study as part of Governor Rick Perry's initiative to assess the potential desalination of seawater to help meet the state's regional water needs. The Padre Island Desalination Plant Feasibility Analysis and Siting Plan is studying the feasibility and costs of building a reverse osmosis (RO) desalination facility (up to five million gallons per day (mgd)), increasing water storage at Padre Island, and using a technology that stores water underground for future use known as aquifer storage and recovery (ASR) in the Chicot Aquifer. The City is also participating in a U.S. Army Corps of Engineers feasibility study to assess the potential for desalination as a water supply source for the region. This study is jointly sponsored by the San Antonio Water System, San Antonio River Authority, and Guadalupe Blanco River Authority.

The Water Department has a long-standing commitment to promoting water conservation in the community. Its public education and communications functions promote community awareness of water resources, the importance of using water wisely, and techniques for efficient use of water. The Department provides free water-related educational materials to local school districts, public outreach, free water saving devices and an extensive year around media campaign. The long-term focus of the Plan is to stretch existing and planned expansions to the water systems by reducing per capita water consumption. Long-term conservation programs include conservation pricing, residential and commercial, and institutional water education designed to help customers reduce per capita water use by one percent per year over the next decade. Increased usage of reuse water and aquifer storage and recovery will also help manage the demand profile and use water more efficiently.

The service area of the City of Corpus Christi is located within the Coastal Bend, designated as Region N Planning area, and the City has provided a copy of its Water Conservation Plan to the Coastal Bend Regional Water Planning Group (RWPG). The Region N Planning Group was initially appointed by the Texas Water Development

Board (TWDB), under the authority of Senate Bill 1, and includes representatives from 12 interests including the public, counties, municipalities, industries, agriculture, the environment, small businesses, electric-generating utilities, port authorities, river authorities, water districts, and water utilities from across the region. This Plan is consistent with the City's role as a leader in water supply planning in Region N, and meets the standards for water conservation planning in TAC Chapter 288. The Water Department has coordinated with the RWPG through the following measures:

1. A City Council member sits on the planning group;
2. The City presented the 2005 Corpus Christi Water Conservation and Drought Contingency Plan at the Region N Water Planning Group Meeting;
3. City staff members (in addition to RWPG representative) attend Planning Group meetings;
4. City staff has made formal comments (at meetings and in writing) at various times regarding issues with population and water demand projections and with selection of water management strategies; and
5. The City has held numerous meetings with the RWPG consultant to address issues related to Corpus Christi and the regional planning process.

Chapter 2
Demand Profile, Targets, and Goals

2.1 Demand Profile

The City of Corpus Christi serves both wholesale and retail customers. Of the wholesale customers, five receive treated water, and six receive raw water from the City. Surface waters from the Nueces and Frio Rivers are impounded in Choke Canyon Reservoir and Lake Corpus Christi, while water from the Navidad River is impounded in Lake Texana.

Of the 112,876 acre-feet of raw water withdrawn in 2004, 26,397 acre-feet, or 30.5 percent, was delivered to the four wholesale and two retail customers on the Choke Canyon/Lake Corpus Christi (CCR/LCC) reservoir system, and 8,077 acre-feet was delivered to one wholesale customer on the Lake Texana side. Raw water customers include Alice Water Authority, Beeville Water Supply District, City of Mathis, San Patricio Municipal Water District, Celanese, and Flint Hills Resources. San Patricio Municipal Water District receives raw water from both the CCR/LCC system and Lake Texana. The remaining 78,402 acre-feet of raw water in 2004 was delivered to the O. N. Stevens Water Treatment Plant (WTP) for treatment and serves as retail and wholesale water supply of potable water. Figure 1, Corpus Christi Water Source Flow Chart 2004, as shown on the following page, reflect the amounts of water delivered to major customers from the two principle surface water sources, from raw water to the WTP, and then on to treated water customers.

The overall water demand by the City of Corpus Christi Water Department customers in the year 2004 was 36.8 billion gallons. In 2004, 46.7 percent of the raw water entered the WTP from the combined CCR/LCC system on the Nueces River. The remaining 53.3 percent of the raw water was withdrawn from Lake Texana on the Navidad River. Of the 25.5 billion gallons of raw water delivered to the O. N. Stevens WTP, 22.6 billion gallons were delivered to wholesale and retail customers.

Figure 1

Corpus Christi

Water Source Flow Chart for 2004

(Million Gallons)

CHOKE CANYON
RESERVOIR

LAKE CORPUS
CHRISTI

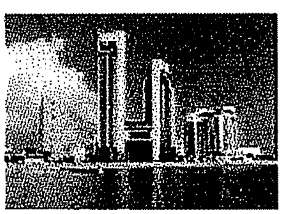
LAKE
TEXANA

Water Drawn from Choke Canyon / Lake Corpus Christi Reservoir System	
Alice	1,150
Beeville	744
Mathis	214
Celanese	1,050
Flint Hills Resources	1,769
San Patricio MWD	3,571
Corpus Christi	11,932
Total	**20,428**

Water Drawn from Lake Texana	
San Patricio MWD	2,625
Corpus Christi	13,616
Total	**16,241**

O. N. Stevens Water Treatment Plant (WTP)	
Raw Water Entering O. N. Stevens WTP	25,548
Treated Water Leaving O. N. Stevens WTP	25,081
UBO Billed Water Consumption	22,578

Treated Water Customers	
Naval Air Station	342
NCWCID #4	431
San Patricio MWD - Treated	1,058
South Texas Water Authority	599
Violet Water Supply Corp	53
Corpus Christi	20,095
Total	**22,578**



Retail industrial and single-family residential customers were the two highest demand sectors in 2004 for treated water at 38 percent and 26 percent respectively (see Figure 2, 2004 Treated Water Use by Customer Class (wholesale customers included)). They were followed by commercial customers at 22 percent and wholesale customers at 9 percent. City and State accounts, which include City parks, municipal buildings and State highway irrigation, represent 4 percent of overall consumption. Multi-family accounts represented approximately 1 percent of demand. Multi-family accounts include residential accounts with up to four housing units per meter. Apartments, condominiums, and domiciles with five or more units per meter are included in the commercial demand segment.

Figure 2

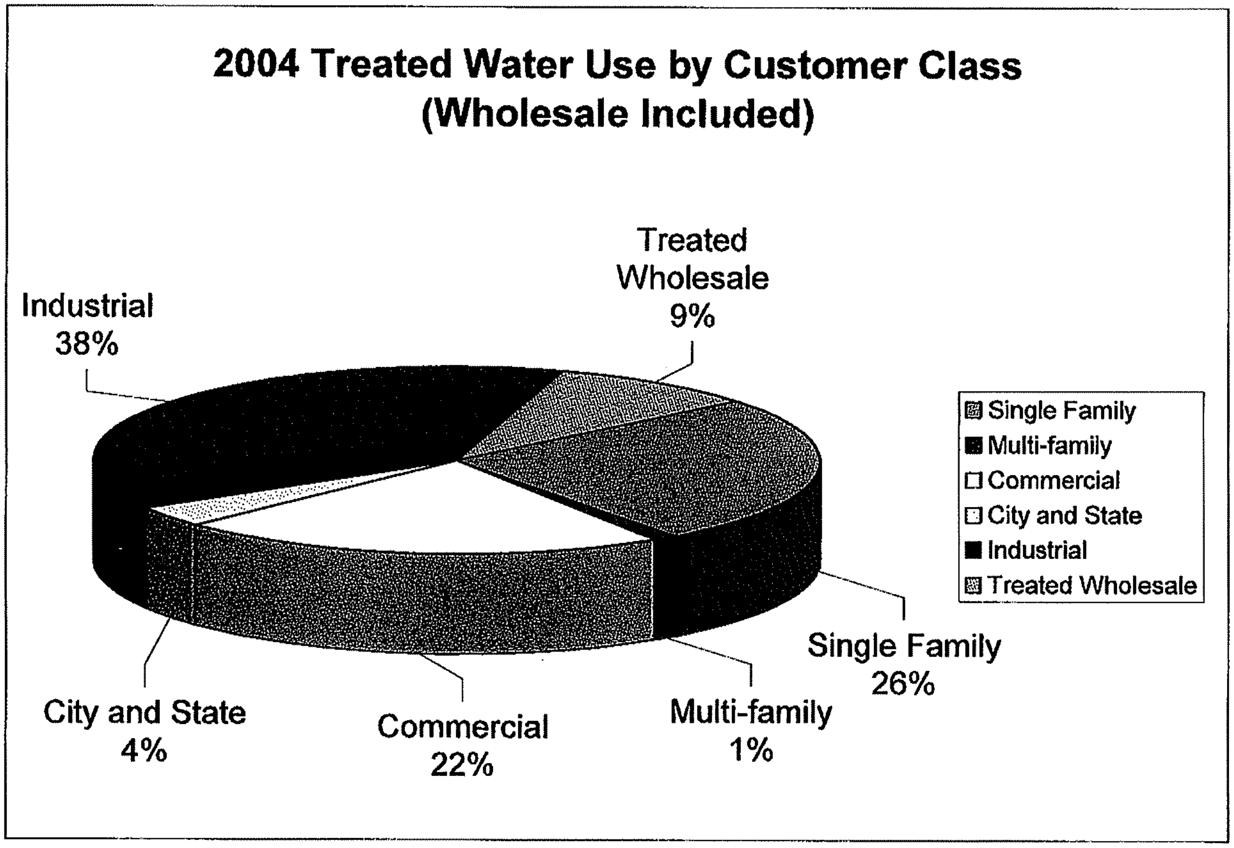
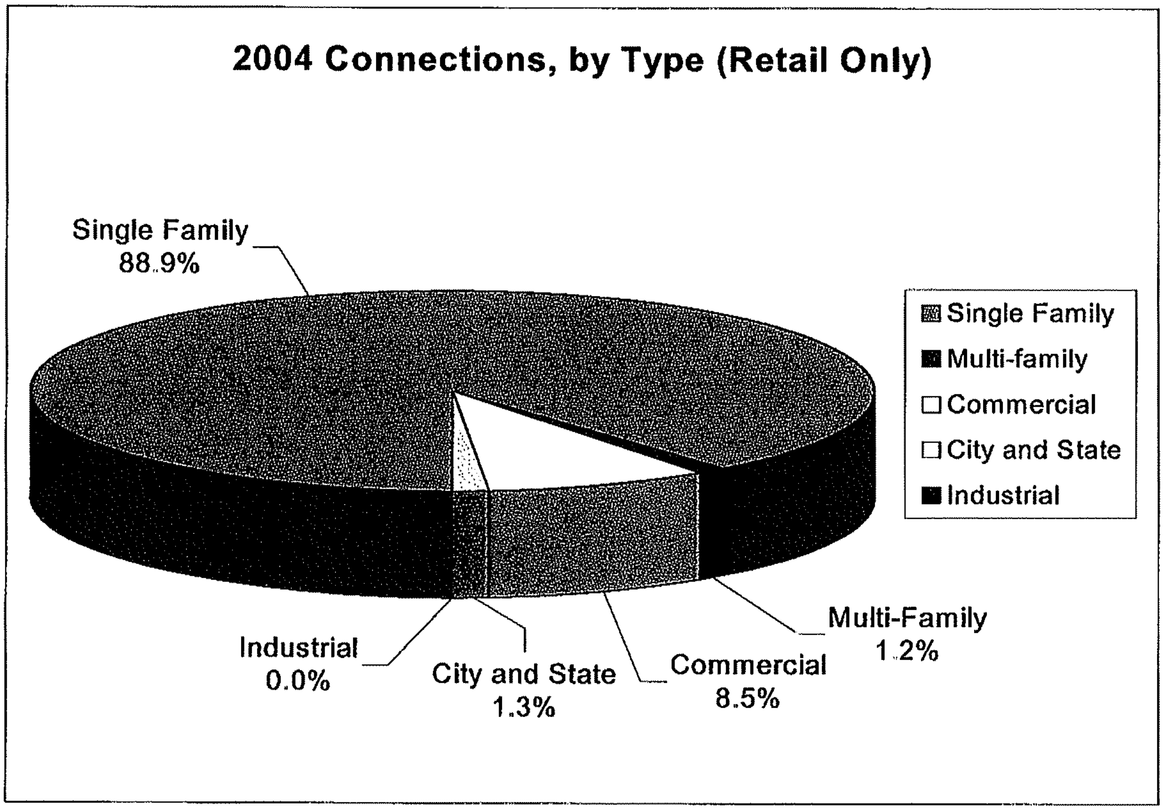


Figure 3, 2004 Connections by Type (Retail Only), shows the breakdown of retail treated water customers by connection. In 2004 the City served an average of 81,814 connections per month. The figure indicates that residential accounts represent the largest number of accounts at 88.9 percent of all retail connections. Commercial customers account for the next largest number of customers at 8.5 percent of all accounts. City and State accounts represent 1.3 percent of all connections; and industrial accounts with 31 connections were less than one-tenth of 1 percent of the total. Wholesale customers represent far less than 1 percent of connections, and are not included in Figure 3.

Figure 3



Examination of average monthly demand by account for retail customers as in Table 1, Average Monthly Gallons Per Connection By Type (Retail Only), 2000-2004, shows that industrial accounts are the largest average monthly volume customers of all retail customers. This suggests that industrial customers, followed by commercial and governmental accounts, offer the largest potential water savings per completed water survey or water conservation measures implemented. Multi-family connections show a consumption rate approximately three times higher that single-family consumption, which was the lowest of the average monthly consumption rates by type.

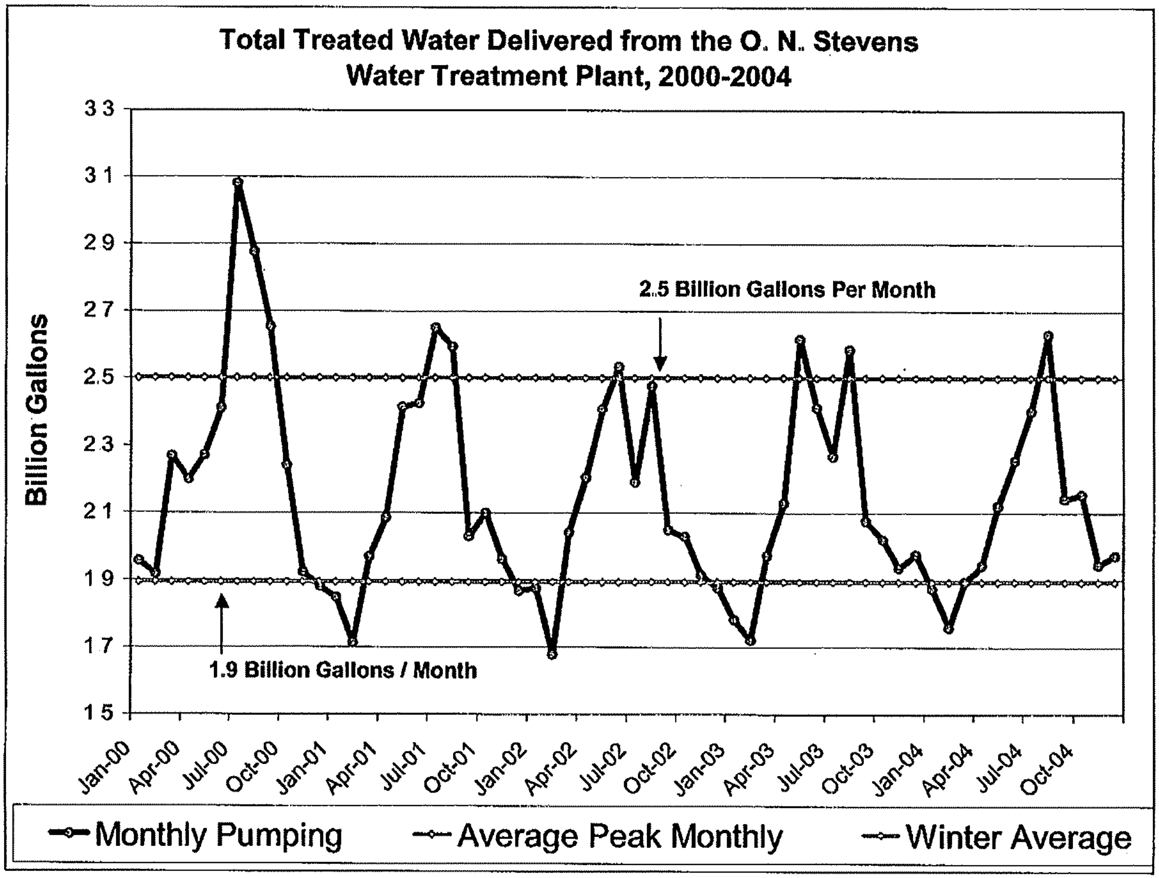
Table 1
Average Monthly Gallons Per Connection By Type (Retail Only), 2000-2004

	2000	2001	2002	2003	2004
Single Family	8,323	7,251	7,494	6,602	6,693
Multi-Family	16,094	15,813	17,560	18,340	19,692
Commercial	71,740	66,398	67,738	69,341	66,658
Industrial	28,382,467	27,785,118	25,051,003	25,347,578	21,885,144
City and State	54,072	50,324	100,642	132,021	20,690

System Efficiency
The Water Department summary showed an unaccounted for water rate of 8.7 percent in 2004, and an average of 5.1 percent over the past five years. The City's unaccounted for water rates are kept below 10 percent through an aggressive leak detection and repair program, timely meter testing and replacement, tracking of system pressures, and water use for construction and other purposes. Detailed descriptions of water loss reduction efforts are found in Chapter 3.

Seasonal Demand
The City's demand profile shows the summer peaks typical of Texas cities. Summer demand has averaged 2.52 billion gallons per month over the past five years. Over a similar time period, the winter average demand was approximately 1.88 billion gallons per month (Figure 4, Total Pumping 2000-2004). Single-family residential customers make up the largest share of summer time pumping, followed by commercial retail and wholesale customers. When viewed as a function of the ratio of winter time average to summer time peak, in 2004, wholesale customers, city and state accounts, and residential customers clustered at or above 1.34 times the winter average. Industrial and commercial customers had a summer peaking ratio of approximately 1.13 times the winter average. The cumulative winter/summer average was 1.34. Also discernible in Figure 4 is a reduction in the average summer/winter ratio from 1.50 in 2000 to 1.28 in 2004; or a reduction in average summer month pumping from 2.8 billion gallons per month (bgm) in 2000 to 2.4 bgm in 2004. This reduction can be attributed to the combined effects rainfall events has had on reduced irrigation usages; and public education over the past several years.

Figure 4



Source: Surface Water Monthly operating reports; TNRCC Form No. 0102c (12/01/00).

2.2 Goals

The City of Corpus Christi water conservation plan focuses on two efficiency goals. The first and most immediate goal is to reduce summertime peak pumping. The second goal is to reduce overall per capita consumption over the next several decades by 1 percent per year from the City's consumption of 259 gallons per capita per day (gpcd) in 1988 to 200 gpcd by 2014. The goals are designed to assist the City with challenges to water supply constraints due to weather, and to ensure that the system is run with the optimum efficiency. The City carefully balances revenue needs and conservation programming to ensure that the system is fiscally sound.

The City has a long history of progressive regional water resource planning. In keeping with that tradition, and to ensure that future generations will have adequate water supplies, the City will promote water conservation as an alternative water supply. Conserving existing supplies is less expensive and has less environmental impact than attempting to build new reservoirs. In order to reduce per capita demand over the next several decades, the City has embarked on a water conservation program designed to educate citizens on the benefits of efficiency, and to provide incentives for reduced water use through changes in behavior and installation of water saving devices.

Table 2, Water Consumption Goals, shows recent gpcd consumption and the goal of 1 percent per year reduction over the next 10 years based upon the City's pre-conservation consumption rates. Actual consumption indicates that the City is ahead of the 1 percent reduction per year in total gpcd recommended by the Texas State Water Conservation Implementation Task Force. The projected gpcd target goals are shown at 5- and 10-year increments as required by House Bill 2660. These targets and goals will be updated whenever the Water Conservation Plan is revised. The reduction in per capita consumption is a result of a combination of conservation efforts, including public education and restrictions on outdoor water use, implemented as part of the City's conservation plan and weather patterns.

Table 2
Water Consumption Goals Based on Gallons Per Capita Per Day (gpcd)[1]

	Actual		Target Goals		
Year	**1988**	**2004**	**2004**	**2009**	**2014**
Total gpcd	259	218	221	210	200
Single-Family Residential gpcd[2]	87	70	74	70	67
Non-Industrial gpcd[3]	152	134	129	123	117

[1] Wholesale customers are excluded.
[2] The City of Corpus Christi's current billing system does not distinguish between multi-family customers with more than five units, and other types of commercial customers. Thus only single-family consumption and 2004 population estimated from 2000 census data for single-family homes are used in the residential gpcd calculation.
[3] The City of Corpus Christi also tracks non-industrial gpcd, since industrial users play such a significant role in overall water usage in the city, and many of the conservation programs are targeted to outdoor discretionary use, which does not impact industrial water consumption.

Total gpcd represents all water pumped to O. N. Stevens WTP divided by total population, wholesale customers excluded. Residential gpcd is calculated by dividing total water sold to single-family residential customers by total single-family population. Table 2 also indicates that the City's actual water consumption has already shown a greater than 1 percent per year reduction in consumption since 1988, when the conservation program began.

In addition to traditional water conservation methods that focus on changes in customer consumption patterns, the Water Department plans to promote demand management techniques that provide the most efficient use of water resources. Demand management programs will be investigated in the next planning time frame to include reuse, aquifer storage and recovery, and conjunctive use of surface and groundwater resources.

Current efforts in reducing water losses focus on a percentage of unaccounted-for water, or the difference between billed water consumption and total water production. The City's goal is to keep the water loss rate below 10 percent. In 2004, the City's water loss was 8.7 percent. In future years, as the Texas Water Development Board (TWDB) provides more guidance, and with the publication of the American Water Works Association (AWWA) water system audit procedures, the City will evaluate moving to the leakage index method articulated in the System Water Audit and Loss Best Management Practice (BMP) identified in Chapter 3.

2.3 Utility Survey Data

A detailed summary of the City's water and wastewater system is included in Appendix A.

Chapter 3
Best Management Practices

3.1 Introduction

Water consumption in the City of Corpus Christi is driven by a wide variety of domestic, commercial, industrial, and institutional needs. Best Management Practices (BMPs) have been developed to improve water use efficiency for the City of Corpus Christi Water Department and for programs to assist the City's water customers in efficient water use. Ten BMPs have been implemented as part of the City's ongoing water conservation effort, which began in 1988. The BMPs are described briefly in the next paragraph, and in greater detail in the remaining sections of this chapter. Following the format recommended by the TWDB, each BMP has five sections; description, implementation, schedule, documentation, and water savings information.

The System Water Audits and Water Loss BMP allow the Water Department to reliably track water uses and provide the information to address unnecessary water and revenue losses. The Metering of All New Connections and Retrofit of Existing Connections BMP have been established to create equity among customers, reduce water waste, and reduce flows to wastewater facilities. The Water Conservation Pricing BMP is designed to discourage the waste of water while assuring the fiscal obligations of the system are met. The Prohibition on Wasting Water BMP is aimed at customers who continue to waste water despite Water Department efforts to educate customers to reduce waste of water. The Conservation Coordinator BMP provides an effective method of ensuring that the City's water conservation programs are well administered and effective.

The Public Information BMP affects water consumption through changes in behavior as customers learn about water resources, the wise use of water, and the conservation program. The Water-Wise Landscape Design Program BMP saves water through the installation of water-wise landscape materials supplemented with subsequent education to ensure efficient irrigation of the new landscapes. The Park Conservation BMP will save water through the implementation of regulations in existing BMPs and use of reclaimed water in the City's two golf courses, two large City-wide parks, five recreation centers, several decorative fountains, nine public swimming pools, and more than 200 neighborhood parks.

3.2 System Water Audit and Water Loss

A. Description

The City of Corpus Christi performs a regular estimate of system water efficiency by comparing water delivered to the treatment plant, potable water produced, and water sold. In accordance with the requirements of House Bill 3338, the City will increase the level of detail of water-use accounting by adding several categories of water-use tracking over the next year. The Water Department already tracks numerous leak detection and repair activities and is able to evaluate its success using the asset management software to compile and track work orders. Potential refinements for the future will include: leak repair summaries, average pressures, meter accuracy test, meter change-out summary, permitted fire hydrant use, and other records that may be kept on water theft and unmetered uses such as street cleaning. The City's top-down water audit, using existing records and some estimation, will provide a more detailed overall picture of water losses within the next calendar year, and will be maintained annually thereafter.

B. Implementation

A working group will be formed with representatives from the following work areas: management, distribution, operations, production, customer service, finance, and conservation. Each of these work areas has an essential role to play in implementing this BMP. Initially, the working group will focus on gathering relevant data and identifying current practices listed below in Step 1 that form the basis for the top-down audit.

> **Step 1.** The top-down audit will be performed using readily available information compiled annually in the Water Department's response to the Texas Commission on Environmental Quality's Utility Profile; with the worksheets provided by the TWDB's water planning division in response to HB 3338; and with plans to incorporate methods recommended by the American Water Works Association (AWWA) in the M36 Water Audit and Leak Detection Manual update.
>
> **Step 2.** The second step of the audit, the bottom-up approach, will involve a more detailed review of utility policies and practices that affect water losses. This review will be performed at least once every five years per the requirements of HB 3338. The Water Department will be able to better incorporate information from utility practices including leak reporting, whether by customers or by City staff, and repairing. Systems pressure tracking, especially analysis of high-end users' effects on systems pressures, will be accomplished through the use of Supervisory Control and Data Acquisition (SCADA) technology. The Water Department will also explore methods for developing better estimates of water use by the fire department and for line flushing and street cleaning. The City will also evaluate night flow and zonal analysis to better estimate leakage; analyze leakage repair records for length of time from reporting to repair of the leak; and analyze pressure throughout the system. The installation of Automatic Meter Readers (AMR) meters over the next several years will facilitate this effort.

Using the AWWA M36 Water Audits and Leak Detection Manual recommended methodology, the City will review and consider incorporating the relevant elements in the water loss control program. Potential elements of the future Water Loss Program will be evaluated including:

1. Using a water loss modeling program;
2. Metering individual pressure zones;

3. Establishing district metering areas (DMA) and measuring daily, weekly, or monthly flows with portable or permanently installed metering equipment;
4. Continuous or intermittent night-flow measurement;
5. Reducing repair time on leaks; and
6. Limiting surges in pressure.

To reduce the potential for leaks on the service lines between the main and the meter, all new construction is required to use Type K copper tubing and a single compression fitting. No splices are allowed in these lines.

C. Schedule

Initial elements to reduce water losses and account for water use and loss were implemented in 1970s.

1. The Water Department will gather the necessary information for conducting the top-down audit, develop the procedures, and complete the audit by March 31, 2006.
2. The Water Department will review the new M36 manual and begin implementing the bottom-up refinements indicated by the TWDB's new guidelines for water audits before March 31, 2007.
3. After such review, the Water Department will propose new water audit standards based upon keeping real water losses below a specific percentage or to achieve an infrastructure leakage index (ILI) below 3.
4. A bottom-up audit will be performed no less than once every five years; and more often if the internal water audit standard is not achieved.

D. Documentation

To track this BMP, the Department will collect and maintain the following documentation:

1. A copy of each annual system audit, the ILI and percentage losses for each year, and a list of actions taken in response to audit recommendations;
2. Annual leak detection and repair report, including number and sizes of leaks repaired;
3. Number of customer service line leaks identified and actions taken to repair these leaks;
4. Pressure reduction actions taken, if any; and
5. Annual revenue increased through reducing apparent losses.

E. Determination of Water Savings

Potential water savings are an integral part of the system water audit process and will be contained in the audit report. Based on the results of the audit, goals will be set for reducing losses.

3.3 Metering of All Connections

A. Description

The purpose of this BMP is to ensure that all aspects of meter installation, replacement testing, and repair are managed optimally for water use efficiency. The City has fully implemented this BMP.

The meter program has several elements:

1. Required metering of all connections.
2. A policy for installation of adequate, proper-sized meters as determined by a customer's current water use patterns.
3. Direct utility metering of each duplex, triplex, and fourplex unit, whether each is on its own separate lot or there are multiple buildings on a single commercial lot.
4. Metering of all utility and publicly owned facilities.
5. Use of construction meters and access keys to account for water used in new construction.
6. Implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, which requires all new apartments be either directly metered by the utility or submetered by the owner.
7. Annual testing and maintenance of all meters larger than two inches. Regular replacement of five-eighth- and three-quarter-inch meters in service for 15 years of service.
8. An effective monthly meter-reading program in which readings are estimated only in cases of inoperable meters or other extenuating circumstances. Broken meters are replaced within five days.
9. An accounting of water savings and revenue gains through the implementation of the Water Department's meter repair and replacement procedures.

B. Implementation

The Water Department ensures the high quality of metering is maintained through the regular review of metered data and revision of metering policies to ensure that the maximum amount of water consumption is accounted for.

The City will continue to conduct a meter repair and replacement procedures following the methodology and frequency currently recommended in industry practices and recommended by the AWWA. This includes:

1. Maintaining a proactive meter-testing program, and repair identified meters; and
2. Notifying customers when it appears that leaks exist on the customer's side of the meter.

The City is also conducting a pilot study conducted to determine whether or not to expand the use of Automatic Meter Readers (AMR) meters.

C. Schedule

The City has already implemented this BMP, and continues to maintain the practice on an ongoing basis.

D. Documentation

To track the effectiveness of the Metering BMP the Water Department gathers the following documentation:

1. Copy of meter installation guidelines based upon customer usage levels;
2. Copy of meter repair and replacement policy;
3. Records of number and size of meters repaired annually;
4. Report on the method used to determine meter replacement and testing intervals for each meter size; and
5. Estimate of water savings achieved through meter repair and replacement program.

E. Determination of Water Savings

Every year the Water Department will estimate its annual water saving from the BMP. Savings can be estimated based upon a statistical sample analyzed as part of the meter repair and replacement program.

3.4 Water Conservation Pricing

A. Description

The City has an increasing block rate structure for residential customers. A copy of the current water rate structure is attached as Appendix D. The basic rate structure is designed to recover the cost of providing service and billing for water, storm water and wastewater service based on actual metered water use. The rates include a consumption charge based upon actual gallons metered so that increasing water consumption results in a larger bill for the customer. Conservation such as an increasing block structure helps to decrease water use by targeting the highest use rates with highest prices.

B. Implementation

A rate study is being initiated to determine the appropriate rate structure for all customer classes. When the study is completed, a new rate structure may be proposed. The existing increasing block for residents will be retained and additional conservation pricing structures will be examined, such as the following:

1. Seasonal rates to reduce peak demands during summer months.

2. Increasing block rates for other customer classes. Rates for single-family residential and other customer classes may be set differently to reflect the different demand patterns of the classes.

Successful adoption of a new rate structure may necessitate developing and implementing a public involvement process to educate the community about the new rate structure. The City's rate structure will adhere to all applicable regulatory procedures and constraints. If the conservation pricing structure is implemented and is substantially different from current practices, a phase-in approach will be evaluated.

At least annually, the Water Department staff will review the consumption patterns (including seasonal use) and the income and expense levels to determine if the conservation rates are effective, and make appropriate, regular rate structure adjustments as needed.

Within one year, the City will consider adopting service rules or an ordinance requiring new commercial and industrial customers to install separate irrigation meters and the feasibility of retrofitting commercial and industrial current customers with irrigation meters.

Public involvement in the development and implementation of conservation rates can help assure that the goals of the conservation pricing initiatives will be met and accepted by local constituents. Public meetings, advisory groups, and public announcements are among ways to generate public involvement.

The City's priority is a rate design that sends the appropriate price signal to customers to reduce discretionary water use. To remain effective, the rates need to be adjusted periodically to take inflation into account, as well as future increases in operating costs.

C. Schedule

Upon completion of the rate study, pricing recommendations will be brought to the Corpus Christi City Council for consideration.

D. Documentation

To track this BMP, the Water Department maintains the following documentation:

1. A copy of its rate ordinance;
2. Billing and customer records that include annual revenues by customer class and revenue derived from commodity charges by customer class for the reporting period;
3. Monthly customer numbers and water consumption by customer class; and
4. A copy of the education materials on the conservation rate sent to customers for each calendar year this BMP is in effect.

E. Determination of Water Savings

Elasticity studies have shown an average reduction in water use of 1 to 3 percent for every 10 percent increase in the average monthly water bill. In implementing a conservation pricing structure, consideration will be given to the factors that influence whether the new structure results in a reduction in water use. The *Water Price Elasticities for Single Family Homes* (TWDB, 1998) study included the City of Corpus Christi among the study subjects. The study found long-term price elasticities of -0.20 for the City, which translates into a reduction of 2 percent in water use for a 10 percent increase in price.

3.5 Prohibition on Wasting Water

A. Description

Water Waste Prohibition measures are enforceable actions and measures that prohibit specific wasteful activities. Under this BMP, ordinances have been enacted and enforced to prohibit wasteful activities. No person may:

1. Allow water to run off yards or plants into gutters or streets.
2. Permit or maintain defective plumbing in a home, business establishment or any location where water is used on the premises. Defective plumbing includes out-of-repair water closets, underground leaks, defective or leaking faucets and taps.
3. Allow water to flow constantly through a tap, hydrant, valve, or otherwise by any use of water connected to the City water system.
4. Use non-recycling decorative water fountain.

Water waste during irrigation includes:

1. Water running along the curb of the street;
2. Irrigation heads or sprinklers spraying directly on paved surfaces such as driveways, parking lots, and sidewalks in public right-of-ways;
3. Operation of an irrigation system with misting heads caused by water pressure higher than recommended design pressure for the heads, or operation with broken heads;
4. Spray irrigation during summer months between the hours of 10 a.m. and 6 p.m.
5. The Water Department is exploring the potential for introducing ordinances requiring rain sensors and/or evapotranspiration (ET) controllers on automatic irrigation systems in the future.

B. Implementation

This BMP is implemented by the regular operating personnel of the Water Department, and leaks on the water system distribution lines are repaired by crews that are available 24 hours a day. Through visual detection of leaks reported by the public or Department staff, and audible detection of leaks by storm water crews, leaks are detected and scheduled for repair.

C. Schedule

The initial water waste provisions on Corpus Christi's City ordinances were introduced in 1986 as part of the Drought Contingency Plan. The drought contingency and water conservation ordinances have been amended numerous times.

Future water waste ordinances, such as rain sensors or ET controllers, will be considered for introduction to the City Council in the 2005-2007 time period.

D. Documentation

To track this BMP, the Water Department maintains the following documentation:

1. Copy of City's Plumbing Code, Section 612 Lawn Irrigation Systems;
2. Copy of compliance or enforcement procedures implemented by the Code Enforcement and Water Department; and
3. Records of enforcement actions including public complaints of violations and responses from Code Enforcement and Water Department.

E. Determination of Water Savings

Total water savings for this BMP can be estimated from each water-wasting measure eliminated through the actions taken under this BMP. The Water Department will develop new tracking methods to determine overall water saved through the water waste prohibition efforts in future years.

3.6 Conservation Coordinator

A. Description

The City's Water Public Relations and Marketing Coordinator oversees and coordinates conservation efforts within the Water Department's service area for retail customers and assists in conservation efforts of wholesale customers.

The Coordinator is responsible for effecting water conservation practices and measures within the Water Department's service area by promotion of water conservation programs, development of marketing strategies for conservation programs, and coordination with other Department staff and program partners. The coordinator also promotes the value of conservation programs within the Department.

Water conservation programs are directed to primary grade school children through the schools and through public events, and to the general public through media awareness campaigns, demonstration gardens, public events, and partnership with other entities such as Texas Cooperative Extension, Nueces County Master Gardeners and local school districts.

Other duties include preparation of the annual conservation budget; preparation and implementation of the water conservation and drought contingency plans; preparation and submittal of annual conservation status reports to Water Department management;

implementation of the Water Department's conservation program; and management of the conservation staff, consultants, and contractors, when appropriate.

B. Implementation

Coordinator and support staff duties include the following:

1. Manage and oversee conservation programs and implementation;
2. Document water conservation program implementation status as it relates to state requirements and water conservation BMPs adopted by the Water Department;
3. Communicate and promote water conservation to Water Department management;
4. Communication and promote water conservation to wholesale customers;
5. Coordinate Water Department conservation programs with operations and planning staff;
6. Prepare annual conservation budget;
7. Manage consultants and contractors assisting in implementing the water conservation program;
8. Coordinate with partnering agencies, such as Texas Cooperative Extension, Texas A&M University – Corpus Christi;
9. Assist in preparing presentations to the Water Resource Advisory Committee and Corpus Christi Community Advisory Council;
10. Develop public outreach and marketing strategies for water conservation; and
11. Serve as media contact and public information spokesperson for the Water Department on conservation issues.

The water conservation plan's budget includes public school education programs, media campaigns, and public event participation and materials.

C. Schedule

The Water Department first hired a conservation coordinator in 1987. The Water Department employs the Public Relations and Marketing Coordinator, assisted by support staff, on an ongoing basis.

D. Documentation

The Water Department gathers the following documentation:

1. Description of the Public Relations and Marketing Coordinator position;
2. Annual or more frequent reports on progress of water conservation program implementation, costs and water savings; and
3. Effectiveness of programs of wholesale customers in terms of water savings.

E. Determination of Water Savings

The Coordinator assists in the implementation of other BMPs. This effort can be considered as essential to the savings accrued by the implementation of the whole range of conservation programs that are offered by the Water Department.

3.7 Public Information

A. Description

The Water Department employs several types of media resources and modes of mass communication to present a compelling and consistent message about the importance of water use efficiency to managing and sustaining existing water supplies and delaying the need to build new treatment facilities. The overall goal of the public information program is to raise awareness among customers and citizens of the overall picture of regional water resources and the importance of conservation.

B. Implementation

The Water Department employs the following methods to bring the water resources awareness and to instill the importance of conservation in the community:

1. **Multi-tiered media campaign.** A budget of $175,000 funds annual television, radio, and print campaigns promoting water use efficiency. Agreements with radio and television stations provide for matching airtime for each ad purchased by the City.

2. **Billboard advertisement.** Ads on two billboards and 25 bus benches were obtained at a discount to promote the City's water conservation campaign, "Make Saving Water a Life Long Habit."

3. **Website.** The Water Conservation Department's website includes tips on outdoor and indoor conservation, an on-line version of the *Xeriscape-to-Go* brochure (the City's plumbing ordinance requiring drip or soaker hose irrigation on landscaped strips narrower than five feet), and information on the Xeriscape Coalition.

4. **Printed brochures.** Printed brochures available to the public are explained in the Water-Wise Landscape Design and Conversation Program:
    a. *Xeriscape To-Go: Planning and Designing a Gardener's Dream*,
    b. *Xeriscape: Landscape with Less Water*, and
    c. *Purple Water-Wise Plant Labels*.

5. **School Education.** Programs targeted to grade school children are explained in the School Education section.

6. **Xeriscape Learning Center and Design Garden.** As part of the Corpus Christi Museum of Science and History, the Xeriscape Corpus Christi Steering Committee, in partnership with the City, maintains a Xeriscape demonstration

garden with more than 100 plant varieties. Within the garden an educational gazebo, The Water Story Exhibit, showcases and 8-foot interactive topographic map of the Nueces River Basin. A second gazebo is directed at children. Educational Walk 'n' Talk Tours are held annually to enhance public education.

7. **Water Hotline.** The Water Hotline was established in 1999 to encourage public access to water conservation information. Customers utilize a dedicated telephone line to request water conservation kits and other information. A radio jingle was recorded to create awareness of the number.

C. Schedule

1. The Xeriscape Learning Center and Design Garden at the Museum of Science and History premiered in 1994 and continues as an ongoing effort.
2. The multi-tiered media campaign was initiated in 1994, and continues as an ongoing effort.
3. The Water Hotline started in 1999.
4. *Xeriscape-to-Go* in both print and on-line versions was developed and printed in 1999.
5. The City's Water Conservation website is continually updated.

D. Documentation

To track the progress of this BMP, the Water Department gathers the following documentation:

1. Number of activities, pieces of information distributed, and number of customers at that activity;
2. Number and schedule of activities or information pieces related to promoting specific BMPs adopted by the Water Department;
3. Number of public school children divided by grade level who received instruction in water resources or water conservation;
4. Number of news programs or advertisements that featured the water conservation message and how many customers had the opportunity to receive each message;
5. Total population in the service area;
6. Total budget by category for public information; and
7. Results of annual or biannual customer survey and/or focus groups to determine the reach and impact of the program.

E. Determination of Water Savings

Water savings due to public information efforts are difficult to quantify. Water savings for other public information programs that result in specific actions by customers such as changes in irrigation scheduling or reduction in water waste occurrences may be quantified through surveys or analysis of water waste reporting in future years.

3.8 School Education

A. Description

School education programs, which may not result in quantifiable water saving, nevertheless enhance a utility's public image, contribute to the attainment of Texas state education goals by students, increase customer goodwill, and increase the viability of its overall water conservation efforts. The message conveyed by students to their families based upon greater knowledge of water sources and conservation can result in behavioral changes resulting in both short- and long-term water savings.

B. Implementation

The City of Corpus Christi Water Department offers the following school educational programs.

- ***Major Rivers.*** Piloted in 1991 and revised for the 2003-2004 school year, the self-contained *Major Rivers* curriculum, incorporated into the 4th grade curriculum, meets or exceeds the requirements of Texas Essential Knowledge and Skills (TEKS). The program educates students on water conservation, supply, treatment, distribution and conservation. The self-contained program offers academic and hands-on activities in math, language arts, science, and social studies, with teacher's guide geared to the interdisciplinary curriculum, as well as an introductory video and home information leaflets. The program includes pre- and post-test evaluations. In addition, teachers receive continuing education credits for participating in *Major Rivers* workshops. The program is funded by the City at a base price of $45 per classroom.

- ***It's Up to Me and to You.*** Introduced to school children in grades pre-kinder to third grade with classroom and special event visits by mascot Toby Globy, this locally produced bilingual program brings the environmental awareness to primary grade school children in sing-along song and coloring books, a compact disc of recorded music in English and Spanish, environment-oriented classroom activities, posters, and a pictorial instruction booklet introducing solid waste, and recycling, in addition to water conservation.

- ***Learning to be Water Wise.*** A pilot scale study program was started in a local 5th grade class. Classroom instruction in science, math, language arts, and social studies is complemented by water conservation kits, which include a toilet water displacement bag, toilet leak detector tablets, showerhead and faucet aerators, and instructions for repairing common toilet leaks. This program, has been shown in a study conducted in 2002 to produce an estimated savings of 8,885 gallons per year in homes in which the water-saving fixtures have been installed (*Learning to Be Waterwise, City of Corpus Christi 2001-2002 Program Summary Report,* Prepared for City of Corpus Christi, Dave Munk, 2002.)

- **Workshop for Daycare Teachers.** In a half-day-long workshop, local daycare providers were introduced to age-appropriate water resources teaching aids, including the educational program "It's Up to Me and to You" and coloring books with a water-conservation message.

- ***Water Source Book.*** The *Water Source Book*, developed by the Water Environment Federation, reinforces water resource issues with hands-on classroom activities and experiments for grades 6 through 8. The classroom activities feature water, wastewater, and stormwater experiments. This book is provided by the City to all local school resource libraries. Continuing education workshops, introduce local classroom teachers to the *Water Source Book*. Teachers can utilize this teaching aid to satisfy certain TEKS objectives as established by the Texas Education Agency.
- **Coastal Bend Teacher Resource Extravaganza.** The City Water Department has participated in the Coastal Bend Informal Educators (CBIE), to offer valuable opportunities and resources for teachers, students and the general public at the annual event.
- **Museum of Science and History.** The Corpus Christi Museum of Science and History offers guided tours to school groups. In addition, one educational gazebo, targeted to children, features various activities including an old-fashioned water pump to measure one's weight in water plus various activities. A second educational gazebo, The Water Story Exhibit, showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources.
- **Other educational materials.** The Water Department of the City of Corpus Christi also provides age-appropriate water resources teaching materials at public events. Materials include *Splash Activity Book*, *My Book About Water and How to Use it Wisely*, and *The Story of Drinking Water*.

C. Schedule

The Water Department of the City of Corpus Christi will continue to offer existing age- and grade-level-appropriate educational programs in the classroom as detailed above.

D. Documentation

To track the progress of this BMP, the utility should gather and have available the following documentation:

1. Number of school presentations made during reporting period;
2. Number and type of curriculum materials developed and/or provided by water supplier;
3. Number and percent of students reached by presentations and by curriculum;
4. Number of students reached outside the utility service area;
5. Number of in-service presentations or teacher's workshops conducted during reporting period;
6. Results of evaluation tools used, such as pre- and posttests, student surveys, teacher surveys;

7. Copies of program marketing and educational materials; and
8. Annual budget for school education programs related to conservation.

E. Determination of Water Savings

Water savings for school education programs are difficult to quantify. The retrofit kit included with the *Learning to be Water Wise* has been shown to reduce domestic water use by 8,885 gallons per year per household.

3.9 Water-Wise Landscape Design and Conversion Program

A. Description

The City will decrease both summertime water consumption peaks and overall water use by the installation of water-wise landscapes at residential properties and subsequent education to ensure efficient irrigation of the new landscapes. Water-wise landscaping involves not only plant selection, but continued attention to appropriate irrigation and landscape maintenance.

In addition, a public education and outreach campaign through the media, Water Department-produced brochures, partnership with the Nueces County Master Gardeners and Texas Cooperative Extension, plant labeling at commercial nurseries, and installation of public demonstration gardens will create a multi-faceted program bringing water-wise landscape design to residential and commercial customers.

The City has adopted a Landscape Ordinance as part of its Zoning Ordinance. This ordinance requires landscape plantings within commercial developments to enhance the beauty of the City. The ordinance assigns points to the various plant materials. To encourage the use of water-wise landscaping, drought-tolerant and low-water-use species are assigned a higher point value. To comply, a landscape design must surpass an established threshold number of points, which is achieved more easily with the water wise and drought-tolerant plants.

B. Implementation

The implementation of this BMP involves continual public education campaigns, including media partnering with groups such as Nueces County Master Gardeners for outreach.

The City will continue existing public outreach measures and existing educational and outreach campaigns:

1. ***Xeriscape To-Go: Planning and Designing a Gardener's Dream.*** A new brochure, both in print and online, designed to educate local residents on the benefits of Xeriscape landscaping, features a plant list suitable for the Coastal

Bend and an explanation of the seven principles of Xeriscaping. The choice of vegetation and the Xeriscape gardening techniques save water and reduce maintenance requirements.

2. ***Xeriscape: Landscape with Less Water.*** A brochure detailing the seven principles of Xeriscaping.
3. ***Purple Water-Wise Plant Labels.*** A brochure produced in cooperation with the non-profit Xeriscape Corpus Christi, commercial nurseries, and Texas Cooperative Extension to bring to public awareness lists of plants that are proven performers in the Coastal Bend. Also, the City's landscape ordinance assigns points to the various plant materials; drought-tolerant species are assigned a higher point value. Water-wise plants are labeled with purple tags at commercial nurseries for easy identification. Purple labels are affixed to water-wise and drought-tolerant plants offered at retail nurseries.
4. **Multi-Tier Media Campaign.** The City will continue local television and radio stations ads, with stations offering to match ad for ad, or provide a rate discount to the City. A television commercial featuring Texas Cooperative Extension horticulture agents will promote water-wise landscaping.
5. **Xeriscape Corpus Christi.** A steering committee established to develop an educational garden teaching the seven principles of Xeriscape. The garden was built at the Museum of Science and History. The steering committee's members include Beautify Corpus Christi Association, the City of Corpus Christi Water Department, Storm Water Department, and Park and Recreation Department, Corpus Christi Museum of Science and History, Friends of the Museum, Mayor's Water Conservation Advisory Committee, Nueces County Master Gardeners, and Texas Cooperative Extension – Nueces County.
6. **Xeriscape Design Garden and Learning Center.** The demonstration garden at the Museum of Science and History exhibits over 100 plant varieties. One educational gazebo, The Water Story Exhibit, showcases an 8-foot interactive topographic map of the Nueces River Basin. The touch of a button activates lights and sound to explain the area's water resources. The second gazebo, targeted to children, features various activities including an old-fashioned water pump to measure your weight in water plus various activities. Other exhibits feature South Texas' hardiest plants, a mulch exhibit, and a classroom exhibit, as well as a feature on South Texas' hardiest plants. Planting events are held twice a month. Tours will continue to be provided to schools and civic organizations upon request.
7. **Rain Sensors.** The Water Department will evaluate the potential for greater savings by adoption of a rain sensor ordinance requiring the use of rain sensors on all automated irrigation systems.
8. **Evapotranspiration (ET) Controllers.** The Water Department will explore the possibility of requiring ET Controllers on new and refurbished irrigation systems. These controllers may also be purchased for use with City property as demonstration project.

In addition, vegetation on each island at the **Xeriscape Design Garden and Learning Center** is grouped based upon water needs. Each island is separately metered, and the individual meters are read monthly. They are watered on average one-quarter inch to one-third inch per week. Rain sensors on the automatic sprinkler systems help reduce water use by running equipment only when water is needed. Landscaping at Water Department properties and some park properties survives on rainfall alone.

C. Schedule

This BMP was initially implemented in 1991 with the initiation of the multi-faceted media campaign to increase public awareness of Xeriscaping. A number of activities listed above have been initiated over the years, and are planned for ongoing implementation, including:

1. Public outreach and educational campaigns and partnership with Nueces County Master Gardeners, Texas Cooperative Extension, and retail plant nurseries since 1993;
2. Plant labeling for water-wise and drought-characteristics at commercial plant nurseries since 2004; and
3. Draft plan for a changes to the commercial landscape ordinance in 2005-2006.

Over the next five years, the City will perform evaluations of its ongoing programs to determine the effectiveness of each effort. The City will also determine the feasibility of ordinances requiring ET-controller and rain sensor installation on automated sprinkler systems by the end of the 2006.

D. Documentation

To track the effectiveness of Water-Wise Landscape Design and Conversion Programs, the Water Department will gather the following documentation:

1. Number of dedicated irrigation meter accounts;
2. Estimated landscape area converted;
3. Estimated water savings based on customer billing records;
4. Customer water use records prior to and after conversion of the landscape. This data is best compared in years of similar rainfall and after the landscape has been installed a sufficient time to establish itself; and
5. Number of rain sensors and ET-controllers on automatic sprinkler systems and customer records prior to and after installation of such devices. This data is best compared in years of similar rainfall and after the landscape has been installed a sufficient time to establish itself.

E. Determination of Water Savings

Water savings will be determined from analysis of actual customer-metered water use before and after landscape conversion and/or installation of rain sensors or ET controllers.

In addition, the effectiveness of educational and public outreach campaigns will be assessed by analysis of peak and annual water volumes per customer class.

3.10 Park Conservation

A. Description

The City of Corpus Christi Parks and Recreation Department manages two golf courses; two large City-wide parks; five recreation centers; several decorative fountains; nine public swimming pools; and more than 200 neighborhood parks, some with irrigated athletic fields. At these facilities, the visible use of water often comes under scrutiny by the public and water resource managers both because of large water demand to maintain a park and because of the perception that the water use may be excessive.

Conservation of water at parks will be achieved through the BMPs on Prohibition on Wasting Water; Water-Wise Landscape Design; existing plumbing ordinances prohibiting irrigation of narrow strips with sprinkler irrigation; Retrofit of Existing Connections and Metering of New Connections; and System Water Audit and Loss program.

The Water Department will also explore the potential and feasibility of expanding irrigation of golf courses with reclaimed wastewater. At present, between 2 and 3 percent of treated wastewater is reclaimed to irrigate golf courses and a baseball field.

B. Implementation

1. Parks properties will be included in the Water Department's System Water Audit and Loss programs identified in Section 3.2.
2. The Parks Department voluntarily adopts Landscape Ordinance provisions of the Corpus Christi Zoning Ordinance, Article 27B.
3. In compliance with Corpus Christi Plumbing Code, Section 612 Lawn Irrigation Systems.

C. Schedule

To accomplish this BMP, the Water Department will:

1. Ensure park properties' landscapes are planted and irrigated in compliance with City ordinances and plumbing codes within the next five years;
2. Continue the use of reclaimed wastewater for irrigation started in 1987;
3. Beginning in 2005, include park properties in the System Water Audit and Loss programs; and
4. Ensure that other BMPs promoting efficient use of water are followed at park properties.

D. Documentation

To track the progress of this BMP, the Water Department will gather and have available the following documentation:

1. Water savings due to offset of potable water use by irrigation with reclaimed waste water;
2. Water savings attributable to repairs of leaks;
3. Changes to irrigation systems, retrofits, or upgrades, regular leak detection, maintenance policies, and estimated water savings from conservation practices;
4. Estimated water savings attributable to changes implemented; and
5. Costs of repairs, equipment upgrades, or new equipment installed.

E. Determination of Water Savings

The Water Department will compare monthly data for irrigation water consumption from irrigation meter readings at park properties on an annual basis or more frequently during times of water shortage. Special emphasis will be placed upon evaluating data from sites before and after significant irrigation system changes or upgrades.

3.11 Reuse of Reclaimed Water

A. Description

The Certificate of Adjudication for Choke Canyon Reservoir required the City of Corpus Christi to provide no less than 151,000 acre feet of water per annum for the estuaries by a combination of releases and spills from Lake Corpus Christi and by way of return flows to the Nueces and Corpus Christi Bays and other receiving estuaries. Subsequent amendments to the City's Certificate of Adjudication refined the freshwater inflow requirements to Nueces Bay by calculating target inflows as a percentage of system storage; however the balance of effluent that can be utilized for reuse purposes by City was determined in the February 2001 TCEQ Agreed Order. The City of Corpus Christi currently has six reclaimed water use customers and recognizes that the direct use of reclaimed water is an effective method of reducing potable water usage. Reclaimed water is defined as, "Domestic or municipal wastewater which has been treated to a quality suitable for a beneficial use, pursuant to the provisions of this chapter and other applicable rules and permits" (30 TAC §210.3(24)). Corpus Christi reclaimed water is primarily used for irrigating recreational tracts and maintaining the Nueces Estuary.

B. Implementation

To facilitate expansion of its reuse program, the Corpus Christi Water Department will identify and rank industrial, commercial, and institutional (ICI) customers according to volume of water use, and investigate the feasibility of replacing some of their potable water uses with reclaimed water. The Water Department will also investigate reuse opportunities within its own accounts or with third parties outside its service area. The City owns several public areas that are candidates for reuse.

Historically, Corpus Christi began its reuse program in the early 1960s when it began delivering reclaimed effluent to its first customer, the Gabe Lozano Golf Course. Over the next several decades, the City acquired five additional reuse customers including two more golf courses, a country club, a softball complex and the landscape median of Park Road 22. The remaining two golf courses within the City recently entered into an agreement with the City for the supply of reclaimed water. Approximately 2.5 percent of the City's overall effluent flows are reused as reclaimed water.

C. Schedule

The Water Department will continue to deliver reclaimed water to its six customers and investigate a possible expansion of the reuse program.

D. Documentation

To track this BMP, the Water Department will gather the following documentation:

1. Description of wastewater treatment facilities and reclaimed water distribution systems.
2. Documentation of its efforts to find reuse opportunities within it customer base, including lists of potential users.
3. Number of gallons or acre-feet of previous potable water use replaced by reuse water since implementation of this BMP.

E. Determination of Water Savings

Water savings are estimated at up to 100 percent of total amount of potable water replaced by reclaimed water. Changes in operating parameters or water balance calculations which depend upon water quality parameters, such as the impact of total dissolved solids (TDS) in irrigation water, may require different quantities of reuse water to be applied for same end uses.

Chapter 4
Wholesale Customer Conservation

4.1 Summary

As part of the 2005 Water Conservation Planning Process, contracts with wholesale customers have been reviewed to determine conformance with the water conservation goals of the Plan.

Communication will be maintained with wholesale customers to ensure that the City's retail and wholesale customers are being treated in an equitable fashion, and for optimum implementation of the Plan. The City offers wholesale customers the opportunity to cosponsor conservation education and information activities.

4.2 Wholesale Customer Targets and Goals

The City of Corpus Christi serves five wholesale customers with treated water and six wholesale customers with raw water. The raw water is delivered to Corpus Christi's four municipal and two industrial customers. The water demands for these customers are summarized in Chapter 2, Demand Profile, Targets, and Goals, and are further detailed in the Water Utility Profile in Appendix A. Due to the fact that the City's wholesale customers have other sources of water in addition to the water provided by the City, the total gpcd provided in Table 2, Wholesale Customer Targets and Goals below, is based upon the Water Resource Planning information from the TWDB.

4.3 Metering, Monitoring, and Records Management

The City meters all water diverted from the raw water supply to its wholesale customers. The City also meters all treated water delivered to its wholesale customers. By contract these meters are calibrated on a semiannual basis, and must be accurate within 2 percent. The meters are read on a monthly basis for billing purposes.

A summary report is prepared, which aggregates all meter readings from wholesale raw water meters, wholesale treated water meters, and all retail customers, as well as the readings from the meters at the intake to the O. N. Stevens Water Treatment.

4.4 Leak Detection and Repair

The treated water wholesale customers are supplied from portions of the City's distribution system. The meter location is the point of sale after which the water enters the customer's system, which is the customer's responsibility to operate and maintain. The portions of the City's distribution system that serve these wholesale customers is subject to the same leak detection and repair program described in Chapter 3, Section 3.2 System Water Audit and Water Loss.

All raw water delivery systems to the wholesale customers are owned and operated by those customers. Therefore, they are responsible for any leak detection and repair programs as well as for unaccounted-for water. Wholesale customers are encouraged to voluntarily report their results to the City in order to promote cooperative efficiency efforts.

4.5 Contractual Requirements

The City has in place valid contracts with various wholesale customers including raw water contracts with municipal water suppliers, Alice Water Authority, Beeville Water Supply District, City of Mathis, and San Patricio Municipal Water District. Treated water customers include Nueces County Water Improvement District No. 4 (Port Aransas), San Patricio Municipal Water District, South Texas Water Authority, and the Violet Water Supply Corporation. Industrial wholesale customers, include Celanese, and Flint Hills Resources. All of these contracts contain language relating to water use restrictions in drought situations. Each contract has a section requiring the customer to accept shortages in supply, should natural or unforeseen circumstances prevent the City from delivering the water. With the exceptions of the Beeville Water Supply District and San Patricio Municipal Water District contracts, the contracts further stipulate that should there be a shortage in the basic supply of water which requires the restriction or curtailing of any consumer of water within the city limits of Corpus Christi that the wholesale customer limit and restrict all of its customers to the same extent.

In the most recent contract, with San Patricio Municipal Water District, language concerning water conservation year-round is included. As the need to renegotiate other contracts arises, the City will include contract language requiring conformance with applicable state and federal regulations concerning water conservation.

The Beeville Water Supply District requires the district to reduce its average raw water consumption by specific percentages whenever the City declares water shortage conditions. The district is required to reduce its average raw water consumption by 10% when the reservoirs fall below 50% (Condition I), 20% when the reservoirs fall below 40% (Condition II), 30% when the reservoirs fall below 30% (Condition III), and to cease raw water withdrawals when reservoir storage levels drop below 20% (Condition IV). In exchange the District is excused from contract minimum payments during the time of shortage; and it has the discretion to supplement river water with groundwater in lieu of imposing water use restrictions on its customers.

The San Patricio Municipal Water District has the discretion to either implement water conservation and drought measures similar to those imposed by the City or to reduce the water it takes from the City's water supply system. If the district elects to reduce the amount of water it takes from the City's water supply system the reductions are based on the average deliveries for the same month of the year over the three previous years. The percent of the reduction is based on the available water in the City's reservoir system. The required decrease in the amount of water that can be taken is 10% when the reservoirs fall below 50% (Condition I), 20% when the reservoirs fall below 40% (Condition II), 30% when the reservoirs fall below 30% (Condition III), and 60% when the reservoirs fall below 20% (Condition IV).

4.6 Targets and Goals

The City has no enforcement mechanism to impose conservation targets and goals upon its wholesale customers at this time. Achieving these goals must be through cooperative efforts to maintain and improve system efficiencies, to educate customers to the importance of conservation, and to enforce existing plumbing regulations within the municipal boundaries of each entity. To assist in meeting these goals, the City plays an active role in Region N water resource planning, working with wholesale customers on a voluntary basis on water conservation programs like those described in Sections 3.7, Public Information; 3.8, School Education; and 3.9, Water-Wise Landscape Design and Conversion Program. Wholesale customers may voluntarily report their progress on water conservation activities on an annual basis.

The Region N Water Resource Planning Group has projected water conservation from plumbing fixture replacements which are listed in Table 3, Wholesale Customer Municipal gpcd. The City will assist its wholesale customers in voluntarily meeting these goals through cooperative efforts like those mentioned above.

Table 3
Wholesale Customer Municipal GPCD

Customer Name	GPCD 2000	GPCD 2010	GPCD 2020
Alice Water Authority	248	244	241
Beeville Water Supply District	172	168	164
City of Mathis	119	115	112
Nueces County Water Control and Improvement District 4 / Port Aransas	187	181	179
San Patricio Municipal Water District	118	111	107
South Texas Water Authority	155	152	148
Violet Water Supply Corporation	151	148	145
GPCD - Weighted Average	**151**	**145**	**141**

Source: 2003 Population and Demand Projections for Region N, TWDB, 2003.

Of the wholesale customers served by the City, five have per capita consumption higher than the statewide goal of 140 gpcd recommended by the Water Conservation implementation Task Force, while two have per capita use rates lower than 140. The aggregate per capita use rates, weighted by population show that the overall per capita for the City's wholesale customers will drop to around 141 gpcd by 2020. The 5- and 10-year targets are 146 gpcd and 143 gpcd. The gpcd targets are not relevant as conservation targets for industrial wholesale customers. Wholesale customers will be encouraged to operate efficiently and to keep water loss rates below 10 percent.

4.7 Reservoir System Operating Plan

The Reservoir System Operating plan is discussed in Chapter 1. A copy of the plan is attached in Appendix C.

Chapter 5
Drought Contingency Plan

5.1 Summary

A drought contingency plan is designed to address drought emergencies or uncontrollable circumstances that can disrupt the normal availability of water supply. The plan identifies water supply sources as well as measures to reduce water use. The plan may be implemented in other than drought emergencies such as system failures or weather-related events such as hurricanes. The City of Corpus Christi has had a Drought Contingency Plan in effect since 1987.

This chapter summarizes the City's Drought Contingency Plan. Emergency contingency planning is not the same as conservation planning. While water conservation involves implementing permanent water use efficiencies, an emergency contingency plan establishes temporary methods or techniques designed to be used only as long as the emergency exists.

The City's Drought Contingency Plan includes the following elements:

A) Trigger conditions signaling the start of an emergency period;

B) Emergency contingency measures;

C) Education and information;

D) Initiation procedures;

E) Termination notification actions; and

F) Implementation.

In addition, under the City's agreed order with the Texas Commission on Environmental Quality under Certificate of Adjudication No. 21-3214, the City is required to implement certain measures when specific trigger conditions are met, if the City elects to reduce the amount of water that is passed through its reservoir system to the Nueces bay and estuary.

The Plan is found codified in ordinance Sections 55-150 to 55-159, and is attached as Appendix B to this Water Conservation and Drought Contingency Plan 2005.

5.2 Procedure – Implementation

The City has automatic measures that are triggered at certain reservoir levels. In addition the City Manager may implement any or all of the water use restriction measures, as appropriate. The City Manager shall notify the members of the City Council before implementing any measures. Criminal penalties do not apply during the time of voluntary conservation.

5.3 Procedure – Notification

When trigger conditions and potential emergency contingency measures appear to be necessary, the City Manager shall publish notice in a daily newspaper of general circulation in Nueces County when each water use restriction measure takes effect. Copies of the notices published by the City Manager under this section shall be filed with the City Secretary who shall send a copy of the notice to each member of the City Council and a certified copy of the notice to the judges of the Municipal Court.

5.4 Plan Applicability

The Drought Contingency Plan applies to all persons and premises receiving retail water from the City of Corpus Christi Water System. Wholesale customers are also subject to the plan under their contracts with the city. Specific restrictions based upon trigger levels and types of water use are detailed in the codified ordinance.

5.5 Enforcement

The City Manager has the authority to designate the enforcement authority of the Drought Contingency Plan. The City may serve a person or user in violation of this Drought Contingency Plan with a written notice stating the nature of the violation and giving a time limit for compliance. This notice may be in the form of a door hanger or written citation. Penalties are set forth in the ordinance. Any police officer, or other City employee designated by the City Manager, may issue a citation to a person s/he reasonably believes to be in violation of this article.

5.6 Emergency Criteria

Emergency criteria triggering the implementation of various stages of the Drought Contingency Plan include, but are not limited to, the following:

A) Voluntary announcement when combined storage in the Choke Canyon/Lake Corpus Christi Reservoir System (Reservoir System Storage) falls below 50 percent of the Reservoir System Storage capacity;
B) Automatic announcement of restrictions when combined storage falls below 40 percent of the Reservoir System Storage capacity;
C) General or geographical emergency; and
D) Water system failures/emergencies (i.e., pressure zone deficiencies, chemical spills, broken water mains, power outages, electrical failures, failures of storage tanks or other equipment, treatment plant breakdown, and/or water contamination).

5.7 Descriptions of Trigger Conditions

Upon the occurrence of an emergency, the City Manager may exercise his or her discretion to request special voluntary water use restrictions and/or to initiate mandatory restrictions. Public information concerning these stages is codified in ordinance and contained in Sections 55-150 to 55-159 inclusive, and attached as Appendix B to this Plan.

The City Manager may consider additional conservation measures that benefit specific water use restrictions as identified in the City's Drought Contingency Plan, Section 55-153, including:

Restricting the use of water for watering foundations.

Restricting use of water for washing of automobiles, trucks, trailers, boats, airplanes and any other type of mobile equipment.

Prohibiting the washing of building exteriors and interiors, trailers, trailer houses and railroad cars with potable water.

Restricting the use of water for recreational uses, such as playing in sprinklers.

Restricting the use of fire hydrants for any purpose other than firefighting.

Prohibiting the use of potable water in ornamental fountains or in artificial waterfalls.

Prohibiting the use of potable water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced area, or building or structure.

Prohibiting the use of potable water for dust control.

Limiting the use of potable water to irrigate golf courses.

Prohibiting new service connections to the city's water system.

Prohibiting the use of potable water to put new agricultural land into production.

Denying applications for new, additional, further expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or other water service facilities of any kind.

Establishing allocations of water use to industrial and commercial customers in amounts, after consultation with the allocation and review committee.

Establishing the maximum monthly use for a residential customer with revised rate schedules and penalties approved by the city council, based on recommendations by the allocation and review committee.

5.8 Target Goals

The Corpus Christi Drought Management Ordinance is designed to reduce water demand through the imposition of specific water use restrictions including the use of bill surcharges and mandatory limits on consumption. As conditions worsen, automatic measures are mandated and additional discretionary measures may be implemented. It is the goal of this Water Conservation and Drought Contingency Plan to achieve specific, quantified targets for water use reductions during periods of water shortage and drought. These targets are summarized in Table 4 Water Reduction Targets below.

5.9 Wholesale Water Contracts

Every wholesale water contract entered into, renewed or modified shall include language relating to the City of Corpus Christi Water Conservation and Drought Contingency Plan, adopted under Section 55-151 of the Code of Ordinances to impose similar restrictions, surcharges or rationing measures on their customers. The City requires that any contract for the resale of water furnished to wholesale water contractors shall contain a similar condition. In addition, every wholesale water contract entered into or renewed after adoption of the plan (April 26, 2005), including contract extensions, must include a provision that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code, §11.039.

Table 4
Water Use Reduction Targets
during Periods of Water Shortage and Drought

Reservoir Storage Level	Target Demand Reduction Levels
<50%	1%
<40%	5%
<30%	10%
<20%	15%

Glossary:

Best Management Practice (BMP) – A conservation measure or system of business procedures that is beneficial, empirically proven, cost-effective, and widely accepted in the professional community.

Conservation – Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

Industrial use – The use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, commercial fish production, and the development of power by means other than hydroelectric, but does not include agricultural use.

Irrigation – The agricultural use of water for the irrigation of crops, trees, and pastureland, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system.

Municipal per capita water use – The sum total of water diverted into a water supply system for residential, commercial, and public and institutional uses divided by actual population served.

Municipal use – The use of potable water within or outside a municipality and its environs whether supplied by a person, privately owned utility, political subdivision, or other entity as well as the use of sewage effluent for certain purposes, including the use of treated water for domestic purposes, fighting fires, sprinkling streets, flushing sewers and drains, watering parks and parkways, and recreational purposes, including public and private swimming pools, the use of potable water in industrial and commercial enterprises supplied by a municipal distribution system without special construction to meet its demands, and for the watering of lawns and family gardens.

Municipal use in gallons per capita per day – The total average daily amount of water diverted or pumped for treatment for potable use by a public water supply system. The calculation is made by dividing the water diverted or pumped for treatment for potable use by population served. Indirect reuse volumes shall be credited against total diversion volumes for the purpose of calculating gallons per capita per day for targets and goals.

Pollution – The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Public water supplier – An individual or entity that supplies water to the public for human consumption.

Regional water planning group – A group established by the Texas Water Development Board to prepare a regional water plan under Texas Water Code, §16.053.

Retail public water supplier – An individual or entity that for compensation supplies water to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants when that water is not resold to or used by others.

Reuse – The authorized use for one or more beneficial purposes of use of water that remains unconsumed after the water is used for the original purpose of use and before that water is either disposed of or discharged or otherwise allowed to flow into a watercourse, lake, or other body of state-owned water.

Single Family Residential gpcd – Total annual single-family residential consumption divided by total population divided by 365.

Total gpcd – Total annual water delivered to treatment plant minus sales to wholesale customers and then divided by total population and divided by 365.

Water conservation plan – A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another water management document(s).

Water loss - The difference between water diverted or treated and water delivered (sold). Water loss can result from:

1. Inaccurate or incomplete record keeping;
2. Meter error;
3. Unmetered uses such as firefighting, line flushing, and water for public buildings and water treatment plants;
4. Leaks; and
5. Water theft and unauthorized use.

Wholesale public water supplier – An individual or entity that for compensation supplies water to another for resale to the public for human consumption. The term does not include an individual or entity that supplies water to itself or its employees or tenants as an incident of that employee service or tenancy when that water is not resold to or used by others, or an individual or entity that conveys water to another individual or entity, but does not own the right to the water which is conveyed, whether or not for a delivery fee.

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Appendix A
(for Appendix E.4)

Utility Profile

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UTILITY PROFILE

TWDB CODE: 185000 EIN: 449385 (178) CF

City of Corpus Christi
Water Department
P. O. Box 9277
Corpus Christi, Texas 78469-9277

A. GROUNDWATER INTAKE	
A1. Active Wells	0
A2. Inactive/Operable	0
A3. Counties/Wells	none
A4. Aquifer(s)	none
A5. State Well Numbers (SWNs)	not applicable
A6. Source Type	not applicable
A7. Supplier	not applicable
A8. 12 month summary	not applicable
A9. Total	not applicable
A10. Metered/Estimated	not applicable

B. SURFACE WATER INTAKE	Source 1	Source 2	Source 3
B1. Source Type	Self-Supplied	Self-Supplied	Purchased
B2. Supplier/Source	Choke Canyon (flows into Nueces River into Lake Corpus Christi)	Lake Corpus Christi	Lavaca- Navidad River Authority /Lake Texana
B3. Water Right No.	21-3214	21-2464	16-2095D
B4. Conveyed	Nueces River	Nueces River	Mary Rhodes Pipeline
B5. County(ies)	McMullen & Live Oak	San Patricio	Jackson County
B6. Monthly Surface Water Intake by Source			
January		1,373,461,965	1,405,457,275
February		1,632,839,361	1,278,860,903
March		1,718,864,025	1,375,136,839
April		1,342,832,971	1,376,453,277
May		1,422,013,764	1,443,063,739
June		1,721,796,684	1,416,646,998
July		1,943,701,215	1,454,331,666
August		2,397,937,509	1,501,211,850
September		1,876,250,058	1,456,175,983
October		1,702,897,326	1,494,919,667
November		1,596,018,198	1,448,267,579
December		2,195,258,187	753,631,451
Total	-	20,923,871,263	16,404,157,227
B7. Percent Treated	0%	100%	84%
B8. Metered/Estimated	Metered	Metered	Metered
B9. Total Self-Supplied Surface Water (gals.)		20,923,871,263	
B10. Total Purchased Surface Water (gals.)			16,404,157,227

TWDB CODE: 185000 EIN: 449385 (178) CF
City of Corpus Christi
Water Department

C. WATER SALES	**Buyer 1**	**Buyer 2**	**Buyer 3**	**Buyer 4**
C1. Buyer	City of Corpus Christi (self-provided)[1]	Nueces County Water Improvement District No. 4	Violet Water Supply Corporation	South Texas Water Authority
C2. Quantity of Water Sold - gals.	23,535,178,000	404,684,000	52,723,000	583,673,000
C3. Treatment	Treated	Treated	Treated	Treated
C4. County	Nueces County	Nueces County	Nueces County	Nueces County

	Buyer 5	**Buyer 6**	**Buyer 7**	**Buyer 8**
C1. Buyer	San Patricio Municipal Water District	San Patricio Municipal Water District	Beeville Water Supply District	Alice Water Authority
C2. Quantity - gals.	971,250,000	6,318,464,588	811,499,000	1,025,725,000
C3. Treatment	Treated	Raw	Raw	Raw
C4. County	San Patricio County	San Patricio County	Bee County	Jim Wells County

	Buyer 9	**Buyer 10**	**Buyer 11**
C1. Buyer	City of Mathis	Flint Hills (formerly Koch Refining)	Hoechst Celanese
C2. Quantity - gals.	220,315,000	1,785,970,385	1,042,862,213
C3. Treatment	Raw	Raw	Raw
C4. County	San Patricio County	Nueces County	Nueces County

(1) includes treated water sales to rural areas outside of Corpus Christi city limits.

C. Water Sales - Large Volume Water Users - 2004 Calendar Year

Name	Consumption	Treatment	County
Valero Refining	2,360,983	Treated	Nueces
Equistar Chemicals LP	1,694,477	Treated	Nueces
Citgo Refining & Chemical	1,151,303	Treated	Nueces
Valero Ref. (1321 Cantwell)	772,664	Treated	Nueces
Koch Refining East Plant	701,769	Treated	Nueces
Naval Air Station - Public Works	342,368	Treated	Nueces
Citgo Refining & Chemical (S. Minerals Rd)	331,129	Treated	Nueces
Koch Refining West Plant	309,855	Treated	Nueces
Valero Refining (Cantwell Dr.)	296,158	Treated	Nueces
Valero Refining (5445 Up River Rd.)	294,422	Treated	Nueces
Total Consumption	8,255,128		

D. WATER SYSTEM INFORMATION			
D1. TCEQ Public Water System Number			**1780003**
	Inside City Limits	**Outside City Limits**	**Total**
D2. Residential Population	287,578		287,578
D3. Service Connections	82,121		82,121
D4. Single Family Connections	72,936	81	73,017
D5. Multi-family Connections	977	3	980
D6. Commercial/Institution Connections	7,940	150	8,090
D7. Industrial Connections	4	4	8
D8. Other Connections - Wholesale		6	6
D9. Percentage of Connections Metered			100%

Service Connections Located in Incorporated Cities	City 1	City 2	City 3	City 4
D10. City	n/a	n/a	n/a	n/a
D11. Connections	n/a	n/a	n/a	n/a
	County 1	County 2	County 3	County 4
D12. County	n/a	n/a	n/a	n/a
D13. Connections	n/a	n/a	n/a	n/a

	D14. Single-Family Residential - Gals	D15. Multi-family Residential - Gals	D16. Commercial/ Institutional-Gals	D17. Industrial - Gals
January	385,367,000	15,783,000	367,065,000	749,735,000
February	404,821,000	14,401,000	371,501,000	696,242,000
March	479,979,000	18,819,000	417,299,000	587,059,000
April	444,165,000	17,355,000	401,281,000	597,354,000
May	517,801,000	18,485,000	487,842,000	747,979,000
June	541,005,000	22,822,000	508,398,000	696,881,000
July	654,626,000	21,250,000	494,911,000	717,240,000
August	604,986,000	20,484,000	514,523,000	809,799,000
September	474,756,000	20,655,000	479,289,000	941,259,000
October	444,976,000	15,031,000	436,112,000	714,631,000
November	434,956,000	17,406,000	437,189,000	668,297,000
December	473,406,000	18,154,000	457,229,000	748,661,000
Total	5,860,844,000	220,645,000	5,372,639,000	8,675,137,000

D18. Total Metered	20,129,265,000	Gallons
D19. TotalUnmetered	2,969,700,000	Gallons
D20. Total Water Loss	1,781,820,000	Gallons
D21. Water Restrictions	none	Days
D22. Primary Use	Municipal	

TWDB CODE: 185000 EIN: 449385 (178) CF
City of Corpus Christi Water Department

E. REUSE (DIRECT & INDIRECT) / SALINE WATER USE		
E1. Direct Reuse	Yes	Y or N
Percentage of total reuse volume used for the following categories		
E2. Total Direct Reuse	264,096,000	Gallons
E3. Percentage Industrial	0	%
E4. Percent Landscape	100	%
E5. Percent Agricultural	0	%
E6. Other	0	%
E7. Indirect Reuse	No	Y or N
E8. Total Indirect Reuse	No	Gallons
E9. Saline Water	No	Y or N
E10. Total Saline Water	0	Gallons
E11. Saline Water TDS	n/a	TDS (ppm)

F. COMMENTS AND CONTACT INFORMATION	
F1. Comments	
F2. Name	Eduardo Garana, P.E.
F3. Title	Water Director
F4. Phone	(361) 857-1681
F5. Email Address	edg@cctexas.com
F6. General Email	--
F7. Date	March 7, 2005

G. UTILITY SERVICE AREA		Geospatial File (digital map)
G1. Format Option		CCN Shapefiles Available Online from TCEQ
		Houston-Area Water Districts
	XX	Service Area = City Boundary
		Paper Map

Appendix B
(for Appendix E.4)

Water Conservation and
Drought Contingency Ordinance

(Not Available at Time of
Final Plan Submittal)

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Appendix C
(for Appendix E.4)

Reservoir Operation Plan

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237629

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

AN AGREED ORDER Amending the operational procedures and continuing an Advisory Council pertaining to Special Condition 5 B., Certificate of Adjudication No 21-3214; Docket No 2001-0230-WR

On April 4, 2001, came to be considered before the Texas Natural Resource Conservation Commission ("Commission") the Motion by the City of Corpus Christi and Nueces River Authority for the adoption of an amendment to the Agreed Order issued April 28, 1995, establishing operating procedures pertaining to Special Condition 5 B , Certificate of Adjudication No 21-3214, held by the City of Corpus Christi, the Nueces River Authority, and the City of Three Rivers" (the two cities and river authority shall be referred to herein as "Certificate Holders") The Certificate Holders and the Executive Director of the Texas Natural Resource Conservation Commission have agreed to the provisions of this Agreed Order

The City of Corpus Christi (managing entity) requests that Section 2 of this Agreed Order be amended to add further detail to the provisions regarding the use of water for bays and estuaries and to make changes in the required passage of inflows for the bays and estuaries automatic at 40 percent and 30 percent of total reservoir system capacity upon institution of mandatory outdoor watering restrictions. Additionally, Certificate Holders request the most recent bathymetric surveys be used for determining reservoir system storage capacity. The Certificate Holders request details be added regarding provisions for two projects to enhance/augment the amount of freshwater going into the receiving estuary and timelines for those projects

After considering the proposals and the presentations of the parties, the Commission finds that it has authority to establish operational procedures under Special Condition 5 B of Certificate of Adjudication No 21-3214, and that operational procedures previously established should be amended The Commission finds that, because of the need to continue to monitor the ecological environment and health of related living marine resources of the estuaries to assess the effectiveness of freshwater inflows provided by requirements contained in this Agreed Order relating to releases and spills from Choke Canyon Reservoir and Lake Corpus Christi (collectively referred to as the Reservoir System), as well as return flows, and to evaluate potential impacts which may occur to the reservoirs as well as to the availability of water to meet the needs of the Certificate Holders and their customers which may result from those operational procedures, the existing advisory council should be maintained to consider such additional information and related issues and to formulate recommendations for the Commission's review

The Commission additionally finds that based on the preliminary application of the Texas Water Development Board's Mathematical Programming Optimization Model, (GRG-2), 138,000 acre-feet of fresh water is necessary to achieve maximum harvest in the Nueces Estuary; and, therefore, when water is impounded in the Lake Corpus Christi-Choke Canyon Reservoir System to the extent greater than 70 percent of the system's storage capacity, the delivery of 138,000 acre-feet of water to Nueces Bay and/or the Nueces Delta, by a combination of releases and spills, together with diversions and return flows noted below, should be accomplished; and that during periods when the reservoir system contains less than 70 percent storage capacity, reductions in releases and spills, along with diversions and return flows, are appropriate in that a satisfactory level of marine harvest will be sustained and the ecological health of the receiving estuaries will be maintained

The Commission finds that return flows, other than to Nueces Bay and/or the Nueces Delta, that are delivered to Corpus Christi Bay and other receiving estuaries are currently in the assumed mount of 54,000 acre-feet per annum (per calendar year), and that they shall be credited at this amount until such time as it is shown that actual return flows to Corpus Christi Bay and other receiving estuaries exceed 54,000 acre-feet per annum

The Commission finds that by contractual relationships, the City of Corpus Christi is the managing entity for operating the Reservoir System

The Commission finds that the Motion by the City of Corpus Christi and Nueces River Authority to Amend this Agreed Order is reasonable and should be granted Benefits of the proposed diversion project and operating changes will include increased water supply, increased reservoir storage levels, increased positive flow events for Rincon Bayou and the upper Nueces Delta, increased sources of nitrogen for the upper delta, and lower salinity levels in the upper delta

When the Commission uses the word "release" in this Order, release means spills, inflow passage, intentional releases, and return flows; provided, however, under this Order no release from storage is required to meet conditions of this Order

By consenting to the issuance of this Agreed Order, no party admits or denies any claim, nor waives with respect to any subsequent proceeding any interpretation or argument which may be contrary to the provisions of this Agreed Order

NOW, THEREFORE, BE IT ORDERED BY THE TEXAS NATURAL RESOURCE CONSERVATION COMMISSION THAT:

1 a The City of Corpus Christi, as operator of the Choke Canyon/Lake Corpus Christi reservoirs (the "Reservoir System"), shall provide not less than 151,000 acre-feet of water per annum (per calendar year) for the estuaries by a combination of releases and spills from the Reservoir System at Lake Corpus Christi Dam and return flows to Nueces and Corpus Christi Bays and other receiving estuaries (including such credits as may be appropriate for diversion of river flows and/or return flows to the Nueces Delta and/or Nueces Bay), as computed and to the extent provided for herein

b When water impounded in the Reservoir System is greater than or equal to 70 percent of storage capacity, a target amount of 138,000 acre-feet is to be delivered to Nueces Bay and/or the Nueces Delta by a combination of releases and spills from the Reservoir System as well as diversions and return flows In accordance with the monthly schedule and except as provided otherwise in this Agreed Order, target inflows to Nueces Bay and/or the Nueces Delta shall be in the acre-foot amounts as follow:

January	2,500	July	6,500
February	2,500	August	6,500
March	3,500	September	28,500
April	3,500	October	20,000
May	25,500	November	9,000
June	25,500	December	4,500

It is expressly provided, however, that releases from Reservoir System storage shall not be required to satisfy the above targeted inflow amounts, as calculated in Subparagraph d

c When water impounded in the Reservoir System is less than 70 percent but greater than or equal to 40 percent of storage capacity, a targeted amount of 97,000 acre-feet is to be delivered to Nueces Bay and/or the Nueces Delta by a combination of releases and spills from the Reservoir System as well as diversions and return flows. In accordance with the monthly schedule and except as provided otherwise in this Agreed Order, target inflows to Nueces Bay and/or the Nueces Delta shall be in the acre-foot amounts as follows:

January	2,500	July	4,500
February	2,500	August	5,000
March	3,500	September	11,500
April	3,500	October	9,000
May	23,500	November	4,000
June	23,000	December	4,500

It is expressly provided, however, that releases from Reservoir System storage shall not be required to satisfy the above targeted inflow amounts as calculated in Subparagraph d.

d The amounts of water required in subparagraphs 1 b and 1,c will consist of return flows, and intentional diversions, as well as spills and releases from the Reservoir System as defined in this subparagraph. For purposes of compliance with monthly targeted amounts prescribed above, the spills and releases described in this paragraph shall be measured at the U.S Geological Survey stream monitoring station on the Nueces River at Calallen, Texas (USGS Station No. 08211500) Any inflows, including measured wastewater effluent and rainfall runoff meeting lawful discharge standards which are intentionally diverted to the upper Nueces Delta region, shall be credited toward the total inflow amount delivered to Nueces Bay and/or the Nueces

Delta Inflow passage from the Reservoir System for the purpose of compliance with the monthly targeted amounts prescribed in subparagraphs 1 b and 1.c shall in no case exceed the estimated inflow to Lake Corpus Christi as if there were no impoundment of inflows at Choke Canyon Reservoir The estimated inflow to Lake Corpus Christi as if there were no impoundment of inflows at Choke Canyon Reservoir shall be computed as the sum of the flows measured at the U.S Geological Survey (USGS) STREAMFLOW GAGING STATIONS ON THE Nueces River near Three Rivers (USGS No. 08210000), Frio River at Tilden, Texas (USGS No 08206600), and San Miguel Creek near Tilden, Texas (USGS No 08206700) less computed releases and spills from Choke Canyon Reservoir

e The passage of inflow necessary to meet the monthly targeted allocations may be distributed over the calendar month in a manner to be determined by the City Relief from the above requirements shall be available under subparagraphs (1) or (2) below and Section 2 (b) and 3 (c) at the option of the City of Corpus Christi However, passage of inflow may only be reduced under one of those subparagraphs below, for any given month

(1) Inflows to Nueces Bay and/or the Nueces Delta in excess of the required monthly targeted amount may be credited for up to fifty (50) percent of the targeted requirement for the following month, based on the amount received

(2) When the mean salinity in Upper Nueces Bay (Lat 27°51'02", Long 97°28'52") for a 10-day period, ending at any time during the calendar month for which the reduction of the passage of inflow is sought, is below the SUB*, pass through of inflow from the reservoir system for that same calendar month may be reduced as follows:

(a) For any month other than May, June, September and October, if 5 parts per thousand (ppt) below the SUB for the month, a reduction of 25% of the current month's targeted Nueces Bay inflow;

(b) If 10 ppt below the SUB for the month, a reduction of 50 % of the current month's targeted Nueces Bay inflow except that credit under this provision is limited to 25 % during the months of May, June, September and October;

* "SUB" means "salinity upper bounds" as set forth more specifically in Section 3 b.

(c) If 15 ppt below the SUB for that month, a reduction of 75% of the current month's targeted Nueces Bay inflow f The City of Corpus Christi shall submit monthly reports to the Commission containing daily inflow amounts provided to the Nueces Estuary in accordance with this Agreed Order through releases, spills, return flows and other freshwater inflows

2 a Certificate holders are to provide in any future contracts or any amendments, modifications or changes to existing contracts the condition that all wholesale customers and any subsequent wholesale customers shall develop and have in effect a water conservation and drought management plan consistent with Commission rule The City of Corpus Christi shall solicit from its customers and report to the Commission annually the result of conservation under the City's plan, the customers' plans, and the feasibility of implementing conservation plans and programs for all users of water from the reservoir system This report shall be submitted with the Certificate Holder's annual water use report as provided by 31 T A C §295 202

b The Certificate Holders may reduce targeted Nueces Bay inflows during times of prolonged drought in accordance with this subparagraph 2.

(1) When the combined storage in the Choke Canyon/Lake Corpus Christi reservoir system (Reservoir System Storage) falls below 50% of the total system storage capacity, the City of Corpus Christi shall issue public notice advising and informing the water users of the region of voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40% and/or 30% of total system storage capacity To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to issue public notice advising and informing the water users of the region of voluntary conservation measures that are requested immediately and required drought management measures to be taken should the Reservoir System Storage fall to under 40% and/or 30% of total system storage capacity

(2) In any month when Reservoir System Storage is less than 40%, but equal to or greater than 30% of total system storage capacity, the City of Corpus Christi shall implement time of day outdoor watering restrictions and shall reduce targeted inflows to Nueces Bay to 1,200 acre-feet per month (1,200 acre-feet per month represents the quantity of water that is the median inflow into Lake Corpus Christi during the drought of record) Time of day outdoor watering restrictions prohibit lawn watering between the hours of 10:00 o'clock a.m and 6:00 o'clock p m and are subject to additional conditions as described in the City of Corpus Christi's approved "Water Conservation and Drought Contingency Plan ("Plan") " To the extent of its legal authority, the City of Corpus Christi shall require its wholesale customers to implement time of day outdoor watering restrictions similar to those of the City

(3) In any month when Reservoir System Storage is less than 30% of total system storage capacity, the City of Corpus Christi shall implement a lawn watering schedule in addition to time of day outdoor watering restrictions (see subparagraph 2 b (2)) and shall suspend the passage of inflow from the Reservoir System for targeted inflows to Nueces Bay However, return flows directed into Nueces Bay and/or the Nueces Delta shall continue The lawn watering schedule shall allow customers to water lawns no oftener than every five days, subject to the time of day restrictions described in subparagraph 2 b (2) and any additional conditions as described in the City's Plan

(4) Certificate Holders' may implement whole or partial suspension of the passage of inflow through the reservoir as described above when the City implements, and requires its customers to implement, water conservation and drought management measures at diminished Reservoir System levels, as set forth in subparagraphs b (2) and b (3)

c For purposes of this Agreed Order, Reservoir System storage capacity shall be determined by the most recently completed bathymetric survey of each reservoir As of 2001, completed bathymetric surveys of each reservoir reports conservation storage capacities of 695,271 acre-feet (below 220 5 feet mean sea level) for Choke Canyon Reservoir (Volumetric Survey of Choke Canyon Reservoir, TWDB September 23, 1993) and 241,241 acre-feet (below 94 feet mean sea level) for Lake Corpus Christi (Regional Water Supply Planning Study-Phase I Nueces River Basin, HDR, December, 1990) 257,000 New survey

d Percentage of the Reservoir System capacity shall be determined on a daily basis and shall govern, in part, the inflow to be passed through the reservoir during the remaining days of the month.

e Within the first ten days of each month, the City of Corpus Christi shall submit to the Commission a monthly report containing the daily capacity of the Reservoir System in percentages and mean sea levels as recorded for the previous month as well as reservoir surface areas and estimated inflows to Lake Corpus Christi assuming no impoundment of inflows at Choke Canyon Reservoir The report shall indicate which gages or measuring devices were used to determine Reservoir System capacity and estimate inflows to Lake Corpus Christi

f Concurrent with implementing subparagraphs 2 b (1) through 2 b (3), the City shall proceed to:

1 Acquire land rights to properties necessary to re-open the Nueces River Overflow Channel and make the Nueces River Overflow Channel and Rincon Bayou Overflow Channel permanent features of the Rincon Bayou Diversion;

2 Construct and operate a conveyance facility to deliver up to 3,000 acre-feet per month of required Reservoir System "pass-throughs" directly from the Calallen Pool into the Upper Rincon Bayou by use of one or two of the five authorized points of diversion under Certificate of Adjudication No 2464, being the existing San Patricio Municipal Water District point of diversion and/or a point on the North bank of the Calallen Pool located at Latitude 27 8823°N, Longitude 97 6254°W, also bearing S 27° 24' W, 4,739 feet from the southwest corner of the J H W Ottman Survey, Abstract No 212, San Patricio County, Texas, where the water will be pumped at the maximum rate of 45,000 gpm; and

3 Implement an on-going monitoring and assessment program designed to facilitate an "adaptive management" program for freshwater inflows into the Nueces Estuary

4 Construction necessary to implement subparagraph 2 f 1 shall be accomplished by December 31, 2001 and work necessary to accomplish subparagraph 2 f 2 shall be accomplished by December 31, 2002

5 In the event the City fails to timely complete the work set forth in subparagraphs 2 f 1 and 2 f 2, this amendment shall automatically terminate and the provisions of the Agreed Order of April 28, 1995 shall be reinstated and become operative despite this amendment, unless the Executive Director grants a modification after considering the recommendations of the Nueces Estuary Advisory Council

g. The Executive Director is delegated authority to make modifications to subparagraph 2 f, after considering the recommendations of the Nueces Estuary Advisory Council However, changes may be made through this process only with the City's consent if the changes result in increased costs to the City

If the Executive Director makes modifications to subparagraph 2 f as authorized in this paragraph, any affected person may file with the chief clerk a motion for reconsideration of the Executive Director's action no later than 23 days after the date the Executive Director mails notice of the modification to the City This motion shall be considered under the provisions of 30 Texas Administrative Code § 50 39(d) and (e)

h. The City shall obtain all necessary permits from the Commission before beginning these projects The deadlines set out above include time necessary to apply for, process and, if necessary, complete hearings on these permits

3 a The City of Corpus Christi, with the assistance and/or participation of federal, state and local entities, shall maintain a monitoring program to assess the effect of this

operating plan on Nueces Bay The cornerstone of this program is the development of a salinity monitoring program The program shall include at least two monitoring stations, one in upper Nueces Bay (Lat 27°51'02", Long 97°28'52") and one in mid Nueces Bay (Lat 27°51'25", Long 97°25'28") with the capability of providing continuous salinity and/or conductivity data, temperature, pH, and dissolved oxygen levels Additional stations may be established at the recommendation of the Advisory Council (continued by paragraph 4 of this Agreed Order) to assess inflow effects throughout the estuarine system, but the City shall not be obligated to establish such additional stations except to the extent authorized by its City Council

b The City of Corpus Christi or its designated representatives shall monitor salinity levels in Upper and Mid-Nueces Bay The lower (SLB) and upper (SUB) salinity bounds (in parts per thousand-ppt) developed for application of the Texas Estuarine Mathematical Programming Model and considered appropriate for use herein, are as follows:

	SLB	SUB		SLB	SUB
January	5	30	July	2	25
February	5	30	August	2	25
March	5	30	September	5	20
April	5	30	October	5	30
May	1	20	November	5	30
June	1	20	December	5	30

c When the average salinity for the third week (the third week includes the seven days from the 15th through 21st) of any month is at or below the subsequent month's established SLB for upper Nueces Bay (Lat 27°51'02", Long 97°28'52"), no releases from the Reservoir System to satisfy targeted Nueces Bay inflow mounts shall be required for that subsequent month

d All data collected as a result of the monitoring program required by paragraph 3 of this Agreed Order shall be submitted monthly to the Commission within the first ten days of the immediately following month The Nueces Estuary Advisory Council shall study the feasibility of developing a method of granting credits for inflows which exceed the required amounts to replace the credits that are set out in subparagraph 1 e (l) and make recommendations to the Commission for possible implementation That method shall have as its goal the maintenance of the proper ecological environment and health of related living marine resources and the provision of maximum reasonable credits towards monthly inflow requirements

4 a To assist the Commission in monitoring implementation of this Order and making recommendations to the Commission relating to any changes to this Agreed Order and the establishment of future operating procedures, the Nueces Estuary Advisory

Council shall be continued Its members shall include, but are not limited to a qualified representative chosen by each of the following entities or groups: the Executive Director of the Texas Natural Resource Conservation Commission, whose representative shall serve as chair the Texas Water Development Board; the Texas Parks and Wildlife Department; the Texas Department of Health; the General Land Office; the holders of Certificate of Adjudication No 21-3214 (the Cities of Corpus Christi and Three Rivers and the Nueces River Authority; the University of Texas Marine Science Institute; Texas A&M University - Corpus Christi; Save Lake Corpus Christi; Corpus Christi Chamber of Commerce; the City of Mathis; Coastal Bend Bays and Estuaries Program, Inc ; a commercial bay fishing group; a conservation group (e g the Sierra Club and the Coastal Bend Bays Foundation); wholesale water suppliers who are customers of the Certificate Holders (e g , the South Texas Water Authority and the San Patricio Municipal Water District); the Port of Corpus Christi Authority; and a representative of industry The representatives should have experience and knowledge relating to current or future water use and management or environmental and economic needs of the Coastal Bend area

b No modification shall be made to this Order without the unanimous consent of the Certificate Holders, except to the extent provided by law

c Matters to be studied by the Nueces Estuary Advisory Council and upon which the Executive Director shall certify recommendations to the Commission shall include, but are not limited to:

(1) the effectiveness of the inflow requirements contained in this Agreed Order on Nueces Estuary and any recommended changes;

(2) the effect of the releases from the Reservoir System upon the aquatic and wildlife habitat and other beneficial and recreational uses of Choke Canyon Reservoir and Lake Corpus Christi;

(3) the development and implementation of a short and long-term regional water management plan for the Coastal Bend Area;

(4) the salinity level to be applied in Paragraphs 1 e and 3 c , at which targeted inflows in the subsequent month may be suspended;

(5) the feasibility of discharges at locations where the increased biological productivity justifies an inflow credit computed by multiplying the amount of discharge by a number greater than one; and development of a methodology for granting credits for inflows which exceed the required amount to replace the credits that are set out in subparagraph 1 e That methodology shall have as its goal the maintenance of the proper ecological

environment and health of related living marine resources and the provision of maximum reasonable credits towards monthly inflow requirements; and,

(6) any other matter pertinent to the conditions contained in this Agreed Order

VOL 213 PAGE 805

5 This Agreed Order shall remain in effect until amended or superseded by the Commission

Issued date: APR 05 2001

TEXAS NATURAL RESOURCE
CONSERVATION COMMISSION

Robert J. Huston, Chairman

237629
FILED FOR RECORD
01 APR 23 AM 8:43
SAM D. DEANDA
COUNTY CLERK KLEBERG COUNTY
BY DEPUTY
ELDA ALEGRIA

STATE OF TEXAS COUNTY OF KLEBERG
I hereby certify that this instrument was filed on the date and time stamped hereon by me and was duly recorded in the OFFICIAL RECORDS of Kleberg County, Texas

VOL 213 PAGE 795
APR 24 2001
Recording Date

County Clerk, Kleberg County

Indexed

Compared

PROVISIONS CONTAINED IN ANY DOCUMENT WHICH RESTRICT THE SALE, RENTAL OR USE OF THE REAL PROPERTY DESCRIBED THEREIN BECAUSE OF RACE OR COLOR ARE INVALID UNDER FEDERAL LAW AND ARE UNENFORCEABLE

Return to:
Timothy L. Brown
Attorney at Law
1600 West 38th Street,
Suite 206
Austin, Texas 78731

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Appendix D
(for Appendix E.4)

Water Rates

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CITY OF CORPUS CHRISTI
UTILITIES BUSINESS OFFICE

UTILITY RATE SCHEDULE

MONTHLY CHARGE FOR WATER SERVICE

Effective August 1, 2005

MINIMUM MONTHLY CHARGE (FOR FIRST 2,000 GALLONS)

INSIDE CITY LIMITS:

Meter Size		Minimum
5/8" x 3/4"	Residential $	6.799
5/8" x 3/4"	Commercial	9.812
1"	....	15.660
1 1/2"	....	26.309
2"	....	40.934
3"	....	146.876
4"	....	167.569
6"	....	251.773
8" or larger	....	378.172

OUTSIDE CITY LIMITS:

Meter Size		Minimum
5/8" x 3/4"	Residential $	14.435
5/8" x 3/4"	Commercial	20.482
1"	....	32.135
1 1/2"	....	53.450
2"	....	82.683
3"	....	294.569
4"	....	335.977
6"	....	504.405
8" or larger	....	757.195

MONTHLY VOLUME CHARGES PER 1,000 GALLONS (above the minimum level)

INSIDE THE CITY LIMITS:

PER 1000/GALLONS

Residential

First	2,000	Gallons	Minimum
Next	13,000	.... $	2.350
Next	15,000	....	3.317
Next	20,000	....	4.059
Next	50,000	....	4.925

Commercial

First	2,000	Gallons	Minimum
Next	13,000	.... $	2.35
Next	85,000	....	2.091
Next	900,000	....	1.589
Over	1,000,000	....	1.245

Large Volume-

Minimum			Minimum
First	10,000,000	Gallons $	12,749.435
Over	10,000,000	....	0.825

OUTSIDE THE CITY LIMITS:

PER 1000/GALLONS

Residential

First	2,000	Gallons	Minimum
Next	13,000	.... $	4.925
Next	15,000	....	4.925
Next	20,000	....	4.925
Next	50,000	....	4.925

Commercial

First	2,000	Gallons	Minimum
Next	13,000	.... $	5.126
Next	85,000	....	4.603
Next	900,000	....	3.576
Over	1,000,000	....	1.951

Large Volume-

Minimum			Minimum
First	10,000,000	Gallons $	21,273.707
Over	10,000,000	....	1.206

Public Agency for Resale

First	2,000	Gallons	Minimum
Next	13,000	.... $	2.27
Next	85,000	....	2.031
Next	900,000	....	1.527
Next	900,000	....	1.205
Over	10,000,000	....	0.784

Raw water rate for all consumption is .904 per 1000/gal
*Raw water contract rate for all consumption is .946 per 1000/gal

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Appendix E.5

San Patricio Municipal Water District Water Conservation and Drought Contingency Plan

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WATER CONSERVATION PLAN
FOR THE
SAN PATRICIO MUNICIPAL WATER DISTRICT
May 1999
Amended May 10, 2005

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the occurrence of water supply shortage or other water supply emergency conditions, the San Patricio Municipal Water District (District) by action of its Board of Directors (Board) adopts the following Water Conservation Plan (the Plan).

Section II: Goals

The Water Conservation goals of the District are:

(a) to maintain in effect a water conservation plan and a separate drought contingency plan providing the information and direction required by the Texas Administrative Code, Title 30, Environmental Quality, Chapter 288, as these regulations may be amended or modified

(b) to work with the Region "N" Water Planning Group to complete development of the regional water plan

(c) to work with the City of Corpus Christi as regional water supplier to continue development of the specifics of the regional water conservation plan and drought contingency plan

(d) to assist District customers in development and continuing implementation of water conservation plans consistent with the regional plan

(e) to assure that the per capita and per production unit water use by District municipal and industrial customers remain at least 10% below previous 5-year State average values

(f) to limit unaccounted-for water from District transmission and storage facilities to no more than 3% of the volume of water delivered

III. Description of District Service Area and Wholesale Customers

The District, in accordance with its enabling legislation, can operate in San Patricio, Aransas and Refugio counties. Present operations and facilities are all located in San Patricio County. Figure 1 presents information on wholesale customers and their wastewater practices. Figure 2 presents information on the water use of wholesale customers. Appendix "A" gives information on the District's water supply system.

IV. Amount of Diversion from Sources of Supply

The present (2005) source of supply for all water sold by the District is the City of Corpus Christi regional supply. Water diverted from this source is measured by standard water meters complying contractual requirements and with American Water Works Association specifications, including accuracy. Raw water is pumped from the Nueces River at Calallen and raw water is taken from the Lake Texana supply at a tap on the Mary Rhodes Memorial Pipeline south of Sinton. A record of all diversions is kept by the District in its Water Accounting Records, and also is kept by the City of Corpus Christi.

V. Water Deliveries, Metering and Losses

All water delivered to customers will be metered through standard meters having an accuracy of plus or minus 2% of flow rate. The District will maintain a set of Water Accounting Records which that will record amounts of water received by the District and sold to its customers. These records will include the billing records and the SCADA records from the delivery meters. Summaries showing monthly and yearly totals, losses, distribution between customers and other information will be prepared yearly. These records will be available to management personnel through the local PC network a yearly report will be prepared each year and will be available to all District customers, the District's water supplier, regulatory agencies and the public. Each District wholesale customer will receive summary information pertaining to its water use for the previous year.

VI. Leak Detection and Repair

The District system is a transmission system. District customers provide distribution of water delivered to them. Major leaks will be detected by changes in pressure and flow values reported to the operator by the SCADA system, (24-hour per day operation), or by area residents or property owners near the District facilities. Pipeline alignments, storage tanks, pump stations and raw water storage reservoirs will be inspected on a daily basis, combined with meter reading and maintenance functions. Pipeline easements crossing range or brush land will be mowed on a regular basis, with personnel observing for indication of leaks. Repairs will be initiated on discovery of a leak.

VII. Contractual Water Conservation Requirements

All contracts with wholesale customers will include the requirement that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements of Chapter 288 previously cited.

VIII. Water Rates

The District will use uniform or increasing block rate schedules for all classes of water customers.

IX. Water Conservation and Reuse and Recycling of Wastewater

The District will continue implementation of an active water conservation education program. The District will actively pursue potentially feasible reuse or recycling options within its service area. This will specifically include reuse of municipal wastewater effluent and select industrial effluent streams.
The District will also work with existing and new water customers to prevent, where possible, contamination of wastewater streams with substances that might preclude the feasibility of reuse of the stream. Specific programs include:

1. Work with new industrial customers at the pre-design stage to assure that potential water conservation elements are included in the final plant process design, where feasible.
2. Reuse all backwash streams at the treatment plants site and maintain "zero discharge".
3. Continued operation and maintenance of the Aransas Pass/Sherwin/Alcoa reclaimed water project
4. Improved use of water treatment plant residual solids for land reclamation.
5. Cooperative programs with school districts addressing specific educational programs.
6. Working with public entities on Xeriscape projects.
7. Working with Earth Day, Coastal Bend Bays and Estuaries Foundation, Informal Science Educators and other similar organizations.

X. Aquifer Storage and Recovery

The District will investigate the use of aquifer storage and recovery techniques within its service area to reduce seasonal peak supply facility demands and to provide storage for accomplishing this without associated evaporative losses.

XI. Implementation, Enforcement and Coordination with Regional Water Planning Groups and Regional Water Supplier

Copies of the Water Conservation Plan and the Drought Contingency Plan, including the dates of adoption by the Board of Directors, will be furnished to all District wholesale customers, the regional water supplier and the Region "N" Water Planning Group. The District will implement and enforce the plans by the means available to it, including Pro Rata Water Allocation during Severe Water Shortage Conditions or Emergency Water Supply Conditions.

DROUGHT CONTINGENCY PLAN
FOR THE
SAN PATRICIO MUNICIPAL WATER DISTRICT
May 1999
Amended May 10, 2005

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the San Patricio Municipal Water District (District) by action of its Board of Directors (Board) adopts the following Drought Contingency Plan (the Plan).

Section II: Public Involvement

Opportunity for the public and wholesale water customers to provide input into the preparation of the Plans was provided by the District by means of a public hearing. Notice of the meeting and copies of the proposed plans were mailed to each District wholesale customer and notices of the hearing were published in papers with circulation in San Patricio and Aransas counties.

Section III: Wholesale Water Customer Education

The District will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. Copies of the Plan will be provided to each wholesale customer, with information about Stages of the Plan and appropriate actions communicated at appropriate times.

Section IV: Coordination with Regional Water Planning Groups

The water service area of the District is located within the Region "N" Water Planning Area and the District has provided a copy of the Plan to the Region "N" Planning Group.

Section V: Authorization

The District Manager, or his/her designee, is hereby authorized and directed to implement the applicable provisions of the Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The District Manager, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in the Plan.

Section VI: Application

The provisions of the Plan shall apply to all customers utilizing water provided by the District. The terms "person" and "customer" as used in the Plan included individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Triggering Criteria for Initiation and Termination of Drought Response Stages

The Manager, or his/her designee, shall monitor water supply and demand conditions on a weekly basis and shall maintain contact with the City of Corpus Christi as regional water supplier. Triggering criteria for initiation and termination of drought response stages relating to basic regional water supply shall be determined by the City of Corpus Christi. Triggering conditions for emergency water supply conditions not relating to basic regional water supply shall be determined by the District Board. The District will notify all of its customers when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by mail or telephone. All of these activities will be coordinated with the City of Corpus Christi to assure that all water customers in the regional area receive the same supply condition message at the same time.

Section VIII: Drought Response Stages

The District will encourage all of its customers to adopt similar demand management measures to those adopted by the City of Corpus Christi for each Water Supply Condition Stage. The District will work with all of its wholesale customers to initiate voluntary and mandatory measures, as appropriate for each Stage, to reduce non-essential water use.

Section IX: Pro Rata Water Allocation

In the event that the triggering criteria for Severe Water Shortage Conditions or Emergency Water Supply Conditions have been met, the Manager is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039 and according to the following procedures.

The Manager, or his/her designee, will maintain a monthly water usage baseline for each wholesale customer. The wholesale customer's water usage baseline will be computed on the average water usage by month for the previous five calendar year period. If the wholesale water customer's billing history is less than five years, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists.

A wholesale customer's monthly allocation shall be a percentage of the customer's water usage baseline. The percentage will be set by resolution of the Board based on the Manager's assessment of the severity of the water shortage condition and the need to curtail water deliveries and may be adjusted periodically by resolution of the Board as conditions warrant. Once pro rata allocation is in effect, water deliveries to each wholesale customer shall be limited to the allocation established for each month.

The Manager shall provide notice, by certified mail, to each wholesale customer informing them of their monthly water usage allocations and shall notify the news media and the executive director of the Texas Natural Resource Conservation Commission upon initiation of pro rata water allocation.

Upon request of the customer or at the initiative of the Manager, the allocation may be reduced or increased if objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the Board.

Section X: Enforcement

During any period when pro rata allocation of available water supplies is in effect, delivery of water to wholesale customers shall be limited to the amount per day which will produce the monthly water usage allocation. Daily deliveries to each wholesale customer will be in as equal an amount as is possible, with each day's delivery target being the amount required to bring the running total delivery for the month to the running total allocation for the month.

Section XI: Variances

The Manager, or his/her designee, may, in writing, grant a temporary variance to the pro rata water allocation policies provided by the Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

District customers requesting an exemption from the provisions of this Plan shall file a petition for variance with the Manager within 10 days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the District Board, and shall include the following:

(a) Name and address of petitioner(s)
(b) Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Plan.
(c) Description of the relief requested
(d) Period of time for which the variance is sought
(e) Alternative measures the petitioner is taking or proposed to take to meet the intent of this Plan and the compliance date.
(f) Other pertinent information.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section XII: Severability

It is hereby declared to be the intention of the Board that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan, since the same would not have been enacted by the Board without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

FIGURE I: (See Spreadsheet File CONSERV1.wk4)
FIGURE II: (See Spreadsheet File CONSERV2.wk4)

APPENDIX "A"
MAJOR WATER FACILITIES OF THE
SAN PATRICIO MUNICIPAL WATER DISTICT

I: General

The District purchases both untreated and potable water from City of Corpus Christi. This water is either resold directly by the District or its quality is modified in treatment facilities and the product sold to District customers. The District is a "Wholesale" water supplier, selling water in large quantities to municipalities and water supply corporations having their own storage, pumping and distribution systems or to industries, which treat and/or distribute the water within their facilities to meet the various process and sanitary needs. Their are several small "single meter" customers which were connected to District facilities, (or transmission facilities which the District later purchased). prior to 1983. Policy does not permit additional connections of this type and existing connections are moved to distribution systems as they become available in the area.

II: Raw Water Facilities

Raw water is received by the District at two points, (1) the Nueces River channel near Calallen, just upstream from the salt water barrier dam, and (2) a connection to the Mary Rhodes Memorial Pipeline at a point just south of the city of Sinton. Water from the Nueces River is pumped from the river channel at the 4-pump W. A. Edwards Pumping Station and flows easterly in a 36" diameter concrete steel cylinder pipeline which terminates at the District water treatment plants site between Gregory and Ingleside. There is a booster pumping station located on the pipeline approximately 3 miles southeast of Odem. The maximum capacity of this facility is approximately 24 million gallons per day peak rate. Raw water from this line is delivered directly to District customers or to the 192 million gallon raw water storage reservoir at the plants site.

Raw water is also received from the Mary Rhodes Pipeline through a 24" valve and meter installation. This water flows easterly in a 36" diameter pipeline to a blending station southeast of Taft, where it is blended with water from the Nueces River. From there the blended water flows easterly in a 42" diameter concrete steel cylinder pipeline to the 192 million gallon raw water storage reservoir located approximately 1000 feet northwesterly from the treatment plants site.

An existing raw water storage reservoir on the treatment plants site has a capacity of 12 million gallons and presently (2005) furnishes raw water to DuPont, Air Liquide and Plant "B". The 192 million gallon raw water storage reservoir at the plants site provides preliminary settling. Water from this reservoir is delivered to Plants "A", "B" and "C" and to Ingleside Cogeneration and Sherwin Alumina.

III: Potable Water Facilities

Potable water treated at the City of Corpus Christi O. N. Stevens Water Treatment Plant is received by the District through a meter located near the Nueces River at Calallen, on the site of the Cunningham Treatment Plant, (no longer in use). This water is conveyed easterly to the District treatment plants site in a 24" diameter concrete steel cylinder and PVC pipeline. There is a booster pumping station located near Odem. The cities of Odem, Taft, Gregory and Portland are served with potable water at metering stations on this line, as are the Seaboard Water Supply Corporation and the Rincon Water Supply Corporation. The capacity of this facility is approximately 7.2 million gallons per day but is presently reduced because of deterioration of portions of the line.

The District owns, operates and maintains two potable water treatment facilities, Plant "A", with a capacity of 9 million gallons per day and Plant "C" with a capacity of 4.6 million gallons per day. Raw water for both plants is taken from both the Nueces and Texana sources. There are transmission lines to the cities of Taft, Gregory, Portland, Ingleside, Aransas Pass and to the Aransas County Conservation and Reclamation District (serving the Rockport/Fulton area) and the Nueces County Water Control and Improvement District (serving the Port Aransas area). A total of 6.25 million gallons of potable water storage is a part of the system, as are pumping stations and metering stations.

IV: Clarified Water Facilities

The District owns, operates and maintains two clarified water treatment facilities, Plant "B", with a capacity of 5.7 million gallons per day and Plant "C" with a capacity of 3.2 million gallons per day. Water from Plant "B" is delivered to Occidental Chemical for their use. Water from Plant "C" is delivered to Ingleside Cogeneration LP for their use.

V. Reclaimed Water Facilities

The District owns. operates and maintains a reclaimed water facility which takes treated wastewater effluent and excess biosolids from the City of Aransas Pass and delivers them to Alcoa for their process and plant use. The facility includes a pump station, metering and transmission line, and delivers approximately 0.7 million gallons per day.

FIGURE I: SERVICE AREA AND CUSTOMER DATA

WATER CONSERVATION PLAN

San Patricio Municipal Water District

May 2005 File: CONSERV1.wk4

Customer	Water Type	Del.Pts , #	Wastewater Information
Rockport/Fulton	Potable	1	Municipal treatment plant, effluent used for watering golf course
Aransas Pass	Potable	2	Municipal treatment plant, effluent reclaimed for use at Sherwin Alumina (90%) and municipal park use (10%)
NCWCID No.4	Potable	1	Municipal treatment plant, discharge to wetlands area and Corpus Christi Bay
Ingleside	Potable	2	Municipal treatment plant, discharge to Kinney Bayou
Gregory	Potable	1	Municipal treatment plant, discharge to Green Lake (drainage) with reuse for golf course irrigation
Portland	Potable	2	Municipal treatment plant, discharge to Nueces Bay
Taft	Potable	1	Municipal treatment plant, discharge to local ditch, Copano Bay
Odem	Potable	1	Municipal treatment plant, discharge to Peters Swale, new plant will divert effluent to Rincon Bayou
Sherwin Alumina	Raw & Pot.	4	Small sanitary waste treatment plant, effluent recycled. All other water, including direct rainfall, reused - no discharge
Ingleside Cogeneration	MF Clarified	1	Cooperative with Dupont and Occidental Chemical
Dupont	Raw & Pot.	2	Industrial treatment plant, discharge to Corpus Christi Bay
Air Liquide	Raw & Pot.	2	Cooperative with Dupont and Occidental Chemical
Gregory Power Partners	Raw & Pot.	2	Industrial treatment plant, effluent reclaimed for use at Sherwin Alumina
Rural	Potable		Individual treatment and disposal
Water Corporations	Potable		Individual treatment and disposal
Other Raw	Raw		None

NOTES:

(1) NCWCID No.4 is Mustang/Padre Island area, which also has service from the City of Corpus Christi

(2) Types of water sold by the District are potable (drinking water), clarified (not disinfected), MF clarified (not disinfected), reclaimed and raw (untreated)

FIGURE II WATER USE DATA

WATER CONSERVATION PLAN

San Patricio Municipal Water District

May 10, 2005

Customer	Total Delivery - M Gals.	Population	Per Capita Use, Gal/Day
Rockport	917,264,000	10,096	248.9
Aransas Pass	562,624,000	8,134	189.5
DuPont	339,747,000		
Gregory	112,265,000	2318	132.7
Ingleside	358,017,700	9388	104.5
NCWCID #4	157,005,000		
Occidental Chem	1,404,474		
Odem	119,644,000	2499	131.2
Portland	552,930,900	17,489	86.6
Sherwin Alum. - Raw	1,058,447,000		
Sherwin Alum. - Pot.	363,240,000		
Taft	161,605,000	5,014	88.3
Rural	32,565,000		
Water Corps.	106,986,000		
Other Raw	1,227,000		

NOTES

(1) NCWCID # 4 includes Mustang/Padre Island Area - also served by City of Corpus Christi
(2) Types of water sold by the District are potable (drinking water), clarified (not disinfected) and raw (untreated)
(3) Total Delivery, Mgals, does not include reclaimed water delivered to Sherwin Alumina
(4) Population data is from US Census 2000
(5) Population data for Rockport does not include total service area
(6) Population data for Taft includes residential area south of Taft

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Appendix E.6

South Texas Water Authority Water Conservation and Drought Contingency Plan (Amended April 2005)

South Texas Water Authority
Water Conservation and Drought Contingency Plan

PART I—WATER CONSERVATION PLAN

Introduction:

The South Texas Water Authority provides wholesale, treated water supplies to approximately 35,000 citizens. Its mission is to:

- provide a high quality, safe, and potable supply of water that meets all federal and state requirements to communities, residents, and entities in central Kleberg County and western Nueces County,
- insure a dependable, abundant supply is available to our customers and
- utilize a regional approach that minimizes adverse cost of service based on entity size.

South Texas Water Authority does not provide wastewater service.

Service Area:

South Texas Water Authority supplies water to nine (9) entities. The following information is the latest population data and information for the last five (5) Fiscal Years:

Table 1

Entity	Population	Service Connections	5 Year Average (annual)	Monthly Peak Demand (last 5 years)
City of Agua Dulce	735	320	33,475,972	4,730,600
City of Bishop	3,305	1,216	103,831,500[2]	20,435,000[3]
City of Driscoll	825	290	31,588,866	3,712,500
City of Kingsville	25,575	7,069	176,995,600	52,522,000
Nueces Water Supply Corp.	1,986[1]	550	78,780,480	9,990,410
Ricardo Water Supply Corp.	2,433[1]	795	96,796,120[4]	15,265,200[4]
Nueces County Water Control & Improvement District #5	810	266	32,524,075	4,017,000
Coastal Bend Youth City	N/A	1	4,514,700	997,000
Coastal Acres, LLC	N/A	1	686,640	321,800

[1] Nueces and Ricardo Water Supply Corporations' population is estimated at 3 times their service connections.
[2] Bishop's average annual usage includes periods of 100% surface use and periods of blending—well usage data is not included
[3] Bishop's monthly peak demand is during a period of 100% surface water usage.
[4] Ricardo WSC annual average and monthly peak include total demand from all sources—surface and ground water

All customers are located within the Authority's district with the exception of the Nueces County Water Control and Improvement District #5 (Banquete), which is served as an Out-of-District customer.

The Authority's facilities were designed and constructed to serve four original customers, Kingsville, Bishop, Driscoll and Agua Dulce with 100% of their needs. At the time of construction in 1983, it was anticipated that these entities would initially require between 5 MGD and 7 MGD. The system was designed to meet a 50-year planning period; therefore, the delivery capacity of the system is 17 MGD.

South Texas Water Authority purchases treated water from the City of Corpus Christi. Supplies are transported approximately thirty (30) miles south from the O.N. Stevens Treatment Plant to the City of Kingsville via a 42" steel reinforced concrete cylinder water line (P-303). Coastal Acres LLC, Coastal Bend Youth City, the City of Driscoll, the City of Bishop and a portion of the Nueces Water Supply Corporation customers are serviced along the route of the 42" transmission line. A smaller asbestos concrete spur line (14-inch and 12-inch) supplies customers in Agua Dulce, Banquete, and the remainder of the Nueces Water Supply Corporation's customers. Water service to the Ricardo Water Supply Corporation is provided via a pass-through agreement between the Authority and the City of Kingsville for a portion of the distance. Water is transported the remainder of the distance through the Authority's 12" ductile iron line to the Corporation's three pump stations. In addition, construction of the system included pump station and storage facilities designed to provide a full day's supply during peak periods.

According to the City of Corpus Christi, the Authority purchased approximately 599 million gallons from the City of Corpus Christi in the year 2004. The Authority's Fiscal Year records (October 2003 through September 2004) indicate a purchase of 532 million gallons. In the past 20 years, however, the largest potential customer, Kingsville, has opted to continue using groundwater wells for the majority of its needs. Therefore, on average the Authority provides less than 2 MGD to its nine customers. During extremely dry conditions, water demand has exceeded 3 MGD.

Water purchased from the City of Corpus Christi is from Lake Corpus Christi, which stores 242,241 acre-feet of water, Choke Canyon Reservoir which stores 695,271 acre-feet of water and the 101-mile-long Mary Rhodes Pipeline which transports water through a 64-inch pipeline from Lake Texana near Edna, Texas. In 1993, the City of Corpus Christi entered into a contract with the Lavaca-Navidad River Authority to purchase 41,840 acre-feet of water per year. According to the City, approximately 50 percent to 70 percent of the water treated at the O.N. Stevens Treatment Plant is transported from Lake Texana.

The O.N. Stevens Water Treatment Plant has a rated capacity of 167 million gallons per day, well above the peak summer demand of 110 million gallons per day. According to the City's Conservation and Drought Contingency Plan, the City's Water Department operates in full compliance with all state and federal requirements.

In addition to the above mentioned supplies, in 1999 the City of Corpus Christi acquired senior water rights to 35,000 acre-feet of water per year in the Navidad River. At this time, the City is also exploring the feasibility of desalination. In 2003, the City was one of three sites awarded a $500,000 state grant to conduct a study as part of Governor Rick Perry's initiative to assess the potential desalination of seawater to help meet the state's regional water needs. The City is also participating in a U.S. Army Corps of Engineers feasibility study to assess the potential for desalination as a water supply source for the region. This study is jointly sponsored by the San Antonio Water System, San Antonio River Authority, and Guadalupe Blanco River Authority.

South Texas Water Authority's district is located within the Region N Planning area and the Authority will be providing a copy of this Plan to the Region N Planning Group. South Texas Water Authority stays abreast of City of Corpus Christi and regional water issues through the Executive Director's participation in the following:

1. as the co-chair of the Coastal Bend Regional Water Planning Group;
2. as the chair of the Corpus Christi Water Resource Advisory Committee;
3. as a member of the Coastal Bend Bay and Estuary Program's Bay Council and chair of the Bay Council Coordination Team; and
4. as a member of the Nueces Estuary Advisory Committee.

Measurement/Accounting and Monitoring/Record Management of Water:

All water is metered as it leaves the O.N. Stevens Plant and enters the Authority's Regional System. Water is metered again as it enters the ground storage tanks servicing the Authority's nine (9) wholesale customers. Meter readings and flow volumes are recorded daily via a Supervisory Control and Data Acquisition system. A water loss report is calculated Monday through Friday. On average, the monthly water loss is less than two percent (2%). The Authority's goal is to keep the water loss rate below that level.

Leak Detection and Repair:

In addition to the daily water loss report and daily metering, the Authority periodically drives out the route of the line. A major portion of the Authority's Regional System's waterlines are located in rural farmlands; therefore, leaks that are not detected by employees are reported by landowners or tenant farmers. For those areas that are not located in cultivated fields, the Authority clears its right-of-way using leased equipment. In addition, leaks have been located as part of the Authority's cathodic protection program, which involves excavating the 42" transmission line to install sacrificial zinc anodes every 100 lineal feet. Master meters are tested annually by an outside company specializing in testing larger meters. For deviations from 100% greater or less than 2%, the meter is re-calibrated. Meters are also tested prior to the annual test date in the event the meter is exhibiting a slow down in registering. Ground storage and elevated tanks are inspected annually. Cathodic protection systems are installed in the two welded steel tanks located in Kingsville and Bishop. Tanks are refurbished every five years, or as needed, by interior and exterior cleaning, spot painting, or in certain instances completely repainting of the tank.

Reservoir Systems Operations Plan:

South Texas Water Authority does not own or operate any reservoir systems. The water wholesaled by STWA is purchased from the City of Corpus Christi, the responsible entity overseeing those tasks.

Five-year and Ten-year targets:

According to the City of Corpus Christi's Water Conservation Plan, the South Texas Water Authority daily per capita use is 155. The City's Plan cites the Texas Water Development Board as the source of the information. A goal of 1 percent reduction per year would result in a gcpd of 145 in the year 2010 and a gpcd of 141 in the year 2020.

It is important to note that of the nine customers that the Authority provides service, only six (6) utilize the Authority for 100% of their needs Of those six customers, two (2), Coastal Bend Youth City and Coastal Acres, LLC do not provide retail service. Table 2 provides specific numbers on these retail service providers. These figures include residential, commercial, and industrial use.

Table 2

Entity	FY 2004 Purchased Volume	FY 2004 Self-supplied Volume	FY 2004 Total	FY 2004 Population	FY 2004 Current Per Capita
Agua Dulce	28,538,500	0	28,538,500	735	106.38
Bishop[1]	69,316,000	61,118,000	130,434,000	3,305	108.13
Driscoll	29,538,500	0	29,538,500	825	98.09
Kingsville[2]	298,974,000	873,788,000	1,172,762,000	25,575	125.63
Nueces WSC	77,727,610	0	77,727,610	1,986	107.23
NCWC&ID#5	34,481,700	0	34,481,700	810	116.63
Ricardo WSC[3]	78,230,000	9,982,600	88,212,600	2,433	99.33

[1] Bishop's well usage is from October 2003 through September 2004 from readings taken by STWA staff.
[2] Kingsville's well usage is from August 2003 through July 2004 from information provided by the City.
[3] Ricardo WSC well usage is from October 2003 through September 2004 from readings taken by STWA staff.

The Authority has no enforcement mechanism to impose conservation targets and goals upon its wholesale customers.

Conservation Strategies:

(A) Conservation-Oriented Water Rates—at this time, South Texas Water Authority is negotiating contracts with its customers based on several components. The Authority is expected to sign contracts based on a rate that will include a Capacity Fee component, which will recoup fixed costs, a Debt Service component to recoup annual payment on debt and a variable cost component to cover the cost of water purchased from Corpus Christi and other variable expenses.

(B) South Texas Water Authority does not sell water to any agricultural customers; therefore, the Authority does not have any programs to assist agricultural customers in the development of conservation pollution prevention and abatement plans.

(C) South Texas Water Authority does not provide wastewater service therefore, it does not have any programs for reuse and/or recycling of wastewater and/or graywater.

The Authority recognizes that there are numerous factors involved in achieving these goals including educating customers, adoption of conservation oriented rates, and proper maintenance of infrastructure. As such, the Authority is actively involved in the Coastal Bend Regional Water Planning Group, the Nueces Estuary Advisory Council, the Coastal Bend Bay and Estuary Program, the City of Corpus Christi Water Resource Advisory Committee, and the recently formed Uranium Resource Incorporated Citizens Advisory Board The Authority will continue to assist its wholesale customers through the following voluntary programs:

- Major Rivers
- Issuance and administration of Contract Revenue Bonds
- Providing financial data for grant/loan applications
- Providing brochure and templates for conservation information

In addition, the Authority makes use of water-wise vegetation and crushed limestone landscaping and grounds keeping. The Authority will request that wholesale customers voluntarily report their progress on water conservation activities on an annual basis.

Future Contracts:

South Texas Water Authority recognizes that a requirement in every future water supply contract entered into stipulates that water conservation must have an adopted plan. In addition, the Authority recognizes that should the customer intend to resell supplies that any contract between the initial supplier and customer must contain water conservation requirements. At this time, the Authority is in the process of renegotiating those contracts which will include those stipulations.

Implementation And Enforcement:

Enclosed is a copy of the resolution adopted by the South Texas Water Authority Board of Directors adopting The Water Conservation And Drought Contingency Plan attached as Appendix A.

Coordination With The Regional Water Planning Group:

Enclosed is a copy of the cover letter sent to the Nueces River Authority, administrator of the Coastal Bend Regional Water Planning Group attached as Appendix B.

Review And Update:

Beginning May 1, 2005, the South Texas Water Authority shall review and update its Water Conservation And Drought Contingency Plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. Therefore, the next review shall not occur later than May 1, 2009, and every five years after that date.

PART II—DROUGHT CONTINGENCY PLAN

The following Part II of the Water Conservation and Drought Contingency Plan is South Texas Water Authority's Drought Contingency Plan adopted by Board resolution on August 26, 1999.

Section I: Declaration of Policy, Purpose and Intent

In order to conserve the available water supply and/or to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the South Texas Water Authority adopts the following Drought Contingency Plan, hereinafter referred to as the "Plan."

It is the intent that the Plan will:

a) maintain in effect a drought contingency plan providing the information and direction required by the Texas Administrative Code, Title 30, Environmental Quality, Chapter 288, as these regulations may be amended or modified;
b) facilitate the development of the specifics of a regional drought contingency plan in conjunction with the Coastal Bend Regional Water Planning Group and the regional water supplier, the City of Corpus Christi;
c) assist District customers in development and implementation of plans.

Section II: Public Involvement

Opportunity for the public and wholesale water customers to provide input into the preparation of the Plan was provided by South Texas Water Authority by means of notice of public meeting and certified letter to wholesale customers.

Section III: Wholesale Water Customer Education

The South Texas Water Authority will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of certified letter.

The South Texas Water Authority currently wholesales water to the cities of Agua Dulce, Bishop, Driscoll, Kingsville and the Nueces County Water Control and Improvement District #5 (Banquete), the Nueces Water Supply Corporation, Ricardo Water Supply Corporation, Coastal Bend Youth City and Coastal Acres LLC. The District is located in western Nueces County and northern Kleberg County.

Section IV: Coordination with Regional Water Planning Groups

The water service area of the South Texas Water Authority is located within Region N and the South Texas Water Authority has provided a copy of the Plan to the Coastal Bend Regional Water Planning Group

Section V: Authorization

The Executive Director, or his/her designee, is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The Executive Director, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all customers utilizing water provided by the South Texas Water Authority. The terms person and customer as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Triggering Criteria for Initiation and Termination of Drought Response Stages

The Executive Director or his/her designee shall monitor water supply and/or demand conditions on a **weekly** basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Coordination with the City of Corpus Christi, the regional water supplier, will be required. Customer notification of the initiation or termination of drought response stages will be made by mail or telephone. The news media will also be informed.

The triggering criteria described below are based on limits as adopted by the City Council of the City of Corpus Christi.

(a) Stage 1 – Mild Water Shortage Conditions

Requirements for initiation – The South Texas Water Authority will recognize that a mild water shortage condition exists when combined water stored in the reservoirs is estimated to be forty percent (40%) of total storage capacity or the percentage established by the City of Corpus Christi, the regional water supplier.

Requirements for termination – Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 1 in the same manner as the notification of initiation of Stage 1 of the Plan.

b) **Stage 2 – Moderate Water Shortage Conditions**

Requirements for initiation – The South Texas Water Authority will recognize that a moderate water shortage condition exists when combined water supply in the City of Corpus Christi's reservoirs is less than 40% but greater than 30% of total storage capacity, or the percentage established by the City of Corpus Christi, and the City Manager directs implementation in order to protect reservoir storage levels.

Requirements for termination – Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. Upon termination of Stage 2, Stage 1 becomes operative, unless the combined water supply has exceeded the 40% level. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 2 in the same manner as the notification of initiation of Stage 1 of the Plan, if applicable.

c) **Stage 3 – Severe Water Shortage Conditions**

Requirements for initiation – The South Texas Water Authority will recognize that a severe water shortage condition exists when combined water storage in the City of Corpus Christi's reservoir system is equal to or less than 30% of total storage capacity, or the percentage established by the City of Corpus Christi, and the City Manager directs implementation in order to protect reservoir storage levels.

Requirements for termination – Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of thirty (30) consecutive days. Upon termination of Stage 3, Stage 2 becomes operative, unless the combined water supply has exceeded the 30% level. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 3 in the same manner as the notification of initiation of Stage 2 of the Plan, if applicable.

(d) **Stage 4 – Emergency Water Shortage Conditions**

Requirements for initiation - The South Texas Water Authority will recognize that an emergency water shortage condition exists when:

a) Water supply in the City of Corpus Christi's reservoirs is estimated to be less than 65,000 acre feet, or a level established by the City of Corpus Christi, or
b) Major water line breaks or pump station failures which cause unprecedented loss of capability to provide water service, or
c) Natural or man-made contamination of the water supply source(s).

Requirements for termination – Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of fifteen (15) consecutive days or earliest and safest time period possible. The South Texas Water Authority will notify its wholesale customers and the media of the termination of Stage 4.

Section VIII: Drought Response Stages

The Executive Director, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria set forth in Section VII, shall determine that mild, moderate, or severe water shortage conditions exist, as established by the City of Corpus Christi, or that an emergency condition exists and shall implement the following actions:

Stage 1 – Mild Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.
2. Supply Management Measures Request wholesale customers and assist in the effort to organize a committee of business, industrial, and residential representatives to make recommendations for the necessary regulations and prohibitions which may include, but are not limited to, the following:

    a) Restrict outdoor use of water for both residential and commercial use: car washing, dust control, watering of lawns and vegetation, and washing building exteriors, sidewalk and driveways.
    b) Prohibit unnecessary waste of water due to defective plumbing including out-of-repair toilets and faucets, underground leaks, leaking hydrants or valves.
    c) Prohibit use of ornamental fountains.
    d) Restrict use of golf course irrigation.
    e) Use of fire hydrants restricted to only fire fighting.
    f) Schedule meetings with large water users, industrial and commercial, to determine any necessary allocation structures and exchange information regarding methods of saving water.
    g) Schedule meetings with utility divisions to review budgets and short and long-term effects of drought restrictions.

3. Demand Management Measures:

    a) The Executive Director, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use
    b) The Executive Director, or his/her designee(s), will provide a weekly report to news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.
    c) The Executive Director, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by preparing a monthly water usage allocation baseline for each

wholesale customer according to the procedures specified in Section IX of the Plan

d) The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 2 – Moderate Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.

2. Supply Management Measures: Request wholesale customers continue in full force with conditions set in Mild Water Shortage Conditions. In addition, request that wholesale customers consider implementation of the following additional regulations or prohibitions:

   a) Limit new connections to distribution system if other service source is available.
   b) Set a mandatory limit of water use for customers with termination limits for excessive use
   c) Service of water in restaurants only at request of customer.
   d) Prohibit water use for expansion of commercial nurseries.
   e) Prohibit water use for scenic and recreational ponds and lakes.
   f) Prohibit water use for swimming pools, wading pools, jacuzzi pools, hot tubs and like or similar uses owned either privately, municipally, commercially (including businesses) or owned by a neighborhood, subdivision, club, or fraternal organization.
   g) Prohibit the use of water for the purpose of placing additional land into agricultural use.
   h) Prohibit new residential, commercial, business, or industrial landscaping or planting.
   i) Devise penalties for violations of any instituted restrictions.

3. Demand Management Measures:

   a) The Executive Director, or his/her designee(s) will initiate weekly contact with wholesale water customers to discuss water supply and/or demand conditions and the possibility of pro rata curtailment of water diversions and/or deliveries.
   b) The Executive Director, or his/her designee(s), will request wholesale water customers to initiate mandatory measures to reduce non-essential water use.
   c) The Executive Director, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by preparing a monthly water usage allocation baseline for each

wholesale customer according to the procedures specified in Section IX of the Plan.

d) The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 3 – Severe Water Shortage Conditions

1. Goal: achieve a comparable percent reduction as requested by the City of Corpus Christi.

2. Supply Management Measures: Request wholesale customers to continue in full force with restrictions set forth in previous condition. In addition, request that wholesale customers consider implementation of the following additional regulations or prohibitions:

   a) Applications for new, additional, expanded, or increased size connections, meters, service lines, pipelines, mains or other water service facilities of any kind should not be approved except by review and approval of the majority of the governing body
   b) Revise allocations to commercial and industrial users.
   c) Establish revised allocations and rates to residential customers based on family size, average historical use, etc.

3. The Executive Director, or his/her designee(s), will provide a weekly report to the City of Corpus Christi with information regarding current wholesale customer usage.

Stage 4 – Emergency Water Shortage Conditions

Whenever emergency water shortage conditions exist as defined in Section VII of the Plan, the Executive Director shall:

1) Assess the severity of the problem and identify the actions needed and time required to solve the problem.

2) Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate, to alleviate problems.

3) If appropriate, notify city, county, and/or state emergency response officials for assistance.

4) Undertake necessary actions, including repairs and/or cleanup as needed.

5) Prepare a post-event assessment report on the incident and critique of emergency response procedures and action.

Section IX: Pro Rata Water Allocation

In the event that the triggering criteria specified in Section VII of the Plan for Stage 3 – Severe Water Shortage Conditions have been met, the Executive Director is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039 and according to the following water allocation policies and procedures:

(a) A wholesale customer's monthly allocation shall be a percentage of the customer's water usage baseline. The percentage will be set by resolution of the Board of Directors based on the Executive Director's assessment of the severity of the water shortage condition and the need to curtail water diversions and/or deliveries and may be adjusted periodically by resolution of the Board of Directors as conditions warrant. Once pro rata allocation is in effect, water diversions by or deliveries to each wholesale customer shall be limited to the allocation established for each month.

(b) A monthly water usage allocation shall be established by the Executive Director, or his/her designee, for each wholesale customer. The wholesale customer's water usage baseline will be computed on the average water usage by month for the last five (5) year period as shown in the example given below. If the wholesale water customer's billing history is less than five (5) years, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists.

Example Calculation of Monthly Allocation for a Hypothetical Wholesale Water Customer

	1994	1995	1996	1997	1998	SUM	AVE	Allocation Percentage	Monthly Allocation
Jan	133	137	146	148	156	719	144	75%	108
Feb	115	122	133	133	147	650	130	75%	98
Mar	130	150	146	149	159	734	147	75%	110
Apr	130	167	168	157	187	808	162	75%	122
May	160	152	179	183	171	845	169	75%	127
June	226	184	172	205	249	1,035	207	75%	155
July	235	274	232	314	246	1,301	260	75%	195
Aug	222	203	206	337	309	1,277	255	75%	191
Sep	199	160	196	229	198	982	196	75%	147
Oct	165	172	197	165	185	884	177	75%	133
Nov	139	142	149	153	162	745	149	75%	112
Dec	142	143	150	156	165	755	151	75%	113
Total	1,995	2,006	2,072	2,330	2,333		2,333		

* UNITS IN 1,000 gallons

(c) The Executive Director shall provide notice, by certified mail, to each wholesale customer informing them of their monthly water usage allocations and shall notify the City of Corpus Christi and the executive director of the Texas Commission on Environmental Quality upon initiation of pro rata water allocation

(d) Upon request of the customer or at the initiative of the Executive Director, the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the wholesale customer's normal water usage; (2) the customer agrees to transfer part of its allocation to another wholesale customer; or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the Board of Directors of the South Texas Water Authority.

Section X: Enforcement

During any period when pro rata allocation of available water supplies is in effect, wholesale customers shall pay their pro rata share of any surcharges that the City of Corpus Christi collects from the South Texas Water Authority. Daily volumes will be provided to each customer to insure they are aware of their monthly allotment standing.

Section XI: Variances

The Executive Director, or his/her designee, may, in writing, grant a temporary variance to the pro rata water allocation policies provided by this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.

(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Plan shall file a petition for variance with the Executive Director within five (5) days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the Board of Directors, and shall include the following:

(a) Name and address of the petitioner(s).

(b) Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the Plan adversely affects the petition or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.

(c) Description of the relief requested

(d) Period of time for which the variance is sought.

(e) Alternative measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.

(f) Other pertinent information.

Variances granted by the Board of Directors shall be subject to the following conditions, unless waived or modified by the Board of Directors or its designee:

(a) Variances granted shall include a timetable for compliance.

(b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section XII: Severability

It is hereby declared to be the intention of the Board of Directors that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan, since the same would not have been enacted by the Board of Directors without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

Appendix F

TWDB Socioeconomic Impacts of Unmet Water Needs in the Coastal Bend Water Planning Area (DRAFT)

Socioeconomic Impacts of Unmet Water Needs in the Coastal Bend Water Planning Area (DRAFT)

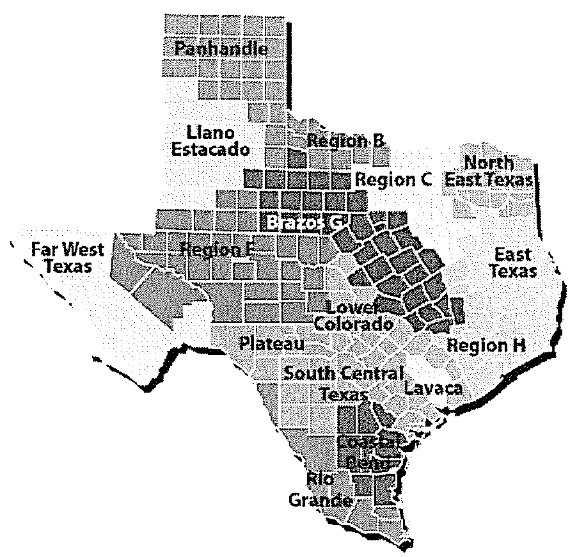
Prepared by:

Stuart Norvell and Kevin Kluge of The Texas Water Development Board's Office of Water Resources Planning

Prepared in support of the:

Coastal Bend Water Planning Group and the 2006 Texas State Water Plan

May 2005



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Executive Summary

Background

Water shortages due to severe drought combined with infrastructure limitations would likely curtail or eliminate economic activity in business and industries heavily reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on business and industry, but they might also bias corporate decision makers against plant expansion or plant location in Texas. From a societal perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Section 357.7(4) of the rules for implementing Texas Senate Bill 1 requires regional water planning groups to evaluate the social and economic impacts of projected water shortages (i.e., "unmet water needs") as part of the planning process. The rules contain provisions that direct the Texas Water Development Board (TWDB) to provide technical assistance to complete socioeconomic impact assessments. In response to requests from regional planning groups, staff of the TWDB's Office of Water Resources Planning designed and conducted analyses to evaluate socioeconomic impacts of unmet water needs.

Overview of Methodology

Two components make up the overall approach to this study: 1) an economic impact module and 2) a social impact module. Economic analysis addresses potential impacts of unmet water needs including effects on residential water consumers and losses to regional economies stemming from reductions in economic output for agricultural, industrial and commercial water uses. Impacts to agriculture, industry and commercial enterprises were estimated using regional "input-output" models commonly used by researchers to estimate how reductions in business activity might affect a given economy. Estimated impacts are *independent* and distinct "what if" scenarios for a given point in time (i.e., 2010, 2020, 2030, 2040, 2050 and 2060). Reported figures are scenarios that illustrate what could happen in a given year if: 1) water supply infrastructure and/or water management strategies do not change through time, 2) the drought of record recurs. Details regarding the methodology and assumptions for individual water use categories (i.e., municipal consumers including residential and commercial water users, manufacturing, steam-electric, mining, and agriculture) are in the main body of the report.

The social component focuses on demographic effects including changes in population and school enrollment. Methods are based on population projection models developed by the TWDB for regional and state water planning. With the assistance of the Texas State Data Center, TWDB staff modified these models and applied them for use here. Basically, the social impact module incorporates results from the economic impact module and assesses how changes in a region's economy due to water shortages could affect patterns of migration in a region.

Summary of Results

Table E-1 and Figure E-1 summarize estimated economic impacts. Variables shown include:[1]

- **sales** - economic output measured by sales revenue;
- **jobs** - number of full and part-time jobs required by a given industry including self-employment;
- **regional income** - total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments for the region; and
- **business taxes** - sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include any type of income tax).

If drought of record conditions return and water supplies are not developed, study results indicate that the Coastal Bend Regional Water Planning Area (Region N) would suffer significant losses. If such conditions occurred 2010 lost income to residents in the region could approach $22 million with associated job losses of 230. State and local governments could lose $3.40 million in tax receipts. If such conditions occurred in 2060, income losses could run $3,214 million and job losses could be as high 36,785. Nearly $233 million worth of state and local taxes would be lost. The majority of impacts stem from projected water shortages for manufacturing firms. Reported figures are probably conservative because they are based on estimated costs for a single year; but in much of Texas, the drought of record lasted several years. For example, in 2040 models indicate that shortages would cost residents and businesses in the region $363 million in lost income. Thus, if shortages lasted for three years total losses related to unmet needs could easily exceed $1,000 million.

Table E-1: Annual Economic Impacts of Unmet Water Needs
(years, 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Sales ($millions)	Income ($millions)	Jobs	State and Local Taxes ($millions)
2010	$75.24	$21.68	230	$3.40
2020	$115.46	$32.63	350	$5.00
2030	$166.17	$50.18	460	$7.34
2040	$1,317.47	$363.83	3,780	$32.66
2050	$4,111.21	$1,113.01	12,385	$85.24
2060	$12,025.66	$3,214.41	36,785	$232.56

* Impacts at the county level are in the main body of the report (see Attachment A). Source: Texas Water Development Board, Office of Water Resources Planning

[1] Total sales are not a good measure of economic prosperity because they include sales to other industries for further processing. For example, a farmer sells rice to a rice mill, which the rice mill processes and sells it to another consumer. Both transactions are counted in an input-output model. Thus, total sales "double count." Regional income plus business taxes are more suitable because they are a better measure of net economic returns.

Figure E-1: Distribution of Lost Income by Water Use Category
(years, 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

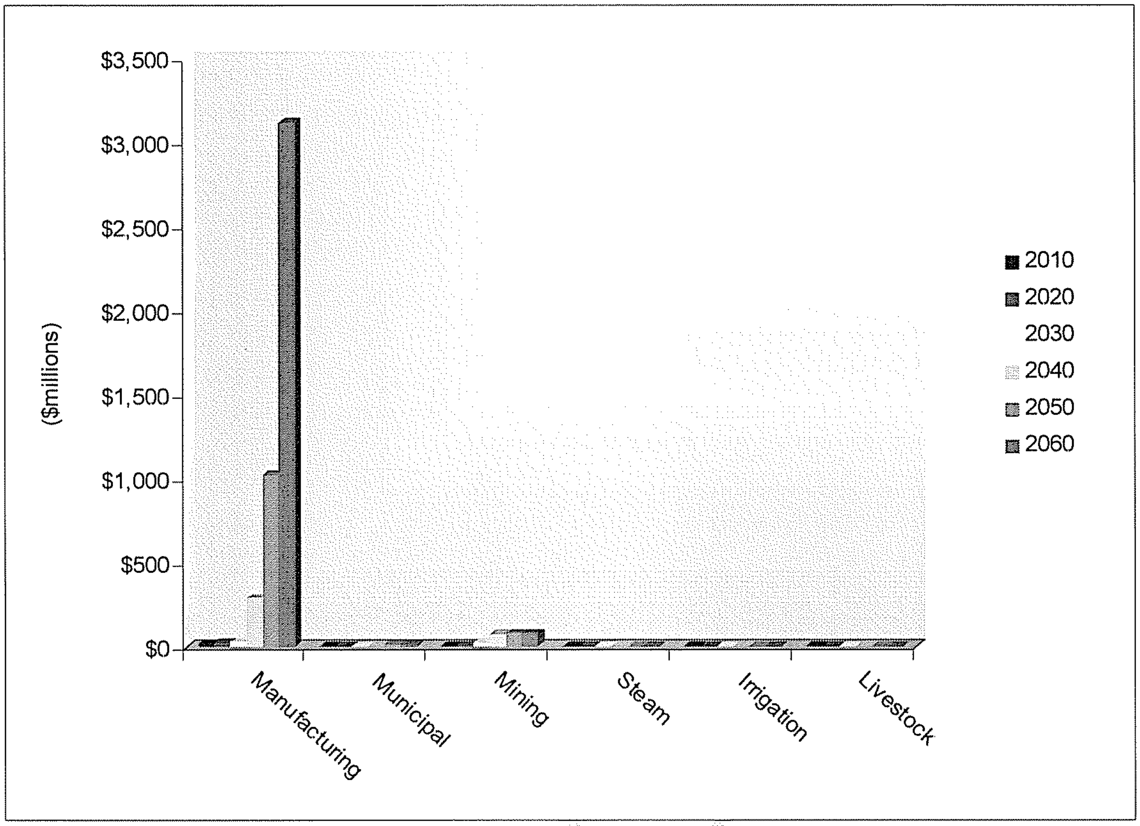

Table E-2 shows potential losses in population and school enrollment. Changes in population stem directly from the number of lost jobs estimated as part of the economic impact module. In other words, many - but not all - people would likely relocate due to a job loss and some have families with school age children. Section 1.3 in the main body of the report discusses methodology in detail.

Table E-2: Estimated Regional Social Impacts of Unmet Water Needs (years, 2010, 2020, 2030, 2040, 2050 and 2060)		
Year	Population Losses	Declines in School Enrollment
2010	400	100
2020	610	150
2030	800	200
2040	6,580	1,700
2050	21,590	5,600
2060	64,140	16,640
Source: Based on models developed by the Texas Water Development Board, Office of Water Resources Planning and the Texas State Data Center.		

Introduction

Texas is one the nation's fastest growing states. From 1950 to 2000, population in the state grew from about 8 million to nearly 21 million. By the year 2050, the total number of people living in Texas is expected to reach 40 million. Rapid growth combined with Texas' susceptibility to severe drought makes water supply a crucial issue. If water infrastructure and water management strategies are not improved, Texas could face serious social, economic and environmental consequences - not only in our large metropolitan cities, but also on our farms and rural areas.

Water shortages due to severe drought combined with infrastructure limitations would likely curtail or eliminate economic activity in business and industries heavily reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on business and industry, but they might also bias corporate decision makers against plant expansion or plant location in Texas. From a societal perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Section 357.7(4) of the rules for implementing Texas Senate Bill 1 requires regional water planning groups to evaluate the social and economic impacts of unmet water needs as part of the planning process. The rules contain provisions that direct the Texas Water Development Board (TWDB) to provide technical assistance to complete socioeconomic impact analyses. In response to requests from regional planning groups, TWDB staff designed and conducted required studies. The following document prepared by the TWDB's Office of Water Resources Planning summarizes analysis and results for the Region N Water Planning Area. Section 1 provides an overview of concepts and methodologies used in the study. Sections 2 and 3 provide detailed information and analyses for each water use category employed in the planning process (i.e., irrigation, livestock, municipal, manufacturing, mining and steam-electric).

1. Overview of Terms and Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

1.1 Measuring Economic Impacts

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts and benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. Specifically, it addresses the potential economic impacts of unmet water needs including: 1) losses to regional economies stemming from reductions in economic output, and 2) costs to residential water consumers associated with implementing emergency water procurement and conservation programs.

1.1.1 Impacts to Agriculture, Business and Industry

As mentioned earlier, severe water shortages would likely affect the ability of business and industry to operate resulting in lost output, which would adversely affect the regional economy. A variety tools are available to estimate such impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Basically, an IO/SAM model is an accounting framework that traces spending and consumption between different economic sectors including businesses, households, government and "foreign" economies in the form of exports and imports. As an example, Table 1 shows a highly aggregated segment of an IO/SAM model that focuses on key agricultural sectors in a local economy. The table contains transactions data for three agricultural sectors (cattle ranchers, dairies and alfalfa farms). Rows in Table 1 reflect sales from each sector to other local industries and institutions including households, government and consumers outside of the region in the form of exports. Columns in the table show purchases by each sector in the same fashion. For instance, the dairy industry buys $11.62 million worth of goods and services needed to produce milk. Local alfalfa farmers provide $2.11 million worth of hay and local households provide about $1.03 million worth of labor. Dairies import $4.17 million worth of inputs and pay $2.37 million in taxes and profits. Total economic activity in the region amounts to about $807.45 million. The entire table is like an accounting balance sheet where total sales equal total purchases.

Table 1: Example of a County-level Transaction and Social Accounting Matrix for Agricultural Sectors ($millions)

Sectors	Cattle	Dairy	Alfalfa	All other Industries	Taxes, govt. & profits	Households	Exports	Total
Cattle	$3.10	$0.01	$0.00	$0.03	$0.02	$0.06	$10.76	$13.98
Dairy	$0.07	$0.13	$0.00	$0.25	$0.01	$0.00	$11.14	$11.60
Alfalfa	$0.00	$2.11	$0.00	$0.01	$0.02	$0.01	$10.38	$12.53
Other industries	$2.20	$1.56	$2.90	$50.02	$70.64	$66.03	$48.48	$241.83
Taxes, govt. & profits	$2.37	$2.61	$5.10	$77.42	$0.23	$49.43	$83.29	$220.45
Households	$0.82	$1.03	$1.38	$50.94	$45.36	$7.13	$14.64	$121.30
Imports	$5.41	$4.17	$3.16	$63.32	$104.17	$5.53	$0.00	$185.76
Total	$13.97	$11.62	$12.54	$241.99	$220.45	$128.19	$178.69	$807.45

* Columns contain purchases and rows represent sales. Source: Adapted from Harris, T.R., Narayanan, R., Englin, J.E., MacDiarmid, T.R., Stoddard, S.W. and Reid, M.E. "*Economic Linkages of Churchill County.*" University of Nevada Reno. May 1993.

To understand how an IO/SAM model works, first visualize that $1 of additional sales of milk is injected into the dairy industry in Table 1. For every $1 the dairies receive in revenue, they spend 18 cents on alfalfa to feed their cows; nine cents is paid to households who provide farm labor, and another 13 cents goes to the category "other industries" to buy items such as machinery, fuel, transportation, accounting services etc. Nearly 22 cents is paid out in the form of profits (i.e., returns to dairy owners) and taxes/fees to local, state and federal government. The value of the initial $1 of revenue in the dairy sector is referred to as a first-round or **direct effect.**

As the name implies, first-round or direct effects are only part of the story. In the example above, alfalfa farmers must make 18 cents worth of hay to supply the increased demand for their product. To do so, they purchase their own inputs, and thus, they spend part of the original 18 cents that they received from the dairies on firms that support their own operations. For example, 12 cents is spent on fertilizers and other chemicals needed to grow alfalfa. The fertilizer industry in turn would take these 12 cents and spend them on inputs in its production process and so on. The sum of all re-spending is referred to as the **indirect effect** of an initial increase in output in the dairy sector.

While direct and indirect impacts capture how industries respond to a change, **induced impacts** measure the behavior of the labor force. As demand for production increases, employees in base industries and supporting industries will have to work more; or alternatively, businesses will have to hire more people. As employment increases, household spending rises. Thus, seemingly unrelated businesses such as video stores, supermarkets and car dealers also feel the effects of an initial change.

Collectively, indirect and induced effects are referred to as **secondary impacts**. In their entirety, all of the above changes (direct and secondary) are referred to as **total economic impacts**. By nature, total impacts are greater than initial changes because of secondary effects. The magnitude of the increase is what is popularly termed a multiplier effect. Input-output models generate numerical multipliers that estimate indirect and induced effects.

In an IO/SAM model impacts stem from changes in output measured by sales revenue that in turn come from changes in consumer demand. In the case of water shortages, one is not assuming a change in demand, but rather a supply shock - in this case severe drought. Demand for a product such as corn has not necessarily changed during a drought. However, farmers in question lack a crucial input (i.e., irrigation water) for which there is no *short-term* substitute. Without irrigation, she cannot grow irrigated crops. As a result, her cash flows decline or cease all together depending upon the severity of the situation. As cash flows dwindle, the farmer's income falls, and she has to reduce expenditures on farm inputs such as labor. Lower revenues not only affect her operation and her employees directly, but they also indirectly affect businesses who sell her inputs such as fuel, chemicals, seeds, consultant services, fertilizer etc.

The methodology used to estimate regional economic impacts consists of three steps: 1) develop IO/SAM models for each county in the region and for the region as whole, 2) estimate direct impacts to economic sectors resulting from water shortages, and 3) calculate total economic impacts (i.e., direct plus secondary effects).

Step 1*: Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[2] Using IMPLAN software and data, transaction tables conceptually similar to the one discussed previously (see Table 1 on page 9) were estimated for

[2]The basic IMPLAN database consists of national level technology matrices based on the Benchmark Input-Output Accounts generated the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN's regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to the national totals using a matrix ratio allocation system and county data are balanced to state totals. In other words, much of the data in IMPLAN is based on a national average for all industries.

each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales** - total production measured by sales revenues;
- **intermediate sales** - sales to other businesses and industry within a given region;
- **final sales** - sales to end users in a region and exports out of a region;
- **employment** - number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income** - total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes** - sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in year 2000 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. All sectors in the IMPLAN database were assigned to a specific water use category (see Attachment A of this report).

Step 2: *Estimate Direct Economic Impacts of Water Shortages*

As mentioned above, direct impacts accrue to immediate businesses and industries that rely on water. Without water industrial processes could suffer. However, output responses would likely vary depending upon the severity of a shortage. A small shortage relative to total water use may have a nominal effect, but as shortages became more critical, effects on productive capacity would increase.

For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky. As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production. But it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

Note that the efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

- if unmet water needs are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;
- if water shortages are 5 to 30 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 0.25 percent reduction in output;
- if water shortages are 30 to 50 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 0.50 percent reduction in output; and
- if water shortages are greater than 50 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 1.0 percent (i.e., a proportional reduction).

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. When calculating direct effects for the municipal, steam electric, manufacturing and livestock water use categories, sales to final demand were applied to avoid double counting impacts. The formula for a given IMPLAN sector is:

$$D_{i,t} = Q_{i,t} *, S_{i,t} * E_Q * RFD_i * DM_{i(Q,L,I,T)}$$

where:

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[3] See, Royal, W. "*High And Dry - Industrial Centers Face Water Shortages.*" in Industry Week, Sept, 2000.

[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages.*" Prepared by Spectrum Economics, Inc. November, 1991.

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Direct impacts to irrigation and mining are based upon the same formula; however, total sales as opposed to final sales were used. To avoid double counting, secondary impacts in sectors other than irrigation and mining (e.g., manufacturing) were reduced by an amount equal to or less than direct losses to irrigation and mining. In addition, in some instances closely linked sectors were moved from one water use category to another. For example, although meat packers and rice mills are technically manufacturers, in some regions they were reclassified as either livestock or irrigation. All direct effects were estimated at the county level and then summed to arrive at a regional figure. See Section 2 of this report for additional discussion regarding methodology and caveats used when estimating direct impacts for each water use category.

Step 3: *Estimate Secondary and Total Economic Impacts of Water Shortages*

As noted earlier, the effects of reduced output would extend well beyond sectors directly affected. Secondary impacts were derived using the same formula used to estimate direct impacts; however, regional level *indirect* and *induced* multiplier coefficients were applied and only final sales were multiplied.

1.1.2 Impacts Associated with Domestic Water Uses

IO/SAM models are not well suited for measuring impacts of shortages for domestic uses, which make up the majority of the municipal category.[5] To estimate impacts associated with domestic uses, municipal water demand and thus needs were subdivided into two categories - residential and commercial. Residential water is considered "domestic" and includes water that people use in their homes for things such as cooking, bathing, drinking and removing household waste and for outdoor purposes including lawn watering, car-washing and swimming pools. Shortages to residential uses were valued using a tiered approach. In other words, the more severe the shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic costs would be much higher in this case because people could probably not live with such a reduction, and would be forced to find emergency alternatives. The alternative assumed in this study is a very uneconomical and worst-case scenario (i.e., hauling water in from other communities by truck or rail). Section 2.3.3 of this report discusses methodology for municipal uses in greater detail.

[5] A notable exception is the potential impacts to the nursery and landscaping industry that could arise due to reductions in outdoor residential uses and impacts to "water intensive" commercial businesses (see Section 2.3.3).

1.2 Measuring Social Impacts

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature - more so analytic in the sense that social impacts are much harder to measure in quantitative terms. Nevertheless, social effects associated with drought and water shortages usually have close ties to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,
- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities.[6]

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on models used by the TWDB for state water planning and by the U.S. Census Bureau for national level population projections. With the assistance of the Texas State Data Center (TSDC), TWDB staff modified population projection models used for state water planning and applied them here. Basically, the social impact model incorporates results from the economic component of the study and assesses how changes in labor demand due to unmet water needs could affect migration patterns in a region. Before discussing particulars of the approach model, some background information regarding population projection models is useful in understanding the overall approach.

1.2.1 Overview of Demographic Projection Models

More often than not, population projections are reported as a single number that represents the size of an overall population. While useful in many cases, a single number says nothing about the composition of projected populations, which is critical to public officials who must make decisions regarding future spending on public services. For example, will a population in the future have more elderly people relative to today, or will it have more children? More children might mean that more schools are needed. Conversely, a population with a greater percentage of elderly people may need additional healthcare facilities. When projecting future populations, cohort-survival models break down a population into groups (i.e., cohorts) based on factors such as age, sex and race. Once a population is separated into cohorts, one can estimate the magnitude and composition of future population changes.

Changes in a population's size and makeup in survival cohort models are driven by three factors:

[6] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment.*" in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

1. *Births:* Obviously, more babies mean more people. However, only certain groups in a population are physically capable of bearing children- typically women between the ages of 13 and 49. The U.S. Census Bureau and the TSDC continually updates fertility rates for different cohorts. For each race/ethnicity category, birth rates decline and then stabilize in the future.

2. *Deaths:* When people die, populations shrink. Unlike giving birth, however, everyone is capable of dying and mortality rates are applied to all cohorts in a given population. Hence their name, cohort-survival models use survival rates as opposed to mortality rates. A survival rate is simply the probability that a given person with certain attributes (i.e., race, age and sex) will survive over a given period of time.

3. *Migration*: Migration is the movement of people in or out of a region. Migration rates used to project future changes in a region are usually based on historic population data. When analyzing historic data, losses or increases that are not attributed to births or deaths are assumed to be the result of migration. Migration can be further broken down into changes resulting from economic and non-economic factors. Economic migrants include workers and their families that relocate because of job losses (or gains), while non-economic migrants move due to lifestyles choices (e.g., retirees fleeing winter cold in the nation's heartland and moving to Texas).

In summary, knowledge of a population's composition in terms of age, sex and race combined with information regarding birth and survival rates, and migratory patterns, allows a great deal of flexibility and realism when estimating future populations. For example, an analyst can isolate population changes due to deaths and births from changes due to people moving in and out of a region. Or perhaps, one could analyze how potential changes in medical technology would affect population by reducing death rates among certain cohorts. Lastly, one could assess how changes in *economic conditions* might affect a regional population

1.2.2 Methodology for Social Impacts

Two components make up the model. The first component projects populations for a given year based on the following six steps:

1) *Separate "special" populations from the "general" population of a region:* The general population of a region includes the portion subject to rates of survival, fertility, economic migration and non-economic migration. In other words, they live, die, have children and can move in and out of a region freely. "Special populations," on the other hand, include college students, prisoners and military personnel. Special populations are treated differently than the general population. For example, fertility rates are not applied to prisoners because in general inmates at correctional facilities do not have children, and they are incapable of freely migrating or out of a region. Projections for special populations were compiled by the TSDC using data from the Higher Education Coordinating Board, the Texas Department of Criminal Justice and the U.S. Department of Defense. Starting from the 2000 Census, general and special populations were broken down into the following cohorts:

- age cohorts ranging from age zero to 75 and older,
- race/ethnicity cohorts, including Anglo, Black, Hispanic and "other," and
- gender cohorts (male and female).

2) *Apply survival and fertility rates to the general population* : Survival and fertility rates were compiled by the TSDC with data from the Texas Department of Health (TDH). Natural decreases (i.e., deaths) are estimated by applying survival rates to each cohort and then subtracting estimated deaths from the total population. Birth rates were then applied to females in each age

and race cohort in general and special populations (college and military only) to arrive at a total figure for new births.

3) *Estimate economic migration based on labor supply and demand*: TSDC year 2000 labor supply estimates include all non-disabled and non-incarcerated civilians between the ages of 16 and 65. Thus, prisoners are not included. Labor supply for years beyond 2001 was calculated by converting year 2000 data to rates according to cohort and applying these rates to future years. Projected labor demand was estimated based on historical employment rates. Differences between total labor supply and labor demand determines the amount of in or out migration in a region. If supply is greater than demand, there is an out-migration of labor. Conversely, if demand is greater than supply, there is an in-migration of labor. The number of migrants does not necessarily reflect total population changes because some migrants have families. To estimate how many people might accompany workers, a migrant worker profile was developed based on the U.S. Census Bureau's Public Use Microdata Samples (PUMs) data. Migrant profiles estimate the number of additional family members, by age and gender that accompany migrating workers. Together, workers and their families constitute economic migration for a given year.

4) *Estimate non-economic migration*: As noted previously, migration patterns of individuals age 65 and older are generally independent of economic conditions. Retirees usually do not work, and when they relocate, it is primarily because of lifestyle preferences. Migratory patterns for people age 65 or older are based on historical PUMs data from the U.S. Census.

5) *Calculate ending population for a given year*: The total year-ending population is estimated by adding together: 1) surviving population from the previous year, 2) new births, 3) net economic migration, 4) net non-economic migration and 5) special populations. This figure serves as the baseline population for the next year and the process repeats itself.

The second component of the social impact model is identical to the first and includes the five steps listed above for each year where water shortages are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060). The only difference is that labor demand changes in years with shortages. Shifts in labor demand stem from employment impacts estimated as part of the economic analysis component of this study with some slight modifications. IMPLAN employment data is based on the number of full and part-time jobs as opposed to the number of people working. To remedy discrepancies, employment impacts from IMPLAN were adjusted to reflect the number of people employed by using simple ratios (i.e., labor supply divided by number of jobs) at the county level. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

1.3 Clarifications, Assumptions and Limitations of Analysis

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1) While useful for planning purposes, this study is not a benefit-cost analysis (BCA). BCA is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of unmet water needs. Nevertheless, one could include some impacts measured in this study as part of a BCA if done so properly.

2) Since this is not a BCA, future impacts are not weighted differently. In other words, estimates are not "discounted." If used as a measure of benefits in a BCA, one must consider the uncertainty of estimated monetary impacts.

3) All monetary figures are reported in constant year 2000 dollars.

4) Shortages reported by regional planning groups are the starting point for socioeconomic analyses. No adjustments or assumptions regarding the magnitude or distributions of unmet needs among different water use categories are incorporated in the analysis.

5) Estimated impacts are point estimates for years in which needs are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities needs are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, *regardless of whether or not there is a drought.* This implies that infrastructure limitations would constrain economic growth. However, since needs as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under "normal" or "most likely" future climatic conditions.

6) IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as "final sales," multipliers for the ranching sector do fully account for all losses to a region's economy. Thus, as mentioned previously, in some cases closely linked sectors were moved from on water use category to another.

7) Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an *upper bound.* Similarly, since population projections are based on reduced employment in the region, they should be considered an upper bound as well.

8) IO models are static in nature. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in the year 2000. In contrast, unmet water needs are projected to occur well into the future (i.e., 2010 through 2060). Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon.

9) With respect to municipal needs, an important assumption is that people would eliminate all outdoor water use before indoor water uses were affected, and people would implement emergency indoor water conservation measures before commercial businesses had to curtail operations, and households had to seek alternative sources of water. Section 2.3.3 discusses this in greater detail.

10) Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in Texas for many communities lasted several years.

2. Economic Impacts

Part 2 of this report summarizes economic analysis for each water use category. Section 2.1 presents the year 2000 economic baseline for Region N. Section 2.2 presents results for agricultural water uses including livestock and irrigated crop production, while Section 2.3 reviews impacts to municipal and industrial water uses including manufacturing, mining, steam-electric and municipal demands. Attachment B of this report contains tables showing the distribution of impacts at the county level and city level (municipal uses only) and Attachment C shows the distribution of impacts by river basin in the region.

2.1 Economic Baseline

Table 2 summarizes baseline economic variables for the region. In year 2000, business and industry in the region produced $29.0 billion in output that generated nearly $12.3 billion worth of income for local residents. Economic activity supported an estimated 223,391 full and part-time jobs. Business and industry also generated $1.1 billion in state and local taxes. Sections 2.2.and 2.3 discuss the composition and contribution of individual water use categories in greater detail.

Table 2: Year 2000 Economic Baseline for in Region N (monetary figures reported in $millions)

	Sales Activity ($millions)			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Irrigation	$13.17	$0.92	$12.25	287	$7.89	$0.42
% of Total	<1%	<1%	<1%	<1%	<1%	<1%
Livestock	$115.78	$90.98	$24.79	2,480	$66.81	$4.68
% of Total	<1%	1%	<1%	1%	1%	<1%
Manufacturing	$10,933.22	$1,322.06	$9,611.15	16,541	$2,069.06	$111.46
% of Total	38%	18%	45%	7%	17%	10%
Mining	$1,652.24	$1,505.68	$146.56	2,633	$768.74	$85.83
% of Total	6%	20%	1%	1%	6%	8%
Steam-electric	$399.92	$122.14	$277.78	761	$337.22	$51.22
% of Total	2%	2%	2%	<1%	3%	5%
Municipal*	$15,842.04	$4,334.87	$11,507.16	200,664	$9,054.00	$830.32
% of Total	55%	59%	53%	90%	74%	77%
Total	$28,956.36	$7,376.66	$21,579.70	223,365	$12,308.41	$1,083.93
% of Total.	100%	100%	100%	100%	100%	100%

* "Municipal" includes all non-industrial commercial enterprises and institutional water uses such as the military, schools and other government organizations. Source: Based input-output models generated using IMPLAN Pro software from MIG Inc.

2.2 Agriculture

In 2000, CBWPA farmers who irrigate produced about $13.7 million dollars worth of crops generating a total of almost $7.9 million in regional income - slightly less than one percent of all income in the region. Livestock sectors produced roughly $115.8 million worth meat and related products and created $66.8 million worth of income for area residents. Collectively, irrigated farming and the livestock industry accounted for less than two percent of total regional income and jobs in the region.

2.2.1 Irrigation

The first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Default IMPLAN data do not distinguish irrigated production from dry-land production. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and the USDA Natural Resources Conservation Service (NRCS) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 3 shows the TWDB crops included in corresponding IMPLAN sectors. Table 4 summarizes acreage and estimated annual water use for each crop classification (year 2000). Table 5 shows year 2000 economic data for irrigated crop production in the region. Generating nearly $8.3 million in sales, vegetable production largest activity in terms sales revenue.

Table 3: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors Applied in Socioeconomic Impact Analysis

IMPLAN Sector	TWDB Sector
Cotton	Cotton
Feed Grains	Corn, sorghum and "forage crops"
Food Grains	Rice, wheat and "other grains"
Fruits	Citrus
Hay and Pasture	Alfalfa and "other hay and pasture"
Oil Crops	Peanuts, soybeans and "other oil crops"
Sugar Crops	Sugar-beets and sugarcane
Tree Nuts	Pecans
Vegetables *	Deep-rooted vegetables, shallow-rooted vegetables and potatoes
Other Crops	"All other crops" "other orchards" and vineyards

* includes melons.

Table 4. Summary of Irrigated Crop Acreage and Water Demand for in Region N
(Year 2000)

Sector	Acres (1000s)	Distribution of Acres	Water Use (1000s of AF)	Distribution of Water Use
Vegetables	4,435	18%	3,205	16%
Cotton	5,713	23%	3,336	16%
Feed Grains	8,267	34%	5,293	26%
Hay and Pasture	5,988	25%	8,791	43%
Other	20	0%	25	<1%
Total	24,423	100%	20,650	100%

Source: Water demand figures are taken from the Texas Water Development Board 2006 Water Plan Projections data for year 2000. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the National Resources Conservation Service (USDA).

Table 5: Year 2000 Direct Economic Activity Associated with Irrigated Crop Production in Region N
(monetary figures reported in $millions)

Sector	Sales Activity ($millions)			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Vegetables	$8.29	$0.82	$7.47	143	$5.82	$0.22
Cotton	$2.36	$0.03	$2.33	23	$0.85	$0.07
Feed Grains	$1.63	$0.04	$1.59	37	$0.77	$0.09
Hay and Pasture	$0.88	$0.02	$0.86	84	$0.44	$0.04
Other	$0.01	<$0.01	$0.01	1	$0.01	<$0.01
Total	$13.17	$0.92	$12.25	287	$7.89	$0.42

Source: Based on data from the Texas Water Development Board, the Texas Agricultural Statistics Service and the Minnesota IMPLAN Group, Inc.

Table 6: Data Used to Estimate Impacts to Irrigated Crop Production in Region N			
Crop sector	Gross sales revenue per irrigated acre	Gross sales revenue per dry-land acre (drought conditions)	Data Sources for yield, prices and planted acreage used to estimate gross sales per acre
Vegetables	$1,880	None	Average *weighted* by acreage for "Shallow-rooted Vegetables" and "Deep-rooted Vegetables." Based on data from TASS statewide surveys for vegetable crops (5-year averages values from 1995-2000)
Cotton	$480	$150	Irrigated value based on TAMU Crop Enterprise Budgets for South Texas region (year 2000). Dry-land value based on 1998 TASS data for cotton yields and prices for Upper Coast region.
Feed Grains	$240	$68	Irrigated value based on five-year averages (1995-2000) for corn in the Coastal Bend region. Dry-land value based on 1998 TASS data for the same region.
Hay and Pasture	$220	$55	Irrigation value based on TAMU Crop Enterprise Budgets for South Texas region for coastal Bermuda hay (2000). Dry-land value based on same data but assumes a 75 percent reduction in yield.
Food Grains	$210	$50	Average weighted of winter wheat (Irrigated) and spring wheat (Irrigated). Data source: TAMU crop budgets. Dry-land value calculated based on TASS 1998 price, yield and planted acreage data for dry-land wheat.
* Values are rounded. TASS = Texas Agricultural Statistics Service. TAMU = Texas A&M University.			

The Region N 2006 Water Plan indicates that under drought of record conditions, shortages to irrigation would occur in Live Oak County. Table 7 summarizes estimated impacts to the planning region. All needs are projected to occur in the Nueces River Basin.

Table 7: Annual Economic Impacts Associated with Unmet Irrigation Water Needs (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)				
Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$0.12	$0.06	0	$0.007
2020	$0.11	$0.06	0	$0.006
2030	$0.09	$0.05	0	$0.006
2040	$0.08	$0.04	0	$0.005
2050	$0.03	$0.02	0	$0.002
2060	$0.02	$0.01	0	$0.001
* Estimates are based on *projected* economic activity in the region. Source: Based on economic impact models developed by the Texas Water Development Board, Office of Water Resources Planning.				

2.2.2 Livestock

No shortages for livestock water uses were reported in Region N.

2.3 Municipal and Industrial

Municipal and industrial (M&I) water uses make up the majority of economic activity in the CBWPA. In 2000, M&I uses generated $28.9 billion in sales and nearly $11.2 billion worth of income for residents in the region. M&I added nearly $1.1 billion to state, local and federal tax coffers and provided 220,625 jobs for people in the region.

2.3.1 Manufacturing

Table 8 summarizes baseline economic data for manufacturing sectors. Petroleum refining, plastics, meatpacking and surgical equipment are the four largest sectors in the region. Collectively, these four sectors generated about $1.5 billion worth of income in Region N, and provided nearly 6,000 jobs. Each sector is heavily reliant on water for its production processes.

Table 8: Year 2000 Economic Baseline for Manufacturing Water Uses in Region N (monetary figures in $millions)

Sector	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Petroleum Refining	$7,649.47	$761.35	$6,888.11	2,825	$926.41	$60.45
Industrial Organic Chemicals	$1,166.10	$205.42	$960.68	1,499	$319.52	$21.51
Inorganic Chemicals	$353.13	$62.21	$290.92	1,138	$177.82	$10.97
Meat Packing Plants	$197.53	$18.35	$179.18	507	$22.55	$1.51
All other manufacturers	$1,566.99	$274.73	$1,292.26	10,572	$622.75	$17.02
Total	$10,933.22	$1,322.06	$9,611.15	16,541	$2,069.06	$111.46

Source: Generated using IMPLAN models and data from MIG, Inc.

Direct impacts to manufacturing were estimated by distributing water shortages among industrial sectors at the county level. Care was taken to include only sectors recorded in the TWDB Water Uses database. Some sectors in IMPLAN databases are not part of the TWDB database given that they use relatively small amounts of water - primarily for on-site sanitation and potable uses. To maintain consistency between IMPLAN and TWDB databases, Standard Industrial Classification (SIC) codes in TWDB databases were matched to IMPLAN sector codes for each affected county. Non-matches were excluded when calculating direct impacts.

The distribution of water shortages among TWDB manufacturing sectors is weighted according to year 2000 water use. Accordingly, industries with the greatest use are affected the most. As a general observation, these sectors include petroleum and chemical refineries, plastic producers, paper mills, food processors and cement manufacturers. Other manufacturing sectors use considerably less water for productive processes and are less likely to suffer substantial negative effects due to water shortages. In other words, they would likely be able to haul in enough water by truck to keep their operations running.

The Region N 2006 Water Plan indicates that under drought of record conditions, shortages to manufacturing could occur in Aransas, Live Oak, Nueces and San Patricio counties. Table 9 summarizes estimated impacts while Attachment B of this report shows impacts by county, and Attachment C shows impacts by major river basin.

Table 9: Annual Economic Associated with Unmet Water Needs for Manufacturing (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$58.98	$14.86	160	$1.00
2020	$87.39	$22.27	250	$1.47
2030	$99.25	$25.26	280	$1.67
2040	$1,104.57	$288.86	3,310	$20.06
2050	$3,883.07	$1,025.80	11,880	$71.52
2060	$11,783.68	$3,122.70	36,250	$217.92

* Estimates are based on *projected* economic activity in the region. Source: Generated by the Texas Water Development Board, Office of Water Planning.

2.3.2 Mining

As shown in Table 10, in year 2000 mining sectors in Region N generated about $770 million worth of income and provided jobs for 2,633 workers. By far, the largest sectors in terms of sales revenues are oil and gas extraction. At this juncture, it important to note that output for the natural gas and oil sectors represent transactions by corporate entities based in Region N. However, it does not *necessarily* reflect the physical production of gas or oil in the region. For instance, company A might employ 300 people at its corporate headquarters in Nueces County, but it does not drill all of its oil in Nueces County. Some oil may originate from well leases elsewhere including those in the Gulf of Mexico. Thus, from an accounting standpoint all sales revenue appears under Nueces County, as do employment, taxes and income regardless of whether or not the oil actually comes from mines located in the county. To account for potential discrepancies, analysts used data from the Texas Railroad Commission to estimate the actual physical product for the gas and oil sectors in affected counties by comparing average well-head market prices for crude and gas to TRC production statistics. For counties with large discrepancies, output estimates based on TRC data were used to assess direct impacts of unmet water needs.

Other considerations with respect mining sectors include:

1) Petroleum and gas extraction industry only uses water in significant amounts for secondary recovery. Known in the industry as "enhanced" or "water flood" extraction, secondary recovery involves pumping water down injection wells to increase underground pressure thereby pushing oil or gas into other wells. IMPLAN output numbers do not distinguish between secondary and non-secondary recovery. To account

for the discrepancy, county-level TRC data that shows the proportion of barrels produced using secondary methods were used to adjust IMPLAN data to reflect only the portion of sales attributed to secondary recovery.

2) A substantial portion of output from the crude extraction sector goes directly to other regional industries in the form of intermediate sales. Obviously, most goes to oil refineries, which are an important forward linkage for the gas and crude mining sector. Thus, reduced drilling activity resulting from water shortages might affect regional oil refineries. However, these impacts were not included here to avoid double counting. Impacts to refineries were incorporated when estimating impacts to manufacturing sectors (see Section 2.3.1).

3) Unlike output in other sectors including manufacturing and municipal, output in the crude and natural gas sectors is not assumed to grow over the planning horizon. Water use will likely increase as secondary recovery occurs in more fields, but the volume of oil and gas extracted from on-shore wells in the state is not likely to grow significantly. However, the analysis does presume that real prices of oil and gas will increase through time and thus sales revenues will increase.

Table 10: Year 2000 Direct Economic Activity from Mining Industries in Region N (monetary figures in $millions)

Sector	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Natural Gas & Crude Petroleum*	$1,174.59	$1,080.74	$93.86	2,182	$608.56	$63.90
Natural Gas Liquids*	$459.70	$422.97	$36.73	351	$149.68	$20.34
Coal Mining	$8.22	$0.94	$7.28	17	$4.61	$1.28
Sand and Gravel	$7.99	$0.15	$7.83	66	$5.23	$0.25
Uranium-radium-vanadium Ores	$0.87	$0.87	$0.00	10	$0.12	$0.03
Dimension Stone	$0.86	$0.01	$0.85	6	$0.55	$0.03
Total	$1,652.24	$1,505.68	$146.56	2,633	$768.74	$85.83

* Sales revenues for oil and gas include product recovered from wells outside of the region (e.g., Gulf of Mexico) that are owned and operated by companies based in Region N. Source: Generated using data from MIG, Inc., and models developed by the TWDB using IMPLAN Pro™ software.

The Region N 2006 Water Plan indicates that under drought of record conditions, shortages to mining could occur in Duval, Live Oak and Nueces counties. Table 11 summarizes estimated impacts while Attachment B of this report shows impacts by county, and Attachment C shows impacts by major river basin.

Table 11: Annual Economic Impacts Associated with Unmet Water Needs for Mining (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$15.96	$5.46	70	$2.39
2020	$27.69	$9.37	100	$3.52
2030	$66.42	$22.49	180	$5.66
2040	$212.30	$72.17	465	$12.58
2050	$227.30	$77.23	500	$13.70
2060	$241.05	$81.87	535	$14.62

* Estimates are based on *projected* economic activity in the region. Source: Generated by the Texas Water Development Board, Office of Water Planning.

2.3.3 Municipal Uses

Table 12 summarizes economic activity for municipal uses. In 2000, commercial businesses and institutions produced $15.8 billion worth of output. In return, they received $9.1 billion in wages, salaries and profits. Municipal uses generate the bulk of business taxes in the region - nearly $830 million (77 percent of all taxes generated in the region). Top commercial sectors in terms of income and output include wholesale trade, real estate, medical services, restaurants and bars, and banking.

Table 12: Year 2000 Baseline for Municipal Sectors (monetary impacts reported in $millions)						
Sector	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Real Estate	$932.96	$472.72	$460.24	5,101	$663.64	$110.38
Wholesale Trade	$811.44	$462.14	$349.30	8,009	$561.15	$115.83
Doctors and Dentists	$678.51	$0.00	$678.51	6,602	$465.86	$8.77
Hospitals	$655.76	$0.83	$654.93	9,605	$415.20	$2.32
Eating & Drinking	$604.67	$32.77	$571.91	16,999	$317.17	$38.84
Banking	$545.53	$222.27	$323.26	3,133	$361.26	$8.82
All other municipal sectors	11613.16	3144.14	8469.03	151,214	6269.72	545.36
Total	$15,842.04	$4,334.87	$11,507.16	200,664	$9,054.00	$830.32
Source: Generated using data from MIG, Inc., and models developed by the TWDB using IMPLAN software.						

Estimating direct economics impacts for the municipal category is complicated for a number of reasons. For one, municipal uses comprise a range of different consumers including commercial businesses, institutions (e.g., schools and government) and households. However, reported shortages do not specify how needs are distributed among different consumers. In other words, how much of a municipal need is commercial and how much is residential? The amount of commercial water use as a percentage of total municipal demand was estimated based on "GED" coefficients (gallons per employee per day) published in secondary sources (see Attachment A). For example, if year 2000 baseline data for a given economic sector (e.g., amusement and recreation services) shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) and thus annual use is 6.7 acre-feet. Water not attributed to commercial use is considered domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as "county-other." The estimated proportion of water used for commercial purposes ranges from about 5 to 35 percent of total municipal demand at the county level. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

As mentioned earlier, a key study assumption is that people would eliminate outdoor water use before indoor water consumption was affected; and they would implement *voluntary* emergency indoor water conservation measures before people had to curtail business operations or seek emergency sources of water. This is logical because most water utilities have drought contingency plans. Plans usually specify curtailment or elimination of outdoor water use during periods of drought. In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses."[7] Thus, when assessing municipal needs there are several important considerations: 1) how much of a need would people reduce via eliminating outdoor uses and implementing emergency indoor conservation measures; and 2) what are the economic implications of such measures?

[7] Non-essential uses include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

Determining how much water is used for outdoor purposes is key to answering these questions. The proportion used here is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[8]Earlier findings of the U.S. Water Resources Council showed a national average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[9] A study conducted for the California Urban Water Agencies (CUWA) calculated values ranging from 25 to 35 percent.[10] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study. With respect to emergency indoor conservation measures, this analysis assumes that citizens in affected communities would reduce needs by an additional 20 percent. Thus, 50 percent of total needs could be eliminated before households and businesses had to implement emergency water procurement activities.

Eliminating outdoor watering would have a range of economic implications. For one, such a restriction would likely have adverse impacts on the landscaping and horticultural industry. If people are unable to water their lawns, they will likely purchase less lawn and garden materials such as plants and fertilizers. On the other hand, during a bad drought people may decide to invest in drought tolerant landscaping, or they might install more efficient landscape plumbing and other water saving devices. But in general, the horticultural industry would probably suffer considerable losses if outdoor water uses were restricted or eliminated. For example, many communities in Colorado, which is in the midst of a prolonged drought, have severely restricted lawn irrigation. In response, the turf industry in Colorado has laid off at least 50 percent of its 2,000 employees.[11] To capture impacts to the horticultural industry, regional sales net of exports for the greenhouse and nursery sectors and the landscaping services sector were reduced by proportion equal to reductions in outdoor water use. Note that these losses would not necessarily appear as losses to the regional or state economies because people would likely spend the money that they would have spent on landscaping on other goods in the economy. Thus, the net effect to state or regional accounts could be neutral.

Other considerations include the "welfare" losses to consumers who had to forgo outdoor and indoor water uses to reduce needs. In other words, the water that people would have to give up has an economic value. Estimating the economic value of this forgone water for each planning area would be a very time consuming and costly task, and thus secondary sources served as a proxy. Previous research funded by the TWDB, explored consumer "willingness to pay" for avoiding restrictions on water use.[12] Surveys revealed that residential water consumers in Texas would be willing to pay - on average across all income levels - $36 to avoid a 30 percent reduction in water availability lasting for at least 28 days. Assuming the average person in Texas uses 140 gallons per day and the typical household in the state has 2.7 persons (based on U.S. Census

[8] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water.*" Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

[9] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation."* USEPA Report no. 841-B-95-002. April, 1995.

[10] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual.*" Prepared for the California Urban Water Agencies. February 1992.

[11] Based on assessments of the Rocky Mountain Sod Growers. See, "*Drought Drying Up Business for Landscapers.*" Associated Press. September, 17 2002.

[12] See, Griffin, R.C., and Mjelde, W.M. "*Valuing and Managing Water Supply Reliability.* Final Research Report for the Texas Water Development Board: Contract no. 95-483-140." December 1997.

data), total monthly water use is 13,205 gallons per household. Therefore, the value of restoring 30 percent of average monthly water use during shortages to residential consumers is roughly one cent per gallon or $2,930 per acre-foot. This figure serves as a proxy to measure consumer welfare losses that would result from restricted outdoor uses and emergency indoor restrictions.

The above data help address the impacts of incurring water needs that are 50 percent or less of projected use. Any amount greater than 50 percent would result in municipal water consumers having to seek alternative sources. Costs to residential and non-water intensive commercial operations (i.e., those that use water only for sanitary purposes) are based on the most likely alternative source of water in the absence of water management strategies. In this case, the most likely alternative is assumed to be "hauled-in" water from other communities at annual cost of $6,530 per acre-foot for small rural communities and approximately and $10,995 per acre-foot for metropolitan areas.[13]

This is not an unreasonable assumption. It happened during the 1950s drought and more recently in Texas and elsewhere. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water hauled delivered to their homes by private contractors.[14] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[15] In Australia, four cities have run out of water as a result of drought, and residents have been trucking in water since November 2002. One town has five trucks carting about one acre-foot eight times daily from a source 20 miles away. They had to build new roads and infrastructure to accommodate the trucks. Residents are currently restricted to indoor water use only.[16]

Direct impacts to commercial sectors were estimated in a fashion similar to other business sectors. Output was reduced among "water intensive" commercial sectors according to the severity of projected shortages. Water intensive is defined as non-medical related sectors that are heavily dependent upon water to provide their services. These include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hotels and lodging places, and
- eating and drinking establishments.

For non-water intensive sectors, it is assumed that businesses would haul water by truck and/or rail.

[13] For rural communities, figure assumes an average truck hauling distance of 50 miles at a cost of 8.4 cents per ton-mile (an acre foot of water weighs about 1,350 tons) with no rail shipment. For communities in metropolitan areas, figure assumes a 50 mile truck haul, and a rail haul of 300 miles at a cost of 1.2 cents per ton-mile. Cents per ton-mile are based on figures in: Forkenbrock, D.J., "*Comparison of External Costs of Rail and Truck Freight Transportation.*" Transportation Research. Vol. 35 (2001).

[14] Zewe, C. "*Tap Threatens to Run Dry in Texas Town.*" July 11, 2000. CNN Cable News Network.

[15] Associated Press, "*Ballinger Scrambles to Finish Pipeline before Lake Dries Up.*" May 19, 2003.

[16] Healey, N. (2003) *Water on Wheels*, Water: Journal of the Australian Water Association, June 2003.

An example will illustrate the breakdown of municipal water needs and the overall approach to estimating impacts of municipal needs. Assume City B has an unmet need of 50 acre feet in 2020 and projected demands of 200 acre-feet. In this case, residents of City B could eliminate needs via restricting all outdoor water use. City A, on the other hand, has an unmet need of 150 acre-feet in 2020 with a projected demand of 200 acre-feet. Thus, total shortages are 75 percent of total demand. Emergency outdoor and indoor conservation measures would eliminate 50 acre-feet of projected needs; however, 50 acre-feet would still remain. This remaining portion would result in costs to residential and commercial water users. Water intensive businesses such as car washes, restaurants, motels, race tracks would have to curtail operations (i.e., output would decline), and residents and non-water intensive businesses would have to have water hauled-in assuming it was available.

The last element of municipal water shortages considered focused on lost water utility revenues. Estimating these was straightforward. Analyst used annual data from the "*Water and Wastewater Rate Survey*" published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, averages rates multiplied by total water needs served as a proxy. For lost wastewater, total unmet needs were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Needs reported as "county-other" were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and needs are considered non-billed or "unaccountable" water that comprises things such leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the "miscellaneous gross receipts tax, "which the state collects from utilities located in most incorporated cities or towns in Texas.

The Region N 2006 Water Plan indicates that under drought of record conditions, shortages to municipal water uses would occur in Aransas, Jim Wells, Kleberg, Live Oak, Nueces, and San Patricio counties. Tables 13 through 16 summarize estimated impacts to domestic uses, commercial businesses (water intensive and non-water intensive), water utilities and the horticultural industry. Attachment B of this report shows impacts by county, and Attachment C shows impacts by major river basin.

Table 13: Annual Economic Impacts of Unmet Water Needs for Water Intensive Commercial Businesses (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$0.00	$0.00	0	$0.00
2020	$0.00	$0.00	0	$0.00
2030	$0.00	$0.00	0	$0.00
2040	$0.00	$0.00	0	$0.00
2050	$0.00	$0.00	0	$0.00
2060	$0.00	$0.00	0	$0.00

* Estimates are based on *projected* economic activity in the region. Source: Source: Texas Water Development Board, Office of Water Resources Planning.

Table 14: Annual Economic Impacts of Unmet Water Needs for the Horticultural Industry (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)				
Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$0.07	$0.04	0	$0.002
2020	$0.06	$0.04	0	$0.002
2030	$0.09	$0.05	0	$0.002
2040	$0.10	$0.06	0	$0.002
2050	$0.28	$0.17	0	$0.007
2060	$0.30	$0.17	0	$0.007
Source: Generated by the Texas Water Development Board, Office of Water Resources Planning.				

Table 15: Annual Impacts to Domestic Water Users (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)	
Year	$millions
2010	$1.26
2020	$0.89
2030	$2.33
2040	$2.71
2050	$9.79
2060	$9.66
Source: Generated by Texas Water Development Board, Office of Water Resources Planning.	

Table 16: Annual Losses of Water Utility Revenues and Taxes due to Unmet Water Needs (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)		
Year	Revenues ($millions)	Utility Taxes ($millions)
2010	$0.11	$0.002
2020	$0.21	$0.004
2030	$0.32	$0.006
2040	$0.43	$0.008
2050	$0.52	$0.009
2060	$0.61	$0.011
Source: Generated by the Texas Water Development Board, Office of Water Resources Planning.		

2.3.4 Steam-Electric

No shortages for steam-electric water uses were reported in Region N.

3. Social Impact Analysis

As discussed previously in Section 1.2, estimated social impacts focus changes including population loss and subsequent related in school enrollment. As shown in Table 20, water shortages in 2010 could result in a population loss of 400 people from the region with a corresponding reduction is school enrollment of 100. Models indicate that shortages in 2060 could cause population in the region to fall by as many as 64,140 people and school enrollment by 16,640 students.

Table 20: Estimated Regional Social Impacts of Unmet Water Needs
(years, 2010, 2020, 2030, 2040, 2050 and 2060)

Year	Population Losses	Declines in School Enrollment
2010	400	100
2020	610	150
2030	800	200
2040	6,580	1,700
2050	21,590	5,600
2060	64,140	16,640

Source: Generated by the Texas Water Development Board, Office of Water Resources Planning.

Attachment A: Baseline Regional Economic Data

Tables A-1 through A-6 contain data from several sources that form a basis of analyses in this report. Economic statistics were extracted and processed via databases purchased from MIG, Inc. using IMPLAN Pro™ software. Values for gallons per employee (i.e. GED coefficients) for the municipal water use category are based on several secondary sources.[17] County-level data sets along with multipliers are not included given their large sizes (i.e., 528 sectors per county each with 12 different multiplier coefficients). Fields in Tables A-1 through A-6 contain the following variables:

- *GED* - average gallons of water use per employee per day (municipal use only);
- *total sales* - total industry production measured in millions of dollars (equal to shipments plus net additions to inventories);
- *intermediate sales* - sales to other industries in the region measured in millions of dollars;
- *final sales* - all sales to end-users including sales to households in the region and exports out of the region;
- *jobs* - number of full and part-time jobs (annual average) required by a given industry;
- *regional income* - total payroll costs (wages and salaries plus benefits), proprietor income, corporate income, rental income and interest payments;
- *business taxes* - sales taxes, excise taxes, fees, licenses and other taxes paid during normal business operations (includes all payments to federal, state and local government except income taxes).

[17] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not: The Potential for Urban Water Conservation in California.*" Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: "*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*," Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States.*" Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, "*Evaluation of Water Conservation for Municipal and Industrial Water Supply.*" U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

Table A-1: Economic Data for Predominant Irrigated Crops in Region N (Year 2000)

Sector	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Cotton	$2.36	$0.03	$2.33	23	$0.85	$0.07
Feed Grains	$1.63	$0.04	$1.59	37	$0.77	$0.09
Hay and Pasture	$0.88	$0.02	$0.86	84	$0.44	$0.04
Tree Nuts	$0.01	$0.00	$0.01	1	$0.01	$0.00
Vegetables	$8.29	$0.82	$7.47	143	$5.82	$0.22
Total	$13.17	$0.92	$12.25	287	$7.89	$0.42

Table A-2: Economic Data for Livestock Sectors, Region N (Year 2000)

Sector	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Cattle Feedlots	$46.91	$45.86	$1.05	303	$36.59	$3.00
Dairy Farm Products	$7.65	$2.12	$5.53	88	$3.77	$0.03
Hogs, Pigs and Swine	$0.63	$0.62	$0.01	17	$0.21	$0.02
Miscellaneous Livestock	$2.11	$0.47	$1.64	146	$0.73	$0.02
Poultry and Eggs	$3.84	$0.90	$2.94	39	$1.56	$0.03
Ranch Fed Cattle	$17.99	$17.58	$0.41	606	$7.54	$0.53
Range Fed Cattle	$36.61	$23.40	$13.21	1,271	$16.39	$1.05
Sheep, Lambs and Goats	$0.05	$0.05	$0.00	10	$0.02	$0.00
Total	$115.78	$90.98	$24.79	2,480	$66.81	$4.68

Table A-3: Economic Data for Municipal Sectors, Region N (Year 2000)

Sector	GED	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Accounting, Auditing and Bookkeeping	120.3	$120.18	$108.34	$11.84	2,083	$94.71	$1.08
Advertising	116.5	$13.93	$12.15	$1.78	141	$6.81	$0.12
Agricultural, Forestry, Fishery Services	171.1	$26.93	$13.17	$13.76	1,228	$15.49	$0.68
Air Transportation	427.1	$132.07	$29.17	$102.90	1,354	$66.87	$9.56
Amusement and Recreation Services,	67.7	$31.52	$0.96	$30.56	1,124	$18.02	$1.75
Apparel & Accessory Stores	129.7	$57.51	$4.19	$53.33	1,726	$31.79	$9.18
Arrangement Of Passenger	680.8	$25.28	$12.14	$13.14	200	$17.46	$0.76
Automobile Parking and Car Wash	147.3	$13.70	$1.83	$11.87	516	$9.25	$0.63
Automobile Rental and Leasing	54.5	$32.62	$22.86	$9.76	407	$19.04	$2.58
Automobile Repair and Services	48.9	$165.38	$50.81	$114.57	2,144	$82.80	$7.50
Automotive Dealers & Service Stations	58.9	$348.37	$73.40	$274.97	4,849	$207.75	$53.88
Banking	215.6	$545.53	$222.27	$323.26	3,133	$352.44	$8.82
Beauty and Barber Shops	85.6	$32.00	$3.09	$28.91	1,285	$19.29	$0.38
Bowling Alleys and Pool Halls	34.6	$4.51	$0.01	$4.50	206	$2.43	$0.40
Building Materials & Gardening	159.7	$61.77	$9.23	$52.54	1,364	$44.08	$10.16
Business Associations	119.5	$41.29	$11.70	$29.59	963	$29.33	$0.03
Child Day Care Services	74.8	$60.09	$0.00	$60.09	1,483	$20.04	$0.58
Colleges, Universities, Schools	390.8	$17.86	$0.31	$17.56	650	$11.72	$0.00
Commercial Sports Except Racing	47.3	$0.71	$0.43	$0.28	10	$0.48	$0.04
Communications, Except Radio and TV	40	$468.33	$191.38	$276.96	1,735	$237.03	$25.23
Computer and Data Processing Services	156.4	$36.39	$29.22	$7.18	482	$29.45	$0.55
Credit Agencies	84.1	$205.45	$115.44	$90.01	5,354	$110.98	$7.17
Detective and Protective Services	202.9	$33.17	$22.70	$10.47	1,180	$25.00	$0.46
Doctors and Dentists	156.6	$678.51	$0.00	$678.51	6,602	$457.09	$8.77
Eating & Drinking	51	$604.67	$32.77	$571.91	16,999	$278.33	$38.84
Electrical Repair Service	37.4	$26.15	$12.08	$14.08	321	$10.94	$0.94
Elementary and Secondary Schools	168.9	$14.03	$0.00	$14.03	621	$8.31	$0.00
Engineering, Architectural Services	87.1	$190.53	$159.90	$30.63	2,015	$85.97	$1.27
Equipment Rental and Leasing	28.5	$157.54	$50.00	$107.54	1,189	$73.07	$5.07
Food Stores	97.9	$283.38	$8.91	$274.47	7,675	$212.45	$45.28
Funeral Service and Crematories	110.6	$14.81	$0.00	$14.81	346	$9.81	$0.42
Furniture & Home Furnishings Stores	41.7	$65.86	$7.77	$58.09	1,648	$42.74	$10.33
Gas Production and Distribution	51	$221.42	$193.36	$28.06	211	$57.36	$15.87
General Merchandise Stores	46.8	$165.08	$7.82	$157.25	5,027	$103.81	$26.34

Table A-3: Economic Data for Municipal Sectors, Region N (Year 2000)

Greenhouse and Nursery Products	120.3	$0.44	$0.11	$0.33	7	$0.18	$0.00
Hospitals	116.5	$655.76	$0.83	$654.93	9,605	$412.88	$2.32
Hotels and Lodging Places	171.1	$153.18	$63.18	$89.99	3,303	$80.55	$10.37
Insurance Agents and Brokers	427.1	$96.52	$24.27	$72.25	2,130	$74.91	$1.03
Insurance Carriers	67.7	$101.90	$10.77	$91.13	885	$52.68	$5.40
Job Trainings & Related Services	129.7	$21.09	$2.43	$18.66	599	$10.02	$0.04
Labor and Civic Organizations	680.8	$49.09	$0.25	$48.84	3,364	$36.47	$0.01
Landscape and Horticultural Services	147.3	$38.69	$30.85	$7.84	1,335	$22.80	$0.98
Laundry, Cleaning and Shoe Repair	54.5	$49.99	$10.72	$39.27	2,121	$36.79	$1.28
Legal Services	48.9	$293.42	$125.45	$167.96	2,879	$225.86	$2.63
Local Government Passenger Transit	58.9	$2.83	$0.39	$2.44	100	-$11.14	$0.00
Local, Interurban Passenger Transit	215.6	$31.23	$4.45	$26.78	681	$18.98	$0.68
Management and Consulting Services	85.6	$124.54	$99.13	$25.42	1,809	$53.47	$0.71
Membership Sports and Recreation	34.6	$20.65	$0.80	$19.85	729	$10.62	$0.75
Miscellaneous Personal Services	159.7	$53.52	$2.79	$50.73	780	$14.93	$1.13
Miscellaneous Repair Shops	119.5	$145.24	$42.82	$102.43	2,127	$67.45	$4.21
Miscellaneous Retail	74.8	$301.99	$27.09	$274.90	7,657	$189.41	$46.14
Motion Pictures	390.8	$64.89	$38.66	$26.23	879	$19.29	$0.68
Motor Freight Transport and	47.3	$338.87	$232.97	$105.90	3,369	$131.02	$4.12
Nursing and Protective Care	40	$125.87	$0.00	$125.87	3,814	$91.68	$3.11
Other Business Services	156.4	$494.81	$209.15	$285.66	5,758	$174.57	$6.35
Other Educational Services	84.1	$38.03	$5.63	$32.41	864	$12.60	$0.94
Other Federal Government Enterprises	202.9	$28.10	$6.58	$21.52	215	$3.73	$0.00
Other Medical and Health Services	156.6	$322.82	$13.50	$309.32	8,833	$142.45	$4.45
Other Nonprofit Organizations	51	$38.76	$1.46	$37.30	1,685	$19.11	$0.24
Other State and Local Govt Enterprises	37.4	$232.15	$71.73	$160.41	1,231	$78.48	$0.00
Owner-occupied Dwellings	168.9	$1,069.19	$0.00	$1,069.19	0	$671.25	$138.64
Personnel Supply Services	87.1	$79.79	$70.49	$9.30	3,821	$76.84	$1.52
Photofinishing, Commercial	28.5	$16.86	$11.25	$5.61	178	$5.70	$0.35
Pipe Lines, Except Natural Gas	97.9	$44.77	$38.68	$6.09	95	$31.08	$3.67
Portrait and Photographic Studios	110.6	$12.09	$0.63	$11.46	314	$5.62	$0.28
Racing and Track Operation	41.7	$11.23	$1.76	$9.47	287	$4.29	$2.01
Radio and TV Broadcasting	51	$109.85	$88.63	$21.22	678	$41.25	$1.52
Railroads and Related Services	46.8	$19.89	$12.74	$7.15	176	$5.43	$0.29
Real Estate	120.3	$932.96	$472.72	$460.24	5,101	$553.27	$110.38
Religious Organizations	116.5	$7.96	$0.00	$7.96	64	$0.95	$0.00
Research, Development & Testing	171.1	$46.88	$34.50	$12.39	799	$25.11	$0.46
Residential Care	427.1	$23.93	$0.00	$23.93	809	$15.46	$0.22
Sanitary Services and Steam Supply	67.7	$56.19	$46.46	$9.73	251	$23.48	$10.29
Security and Commodity Brokers	129.7	$153.48	$107.75	$45.73	773	$63.49	$5.38
Services To Buildings	680.8	$68.82	$50.65	$18.17	1,903	$29.57	$1.17
Social Services, N.E.C.	147.3	$72.91	$6.82	$66.08	1,448	$26.30	$0.08
Theatrical Producers, Bands Etc.	54.5	$10.35	$6.50	$3.85	145	$3.58	$0.32
Transportation Services	48.9	$33.63	$16.15	$17.48	267	$25.12	$0.29
U.S. Postal Service	58.9	$84.45	$53.53	$30.92	1,056	$62.54	$0.00
Watch, Clock, Jewelry and Furniture	215.6	$4.22	$0.08	$4.15	88	$1.28	$0.18
Water Supply and Sewerage Systems	85.6	$2.74	$0.88	$1.86	18	$1.49	$0.19
Water Transportation	34.6	$105.94	$52.10	$53.84	490	$23.40	$2.08
Wholesale Trade	159.7	$811.44	$462.14	$349.30	8,009	$445.32	$115.83
Total	-	$15,842.04	$4,334.87	$11,507.16	200,664	$9,054.00	$830.32

NEC = not elsewhere classified. "na" = not available.

Table A-4: Economic Data for Manufacturing Sectors, Region N (Year 2000)

Sector	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Adhesives and Sealants	$0.50	$0.35	$0.15	3	$0.12	$0.00
Aircraft and Missile Engines and Parts	$2.89	$0.17	$2.72	14	$0.95	$0.02
Aircraft and Missile Equipment,	$0.11	$0.00	$0.11	1	$0.03	$0.00
Alkalies & Chlorine	$66.07	$11.64	$54.43	216	$35.66	$1.38
Apparel Made From Purchased Materials	$0.24	$0.00	$0.24	2	$0.07	$0.00
Architectural Metal Work	$0.09	$0.00	$0.09	1	$0.05	$0.00
Automotive and Apparel Trimmings	$1.24	$0.07	$1.18	9	$0.19	$0.01
Boat Building and Repairing	$27.83	$0.09	$27.74	241	$10.25	$0.21
Book Publishing	$3.06	$0.28	$2.78	14	$0.92	$0.03
Bottled and Canned Soft Drinks & Water	$33.26	$0.15	$33.11	99	$7.06	$0.25
Brass, Bronze, and Copper Foundries	$0.10	$0.02	$0.08	2	$0.07	$0.00
Bread, Cake, and Related Products	$63.75	$15.62	$48.13	421	$18.93	$0.32
Broadwoven Fabric Mills and Finishing	$1.19	$0.10	$1.10	8	$0.55	$0.01
Canned Fruits and Vegetables	$0.48	$0.00	$0.47	2	$0.13	$0.00
Canvas Products	$1.21	$0.80	$0.40	19	$0.49	$0.01
Carbon Black	$2.65	$0.01	$2.64	5	$1.43	$0.02
Chemical Preparations, N.E.C	$33.35	$22.58	$10.76	79	$13.74	$0.39

Table A-4: Economic Data for Manufacturing Sectors, Region N (Year 2000)

Commercial Fishing	$36.31	$0.99	$35.32	1104	$34.07	$1.17
Commercial Printing	$33.38	$17.98	$15.40	307	$10.89	$0.32
Communications Equipment N.E.C.	$1.01	$0.55	$0.46	6	$0.72	$0.01
Concrete Block and Brick	$1.75	$0.01	$1.73	12	$0.55	$0.02
Concrete Products, N.E.C	$36.41	$0.29	$36.12	307	$13.13	$0.47
Condensed and Evaporated Milk	$7.49	$1.78	$5.71	16	$1.38	$0.04
Confectionery Products	$6.57	$0.03	$6.54	27	$1.54	$0.03
Construction Machinery and Equipment	$0.49	$0.04	$0.46	2	$0.07	$0.00
Cookies and Crackers	$0.26	$0.01	$0.25	2	$0.10	$0.00
Curtains and Draperies	$1.39	$0.14	$1.25	17	$0.27	$0.01
Cut Stone and Stone Products	$0.65	$0.00	$0.65	6	$0.40	$0.01
Cyclic Crudes, Interm. & Indus. Organic Chem.	$1,166.10	$205.42	$960.68	1499	$319.52	$21.51
Drugs	$0.43	$0.14	$0.29	4	$0.19	$0.00
Electrical Equipment, N.E.C.	$0.66	$0.13	$0.54	3	$0.15	$0.00
Electronic Components, N.E.C.	$47.84	$16.01	$31.83	179	$11.82	$0.40
Electronic Computers	$1.70	$0.31	$1.39	6	$0.60	$0.01
Engine Electrical Equipment	$9.92	$4.82	$5.10	47	$4.73	$0.11
Fabricated Plate Work (Boiler Shops)	$29.54	$0.57	$28.97	314	$16.53	$0.28
Fabricated Rubber Products, N.E.C.	$0.56	$0.01	$0.55	4	$0.15	$0.00
Fabricated Structural Metal	$22.44	$0.58	$21.86	136	$8.72	$0.22
Fabricated Textile Products, N.E.C.	$1.68	$0.39	$1.29	13	$0.40	$0.01
Farm Machinery and Equipment	$2.31	$1.23	$1.08	13	$0.61	$0.02
Fluid Milk	$66.93	$3.68	$63.25	192	$8.57	$0.37
Food Preparations, N.E.C	$28.49	$0.12	$28.37	182	$5.85	$0.12
Forestry Products	$1.33	$0.00	$1.33	12	$1.21	$0.21
Games, Toys, and Childrens Vehicles	$0.14	$0.00	$0.14	1	$0.08	$0.00
Gaskets, Packing and Sealing Devices	$13.48	$0.16	$13.32	114	$4.72	$0.08
Glass and Glass Products, Exc Containers	$0.52	$0.38	$0.14	5	$0.20	$0.00
Heating Equipment, Except Electric	$1.61	$0.06	$1.55	12	$0.74	$0.01
Housefurnishings, N.E.C	$0.95	$0.15	$0.80	8	$0.20	$0.00
Household Furniture, N.E.C	$0.92	$0.02	$0.90	13	$0.32	$0.00
Ice Cream and Frozen Desserts	$0.42	$0.14	$0.28	2	$0.08	$0.00
Industrial and Fluid Valves	$0.80	$0.31	$0.49	4	$0.16	$0.00
Industrial Gases	$3.55	$0.63	$2.93	24	$2.82	$0.08
Industrial Machines N.E.C.	$44.67	$0.55	$44.11	421	$19.91	$0.38
Industrial Trucks and Tractors	$0.59	$0.28	$0.31	4	$0.10	$0.00
Inorganic Chemicals Nec.	$353.13	$62.21	$290.92	1138	$177.82	$10.97
Inorganic Pigments	$70.51	$12.42	$58.08	198	$31.10	$1.66
Internal Combustion Engines, N.E.C.	$2.77	$1.59	$1.18	8	$0.54	$0.02
Leather Goods, N.E.C	$0.30	$0.06	$0.25	6	$0.23	$0.00
Leather Tanning and Finishing	$0.33	$0.17	$0.16	1	$0.13	$0.00
Lubricating Oils and Greases	$1.74	$0.21	$1.52	4	$0.17	$0.01
Machine Tools, Metal Forming Types	$2.49	$0.27	$2.22	23	$1.05	$0.02
Manufactured Ice	$1.03	$0.12	$0.90	25	$0.60	$0.01
Marking Devices	$1.09	$0.12	$0.97	24	$0.90	$0.01
Mattresses and Bedsprings	$3.42	$0.16	$3.26	29	$1.00	$0.01
Meat Packing Plants	$197.53	$18.35	$179.18	507	$22.55	$1.51
Mechanical Measuring Devices	$23.55	$3.35	$20.19	155	$10.26	$0.28
Metal Coating and Allied Services	$1.46	$0.21	$1.25	10	$0.55	$0.01
Metal Doors, Sash, and Trim	$44.58	$1.92	$42.67	347	$21.56	$0.47
Metal Heat Treating	$3.15	$0.09	$3.06	12	$1.52	$0.04
Metal Household Furniture	$0.27	$0.03	$0.24	2	$0.06	$0.00
Metal Sanitary Ware	$3.23	$0.09	$3.14	47	$2.38	$0.03
Metal Stampings, N.E.C.	$16.94	$1.87	$15.07	102	$6.50	$0.15
Millwork	$11.22	$10.81	$0.42	119	$3.81	$0.09
Minerals, Ground Or Treated	$7.64	$0.08	$7.56	63	$2.80	$0.07
Miscellaneous Fabricated Wire Products	$0.85	$0.54	$0.31	9	$0.32	$0.01
Miscellaneous Metal Work	$15.20	$0.55	$14.65	37	$2.26	$0.12
Miscellaneous Plastics Products	$32.52	$0.54	$31.98	187	$9.38	$0.21
Miscellaneous Publishing	$3.36	$2.35	$1.01	39	$1.29	$0.03
Mobile Homes	$0.28	$0.00	$0.28	3	$0.10	$0.00
Motor Vehicle Parts and Accessories	$7.66	$4.41	$3.26	37	$1.54	$0.02
Newspapers	$58.18	$37.12	$21.07	699	$28.24	$0.64
Oil Field Machinery	$20.46	$3.44	$17.02	160	$9.67	$0.20
Paints and Allied Products	$5.28	$0.05	$5.23	16	$1.76	$0.05
Paving Mixtures and Blocks	$29.52	$16.82	$12.70	78	$13.34	$0.24
Periodicals	$1.70	$0.91	$0.78	15	$0.30	$0.01
Petroleum Refining	$7,649.47	$761.35	$6,888.11	2825	$926.41	$60.45
Phonograph Records and Tape	$0.40	$0.12	$0.27	4	$0.27	$0.00
Photographic Equipment and Supplies	$1.05	$0.17	$0.88	4	$0.15	$0.01
Pipe, Valves, and Pipe Fittings	$10.79	$4.14	$6.65	91	$4.35	$0.08
Plastics Materials and Resins	$1.82	$0.23	$1.60	3	$0.17	$0.01
Plating and Polishing	$0.36	$0.07	$0.29	6	$0.29	$0.00
Pleating and Stitching	$0.13	$0.00	$0.13	2	$0.09	$0.00
Pottery Products, N.E.C	$0.63	$0.00	$0.62	10	$0.18	$0.01
Power Transmission Equipment	$6.51	$0.13	$6.38	46	$1.83	$0.05
Prefabricated Metal Buildings	$19.54	$0.39	$19.15	132	$9.55	$0.19
Prefabricated Wood Buildings	$0.18	$0.00	$0.17	1	$0.10	$0.00

Table A-4: Economic Data for Manufacturing Sectors, Region N (Year 2000)

Prepared Fresh Or Frozen Fish Or Seafood	$8.61	$0.10	$8.51	45	$2.77	$0.10
Pumps and Compressors	$127.71	$4.38	$123.33	422	$47.56	$1.48
Radio and Tv Communication Equipment	$0.53	$0.29	$0.24	1	$0.21	$0.00
Railroads and Related Services	$19.89	$12.74	$7.15	176	$5.71	$0.29
Ready-mixed Concrete	$27.03	$0.17	$26.86	199	$7.86	$0.31
Refrigeration and Heating Equipment	$4.74	$3.27	$1.48	22	$1.39	$0.05
Relays & Industrial Controls	$0.35	$0.19	$0.17	2	$0.09	$0.00
Roasted Coffee	$2.65	$0.75	$1.90	5	$0.39	$0.01
Sausages and Other Prepared Meats	$35.05	$4.49	$30.56	154	$7.57	$0.28
Screw Machine Products and Bolts, Etc.	$2.42	$0.75	$1.67	21	$0.96	$0.02
Semiconductors and Related Devices	$62.96	$23.59	$39.37	212	$35.37	$0.58
Service Industry Machines, N.E.C.	$0.48	$0.26	$0.22	3	$0.12	$0.00
Sheet Metal Work	$13.09	$0.26	$12.83	100	$5.33	$0.11
Ship Building and Repairing	$157.62	$0.11	$157.51	1345	$75.54	$1.42
Signs and Advertising Displays	$3.42	$1.25	$2.17	38	$1.56	$0.03
Soap and Other Detergents	$1.24	$0.17	$1.07	9	$0.67	$0.01
Special Dies and Tools and Accessories	$3.09	$1.97	$1.12	33	$1.73	$0.03
Sporting and Athletic Goods, N.E.C.	$5.24	$0.02	$5.22	43	$2.27	$0.18
Structural Wood Members, N.E.C	$0.94	$0.88	$0.05	7	$0.39	$0.01
Surgical Appliances and Supplies	$1.58	$0.41	$1.16	9	$0.31	$0.01
Switchgear and Switchboard Apparatus	$1.04	$0.74	$0.29	4	$0.56	$0.01
Telephone and Telegraph Apparatus	$1.43	$0.94	$0.49	4	$0.20	$0.00
Textile Bags	$10.90	$0.78	$10.12	122	$4.09	$0.10
Transportation Equipment, N.E.C	$0.48	$0.01	$0.47	2	$0.06	$0.00
Womens Handbags and Purses	$0.53	$0.01	$0.53	11	$0.17	$0.00
Wood Household Furniture	$9.33	$0.15	$9.19	99	$3.77	$0.07
Wood Kitchen Cabinets	$4.05	$4.00	$0.05	48	$1.99	$0.04
Wood Partitions and Fixtures	$3.23	$2.13	$1.10	31	$1.14	$0.02
	$10,933.22	$1,322.06	$9,611.15	16541	$2,069.06	$111.46

NEC = not elsewhere classified. "na" = not available.

Table A-5: Economic Data for Mining Sectors, Region N (Year 2000)

Sector	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Coal Mining	$8.22	$0.94	$7.28	17	$3.33	$1.28
Dimension Stone	$0.86	$0.01	$0.85	6	$0.52	$0.03
Natural Gas & Crude Petroleum	$1,174.59	$1,080.74	$93.86	2,182	$544.66	$63.90
Natural Gas Liquids	$459.70	$422.97	$36.73	351	$129.34	$20.34
Sand and Gravel	$7.99	$0.15	$7.83	66	$4.98	$0.25
Uranium-radium-vanadium Ores	$0.87	$0.87	$0.00	10	$0.08	$0.03
TOTAL	$1,652.24	$1,505.68	$146.56	2,633	$682.91	$85.83

Table A-6: Economic Data for the Steam Electric Sector, Region N (Year 2000)

Sector	Total Sales	Intermediate Sales	Final Sales	Labor Force	Regional Income	Business Taxes
Electric Services	$399.92	$122.14	$277.78	761	$285.99	$51.22

na = "not available"

Attachment B: Distribution of Economic Impacts by County and Water User Group

Tables B-1 through B-6 show economic impacts by county and water user group; however, **caution** is warranted. Figures shown for specific counties are *direct* impacts only. For the most part, figures reported in the main text for all water use categories uses include *direct and secondary* impacts. Secondary effects were estimated using regional level multipliers that treat each regional water planning area as an aggregate and autonomous economy. Multipliers do not specify where secondary impacts will occur at a sub-regional level (i.e., in which counties or cities). All economic impacts that would accrue to a region as a whole due to secondary economic effects are reported in Tables B-1 through B-6 as "secondary regional level impacts."

For example, assume that in a given county (or city) water shortages caused significant reductions in output for a manufacturing plant. Reduced output resulted in lay-offs and lost income for workers and owners of the plant. This is a *direct* impact. Direct impacts were estimated at a county level; and thus one can say with certainty that direct impacts occurred in that county. However, secondary impacts accrue to businesses and households throughout the region where the business operates, and it is impossible using input-output models to determine where these businesses are located spatially.

The same logic applies to changes in population and school enrollment. Since employment losses and subsequent out-migration from a region were estimated using *direct* and *secondary* multipliers, it is impossible to say with any degree of certainty how many people a given county would lose regardless of whether the economic impact was direct or secondary. For example, assume the manufacturing plant referred to above is in County A. If the firm eliminated 50 jobs, one could state with certainty that water shortages in County A resulted in a loss of 50 jobs in that county. However, one could not unequivocally say whether 100 percent of the population loss due to lay-offs at the manufacturing would accrue to County A because many affected workers might commute from adjacent counties. This is particularly true in large metropolitan areas that overlay one or counties. Thus, population and school enrollment impacts cannot be reported at a county level.

Irrigation

Table B-1: Distribution of Economic Impacts by County and Water User Groups: (Irrigation)						
Lost Sales, $millions)						
County	2010	2020	2030	2040	2050	2060
Live Oak						
Direct	$0.08	$0.08	$0.07	$0.06	$0.02	$0.02
Secondary Regional Level Impacts	$0.03	$0.03	$0.03	$0.02	$0.01	$0.01
Total	$0.12	$0.11	$0.09	$0.08	$0.03	$0.02
Lost Income ($millions)						
County	2010	2020	2030	2040	2050	2060
Live Oak						
Direct	$0.045	$0.040	$0.035	$0.030	$0.012	$0.009
Secondary Regional Level Impacts	$0.019	$0.017	$0.015	$0.013	$0.005	$0.004
Total	$0.063	$0.057	$0.050	$0.043	$0.018	$0.013
Lost Jobs						
	2010	2020	2030	2040	2050	2060
Live Oak						
Direct	0	0	0	0	0	0
Secondary Regional Level Impacts	0	0	0	0	0	0
Total	0	0	0	0	0	0
Lost Business Taxes ($millions)						
	2010	2020	2030	2040	2050	2060
Live Oak						
Direct	$0.005	$0.004	$0.004	$0.003	$0.001	$0.001
Secondary Regional Level Impacts	$0.002	$0.002	$0.002	$0.001	$0.001	$< 0.001
Total	$0.007	$0.006	$0.006	$0.005	$0.002	$0.001
Source: Texas Water Development Board, Office of Water Resources Planning						

Mining

Table B-2: Distribution of Economic Impacts by County and Water User Groups: (Mining)						
Lost Output (Total Sales, $millions)						
County	2010	2020	2030	2040	2050	2060
Duval						
Direct	$10.06	$13.53	$15.58	$16.61	$19.13	$20.85
Secondary Regional Level Impacts	$4.81	$6.47	$7.45	$7.94	$9.14	$9.97
Live Oak						
Direct	$1.03	$7.25	$13.27	$18.28	$22.05	$25.64
Secondary Regional Level Impacts	$0.06	$0.44	$0.80	$1.10	$1.33	$1.54
Nueces						
Direct	$0.00	$0.00	$27.15	$155.96	$162.70	$169.56

	2010	2020	2030	2040	2050	2060
Secondary Regional Level Impacts	$0.00	$0.00	$2.16	$12.41	$12.95	$13.49
Total	$15.96	$27.69	$66.42	$212.30	$227.30	$241.05
Lost Income ($millions)						
County	2010	2020	2030	2040	2050	2060
Duval						
Direct	18	24	27	29	34	37
Secondary Regional Level Impacts	48	65	75	80	92	100
Live Oak						
Direct	1	7	13	18	21	25
Secondary Regional Level Impacts	1	4	8	10	13	15
Nueces						
Direct	0	0	35	200	209	218
Secondary Regional Level Impacts	0	0	22	129	134	140
Total	68	100	180	467	503	534
Lost Jobs (numbers may not sum to figures in text due to rounding)						
	2010	2020	2030	2040	2050	2060
Duval						
Direct	$3.01	$4.04	$4.66	$4.96	$5.71	$6.23
Secondary Regional Level Impacts	$2.10	$2.82	$3.25	$3.46	$3.99	$4.35
Live Oak						
Direct	$0.32	$2.28	$4.17	$5.74	$6.93	$8.05
Secondary Regional Level Impacts	$0.03	$0.23	$0.42	$0.58	$0.71	$0.82
Nueces						
Direct	$0.00	$0.00	$8.81	$50.59	$52.77	$55.00
Secondary Regional Level Impacts	$0.00	$0.00	$1.19	$6.83	$7.12	$7.42
Total	$5.46	$9.37	$22.49	$72.17	$77.23	$81.87
Lost Business Taxes ($millions)						
County	2010	2020	2030	2040	2050	2060
Duval						
Direct	$1.47	$1.97	$2.27	$2.42	$2.79	$3.04
Secondary Regional Level Impacts	$0.88	$1.18	$1.36	$1.45	$1.66	$1.81
Live Oak						
Direct	$0.05	$0.33	$0.61	$0.84	$1.02	$1.18
Secondary Regional Level Impacts	$0.00	$0.03	$0.06	$0.09	$0.11	$0.12
Nueces						
Direct	$0.00	$0.00	$1.22	$7.03	$7.33	$7.64
Secondary Regional Level Impacts	$0.00	$0.00	$0.13	$0.76	$0.79	$0.82
Total	$2.39	$3.52	$5.66	$12.58	$13.70	$14.62
Source: Texas Water Development Board, Office of Water Resources Planning						

Manufacturing

Table B-3: Distribution of Economic Impacts by County and Water User Groups: Manufacturing						
Lost Output (Total Sales, $millions)						
County	2010	2020	2030	2040	2050	2060
Aransas						
Direct	$1.05	$2.47	$2.68	$3.39	$3.39	$3.98
Secondary Regional Level Impacts	$0.55	$1.29	$1.40	$1.78	$1.78	$2.08
Nueces						
Direct	$0.00	$0.00	$0.00	$540.02	$2,237.35	$7,039.76
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$338.36	$1,401.85	$4,410.89
San Patricio						
Direct	$0.00	$0.00	$0.00	$0.00	$8.64	$38.50
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$6.35	$28.32
Live Oak						
Direct	$35.82	$52.21	$59.42	$138.00	$139.67	$162.42
Secondary Regional Level Impacts	$21.55	$31.42	$35.75	$83.04	$84.04	$97.73
Total	$58.98	$87.39	$99.25	$1,104.57	$3,883.07	$11,783.68
Job Losses (numbers may not sum to figures in text due to rounding)						
County	2010	2020	2030	2040	2050	2060
Aransas						
Direct	6	13	14	18	18	21
Secondary Regional Level Impacts	7	18	19	24	24	28
Nueces						
Direct	0	0	0	307	1,270	3,997
Secondary Regional Level Impacts	0	0	0	2,389	9,899	31,147
San Patricio						
Direct	0	0	0	0	23	103
Secondary Regional Level Impacts	0	0	0	0	63	280
Live Oak						
Direct	14	21	23	54	55	64
Secondary Regional Level Impacts	135	197	224	520	526	612
Total	162	249	280	3,312	11,878	36,252
Income Losses ($millions)						
County	2010	2020	2030	2040	2050	2060
Aransas						
Direct	$0.38	$0.90	$0.97	$1.24	$1.24	$1.45
Secondary Regional Level Impacts	$0.32	$0.75	$0.81	$1.03	$1.03	$1.21
Nueces						
Direct	$0.00	$0.00	$0.00	$70.90	$293.74	$924.23
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$161.17	$667.75	$2,101.07
San Patricio						
Direct	$0.00	$0.00	$0.00	$0.00	$3.57	$15.90
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$3.29	$14.68
Live Oak						
Direct	$4.08	$5.95	$6.77	$15.73	$15.92	$18.51
Secondary Regional Level Impacts	$10.07	$14.68	$16.70	$38.79	$39.26	$45.65
Total	$14.86	$22.27	$25.26	$288.86	$1,025.80	$3,122.70

Business Taxes ($millions)						
County	2010	2020	2030	2040	2050	2060
Aransas						
Direct	$0.01	$0.02	$0.02	$0.03	$0.03	$0.03
Secondary Regional Level Impacts	$0.01	$0.02	$0.02	$0.02	$0.02	$0.03
Nueces						
Direct	$0.00	$0.00	$0.00	$4.95	$20.51	$64.54
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$11.27	$46.70	$146.94
San Patricio						
Direct	$0.00	$0.00	$0.00	$0.00	$0.22	$0.99
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.21	$0.93
Live Oak						
Direct	$0.28	$0.41	$0.47	$1.09	$1.10	$1.28
Secondary Regional Level Impacts	$0.70	$1.02	$1.16	$2.70	$2.73	$3.17
Total	$1.00	$1.47	$1.67	$20.06	$71.52	$217.92
Source: Texas Water Development Board, Office of Water Resources Planning						

Municipal

Impacts to the horticultural industry were estimated at the regional level only and are not included.

Table B-4: Lost Water Utility Revenues (Municipal)						
County	2010	2020	2030	2040	2050	2060
Aransas	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Jim Wells	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Kleberg	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Live Oak	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Nueces	$0.11	$0.21	$0.31	$0.40	$0.48	$0.56
San Patricio	$0.00	$0.00	$0.01	$0.03	$0.04	$0.05
Total	$0.11	$0.21	$0.32	$0.43	$0.52	$0.61
Source: Texas Water Development Board, Office of Water Resources Planning						

Table B-5: Lost Water Utility Taxes (Municipal)						
County	2010	2020	2030	2040	2050	2060
Aransas	-	-	-	-	-	-
Jim Wells	-	-	-	-	-	-
Kleberg	-	-	-	-	-	-
Live Oak	-	-	-	-	-	-
Nueces	$0.002	$0.004	$0.005	$0.007	$0.009	$0.010
San Patricio	$0.000	$0.000	$0.000	$0.000	$0.001	$0.001
Total	$0.002	$0.004	$0.006	$0.008	$0.009	$0.011
Source: Texas Water Development Board, Office of Water Resources Planning						

Table B-6: Impacts Associated with Unmet Domestic Water Needs						
County	2010	2020	2030	2040	2050	2060
Aransas	$0.00	$0.00	$0.00	$0.00	$6.69	$6.32
Jim Wells	$0.49	$0.70	$0.77	$0.71	$0.62	$0.50
Kleberg	$0.00	$0.09	$0.24	$0.32	$0.45	$0.46
Live Oak	$0.00	$0.09	$0.13	$0.04	$0.00	$0.00
Nueces	$0.77	$0.00	$1.16	$1.58	$1.95	$2.27
San Patricio	$0.00	$0.00	$0.03	$0.06	$0.08	$0.11
Total	$1.26	$0.89	$2.33	$2.71	$9.79	$9.66
Source: Texas Water Development Board, Office of Water Resources Planning						

Attachment C: Allocation of Economic Impacts by River Basin

Tables C-1 through C-3 distribute regional economic and social impacts by major river basin. Impacts were allocated based on distribution of water shortages among counties. For instance, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin then impacts were split equally among the two basins.

Irrigation

All needs are projected to occur in the Nueces River Basin.

Mining

Table C1: Distribution of Impacts among Major River Basins (Mining Water Uses)						
Lost Sales ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	$6.19	$12.76	$29.50	$84.00	$94.09	$103.05
Nueces- Rio Grande	$9.77	$14.92	$28.45	$94.59	$100.20	$105.34
San Antonio-Nueces	$0.00	$0.00	$8.47	$33.70	$33.01	$32.66
Total	$15.96	$27.69	$66.42	$212.30	$227.30	$241.05
Lost Income ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	$2.12	$4.32	$9.99	$28.55	$31.97	$35.00
Nueces- Rio Grande	$3.34	$5.05	$9.63	$32.16	$34.05	$35.78
San Antonio-Nueces	$0.00	$0.00	$2.87	$11.46	$11.22	$11.09
Total	$5.46	$9.37	$22.49	$72.17	$77.23	$81.87
Job Losses (numbers may not sum to figures in text due to rounding)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	26	46	80	185	208	228
Nueces- Rio Grande	41	54	77	208	222	234
San Antonio-Nueces	0	0	23	74	73	72
Total	68	100	180	467	503	534
Lost Business Taxes ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	$0.93	$1.62	$2.51	$4.98	$5.67	$6.25
Nueces- Rio Grande	$1.47	$1.90	$2.42	$5.61	$6.04	$6.39
San Antonio-Nueces	$0.00	$0.00	$0.72	$2.00	$1.99	$1.98
Total	$2.39	$3.52	$5.66	$12.58	$13.70	$14.62
Source: Texas Water Development Board, Office of Water Resources Planning						

Manufacturing

Table C-2: Distribution of Impacts among Major River Basins (Manufacturing Water Uses)						
Lost Sales ($millions)						
Basin	2010	2020	2030	2040	2050	2060
San Antonio-Nueces	$10.38	$13.21	$14.68	$9.57	$195.74	$1,212.89
Nueces	$48.60	$74.18	$84.57	$55.01	$97.91	$208.92
Nueces- Rio Grande	$0.00	$0.00	$0.00	$1,039.99	$3,589.42	$10,361.87
Total	$58.98	$87.39	$99.25	$1,104.57	$3,883.07	$11,783.68
Lost Income ($millions)						
Basin	2010	2020	2030	2040	2050	2060
San Antonio-Nueces	$2.62	$3.37	$3.74	$2.50	$51.71	$321.42
Nueces	$12.24	$18.91	$21.53	$14.39	$25.86	$55.36
Nueces- Rio Grande	$0.00	$0.00	$0.00	$271.97	$948.22	$2,745.92
Total	$14.86	$22.27	$25.26	$288.86	$1,025.80	$3,122.70
Job Losses (numbers may not sum to figures in text due to rounding)						
Basin	2010	2020	2030	2040	2050	2060
San Antonio-Nueces	29	37	41	29	599	3,765
Nueces	133	210	239	165	299	649
Nueces- Rio Grande	0	0	0	3,118	10,979	32,167
Total	162	248	280	3,311	11,878	36,580
Lost Business Taxes ($millions)						
Basin	2010	2020	2030	2040	2050	2060
San Antonio-Nueces	$0.18	$0.22	$0.25	$0.17	$3.61	$22.43
Nueces	$0.82	$1.25	$1.42	$1.00	$1.80	$3.86
Nueces- Rio Grande	$0.00	$0.00	$0.00	$18.88	$66.11	$191.62
Total	$1.00	$1.47	$1.67	$20.06	$71.52	$217.92
Source: Texas Water Development Board, Office of Water Resources Planning						

Municipal

Table C-3: Distribution of Regional Impacts among Major River Basins (Municipal Uses including Water Intensive Commercial Businesses, Domestic Uses and Horticultural Industry and Water Utilities)						
Lost Sales ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	$0.04	$0.14	$0.22	$0.30	$0.18	$0.24
Nueces- Rio Grande	$0.13	$0.13	$0.19	$0.22	$0.12	$0.12
San Antonio-Nueces	$0.00	$0.00	$0.00	$0.00	$0.51	$0.54
Total	$0.18	$0.27	$0.41	$0.52	$0.81	$0.90
Lost Income ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	$0.32	$0.48	$1.30	$1.60	$2.24	$2.57
Nueces- Rio Grande	$0.98	$0.45	$1.08	$1.16	$1.48	$1.33
San Antonio-Nueces	$0.00	$0.00	$0.00	$0.00	$6.23	$5.92
Total	$1.30	$0.92	$2.38	$2.76	$9.96	$9.83
Job Losses (numbers may not sum to figures in text due to rounding)						
Basin	2010	2020	2030	2040	2050	2060
Nueces	0	0	0	0	0	0
Nueces- Rio Grande	0	0	0	0	0	0
San Antonio-Nueces	0	0	0	0	0	0
Total	0	0	0	0	0	0
Basin	2010	2020	2030	2040	2050	2060
Nueces	$0.00	$0.00	$0.00	$0.01	$0.00	$0.00
Nueces- Rio Grande	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
San Antonio-Nueces	$0.00	$0.00	$0.00	$0.00	$0.01	$0.01
Total	$0.00	$0.01	$0.01	$0.01	$0.02	$0.02
Source: Texas Water Development Board, Office of Water Resources Planning						

Appendix G

Summary of Texas Parks and Wildlife Ecologically Significant River and Stream Segments of the Coastal Bend Water Planning Area (Region N), August 2002

Region N (Coastal Bend)

Aransas River - From the confluence with Copano Bay in Aransas/Refugio County to a point 3.3 miles upstream of Chiltipin Creek in Refugio/San Patricio County (TNRCC classified stream segment 2003).

Biological function - Extensive estuarine wetland habitat (National Wetlands Inventory, 1999)
Threatened or endangered species/unique communities - reddish egret (SOC/St.T), piping plover (Fed.T/St. T), snowy plover (SOC), white-faced ibis (SOC/St.T), wood stork (SOC/St.T), brown pelican (Fed.E/St.E) (TPWD, 2000)

Nueces River - From the Calallan saltwater barrier upstream about 35 miles to Seale Dam at Lake Corpus Christi (TNRCC classified stream segment 2102).

Biological function - Freshwater marsh on the floodplain at the lower portion of this segment (U.S. Fish and Wildlife Service, 2000)
Riparian conservation area - City of Corpus Christi Wildlife Sanctuary; Hazel Bazemore County Park.
High water quality/exceptional aquatic life/high aesthetic value - High aesthetic and economic value for outdoor recreation, especially birdwatching. Hazel Bazemore Park is a world-class hawk migration site (Texas Parks & Wildlife and Texas Department of Transportation, 1999-2000)

Nueces River - From the confluence with Nueces Bay in Nueces County upstream to Calallen Dam 1870 yards upstream of US 77/IH 37 in Nueces/San Patricio County (TNRCC classified stream segment 2101).

Biological function - Extensive freshwater and estuarine wetland habitat (Bauer et al., 1991)
High water quality/exceptional aquatic life/high aesthetic value - exceptional aquatic life use (TNRCC, 1996)
Threatened or endangered species/unique communities - diamondback terrapin (SOC) (B. Ortego, 1999, pers. comm.)

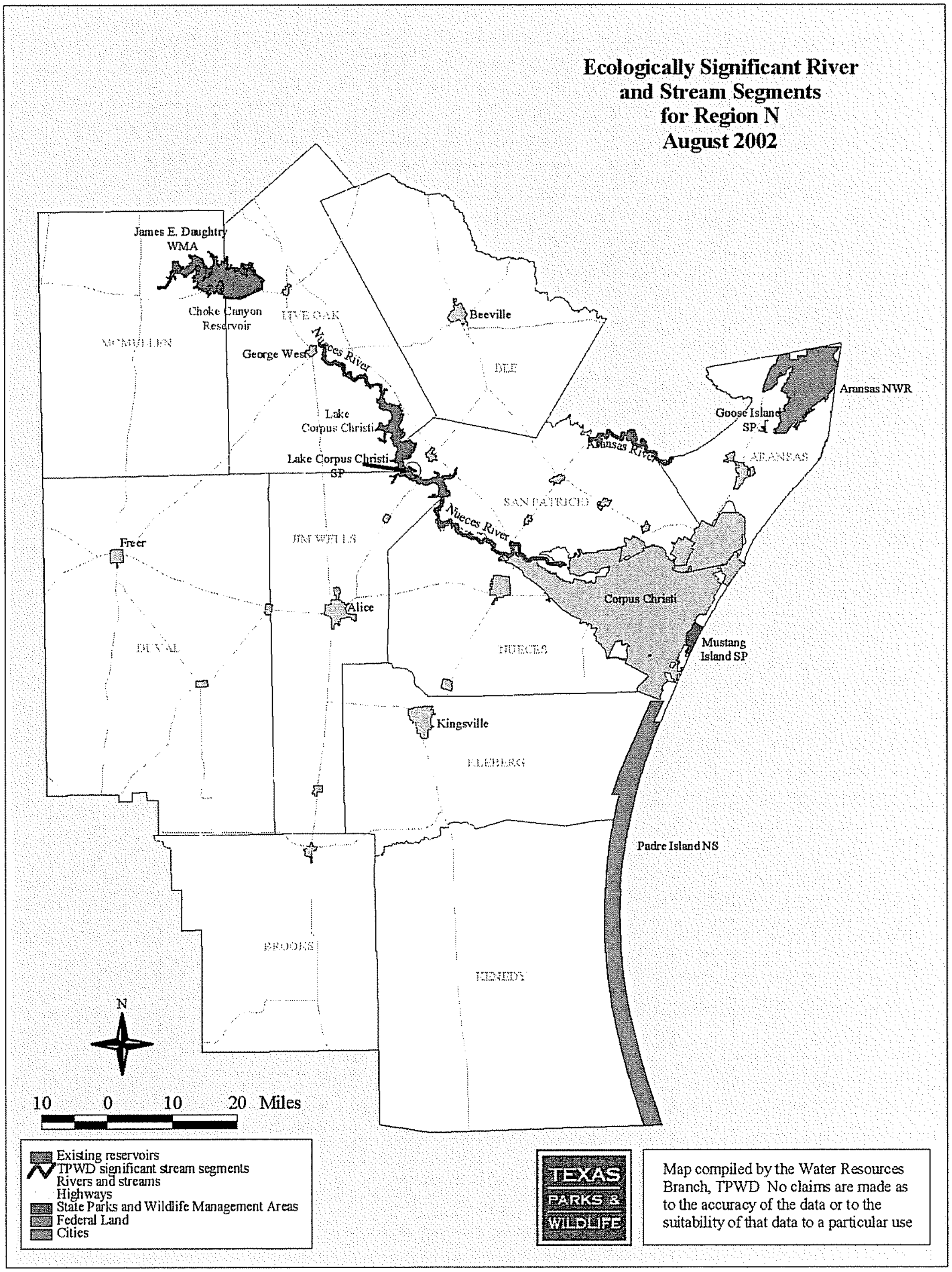
Nueces River - From the headwaters of Lake Corpus Christi in Live Oak County upstream to US 59 in Live Oak County (within TNRCC classified stream segment 2103).

Threatened or endangered species/unique communities - One of only four known remaining populations of the endemic golden orb (Howells, 1997 and Howells et al., 1997)

Abbreviation List

CIR - Color Infrared
DOQ - Digital Orthophoto Quadrangle
E - Endangered
Fed. - Federal
GTCBT - Great Texas Coastal Birding Trail
LE - Lised Endangered
NPS - National Park Service
PDL - Proposed To Be Delisted
RWPG - Regional Water Planning Group
SFH - State Fish Hatchery
SOC - Species of Concern
SP - State Park
St. - State
T - Threatened
TAC - Texas Administrative Code
TNRCC - Texas Natural Resource Conservation Commission
TPWD - Texas Parks & Wildlife Department
TWDB - Texas Water Development Board
USFWS - United States Fish and Wildlife Service
WMA - Wildlife Management Area
TOES - Texas Organization for Endangered Species.
MWMA - Matagorda Wildlife Management Area

Map


Ecologically Significant River
and Stream Segments
for Region N
August 2002
James E. Daughtry
WMA
Choke Canyon
Reservoir
George West
Nueces River
Beeville
Lake
Corpus Christi
Lake Corpus Christi
SP
Aransas River
Aransas NWR
Goose Island
SP
Nueces River
Freer
Corpus Christi
Alice
Mustang
Island SP
Kingsville
Padre Island NS
N
10 0 10 20 Miles
Existing reservoirs
TPWD significant stream segments
Rivers and streams
Highways
State Parks and Wildlife Management Areas
Federal Land
Cities
TEXAS
PARKS &
WILDLIFE
Map compiled by the Water Resources
Branch, TPWD No claims are made as
to the accuracy of the data or to the
suitability of that data to a particular use

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Please send comments, suggestions, or questions to:

Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, Texas 78744

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Appendix H

RWPG Newsletters

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COASTAL BEND

Water Report

Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org

No. 6 • Fall 2004

Coastal Bend water planning moves ahead

The Coastal Bend Regional Water Planning Group (RWPG) has been at work for the past two years coordinating the process of updating the comprehensive regional water plan adopted in 2000.

This review and revision process will lead to publication next May of a draft plan for the Coastal Bend. That will be followed by public meetings and finally by adoption of a revised plan by the end of 2005.

The current effort is part of the second round of regional water planning in Texas that began with adoption of Senate Bill 1 in 1997. Sixteen regional planning groups were appointed and prepared plans describing how local entities may address water supply needs for the next 50 years. The final regional plans were incorporated into the Texas Water Plan adopted by the Texas Water Development Board (TWDB) and presented to the Texas Legislature in 2001.

Recognizing that water resources must be managed efficiently and effectively to meet future needs, the Legislature directed that regional and state water plans be updated every five years to respond to changing climate, environmental, socioeconomic and demographic conditions.

The result is the second round of planning (2002-2006) during which the 16 planning groups are updating their regional plans to comply with new planning considerations included in Senate Bill 2, enacted in 2001, and new TWDB rules and guidelines developed in response to legislative directives and public comments.

Carola Serrato, executive director of the South Texas Water Authority and co-chair of the Coastal Bend RWPG, said it is important to local communities that all viable water management options be addressed in the 2005 revised regional plan. State financial assistance through TWDB may only be provided to those water supply projects that meet identified needs in a manner consistent with the approved regional water plan. In addition, the Texas Commission on Environmental Quality (TCEQ) may not issue a water rights permit for municipal purposes unless it is consistent with the approved plan.

Each planning group will review, revise, and refine their currently approved regional water plan to respond to changed conditions that may impact estimated demands for water, water supplies, or recommended water management strategies.

SCHEDULE

2003	Final population and water demand projections developed
2004	Ongoing evaluation of water supply and conservation strategies
2005	May - Issue draft plan for public comment Summer - Public meetings December - Plan adopted
2006	TWDB incorporates regional plans and legislative recommendations into new comprehensive state water plan
2007	TWDB delivers 2007 State Water Plan to Texas Legislature completing 5-year planning cycle

Specific components of the ongoing planning process are:

- Updating Regional Water Plans based on new population and water demand projections resulting from the 2000 Census.
- Developing and revising water supply and water availability estimates based on new Groundwater Availability Models and Water Availability Models.
- Evaluating and recommending water management strategies to meet water supply needs, placing a greater emphasis on water conservation and evaluating the impacts of these strategies on the environment.
- Considering and possibly recommending changes to current water policy and water law in Texas that may serve to better manage the State's water resources.

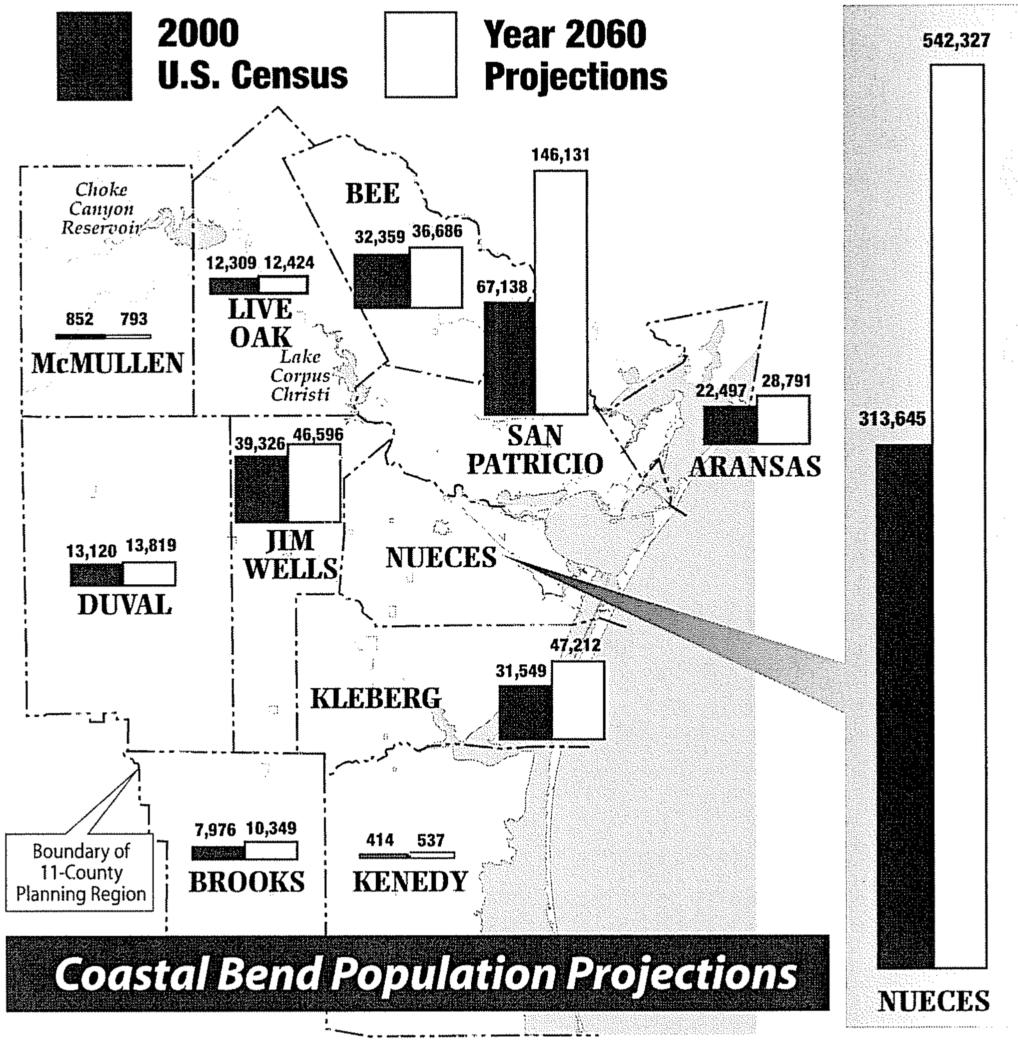
The total estimated statewide budget for completing 2002-2006 regional water planning activities is $18 million. These funds were allocated proportionately to the 16 planning groups to comply with statutory requirements which include updating the regional plan, addressing new planning requirements, performing additional water supply studies and evaluating each water management strategy.

Coming Up In January

Management Strategies

We'll summarize the water management strategies being evaluated for the Coastal Bend and how they have been updated to reflect new population, demand projections and climate data.

Moderate population, water demand growth projected for Coastal Bend



One of the first steps in developing a comprehensive water plan for the state and the region is to methodically prepare population growth and future water demand projections.

The Texas Water Development Board (TWDB) has published population projections which anticipate moderate growth in the Coastal Bend over the next 60 years. The TWDB projects an increase in the 11-county area from 541,184 in the 2000 Census to 885,665 in 2060, an increase of 64%. That is an annual compounded rate of .82%, a rate that is somewhat lower than the .97% rate projected by the state five years earlier.

The region is expected to grow at a somewhat slower rate than the state as a whole which is expected to more than double population from 20.8 million in 2000 to a projected 45.5 million in 2060.

Following the patterns of the past 30 years, San Patricio and Nueces counties are expected to be the fastest growing counties in the region. The population growth in these two counties accounts for 89% of the total projected for the region over the coming decades. Nueces County is projected to grow by 45,000 in the current decade and another 47,000 by 2020. San Patricio County is projected to have the fastest growth rate in the region, adding 14,000 people by 2010 and another 15,000 by 2020.

Significant growth is projected in Bee, Brooks, Jim Wells and Kleberg counties over the 60-year period but less than the regional average. Little growth is projected for Kenedy, Duval, Live Oak and McMullen counties which are dominated by ranchland. While coastal Aransas County had a rapid annual growth rate of 2.3% from 1980 to 2000, the TWDB projects growth there may slow by 2020 and the population may begin declining slightly after 2030.

TWDB population projections were developed for cities with a population of greater than 500 and for rural areas including those served by water districts. Each city within the region was provided an opportunity to review their respective population and water demand projections. During this review period, no city within the region chose to revise their projections.

The population projections are a consensus-based "most-likely" scenario of growth, based on recent and prospective growth trends as determined by the opinions of a Technical Advisory Committee consisting of state agencies, key interest groups and the general public.

Water Demand Projections

Total demand for water in the 11 Coastal Bend counties will increase with additional population during the 50-year planning period but is expected to be tempered by anticipated water conservation savings.

Half the region's water demand comes from municipal users and decreasing per capita use rates are expected as people modify their habits, install more efficient landscaping and replace plumbing.

Total regional demand from all users in 2000 was 205,936 acre-feet per year (acft/yr) with the water coming from the Nueces River, Lake Texana and groundwater sources. The total is expected to be 308,577 acft/yr by 2060, a 50% increase compared to a 64% population increase. (An acre-foot is equal to 325,851 gallons.)

Municipal, manufacturing, steam-electric and mining water use are projected to increase in the Coastal Bend while irrigation use is projected to decline and livestock use is likely to be unchanged.

MUNICIPAL - Half the region's demand is for municipal water used by households, commercial establishments, and for fire protection, public recreation and sanitation. This type of water must meet safe drinking water standards.

The TWDB computes future municipal water demand by multiplying the projected population of an area by the projected per capita water use, adjusted for conservation savings. In 2000 total municipal use in the Coastal Bend region was 99,950 acft/yr. Nueces and San Patricio counties accounted for 71.6% of the total. Municipal use is projected to increase 51.5% to 151,474 acft in 2060. Per capita water use in the region is expected to decline about 8% in the coming decades.

INDUSTRIAL - Manufacturing is an integral part of the area economy and water plays a key role in some manufacturing processes. The water-using manufacturers in Coastal Bend are food processing, chemicals, petroleum refining, stone and concrete, fabricated metal, and electronic and electrical equipment.

In 2000, total manufacturing water use was 54,481 acft. Manufacturing use is projected to be 73,861 acft in 2030 and 88,122 acft in 2060, a 61.7% increase. Growth is expected to come from refining and petrochemical processors in Nueces and San Patricio counties.

Process plants in the region have been aggressive in improving water use efficiency over the past 25 years. Corpus Christi refineries use on average 46 gallons of water per barrel of crude oil refined, compared to the state average of 100 gallons per barrel refined.

MINING - Substantial amounts of groundwater are used for mining sand, gravel and production of crude oil in Live Oak, Duval and Kleberg counties. The total for the region in 2000 was 11,897 acft. Mining water use in 2030 is expected to be 16,640 acft and is projected to increase to 19,114 acft in 2060, a 60% increase from 2000 to 2060.

AGRICULTURE - Some crop irrigation is done in nine area counties with 70% coming from groundwater. In 1997 there were 17,873 acres irrigated, accounting for only 2.1% of all harvested cropland. Irrigation water demand projections are based on specific assumptions regarding crop prices, crop yields, agricultural policy, and technological advances in irrigation systems. The TWDB estimated 2000 total irrigated water use at 21,971 acft. Irrigated water use is projected to decrease by 39% by 2060 because of increased efficiencies in irrigation techniques and less irrigated farming.

Livestock water demand, primarily for cattle, amounts to some 8,800 acre feet per year and is expected to remain constant in the decades ahead.

How to get information; websites you can visit

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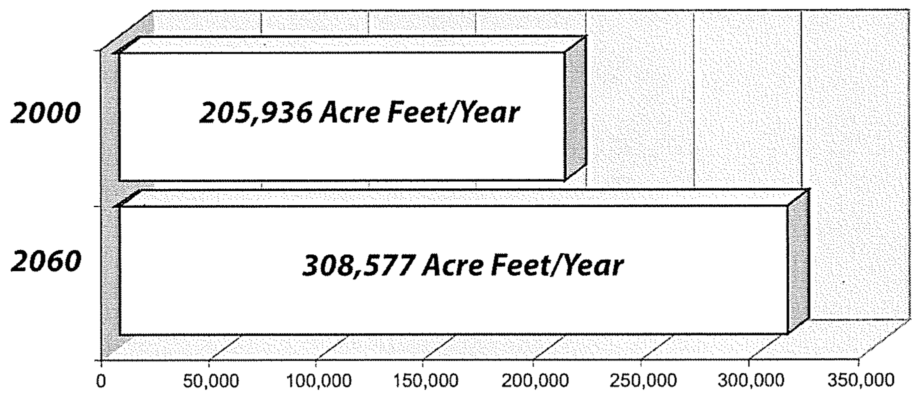
361-825-3193; fax 361-825-3195; or e-mail: **rfreund@nueces-ra.org**

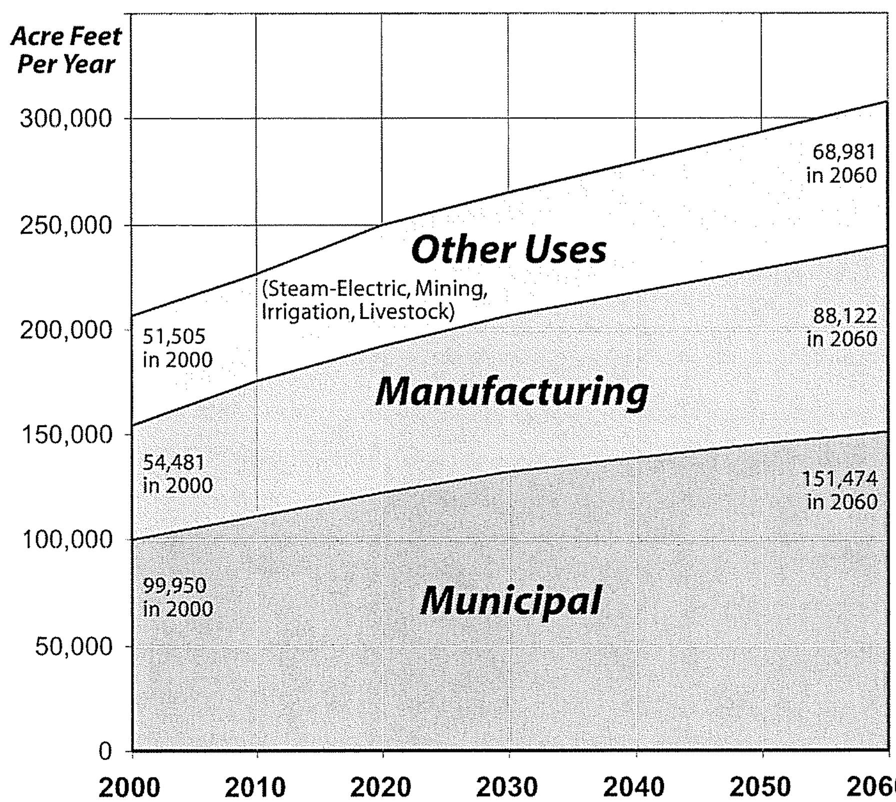
There are a growing number of websites available dealing with water issues, including:

www.twdb.state.tx.us www.texaswater.org
www.tceq.state.tx.us www.cctexas.com

Projected Total Regional Water Demand



Projected Demand By Category



Coastal Bend RWPG Members

The 16 members of the Coastal Bend Regional Water Planning Group were appointed to represent a wide range of stakeholder interests and act as a steering and decisionmaking organization.

South Texas Water Authority Executive Director Carola Serrato and Corpus Christi businessman Jerry Kane co-chair the group.

Members were appointed to represent specific interest categories. They are:

AGRICULTURE

Bobby Nedbalek, Sinton

Ray Burdette, Raymondville

COUNTY

Josephine Miller, San Patricio Economic Development Corp.; past co-chair

ELECTRICAL GENERATING UTILITY

Bill Beck, Barney M Davis, LP

ENVIRONMENT

Teresa Carrillo, Coastal Bend Bays Foundation

INDUSTRY

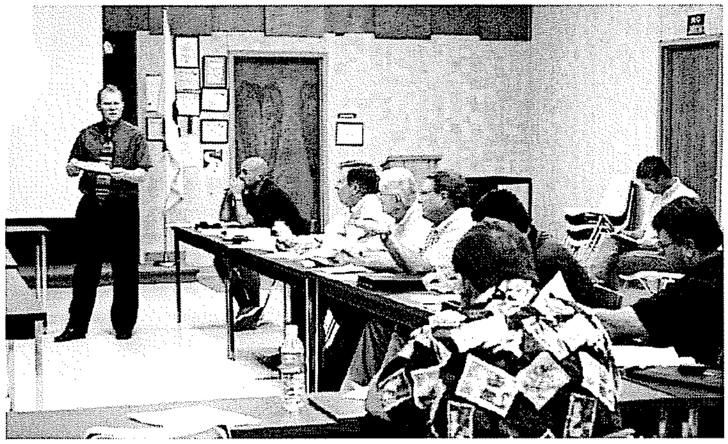
Robert Kunkel, Equistar Chemicals

Jerry Kane, Sam Kane Beef Processors

MUNICIPAL

Mark Scott, Corpus Christi City Council

Billy Dick, Rockport



RWPG members discuss Coastal Bend groundwater resources following a presentation by Ken Choffel of HDR Engineering

NUECES RIVER AUTHORITY

Thomas M. Reding, Jr., Portland

OTHER

Bernard Paulson, Corpus Christi

PUBLIC

Kimberly Stockseth, Corpus Christi

SMALL BUSINESS

Dr. Patrick Hubert, Kingsville, RWPG Secretary

Newell Atkinson, Alice

WATER DISTRICT

Scott Bledsoe, III, Oakville

WATER UTILITIES

Carola Serrato, Kingsville

Non-voting members are Ralph Boeker of the Texas Water Development Board; Vincente Guerra, Freer WCID; George Aguilar, Texas Department of Agriculture; Dr. Jim Tolan, Texas Parks and Wildlife Dept.; Dexter Svetlik, USDA-NRCS; Con Mims, South-Central RWPG liaison; Haskell Simon, Lower Colorado RWPG liaison; and Robert Fulbright, Rio Grande RWPG liaison.

COASTAL BEND

Water Report

The **Coastal Bend Water Report** is published by the Coastal Bend Regional Water Planning Group which is reviewing and revising the current regional plan that is part of Water For Texas 2002, the comprehensive state water plan. A revised statewide plan will be adopted by the Texas Water Development Board in early 2007.

Prepared by The Rodman Company

COASTAL BEND REGIONAL WATER PLANNING GROUP

c/o Nueces River Authority • Coastal Bend Division

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COASTAL BEND

Water Report

Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org

No. 7 • Winter 2005

Planning process entering final stages

The multi-year process of updating the comprehensive regional water plan for the Coastal Bend is moving into the decisive final stages.

When members of the Coastal Bend Regional Water Planning Group (RWPG) gather for their March meeting they will select which water management strategies will be included in the initial draft of the 2006 regional plan scheduled for publication in May.

After the draft plan is complete there will be public meetings and opportunities for public review and comment this summer. Those comments will be considered in the final regional plan which must be adopted by the RWPG before the end of the year.

The Texas Water Development Board will then spend 2006 developing a new statewide comprehensive water plan for presentation to the Texas Legislature in 2007. The State Water Plan will incorporate the regional water plans prepared by 16 regional groups. It will also resolve interregional conflicts, provide additional analysis, and make policy recommendations.

The Legislature has directed that regional and state water plans be updated every five years to respond to changing growth patterns, shifts in water usage and new climate data.

Regional Water Planning Group March Meeting:
Noon
Thursday, March 10
Johnny Calderon County Building
710 E. Main
Robstown

Coming Up Next Time

Plan Summary

We'll give you a look at the components of the new draft regional water plan before public comments are sought and a public hearing is held.

Water supply management strategies being closely examined

The process of developing a revised comprehensive regional water plan is now focused on evaluating the water supply options and management strategies that could be used to meet future water supply needs in the Coastal Bend.

Fifty-year projections of future population growth and increased water demand have been developed for each community in the region. This allows planners to estimate potential shortages that need to be addressed in the 2006 regional water plan.

Coastal Bend communities can be divided into two basic categories: (1) those that are served by the Nueces River/Lake Texana surface water system, and (2) those that rely on groundwater. In most cases water supply strategies are different for surface water and groundwater systems.

MANAGEMENT STRATEGIES

Regional stakeholders – particularly local drinking water providers – have participated in a process of selecting the water supply options and management strategies that deserved in-depth study. Over the past six months members of the Regional Water Planning Group heard draft reports from project consultants on a list of options and strategies. They include:

Water Conservation

Water conservation strategies are divided into four separate user groups – municipal, irrigation, manufacturing and mining.

State rules require that practical conservation strategies be considered first by any community

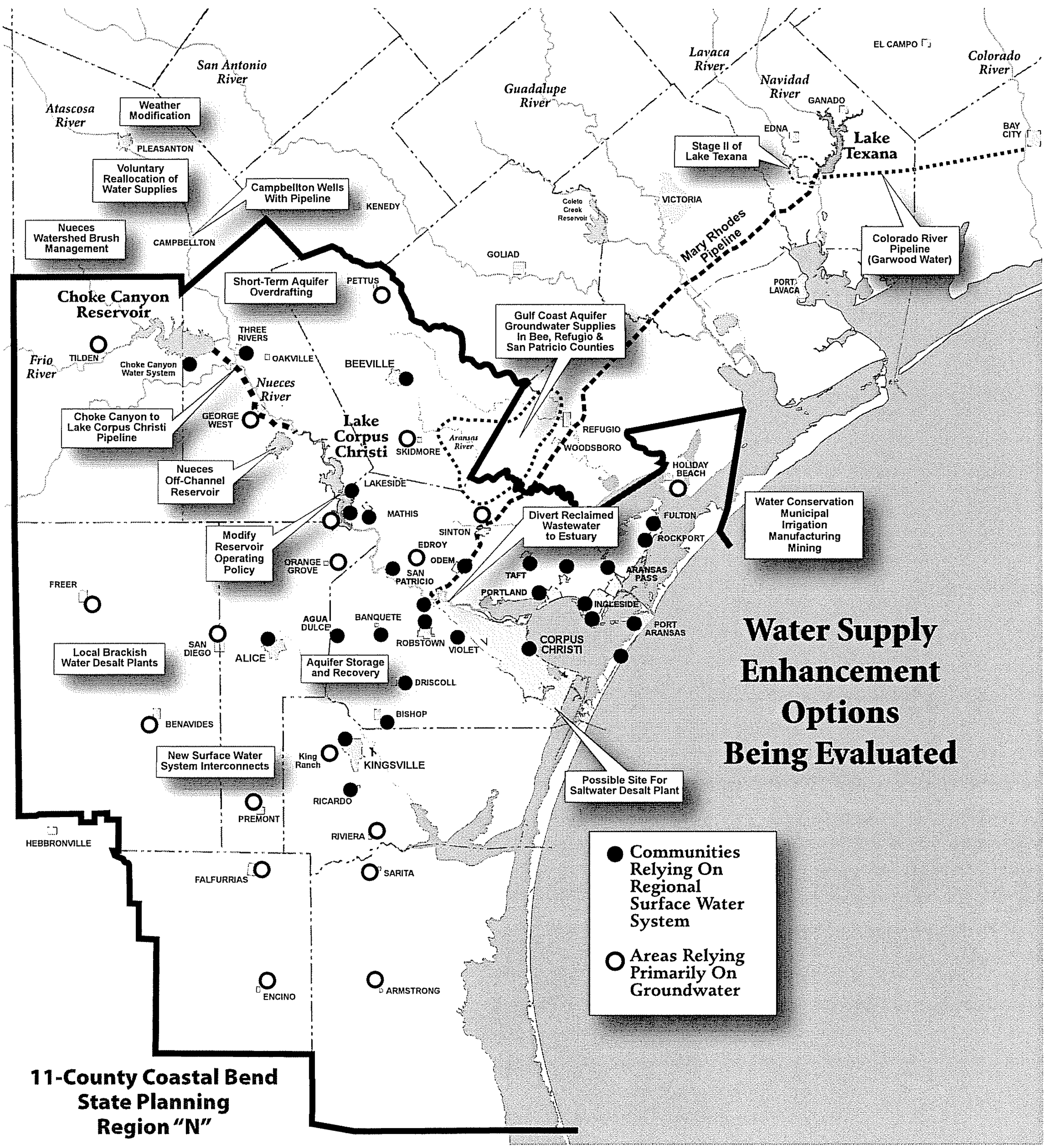
Water Management Strategies Being Considered	New Strategy for 2006 Plan	Minimal Change From 2001	Significant Change From 2001
Municipal Water Conservation		◆	
Irrigation Water Conservation		◆	
Manufacturing Conservation & Water Quality Issues		◆	
Mining Water Conservation (as needed)	◆		
Reclaimed Wastewater Supplies		◆	
Gulf Coast Aquifer Groundwater Supplies			◆
Potential Aquifer Storage and Recovery (ASR)			◆
Modification of Existing Operating Policy			◆
Choke Canyon to Lake Corpus Christi Pipeline			◆
Nueces Off-Channel Reservoir	◆		
Voluntary Redistribution/Reallocation and COE Study	◆		
Stage II of Lake Texana (Palmetto Bend)		◆	
Colorado River Pipeline (Garwood Water)		◆	
Brush Management in Nueces Watershed		◆	
Weather Modification		◆	
Saltwater Desalination		◆	
Potential Water System Interconnects		◆	
Carrizo-Wilcox Aquifer Groundwater		◆	

facing water shortages. In 2000 the Coastal Bend region used an average of 155 gallons per capita per day (gpcd). It is estimated that the regional average will be reduced to about 140 gpcd by the year 2060.

Municipal water conservation would be achieved through programs such as plumbing fixture retrofits, incentive campaigns and conservation landscaping. Rainwater harvesting as a conservation strategy will be addressed in the new water plan.

Irrigation water conservation reduces the quantity of water lost to deep percolation, evaporation and evapotranspiration by installing high efficiency irrigation systems. While there are not a large number of irrigators in the Coastal Bend, some of them have already implemented water conservation measures.

Manufacturing conservation has already been aggressively implemented in the Coastal Bend. Much of this water is used for cooling purposes. This usage could be reduced by providing refineries and chemical processors water with lower mineral content. High levels of



Summary of Coastal Bend Region's Water Management Strategies

dissolved minerals in Nueces River water limit the number of times the water can be reused in cooling. Chlorides in the river near Calallen are the result of groundwater seepage and possibly periodic discharges from upstream users. Several control strategies have been considered to improve water quality including modification of intakes and building a pipeline from Lake Corpus Christi to the O.N. Stevens water plant at Calallen.

Mining water conservation will be a new strategy in the regional plan. New state rules require that any entity or user group with a projected shortage in the 60-year planning period must consider conservation strategies.

Reclamation of Wastewater

Wastewater is collected, treated and then re-used for non-potable purposes such as industrial uses, golf course irrigation, or discharged to receiving waters. A significant portion of treated effluent is discharged into streams that flow into the bays to meet freshwater needs of the Nueces Estuary. Three potential reuse strategies considered include: (1) wastewater reuse for municipal/industrial non-potable purposes; (2) wastewater diversions to the Nueces Delta; and (3) effects of wastewater reuse and water conservation on estuarine inflows.

Colorado River Pipeline (Garwood Water)

In 1998 the City of Corpus Christi completed purchase of water rights from Garwood Irrigation Company authorizing up to 35,000 acre feet per year diversion from the Colorado River. For the Coastal Bend to use this water it will be necessary to build a large 41-mile pipeline from near Bay City to a connection with the Mary Rhodes Pipeline near Lake Texana. Operational efficiency could be enhanced by building an off channel storage facility near Bay City.

Gulf Coast Aquifer Well Fields

Since the 2001 Water Plan was adopted, owners of substantial land holdings in San Patricio, Bee and Refugio counties have expressed interest in selling Gulf Coast Aquifer groundwater from under their property. The San Patricio Municipal Water District has been investigating these supplies and is seeking 11,000 acre feet of water per year to meet future needs. The City of Corpus Christi has expressed an interest in also developing additional groundwater that may be available from the same area to supplement supplies for the rest of the regional supply system. Some of this water could readily be delivered to the regional system via the Mary Rhodes Texana Pipeline which was upsized at construction so that it could carry additional water in the future. Planning is underway to evaluate the quality and sustainable quantity of water that may be available from these sources.

Groundwater from the Carrizo-Wilcox and Gulf Coast Aquifer is also considered as a supply source for small municipal and rural water systems. Well field expansions are presented for small municipalities in Duval County. Desalination plants to treat brackish groundwater are considered for George West, Orange Grove, Benavides and Freer.

Voluntary Reallocation of Water Supplies and Corps of Engineers Study

This option considers reallocation of surface water by selling existing unused water rights and/or trading/transfer of surface water with Region L (San Antonio area) including Corps of Engineers Nueces River Basin Feasibility projects. Under-utilized surface water supplies exist for the City of Three Rivers, irrigation water rights in the Nueces Basin, and Nueces County WCID #3, and could potentially be available to meet other regional needs. Interbasin trades/transfers considered include trading water from Choke Canyon Reservoir to Region L in exchange for a desalination facility near Corpus Christi.

The Corps of Engineers is currently studying six projects as part of the Nueces River Basin Feasibility Study to evaluate opportunities for ecosystem restoration and flood damage reduction. One or more of these projects may eventually be used to mitigate effects of recharge enhancement projects constructed on the upper reaches of the Nueces River Basin to supply water to Region L.

Modify Reservoir Operating Policy

The Nueces River is the primary source of water for customers of the Coastal Bend surface water supply system. A four-phased operating plan for the Choke Canyon/Lake Corpus Christi (CCR/LCC) storage system was established to provide a dependable water supply while maintaining inflows to downstream bays and estuaries. The operating plan includes Choke Canyon releases to meet instream flow requirements, potential efforts to minimize drawdown of Lake Corpus Christi, release protocols based on user demands, and freshwater pass-through requirements for the Nueces Estuary.

Records show that the Nueces River watershed produces less flow with each new drought – down 36% since the 1950s. This water supply strategy considers updating the reservoir operating policy to potentially include a small reserve volume of storage in Lake Corpus Christi (safe yield) to ensure water supplies are adequate in the event of a drought worse than previous droughts.

Choke Canyon to Lake Corpus Christi Pipeline

Channel losses between Choke Canyon Reservoir and Lake Corpus Christi can exceed 30%. This loss could be reduced if a pipeline delivered water from Choke Canyon Reservoir to Lake Corpus Christi, bypassing stream channels. The 2001 Water Plan evaluated a two-way pipeline between the lakes. Further study suggests that a shorter one-way pipeline would cost less and could provide 39,000 acre feet of low cost additional annual yield.

Off-Channel Reservoir

It may be possible to significantly increase the yield from the Choke Canyon/Lake Corpus Christi system by developing an off-channel storage reservoir south of George West in Live Oak County. Water would be pumped from Lake Corpus Christi into the off-channel storage reservoir during high flow conditions. Then the water would flow back into the lake during dry seasons. It would be operated so that freshwater pass-throughs for the Nueces Estuary would not significantly be affected. The system could also reduce flood events downstream from Wesley Seale Dam.

Elimination of Lake Dredging

The 2001 Water Plan includes a proposal to dredge sediment from Lake Corpus Christi in order to increase system yield. The RWPG is considering removing this strategy from the 2006 plan because of high cost and new sedimentation data which indicates the actual sedimentation rate is about 37% of previous estimates.

Potential Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) was considered as a dual-purpose operation to inject water into the aquifer for storage during times when water is available and for removal (recovery) at a later date during times of shortage or need. For the 2006 Plan, a multi-year ASR system was evaluated that stores water in the Gulf Coast Aquifer after treatment at O.N. Stevens. The water would come from several sources: (1) diversion from CCR/LCC when reservoirs are full or nearly full; (2) additional water available from reduction in channel losses by operating a proposed CCR/LCC pipeline; and (3) additional water available from a proposed Nueces River off-channel storage.

Lake Texana – Stage II

The Lavaca-Navidad River Authority has water rights to develop a second reservoir near Lake Texana referred to as Palmetto Bend Stage II Dam and Reservoir. If this option is developed it could provide an additional water supply of up to 23,000 acre feet per year to Coastal Bend customers via the Mary Rhodes Pipeline.

Desalination

Desalination is a potential source of fresh-water supplies for municipal and industrial uses. One option considered a 28,000 acre-foot per year desalination facility co-sited with Barney M. Davis Power Station in Corpus Christi. This option could potentially be funded, in part, by state and/or federal funds depending on future legislative appropriations. Also evaluated was a combination of brackish groundwater and sea-water to produce various volumes of desalinated water. Both seawater and combined seawater and brackish groundwater desalination options required extensive coordination with regulatory agencies and high costs to implement. Use of brackish water has the benefits of needing little or no pretreatment and lower concentrations of salinity in reject water than seawater.

Other Options

Brush management in the Nueces River watershed could result in decreasing evapotranspiration and increased quantities of recharge to aquifers and run-off to streams which may translate to greater water supplies for other uses. To make a significant impact upon increasing yield of recharge to the Carrizo- Wilcox, Gulf Coast Aquifers and/or CCR/LCC System, brush control or removal would have to be practiced over a considerable area.

Weather modification involves cloud seeding with silver iodide (AgI) to enhance rainfall above what would have naturally occurred. This strategy could potentially improve stream and estuary conditions by increasing freshwater flows and/or improve crop production. While cloud seeding appears to be beneficial, it remains a somewhat uncertain source of dependable water.

Water system interconnections were considered as a potential source of freshwater supplies for municipal and industrial uses to provide backup water supplies for emergencies. The Coastal Bend Area has listed 24 municipal water systems that have converted at least a part of their groundwater supply to the regional surface water system. This option included interconnections to serve community water systems in Duval, Brooks and Jim Wells Counties. Additionally, Kleberg and Kenedy Counties could receive water service through a connection to the South Texas Water Authority's (STWA) surface water system in Kingsville. And lastly, the City of Sinton and community of Edroy could connect to the San Patricio Municipal Water District's treated surface water system.

Campbellton Wells - This option involves pumping water from the Campbellton well field (in Atascosa County) and delivering it to the CCR/LCC system. The City of Corpus Christi is reconsidering the usefulness of this strategy because the wells produce hot water which must be cooled prior to use.

How to get information; websites you can visit

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Prepared by: The Rodman Company

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Corpus Christi, Texas 78412-5865

COASTAL BEND

Water Report

Coastal Bend Regional Water Planning Group
Website: www.nueces-ra.org

No. 8 • Summer 2005

Public comments sought on updated Coastal Bend Regional Water Plan

The Coastal Bend Regional Water Planning Group (CBRWPG) will hold a public hearing to receive oral and written comments from the public on the comprehensive Coastal Bend Draft 2006 Regional Water Plan.

The hearing will be at 1:30 p.m., Thursday, July 14th, in the auditorium at the Johnny Calderon County Building, 710 E. Main, in Robstown. Written comments can be submitted to the CBRWPG until Sept. 12th. They should be addressed to:

CBRWPG c/o Nueces River Authority
6300 Ocean Dr., Unit 5865
Corpus Christi, Tx 78412-5865

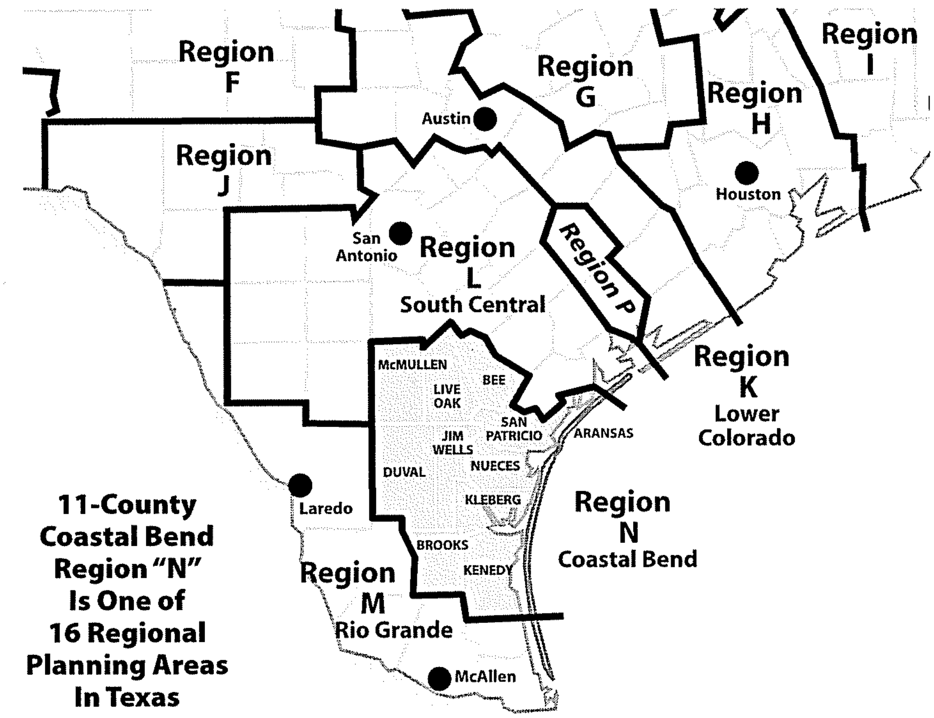
All public comments will then be considered in revising the draft plan. The CBRWPG must adopt the final plan for submission to the Texas Water Development Board (TWDB) before the end of the year.

The regional planning process was established by Senate Bill 1 (SB 1) enacted by the Legislature in 1997. It resulted in the creation of a "bottom up" water planning process with 16 regional water planning groups (RWPG) and the TWDB serving as the overall statewide planning coordinator.

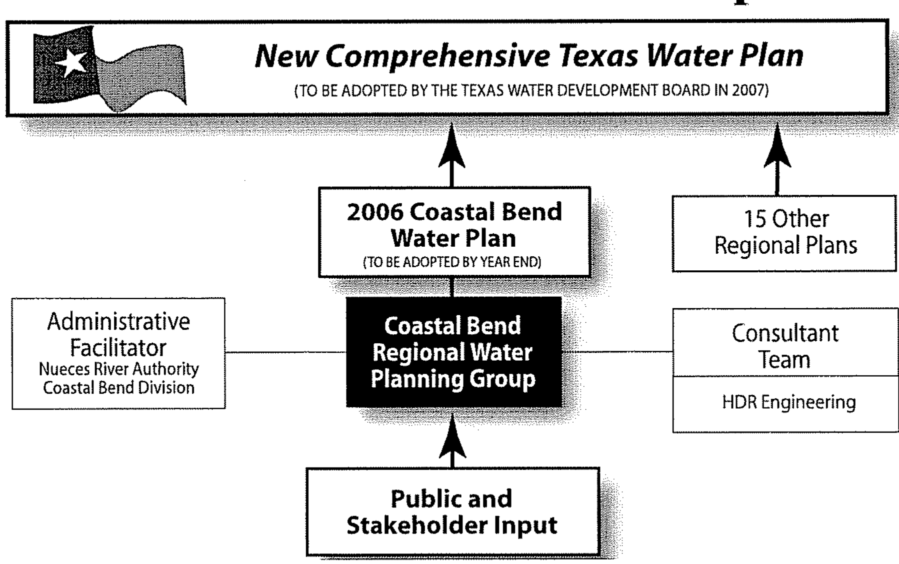
Each RWPG is responsible for preparing and adopting a regional water plan for their area. The current regional plans were adopted in 2001. The planning groups are required to update their plan every five years to reflect the latest trends in population growth and water demand. The current 5-year planning cycle has been underway since 2003. The public is now being encouraged to review and comment on the draft 2005 update of the Coastal Bend Regional Water Plan.

The planning horizon used in the Plan is the 60-year period from 2000 to 2060. This period allows for long-term forecasts of the prospective water situation, sufficiently in advance of needs, to allow for appropriate water management strategies to be implemented.

Future state financial assistance may only be provided if water supply projects are consistent with the latest approved regional water plan.



How Texas Water Plan Is Developed



Water Supply Options Matched to Future Demand

The Coastal Bend Regional Water Plan has been developed through a methodical process and covers an 11-county planning area stretching from Beeville on the north to Falfurrias on the south and from the islands west to Freer.

Water Supply

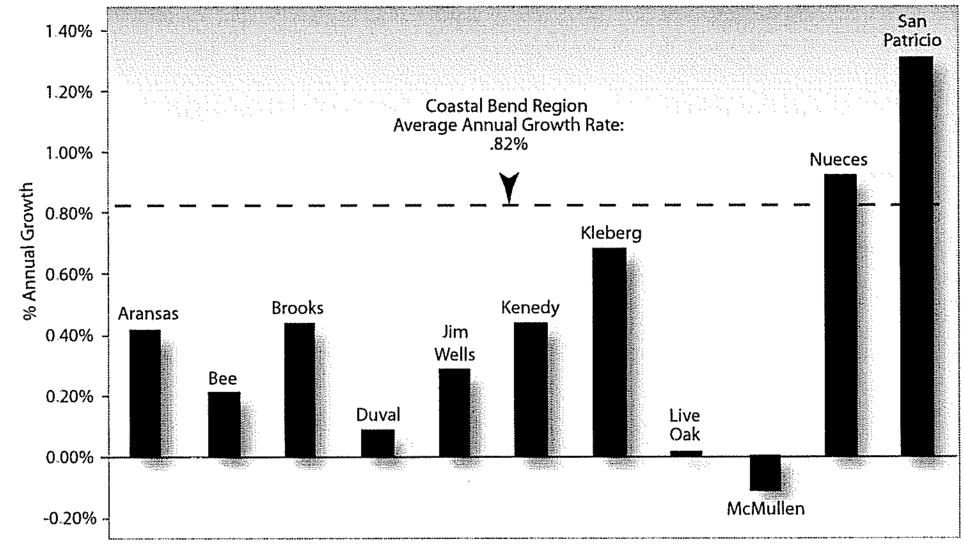
Most customers in the area get their water from the surface water system that includes Lake Corpus Christi, Choke Canyon Reservoir and Lake Texana via the Mary Rhodes Pipeline. Other communities and rural residents rely on groundwater supplies. Some 85% of the region's water demand is created by municipal and industrial users.

The Regional Water Planning Group has adopted a standard called "safe yield" to indicate how much water is available from the three-reservoir surface water system in times of severe drought. The system is projected to have a safe annual yield of 205,000 acft/yr in 2010. Safe yield is a formula which would leave 75,000 acft in storage during the critical month of the drought of record. System yield declines somewhat with each passing year because sediment coming into the lakes reduces storage capacity.

A significant planning consideration for the region is the fact that chloride levels in the Nueces River near Calallen are 2.5 times the level in water when it is released upstream at Lake Corpus Christi. This lower water quality results in increased industrial cooling water use due to accelerated buildup of minerals in industrial cooling facilities. Improvements in water quality will result in reduced levels of water consumption, provide additional water conservation for the region, and reduce chloride and bromide levels in drinking water.

Schedule for Adopting Revised Water Plan

2003	Final population and water demand projections developed
2004	Evaluation of water supply and conservation strategies
2005	May - Publication of Draft Plan for public comment June - Public Hearing Sept 12 - End Comment Period December - Plan Adoption
2006	TWDB incorporates regional plans and legislative recommendations into new comprehensive state water plan
2007	TWDB delivers 2007 State Water Plan to Texas Legislature completing 5-year planning cycle



Projected Percent Annual Population Growth Rate Through 2060

One Acre Foot = 325,851 gallons

Current demand from the surface water system is approximately 165,000 acft/yr. Current overall demand in the Coastal Bend from all water sources is approximately 215,000 acft/yr.

There are four aquifers in the region with the Gulf Coast Aquifer being the primary groundwater resource. 2060 availability of water from these aquifers is estimated at 102,600 acft/yr with projected 2060 water use of 54,600 acft/yr. The highest groundwater use in the region is in Duval, Live Oak and Kleberg Counties.

Population Growth

In 2002, the TWDB published new population and water demand projections for each Texas county. The state anticipates moderate growth in the Coastal Bend over the next 60 years. The state projects an increase in the 11-county area from 541,184 in the 2000 Census to 885,665 people in 2060, an increase of 64%. That is an annual compounded rate of 0.82%, a rate that is somewhat slower than the state as a whole which is expected to more than double population in the same period.

San Patricio and Nueces Counties have growth rates higher than the regional average and this is expected to continue in the coming decades. San Patricio County had a 2000 population of 67,138 and is expected to grow to 109,518 (63%) by 2030. Nueces County is projected to grow from 313,645 in 2000 to 447,014 (43%) in 2030.

The regional plan anticipates that new plumbing fixtures and other water conservation efforts will save more water in the future. Municipal water demand is projected to increase only 52% at the same time population increases 64% over 60 years. This assumes that daily per capita water use will go down from the current 155 to 142 gallons by 2060.

Water Demand

Water demand projections were compiled for six categories of water use: (1) Municipal, (2) Manufacturing, (3) Steam-Electric Cooling, (4) Mining, (5) Irrigation, and (6) Livestock.

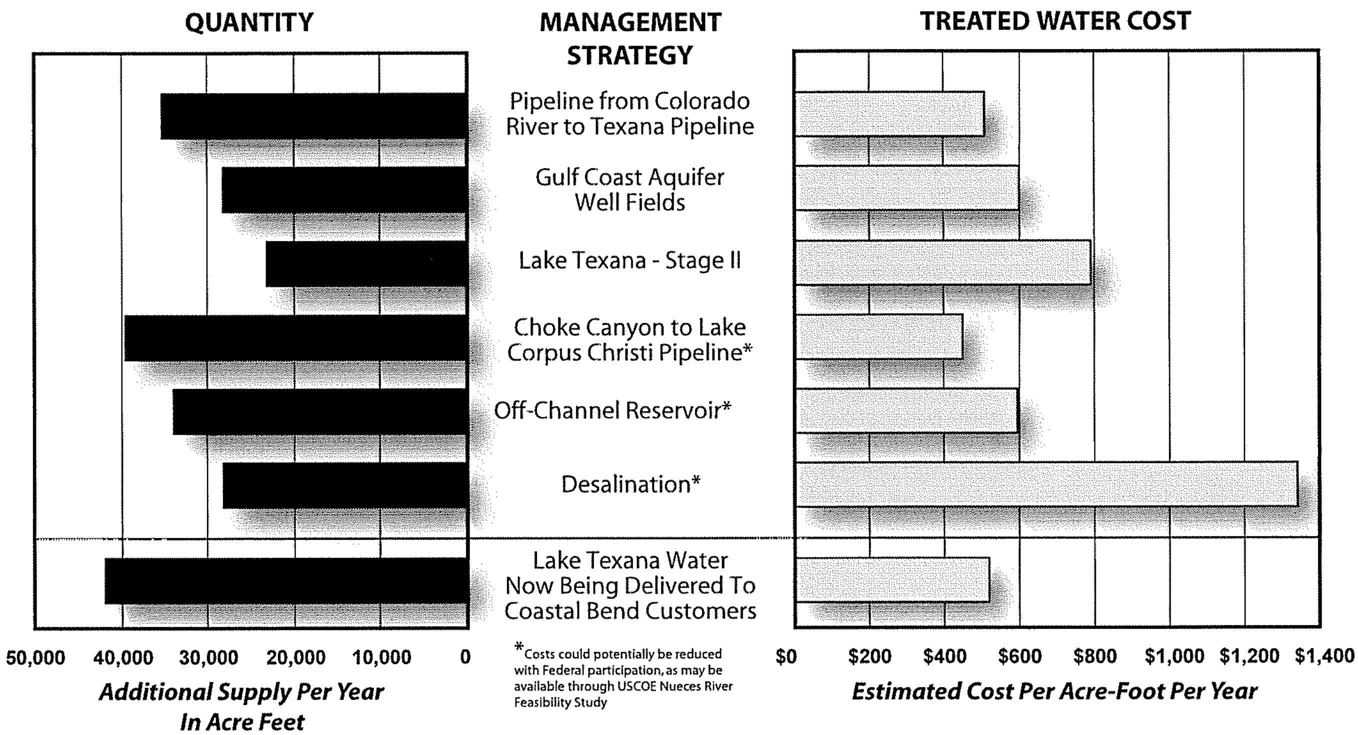
The Regional Plan anticipates that after several decades the region will have a 50% increase in water demand and substantial water needs that cannot be met with supplies that are currently developed and being used. All use categories will increase except irrigation and livestock.

By the year 2060 the demand for water will exceed water supplies currently available by approximately 45,200 acre feet per year in the Corpus Christi Service Area which is made up of communities that get their water from the City of Corpus Christi, San Patricio Municipal Water District or South Texas Water Authority. This area includes 90% of the municipal and industrial water customers in the region.

Water Supply Strategies

Numerous water management strategies were identified by regional stakeholders as potentially feasible to meet anticipated future water supply shortages. Each of 18 strategies was evaluated and compared to criteria adopted by the

Initial Estimates of Additional Water Yield & Cost



CBRWPG. The quantity of potential annual yield and the estimated unit cost of making the water available were compared. A detailed analysis of each strategy appears in the draft plan.

The Plan includes specific water management strategies that were identified as likely candidates for each community where a shortage was indicated. Right-size strategies are identified for small communities including such things as new well fields or system interconnects. Large scale projects are needed to meet the long-term needs of Nueces, San Patricio, Aransas and Kleberg Counties. These are compared in the chart above and include:

Colorado River Pipeline

The Corpus Christi regional system owns a right to divert 35,000 acre feet per year from the Colorado River. To use this water a 41-mile pipeline must be built from Bay City to connect with the Mary Rhodes Pipeline.

Gulf Coast Aquifer Well Fields

The San Patricio Municipal Water District and the City of Corpus Christi have been exploring possible development of groundwater resources in Bee, Refugio and San Patricio Counties along the route of the Mary Rhodes Pipeline which could be used to deliver the water to the regional system.

Lake Texana Stage II

The Lavaca-Navidad River Authority has rights to develop a second reservoir near Lake Texana. It could provide up to 23,000 acft/yr to Coastal Bend customers via the Mary Rhodes Pipeline.

Choke Canyon to Lake CC Pipeline

Channel losses between the lakes exceed 30% and can be reduced with a bypass pipeline that could provide 39,000 acre feet of low cost additional annual yield.

Off-Channel Reservoir

Developing an off-channel storage reservoir south of George West could increase system yield. Water would be pumped from Lake Corpus Christi into the reservoir during high flow conditions then would flow back to the lake during dry seasons.

Desalination

Desalination remains the most expensive strategy available for producing large amounts of new water supply. One option considered a 28,000 acft/yr facility at the Barney M. Davis LP power station in Flour Bluff. Also evaluated was a combination of brackish groundwater and seawater to produce various volumes of desalinated water.

Other Strategies

Water conservation strategies are among the most cost effective available and are divided into four groups - municipal, irrigation, manufacturing and mining. Practical conservation measures should be considered first by any community facing water shortages.

Both reuse and diversion of treated wastewater to the Nueces Delta present opportunities to increase the region's water supply This is because the state has established operational procedures for the region's reservoirs that include scheduled minimum inflows to the estuary. Increasing wastewater diversions to the delta could justify an inflow credit and may allow recovery of additional CCR/LCC system yield.

Other strategies evaluated in the Plan include modifications at Calallen to improve water quality and potential system interconnections to areas not yet served by the regional surface water system.

Coastal Bend RWPG Members

The 19 members of the Coastal Bend Regional Water Planning Group were appointed to represent a wide range of stakeholder interests and act as a steering and decision-making body.

Members were appointed to represent specific interest categories:

Agriculture: Ray Burdette, Bobby Nedbalek
Counties: Josephine Miller
Electric Generating Utilities: Bill Beck; Greg Carter (resigned)
Environmental: Teresa Carrillo
Industry: Robert Kunkel; Tom Ballou; Jerry Kane (resigned)
Municipalities: Billy Dick; Mark Scott
Other: Bernard Paulson
Public: Kimberly Stockseth
River Authorities: Thomas M. Reding Jr.
Small Business: Patrick Hubert; Pearson Knolle
Water Districts: Scott Bledsoe II
Water Utilities: Carola Serrato

Ms. Serrato and Mr. Bledsoe are co-chairs.

Where You Can See A Copy of the Draft Water Plan

Copies of the Coastal Bend Draft 2006 Regional Water Plan are available for viewing at 21 locations in the region or online.

You can also view or download all or part of the document on the web at:

www.nueces-ra.org/CP/RWPG/ipp.html

or at:

www.wdb.tx.us/rwpg/main-docs

Locations where the document can be viewed are:

Aransas County Clerk's Office
301 North Live Oak - Rockport
Aransas County Public Library
701 E. Mimosa Street - Rockport
Bee County Clerk's Office
105 West Corpus Christi St. - Beeville
Joe Barnhart Bee County Library
210 E. Corpus Christi Street - Beeville
Brooks County Clerk's Office
100 East Miller Street - Falfurrias
Brooks County Library
203 S. Henry Street - Falfurrias
Duval County Clerk's Office
400 East Gravis - San Diego, TX 78384
San Diego Public Library
315 E. Dunlap St. - San Diego
Jim Wells County Clerk's Office
200 North Almond - Alice
Alice Public Library
401 E. 3rd Street - Alice
Kenedy County Clerk's Office
101 Mallory Street - Sarita
Kleberg County Clerk's Office
700 East Kleberg Street - Kingsville
Kingsville Library
220 N. 4th Street - Kingsville
Live Oak County Clerk's Office
301 Houston Street - George West
Live Oak County Library
402 Houston Street - George West
McMullen County Clerk's Office
River & Elm Street - Tilden
Nueces County Clerk's Office
901 Leopard St. - Corpus Christi
Corpus Christi Public Library
805 Comanche St. - Corpus Christi
Nueces River Authority
6300 Ocean Dr. - Corpus Christi
San Patricio County Clerk's Office
400 West Sinton Street - Sinton
Sinton Public Library - 100 N. Pirate - Sinton

How to get information; websites you can visit

Administrative support for the Coastal Bend RWPG is being provided by the Nueces River Authority's Coastal Bend Division which offices on the campus of Texas A&M University-Corpus Christi. For more information about this program contact Rocky Freund, NRA division director at:
361-825-3193; fax 361-825-3195; or
e-mail: rfreund@nueces-ra.org

There are a growing number of websites available dealing with water issues, including:

www.twdb.state.tx.us
www.texaswater.org
www.tceq.state.tx.us
www.cctexas.com

Notice of Public Hearing on Draft Region "N" Water Plan

1:30 p.m. • Thursday • July 14, 2005

Johnny Calderon County Building • 710 E. Main in Robstown

COASTAL BEND
Water Report

The Coastal Bend Water Report is published by the Coastal Bend Regional Water Planning Group which is reviewing and revising the current regional plan that is part of Water For Texas 2002, the comprehensive state water plan. A revised statewide plan will be adopted by the Texas Water Development Board in early 2007.

Prepared by The Rodman Company

COASTAL BEND REGIONAL WATER PLANNING GROUP
c/o Nueces River Authority • Coastal Bend Division
6300 Ocean Drive, Unit 5865
Corpus Christi, Texas 78412-5865

Appendix I

Lower Nueces River Dissolved Minerals Study and Surface Water – Groundwater Interactions Study

Appendix I.1

Lower Nueces River Dissolved Minerals Study

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Lower Nueces River Dissolved Minerals Study

Background

Previous studies by the U.S. Geological Survey (USGS) and others have indicated a significant increase in the concentration of dissolved minerals in the Lower Nueces River between Mathis and the Calallen Saltwater Barrier Dam. A graphical summary of the findings of these studies is shown in Figure 1.

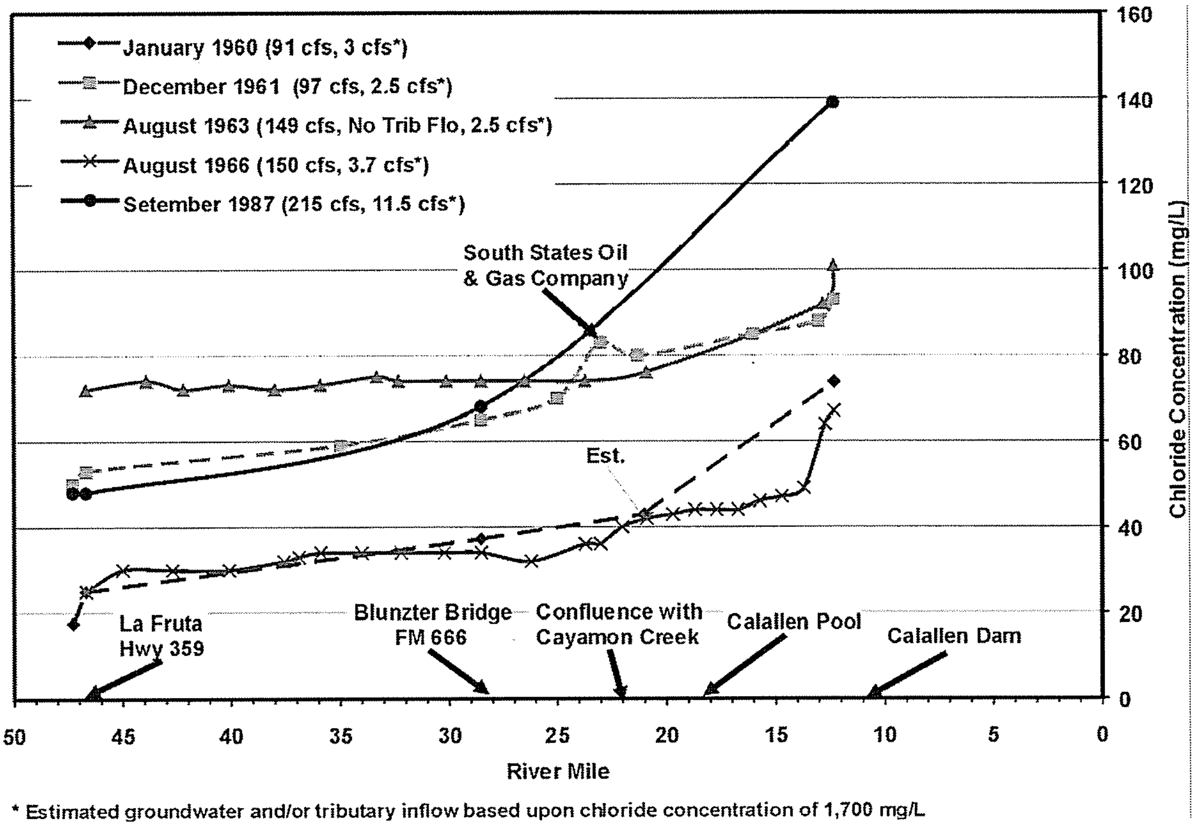


Figure 1. Summary of Historical Data — Chloride Content of the Lower Nueces River, Segment 2102

Figure 1 shows that chloride concentrations at the Calallen Pool on the average are 2.5 times the level of chlorides in water released from Lake Corpus Christi. Figure 1 also shows the change in chloride concentrations occurring between Lake Corpus Christi (Hwy 359 site) and the Calallen Dam for five previous studies. The results of these studies indicate that on the average about 60 percent of the increase in chlorides occurs upstream of the Calallen Pool and about 40 percent of the increase within the pool. Despite similar conclusions from the various previous studies, the source(s) of this increase in mineral concentrations has not previously been conclusively established. Potential sources of minerals to the Calallen Pool include saltwater intrusion, groundwater seepage, and upstream sources of contamination from abandoned wells in adjacent oil fields and gravel washing operations. During the course of this study, a Nueces River sampling program was implemented to confirm the increase in mineral concentrations and to determine the source of dissolved minerals within the Calallen Pool.

A summary of monitoring data collected by the City of Corpus Christi during the 1993 through 1999 timeframe is shown in Figure 2. This figure demonstrates the range of chloride concentrations within the Nueces River from the Fruta Bridge near Lake Corpus Christi to Hazel Bazemore Park. The maximum, mean and minimum values at nine sites are plotted against river mile. This stretch of river is over 33 river miles long. The data shows that the median increase in chlorides from Lake Corpus Christi to Hazel Bazemore Park is from 75 mg/L to about 140 mg/L -- a 90 percent increase. The highest variation in the chloride concentrations above Hazel Bazemore Park were observed to occur near river mile 22, which suggests that periodic discharges may influence readings at this site.

Project Description

The purpose of this study is to confirm the increase in mineral concentrations and to determine the source of dissolved minerals to the Nueces River between Lake Corpus Christi and the Calallen Dam. The sampling data was used to determine spatial and temporal trends in the distribution of dissolved minerals within the Calallen pool. To better understand the system, the river segment was evaluated using a geochemical approach to discern the unique chemical "fingerprint" for the inflows and outflows of the river segment to determine the source of the dissolved minerals. The inherent error in flow measurements may result in significant inflows to go undetected. This approach is useful because the analysis is independent of flow. This sampling plan was designed to collect the appropriate types and amount of information for conducting these analyses.

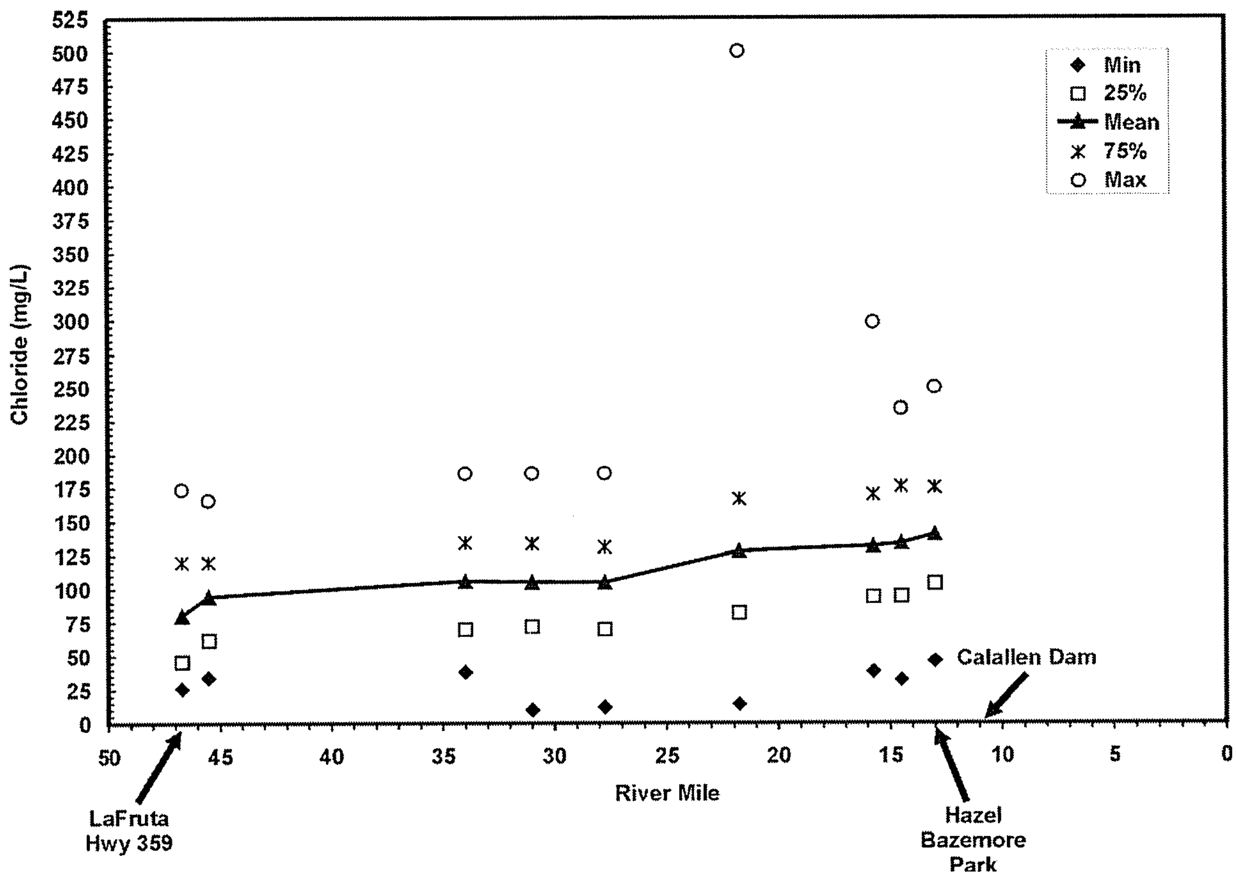


Figure 2. Nueces River Chloride Concentration from La Fruta Bridge to Hazel Bazemore Park (1993-1999)

Sampling trips were conducted once a month through the calendar year from August 1999 to June 2000. Various water quality parameters including pH, temperature, dissolved oxygen, specific conductance, and salinity were measured using a multimeter probe, in addition to measuring chloride concentrations with an ion specific probe. Water samples were also collected and sent to a laboratory for analysis of calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, alkalinity (as calcium carbonate) and total hardness (as calcium carbonate). Surface water monitoring activities and sample collection were conducted at sites from an outboard motor boat that was navigated though the river channel. Groundwater samples were also taken at various locations along the channel by hand augering sample wells and analyzed for the same suite of constituents as the surface water samples.

Preliminary Field Investigation

On August 5, 1999, a preliminary series of samples were collected at various locations and depths along segment 2102 of the Nueces River in order to establish sampling sites for this study and to evaluate the extent of the saltwater intrusion. The following parameters were measured at each location using a Hydrolab Series 4-Data Sonde 4 portable multimeter probe:

- Specific Conductance (mS/cm)
- Total Dissolved Solids (mg/L)
- Dissolved Oxygen (mg/L)
- pH
- Temperature (^{o}C)
- Salinity (ppt)

Grab samples were also taken at four locations along the river segment (river miles 11, 12, 14.5 and 22.3) and analyzed for calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, alkalinity (as calcium carbonate), and hardness (as calcium carbonate).

The results from this preliminary monitoring effort in the Calallen Pool of the Nueces River are summarized in Figures 3 and 4. The results indicate mineral concentrations increase with distance downstream toward the dam, especially just downstream of the Stevens Intake and at the San Patricio Intake. The results show stratification, with large mineral concentrations occurring in the bottom 1 to 2 feet. The dissolved oxygen levels (Figure 4) decrease sharply at the sites where the TDS increases significantly. This drop in DO may indicate that the source of the dissolved solids is from seepage of saline groundwater with very low dissolved oxygen levels into the channel lake, or that mixing and the resultant redistribution of dissolved oxygen is hindered by the more dense (heavier) saltwater settling in a depression on the bottom of the channel.

Table 1 reports the lab analysis results for the four grab samples taken. The significant results from this analysis are the concentration increases in chloride, sodium, total dissolved solids, and bromide between the confluence with Cayamon Creek to the Calallen Dam of 68 percent, 183 percent, 136 percent, and >200 percent, respectively. The lab and field results are consistent.

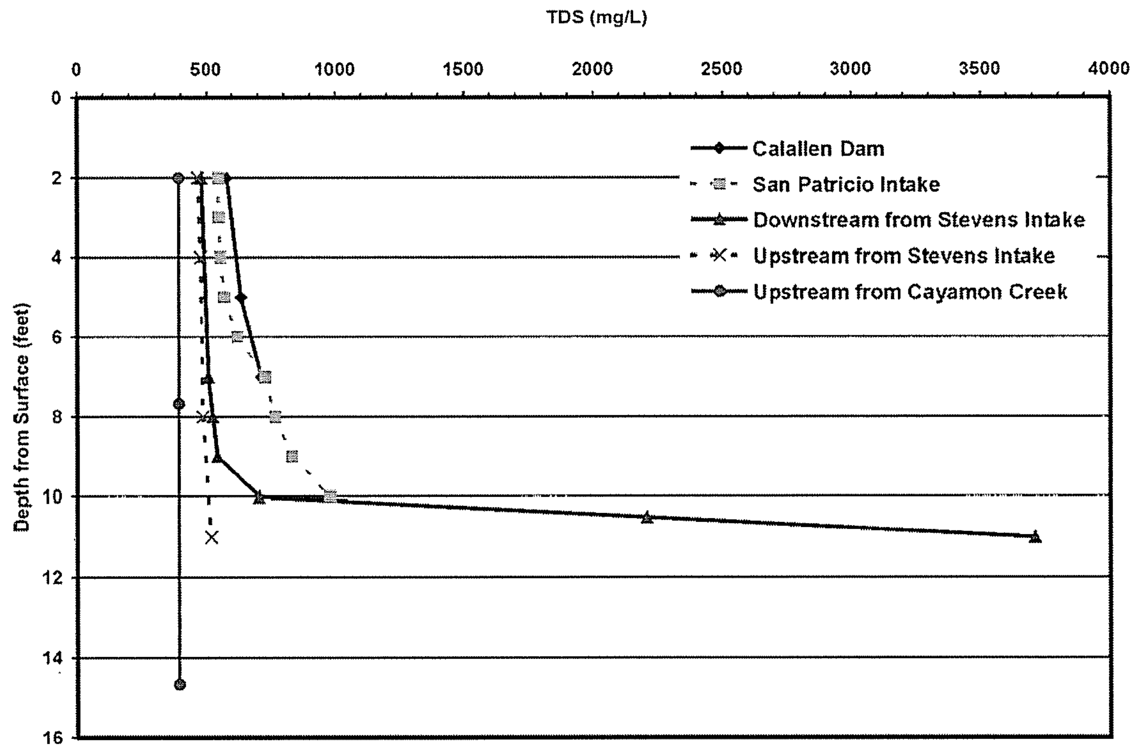


Figure 3. Total Dissolved Solids Profile at Selected Sites of the Nueces River (August 5, 1999)

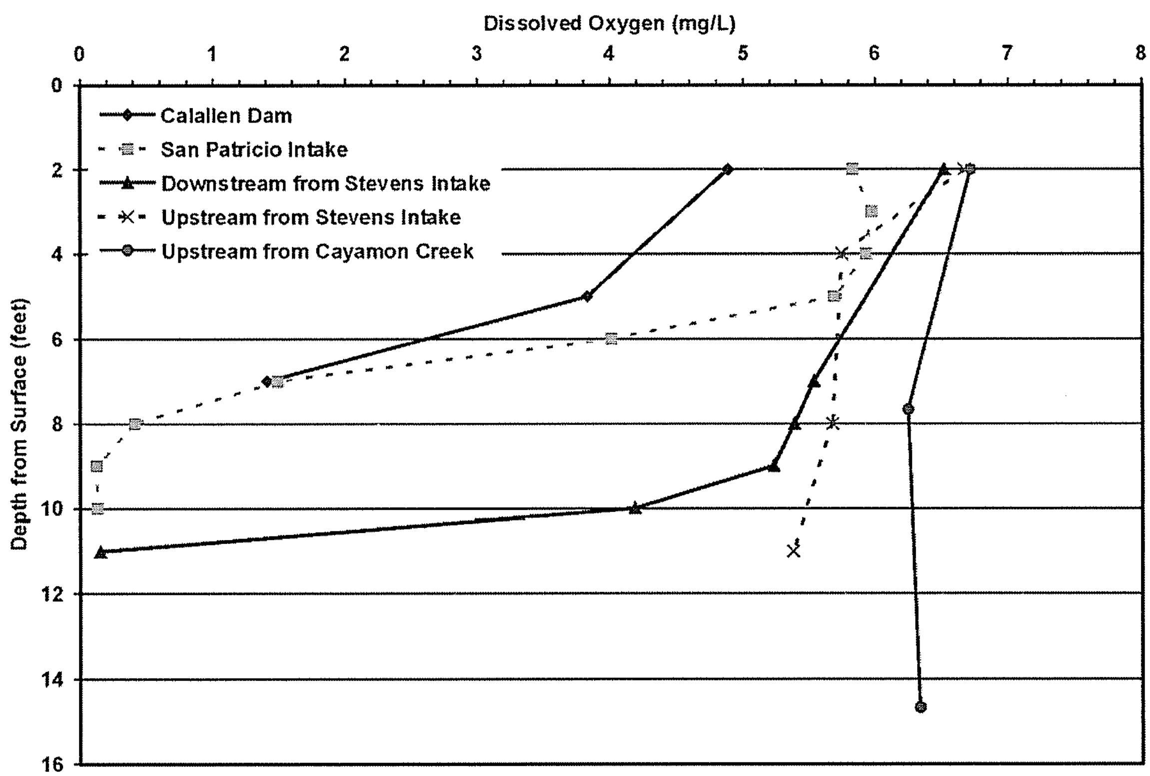


Figure 4. Dissolved Oxygen Profile at Selected Sites of the Nueces River (August 5, 1999)

Table 1.
Surface Grab Sample Analysis:
Concentration of Various Constituents

Constituent	Sample Mile			
	22.3	**14.5**	**12**	**11**
Calcium (mg/L)	66	68	75	75
Magnesium (mg/L)	11	12	13	13
Sodium (mg/L)	50	59	73	84
Potassium (mg/L)	8.8	8.9	9.1	9.6
Sulfate (mg/L)	43	46	52	64
Chloride (mg/L)	76	95	116	139
TDS (mg/L)	382	423	473	518
Alkalinity as $CaCO_3$ (mg/L)	173	177	177	178
Hardness as $CaCO_3$ (mg/L)	210	219	241	241
Bromide (mg/L)	<0.1	<0.1	0.2	0.3
pH (mg/L)	8.39	8.31	8.39	8.38

Surface Water Sampling

Based upon the historical studies and the findings of the preliminary field investigation in August 1999, the Calallen Channel Lake segment of the Nueces River is significantly impacted by sources of dissolved minerals. Therefore, the sampling effort was designed to concentrate on sites within the channel lake. The sample sites are described and identified by river mile in Table 2. The river mileage convention used for this study assumes a river mile of zero at the mouth of the Nueces River. River miles increase moving upstream. For example, the Calallen Dam is at river mile 11 and the USGS gauging station at the Bluntzer Bridge upstream is at river mile 27.8.

During the August 1999 through June 2000 timeframe, the Nueces River sampling sites described in Table 2 were monitored monthly for pH, temperature, specific conductance, total dissolved solids (TDS), dissolved oxygen, salinity and chloride concentrations. Water samples were collected and sent to Jordan Laboratories, Inc. in Corpus Christi, Texas for analysis of calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, TDS, total hardness (as calcium carbonate) and alkalinity (as calcium carbonate). Figure 5 indicates the location of each surface water sampling site

Table 2.
Sample Sites for Nueces River Study

Sample Site	*Location Description*	*River Mile*	*Hydrolab Monitoring*	*Water Samples*
Surface Water				
1	Nueces River just Downstream from Calallen Dam	10.9	S	G
2	Nueces River at Calallen Dam	11	D_H	D_P
3	Nueces River at San Patricio MWD Intake	11.1	D_H	-
4	Nueces River 200 yd. upstream from San Patricio Intake	11.2	D_H	D_P
5	Nueces River 100 yd. Downstream from Stevens Intake	12.4	D_H	D_P
6	Nueces River 100yd. Upstream from Stevens Intake	12.6	D_H	D_P
7	Nueces River River View	14.5	S	G
Groundwater				
SP1	Adjacent to San Patricio Intake, 410 ft. from Bank	-	-	G
SP2	Adjacent to San Patricio Intake, 130 ft. from Bank	-	-	G
SP3	Adjacent to San Patricio Intake, 5 ft. from Bank	-	-	G
HB1	Hazel Bazemore Park, 1000 ft from Bank, Adjacent to Western Fence line	-	-	G
HB2	Hazel Bazemore Park Wetland area, Near Park Road	-	-	G
Key: S-single reading of parameters (temperature, specific conductance, pH, dissolved oxygen, salinity, chloride); D_H-parameter readings taken at top, middle and bottom depths within center of channel; G- single grab sample; D_P-water samples taken at middle and bottom depths within channel (Figure 5).				

There were four different methods for collecting data at the sampling sites. Table 2 describes which method was used at each site. Water quality readings were taken with the Hydrolab multiprobe at a single location within the channel at two sites. A single grab sample was also taken at these sites. The Hydrolab monitoring was conducted at three depth fractions of 0.1, 0.5, and 0.9 within the center of the channel. The water samples were taken at 1 foot from the bottom of the channel and at the mid-depth within the channel.

To characterize potential mineral contributions to the main river channel from groundwater, one set of five groundwater samples were taken from hand augered wells along the riverbanks. The chemical composition of the samples was analyzed just like the surface water samples. Location descriptions of the groundwater sample sites are also included in Table 2. Figure 6 shows the site locations relative to the Nueces River channel.

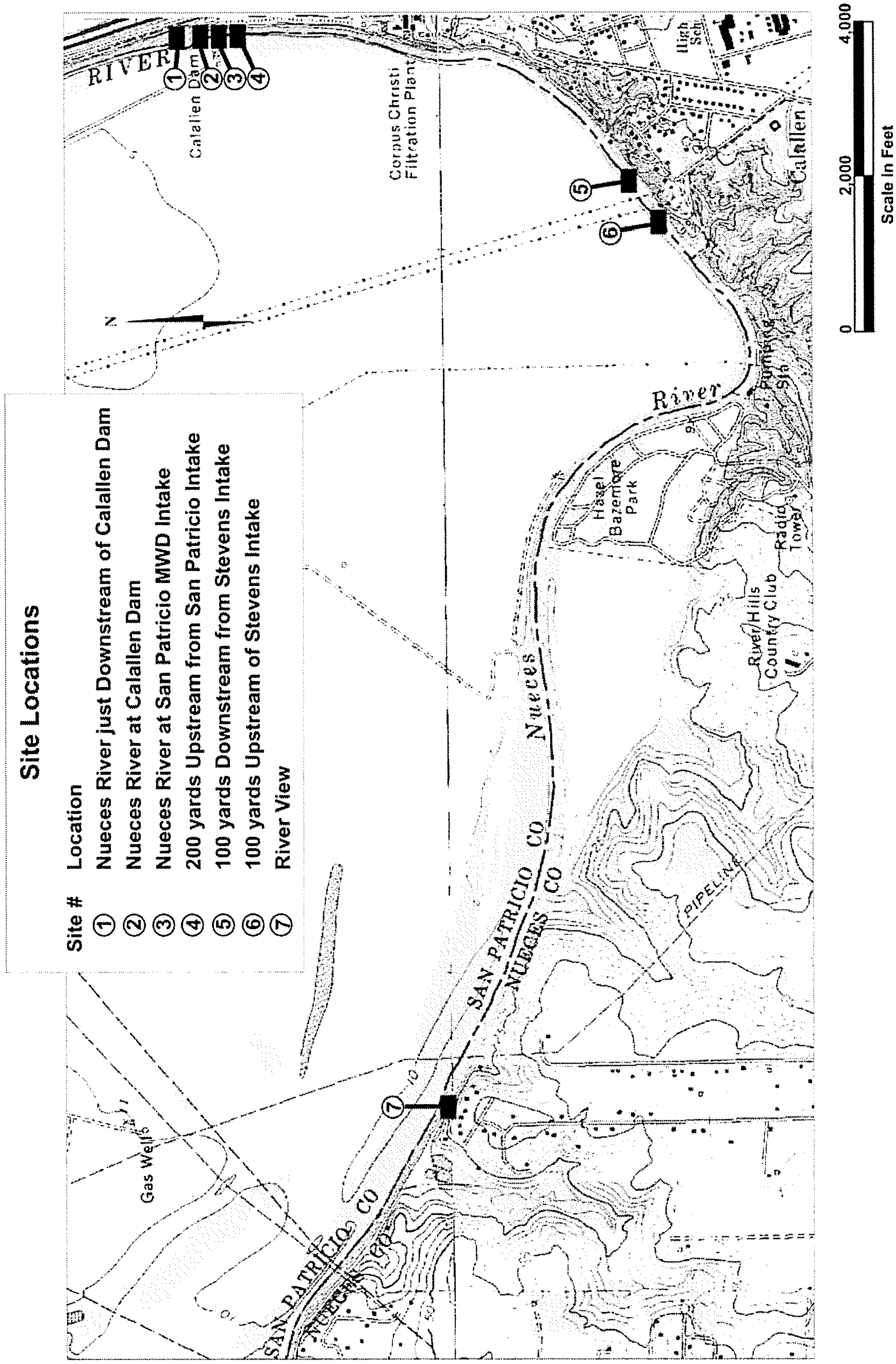


Figure 5. Nueces River Sampling Site Locations

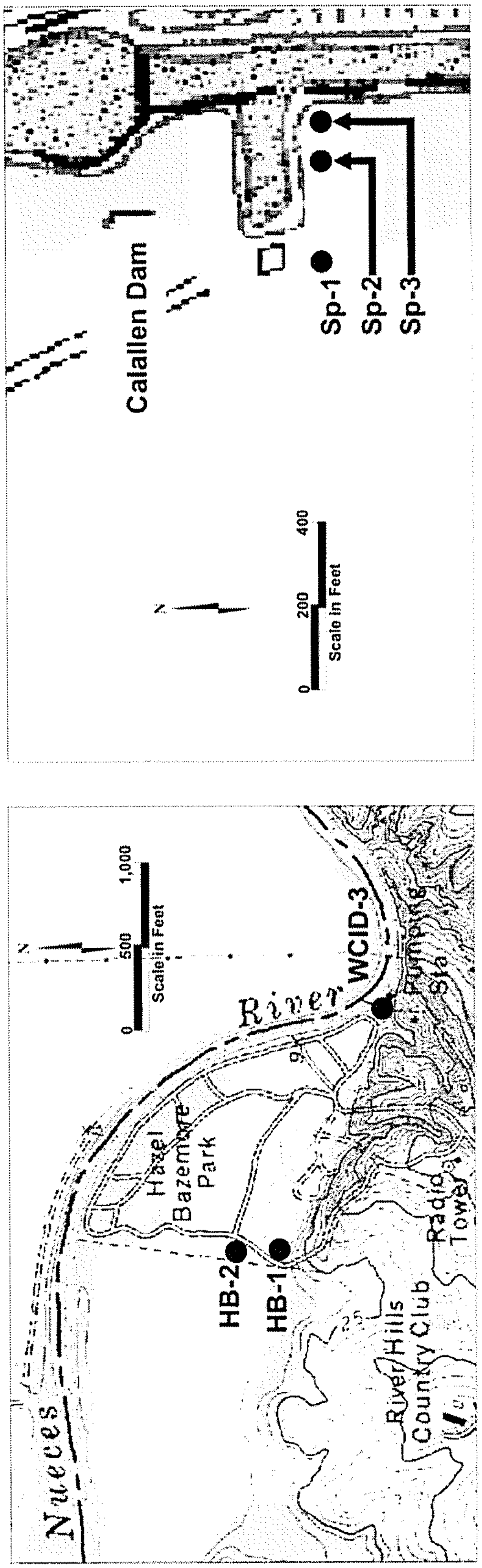


Figure 6. Groundwater Sampling Sites for the Nueces River Dissolved Mineral Study

Results

The purpose of the data analysis is to characterize the extent of the increase in dissolved solids occurring within the lower portion of the Calallen pool downstream of Hazel Bazemore Park, and to determine the source of this increase.

Composite observations of the stream monitoring and lab analysis obtained during this study are summarized in Figures 7, 8 and 9. Three sites along the river are represented to demonstrate the range in constituent concentration along the course of the river and at various depths within the channel at each site. Additionally, a composite of all groundwater samples is shown in the figures. The maximum, median and minimum surface water and composite groundwater concentration ranges are plotted for chloride, hardness, TDS, sulfate, bromide and dissolved oxygen at each site. Median values are plotted instead of mean values to prevent the maximum values from skewing the data. The entire set of data collected during this study is attached to the end of this report.

Figure 7 shows the range of chloride and bromide concentrations at the Riverview sampling site, just downstream of the O.N. Stevens Intake (site 5) and just upstream of the Calallen Dam. The distance between Riverview and the Calallen Dam is 3.5 river miles. The median chloride concentration range is from 95 mg/L to 117 mg/L along the river channel. The most significant concentration increase in chlorides (and dissolved minerals in general) occurs, however, with increasing depth within the channel. This is most apparent at Site 5, just downstream of the O.N. Stevens intake where the maximum chloride concentration ranges from 311.6 mg/L to 3,230 mg/L.

Bromide is a precursor to disinfection byproducts and is present in elevated concentrations in the Calallen Pool. Figure 7 presents the range of bromide within the pool. The median bromide concentration at the bottom of the river is 0.6 mg/L and was measured as high as 13 mg/L. These values are in contrast to the median bromide concentration at Riverview of 0.1 mg/L.

Figure 8 shows the concentration range of total hardness and total dissolved solids. The concentration of total hardness at Riverview was measured within a very narrow range compared to values downstream at the O.N. Stevens intake and at the Calallen Dam. The median total dissolved solids concentration at Calallen is 34% higher than at Riverview.

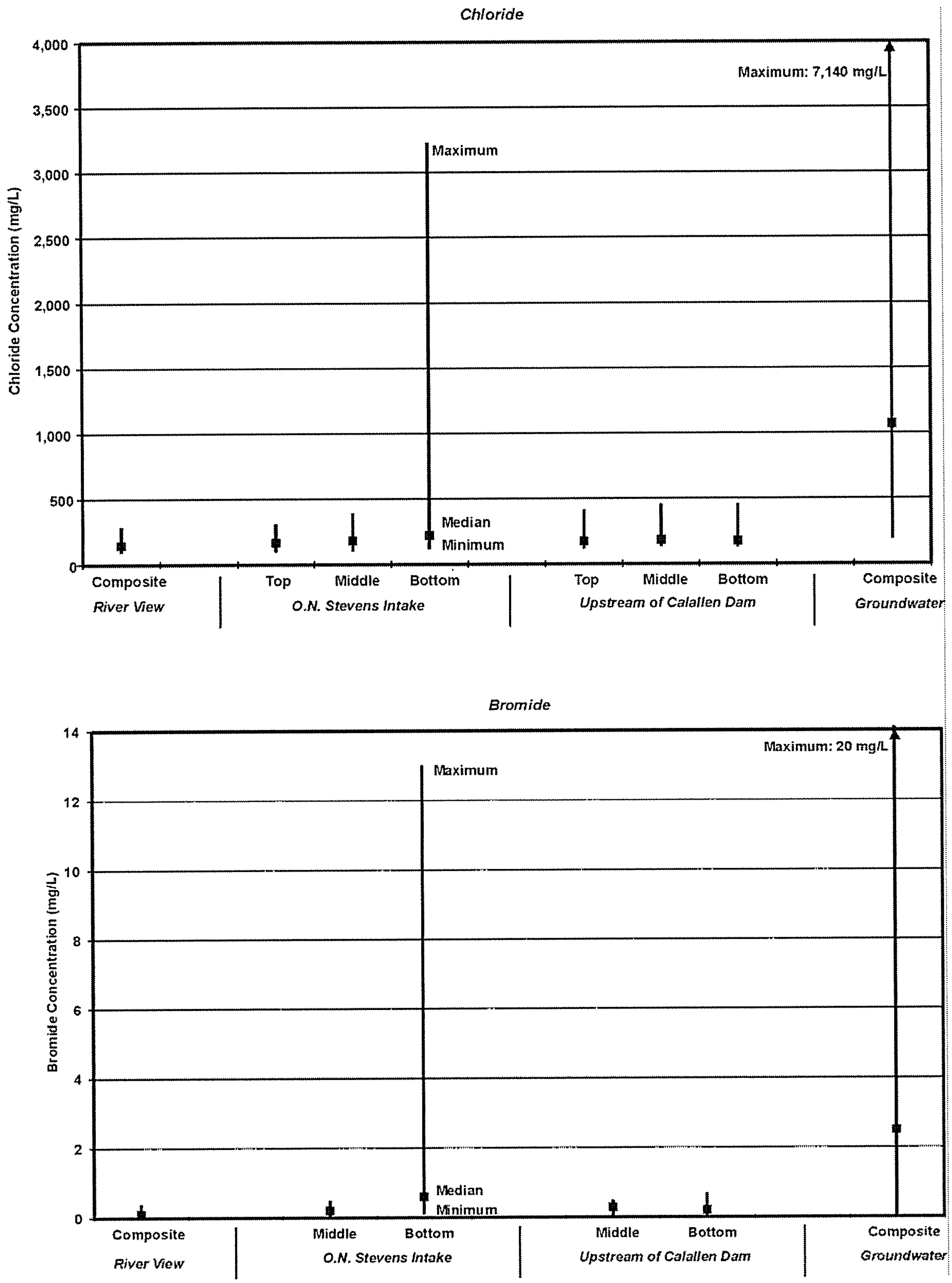
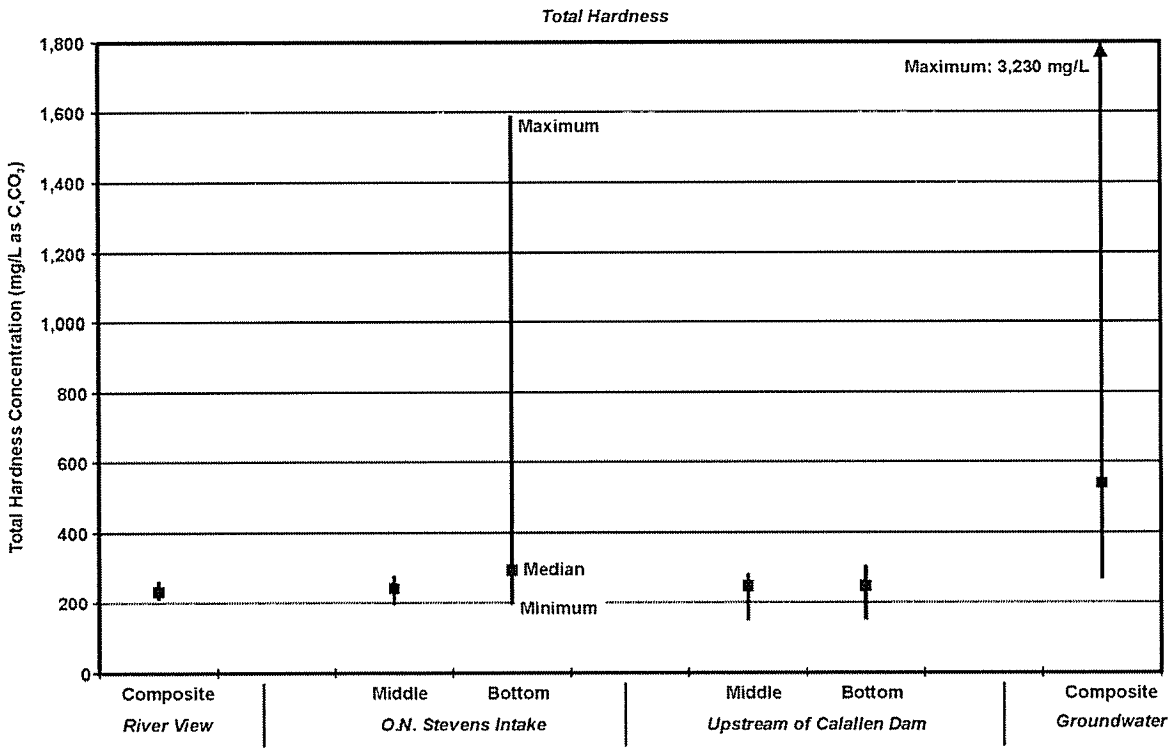


Figure 7. Nueces River Chloride and Bromide Concentrations at Selected Locations



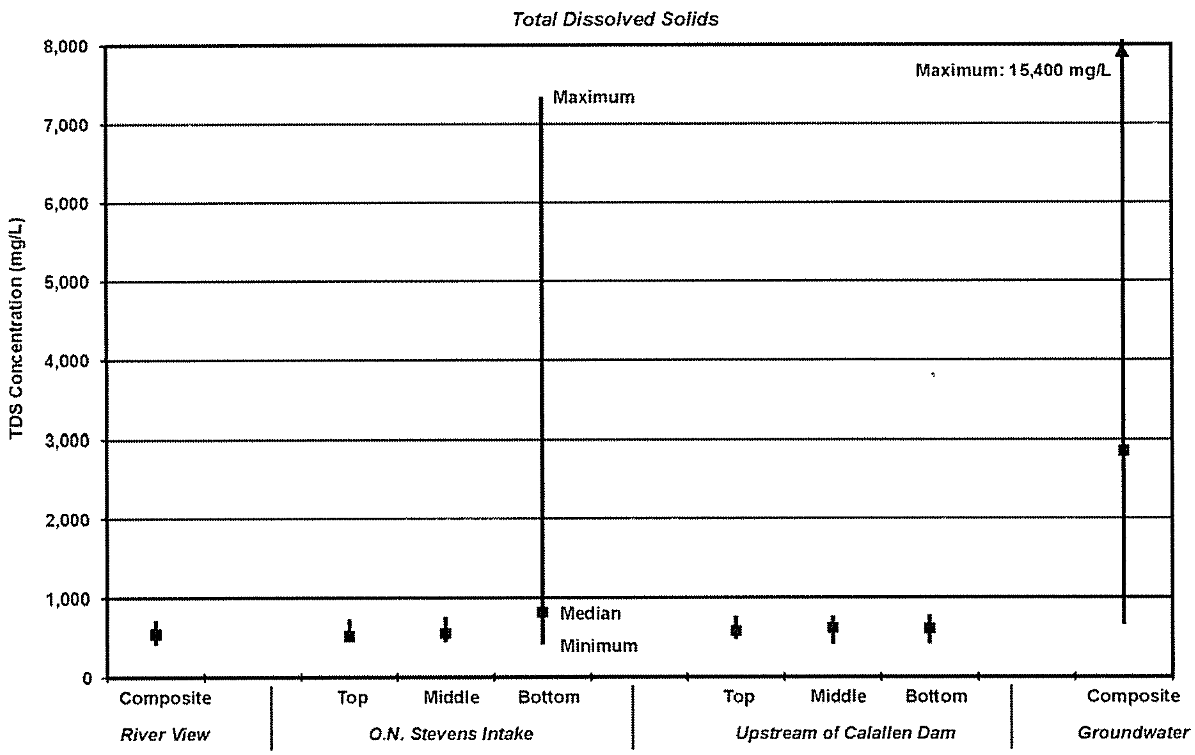
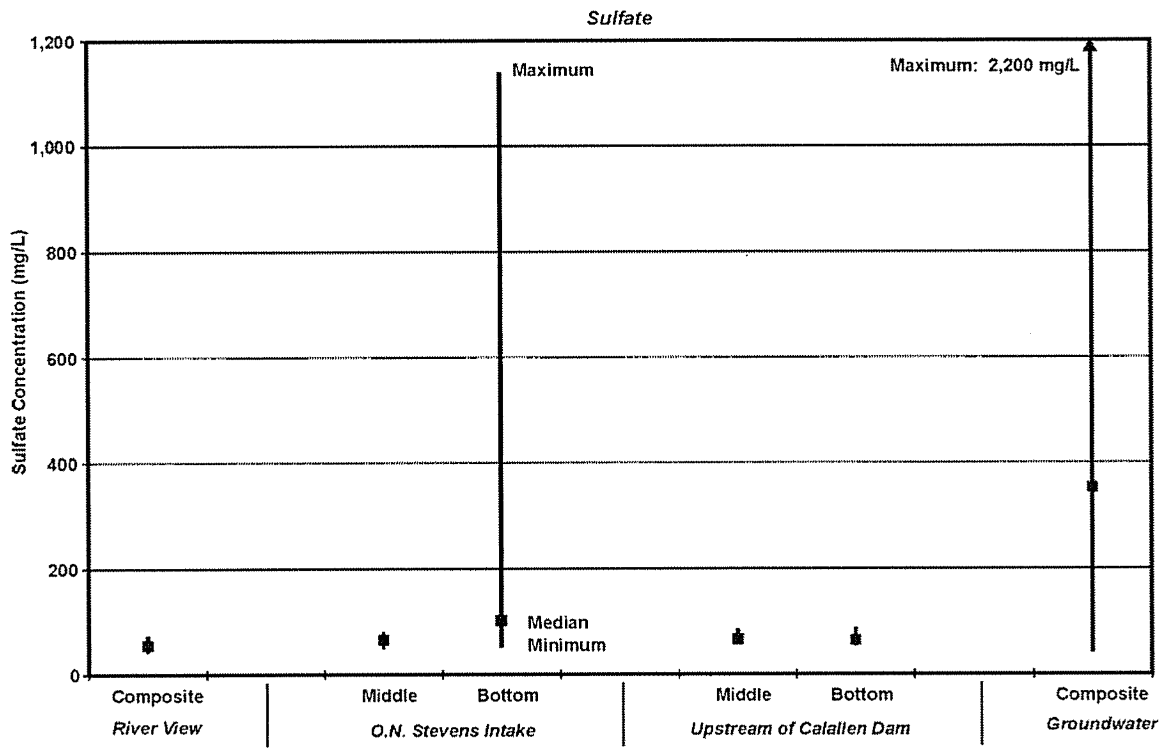


Figure 8. Nueces River Total Hardness and TDS Concentrations at Selected Locations



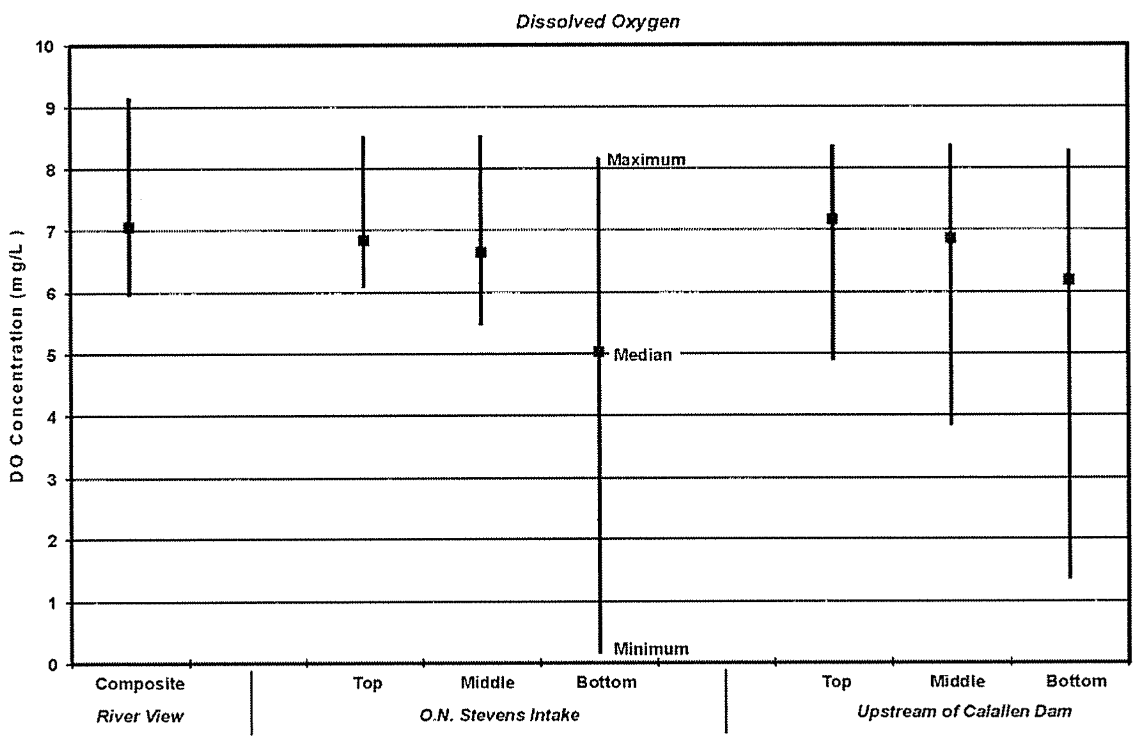


Figure 9. Nueces River Sulfate and Dissolved Oxygen Concentrations at Selected Locations

Figure 9 represents the concentration ranges of sulfate and dissolved oxygen. The variation in sulfate is very small for all samples except for the samples taken at the bottom of the Stevens intake site. At this site, the sulfate concentration ranges from 52 mg/L to 1140 mg/L. Dissolved oxygen concentration decrease with depth within the channel. The lowest values of dissolved oxygen were detected at the bottom of the channel at the Stevens intake.

Figure 10 is a representation of the total dissolved solids stratification measured within the channel on October 1999. The results show large mineral concentration increases occurring within the bottom 2 feet of the channel near the water intake locations. This stratification was found to be the most significant when no water was spilling over the dam and the least detectable during periods of high flow. The data supporting this observation is plotted in Figure 11. Chloride concentrations monitored at the Stevens intake and upstream of the Calallen Dam are plotted by sampling date. The flow over the dam is plotted on a second axis for the same sampling dates.

To determine the source of the dissolved minerals, the river segment was evaluated using a geochemical approach to discern different hydrochemical water types of the inflows and outflows of the river segment. A Schoeller diagram (Figure 12) plots the major ion concentrations for a composite set of surface water sample values, a groundwater sample taken at HB1 and a surface water sample taken from the bottom of the pool at the O.N. Stevens intake. The relative ion concentrations of calcium, magnesium, sodium, chloride, sulfate and bicarbonate (calculated from hardness and alkalinity values) are plotted on a logarithmic scale. The diagram shows that the surface water sample taken near the bottom at the Stevens intake is geochemically more similar to the groundwater sample taken at Hazel Bazemore Park, than to any of the other surface water samples (including samples taken at the same location, just three feet higher in the water column). This suggests that groundwater intrusion is taking place in the Calallen Pool. A more detailed analysis of groundwater inflows into the system will be needed to confirm these initial findings and to determine appropriate options to improve the water quality in the channel.

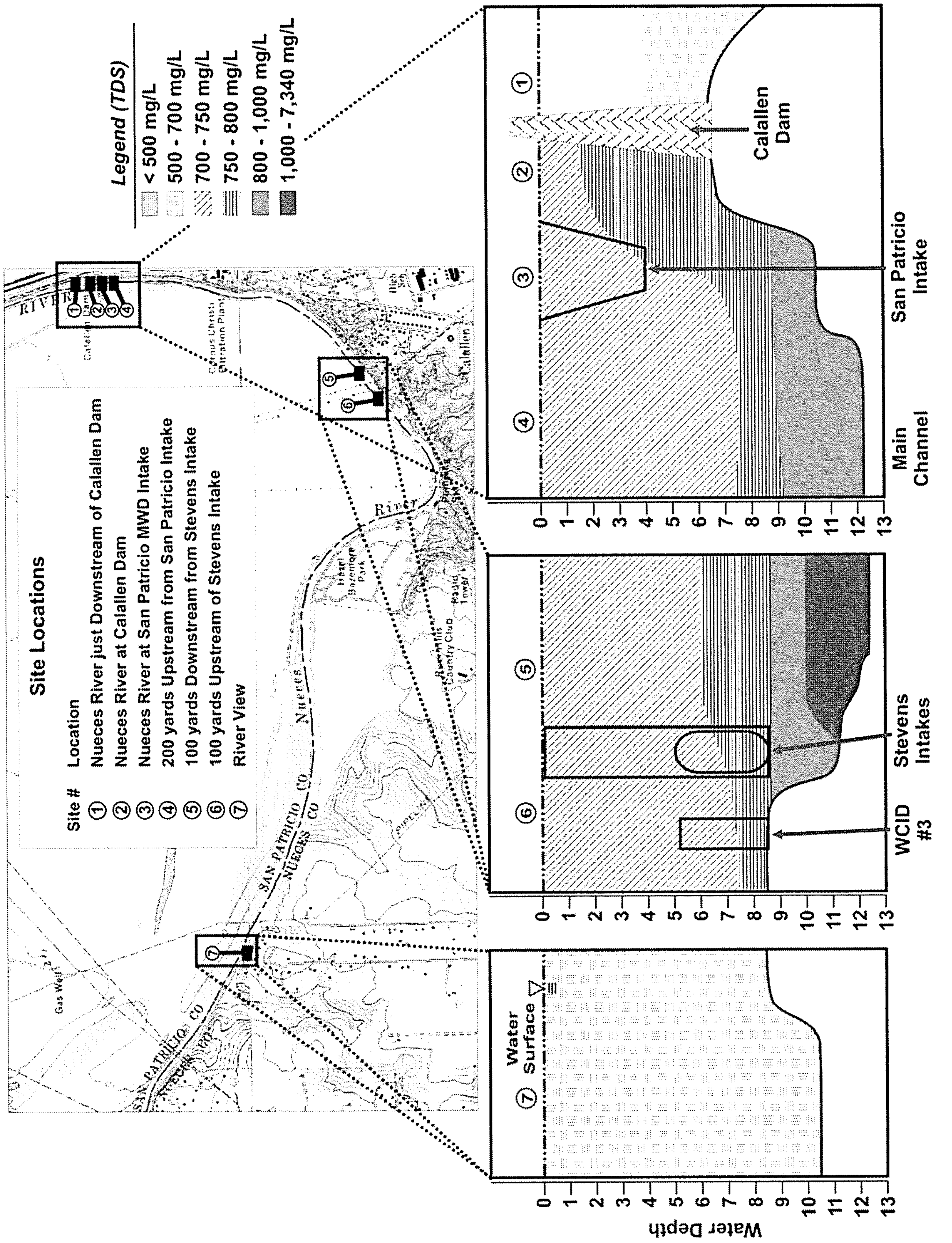


Figure 10. Stratification of TDS Concentration in the Nueces River Channel (October 1999)

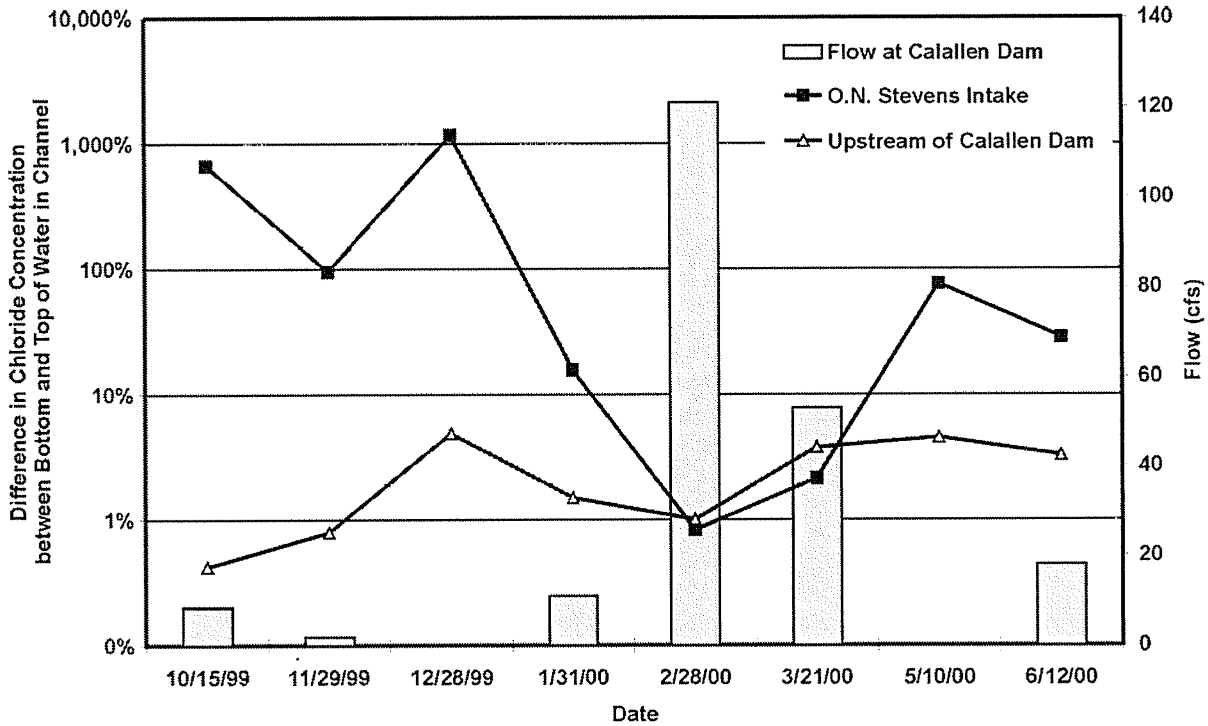


Figure 11. Variation of Chloride with Flow

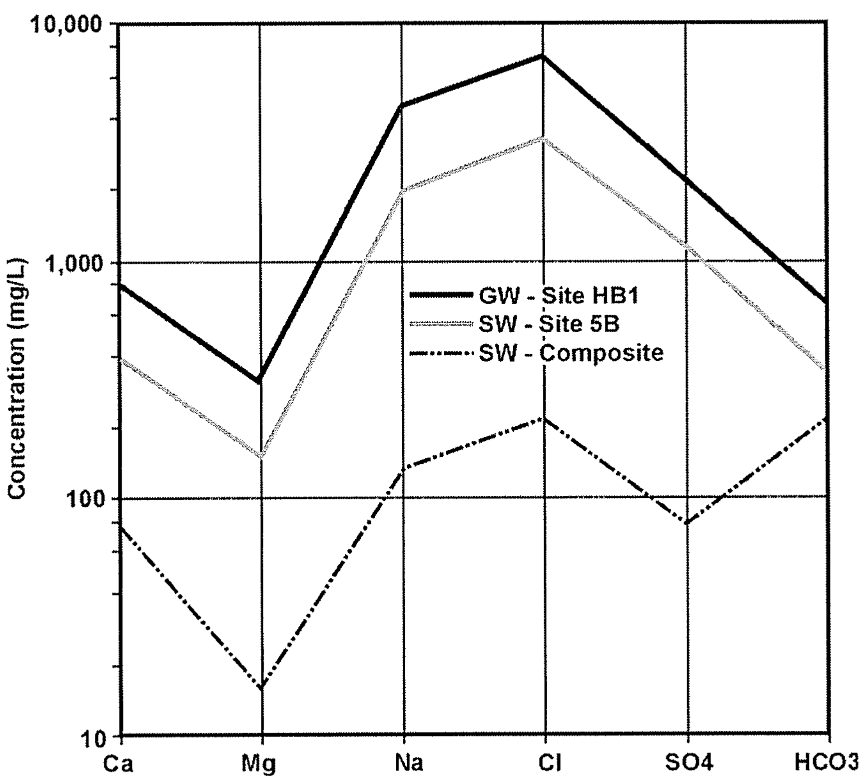


Figure 12. Schoeller Diagram- Nueces River Dissolved Minerals Study

Surface Water – Ground Water Interactions

A second phase of this investigation was initiated by HDR Engineering, Inc., the Nueces River Authority, and the Center for Water Supply Studies at Texas A&M University – Corpus Christi in an effort to identify the possible sources of elevated levels of dissolved solids in the Nueces River water in addition to the surface water sampling effort just described. This effort included monitor well installation, groundwater and surface water sampling, obtaining and interpreting aerial/satellite imagery of the area between Wesley Seale Dam and Calallen Pool, to identify possible point source contributions (specifically, abandoned oil and gas wells and sand/gravel washing operations), and groundwater intrusion. The results of this study are included in Appendix G2 of this report.

One of the primary objectives of this second phase was to investigate the potential interaction of groundwater in sediments along the Nueces River with surface water in the Calallen Pool. In order to measure groundwater levels and obtain samples of the groundwater, the study included the installation of several permanent monitoring wells. Seven borings, completed as monitor wells, were drilled at four locations adjacent to the Nueces River. The locations, well designations, and location considerations were as follows: (Note: the locations of these monitoring well sites are shown in Appendix G2.)

The first Hazel Bazemore Park site (HB-1, HB-2) is located where previous hand augered groundwater samples were collected. (Previous analyses indicated that the ionic ratios in those samples closely matched the ionic ratios found in samples of the more saline, stratified water of concern in the Calallen Pool.) The second site, in Hazel Bazemore Park (HB-3, HB-4), is located near the WCID # 3 intake and adjacent to a deeper pool of the Nueces River where stratification of water has been observed in previous investigations. The third site, on the San Patricio Municipal Water District (MWD) pump station property (SP-1, SP-2), is located near the Calallen Dam and a raw water intake where there has been noticeably elevated total dissolved solids and chlorides concentrations. The last site, at the City of Corpus Christi Cunningham Plant (CP-1), is adjacent to a deeper pool of the Nueces River close to both the Celanese—Bishop and the Koch Refinery raw water pump stations. (This site is on the opposite side of the Nueces River from the SP-1 and SP-2 sites and will be important for future use in making water level comparisons from each bank and the river surface to establish gaining and losing stream conditions as water releases and other system changes occur.)

On October 27, 2000 HDR Engineering, Inc., Nueces River Authority, and the Center for Water Supply Studies staff sampled the new groundwater wells. On October 30, 2000 the Nueces River Authority staff collected additional samples from the Nueces River. Surface water and groundwater samples were analyzed for dissolved constituents including cations (calcium, magnesium, sodium, and potassium) anions (carbonate, bicarbonate, sulfate, chloride), total dissolved solids (TDS), alkalinity (as calcium carbonate) and hardness (as calcium carbonate).

The results of the surface and groundwater sampling support the findings of the previous sampling effort. The groundwater sampled in the wells has chloride concentrations in excess of 1,000 ppm and more in the range of 2,000 to 3,000 ppm, except for CP-1 and SP-2. CP-1 is screened in a gravel/sand which appears to be in direct communication with the river. SP-2 is completed almost entirely in clay and goes dry during purging. Analytical results from SP-2 probably more closely represent pore water in the clays than formation water from a productive aquifer system. The chloride concentrations are shown in Figure 13.

The opportunity exists with permanent monitor wells in place around the Calallen Pool to conduct a comprehensive sampling program to evaluate the gaining and losing nature of the surface/groundwater system and then relate this information to surface water and groundwater sample results acquired within a time period during which the Calallen Pool experiences low and high flow conditions. Based upon the result of the sampling program best management practices and mitigation can then be suggested.

Water supply intakes in the Calallen Pool receive Lake Corpus Christi water via the 'bed and banks' of the Nueces River. The purpose of this section is to evaluate options to improve the quality of the water entering the water supply intakes. The following control strategies are considered:

- Blending of Lake Texana Water with Nueces River Water
- Outlet Works to Remove High TDS Water from the Calallen Pool
- Modification of Existing Intakes
- Pipeline from Lake Corpus Christi to the O.N. Stevens WTP
- Plugging Leaky and Abandoned Oil Wells

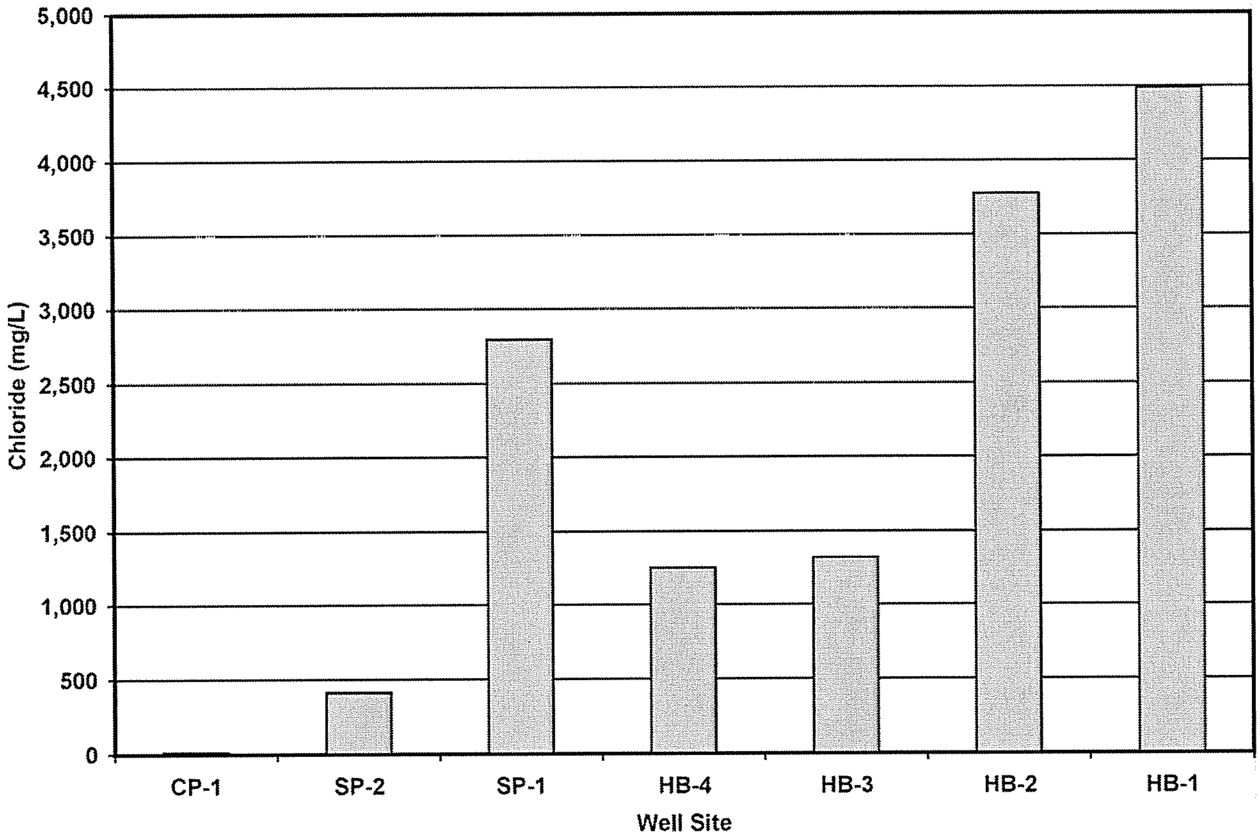


Figure 5A.3-13. Chloride Concentrations of Well Samples along the Lower Nueces River

The potential for manufacturing water use savings is based on the reduction in chloride concentration of the water supply achieved by each option. Figure 5A.3-9 shows the estimated industrial cooling water usage savings for various levels of water quality improvement. These estimates are based on correspondence with local industries and other sources.

Conclusions

High levels of dissolved minerals result in an increase in manufacturing water demands, due to accelerated build-up of mineral deposits in industrial cooling facilities. High bromide concentrations in source waters such as the Nueces River also lead to elevated disinfection by-product concentrations and higher drinking water treatment costs. Previous studies determined that there is a high dissolved solids problem in the Calallen channel, but did not conclusively determine the source. The results of the sampling program strongly suggests that groundwater intruding into the Calallen Pool is a major source of the high dissolved solids concentrations.

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Appendix
Water Quality Data

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Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
8/5/99	20.00																		
8/5/99		2	Field	2.00	31.04	8.10	4.89	904.00	580.00	440	---	---	---	---	---	---	---	---	---
8/5/99		2	Field	5.00	30.04	7.93	3.83	987.00	634.00	490	---	---	---	---	---	---	---	---	---
8/5/99		2	Field	7.00	30.54	7.56	1.41	1086.00	712.00	550	---	---	---	---	---	---	---	---	---
8/5/99		2	Lab	Top	---	8.38	---	---	518.00	---	139.00	178	---	---	84.00	9.60	64.00	241.00	0.30
8/5/99		3	Field	2.00	31.06	8.22	5.83	853.00	546.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	2.10	31.04	8.18	5.61	857.00	549.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	3.00	31.04	8.19	5.97	857.00	548.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	4.00	31.00	8.16	5.93	862.00	554.00	420	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	5.00	30.93	8.11	5.69	886.00	569.00	440	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	6.00	30.86	7.95	4.01	983.00	619.00	480	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	7.00	30.52	7.65	1.49	1137.00	727.00	550	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	8.00	30.32	7.50	0.41	1216.00	767.00	600	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	9.00	29.82	7.34	0.12	1297.00	832.00	620	---	---	---	---	---	---	---	---	---
8/5/99		3	Field	10.00	29.28	7.20	0.13	1401.00	980.00	700	---	---	---	---	---	---	---	---	---
8/5/99		4	Field	2.00	31.04	8.18	5.87	870.00	557.00	430	---	---	---	---	---	---	---	---	---
8/5/99		4	Field	10.00	28.53	7.13	0.01	1839.00	1180.00	990	---	---	---	---	---	---	---	---	---
8/5/99		4	Field	14.00	30.54	7.58	1.23	1433.00	927.00	720	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	2.00	33.20	8.26	6.52	752.00	479.00	370	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	7.00	31.50	8.33	5.54	795.00	507.00	390	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	8.00	31.40	8.31	5.39	818.00	524.00	400	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	9.00	31.34	8.28	5.23	848.00	542.00	410	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	10.00	31.09	8.07	4.19	1100.00	704.00	540	---	---	---	---	---	---	---	---	---
8/5/99		5	Field	11.00	29.54	6.99	0.15	5749.00	3710.00	3130	---	---	---	---	---	---	---	---	---
8/5/99		5	Lab	Top	---	8.39	---	---	473.00	---	116.00	177	---	---	73.00	9.10	52.00	241.00	0.20
8/5/99		6	Field	2.00	33.02	8.33	6.67	727.00	466.00	360	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	4.00	31.51	8.27	5.75	744.00	477.00	360	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	8.00	31.57	8.22	5.68	752.00	485.00	380	---	---	---	---	---	---	---	---	---
8/5/99		6	Field	11.00	31.28	8.29	5.38	810.00	517.00	400	---	---	---	---	---	---	---	---	---
8/5/99		7	Field	2.00	32.23	8.28	6.30	682.00	438.00	330	---	---	---	---	---	---	---	---	---
8/5/99		7	Field	12.00	31.41	8.23	5.68	687.00	440.00	330	---	---	---	---	---	---	---	---	---
8/5/99		7	Lab	Top	---	8.31		---	423.00	---	95.00	177	---	---	59.00	8.90	46.00	219.00	<0.1

Note: Grab samples taken near surface of water

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
10/15/99	8.40																		
10/15/99		1	Lab	Top	---	8.01	---	---	656.00	---	247.00	161	73.00	16.00	144.00	10.00	74.00	248.00	0.40
10/15/99		2	Field	0.98	27.47	8.06	7.61	1204.00	771.30	600	413.90	---	---	---	---	---	---	---	---
10/15/99		2	Field	2.93	27.20	8.00	7.35	1206.00	770.50	600	397.00	---	---	---	---	---	---	---	---
10/15/99		2	Field	4.88	26.81	8.00	6.74	1205.00	771.10	600	456.40	---	---	---	---	---	---	---	---
10/15/99		2	Field	6.83	26.14	7.57	3.44	1186.00	754.90	590	469.10	---	---	---	---	---	---	---	---
10/15/99		2	Field	8.78	25.45	7.32	1.34	1121.00	710.30	580	454.50	---	---	---	---	---	---	---	---
10/15/99		2	Lab	Bottom	---	7.38	---	---	648.00	---	216.00	162	75.00	15.00	131.00	10.00	76.00	249.00	0.30
10/15/99		2	Lab	Middle	---	7.98	---	---	720.00	---	235.00	185	82.00	17.00	143.00	9.80	85.00	275.00	0.50
10/15/99		3	Field	1.03	27.83	8.05	8.19	1208.00	772.60	600	363.90	---	---	---	---	---	---	---	---
10/15/99		3	Field	3.08	27.47	7.97	8.60	1207.00	774.50	600	399.40	---	---	---	---	---	---	---	---
10/15/99		3	Field	5.14	26.81	7.96	6.28	1224.00	781.70	610	477.00	---	---	---	---	---	---	---	---
10/15/99		3	Field	7.19	26.06	7.53	2.69	1232.00	787.00	610	493.70	---	---	---	---	---	---	---	---
10/15/99		3	Field	9.24	24.90	7.29	0.32	1102.00	711.90	540	462.90	---	---	---	---	---	---	---	---
10/15/99		4	Field	1.30	28.03	8.13	8.27	1194.00	764.30	590	398.60	---	---	---	---	---	---	---	---
10/15/99		4	Field	3.90	26.92	8.04	6.82	1208.00	780.10	600	460.20	---	---	---	---	---	---	---	---
10/15/99		4	Field	6.60	26.52	7.75	4.32	1277.00	819.20	640	510.70	---	---	---	---	---	---	---	---
10/15/99		4	Field	9.20	24.97	7.35	0.50	1150.00	748.00	570	493.40	---	---	---	---	---	---	---	---
10/15/99		4	Field	11.80	24.69	7.20	0.14	1274.00	816.90	630	537.50	---	---	---	---	---	---	---	---
10/15/99		4	Lab	Bottom	---	7.26	---	---	755.00	---	263.00	159	83.00	18.00	159.00	9.70	94.00	281.00	0.30
10/15/99		4	Lab	Middle	---	7.71	---	---	738.00	---	260.00	180	83.00	18.00	159.00	9.70	92.00	281.00	0.50
10/15/99		5	Lab	Bottom	---	6.91	---	---	7340.00	---	3230.00	274	390.00	150.00	1980.00	21.00	1140.00	1590.00	10.00
10/15/99		5	Lab	Middle	---	7.98	---	---	658.00	---	207.00	183	76.00	16.00	125.00	9.40	76.00	256.00	0.40
10/15/99		6	Lab	Bottom	---	7.98	---	---	673.00	---	212.00	182	79.00	16.00	129.00	9.20	79.00	263.00	0.40
10/15/99		6	Lab	Middle	---	8.00	---	---	579.00	---	175.00	181	74.00	15.00	108.00	9.20	65.00	247.00	0.30
10/15/99		7	Field	2.50	26.71	7.93	6.31	874.40	559.80	430	258.10	---	---	---	---	---	---	---	---
10/15/99		7	Field	2.50	26.71	7.97	6.34	870.30	556.10	430	289.20	---	---	---	---	---	---	---	---
10/15/99		7	Field	6.10	26.67	8.02	6.21	876.80	560.60	430	304.90	---	---	---	---	---	---	---	---
10/15/99		7	Field	10.80	26.65	8.02	6.15	877.10	561.40	430	311.10	---	---	---	---	---	---	---	---
10/15/99		7	Lab	Top	---	8.06	---	---	533.00	---	146.00	178	71.00	13.00	91.00	9.40	56.00	231.00	0.20

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
11/29/99	1.90																		
11/29/99		1	Lab	Top	---	8.05	---	---	648.00	---	196.00	179	78.00	16.00	123.00	9.30	70.00	261.00	0.30
11/29/99		1	Field	Top	19.90	7.76	8.34	1000.30	659.90	510	253.40	---	---	---	---	---	---	---	---
11/29/99		2	Field	0.83	18.28	7.94	7.28	970.70	624.30	480	255.00	---	---	---	---	---	---	---	---
11/29/99		2	Field	2.50	17.07	7.92	7.07	971.80	622.00	480	263.10	---	---	---	---	---	---	---	---
11/29/99		2	Field	4.17	17.80	7.93	6.98	971.80	621.60	480	264.70	---	---	---	---	---	---	---	---
11/29/99		2	Field	5.84	17.72	7.91	6.80	972.60	623.60	480	266.70	---	---	---	---	---	---	---	---
11/29/99		2	Field	7.51	17.62	7.88	6.82	976.40	624.90	480	266.80	---	---	---	---	---	---	---	---
11/29/99		2	Lab	Bottom	---	7.99	---	---	623.00	---	177.00	179	78.00	15.00	109.00	9.00	67.00	257.00	0.20
11/29/99		2	Lab	Middle	---	8.00	---	---	620.00	---	176.00	179	75.00	15.00	109.00	9.50	67.00	249.00	0.30
11/29/99		3	Field	1.24	18.62	7.95	7.38	972.10	622.00	480	263.40	---	---	---	---	---	---	---	---
11/29/99		3	Field	3.20	17.99	7.94	7.07	972.50	622.10	480	268.10	---	---	---	---	---	---	---	---
11/29/99		3	Field	5.30	17.75	7.93	6.79	970.40	619.70	480	277.80	---	---	---	---	---	---	---	---
11/29/99		3	Field	7.40	17.72	7.87	6.49	7005.00	643.60	500	281.10	---	---	---	---	---	---	---	---
11/29/99		3	Field	9.60	17.72	7.87	6.57	1004.00	642.50	500	282.10	---	---	---	---	---	---	---	---
11/29/99		4	Field	1.20	19.49	8.10	84.00	970.30	620.40	480	272.30	---	---	---	---	---	---	---	---
11/29/99		4	Field	3.50	18.07	8.02	7.51	964.00	617.60	480	282.00	---	---	---	---	---	---	---	---
11/29/99		4	Field	5.80	17.83	7.97	7.14	982.20	628.80	490	292.20	---	---	---	---	---	---	---	---
11/29/99		4	Field	8.10	17.77	7.88	6.61	1069.00	682.30	530	309.60	---	---	---	---	---	---	---	---
11/29/99		4	Field	10.40	17.77	7.86	6.66	1093.00	699.00	540	312.40	---	---	---	---	---	---	---	---
11/29/99		4	Lab	Bottom	---	7.93	---	---	695.00	---	207.00	179	78.00	17.00	125.00	9.20	77.00	265.00	0.40
11/29/99		4	Lab	Middle	---	8.03	---	---	638.00	---	179.00	178	75.00	15.00	108.00	9.20	66.00	249.00	0.20
11/29/99		5	Field	1.20	19.21	8.05	7.78	945.30	604.90	470	311.00	---	---	---	---	---	---	---	---
11/29/99		5	Field	3.50	18.56	8.04	7.60	949.20	606.90	470	328.50	---	---	---	---	---	---	---	---
11/29/99		5	Field	5.80	17.74	7.99	7.29	1001.00	640.80	500	390.40	---	---	---	---	---	---	---	---
11/29/99		5	Field	8.20	17.65	7.97	7.24	1038.00	664.70	520	425.50	---	---	---	---	---	---	---	---
11/29/99		5	Field	10.50	17.73	7.59	5.61	1887.00	1008.00	800	643.00	---	---	---	---	---	---	---	---
11/29/99		5	Lab	Bottom	---	7.68	---	---	1360.00	---	483.00	195	110.00	32.00	305.00	13.00	201.00	406.00	1.20
11/29/99		5	Lab	Middle	---	8.05	---	---	630.00	---	182.00	178	85.00	15.00	128.00	9.30	68.00	274.00	0.30
11/29/99		6	Field	0.90	18.62	8.05	7.90	915.00	585.90	450	274.50	---	---	---	---	---	---	---	---
11/29/99		6	Field	2.80	18.41	8.03	7.61	939.70	601.20	470	297.00	---	---	---	---	---	---	---	---
11/29/99		6	Field	4.70	17.57	8.01	7.38	929.90	594.50	460	318.30	---	---	---	---	---	---	---	---
11/29/99		6	Field	6.60	17.51	7.96	7.32	999.90	639.10	510	335.10	---	---	---	---	---	---	---	---
11/29/99		6	Field	8.40	17.54	7.94	7.30	1043.00	664.90	510	383.20	---	---	---	---	---	---	---	---
11/29/99		6	Lab	Bottom	---	8.05	---	---	66.00	---	193.00	178	83.00	15.00	135.00	9.30	71.00	269.00	0.40
11/29/99		6	Lab	Middle	---	8.12	---	---	588.00	---	167.00	177	86.00	15.00	103.00	9.10	61.00	277.00	0.10
11/29/99		7	Lab	Top	---	8.04	---	---	565.00	---	149.00	177	70.00	14.00	90.00	9.10	56.00	232.00	0.10
11/29/99		7	Field	Top	17.16	8.02	8.47	866.20	554.20	430	215.60	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
12/28/99	0.00																		
12/28/99		1	Lab	Top	---	8.37	---	---	743.00	---	223.00	188	81.00	18.00	132.00	9.60	77.00	276.00	0.50
12/28/99		1	Field	Top	12.80	8.24	13.87	1228.00	781.90	620	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	1.50	14.10	7.80	7.67	1161.00	743.00	580	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	3.50	13.90	7.76	7.28	1199.00	766.10	600	---	---	---	---	---	---	---	---	---
12/28/99		2	Field	5.94	13.97	7.72	6.96	1222.00	784.20	620	---	---	---	---	---	---	---	---	---
12/28/99		2	Lab	Bottom	---	7.97	---	---	788.00	---	246.00	187	92.00	18.00	146.00	11.00	88.00	304.00	0.70
12/28/99		2	Lab	Middle	---	8.04	---	---	768.00	---	234.00	186	83.00	18.00	140.00	9.80	86.00	281.00	0.50
12/28/99		3	Field	1.50	14.09	7.05	8.11	1129.00	724.40	570	---	---	---	---	---	---	---	---	---
12/28/99		3	Field	5.40	14.01	7.04	7.88	1134.00	726.00	570	---	---	---	---	---	---	---	---	---
12/28/99		3	Field	9.80	13.98	7.75	7.01	1237.00	795.30	620	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	1.50	14.30	7.88	8.40	1094.00	700.10	550	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	6.10	13.95	7.87	8.23	1107.00	709.40	550	---	---	---	---	---	---	---	---	---
12/28/99		4	Field	11.20	14.12	7.71	7.38	1366.00	873.30	690	---	---	---	---	---	---	---	---	---
12/28/99		4	Lab	Bottom	---	8.02	---	---	868.00	---	286.00	187	88.00	20.00	163.00	9.60	100.00	302.00	0.70
12/28/99		4	Lab	Middle	---	8.07	---	---	716.00	---	213.00	184	80.00	17.00	126.00	9.10	76.00	270.00	0.40
12/28/99		5	Field	1.50	14.77	7.90	8.53	1157.00	739.20	580	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	6.05	14.24	7.89	8.54	1170.00	749.50	590	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	10.00	15.01	7.29	4.48	3023.00	2147.00	1800	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	10.90	17.12	6.82	1.05	9763.00	6276.00	5690	---	---	---	---	---	---	---	---	---
12/28/99		5	Field	11.20	18.28	6.73	0.59	11125.00	7123.00	6400	---	---	---	---	---	---	---	---	---
12/28/99		5	Lab	Bottom	---	7.36	---	---	7210.00	---	3100.00	282	388.00	151.00	1880.00	20.00	1130.00	1590.00	13.00
12/28/99		5	Lab	Middle	---	8.04	---	---	765.00	---	229.00	190	83.00	17.00	131.00	9.00	81.00	277.00	0.50
12/28/99		6	Field	1.50	14.73	7.92	8.58	1122.00	714.70	560	---	---	---	---	---	---	---	---	---
12/28/99		6	Field	4.20	14.60	7.92	8.52	1150.00	734.30	580	---	---	---	---	---	---	---	---	---
12/28/99		6	Field	7.50	14.34	7.90	8.53	1162.00	744.00	570	---	---	---	---	---	---	---	---	---
12/28/99		6	Lab	Bottom	---	7.89	---	---	765.00	---	233.00	189	82.00	18.00	133.00	9.30	80.00	279.00	0.50
12/28/99		6	Lab	Middle	---	8.05	---	---	748.00	---	222.00	190	81.00	17.00	128.00	9.30	79.00	272.00	0.50
12/28/99		7	Field	1.90	14.61	7.93	8.82	1082.00	693.00	540	---	---	---	---	---	---	---	---	---
12/28/99		7	Lab	Top	---	8.03	---	---	720.00	---	204.00	189	77.00	17.00	121.00	9.30	75.00	262.00	0.40

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
1/31/00	11.00																		
1/31/00		1	Lab	Top	---	8.26	---	---	558.00	---	135.00	178	69.00	13.00	83.00	8.70	55.00	226.00	0.10
1/31/00		1	Field	Top	13.85	8.16	10.10	818.50	524.00	410	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	1.00	13.44	8.04	8.37	813.40	520.60	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	3.75	13.41	8.04	8.38	813.70	520.70	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Field	7.50	13.41	8.03	8.29	813.80	520.90	400	---	---	---	---	---	---	---	---	---
1/31/00		2	Lab	Bottom	---	8.17	---	---	547.00	---	134.00	179	68.00	13.00	82.00	8.60	56.00	223.00	0.20
1/31/00		2	Lab	Middle	---	8.18	---	---	535.00	---	132.00	179	69.00	13.00	82.00	8.70	56.00	226.00	0.20
1/31/00		3	Field	1.00	13.57	8.05	8.42	813.10	520.10	400	---	---	---	---	---	---	---	---	---
1/31/00		3	Field	4.90	13.45	8.03	8.15	813.20	520.40	400	---	---	---	---	---	---	---	---	---
1/31/00		3	Field	8.75	13.40	8.00	8.62	814.70	521.30	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	1.30	13.59	8.08	8.22	813.60	521.40	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	1.70	13.36	8.06	7.95	818.50	524.10	410	---	---	---	---	---	---	---	---	---
1/31/00		4	Field	6.50	13.35	8.04	7.98	817.20	522.90	400	---	---	---	---	---	---	---	---	---
1/31/00		4	Lab	Bottom	---	8.17	---	---	543.00	---	134.00	179	69.00	13.00	83.00	8.70	56.00	226.00	0.10
1/31/00		4	Lab	Middle	---	8.17	---	---	543.00	---	134.00	179	69.00	13.00	82.00	8.90	56.00	226.00	0.10
1/31/00		5	Field	1.00	13.49	8.05	8.45	824.90	528.10	410	---	---	---	---	---	---	---	---	---
1/31/00		5	Field	5.00	13.40	8.04	8.29	834.40	537.10	420	---	---	---	---	---	---	---	---	---
1/31/00		5	Field	9.00	13.34	7.97	8.17	920.10	588.90	460	---	---	---	---	---	---	---	---	---
1/31/00		5	Lab	Bottom	---	8.14	---	---	610.00	---	160.00	179	71.00	14.00	100.00	9.20	66.00	235.00	0.30
1/31/00		5	Lab	Middle	---	8.18	---	---	568.00	---	139.00	179	70.00	13.00	85.00	8.60	57.00	228.00	0.20
1/31/00		6	Field	1.00	13.30	8.03	8.74	795.50	509.60	390	---	---	---	---	---	---	---	---	---
1/31/00		6	Field	5.00	13.25	8.01	11.38	951.10	604.10	470	---	---	---	---	---	---	---	---	---
1/31/00		6	Lab	Bottom	---	8.12	---	---	590.00	---	153.00	179	73.00	14.00	89.00	8.90	62.00	240.00	0.20
1/31/00		6	Lab	Middle	---	8.21	---	---	520.00	---	131.00	179	69.00	13.00	75.00	8.90	53.00	226.00	0.11
1/31/00		7	Lab	Top	---	8.15	---	---	493.00	---	116.00	178	68.00	12.00	70.00	8.50	45.00	219.00	<0.1
1/31/00		7	Field	Top	12.68	8.03	9.16	740.80	474.30	370	---	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
2/28/00	121.00	1	Lab	Top	---	8.09	---	---	488.00	---	132.00	181	70.00	12.00	83.00	9.20	54.00	554.00	0.20
2/28/00		1	Field	Top	20.43	8.13	8.49	818.80	524.00	400	172.70	---	---	---	---	---	---	---	---
2/28/00		2	Field	1.14	20.58	8.12	7.05		516.70	400	170.60	---	---	---	---	---	---	---	---
2/28/00		2	Field	3.25	20.35	8.09	7.02	806.80	516.40	400	168.60	---	---	---	---	---	---	---	---
2/28/00		2	Field	5.54	20.34	8.08	7.08	807.70	516.50	400	170.30	---	---	---	---	---	---	---	---
2/28/00		2	Lab	Bottom	---	8.15	---	---	478.00	---	128.00	180	70.00	12.00	80.00	8.60	54.00	224.00	0.10
2/28/00		3	Field	1.10	20.67	8.11	7.07	807.00	517.10	400	163.70	---	---	---	---	---	---	---	---
2/28/00		3	Field	4.94	20.36	8.10	6.94	807.70	516.90	400	161.70	---	---	---	---	---	---	---	---
2/28/00		3	Field	8.97	20.31	8.08	6.90	807.30	516.80	400	155.80	---	---	---	---	---	---	---	---
2/28/00		3	Lab	Bottom	---	8.19	---	---	498.00	---	126.00	181	69.00	12.00	78.00	8.60	54.00	222.00	0.20
2/28/00		3	Lab	Middle	---	8.18	---	---	460.00	---	126.00	182	69.00	12.00	79.00	8.70	54.00	222.00	0.20
2/28/00		4	Field	1.10	20.66	8.13	7.04	803.00	513.90	390	163.70	---	---	---	---	---	---	---	---
2/28/00		4	Field	5.50	20.34	8.10	6.91	804.20	514.70	400	158.60	---	---	---	---	---	---	---	---
2/28/00		4	Field	10.31	20.26	8.08	6.88	809.60	519.30	400	158.70	---	---	---	---	---	---	---	---
2/28/00		4	Lab	Bottom	---	8.12	---	---	485.00	---	128.00	181	71.00	12.00	79.00	9.30	57.00	227.00	0.10
2/28/00		4	Lab	Middle	---	8.20	---	---	455.00	---	128.00	181	68.00	12.00	77.00	8.80	57.00	219.00	0.10
2/28/00		5	Field	1.09	21.27	8.15	7.15	743.60	476.30	360	140.90	---	---	---	---	---	---	---	---
2/28/00		5	Field	6.00	20.53	8.12	7.05	741.60	476.10	360	142.60	---	---	---	---	---	---	---	---
2/28/00		5	Field	11.05	20.34	8.09	6.98	761.50	487.20	370	141.20	---	---	---	---	---	---	---	---
2/28/00		5	Lab	Bottom	---	8.20	---	---	415.00	---	116.00	181	70.00	12.00	72.00	8.60	52.00	224.00	0.10
2/28/00		5	Lab	Middle	---	8.19	---	---	443.00	---	113.00	181	70.00	12.00	69.00	8.90	49.00	224.00	<0.1
2/28/00		6	Field	1.17	20.99	8.14	7.19	724.70	463.60	350	135.30	---	---	---	---	---	---	---	---
2/28/00		6	Field	2.83	20.33	8.12	7.08	728.80	463.40	360	134.50	---	---	---	---	---	---	---	---
2/28/00		6	Field	4.86	20.30	4.85	6.99	749.70	479.90	360	138.80	---	---	---	---	---	---	---	---
2/28/00		6	Lab	Middle	---	8.21	---	---	434.00	---	106.00	180	66.00	12.00	66.00	8.40	47.00	214.00	<0.1
2/28/00		7	Lab	Top	---	8.17	---	---	413.00	---	95.00	180	65.00	11.00	60.00	9.40	43.00	208.00	0.10
2/28/00		7	Field	Top	19.89	8.10	7.06	680.20	434.50	330	115.60	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
3/21/00	53.00																		
3/21/00		1	Lab	Top	---	7.70	---	---	420.00	---	141.00	106	45.00	8.50	90.00	7.90	58.00	147.00	<0.1
3/21/00		1	Field	Top	20.94	7.57	8.59	735.20	470.70	380	166.50	---	---	---	---	---	---	---	---
3/21/00		2	Field	1.00	20.96	7.50	5.90	742.20	474.70	380	178.90	---	---	---	---	---	---	---	---
3/21/00		2	Field	2.80	19.75	7.45	5.49	782.50	481.60	370	181.70	---	---	---	---	---	---	---	---
3/21/00		2	Field	5.00	19.74	7.42	5.56	758.20	486.60	370	188.60	---	---	---	---	---	---	---	---
3/21/00		2	Lab	Bottom	---	7.60	---	---	422.00	---	148.00	105	46.00	8.60	93.00	8.10	57.00	150.00	<0.1
3/21/00		2	Lab	Middle	---	7.70	---	---	415.00	---	147.00	106	45.00	8.50	93.00	7.70	56.00	147.00	<0.1
3/21/00		3	Field	1.00	21.35	7.52	6.05	743.60	476.50	360	173.70	---	---	---	---	---	---	---	---
3/21/00		3	Field	5.00	19.65	7.42	5.27	766.60	490.70	380	177.20	---	---	---	---	---	---	---	---
3/21/00		3	Field	9.00	19.56	8.58	5.10	767.50	491.20	380	177.20	---	---	---	---	---	---	---	---
3/21/00		4	Field	1.00	21.04	7.52	5.88	749.50	480.00	370	170.30	---	---	---	---	---	---	---	---
3/21/00		4	Field	3.30	20.21	7.47	5.62	745.10	478.70	370	172.20	---	---	---	---	---	---	---	---
3/21/00		4	Field	6.00	19.85	7.45	5.49	757.60	484.70	370	172.00	---	---	---	---	---	---	---	---
3/21/00		4	Lab	Bottom	---	7.60	---	---	430.00	---	150.00	106	46.00	8.80	96.00	8.50	55.00	151.00	<0.1
3/21/00		4	Lab	Middle	---	7.70	---	---	430.00	---	145.00	105	45.00	8.50	92.00	8.00	57.00	147.00	<0.1
3/21/00		5	Field	1.00	21.28	7.62	6.46	805.50	514.60	400	191.60	---	---	---	---	---	---	---	---
3/21/00		5	Field	4.75	20.22	7.57	6.24	852.30	551.00	430	218.40	---	---	---	---	---	---	---	---
3/21/00		5	Field	8.10	20.15	7.53	6.09	895.60	572.70	440	214.40	---	---	---	---	---	---	---	---
3/21/00		5	Lab	Bottom	---	7.70	---	---	578.00	---	176.00	125	59.00	11.00	108.00	8.10	66.00	193.00	0.10
3/21/00		5	Lab	Middle	---	7.70	---	---	553.00	---	169.00	124	59.00	11.00	105.00	8.60	65.00	193.00	0.10
3/21/00		6	Field	1.00	21.14	7.65	6.49	822.50	524.50	400	184.80	---	---	---	---	---	---	---	---
3/21/00		6	Field	4.50	20.60	7.64	6.30	826.30	522.80	410	189.80	---	---	---	---	---	---	---	---
3/21/00		6	Lab	Bottom	---	7.80	---	---	578.00	---	177.00	132	63.00	11.00	109.00	8.80	62.00	203.00	0.10
3/21/00		6	Lab	Middle	---	7.80	---	---	525.00	---	158.00	128	58.00	9.80	94.00	8.70	58.00	185.00	<0.1
3/21/00		7	Lab	Top	---	8.00	---	---	591.00	---	161.00	175	74.00	12.00	96.00	96.00	55.00	234.00	0.10
3/21/00		7	Field	Top	20.17	7.78	7.09	906.80	581.30	450	217.40	---	---	---	---	---	---	---	---
3/21/00		HB-2	Lab	GW: 7.00	---	6.90	---	---	12400.00	---	5460.00	367	920.00	185.00	3250.00	11.00	2010.00	3060.00	20.00
3/21/00		SP-1	Lab	GW: 6.70	---	7.40	---	---	7160.00	---	3570.00	634	125.00	82.00	2400.00	16.00	406.00	650.00	18.00
3/21/00		SP-2	Lab	GW: 4.00	---	6.90	---	---	1590.00	---	422.00	632	160.00	34.00	358.00	8.50	150.00	539.00	2.50
3/21/00		SP-3	Lab	GW: 4.00	---	6.80	---	---	883.00	---	214.00	424	135.00	14.00	153.00	3.00	41.00	395.00	0.70
3/21/00		WCID-3	Lab	GW: 2.25	---	7.10	---	---	2850.00	---	1070.00	550	1160.00	31.00	820.00	8.70	354.00	527.00	4.00
4/23/00	79.00																		
4/23/00		HB-1	Lab	GW: 2.50	---	6.87	---	---	15400.00	---	7140.00	538	800.00	300.00	4350.00	23.00	2200.00	3230.00	<0.1

Note: The depth of the groundwater samples (GW) refers to depth from ground surface.

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
5/10/00	0.00																		
5/10/00		1	Lab	Top	---	8.55	---	---	1470.00	---	622.00	195	96.00	43.00	338.00	21.00	128.00	417.00	1.50
5/10/00		2	Lab	Bottom	---	8.22	---	---	633.00	---	170.00	194	84.00	15.00	105.00	10.00	73.00	272.00	0.40
5/10/00		2	Lab	Middle	---	8.49	---	---	653.00	---	184.00	196	80.00	16.00	106.00	12.00	74.00	266.00	0.40
5/10/00		4	Lab	Bottom	---	8.17	---	---	620.00	---	165.00	195	78.00	15.00	99.00	10.00	69.00	257.00	0.30
5/10/00		4	Lab	Middle	---	8.46	---	---	650.00	---	184.00	194	83.00	15.00	106.00	11.00	73.00	269.00	0.30
5/10/00		5	Field	1.30	28.39	7.23	6.09	3739.00	2395.00	1970	216.30	---	---	---	---	---	---	---	---
5/10/00		5	Field	3.10	28.15	7.19	5.83	3747.00	2397.00	1970	223.50	---	---	---	---	---	---	---	---
5/10/00		5	Field	4.70	28.07	7.14	5.47	3709.00	2374.00	1950	244.60	---	---	---	---	---	---	---	---
5/10/00		5	Field	5.80	27.84	7.11	5.43	3714.00	2377.00	1950	350.90	---	---	---	---	---	---	---	---
5/10/00		5	Field	7.60	27.21	6.86	1.27	3721.00	2385.00	1950	378.80	---	---	---	---	---	---	---	---
5/10/00		5	Lab	Bottom	---	8.13	---	---	898.00	---	280.00	198	90.00	20.00	168.00	11.00	107.00	307.00	0.70
5/10/00		5	Lab	Middle	---	8.48	---	---	660.00	---	188.00	195	80.00	17.00	115.00	10.00	73.00	270.00	0.50
5/10/00		6	Field	1.50	28.32	8.17	6.22	1011.00	646.80	500	201.90	---	---	---	---	---	---	---	---
5/10/00		6	Field	2.50	28.11	8.14	6.02	1019.00	652.70	500	205.50	---	---	---	---	---	---	---	---
5/10/00		6	Field	3.50	28.07	8.13	5.95	1032.00	657.90	500	230.00	---	---	---	---	---	---	---	---
5/10/00		6	Field	4.50	28.04	8.10	5.86	1230.00	788.00	620	272.90	---	---	---	---	---	---	---	---
5/10/00		6	Lab	Bottom	---	8.25	---	---	798.00	---	240.00	194	88.00	18.00	141.00	11.00	95.00	294.00	0.50
5/10/00		6	Lab	Middle	---	8.47	---	---	658.00	---	186.00	195	80.00	16.00	108.00	11.00	72.00	266.00	0.30
5/10/00		7	Lab	Top	---	8.48	---	---	612.00	---	170.00	194	78.00	15.00	100.00	11.00	67.00	257.00	0.30
5/10/00		7	Field	Top	27.81	8.17	5.95	974.30	623.60	480	193.00	---	---	---	---	---	---	---	---

Date	Flow (cfs) at Calallen Dam (USGS 08211500)	Sample Site	Analysis Type (Field/Lab)	Depth (ft)	Temp (oC)	pH	DO (mg/L)	Specific Conductance (mS/cm)	TDS (mg/l)	Salinity (mg/l)	Chloride (mg/L)	Alkalinity (mg/l as CaCO3)	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Sulfate (mg/l)	Total Hardness (mg/l)	Bromide (mg/l)
6/12/00	18.00																		
6/12/00		1	Lab	Top	---	8.38	---	---	530.00	---	144.00	195	75.00	14.00	86.00	10.00	62.00	245.00	0.20
6/12/00		1	Field	Top	28.90	8.19	6.67	902.10	577.30	400	103.40	---	---	---	---	---	---	---	---
6/12/00		2	Field	1.37	29.04	8.18	6.02	909.70	582.10	450	117.00	---	---	---	---	---	---	---	---
6/12/00		2	Field	4.14	28.96	8.18	6.07	910.60	582.70	450	237.80	---	---	---	---	---	---	---	---
6/12/00		2	Field	6.73	28.75	8.09	5.32	932.50	596.40	400	230.30	---	---	---	---	---	---	---	---
6/12/00		2	Lab	Bottom	---	8.29	---	---	550.00	---	144.00	196	75.00	14.00	86.00	10.00	63.00	245.00	0.20
6/12/00		2	Lab	Middle	---	8.38	---	---	538.00	---	144.00	194	75.00	14.00	85.00	10.00	63.00	245.00	0.30
6/12/00		3	Field	1.57	29.05	8.21	6.23	904.80	578.70	440	112.10	---	---	---	---	---	---	---	---
6/12/00		3	Field	5.20	28.83	8.11	5.30	926.60	592.40	450	115.30	---	---	---	---	---	---	---	---
6/12/00		3	Field	8.93	28.70	8.07	4.94	937.00	597.20	460	114.80	---	---	---	---	---	---	---	---
6/12/00		3	Lab	Bottom	---	8.29	---	---	560.00	---	151.00	194	75.00	14.00	90.00	10.00	65.00	245.00	0.30
6/12/00		3	Lab	Middle	---	8.40	---	---	555.00	---	148.00	193	75.00	14.00	89.00	10.00	64.00	245.00	0.30
6/12/00		4	Field	1.34	29.10	8.20	6.14	906.30	570.00	440	111.90	---	---	---	---	---	---	---	---
6/12/00		4	Field	7.92	28.72	8.08	4.90	938.70	603.20	460	111.60	---	---	---	---	---	---	---	---
6/12/00		4	Field	12.20	28.20	8.06	3.23	903.80	580.90	440	105.70	---	---	---	---	---	---	---	---
6/12/00		4	Lab	Bottom	---	8.36	---	---	543.00	---	140.00	197	76.00	14.00	85.00	10.00	63.00	247.00	0.30
6/12/00		4	Lab	Middle	---	8.28	---	---	578.00	---	152.00	193	75.00	15.00	91.00	10.00	64.00	249.00	0.20
6/12/00		5	Field	1.14	29.54	8.26	6.49	851.60	545.20	420	96.66	---	---	---	---	---	---	---	---
6/12/00		5	Field	5.43	28.99	8.19	5.78	866.80	555.80	430	100.60	---	---	---	---	---	---	---	---
6/12/00		5	Field	10.19	28.73	7.86	4.45	1188.00	821.20	600	166.10	---	---	---	---	---	---	---	---
6/12/00		5	Lab	Bottom	---	8.33	---	---	748.00	---	222.00	196	83.00	17.00	136.00	11.00	96.00	277.00	0.60
6/12/00		5	Lab	Middle	---	8.39	---	---	518.00	---	132.00	183	73.00	14.00	82.00	10.00	60.00	240.00	0.20
6/12/00		6	Field	1.41	29.48	8.25	6.52	836.70	535.50	410	90.51	---	---	---	---	---	---	---	---
6/12/00		6	Field	2.51	29.31	8.21	6.03	835.70	535.70	410	91.38	---	---	---	---	---	---	---	---
6/12/00		6	Field	3.76	29.15	8.18	5.93	870.90	557.60	430	96.41	---	---	---	---	---	---	---	---
6/12/00		6	Lab	Bottom	---	8.40	---	---	540.00	---	135.00	192	73.00	14.00	81.00	10.00	63.00	240.00	0.10
6/12/00		6	Lab	Middle	---	8.45	---	---	513.00	---	128.00	193	73.00	13.00	77.00	10.00	60.00	236.00	0.30
6/12/00		7	Lab	Top	---	8.41	---	---	508.00	---	123.00	192	73.00	13.00	71.00	9.80	56.00	236.00	0.10
6/12/00		7	Field	Top	28.96	8.25	6.49	814.70	521.20	400	110.40	---	---	---	---	---	---	---	---

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Appendix I.2

Surface Water – Groundwater Interactions Study

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Surface Water – Ground Water Interactions Study

As part of the Senate Bill 1 Regional Water Planning Program for the Coastal Bend area, HDR Engineering, Inc., the Nueces River Authority, and the Center for Water Supply Studies at Texas A&M University – Corpus Christi initiated an effort to identify the possible sources of elevated levels of dissolved solids in the Nueces River water. This initial phase of investigation included monitor well installation, groundwater and surface water sampling, obtaining and interpreting aerial/satellite imagery of the area between Wesley Seale Dam and Calallen Pool, possible point source contributions (specifically, abandoned oil and gas well and sand/gravel washing operations), and groundwater intrusion.

The Calallen Pool

In his book "Corpus Christi Water Supply Documented History 1852 – 1997," former Corpus Christi Water Superintendent, Atlee Cunningham, P.E., described the development of the Calallen Pool:

> *Prior to construction of the Calallen Dam, the lower reach of the Nueces River consisted of a salt water estuary with a bottom elevation below sea level for a distance of 23.17 miles upstream from the mouth of the River where it empties into the Nueces Bay. This section, which includes the area known now as the Calallen Pool, was subject to salt water intrusion during periods of high tides, wind tides and drought conditions when the river flow was not sufficient to keep the river fresh. The combination of tidal surges from the Nueces Bay into the lower reach of the river and groundwater seepage from the salt flats increased salinity to levels which made the water unfit for public use.*
>
> *To mitigate the saltwater intrusion problem the Calallen Dam was constructed. The dates that the dam construction was started and finished are not known; however, the first work is estimated to have started around 1898. The dam construction was described as being wood crib type construction extending across the river channel with sand and loose rock fill. The cribbing was made of cut cypress and assembled into nine foot square cribs. The walls of the crib were made of seven by seven inch cypress timber installed vertically with seven by seven inch whalers. These dimensions were confirmed on June 22, 1971 by city water crews excavating one of the cribs for inspecting and measuring. The cribs were constructed to sit on the river bottom according to the depth of water at that crib location with the maximum depth being 16.5 feet. The first crest of the dam was 1.5 feet above high tide and created a 928 acre foot reservoir within the natural river channel for a distance of about ten miles upstream to near Bluntzer, Texas. This is known as the Calallen Pool. In 1952, the City of Corpus Christi completed constructing a concrete spillway across the dam with a crest 4.5 feet*

above high tide. This height increase of the dam increased the total storage to 1,273.4 acre feet.
In 1964, the City of Corpus Christi Water Division measured the amount of leakage through the dam and reported leakage averages 34.2 gpm at reservoir level of 4.5 feet on the staff gage with a down stream water surface elevation of 0.6 feet msl. This leakage will remain relatively constant since it is due to leakage through the interlocking steel sheet piling and will decrease as the reservoir is drawn down.

Today, the majority of the diversions for municipal and industrial (M&I) water supply in the Coastal Bend area are drawn from the Calallen Pool. Five pump stations are located on its banks: City of Corpus Christi Stevens Water Treatment Plant Intake and Pump Station; San Patricio Municipal Water District Raw Water Intake; WCID No. 3 (Robstown) Pump Station; Celanese – Bishop Facility Raw Water Pump Station; and Koch Refinery Raw Water Pump Station. Water quality in the Calallen Pool has a direct bearing on the final quality of potable and industrial water supplies throughout the region. The problem of elevated dissolved solids in the water withdrawn from the Calallen Pool is therefore a major concern from both a human health and a water use/water conservation perspective. The current investigation is designed to provide additional information that can be used to address this problem.

Potential sources of elevated levels of dissolved solids in the Nueces River water in the Calallen Pool include:

- Saltwater intrusion
- Groundwater seepage
- Oilfield impacts
- Sand and gravel washing operations

Saltwater Intrusion

Studies have suggested that saltwater intrusion from the Calallen Dam is a source of dissolved solids in the Calallen Pool. However, there is no direct evidence that can identify whether this process is occurring or, if it is occurring, to what extent it is contributing to the elevated total dissolved solids (TDS) levels above the Calallen Dam. It has been suggested that the density gradient between the fresh water upstream of the dam and saltwater downstream of the dam is the source of the saltwater intrusion. However, the range in elevation difference is never small enough between the upstream and downstream sides of the dam for the density gradient to overcome the hydraulic gradient.

Groundwater seepage

In his book, Atlee Cunningham also described the physical and geological setting that results in groundwater seepage into the Calallen Pool:

The Calallen Pool resides in a flood plain area identified as a salt water bay. The salt deposits from the evaporated prehistoric shallow bays are partially dissolved by rainfall seeping downward through the soil then carried into the natural river channel with the groundwater seepage inflow. This causes the inflow to be highly saline. The United States Geological Service has found the ground water in the flood plain to have a saline content of as much as 23,000 parts per million. Typically, however, the salt seepage inflow along the river banks through the salt flat or flood plain area is in the range of 3,000 parts per million. During periods of low flow in the river this salt intrusion adds to the brackish condition of the water.

Any attempt to pump the water below minus 4.5 foot elevation will cause an inflow of highly saline water from the bed and banks of the river. During periods of no flood flows the salt water accumulated in the low sections of the river bottom. We found the chloride content of the water, at a depth of twelve feet, to be in the thousands of parts per million and far too saline to use for domestic or industrial purposes.

The profile showing the 1913 soundings of the river bed in the Calallen Reservoir show an uneven bottom from the dam to Bluntzer. It also shows the presence of saline water and dead storage that severely limits the amount and quality of usable storage. During the years from 1898 to 1933, the city operated the reservoir with the water surface from the dam crest down to –1.5 feet elevation. This could be done due to the small suction pipe and low flow velocities whereby a vortex would not be created. However, when water levels in the reservoir were lowered to below sea level, salty groundwater flowed from the adjacent saline sand and raised the chloride content of the reservoir water in excess of the limits set by the United States Public Health Service. The State Health Department made two investigations of the source of saline water intrusion into the Calallen Reservoir: Lower Nueces River Chloride Investigation in January 1960 and Lower Nueces River Water Quality Survey in 1961. The Texas Water Rights Commission made further studies on both saline water intrusion and water quantity gain or loss in transit. The surveys were made by taking river flow measurements at the state highway bridge at Bluntzer and at the stream flow gaging station below Lake Corpus Christi. The Bluntzer location was at the head of the Calallen Reservoir and the results do not include losses or gains in the 10.5 miles of the reservoir. A portion of the findings is as follows:

August	*20 ppm chloride gain with 15 cfs loss (149 cfs to 134 cfs)*
February	*37 ppm chloride gain with 8 cfs loss (150 cfs to 142 cfs)*
August	*47 ppm chloride gain with 3 cfs gain (145 cfs to 148 cfs)*

The Water Division had determined that the losses in the upper reach of the river were affected by irrigation from wells on the Knolle Dairy Farm near Sandia, Texas. The river channel passes through gravel deposits near the dairy farm and the wells are located nearby with a depth of approximately 80 feet. Prior to the drilling of the wells, the owner had been irrigating from the river until being stopped the City of Corpus Christi and the Water Rights Commission for taking water from the river without a permit. One study indicated a loss of approximately 10% but did not identify the cause. The study included mineral analysis of ground water from test wells that were placed in the flood plain (known as the salt flats) near the reservoir and tree line and found shallow ground water a few feet below the surface that had up to 22,000 parts per million of chlorides. The study also showed that the test wells in the tree line were affected by the time of day and weather.

Saline groundwater was found at the O.N. Stevens water plant construction site of an intake flume on the river in 1954 where it was necessary to excavate the East bank to a depth of twelve feet below sea level. A coffer dam was placed in the river to hold the water back, and well points were used to dewater for excavation. The groundwater was pumped continuously for several months with a salt content of approximately 3,000 parts per million while the structure was completed. The same groundwater condition was found in 1982 when the O.N. Stevens plant was expanded and a new river pump station was constructed upstream from the 1954 plant's river station. The inflow of groundwater along the 35 miles of river caused the chlorides in the water from the lake to increase an average of 50 parts per million and also reduced losses somewhat. A flow of 75 mgd would gain 50 ppm; however, a higher rate would reduce a gain by dilution. Also, a higher flow of groundwater, due to rainfall on the flood plain, would increase the saline water flow into the Calallen reservoir. A flow of 75 mgd in the river would require 31,294 pounds of salt to produce a 50 ppm gain by assuming that the groundwater had 3,000 ppm of chloride salt. This would require an inflow of 1.25 mgd of saline water to raise the chloride content of the 75 mgd flow from the lake by 50 ppm.

During the 1960's, the City of Corpus Christi Water Department made an extensive field investigation of the water gain and loss in the 25 mile reach of the Nueces River from the Wesley Seale Dam to the Calallen Dam. It was found that an average loss of 7.74 cubic feet per second or 5 mgd occurred throughout the months of March to September during the growing season. The loss started as the leaves appeared on the trees in the Spring at twice the average rate, then decreased to no loss six months later. No loss was noted on overcast days and the remaining months. Variation in the river flow made no noticeable difference in the loss rate. The annual loss averaged 2,801 ac-ft or 913 million gallons. Assuming that all saline water inflow averaged 3,000 ppm of chlorides, the annual inflow would be 457 million gallons. During the years that the City of Corpus Christi was surviving on the storage in the Calallen Reservoir and during periods of no flow in the river, the saline seepage benefited the city; however, the chlorides became excessive at times and created problems in irrigation. The use *of the reservoir was made possible due to the short critical period of two months when local rainfall or a rise in the river would freshen the reservoir water. Irrigators in the Nueces County WC&ID (Robstown) often complained of the salty water and were grateful for fresh water after a freshening of the river.*

Several attempts to farm the flood plain in the first three decades of this century were without success. A few inches to a foot of fresh water generally can be found in the flood plain resting on the saline water layer which is about three feet from the surface. The soil is predominately coarse, usually referred to as "buckshot", that is very pervious and will hold moisture for only a short time. Salt tolerant bunch grass grows well in the flood plain and is used for cattle grazing. Hackberry, willow and river elm grow along the river in a band some 50 feet wide where their roots can have access to the fresh river water. Vegetation returns to the salt grass immediately beyond the tree line.

Intrusion of higher salinity groundwater into the surface water residing in the Calallen Pool is a fairly well documented occurrence. However, the information published to date does not provide enough definition on the various sources, flux rates and chemical characteristics to determine if these contributions can be reduced through changes in operating policies, intake structures, or other measures. This investigation, including the installation of permanent groundwater monitoring wells, is designed to provide new information that will better identify the nature of the groundwater intrusion and develop appropriate measures to address the problem.

Oilfield impacts

Oil and gas production facilities dot the flood plain along both sides of the Nueces River between Wesley Seale Dam and the Calallen Pool. While current regulations prohibit the discharge of "produced water" (brines) into freshwater streams, the practice seems to have been fairly widespread at one time and was thought to have been at least one source of the TDS loadings in this reach of the Nueces River. Atlee Cunningham wrote that:

Daily chemical analysis of the river water at the plants, when compared with the water analysis leaving the lake, showed an approximate gain of 50 parts per million of chlorides while in transit from the lake. At first, it was thought that the salt was from six oil fields located along the river, and a thorough investigation was made to find the pollution source. Some illegal discharge was found and stopped; however, the tonnage of salt necessary to produce 50 ppm chloride gain at the water plants was far greater than could be produced by the oil fields.

While current oil and gas operations are required to dispose of produced water via injection wells or other methods besides discharge to surface waters, it is possible that historical contamination of soils and shallow aquifers in the vicinity of these operations could still contribute TDS loadings periodically during runoff events or continually from groundwater discharge to creeks and other tributary streams. Additionally, improperly plugged oil and gas wells may allow brine waters to come to surface and recharge the water table aquifer. Determination of the quantity and quality of these discharges is extremely difficult, but this investigation attempts to locate potential sites where impacts from oil and gas operations may be occurring by using remote sensing imagery to evaluate site conditions around abandoned oil and gas wells to determine if impact to vegetation has occurred at these sites (Appendix 1).

Sand and gravel washing operations

The alluvium in the flood plain of the Nueces River below Wesley Seale Dam is a rich source of construction grade sand and gravel materials. A number of commercial sand and gravel mining operations have operated in the area around Bluntzer and San Patricio, as well as downstream in the County Road No. 73 area. These operations excavate large pits to expose deposits of sand and gravel, then remove these materials, some of which then undergoes rinsing to remove clays and other fine sediments. Because of the shallow groundwater levels in these flood plain areas, these pits invariably fill with groundwater, often of a fairly brackish nature, which is then used to rinse the excavated materials. The rinsing operations sometimes generate discharges into creeks and other tributary streams, ultimately impacting the Nueces River. Atlee Cunningham described these activities:

> *Several gravel pits were located on either side of the river from Riverside area to above Bluntzer. Each pit had high salt content in the groundwater, which was used in the gravel washing operation. Occasionally, the water would accumulate and interfere with the mining of the gravel, at which time the excess water would be pumped to a drainage ditch. The salt water would either flow into the river or accumulate and be washed into the river at the next rain. We were able to pursued the pit owners to store the excess water in worked out pit; however, since the gravel strata crossed the river in a number of locations, we felt that most of the salt increase in the river above Bluntzer was from the gravel pits.*

Today, several active sand and gravel washing operations exist along the reach of the Nueces River between Wesley Seale Dam and the Calallen Dam. Remnant pits from suspended operations also exist throughout the same area. Two of the larger existing sand and gravel mining operations are the Wright Materials, Inc. facilities and the Bay, Inc. facility. However, a review of active water quality permits in the Texas Natural Resource Conservation Commission (TNRCC) Water Quality Permit Application database for facilities in Nueces, San Patricio, and Jim Wells counties revealed Wright Materials, Inc. as the only permittee with a designation of a sand and gravel washing operation (SIC 1442) (Appendix 2). According to local sources, another sand and gravel mining operation is being developed on the North bank of the Calallen Pool, just upstream from Hazel Bazemore Park, but no record of this pending operation exists in TNRCC files.

Applicable regulations for sand and gravel washing operations are: the Federal Clean Water Act – Section 402; Texas Water Code § 26.027; and 30 Texas Administrative Code Chapter 305, Subchapters C through F, Chapter 307 and 319, as well as TNRCC policies and EPA guidelines. Wright Materials, Inc. operates the Nason Plant No. 1 as an industrial wastewater permittee under the Texas Pollutant Discharge Elimination System (TPDES) Permit No. 02027 (TX0070629) issued November 29, 1999 and expiring May 1, 2003. As Wright Materials, Inc. mines for sand and gravel, groundwater infiltrates existing ponds which were previously mined areas. Stormwater runoff and washwater discharges also enter these ponds. The permitee stated in the permit application that no discharge occurs from these ponds except in unusually large floods. In such a situation, pumping is required until the water level in the ponds is lowered. Exhibit 5 of the permit application illustrates the poteniometric surface of the water table is encountered 15 feet below ground surface, a fine sand strata between 15 and 20 feet below ground surface and a sand/gravel strata interval between 20 and 40 feet below ground surface. According to the "Statement of Technical Summary" in their most recent permit application, the Nason Plant No. 1 had no occurrence of such discharge during the previous self-reporting interval -- from December 1996 through May 1999.

The Nason Plant No. 1 is located on Farm-to-Market Road 3088, approximately 1.5 miles northwest of intersection of Farm-to-Market Road 624 and Farm-to-Market Road 666, and approximately ten miles northwest of the City of Robstown, Nueces County, Texas. During large rain events, their permit states that stormwater is discharged into Cayamon Creek; thence into Segment No. 2102 of the Nueces River Basin (the "Nueces River Below Lake Corpus Christi"). Stream Segment No. 2102 is effluent limited. The designated uses for Segment No 2102 are high aquatic life use, contact recreation, and public water supply. Under the TPDES permit for the Nason Plant No. 1, Outfall 001, which discharges from the holding pond to Cayamon Creek, has discharge limitations (single grab sample) for total suspended solids (TSS) of 45 mg/l and chlorides of 300 mg/l (Appendix 3). Sample results reported in the most recent permit renewal application, dated January 8, 1998, revealed that a grab sample obtained at Outfall 001 had a TSS concentration of 24 mg/l and chlorides of **490 mg/l,** with total dissolved solids of 1,448 mg/l. This was the only documented grab sample reported for Outfall 001 found during TNRCC Region 14 record review (Appendix 3).

The City of Corpus Christi Water Division monitors, twice monthly, a number of water quality parameters, including chlorides, at stations along the Nueces River between the Wesley Seale Dam and Calallen Dam. One of these stations is located where Cayamon Creek discharges into the Nueces River. Samples taken from Cayamon Creek at this location consistently reveal chloride levels an order of magnitude greater than samples taken directly from the Nueces River above and below this station. Whether the high chlorides in Cayamon Creek are the result of natural sources such as brackish groundwater discharges, or the result of anthropogenic activities such as sand and gravel mining operations or oil and gas extraction, this water is discharged into the Nueces River and can have a significant impact on TDS levels.

The relationship between the discharges from Cayamon Creek and elevated TDS levels in raw water being diverted to the City of Corpus Christi O.N. Stevens Water Treatment Plant were identified during Atlee Cunningham's tenure as Water Superintendent for the City of Corpus Christi. He noticed that elevated TDS levels occurred at the water treatment plant during discharges from Cayamon Creek and routinely reported these episodes to the local office of the Texas Water Quality Commission (now TNRCC), asking that they investigate and cite the sand and gravel operators for any permit violations that may be occurring **(Personal Communication, Jim Bowman, Air Program Manager (and former Water Quality Program Manager), TNRCC Region 14).**

Current monitoring data and historical information support the fact that sand and gravel mining operations have the potential to contribute brackish groundwater and surface water discharges to the Nueces River. The most recognizable problem is episodic point source discharges, primarily during higher rainfall periods. Less definable is the contribution of higher TDS groundwater discharging into the Nueces River on a regular basis. This signal may be too difficult to detect in the background of natural discharges of brackish groundwater.

Surface Water – Ground Water Interactions

Monitoring Well Installation

One of the primary objectives of this study was to investigate the potential interaction of groundwater in sediments along the Nueces River with surface water in the Calallen Pool. In order to measure groundwater levels and obtain samples of the groundwater, the study included the installation of several permanent monitoring wells. Seven borings, completed as monitor wells, were drilled at four locations adjacent to the Nueces River. Access agreements were acquired and formalized by letter where appropriate (Appendix 5). The four locations were selected based on drilling rig accessibility requirements, underground utility and pipeline locations, and areas of most significant hydrogeologic interest. The locations, well designations, and location considerations were as follows:

The first Hazel Bazemore Park site (**HB-1, HB-2**) is located where previous hand augered groundwater samples were collected. Previous analyses indicated that the ionic ratios in those samples closely matched the ionic ratios found in samples of the more saline, stratified water of concern in the Calallen Pool. The second site, in Hazel Bazemore Park (**HB-3, HB-4**), is located near the WCID # 3 intake and adjacent to a deeper pool of the Nueces River where stratification of water has been observed in previous investigations. The third site, on the San Patricio Municipal Water District (MWD) pump station property (**SP-1, SP-2**), is located near the Calallen Dam and a raw water intake where there has been noticeably elevated total dissolved solids and chlorides concentrations. The last site, at the City of Corpus Christi Cunningham Plant (**CP-1**), is adjacent to a deeper pool of the Nueces River close to both the Celanese – Bishop and the Koch Refinery raw water pump stations. This site is on the opposite side of the Nueces River from the **SP-1** and **SP-2** sites and will be important for future use in making water level comparisons from each bank and the river surface to establish gaining and losing stream conditions as water releases and other system changes occur. The locations of these monitoring well sites are shown in Appendix 6.

A well arrangement of 2 wells per location was established in order to screen and characterize groundwater at various depths. An exception to this arrangement was made at the Cunnigham Plant location where steep banks and unmapped underground hazards prevented safe installation of more than the one well.

The monitor wells were installed by Charles Thomas Weakley of Front Range Environmental, a licensed water well driller with the Texas Department of Licensing and Regulation (License Number WWDPMP00002094). The borings were drilled using a hollow stem auger and completed as wells constructed of 2 inch PVC and 2 feet of .010 inch slotted screen. The wells have a minimum two foot stick-up surrounded by a metal riser mounted in a 3 foot by 3 foot sloped concrete surface pad. Additionally, each well is equipped with a watertight sanitary well seal and is secured with a locked protective casing.

Sediment samples were collected during drilling using a split spoon corer or taking a grab sample between auger flights, depending on the lithology. Where possible, cores from the split spoon have been retained and are being stored at the Center for Water Supply Studies laboratory. Additionally, grab samples have also been retained and stored should further analysis of the samples be desired in future studies.

The borings were completed to a depth determined by the onsite geologist. The shallow well of each paired well was set at a depth just below the depth where water was first encountered in the boring. The shallow well completion represents the first water bearing sand. The deeper well of the well pair was set at a depth of about 10 feet below the first water bearing sand in the most appropriate water-bearing unit. The air-lift method was used to develop the wells (Appendix 7).

Naismith Engineering surveyed the wells to measure top-of-casing elevations to a referenced bench mark so that extremely accurate measurements may be obtained to evaluate shallow groundwater levels relative to various Nueces River stage heights. Previous survey efforts near the Calallen Dam as reported by Atlee Cunningham consisted of the following:

> *The river staff gage was established on May 8, 1915 and a bench mark was installed on the top of the concrete intake suction box in 1916 by the USGS at elevation 2.19 feet mean sea level. The USGS records show that the river gage was set with the 0.0 on the gage at 0.84 feet msl, USGS datum or at high tide. When the 1898 reservoir was full the gage registered 1.5 feet of storage above high tide which would be a surface elevation of 2.34 feet msl USGS datum. The USGS installed a benchmark No. 4 at elevation 19.2 feet USGS on the top of the circular clear well west of the 1915 pump house on September 4, 1939.*
>
> *Survey discrepancies exist for the actual height of the Calallen Dam crest. The elevation had been estimated to be 5.62 feet msl, USGS datum but not verified by survey. According to Mr. Cunningham, the elevation should be 5.34, USGS*

datum if the river gage was set with 0.0 on the gage at the 0.84 USGS datum when the dam was increased in height.

Groundwater and Surface Water Sampling

On October 27, 2000 HDR Engineering, Inc., Nueces River Authority, and the Center for Water Supply Studies staff sampled the recently installed groundwater wells and the Nueces River at two locations. R-1 was a surface water sample collected from the banks of the Nueces River most adjacent to the HB-3/HB-4 well cluster. R-2 was a surface water sample collected from the banks of the Nueces River most adjacent to the SP-1/SP-2 well cluster. The daily average flow of the river was 119 cubic feet per second (cfs). Well volumes were calculated for each well and a minimum of three well volumes was purged from each well using a bailer.

On October 30, 2000 the Nueces River Authority staff collected additional samples from the Nueces River. Two samples were collected at the deep pool near the O.N. Stevens pump station. OS1-B was collected near bottom and OS1-M was collected near the middle vertical depth of the Nueces River. Two samples were collected at the deep pool near the Robstown intake. WCID1-B was collected near bottom and WCID1-M was collected near the middle vertical depth of the Nueces River. Water releases from the reservoir system were occurring and the flow was 336 cfs. The river system was "well-flushed" due to previous releases and the release amount between October 27 and October 30, 2000, which exceeded 1927 acre-feet, the total capacity of the Calallen Pool.

Surface water and groundwater samples were analyzed for dissolved constituents including cations (calcium, magnesium, sodium, and potassium) anions (carbonate, bicarbonate, sulfate, chloride), total dissolved solids (TDS), alkalinity (as calcium carbonate) and hardness (as calcium carbonate) (Appendix 8)

The results of the sampling program (Appendix 9) support previous investigations conducted by USGS and others. The groundwater sampled in the wells have chloride concentrations in excess of 1,000 ppm and more in the range of 2,000 to 3,000 ppm, except for CP-1 and SP-2. CP-1 is screened in a gravel/sand which appears to be in direct communication with the river. SP-2 is completed almost entirely in clay and goes dry during purging. Analytical results from SP-2 probably more closely represent pore water in the clays than formation water from a productive aquifer system. The graph represents the separate nature of the groundwater versus surface water which would be present in a fresh surface water system that partially penetrates a flood plain area identified as a saltwater bay. Earlier studies conducted by HDR and others indicate stratification of the channel was found to be the most significant when no water was spilling over Calallen dam and the least detectable during periods of high flow. This "flushing" of the stratification in the channel is supported because the Nueces River samples collected are very consistent with each other in their geochemical nature or "fingerprint" and releases were occurring during the sampling event.

Conclusion

Groundwater seepage, **oilfield impacts**, and **sand and gravel operations** all appear to be contributors to the degraded water quality along the reach of the Nueces River between Wesley Seale Dam and Calallen Dam. Saltwater intrusion is an unlikely contributor. To prioritize the relative contributions of these various sources to the elevated levels of dissolved solids in the water in the Calallen Pool, it is necessary to develop some criteria relating the volume and concentration of loading of dissolved solids - primarily chlorides – with its impact on waters in the proximity of intake structures of the raw water users.

Saltwater intrusion has been indicated as a possible source of high dissolved solids in the lower Calallen Pool. However, there is not direct evidence that this is occurring. The Nueces River Authority conducts routine sampling in the Calallen Pool and has demonstrated that the San Patricio Municipal Water District intake structure which is closest to the Calallen Dam is most significantly impacted by increased dissolved solids. The City of Corpus Christi has launched a comprehensive study to evaluate the integrity of the Calallen Dam. This study coupled with previous SB1 studies conducted by HDR and another phase of investigations originating from the findings of this report should provide the stakeholders some best management practices.

Based on previous accounts documented by Atlee Cunningham, USGS and others, **groundwater seepage** is a significant contributor to increase in dissolved solids in the Calallen Pool during low flow conditions. This occurrence is supported by the sampling program undertaken by HDR in previous studies and continued in this investigation. The opportunity exists with permanent monitor wells in place around the Calallen Pool to conduct a comprehensive sampling program. This sampling program would evaluate the gaining and losing nature of the surface/groundwater system and then relate this information to surface water and groundwater sample results acquired during this same period of time. The time period would include events where the Calallen Pool experiences low and high flow conditions. Best management practices and mitigation can then be suggested.

Oilfield impacts from brine water discharges, improperly plugged and abandoned wells, and historical contamination can be mitigated now that the locations of the oilfield activities have been identified. Compliance monitoring for brine water discharges and continued remote sensing evaluation of the oilfield areas coupled with ground truthing could be a method used to establish any impacted areas. If improperly plugged and abandoned wells are identified, mechanisms exist to pursue proper plugging and abandonment of these wells, which includes accessing a fund administered by the Railroad Commission to address plugging of abandoned wells. None of the sample results in this investigation revealed the geochemical "fingerprint" which directly relates to brine water associated with oil and gas wells. The specific characteristic of undiluted brine water is the absence of the sulfate. However, to adequately determine the contribution of the oilfield impacts, samples would need to be taken closer to the source where dilution from groundwater or surface water would be minimal.

Sand and gravel washing operations contribution to increase dissolved solids in the Calallen Pool could be significant. Based on accounts documented by Jim Bowman and Atlee Cunningham, upsets in the surface water treatment plant can be directly related back to episodic point discharges from the sand and gravel washing operations. Also the less definable contribution of higher TDS groundwater discharging into the Nueces River on a regular basis may have a significant impact to the cumulative increase in dissolved solids – primarily chlorides. A sampling program which involves sampling upstream of the sand and gravel pits as well as the pits ponds and discharge points would better define this impact. Further groundwater quality assessments in the areas where the pits are located, may determine that the daily maximum limit of 300 mg/l chlorides taken as a grab at the point of discharge or designated outfall may not be obtainable. Further compliance monitoring and evaluation of the potential of non-permitted discharges is recommended especially in view of the fact that these operations are increasing along this reach of the river with the latest account of activity occurring off the North bank of the Calallen Pool. The extensive marking on the aerial photograph of remnant pits and ponds from gravel and sand washing operations suggests that these inactive sites should also be evaluated as to their impact to the water quality along the Nueces River.

Appendices

1 Aerial imagery with stress vegetation results
2 TNRCC water quality permit application database query
3 Wright Materials, Inc., Permit No. 02027
4 Sample results from outfall 001
5 Signed access agreement letter for groundwater monitor well installation in Hazel Bazemore Park
6 Aerial image with well location information
7 Monitor well logs
8 Sample results
9 Sample graphs

Appendix 1
Aerial Imagery with Stressed Vegetation Results

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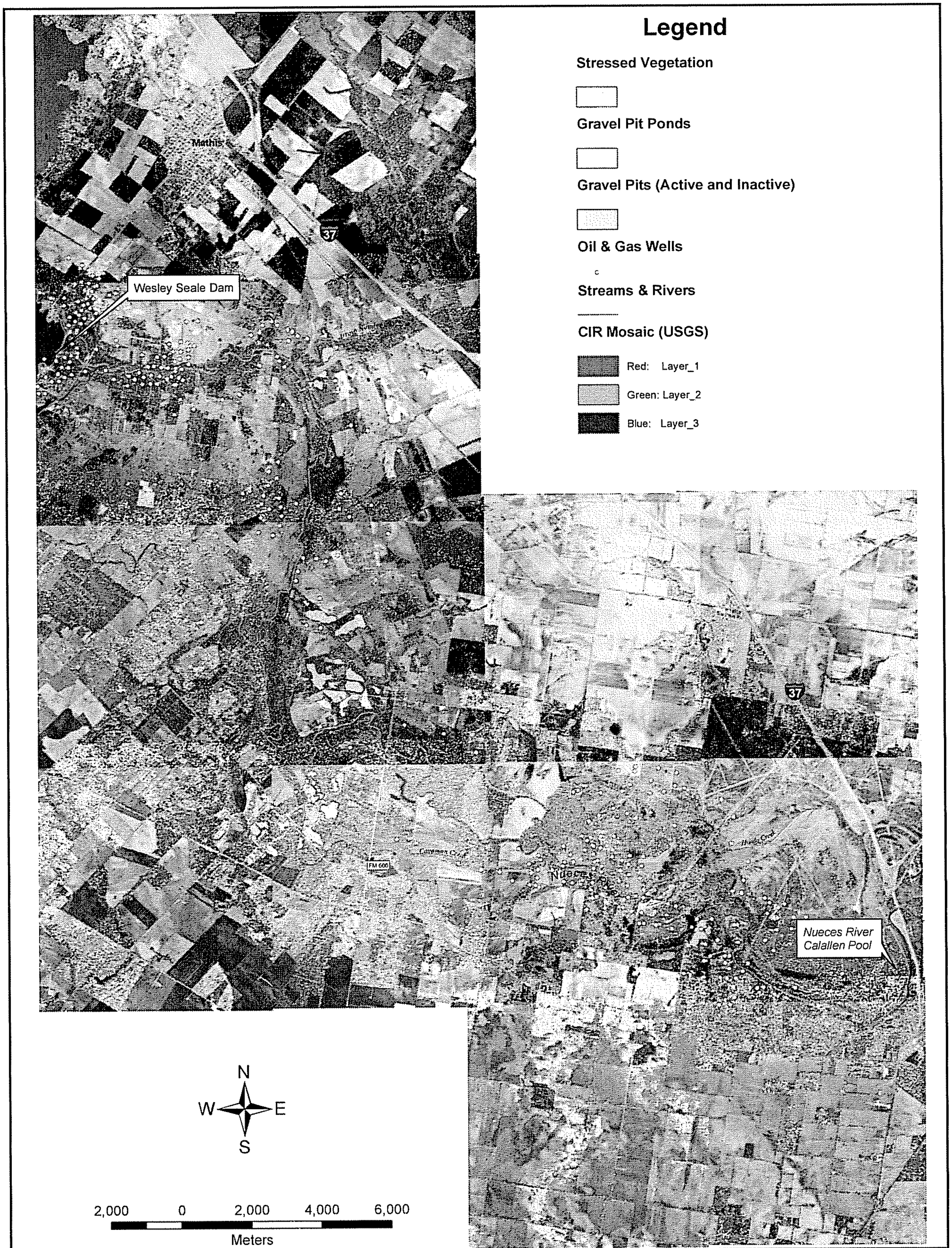

Appendix 1. Aerial Imagery with Stressed Vegetation Results

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Appendix 2
TNRCC Water Quality Permit Application Database Query Results

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

Dear Data Requestor:

Enclosed is the information you requested. The TNRCC Information Resources Division is pleased to provide this service "at cost" to those needing such information. Please understand that we cannot guarantee the accuracy or completeness of the information being supplied. At the time your request was processed, this data was the most current information available from our database and every effort was made to retrieve it according to your specifications.

If the information you receive is in a digital format and you find it to be unreadable, please contact our customer service representatives at (512) 239-3282 ***within 45 days of*** *the invoice date. The original purchaser may request a replacement at no additional charge.*

For your convenience, we have attached the individual business card of the staff member who processed your request. Please contact this person if you have any questions or need additional information.

Thank you for the opportunity to serve you through our TNRCC Information Resources Division.

Sincerely,

Carry Shults

Carry Shults
Director
Information Resources Division

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/239-1000 • Internet address: www.tnrcc.state.tx.us

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Texas Natural Resource Conservation Commission

LPS Form [illegible] [illegible]

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M Un sity

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010536-002 TPDES0034002	ALICE, CITY OF 500 E MAIN ALICE, TX 78332	SOUTHSIDE PLANT	Active Jim Wells	14 22 2492 Public Domestic Major	Municipal Gover 00/07/11	49520 05/07/01
	ALICE CITY OF	Self Reporting Contact				
	1 OTFL 001 SOUTHSIDE PLANT	*TPDES*	Active	Discharge	3 89/04/10	/ /
WQ0010536-004 TX0091219-000	ALICE, CITY OF PO BOX 3229 ALICE, TX 78333	East Plant	Active Jim Wells	14 22 2492 Public Domestic Major	Municipal Gover 95/02/28	49520 00/02/28
	ALICE, CITY OF	Self Reporting Contact				
	4 OTFL 001 East Plant		Active	Discharge	3 92/10/01	/ /
	104 Soil Mon 104 Ann 0-6 inches		Active	Sample	1 95/02/28	/ /
	204 Soil Mon 204 Ann 6-18 inches		Active	Sample	1 95/02/28	/ /
	304 Soil Mon 304 Ann 18-30 inches		Active	Sample	1 95/02/28	/ /
WQ0003330-000 TPDES0121690	HOWELL CATTLE CO., INC. DRAWER 809 PREMONT, TX 78375-0000	CATTLE FEEDLOT 10000	Active Jim Wells	14 22 2492 Agricultural-B Minor	Corporation 00/01/14	02110 01/04/26
	JESSE W HOWELL	Self Reporting Contact				
	1 CATTLE FEEDLOT 10000 HEAD *TPDES*		Active	Retention	1 96/04/26	/ /
	101 SOIL MON 101 ANN 0-6 *TPDES*		Active	Sample	1 91/09/18	/ /
	201 SOIL MON 201 ANN 6-18		Stopped	Sample	1 91/09/18	/ /
	301 SOIL MON 301 ANN 18-30		Stopped	Sample	1 91/09/18	/ /
	401 SOIL MON 401 ANN 6-24 *TPDES*		Active	Sample	1 00/01/14	/ /
WQ0003009-000 TPDES0131105	KNOLLE CATTLE COMPANY RT 1 BOX 37 SANDIA, TX 78383-0000	DAIRY FARM 950	Active Jim Wells	14 21 2102 Agricultural-B Minor	Corporation 00/08/04	02410 05/08/04
	KNOLLE CATTLE COMPANY	Self Reporting Contact	512-547-6501			
	1 OFLT 001 TPDES		Active	Retention	1 88/11/29	/ /
	101 SOIL MON 101 ANN 0-6 TPDES		Active	Sample	1 88/11/29	/ /
	201 SOIL MON 201 ANN 6-24 TPDES		Active	Sample	1 00/08/04	/ /
WQ0010592-001 TPDES0020397	ORANGE GROVE, CITY OF P.O. BOX 1350 ORANGE GROVE, TX 78372	CITY OF ORANGE GROVE	Active Jim Wells	14 22 2204 Public Domestic Minor	Municipal Gover 99/10/07	49520 00/06/01
		Self Reporting Contact				

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001		Active	Discharge	6 96/01/01	/ /
WQ0010253-001	PREMONT, CITY OF P O DRAWER 340 PREMONT, TX 78375-0000	City of Premont	Active Jim Wells	14 22 2492 Public Domestic Minor	Municipal Gover 88/01/05	49520 98/01/05
	PREMONT, CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Retention	3 88/01/05	/ /
	101 SOIL MONITORING INPT 101		Active	Sample	1 88/01/05	/ /
WQ0003435-000	SANDIA AGRICULTURAL ENTP INC PO BOX 119 SANDIA, TX 78383-0000	DAIRY FARM 450	Active Jim Wells	14 21 2102 Agricultural-B Minor	Corporation 97/02/14	02410 02/05/08
	SANDIA AGRICULTURAL ENTP INC	Self Reporting Contact				
	1 DAIRY FARM 450 HEAD		Active	Retention	1 97/02/14	02/05/08
	101 SOIL MON 101 ANN 0-6 IN		Active	Sample	1 92/05/08	/ /
	201 SOIL MON 201 ANN 6-18 IN		Active	Sample	1 92/05/08	/ /
	301 SOIL MON 301 ANN 18-30 IN		Active	Sample	1 92/05/08	/ /
WQ0010140-001 TX0033367-000	AGUA DULCE, CITY OF P.O. Box 297 Agua Dulce, TX 78330-0000	City of Agua Dulce	Active Nueces	14 22 2204 Public Domestic Minor	Municipal Gover 94/11/04	49520 99/11/04
	AGUA DULCE CITY OF	Billing Contact Self Reporting Contact	(512)-998-2532	Ext:		
	1 OTFL 001 City of Agua Dulce		Active	Discharge	3 89/07/10	/ /
WQ0002291-000 TPDES0081647	APPLIED INDUSTRIAL MATERIALS P.O. Box 1727 Texas City, TX 77592	AIMCOR TERMINAL	Active Nueces	14 22 2484 Industrial Minor	Corporation 00/08/24	44910 05/06/01
	F D OSBORNE	Self Reporting Contact	409-945-7210			
	1 OTFL 001 -"TPDES"		Active	Discharge	1 82/06/07	/ /
WQ0011754-001 TPDES0069884	BISHOP CONSOLIDATED ISD 719 E SIXTH ST. BISHOP, TX 78343	PETRONILA ELEMENTARY	Active Nueces	14 22 2204 Public Domestic Minor	Independent Sch 00/06/01	49520 02/12/01
	BISHOP CONSOLIDATED ISD	Self Reporting Contact				
	1 OTFL 001	*TPDES*	Active	Discharge	3 96/04/01	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010427-001 TX0023019-000	BISHOP, CITY OF PO BOX 356 BISHOP, TX 78343-0000	CITY OF BISHOP	Active Nueces	14 22 2492 Public Domestic Minor	Municipal Gover 96/04/12	49520 00/07/01
	BISHOP CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	6 96/04/01	/ /
WQ0003450-000 TPDES0118796	CELANESE LTD. P O BOX 9077 CORPUS CHRISTI, TX 78469-9077	HOECHST CELANESE CORP	Active Nueces	14 22 2485 Industrial Minor	Partnership 99/09/08	28690 00/06/01
	CELANESE LTD.	Self Reporting Contact	512-242-4075			
	1 OTFL 001 *TPDES*		Active	Discharge	1 92/10/16	/ /
WQ0000311-000	CENTEX CEMENT CORP 1000 JACK C. HAYS TRAIL BUDA, TX 78610	CORPUS CHRISTI CEMENT PLANT	Active Nueces	14 20 2482 Industrial Minor	Corporation 88/12/13	32410 98/12/13
	POB 9294 CORPUS CHRISTI 78469 CENTEX CEMENT CORPORATION	Billing Contact Self Reporting Contact	()-- Ext:			
	1 OTFL 001 containment/ evaporation ponds 101 OUTFALL 101 PRECIPITATOR		Active Stopped	Retention Discharge	1 88/12/13 1 88/12/13	98/12/13 98/12/13
WQ0001244-000 TX0003581-000	CENTRAL POWER & LIGHT COMPANY PO BOX 2121 CORPUS CHRISTI, TX 78403-0000	NUECES BAY SES	Active Nueces	14 20 2482 Industrial Major	Corporation 96/01/22	49110 01/01/22
	CENTRAL POWER & LIGHT COMPANY	Self Reporting Contact	512-886-4724			
	1 OTFL 001 NUECES BAY SES 101 INPT 101 NUECES BAY SES		Active Active	Discharge Sample	5 87/06/09 3 87/06/09	/ / / /
WQ0001255-000 TPDES0003565	CENTRAL POWER & LIGHT COMPANY PO BOX 2121 CORPUS CHRISTI, TX 78403-0000	Lon C. Hill Power Station	Active Nueces	14 21 2101 Industrial Major	Corporation 00/01/03	49110 03/05/01
	CENTRAL POWER & LIGHT COMPANY	Self Reporting Contact	512-241-1521			
	1 OTFL 001 2 OTFL 002	*TPDES *TPDES*	Active Active	Discharge Discharge	4 88/05/03 4 88/05/03	/ / / /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0001490-000 TPDES0008826	CENTRAL POWER & LIGHT COMPANY PO BOX 2121 CORPUS CHRISTI, TX 78403-0000	BARNEY M DAVIS SES	Active Nueces	14 22 2485 Industrial Major	Corporation 00/07/13	49110 03/06/01
	CENTRAL POWER & LIGHT COMPANY	Self Reporting Contact	214-777-2014			
	1 OTFL 001 BARNEY M DAVIS SES	*TPDES*	Active	Discharge	5 87/06/09	/ /
	101 INPT 101 BARNEY M DAVIS SES	*TPDES*	Active	Sample	2 87/06/09	/ /
	201 INPT 201 BARNEY M DAVIS SES	*TPDES*	Active	Sample	3 87/06/09	/ /
WQ0000467-000 TPDES0006211	CITGO REFINING AND CHEMICALS P O BOX 9176 CORPUS CHRISTI, TX 78469-0321	CORPUS CHRISTI REFINERY	Active Nueces	14 22 2484 Industrial Major	Partnership 99/07/30	29110 02/06/01
	CITGO REFINING & CHEMICALS CO LP	Self Reporting Contact	512-844-4000			
	1 OTFL 001 PROCESS WASTEWATER *TPDES*		Active	Discharge	9 92/10/22	/ /
	2 OTFL 002 PROCESS WASTEWATER *TPDES*		Active	Discharge	4 92/10/22	/ /
	3 OTFL 003 STORMWATER *TPDES*		Active	Discharge	4 92/10/22	/ /
	4 OTFL 004 NON PROCESS AREA SW *TPDES*		Active	Discharge	1 99/07/30	/ /
	5 OTFL 005 NON PROCESS AREA SW *TPDES*		Active	Discharge	1 99/07/30	/ /
	6 OTFL 006 NON PROCESS AREA SW *TPDES*		Active	Discharge	1 99/07/30	/ /
	7 OTFL 007 NON PROCESS AREA SW *TPDES*		Active	Discharge	1 99/07/30	/ /
WQ0002614-000 TPDES0092461	CITGO REFINING AND CHEMICALS P O BOX 9176 CORPUS CHRISTI, TX 78469-0321	DEEP SEA TERMINAL	Active Nueces	14 22 2484 Industrial Minor	Partnership 99/10/05	42260 02/01/01
	CITGO REFINING & CHEMICALS CO. L.P	Self Reporting Contact	512-844-4000			
	1 OTFL 001 DEEP SEA TERMINAL		Active	Discharge	2 89/05/01	/ /
	2 OTFL 002 DEEP SEA TERMINAL		Active	Discharge	2 89/05/01	/ /
	3 OTFL 003		Active	Discharge	1 99/10/05	/ /
WQ0003562-000 TPDES0110124	CITGO REFINING AND CHEMICALS P O BOX 9176 CORPUS CHRISTI, TX 78469	CITGO REFINING AND CHEMICALS	Active Nueces	14 22 2484 Industrial Minor	Partnership 99/11/30	51710 02/06/01
	CITGO REFINING & CHEMICALS CO L P	Self Reporting Contact	512-844-4000			
	1 OTFL 001 PORT AVENUE TERMINAL	*TPDES*	Active	Discharge	1 93/03/12	/ /
	2 OTFL 002 PORT AVENUE TERMINAL	*TPDES*	Active	Discharge	1 93/03/12	/ /
	3 OTFL 003 PORT AVENUE TERMINAL	*TPDES*	Active	Discharge	1 93/03/12	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0011689-001 TPDES0064408	COASTAL BEND YOUTH CITY 2547 U. S. HWY 77 DRISCOLL, TX 78351	CITY OF COASTAL BEND YOUTH CI	Active Nueces	14 22 2204 Private Domestic Minor	Corporation 99/11/18	49520 00/06/01
	COASTAL BEND YOUTH CITY	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	3 96/04/01	/ /
WQ0000465-000 TX0006904-000	COASTAL REFINING & MARKETING, PO BOX 109 CORPUS CHRISTI, TX 78403	COASTAL/CORPUS CHRISTI	Active Nueces	14 22 2484 Industrial Major	Corporation 93/03/23	29110 98/03/23
	TERRY A. SOULE'	Self Reporting Contact	512-887-4100			
	1 OTFL 001 CORPUS CHRISTI REFINERY		Active	Discharge	5 89/10/17	/ /
	2 OTFL 002 CORPUS CHRISTI REFINERY		Active	Discharge	2 79/05/29	/ /
	3 OTFL 003 CORPUS CHRISTI REFINERY		Active	Discharge	1 79/05/29	/ /
	4 OTFL 004 CORPUS CHRISTI REFINERY		Active	Discharge	1 89/10/17	/ /
WQ0002540-000 TPDES0089516	COASTAL REFINING & MARKETING, P O BOX 109 CORPUS CHRISTI, TX 78403	COASTAL REFINING AND MARKETIN	Active Nueces	14 22 2484 Industrial Minor	Corporation 00/07/18	51710 05/06/01
	TERRY A. SOULE'	Self Reporting Contact	361-887-4202			
	1 COASTAL REFINING & MARKETING - OTFL 001 "TPDES"		Active	Discharge	2 93/02/19	/ /
WQ0004158-000 TPDES0119725	CORPUS CHRISTI COGENERATION L 650 DUNDEE RD. SUITE 350 NORTHBROOK, IL 60062	CORPUS CHRISTI ENERGY CENTER	Active Nueces	14 22 2484 Industrial Minor	Partnership 00/06/01	49110 05/06/01
	CORPUS CHRISTI COGENERATION LP	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Inactive	Discharge	1 00/06/01	/ /
WQ0011134-001 TX0076767-000	CORPUS CHRISTI PEOPLES BAPTIS ROUTE 3, BOX 440-A CORPUS CHRISTI, TX 78415	ROLOFF FACILITY	Active Nueces	14 22 2485 Public Domestic Minor	Unknown 97/11/14	49520 00/06/01
	CORPUS CHRISITI PEOPLES BAPTIST CH	Self Reporting Contact				
	1 OTFL 001 ROLOFF FACILITY		Active	Discharge	3 95/10/01	/ /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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12-OCT-20..                * * * TEXAS  NATURAL  RESOURCE  CONSERVA...N  COMMISSION * * *                Page:   6
                                              STATE PERMIT SUBSYSTEM
                                              CLIENT FACILITY SUMMARY
                                              For Texas A & M University

TWC PERMIT    PERMITTEE NAME                  FACILITY NAME              PERMIT STATUS  RGN BASIN SEG     BUSINESS TYPE    SIC CD
EPA PERMIT    MAILING ADDRESS                                            COUNTY         PMT CATEGORY      PMT BEGIN DTE    PMT END
              CONTACT NAME                    CONTACT TYPE               PHONE
              EXT  EXTENSION NAME                                        EXT STATUS     DSCG/RETAIN       SET BEGIN DTE    EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0004200-000 CORPUS CHRISTI, CITY OF      ***DO NOT MAIL OUT SR FORMS F Active           14  22   2485   Municipal Gover  91210
TXS000601     P O BOX 9277                                               Nueces         Industrial           95/04/21  00/05/31
              CORPUS CHRISTI, TX  78469                                                 Minor

              CITY OF CORPUS CHRISTI          Self Reporting Contact

                 1  OTFL 001   MW4 SW  *DO NOT MAIL*                     Active         Discharge         1  95/05/01    /  /
                 2  OTFL 002  MS4  SW  *DO NOT MAIL*                     Active         Discharge         1  95/05/01    /  /
                 3  OTFL 003  MS4 SW  *DO NOT MAIL*                      Active         Discharge         1  95/05/01    /  /
                 4  OTFL 004  MSW4  SW  *DO NOT MAIL*                    Active         Discharge         1  95/05/01    /  /
                 5  OTFL 005  MS4  SW  *DO NOT MAIL*                     Active         Discharge         1  95/05/01    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-003 CORPUS CHRISTI, CITY OF      GREENWOOD PLANT               Active           14  22   2485   Municipal Gover  49520
TPDES0047074  P.O. BOX 9277                                              Nueces         Public Domestic      99/12/22  02/02/01
              CORPUS CHRISTI, TX  78469-9277                                            Major

              FOSTER CROWELL, ASST WW SUPERI  Billing Contact            (512)-857-1800  Ext:
              CORPUS CHRISTI CITY OF          Self Reporting Contact

                 1  OTFL 001 GREENWOOD PLT    *TPDES*                    Active         Discharge         4  97/03/31    /  /
               103  SOIL MON 103 ANN 0-6                                 Stopped        Sample            4  97/03/31    /  /
               189  COMBINED MON FOR 001,800 & 900 GREENWOOD PLT         Active         Sample            1  99/12/22    /  /
               203  SOIL MON 203 ANN 6-18                                Stopped        Sample            1  99/12/22    /  /
               303  SOIL MON 303 ANN 18-30                               Stopped        Sample            1  99/12/22    /  /
               800  RECLAIMED WATER  800 TYPE I GREENWOOD PLT            Active         Sample            1  99/12/22    /  /
               900  RECLAIMED WATER 900 TYPE II GREENWOOD PLT            Active         Sample            1  99/12/22    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-004 CORPUS CHRISTI, CITY OF      OSO FACILITY                  Active           14  22   2485   Municipal Gover  49520
TPDES0047058  P.O. BOX 9277                                              Nueces         Public Domestic      99/12/22  01/09/01
              CORPUS CHRISTI, TX  78469-9277                                            Major

              CORPUS CHRISTI CITY OF          Self Reporting Contact

                 1  OTFL 001  OSO PLANT 10401-004    *TPDES*             Active         Discharge         4  88/03/01    /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010401-005 CORPUS CHRISTI, CITY OF      BROADWAY PLANT                Active           14  22   2484   Municipal Gover  49520
TX0047066-000 P.O. BOX 9277                                              Nueces         Public Domestic      97/08/01  00/06/01
              CORPUS CHRISTI, TX  78469-9277                                            Major

              CORPUS CHRISTI CITY OF          Self Reporting Contact

                 1  OTFL 001 BROADWAY PLANT (10401-005)                  Active         Discharge         4  92/11/01    /  /

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Abbreviations and Codes:  RGN = Region   SEG = Segment   SIC = Standard Industrial Classification Code
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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010401-006 TX0047082-000	CORPUS CHRISTI, CITY OF P O BOX 9277 CORPUS CHRISTI, TX 78469	ALLISON PLANT	Active Nueces	14 21 2101 Public Domestic Major	Municipal Gover 97/11/14	49520 02/11/14
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	3 96/11/01	/ /
	2 OTFL 002 EFFL DIVERSION DEMO PROJECT		Active	Discharge	1 96/03/08	/ /
	102 INPT 102 COMBINED FLOW		Active	Sample	1 96/03/08	/ /
WQ0010401-008 TX0047104-000	CORPUS CHRISTI, CITY OF P O BOX 9277 CORPUS CHRISTI, TX 78469-9277	LAGUNA MADRE	Active Nueces	14 22 2491 Public Domestic Major	Municipal Gover 98/09/14	49520 00/10/01
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001 LAGUNA MADRE		Active	Discharge	6 87/12/01	/ /
WQ0010401-009 TPDES0047121	CORPUS CHRISTI, CITY OF P.O. BOX 9277 CORPUS CHRISTI, TX 78469-9277	WHITECAP PLANT	Active Nueces	14 22 2491 Public Domestic Minor	Municipal Gover 99/12/27	49520 02/07/01
	CORPUS CHRISTI CITY OF	Self Reporting Contact				
	1 OTFL 001 "TPDES"		Active	Discharge	4 92/03/20	/ /
WQ0002857-000 TPDES0007129	DIAMOND SHAMROCK REFINING AND PO BOX 696000 SAN ANTONIO, TX 78269-6000	Diamond Shamrock Refining	Active Nueces	14 22 2484 Industrial Minor	Corporation 99/09/28	47890 02/06/01
	Diamond Shamrock Refining &	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	2 92/12/11	/ /
	2 Otfl 002 *TPDES*		Active	Discharge	1 92/12/11	/ /
	3 Otfl 003 *TPDES*		Active	Discharge	1 92/12/11	/ /
WQ0011541-001 TX0094145-000	DRISCOLL, CITY OF PO BOX 178 DRISCOLL, TX 78351-0000	Driscoll Plant	Active Nueces	14 22 2204 Public Domestic Minor	Municipal Gover 95/03/24	49520 00/03/24
	DRISCOLL CITY OF	Self Reporting Contact				
	1 OTFL 001 Driscoll Plant		Active	Discharge	3 90/04/25	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0000349-000 TX0004685-000	ELEMENTS CHROMIUM L.P. P O BOX 9912 CORPUS CHRISTI, TX 78469	CORPUS CHRISTI FACILITY	Active Nueces	14 22 2484 Industrial Major	Partnership 96/07/19	28190 99/10/31
	ELEMENTIS CHROMIUM L.P.	Self Reporting Contact				
	1 OTFL 001 MIXED WASTEWATER		Active	Discharge	4 89/09/26	/ /
	101 INPT 101 process, chrome reduction, storm etc		Active	Sample	4 89/09/26	/ /
	201 INPT 201 chromic oxide, utility & storm (NEW)		Active	Sample	1 89/09/26	/ /
WQ0000314-000 TX0003191-000	ENCYCLE/TEXAS, INC. 5500 UP RIVER RD. CORPUS CHRISTI, TX 78407	CORPUS CHRISTI PLANT	Active Nueces	14 22 2484 Industrial Major	Corporation 97/08/22	49530 00/06/01
	J. W. D'NEIL	Self Reporting Contact	512-289-0300			
	1 OTFL 001 TPWW,TDS & SW		Active	Discharge	8 89/05/01	/ /
	2 OTFL 002 SW		Active	Discharge	2 89/03/06	/ /
WQ0002075-000 TX0076996-000	EQUISTAR CHEMICALS, L.P. P O BOX 10940 CORPUS CHRISTI, TX 78640	OXY PETROCHEMICALS/CORPUS	Active Nueces	14 22 2484 Industrial Major	Partnership 97/08/22	28690 00/06/01
	EQUISTAR CHEMICALS, L.P.	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	6 92/09/01	/ /
	2 OTFL 002		Active	Discharge	1 80/06/05	/ /
	3 OTFL 003		Active	Discharge	1 92/02/03	/ /
	101 INPT 101		Stopped	Sample	1 92/02/03	/ /
	201 INPT 201		Stopped	Sample	1 92/02/03	/ /
WQ0002506-000	FARCO MINING, INC 7305 SAN DARIO 329 LAREDO, TX 78045	Farco Mining	Active Nueces	14 22 2484 Industrial Minor	Corporation 89/09/12	44630 99/09/12
		Billing Contact	(501)-646-4366 Ext:			
	FARCO MINING, INC.	Self Reporting Contact				
	1 OTFL 001		Active	Retention	1 89/09/12	/ /
WQ0011712-001	J. RAY MCDERMOTT, INC. P.O. Box 188 Morgan City, LA 70381	McDermott	Active Nueces	14 20 2481 Private Domestic Minor	Corporation 89/07/31	49520 99/07/31
	J. Ray McDermott, Inc.	Self Reporting Contact				
	1 OTFL 001		Active	Retention	2 89/07/31	/ /

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12-OCT-2000          * * * TEXAS  NATURAL  RESOURCE  CONSERVATION  COMMISSION * * *                 Page:    9
                                     STATE PERMIT SUBSYSTEM
                                     CLIENT FACILITY SUMMARY
                                     For Texas A & M University

 TWC PERMIT    PERMITTEE NAME               FACILITY NAME              PERMIT STATUS  RGN BASIN SEG  BUSINESS TYPE   SIC CD
 EPA PERMIT    MAILING ADDRESS                                         COUNTY         PMT CATEGORY   PMT BEGIN DTE   PMT END
               CONTACT NAME                 CONTACT TYPE               PHONE
               EXT  EXTENSION NAME                                     EXT STATUS     DSCG/RETAIN    SET BEGIN DTE   EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0003137-000  JAVELINA COMPANY             JAVELINA COMPANY           Active          14  22   2484  Corporation     49250
TPDES0105481   P.O. Box 23055                                          Nueces         Industrial          99/12/31  02/12/31
               Environmental Supervisor
               Corpus Christi, TX  78403                                              Major

               JAVELINA COMPANY             Self Reporting Contact

                 1  OTFL 001   PROCESS        *TPDES*                  Active         Discharge        1  90/08/31   /  /
               101  INPT 101   PROCESS/SW    *TPDES*                   Active         Sample           1  90/08/31   /  /
               201  INPT 201   UTILITY          *TPDES*                Active         Sample           1  90/08/31   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002774-000  KOCH CARBON INC              CORPUS CHRISTI COKE S      Active          14  22   2484  Corporation     44630
TX0100048-000  PO BOX 2219                                             Nueces         Industrial          91/06/17  01/06/17
               WICHITA, KS  67201-0000                                                Minor

               CK ADDR: POB 2256  ZIP --2256  Billing Contact          (316)-832-5641  Ext:
               KOCH CARBON INC              Self Reporting Contact

                 1  OTFL 001 CORPUS CHRISTI COKE S                     Active         Retention        1  91/06/17  01/06/17
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0002578-000  KOCH PIPELINE COMPANY, L.P   Corpus Christi Term/Koch   Active          14  22   2484  Partnership     44910
TX0090328-000  8606 IH 37                                              Nueces         Industrial          94/09/02  99/09/02
               Corpus Christi, TX  78409                                              Minor

               KOCH PIPELINE COMPANY LP     Self Reporting Contact     512-776-7535

                 1  OTFL 001 CORPUS CHRISTI TERM.                      Active         Discharge        2  88/02/09   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0000457-000  KOCH REFINING COMPANY, L.P.  CORPUS CHRISTI REFINERY    Active          14  22   2484  Partnership     29110
TX0006599-000  P O BOX 2608                                            Nueces         Industrial          96/08/02  00/01/19
               CORPUS CHRISTI, TX  78403                                              Major

               KOCH REFINING COMPANY LP     Self Reporting Contact

                 1  OTFL 001                                           Active         Discharge        4  95/01/19   /  /
                 2  OTFL 002 (Termianl 1 area)                         Stopped        Discharge        4  95/01/19   /  /
                 3  OTFL 003 (Terminal 2 area)                         Active         Discharge        6  95/01/19   /  /
                 4  OTFL 004 (Terminal 3 area)                         Active         Discharge        4  95/01/19   /  /
                 5  OTFL 005                                           Stopped        Discharge        4  95/01/19   /  /
                 6  OTFL 006                                           Active         Discharge        1  95/01/19   /  /
                 7  OTFL 007                                           Active         Discharge        1  95/01/19   /  /
                 8  OTFL 008                                           Active         Discharge        1  95/01/19   /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0000531-000  KOCH REFINING COMPANY, L.P.  KOCH PETROLEUM             Active          14  22   2484  Partnership     29110
TPDES0006289   P.O. Box 2608                                           Nueces         Industrial          99/12/31  02/12/31
               Corpus Christi, TX  78403                                              Major

               KOCH REFINING COMPANY L P    Self Reporting Contact
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Abbreviations and Codes:  RGN = Region   SEG = Segment   SIC = Standard Industrial Classification Code
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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M Ur 'sity

TWC PERMI; EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0012731-001 TX0093157-000	TESORO MARINE SERVICES, INC. 9426 TELEPHONE RD. ATTN: JEFF BAKER JR., P.E. HOUSTON, TX 77075	Harbor Island Plant	Active Nueces	14 12 2501 Private Domestic Minor	Corporation 95/01/30	49520 00/01/30
	TESORO MARINE SERVICES INC	Self Reporting Contact				
	1 OTFL 001 Harbor Island Plant		Active	Discharge	2 89/02/27	/ /
WQ0003646-000 TX0112194	TEXAS A&M UNIVERSITY SYSTEM 6300 OCEAN DR. TEXAS A&M UNIVERSITY SYSTEM CORPUS CHRISTI, TX 78412	LA COSS FACILITY CORPUS CHRIS	Active Nueces	14 22 2485 Industrial Minor	Unknown 96/05/03	87330 00/06/16
	CHRIS FULLER	Self Reporting Contact	512-9372677			
	1 OTFL 001		Active	Discharge	1 95/06/16	/ /
WQ0011345-001 TPDES0066036	TEXAS A&M UNIVERSITY SYSTEM ROUTE 2, BOX 589 CORPUS CHRISTI, TX 78406	RESEARCH & EXTENSION	Active Nueces	14 22 2485 Public Domestic Minor	State Governmen 99/10/15	49520 00/06/01
	TEXAS A&M UNIVERSITY SYSTEM	Self Reporting Contact				
	1 OTFL 001 RESEARCH & EXTENSION		Active	Discharge	3 96/01/01	/ /
WQ0002888-000 TPDES0104400	TEXAS ECOLOGISTS, INC. P. O. Box 307 Robstown, TX 78380-0000	TEXAS ECOLOGISTS INC	Active Nueces	14 22 2492 Industrial Minor	Corporation 99/11/30	49530 02/07/01
	Phillip D. Minns	Self Reporting Contact	713-624-1900			
	1 OTFL 001	*TPDES*	Active	Discharge	1 88/12/05	/ /
	2 OTFL 002	*TPDES*	Active	Discharge	1 88/12/05	/ /
	3 OTFL 003	*TPDES*	Suspended	Discharge	1 88/12/05	/ /
WQ0000579-000 TX0006025-000	TICONA POLYMERS, INC. P O BOX 428 BISHOP, TX 78343	BISHOP PLANT	Active Nueces	14 22 2492 Industrial Major	Corporation 98/08/21	28690 00/10/01
	TICONA POLYMERS, INC.	Self Reporting Contact				
	1 OTFL 001 PROCESS/UTIL/DOM/SW		Active	Discharge	4 92/09/08	/ /
	2 OTFL 002 STORMWATER		Active	Discharge	1 85/05/29	/ /
	101 INPT 101 PROCESS/DOMESTIC		Active	Sample	3 92/09/08	/ /

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12-OCT-2000          * * * TEXAS  NATURAL  RESOURCE  CONSERVATION  COMMISSION * * *              Page:   10
                                          STATE PERMIT SUBSYSTEM
                                          CLIENT FACILITY SUMMARY
                                          For Texas A & M University

TWC PERMIT     PERMITTEE NAME                      FACILITY NAME          PERMIT STATUS  RGN BASIN SEG   BUSINESS TYPE   SIC CD
EPA PERMIT     MAILING ADDRESS                                            COUNTY         PMT CATEGORY    PMT BEGIN DTE   PMT END
               CONTACT NAME                        CONTACT TYPE           PHONE
               EXT  EXTENSION NAME                                        EXT STATUS     DSCG/RETAIN     SET BEGIN DTE   EXT END
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                1  OTFL 001 PAGES  2 & 2A PHASE    *TPDES*                Active         Discharge       1  74/10/22     /  /
                2  OTFL 002              *TPDES*                          Active         Discharge       2  83/04/04     /  /
                3  OTFL 003             *TPDES*                           Active         Discharge       2  83/04/04     /  /
                4  OTFL 004          *TPDES*                              Active         Discharge       2  83/04/04     /  /
                5  OTFL 005 WEST PLANT       *TPDES*                      Active         Discharge       1  84/02/28     /  /
                6  OTFL 006 NORTH     *TPDES*                             Active         Discharge       1  86/12/09     /  /
                7  OTFL 007     *TPDES*                                   Active         Discharge       1  94/09/13     /  /
                8  OTFL 008      *TPDES*                                  Active         Discharge       1  94/09/13     /  /
                9  OTFL 009      *TPDES*                                  Active         Discharge       1  94/09/13     /  /
               10  OTFL 010        *TPDES*                                Active         Discharge       1  99/12/31     /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010846-001  NUECES CO WCID NO. 4                MUSTANG ISLAND NORTH   Active          14  22   2481  Local Water Dis  49520
TPDES0024287   315 S 9TH ST.                                              Nueces         Public Domestic    00/05/18   05/04/01
               PORT ARANSAS, TX  78373                                                   Major

               NUECES CO WCID 004                  Self Reporting Contact

                1  OTFL 001 MUSTANG ISLAND NORTH         *TPDES*          Active         Discharge       6  97/02/01     /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010846-002  NUECES CO WCID NO. 4                DIST MUSTANG ISLAND SOUTH PLA  Active   14  20   2481  Local Water Dis  49520
TPDES0091031   315 S 9TH ST.                                              Nueces         Public Domestic    94/06/16   99/06/16
               PORT ARANSAS, TX  78373                                                   Major

               NONA SHERRILL                       Billing Contact        (512)-749-5201  Ext:
               NUECES CO WCID 004                  Self Reporting Contact

                2  OTFL 002  Dist. Mustang Island  South Plant            Inactive       Discharge       1   /  /        /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0011583-001  NUECES CO WCID NO. 5                Banquete Plant         Active          14  22   2204  Local Water Dis  49520
TX0054291-000  PO BOX 157                                                 Nueces         Public Domestic    95/10/20   00/06/01
               Banquete, TX  78339-0157                                                  Minor

               NUECES CO WCID 005                  Self Reporting Contact

                1  OTFL 001                                               Active         Discharge       3  95/10/01     /  /
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
WQ0010261-001  ROBSTOWN, CITY OF                   CITY OF ROBSTOWN       Active          14  22   2485  Municipal Gover  49520
TX0020389-000  PO BOX 71                                                  Nueces         Public Domestic    96/03/29   00/06/01
               ROBSTOWN, TX  78380-0000                                                  Major

               ROBSTOWN CITY OF                    Self Reporting Contact

                1  OTFL 001                                               Active         Discharge       6  95/10/01     /  /

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
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12-OCT-20.. * * * TEXAS NATURAL RESOURCE CONSERVA..ON COMMISSION * * * Page: 12

STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0002720-000 TPDES0096474	TRIFINERY PETROLEUM SERVICES P O BOX 9606 CORPUS CHRISTI, TX 76469-9606	CORPUS CHRISTI PLT	Active Nueces	14 22 2484 Industrial Minor	Corporation 99/12/20	29110 04/10/01
	TRIFINERY PETROLEUM SERVICES, A TE	Self Reporting Contact	361-289-6762 EXT. 22			
	1 OTFL 001 PROCESS		Active	Discharge	2 87/06/30	/ /
	2 OTFL 002 STORMWATER		Active	Discharge	1 84/12/04	/ /
WQ0002317-000 TPDES0007889	US DEPT OF THE NAVY 8851 OCEAN DR. STE. 205 BLDG 19; ATTN: PUBLIC WORKS CORPUS CHRISTI, TX 78419	CORPUS CHRISTI NAVAL AIR STAT	Active Nueces	14 22 2481 Industrial Major	Federal Governm 99/12/31	34710 02/04/01
	C R POTTS	Self Reporting Contact	512-939-2170			
	1 OTFL 001 CORPUS DOMESTIC	*TPDES*	Active	Discharge	7 94/05/31	/ /
	101 OTFL 101 CORPUS PROCESS	*TPDES*	Active	Discharge	4 94/05/31	/ /
WQ0001909-000 TPDES0063355	VALERO REFINING COMPANY-TEXAS P O BOX 9370 CORPUS CHRISTI, TX 78469-9370	CORPUS CHRISTI PLANT	Active Nueces	14 22 2484 Industrial Major	Corporation 99/12/31	29110 04/12/01
	VALERO REFINING COMPANY-TEXAS	Self Reporting Contact	361-289-3305			
	1 OTFL 001 CORPUS PLANT (SW) *TPDES*		Active	Discharge	4 94/05/23	/ /
	2 OTFL 002 CORPUS PLANT SW *TPDES*		Active	Discharge	4 94/05/23	/ /
	3 OTFL 003 CORPUS PLANT PROCESS WATER *TPDES*		Active	Discharge	7 94/05/23	/ /
	4 OTFL 004 CORPUS PLANT SW *TPDES*		Active	Discharge	3 94/05/23	/ /
	5 OTFL 005 CORPUS PLANT (DOMESTIC) *TPDES*		Active	Discharge	5 96/10/01	/ /
	6 OTFL 006 CORPUS FACILITY SW *TPDES*		Active	Discharge	3 94/05/23	/ /
	7 OTFL 007 CORPUS FACILITY UTILITY *TPDES*		Active	Discharge	4 94/05/23	/ /
	8 OTFL 008 CORPUS PLANT SW *TPDES*		Active	Discharge	2 94/05/23	/ /
	9 OTFL 009 CORPUS PLANT SW *TPDES*		Active	Discharge	1 99/12/31	/ /
	10 OTFL 010 CORPUS PLANT SW *TPDES*		Active	Discharge	1 99/12/31	/ /
	11 OTFL 011 CORPUS PLANT SW *TPDES*		Active	Discharge	1 99/12/31	/ /
	12 OTFL 012 CORPUS PLANT SW *TPDES*		Active	Discharge	1 99/12/31	/ /
	13 OTFL 013 CORPUS PLANT SW *TPDES*		Active	Discharge	1 99/12/31	/ /
WQ0002070-000 TPDES0072737	WILLIAMS TERMINALS HOLDINGS, P O BOX 1396 HOUSTON, TX 77251-1396	CORPUS CHRISTI PLANT	Active Nueces	14 22 2484 Industrial Minor	Partnership 99/06/18	42260 02/06/18
	WILLIAMS TERMINALS HOLDINGS LLC	Self Reporting Contact				
	1 OTFL 001 Corpus Christi Terminal		Active	Discharge	3 88/02/02	/ /

Abbreviations and Codes: RGN = Region SEG = Segment SIC = Standard Industrial Classification Code

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0002027-000 TPDES0070629	WRIGHT MATERIALS, INC. RT 1 BOX 143 ROBSTOWN, TX 78380	WRIGHT MATERIALS	Active Nueces	14 21 2102 Industrial Minor	Corporation 99/11/29	14420 03/05/01
	WRIGHT MATERIALS INC	Self Reporting Contact	512-387-1511			
	1 OTFL 001	*TPDES*	Active	Discharge	3 92/12/11	/ /
WQ0003012-000 TPDES0102890	AKER GULF MARINE P.O. Box C Ingleside, TX 78362	AKER GULF MARINE	Active San Patricio	14 20 2483 Industrial Minor	Partnership 99/11/08	34410 03/06/01
	AKER GULF MARINE	Self Reporting Contact	361-779-3367			
	1 OTFL 001		Active	Discharge	3 96/10/01	/ /
WQ0012064-001 TPDES0078743	AKER GULF MARINE P.O. Box C Ingleside, TX 78362	AKER GULF MARINE	Active San Patricio	14 20 2483 Private Domestic Minor	Partnership 00/01/04	49520 02/06/01
	AKER GULF MARINE	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	6 96/07/01	/ /
WQ0010521-002 TPDES0025682	ARANSAS PASS, CITY OF P O BOX 2000 ARANSAS PASS, TX 78336	CITY OF ARANSAS PASS	Active San Patricio	14 20 2483 Public Domestic Major	Municipal Gover 00/02/15	49520 02/02/01
	ARANSAS PASS CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES* 2 OTFL 002 NO DISCHARGE	*TPDES*	Active Active	Discharge Retention	3 88/02/16 1 00/02/15	/ / / /
WQ0003780-000 TX0118907	COASTAL CHEMICAL CO L.L.C. P O BOX 277 PORTLAND, TX 78374	Portland Plant	Active San Patricio	14 20 2482 Industrial Minor	Partnership 95/10/27	51690 00/10/27
	COASTAL CHEMICAL CO LLC Wayne McClelland	Self Reporting Contact Unknown	713 477 6675			
	1 OTFL 001		Active	Discharge	1 95/10/27	/ /
WQ0001651-000 TX0008907-000	E.I. DU PONT DE NEMOURS & CO. P.O. Box JJ Ingleside, TX 78362	Ingleside plant	Active San Patricio	14 20 2481 Industrial Major	Corporation 95/10/20	28120 00/04/01
	D J GOODCHILD	Self Reporting Contact	512-643-7511			

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001 CHEMICAL MFG PLANT 2 OTFL 002 CHEMICAL MFG PLANT		Active Active	Discharge Discharge	11 97/06/30 2 88/01/26	/ / / /
WQ0010092-001 TX0083062-000	GREGORY, CITY OF PO BOX 297 GREGORY, TX 78359-0000	CITY OF GREGORY	Active San Patricio	14 20 2481 Public Domestic Minor	Municipal Gover 97/01/31	49520 00/04/01
	GREGORY CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	5 96/07/01	/ /
WQ0001497-000 TX0037117-000	Hondo Creek Cattle Co. PO BOX 70 EDROY, TX 78352-0000	CATTLE FEEDLOT 10500	Active San Patricio	14 21 2102 Agricultural-B Minor	Corporation 80/02/25	02110 99/12/31
	LYKES BROS., INC. FEED YARD	Self Reporting Contact				
	1 CATTLE FEEDLOT 10500		Active	Retention	5 80/02/25	99/12/31
WQ0010422-001 TPDES0020401	INGLESIDE, CITY OF PO Drawer 400 INGLESIDE, TX 78362-0000	City of Ingleside	Active San Patricio	14 20 2481 Public Domestic Major	Municipal Gover 99/12/27	49520 02/12/27
	INGLESIDE, CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES*		Active	Discharge	6 97/06/30	/ /
WQ0001207-000 TX0002771-000	KOCH PIPELINE COMPANY, L.P. 8606 IH 37 Corpus Christi, TX 78409	INGLESIDE TERMINAL	Active San Patricio	14 20 2481 Industrial Minor	Partnership 95/11/03	44910 00/04/01
	KOCH PIPELINE COMPANY LP	Self Reporting Contact	361-776-7535			
	1 OTFL 001 northeast corner 2 OTFL 002 Eastern Location 3 OTFL 003 Central location 4 OTFL 004 western location		Active Active Active Active	Discharge Discharge Discharge Discharge	5 95/11/03 3 95/11/03 3 95/11/03 3 95/11/03	/ / / / / / / /
WQ0010015-001 TPDES0020419	MATHIS, CITY OF 411 E SAN PATRICIO AVE MATHIS, TX 78368-0000	CITY OF MATHIS	Active San Patricio	14 21 2103 Public Domestic Minor	Municipal Gover 99/10/11	49520 00/12/01
	MATHIS, CITY OF	Self Reporting Contact				
	1 OTFL 001 *TPDES* 101 Soil Mon 101 ANN 0-6 *TPDES*		Active Active	Discharge Sample	8 95/10/01 2 92/11/20	/ / / /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	201 Soil Mon 201 ANN 6-18	*TPDES*	Active	Sample	1 92/11/20	/ /
	301 Soil Mon 301 ANN 18-30	*TPDES*	Active	Sample	1 92/11/20	/ /
WQ0003083-000 TX0104876-000	OCCIDENTAL CHEMICAL CORPORATI ,	CORPUS CHRISTI PLANT	Active San Patricio	14 22 2481 Industrial Major	Corporation 97/06/02	28690 00/06/01
	ENCARNACION SERNA, JR.	Self Reporting Contact	361-776-6174			
	1 OTFL 001 CORPUS CHRISTI PLANT		Active	Discharge	1 89/03/06	/ /
WQ0010237-001 TX0025135-000	ODEM CITY OF P O BOX 754 ODEM, TX 78370-0754	City of Odem	Active San Patricio	14 20 2003 Public Domestic Minor	Municipal Gover 96/02/09	49520 00/03/01
	ODEM CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	7 97/03/01	/ /
WQ0010478-001 TPDES0055433	PORTLAND, CITY OF PO DRAWER 1285 PORTLAND, TX 78374-0000	PLANT #1, CITY OF PORTLAND	Active San Patricio	14 20 2482 Public Domestic Major	Municipal Gover 00/01/24	49520 02/04/01
	PORTLAND, CITY OF	Self Reporting Contact				
	1 OTFL 001 PLANT #1	*TPDES*	Active	Discharge	7 97/01/01	/ /
WQ0003966-000 SS0003966-000	REYNOLDS METALS COMPANY P O BOX 9911 CORPUS CHRISTI, TX 78469-9911	REYNOLDS METAL CO INC	Active San Patricio	14 22 2481 Industrial Minor	Corporation 98/07/07	49520 00/07/01
	REYNOLDS METAL CO INC	Self Reporting Contact				
	1 OTFL 001		Active	Retention	7 98/07/07	00/07/01
WQ0013644-001 TPDES0110337	SAN PATRICIO CO MUD NO. 1 P. O. BOX 39 EDROY, TX 78352	SAN PATRICIO CO MUD 001	Active San Patricio	14 21 2101 Public Domestic Minor	County Governme 99/06/25	49520 02/05/01
	SAN PATRICIO CO MUD 001	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	2 96/01/01	/ /

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
WQ0010055-001 TPDES0024562	SINTON, CITY OF PO BOX 1395 SINTON, TX 78387-0000	CITY OF SINTON	Active San Patricio	14 20 2003 Public Domestic Minor	Municipal Gover 99/07/02	49520 02/08/01
	SINTON, CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	7 96/09/01	/ /
WQ0013641-001 TPDES0110361	SINTON, CITY OF P. O. BOX 1395 SINTON, TX 78387	Rob & Bessie Welder Park	Active San Patricio	14 20 2003 Public Domestic Minor	 99/08/24	49520 01/07/01
	Sinton, City of	Self Reporting Contact				
	1 OTFL 001 ROB & BESSIE WELDER PARK		Active	Discharge	1 95/06/01	/ /
WQ0014119-001 TPDES0119563	ST. PAUL WATER SUPPLY CORPORA ROUTE 1, BOX 207B SINTON, TX 78387	ST. PAUL WSC	Active San Patricio	14 20 2003 Private Domestic Minor	Water Supply Co 00/07/13	49520 05/03/01
	ST PAUL WSC	Self Reporting Contact				
	1 OTFL 001	*TPDES*	Inactive	Discharge	1 00/07/13	/ /
WQ0011096-001 TX0066664-000	SUBLIGHT ENTERPRISES, INC. 601 HIGHWAY 181 PORTLAND, TX 78374	PORTLAND INN	Active San Patricio	14 20 2482 Private Domestic Minor	Corporation 97/11/21	49520 00/04/01
	SUBLIGHT ENTERPRISES INC	Self Reporting Contact				
	1 OTFL 001 PORTLAND INN		Active	Discharge	4 95/10/01	/ /
WQ0010705-001 TX0027472-000	TAFT, CITY OF P O BOX 416 TAFT, TX 78390-0416	CITY OF TAFT	Active San Patricio	14 20 2472 Public Domestic Minor	Municipal Gover 96/03/29	49520 00/03/01
	TAFT CITY OF	Self Reporting Contact				
	1 OTFL 001		Active	Discharge	5 96/01/01	/ /
WQ0011660-001	TEXAS DEPT OF TRANSPORTATION P.O. Box 9907 District 16 Corpus Christi, TX 78469	SAN PATRICIO COUNTY REST AREA	Active San Patricio	14 21 2102 Public Domestic Minor	State Governmen 99/12/16	49520 05/05/01
	STATE DEPT OF HIGHWAYS AND	Self Reporting Contact				

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STATE PERMIT SUBSYSTEM
CLIENT FACILITY SUMMARY
For Texas A & M University

TWC PERMIT EPA PERMIT	PERMITTEE NAME MAILING ADDRESS CONTACT NAME EXT EXTENSION NAME	FACILITY NAME CONTACT TYPE	PERMIT STATUS COUNTY PHONE EXT STATUS	RGN BASIN SEG PMT CATEGORY DSCG/RETAIN	BUSINESS TYPE PMT BEGIN DTE SET BEGIN DTE	SIC CD PMT END EXT END
	1 OTFL 001 SAN PATRICIO RESTAREA		Active	Retention	2 89/06/26	/ /
	101 SOIL MON 101 ANN 0-6		Active	Sample	1 99/12/16	/ /
	201 SOIL MON 201 ANN 6-18		Active	Sample	1 99/12/16	/ /
	301 SOIL MON 301 ANN 18-30		Active	Sample	1 99/12/16	/ /
WQ0011660-002	TEXAS DEPT OF TRANSPORTATION	SAN PATRICIO COUNTY REST AREA	Active	14 21 2102	State Governmen	49520
	P O BOX 9907		San Patricio	Public Domestic	99/10/06	05/05/01
	CORPUS CHRISTI, TX 78469			Minor		
	TEXAS DEPT OF TRANSPORTATION	Self Reporting Contact				
	1 OTFL 001 SAN PATRICIO CO SOUTH		Active	Retention	2 89/06/26	/ /
	201 SOIL MON 201 (ANNUAL) SANPAT/SS		Stopped	Sample	2 89/06/26	/ /
	301 SOIL MON 301 ANN 0-6		Active	Sample	1 99/10/06	/ /
	401 SOIL MON 401 ANN 6-18		Active	Sample	1 99/10/06	/ /
	501 SOIL MON 501 ANN 18-30		Active	Sample	1 99/10/06	/ /
WQ0013412-001 TPDES0102920	TEXAS DEPT OF TRANSPORTATION	SINTON MAINT./CONST	Active	14 20 2003	State Governmen	49520
	P.O. Box 9907		San Patricio	Public Domestic	99/07/09	02/08/01
	Corpus Christi, TX 78469			Minor		
		Self Reporting Contact				
	1 OTFL 001 SINTON MAINT./CONST		Active	Discharge	3 96/01/01	/ /
WQ0011165-001	TEXAS PARKS & WILDLIFE DEPT	LAKE CORPUS CHRISTI PARK	Active	14 21 2103	State Governmen	49520
	4200 SMITH SCHOOL RD.		San Patricio	Public Domestic	89/08/07	99/08/07
	TNRCC COOR (CODE 32); INFRASTRUCTURE DIV					
	AUSTIN, TX 78744-9822			Minor		
	TEXAS PARKS & WILDLIFE DEPT	Self Reporting Contact				
	1 OTFL 001 LK CORPUS CHRISTI PK.		Active	Retention	2 89/08/07	10/12/31

END OF REPORT

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Appendix 3
Wright Materials, Inc., TPDES Permit No. 02027

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RGO

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

December 7, 1999

Mr. Milus Wright, Manager
Wright Materials, Inc.
Route 1, Box 143
Robstown, Texas 78380

Re: Wright Materials, Inc., Permit No. 02027

Dear Mr. Wright:

Enclosed is a copy of the above referenced permit for a wastewater treatment facility issued on behalf of the Executive Director pursuant to Chapter 26 of the Texas Water Code.

Self-reporting or Discharge Monitoring Forms and instructions will be forwarded to you from the Water Quality Management Information Systems Team so that you may comply with monitoring requirements. For existing facilities, revised forms will be forwarded if monitoring requirements have changed.

Enclosed is a "Notification of Completion of Wastewater Treatment Facilities" form. Use this form when the facility begins to operate or goes into a new phase. The form notifies the agency when the proposed facility is completed or when it is placed in operation. This notification complies with the special provision incorporated into the permit.

Should you have any questions, please contact Ms. Nicole Janak of the Texas Natural Resource Conservation Commission's Wastewater Permitting Section at (512) 239-4433, or if by correspondence, include MC 148 in the letterhead address below.

Sincerely,

Ronald R. Pedde, P.E., Director
Water Permits & Resource Management Division

RRP/nj

Enclosures

cc: [redacted]
Ms. Nicole Janak, Permit Writer, Industrial Permits Team, MC 148
Mr. C.W. Settles, P.E., Associated Engineers and Surveyors, P.O. Box 4256, Victoria, Texas 77903

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/239-1000 • Internet address: www.tnrcc.state.tx.us

printed on recycled paper using soy based ink

TPDES PERMIT NO. 02027
[For TNRCC office use only - EPA I.D. No. TX0070629]

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
P. O. Box 13087
Austin, Texas 78711-3087

This is a renewal of TNRCC Permit No. 02027, issued on December 11, 1992.

PERMIT TO DISPOSE OF WASTES
under provisions of
Section 402 of the Clean Water Act
and Chapter 26 of the Texas Water Code

Wright Materials Inc.

whose mailing address is

Route 1, Box 143
Robstown, Texas 78380

is authorized to treat and dispose of wastes from the Nason Plant No. 1, a sand and gravel washing operation (SIC 1442)

located on Farm-to-Market Road 3088, approximately 1.5 miles northwest of the intersection of Farm-to-Market Road 624 and Farm-to-Market Road 666, and approximately ten miles northwest of the City of Robstown, Nueces County, Texas

to Cayamon Creek; thence to the Nueces River Below Lake Corpus Christi in Segment No. 2102 of the Nueces River Basin

only according to effluent limitations, monitoring requirements and other conditions set forth in this permit, as well as the rules of the Texas Natural Resource Conservation Commission (TNRCC), the laws of the State of Texas, and other orders of the TNRCC. The issuance of this permit does not grant to the permittee the right to use private or public property for conveyance of wastewater along the discharge route described in this permit. This includes, but is not limited to, property belonging to any individual, partnership, corporation or other entity. Neither does this permit authorize any invasion of personal rights nor any violation of federal, state, or local laws or regulations. It is the responsibility of the permittee to acquire property rights as may be necessary to use the discharge route.

This permit shall expire at midnight on May 1, 2003.

ISSUED DATE: NOV 29 1999

For the Commission

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Outfall Number 001

1. During the period beginning upon date of issuance and lasting through the expiration date, the permittee is authorized to discharge washwater and stormwater subject to the following effluent limitations:

   Volume: Intermittent and Flow Variable.

Effluent Characteristic	Discharge Limitations			Minimum Self-Monitoring Requirements	
	Daily Avg mg/l	Daily Max mg/l	Single Grab mg/l	Report Daily Avg. & Daily Max. Measurement Frequency	Sample Type
Flow (MGD)	(Report)	(Report)	N/A	1/day (*1)	Instantaneous
Total Suspended Solids	25	45	45	3/day (*1)	Grab
Chlorides	N/A	300	300	1/year (*1)	Grab

   (*1) When discharging.

2. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/day (*1), by grab sample.

3. There shall be no discharge of floating solids or visible foam in other than trace amounts and no discharge of visible oil.

4. Effluent monitoring samples shall be taken at the following location: At Outfall 001, which discharges from the holding pond to Cayamon Creek.

Page ; TPDES Permit No. 02027

Wright Mat ; Inc.

Wright Materials Inc. TPDES Permit No. 02027

DEFINITIONS AND STANDARD PERMIT CONDITIONS

As required by Title 30 Texas Administrative Code (TAC) Chapter 305, certain regulations appear as standard conditions in waste discharge permits. 30 TAC §§ 305.121 - 305.129, Subchapter F, "Permit Characteristics and Conditions" as promulgated under the Texas Water Code §§ 5.103 and 5.105, and the Texas Health and Safety Code §§ 361.017 and 361.024(a), establish the characteristics and standards for waste discharge permits, including sewage sludge, and those sections of 40 Code of Federal Regulations (CFR) 122 adopted by reference by the Commission. The following text includes these conditions and incorporates them into this permit. All definitions in Section 26.001 of the Texas Water Code and 30 TAC Chapter 305 shall apply to this permit and are incorporated by reference. Some Specific definitions of words or phrases used in this permit are as follows:

1. Flow Measurements

   a. Annual average flow - the arithmetic average of all daily flow determinations taken within the preceding 12 consecutive calendar months. The annual average flow determination shall consist of daily flow volume determinations made by a totalizing meter, charted on a chart recorder and limited to major domestic wastewater discharge facilities with a 1 million gallons per day or greater permitted flow.

   b. Daily average flow - the arithmetic average of all determinations of the daily discharge within a period of one calendar month. The daily average flow determination shall consist of determinations made on at least four separate days. If instantaneous measurements are used to determine the daily discharge, the determination shall be the arithmetic average of all instantaneous measurements taken during that month. Daily average flow determination for intermittent discharges shall consist of a minimum of three flow determinations on days of discharge.

   c. Daily maximum flow - the highest total flow for any 24-hour period in a calendar month.

   d. Instantaneous flow - the measured flow during the minimum time required to interpret the flow measuring device.

   e. 2-hour peak flow (domestic wastewater treatment plants) - the maximum flow sustained for a two-hour period during the period of daily discharge. Multiple measurements of instantaneous maximum flow within a two-hour period may be compared to the permitted 2-hour peak flow.

   f. Maximum 2-hour peak flow (domestic wastewater treatment plants) - the highest 2-hour peak flow for any 24-hour period in a calender month.

2. Concentration Measurements

   a. Daily average concentration - the arithmetic average of all effluent samples, composite or grab as required by this permit, within a period of one calendar month, consisting of at least four separate representative measurements. When four samples are not available in a calendar month, the arithmetic average of the four most recent measurements or the arithmetic average (weighted by flow) of all values taken during the month shall be used as the daily average concentration.

   b. 7-day average concentration - the arithmetic average of all effluent samples, composite or grab as required by this permit, within a period of one calendar week, Sunday through Saturday.

   c. Daily maximum concentration - the maximum concentration measured on a single day, by composite sample unless otherwise specified elsewhere in this permit, within a period of one calender month.

   d. Daily discharge - the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in terms of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the sampling day. For pollutants with limitations expressed in other units of measurement, the "daily discharge" is calculated as the average measurement of the pollutant over the sampling day.

      The "daily discharge" determination of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the "daily discharge" determination of concentration shall be the arithmetic average (weighted by flow value) of all samples collected during that day.

c. Fecal coliform bacteria concentration - the number of colonies of fecal coliform bacteria per 100 milliliters effluent. The fecal coliform bacteria daily average is a geometric mean of the values for the effluent samples collected in a calendar month. The geometric mean shall be determined by calculating the nth root of the product of all measurements made in a particular period of time. For example in a month's time, where n equals the number of measurements made; or, computed as the antilogarithm of the sum of the logarithm of each measurement made. For any measurement of fecal coliform bacteria equaling zero, a substituted value of one shall be made for input into either computation method.

3. Sample Type

   a. Composite sample - for domestic wastewater a sample made up of a minimum of three effluent portions collected in a continuous 24-hour period or during the period of daily discharge if less than 24 hours, and combined in volumes proportional to flow, and collected no closer than two hours apart. For industrial wastewater a composite sample is a sample made up of a minimum of three effluent portions collected in a continuous 24-hour period or during the period of daily discharge if less than 24 hours, and combined in volumes proportional to flow, and collected no closer than one hour apart.

   b. Grab sample - an individual sample collected in less than 15 minutes.

4. Treatment Facility (facility) - wastewater facilities used in the conveyance, storage, treatment, recycling, reclamation and/or disposal of domestic sewage, industrial wastes, agricultural wastes, recreational wastes, or other wastes including sludge handling or disposal facilities under the jurisdiction of the Commission.

5. The term "sewage sludge" is defined as solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in 30 TAC Chapter 312. This includes the solids which have not been classified as hazardous waste separated from wastewater by unit processes.

6. Bypass - the intentional diversion of a waste stream from any portion of a treatment facility.

MONITORING AND REPORTING REQUIREMENTS

1. Self-Reporting

   Monitoring results shall be provided at the intervals specified in the permit. Unless otherwise specified in this permit or otherwise ordered by the Commission, the permittee shall conduct effluent sampling and reporting in accordance with 30 TAC §§ 319.4 - 319.12. Unless otherwise specified, a monthly effluent report shall be submitted each month, to the location(s) specified on the reporting form or the instruction sheet, by the 20th day of the following month for each discharge which is described by this permit whether or not a discharge is made for that month. Monitoring results must be reported on the approved TPDES self-report form, Discharge Monitoring Report (DMR) Form EPA No. 3320-1, signed and certified as required by Monitoring and Reporting Requirements No. 10.

   As provided by state law, the permittee is subject to administrative, civil and criminal penalties, as applicable, for negligently or knowingly violating the Clean Water Act, the Texas Water Code, Chapters 26, 27, and 28, and Texas Health and Safety Code, Chapter 361, including but not limited to knowingly making any false statement, representation, or certification on any report, record, or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, or falsifying, tampering with or knowingly rendering inaccurate any monitoring device or method required by this permit or violating any other requirement imposed by state or federal regulations.

2. Test Procedures

   Unless otherwise specified in this permit, test procedures for the analysis of pollutants shall comply with procedures specified in 30 TAC §§319.11 - 319.12. Measurements, tests and calculations shall be accurately accomplished in a representative manner.

3. Records of Results

   a. Monitoring samples and measurements shall be taken at times and in a manner so as to be representative of the monitored activity.

Wright Materials Inc. TPDES Permit No. 02027

b. Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR Part 503), monitoring and reporting records, including strip charts and records of calibration and maintenance, copies of all records required by this permit, records of all data used to complete the application for this permit, and the certification required by 40 CFR § 264.73(b)(9) shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years from the date of the record or sample, measurement, report, application or certification. This period shall be extended at the request of the Executive Director.

c. Records of monitoring activities shall include the following:

i. date, time and place of sample or measurement;
ii. identity of individual who collected the sample or made the measurement.
iii. date and time of analysis;
iv. identity of the individual and laboratory who performed the analysis;
v. the technique or method of analysis; and
vi. the results of the analysis or measurement and quality assurance/quality control records.

The period during which records are required to be kept shall be automatically extended to the date of the final disposition of any administrative or judicial enforcement action that maybe instituted against the permittee.

4. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit using approved analytical methods as specified above, all results of such monitoring shall be included in the calculation and reporting of the values submitted on the approved TPDES self-report form. Increased frequency of sampling shall be indicated on the self-report form.

5. Calibration of Instruments

All automatic flow measuring and/or recording devices and/or totalizing meters for measuring flows shall be accurately calibrated by a trained person at plant start-up and as often thereafter as necessary to ensure accuracy, but not less often than annually unless authorized by the Executive Director for a longer period. Such person shall verify in writing that the device is operating properly and giving accurate results. Copies of the verification shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years.

6. Compliance Schedule Reports

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of the permit shall be submitted no later than 14 days following each schedule date to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division.

7. Noncompliance Notification

a. In accordance with 30 TAC § 305.125(9) any noncompliance which may endanger human health or safety, or the environment shall be reported by the permittee to the TNRCC. Report of such information shall be provided orally or by facsimile transmission (FAX) to the Regional Office within 24 hours of becoming aware of the noncompliance. A written submission of such information shall also be provided by the permittee to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division within five working days of becoming aware of the noncompliance. The written submission shall contain a description of the noncompliance and its cause; the potential danger to human health or safety, or the environment; the period of noncompliance, including exact dates and times; if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance, and to mitigate its adverse effects.

b. The following violations shall be reported under Monitoring and Reporting Requirement 7.a.:

i. Unauthorized discharges as defined in Permit Condition 2(g).
ii. Any unanticipated bypass which exceeds any effluent limitation in the permit.
iii. Violation of a permitted maximum daily discharge limitation for pollutants listed specifically in the Other Requirements section of an Industrial TPDES permit.

Wright Materials Inc. TPDES Permit No. 02027

c. In addition to the above, any effluent violation which deviates from the permitted effluent limitation by more than 40% shall be reported by the permittee in writing to the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division within 5 working days of becoming aware of the noncompliance.

d. Any noncompliance other than that specified in this section, or any required information not submitted or submitted incorrectly, shall be reported to the Water Quality Management Information Systems Team (MC 224) of the Enforcement Division as promptly as possible. This requirement means to report these types of noncompliance on the approved TPDES self-report form.

8. In accordance with the procedures described in 30 TAC §§ 305.21, 305.22 and 305.23 (relating to Emergency Orders, Temporary Orders and Executive Director Authorizations) if the permittee knows in advance of the need for a bypass, it shall submit prior notice by applying for such authorization.

9. Changes in Discharges of Toxic Substances

All existing manufacturing, commercial, mining, and silvicultural permittees shall notify the Regional Office, orally or by facsimile transmission within 24 hours, and both the Regional Office and the Manager of the Water and Multimedia Section (MC 149) of the Enforcement Division in writing within five (5) working days, after becoming aware of or having reason to believe:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant listed at 40 CFR Part 122, Appendix D, Tables II and III (excluding Total Phenols) which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. One hundred micrograms per liter (100 μg/L);
ii. Two hundred micrograms per liter (200 μg/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 μg/L) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;
iii. Five (5) times the maximum concentration value reported for that pollutant in the permit application; or
iv. The level established by the TNRCC.

b. That any activity has occurred or will occur which would result in any discharge, on a nonroutine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. Five hundred micrograms per liter (500 μg/L);
ii. One milligram per liter (1 mg/L) for antimony;
iii. Ten (10) times the maximum concentration value reported for that pollutant in the permit application; or
iv. The level established by the TNRCC.

10. Signatories to Reports

All reports and other information requested by the Executive Director shall be signed by the person and in the manner required by 30 TAC § 305.128 (relating to Signatories to Reports).

11. All POTWs must provide adequate notice to the Executive Director of the following:

a. Any new introduction of pollutants into the POTW from an indirect discharger which would be subject to section 301 or 306 of the CWA if it were directly discharging those pollutants;

b. Any substantial change in the volume or character of pollutants being introduced into that POTW by a source introducing pollutants into the POTW at the time of issuance of the permit; and

c. For the purpose of this paragraph, adequate notice shall include information on:

i. The quality and quantity of effluent introduced into the POTW; and
ii. Any anticipated impact of the change on the quantity or quality of effluent to be discharged from the POTW.

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Wright Materials Inc. TPDES Permit No. 02027

PERMIT CONDITIONS

1. General

   a. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in an application or in any report to the Executive Director, it shall promptly submit such facts or information.

   b. This permit is granted on the basis of the information supplied and representations made by the permittee during action on an application in accordance with 30 TAC Chapter 50 and the application process in accordance with 30 TAC Chapter 281, and relying upon the accuracy and completeness of that information and those representations in accordance with 30 TAC Chapter 305. After notice in accordance with 30 TAC Chapter 39 and opportunity for a hearing in accordance with 30 TAC §§ 55.21 - 55.31, Subchapter B, "Hearing Requests, Public Comment", this permit may be modified, suspended, or revoked, in whole or in part in accordance with 30 TAC Chapter 305 Subchapter D, during its term for cause including but not limited to, the following:

      i. Violation of any terms or conditions of this permit;
      ii. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or
      iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

   c. The permittee shall furnish to the Executive Director, upon request and within a reasonable time, any information to determine whether cause exists for amending, revoking, suspending or terminating the permit. The permittee shall also furnish to the Executive Director, upon request, copies of records required to be kept by the permit.

2. Compliance

   a. Acceptance of the permit by the person to whom it is issued constitutes acknowledgment and agreement that such person will comply with all the terms and conditions embodied in the permit, and the rules and other orders of the Commission.

   b. The permittee has a duty to comply with all conditions of the permit. Failure to comply with any permit condition constitutes a violation of the permit and the Texas Water Code or the Texas Health and Safety Code, and is grounds for enforcement action, for permit amendment, revocation or suspension, or for denial of a permit renewal application or of an application for a permit for another facility.

   c. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of the permit.

   d. The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal or other permit violation which has a reasonable likelihood of adversely affecting human health or the environment.

   e. Authorization from the Commission is required before beginning any change in the permitted facility or activity that may result in noncompliance with any permit requirements.

   f. A permit may be amended, suspended and reissued, or revoked for cause in accordance with 30 TAC §§ 305.62 and 305.66 and the Texas Water Code Section 7.302. The filing of a request by the permittee for a permit amendment, suspension and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

   g. There shall be no unauthorized discharge of wastewater or any other waste. For the purpose of this permit, an unauthorized discharge is considered to be any discharge of wastewater into or adjacent to waters in the state at any location not permitted as an outfall or otherwise defined in the Other Requirements section of this permit.

   h. In accordance with 30 TAC § 305.535(a), the permittee may allow any bypass to occur from a TPDES permitted facility which does not cause permitted effluent limitations to be exceeded, but only if the diversion is also for essential maintenance to assure efficient operation.

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i. The permittee is subject to administrative, civil, and criminal penalties, as applicable, under Texas Water Code §§ 26.136, 26.212, and 26.213 for violations including but not limited to negligently or knowingly violating the federal Clean Water Act, §§ 301, 302, 306, 307, 308, 318, or 405, or any condition or limitation implementing any sections in a permit issued under the CWA § 402, or any requirement imposed in a pretreatment program approved under the CWA §§ 402 (a)(3) or 402 (b)(8).

3. Inspections and Entry

a. Inspection and entry shall be allowed as prescribed in the Texas Water Code Chapters 26, 27, and 28, and Texas Health and Safety Code Chapter 361.

b. The members of the Commission and employees and agents of the Commission are entitled to enter any public or private property at any reasonable time for the purpose of inspecting and investigating conditions relating to the quality of water in the state or the compliance with any rule, regulation, permit or other order of the Commission. Members, employees, or agents of the Commission and Commission contractors are entitled to enter public or private property at any reasonable time to investigate or monitor or, if the responsible party is not responsive or there is an immediate danger to public health or the environment, to remove or remediate a condition related to the quality of water in the state. Members, employees, Commission contractors, or agents acting under this authority who enter private property shall observe the establishment's rules and regulations concerning safety, internal security, and fire protection, and if the property has management in residence, shall notify management or the person then in charge of his presence and shall exhibit proper credentials. If any member, employee, Commission contractor, or agent is refused the right to enter in or on public or private property under this authority, the Executive Director may invoke the remedies authorized in Texas Water Code Section 7.002.

4. Permit Amendment and/or Renewal

a. The permittee shall give notice to the Executive Director as soon as possible of any planned physical alterations or additions to the permitted facility if such alterations or additions would require a permit amendment or result in a violation of permit requirements. Notice shall also be required under this paragraph when:

i. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in accordance with 30 TAC § 305.534 (relating to New Sources and New Dischargers); or

ii. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements in Monitoring and Reporting Requirements No. 8 and as adopted by 30 TAC § 305.531(a) (relating to Establishing and Calculating Additional Conditions and Limitations for TPDES Permits);

iii The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan.

b. Prior to any facility modifications, additions and/or expansions of a permitted facility that will increase the plant capacity beyond the permitted flow, the permittee must apply for and obtain proper authorization from the Commission before commencing construction.

c. The permittee must apply for an amendment or renewal at least 180 days prior to expiration of the existing permit in order to continue a permitted activity after the expiration date of the permit. Authorization to continue such activity will terminate upon the effective denial of said application.

d. Prior to accepting or generating wastes which are not described in the permit application or which would result in a significant change in the quantity or quality of the existing discharge, the permittee must report the proposed changes to the Commission. The permittee must apply for a permit amendment reflecting any necessary changes in permit conditions, including effluent limitations for pollutants not identified and limited by this permit.

e. In accordance with the Texas Water Code § 26.029(b), after a public hearing, notice of which shall be given to the permittee, the Commission may require the permittee, from time to time, for good cause, in accordance with applicable laws, to conform to new or additional conditions.

f. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this permit, this permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regulations that established those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

5. Permit Transfer

a. Prior to any transfer of this permit, Commission approval must be obtained. The Commission shall be notified in writing of any change in control or ownership of facilities authorized by this permit. Such notification should be sent to the Wastewater Permits Section Application Team (MC 148) of the Water Quality Division.

b. A permit may be transferred only according to the provisions of 30 TAC § 305.64 (relating to Transfer of Permits) and 30 TAC § 50.33 (relating to Executive Director Action on Application for Transfer).

6. Relationship to Hazardous Waste Activities

This permit does not authorize any activity of hazardous waste storage, processing, or disposal which requires a permit or other authorization pursuant to the Texas Health and Safety Code.

7. Relationship to Water Rights

Disposal of treated effluent by any means other than discharge directly to the waters in the state must be specifically authorized in this permit and may require a permit pursuant to Chapter 11 of the Texas Water Code.

8. Property Rights

A permit does not convey any property rights of any sort, or any exclusive privilege.

9. Permit Enforceability

The conditions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

OPERATIONAL REQUIREMENTS

1. The permittee shall at all times ensure that the facility and all of its systems of collection, treatment, and disposal are properly operated and maintained. This includes the regular, periodic examination of wastewater solids within the treatment plant by the operator in order to maintain an appropriate quantity and quality of solids inventory as described in the various operator training manuals and according to accepted industry standards for process control such as the Commission's "Recommendations for Minimum Process Control Tests for Domestic Wastewater Treatment Facilities." Process control records shall be retained at the facility site and/or shall be readily available for review by a TNRCC representative for a period of three years.

2. Upon request by the Executive Director, the permittee shall take appropriate samples and provide proper analysis in order to demonstrate compliance with Commission rules. Unless otherwise specified in this permit or otherwise ordered by the Commission, the permittee shall comply with all provisions of 30 TAC §§ 312.1 - 312.13 concerning sewage sludge use and disposal and 30 TAC §§ 319.21 - 319.29 concerning the discharge of certain hazardous metals.

3. Domestic wastewater treatment facilities shall comply with the following provisions:

a. The permittee shall notify the Executive Director in care of the Wastewater Permits Section (MC 148) of the Water Quality Division, in writing of any closure activity or facility expansion at least 90 days prior to conducting such activity.

b. Closure activities include those associated with any pit, tank, pond, lagoon, or surface impoundment regulated by this permit.

c. As part of the notification, the permittee shall submit to the Municipal Permits Team (MC 148) of the Wastewater Permits Section of the Water Quality Division, a closure plan which has been developed in accordance with the "Closure Guidance Documents Nos. 4 and 5" available through the Publications Inventory and Distribution Section (MC 195) of the Agency Communications Division.

4. The permittee is responsible for installing prior to plant start-up, and subsequently maintaining, adequate safeguards to prevent the discharge of untreated or inadequately treated wastes during electrical power failures by means of alternate power sources, standby generators, and/or retention of inadequately treated wastewater.

5. Unless otherwise specified, the permittee shall provide a readily accessible sampling point and, where applicable, an effluent flow measuring device or other acceptable means by which effluent flow may be determined.

6. The permittee shall remit an annual waste treatment fee to the Commission as required by 30 TAC Chapter 305 Subchapter M and an annual water quality assessment fee to the Commission as required by 30 TAC Chapter 320. Failure to pay either fee may result in revocation of this permit.

7. Documentation

For all written notifications to the Commission required of the permittee by this permit, the permittee shall keep and make available a copy of each such notification under the same conditions as self-monitoring data are required to be kept and made available. Except for applications, effluent data, permits, and other data specified in 30 TAC § 305.46, any information submitted pursuant to this permit may be claimed as confidential by the submitter. Any such claim must be asserted in the manner prescribed in the application form or by stamping the words "confidential business information" on each page containing such information. If no claim is made at the time of submission, information may be made available to the public without further notice.

8. Facilities which generate domestic wastewater shall comply with the following provisions; domestic wastewater treatment facilities at permitted industrial sites are excluded.

a. Whenever flow measurements for any domestic sewage treatment facility reach 75 percent of the permitted daily average or annual average flow for three consecutive months, the permittee must initiate engineering and financial planning for expansion and/or upgrading of the domestic wastewater treatment and/or collection facilities. Whenever, the flow reaches 90 percent of the permitted daily average or annual average flow for three consecutive months, the permittee shall obtain necessary authorization from the Commission to commence construction of the necessary additional treatment and/or collection facilities. In the case of a domestic wastewater treatment facility which reaches 75 percent of the permitted daily average or annual average flow for three consecutive months, and the planned population to be served or the quantity of waste produced is not expected to exceed the design limitations of the treatment facility, the permittee shall submit an engineering report supporting this claim to the Executive Director of the Commission.

If in the judgement of the Executive Director the population to be served will not cause permit noncompliance, then the requirement of this section may be waived. To be effective, any waiver must be in writing and signed by the Director of the Water Quality Division (MC 148) of the Commission, and such waiver of these requirements will be reviewed upon expiration of the existing permit; however, any such waiver shall not be interpreted as condoning or excusing any violation of any permit parameter.

b. The plans and specifications for domestic sewage collection and treatment works associated with any domestic permit must be approved by the Commission, and failure to secure approval before commencing construction of such works or making a discharge is a violation of this permit and each day is an additional violation until approval has been secured.

c. Permits for domestic wastewater treatment plants are granted subject to the policy of the Commission to encourage the development of area-wide waste collection, treatment and disposal systems. The Commission reserves the right to amend any domestic wastewater permit in accordance with applicable procedural requirements to require the system covered by this permit to be integrated into an area-wide system, should such be developed; to require the delivery of the wastes authorized to be collected in, treated by or discharged from said system, to such area-wide system; or to amend this permit in any other particular to effectuate the Commission's policy. Such amendments may be made when the changes required are advisable for water quality control purposes and are feasible on the basis of waste treatment technology, engineering, financial, and related considerations existing at the time the changes are required, exclusive of the loss of investment in or revenues from any then existing or proposed waste collection, treatment or disposal system.

Wright Materials Inc. TPDES Permit No. 02027

9. Domestic wastewater treatment plants shall be operated and maintained by sewage plant operators holding a valid certificate of competency at the required level as defined in 30 TAC Chapter 325.

10. For publicly owned treatment works, the 30-day average (or Monthly average) percent removal for BOD and TSS shall not be less than 85 percent, unless otherwise authorized by this permit.

11. Facilities which generate industrial solid waste as defined in 30 TAC § 335.1 shall comply with these provisions:

    a. Any solid waste generated by the permittee during the management and treatment of wastewater, as defined in 30 TAC § 335.1 (including but not limited to such wastes as garbage, refuse, sludge from a waste treatment, water supply treatment plant or air pollution control facility, discarded materials, discarded materials to be recycled, whether the waste is solid, liquid, or semisolid) must be managed in accordance with all applicable provisions of 30 TAC Chapter 335, relating to Industrial Solid Waste Management.

    b. Industrial wastewater that is being collected, accumulated, stored, or processed before discharge through any final discharge outfall, specified by this permit, is considered to be industrial solid waste until the wastewater passes through the actual point source discharge and must be managed in accordance with all applicable provisions of 30 TAC Chapter 335.

    c. The permittee shall provide written notification, pursuant to the requirements of 30 TAC § 335.6(g), to the Corrective Action Section (MC 127) of the Industrial and Hazardous Waste Division informing the Commission of any closure activity involving an Industrial Solid Waste Management Unit, at least 90 days prior to conducting such an activity.

    d. Construction of any industrial solid waste management unit requires the prior written notification of the proposed activity to the Waste Evaluation Section (MC 129) of the Industrial and Hazardous Waste Division. No person shall dispose of industrial solid waste, including sludge or other solids from wastewater treatment processes, prior to fulfilling the deed recordation requirements of 30 TAC § 335.5.

    e. The term "industrial solid waste management unit" means a landfill, surface impoundment, waste-pile, industrial furnace, incinerator, cement kiln, injection well, container, drum, salt dome waste containment cavern, or any other structure vessel, appurtenance, or other improvement on land used to manage industrial solid waste.

    f. The permittee shall keep management records for all sludge (or other waste) removed from any wastewater treatment process. These records shall fulfill all applicable requirements of 30 TAC Chapter 335 and must include the following, as it pertains to wastewater treatment and discharge:

        i. Volume of waste and date(s) generated from treatment process;
        ii. Volume of waste disposed of on-site or shipped off-site;
        iii. Date(s) of disposal;
        iv. Identity of hauler or transporter;
        v. Location of disposal site; and
        vi. Method of final disposal.

    The above records shall be maintained on a monthly basis. The records shall be retained at the facility site and/or shall be readily available for review by authorized representatives of the TNRCC for at least five years.

12. For industrial facilities to which the requirements of 30 TAC Chapter 335 do not apply, sludge and solid wastes, including tank cleaning and contaminated solids for disposal, shall be disposed of in accordance with Chapter 361 of the Health and Safety Code of Texas.

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Wright Materials Inc. TPDES Permit No. 02027

OTHER REQUIREMENTS

1. Violations of daily maximum limitations for the following pollutants shall be reported orally to TNRCC Region 14, within 24 hours from the time the permittee becomes aware of the violation followed by a written report within five days: None.

2. There is no mixing zone established for this discharge to an intermittent stream. Acute toxic criteria apply at the point of discharge.

3. There shall be no discharge of domestic sewage. All sewage shall be routed to a septic tank/drainfield system.

4. The applicant will take all necessary precautions, such as diking the storage ponds and working pits to prevent the accumulation of surface runoff during periods of average rainfall. During periods of heavy rainfall when overflow into the storage and working pits occurs, the applicant may dewater the pits in order to resume operations. All such discharges will be made in accordance with the requirements on page 2.

5. All new points of discharge to the Nueces River and/or Cayamon Creek will be established with prior notification to the Texas Natural Resource Conservation Commission Region 14 Office. These discharge points will be temporary and must be re-established for each dewatering after major storm events.

6. No discharge shall be made from this operation unless the Texas Natural Resource Conservation Commission Region 14 Office has been notified 24 hours prior to discharge.

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Appendix 4
Sample Results from Outfall 001
Wright Materials, Inc. Nason Plant No. 1

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consist solely of stormwater. Outfalls that contain any wastewater other than stormwater, for example, process wastewater, utility wastewater, domestic wastewater or groundwater, must complete TABLE 2. Facilities that utilize land application or evaporation for wastewater treatment/disposal must also provide these analytical results. Average and maximum concentrations must be calculated from at least 4 separate analytical results obtained from 4 grab or composite samples collected at a frequency of 1/week for a period of 4 weeks from the wastewater stream. If this application is for a new facility, submit results from similar facilities, treatability studies, design information, or literature sources. If this application is for an operating facility, report the results for the influent and effluent.

TABLE 2

OUTFALL 001 Sample Type: GRAB X COMPOSITE____

POLLUTANT	INFLUENT CONCENTRATION (mg/l) AVG.	INFLUENT CONCENTRATION (mg/l) MAX.	NUMBER OF SAMPLES	EFFLUENT CONCENTRATION (mg/l) AVG.	EFFLUENT CONCENTRATION (mg/l) MAX.	NUMBER OF SAMPLES
BOD (5-day)					< 2.0	1
CBOD (5-day)					< 2.0	1
Chemical Oxygen Demand					< 5.0	1
Total Organic Carbon					2.5	1
Ammonia Nitrogen					< 0.1	1
Total Suspended Solids					24.0	1
Nitrate Nitrogen					0.05	1
Total Organic Nitrogen	*Discharges have not been				1.4	1
Total Phosphorus	required during the				< 0.01	1
Oil and Grease	current permit period				< 1.0	1
Total Residual Chlorine					< 0.10	1
Total Dissolved Solids	*Tests are from Cayamon				1,448.0	1
Sulfate	Creek (see attached				220.0	1
Chloride	sheet)				490.0	1
Fluoride					1.12	1
Fecal Coliform	-50 CFU/100 ML-					1
Summer Temperature (^{o}F)					Not Available	1
Winter Temperature (^{o}F)					62	1
pH (Standard Units; min/max)					8.23	1

*Discharges are required by floods. Exact testing is not possible.

POLLUTANT	EFFLUENT CONCENTRATION (µg/l) AVG.	EFFLUENT CONCENTRATION (µg/l) MAX.	NUMBER OF SAMPLES	MAL µg/l
Total Aluminum *		0.91	1	30
Total Arsenic *		0.016	1	10
Total Barium *		0.11	1	10
Total Cadmium *		< 0.001	1	1
Total Chromium *		< 0.005	1	10
Trivalent Chromium		< 0.005	1	--
Hexavalent Chromium *		< 0.01	1	10
Total Copper *		0.01	1	10
Cyanide, (Amenable to Chlorination or Weak-Acid Dissociable) *		< 0.02	1	20
Total Lead *		< 0.002	1	5
Total Mercury *		< 0.0002	1	0.2
Total Nickel *		0.01	1	10
Total Selenium *		< 0.002	1	10
Total Silver *		< 0.001	1	2
Total Zinc *		< 0.005	1	5

* **Test Methods utilized should be sensitive enough to detect these constituents at the Minimum Analytical Level (MAL) specified above in micrograms/liter (µg/l).**

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Appendix 5
Signed Access Agreement Letter for Groundwater Monitor Well Installation in Hazel Bazemore Park

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NUECES RIVER AUTHORITY

GENERAL OFFICE
First State Bank Bldg., Suite 208
200 E. Nopal ● P O Box 349
Uvalde, Texas 78802-0349
Tel 830-278-6810 ● Fax: 830-278-2025

COASTAL BEND DIVISION
Natural Resources Center, Suite 3100
6300 Ocean Drive
Corpus Christi, Texas 78412
Tel. 361-825-3193 ● Fax: 361-825-3195

October 9, 2000

Honorable Richard Borchard
County Judge
Nueces County
901 Leopard St.
Corpus Christi, Texas 78401

Re: Groundwater Monitoring Well Installations in Hazel Bazemore Park

Dear Judge Borchard:

As part of the Senate Bill 1 Regional Water Planning Program for the Coastal Bend area, the Nueces River Authority and the Center for Water Supply Studies at Texas A&M University - Corpus Christi are conducting water quality investigations in the Nueces River above the Calallen Dam. These studies are designed to address the problem of elevated levels of dissolved solids in the Nueces River water. The higher salt content in the water being diverted from the Nueces River at Calallen interferes with industrial water use. If we can find ways to prevent these increases, industries can use these water supplies more efficiently, thus reducing industrial water demands.

The levels of chloride and other dissolved minerals increase significantly in the river reach below Wesley Seale Dam, particularly in the vicinity of the Calallen Pool. We believe that groundwater intrusion may be the primary cause of these salt loadings. In order to identify the sources, we are installing groundwater monitoring wells at several locations adjacent to the Calallen Pool. The Hazel Bazemore Nueces County Park is one of the best situated sites we have identified for our monitoring studies.

With your permission, we would like to install two permanent groundwater monitoring wells and sample these wells on a routine basis. Both wells would be 4" diameter, cased wells; one would be drilled to approximately 15 feet in depth and the other to approximately 30 feet in depth. Both wells would be installed by a licensed water well driller according to the requirements in the Texas Water Code. The wells would be capped with a locking device to prevent unauthorized access. We will be happy to work with the Nueces County Parks Department personnel in selecting an appropriate site for the wells within Hazel Bazemore Park.

Our timeframe for installing these wells is fairly tight in order to meet a monitoring schedule that begins in the last week of this month. If possible, we would like to have the wells installed by the end of this week. I apologize for the lateness of this request, but would ask for your approval as quickly as possible. I have included a signature line at the end of this letter as a method of approval.

Honorable Richard Borchard
County Judge, Nueces County
October 9, 2000
Page two

Thank you for your kind consideration and cooperation.

Sincerely,

James Dodson

James A. Dodson
Deputy Executive Director

c: Mr. Frank Rios, Director, Nueces County Parks and Recreation
Dr. C. Alan Berkebile, Director, Center for Water Supply Studies, TAMU-CC

Approved by:

R Borchard 10/9/00

Judge Richard Borchard **Date**
Nueces County, Texas

Appendix 6
Aerial Image with Well Location Information

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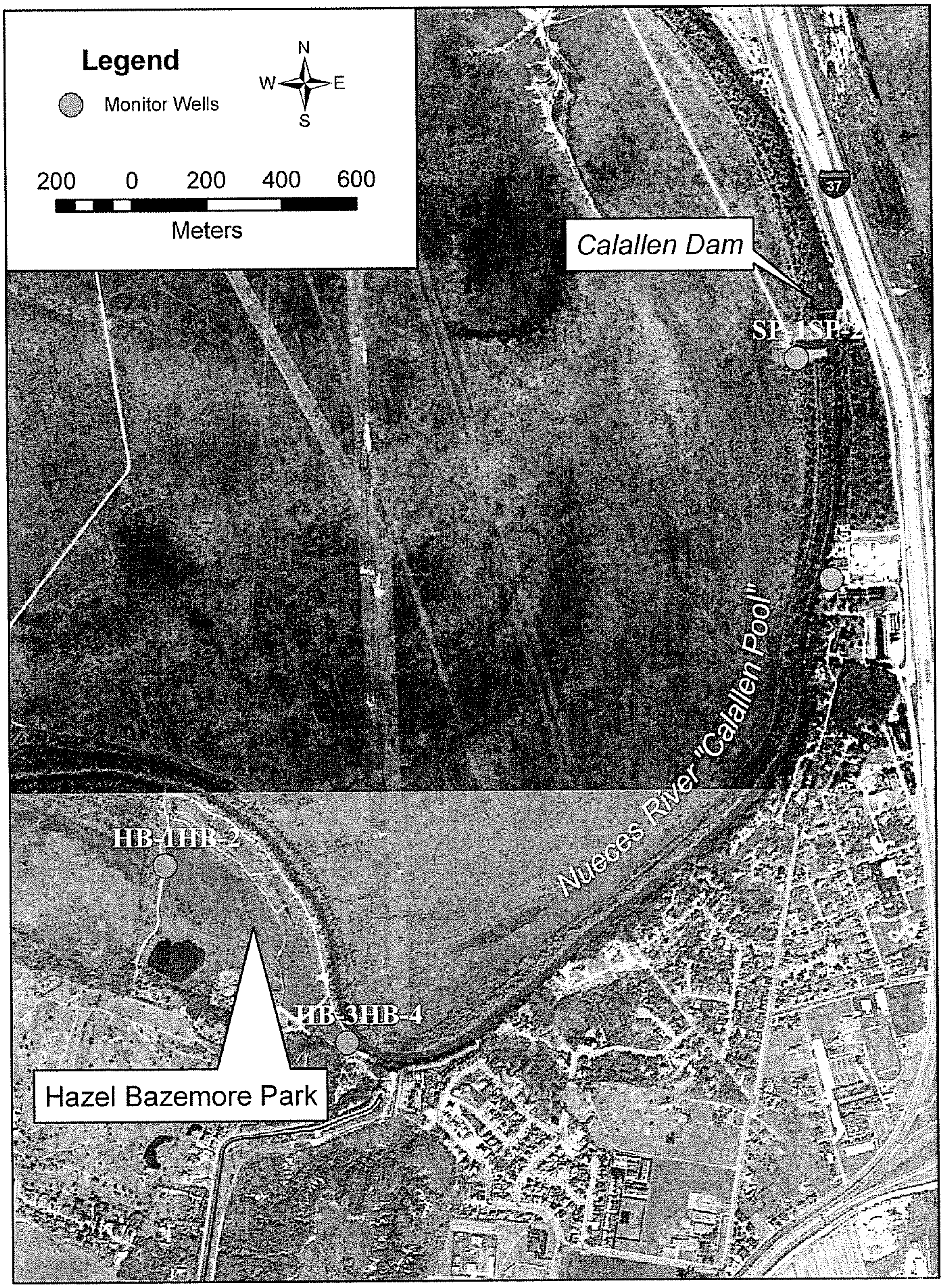

Appendix 6. Aerial Image with Well Location Information

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Appendix 7
Monitor Well Logs

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CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	HB-1
		PROJECT NAME	Nueces River Project
		LOCATION	Hazel Bazemore Park
COORDINATES	E 633515 N 3083345	PROJECT NUMBER	
SURFACE ELEVATION	DATUM GL	LOGGED BY	K. Dodson

SAMPLE INFORMATION						STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)				
		SS					Clay	Cement	
3		SS					Clay	Bentonite	
								PVC Riser	
		SS							
6							Clay - lt. Gray		
		SS					Sand w/clay stringers	PVC Screen	
9									

DRILLING CONTRACTOR	Front Range Environmental	REMARKS: Water 5' below surface. TD 8' UTM 14 - NAD27	
DRILLING METHOD	Hollow stem auger		
DRILLING EQUIPMENT			
DRILLING STARTED	10/13/2000 ENDED 10/13/2000		

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	HB-2
COORDINATES	E 633515 N 3083345	PROJECT NAME	Nueces River Project
SURFACE ELEVATION	DATUM GL	LOCATION	Hazel Bazemore Park (West End)
		PROJECT NUMBER	
		LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		GS					Clay	Cement	
3								Bentonite	
								PVC Riser	
6		GS					Sandy Clay		
9									
		GS					Sand - Gray unconsolidated		
12									
15									
		GS					Sand - Gray silty		
18								PVC Screen	
21									

DRILLING CONTRACTOR	Front Range Environmental
DRILLING METHOD	Hollow stem auger
DRILLING EQUIPMENT	
DRILLING STARTED	10/13/2000 ENDED 10/13/2000

REMARKS: TD 20' UTM 14 - NAD27

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	HB-3
		PROJECT NAME	Nueces River Project
		LOCATION	Hazel Bazemore Park (east end)
COORDINATES		PROJECT NUMBER	
SURFACE ELEVATION	DATUM GL	LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Black-Brown Clay	Cement	
							Brown Sand		
3		SS					lt. Brown clay w/ some sand	Bentonite	
								PVC Riser	
		SS					lt. Brown clay (sandy)		
6							Black Clay		
		SS					Black Clay		
							Black Clay		
9		SS					Clay Sand w/pebble & caliche		
							lt. Brown Sand (clayey)	PVC Screen	
		SS					poorly sorted w/ pebbles		
12									

DRILLING CONTRACTOR	Front Range Environmental	REMARKS: Water 3.66' below surface. TD 12'
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/18/2000 ENDED 10/18/2000	

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	HB-4
COORDINATES		PROJECT NAME	Nueces River Project
SURFACE ELEVATION	DATUM GL	LOCATION	Hazel Bazemore Park
		PROJECT NUMBER	
		LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Not Logged	Cement	
3		SS						Bentonite PVC Riser	
6		SS					Gray Clay		
9		SS					lt. Brown-gray sand w/clay stringers		
12		SS							
15		SS					Partial returns w/clay stringers		
18		SS						PVC Screen	
21		SS							

DRILLING CONTRACTOR	Front Range Environmental	REMARKS:
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/18/2000 ENDED 10/18/2000	

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	SP-1
		PROJECT NAME	Nueces River Project
		LOCATION	SPMWD
COORDINATES	E 635207 N 3084684	PROJECT NUMBER	
SURFACE ELEVATION	DATUM GL	LOGGED BY	R. Hay

SAMPLE INFORMATION						STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)				
		GS					Black Clay	Cement	
3		GS						Bentonite	
							Sand	PVC Riser	
		GS					Tan/gray Clay w/sand stringers		
6		GS					Tan/gray Clay w/sand stringers		
9		GS					Sandy Clay		
		GS					Gray Sand		
12							Gray Clay		
		GS					Gray Sand w/brown-tan clay		
15		GS					Brown Clay	PVC Screen	
							Gray Sandy Clay		
		GS					Brown Clay		
18							Gray Sandy Clay		

DRILLING CONTRACTOR	Front Range Environmental
DRILLING METHOD	Hollow stem auger
DRILLING EQUIPMENT	
DRILLING STARTED	10/16/2000 ENDED 10/16/2000

REMARKS: Water 10.5' below surface. TD 18'

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	SP-2
		PROJECT NAME	Nueces River Project
		LOCATION	SPMWD
COORDINATES	E 635207 N 3084684	PROJECT NUMBER	
SURFACE ELEVATION	DATUM GL	LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		GS				Black Clay	Cement	
3							Bentonite	
		GS				Brown Clay	PVC Riser	
6		GS				Brown Clay		
9		GS				Brown-gray Sandy Clay		
		GS				Gray Sandy Clay		
12								
		GS				No Returns		
15								
		GS				Gray Sandy Clay		
18								
21		GS				Gray Sandy Clay occasionally no returns		
24							PVC Screen	
27								

DRILLING CONTRACTOR	Front Range Environmental
DRILLING METHOD	Hollow stem auger
DRILLING EQUIPMENT	
DRILLING STARTED	10/16/2000 ENDED 10/16/2000

REMARKS: Water 6.5' below surface. TD 8'

CENTER FOR WATER SUPPLY STUDIES	6300 Ocean Drive CORPUS CHRISTI, TX 78412 (361) 825-3344	BORING NUMBER	CP-1
		PROJECT NAME	Nueces River Project
		LOCATION	Cunningham Plant
COORDINATES	E 635298 N 3084123	PROJECT NUMBER	
SURFACE ELEVATION	DATUM GL	LOGGED BY	R. Hay

DEPTH FEET	LAB SAMPLE	SAMPLE TYPE	BLOW COUNTS	Recovery %	OVA (ppm)	STRATA	DESCRIPTION	WELL CONSTRUCTION DETAIL	ELEVATION FEET
		SS					Dark Brown Clay	Cement	
							Hard Caliche		
3		SS					Caliche	Bentonite	
								PVC Riser	
		SS					Caliche		
6									
		SS					Caliche		
							lt. Brown Sand w/ gravel		
9		SS					lt. Brown Sand w/ gravel		
		SS					lt. Brown Sand w/ gravel		
12									
		SS					Gravel and Sand		
							Clay at bottom		
15		SS					Gavel and Sand	PVC Screen	
							moderate production		
18									
27									

DRILLING CONTRACTOR	Front Range Environmental	REMARKS: Water 11' below surface. TD 16'
DRILLING METHOD	Hollow stem auger	
DRILLING EQUIPMENT		
DRILLING STARTED	10/17/2000 ENDED 10/17/2000	

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Appendix 8
Sample Results

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CUSTOMᵀᴱ**R RECORD and ANALYS**

Send Results to: :ielle Grunkemeyer
Nueces River Authority
Address: NRC Bldg., Suite 3100
6300 Ocean Drive
Corpus Christi, TX 78412

NUECES RIVER AUTHOR. . Y

Lab Analysis Request

Phone:	Fax:	Project Name:	Project No.:
361-825-3193	361-825-3195	Nueces River Dissolved Minerals Study	SB-1

Sampling by: Gabrielle Grunkemeyer, Karen Dodson, and Angela Rodriguez

Sampling Location Identification:	Lab Only	No. Containers	Matrix: Liquid	Matrix: Soil	Preserved with Ice (4° C)		Sampling: Date	Sampling: Time	Calcium 600 215.1	Magnesium 600 242.1	Sodium 600 273.1	Potassium 600 258.1	Sulfate method 600 375.3	Chloride method SM 4500-Cl B	TDS method 600 310.1	Alkalinity method 310.1	Bromide SM 4500-Br- B	Hardness method 130				
HB-1			X		✓		10/27/2000	9:55														
HB-2			X		✓		10/27/2000	9:50														
HB-3			X		✓		10/27/2000	10:45														
HB-4			X		✓		10/27/2000	10:45														
R-1			X		✓		10/27/2000	10:30														
R-2			X		✓		10/27/2000	11:30														
SP-1			X		✓		10/27/2000	11:59														
SP-2			X		✓		10/27/2000	11:54														
CP-1			X		✓		10/27/2000	12:40														
			X																			
Replicate:			X																			

Relinquished by:	Date	Time	Received By:	Date	Time	Remarks: X = laboratory measurement
[signature]	10/27/2000	1:35 pm	[signature]	10-27-00	1:35	Field measurements = DO, Conductance, Temperature, pH.

D-1

CUSTOMER RECORD and ANALYSI

Send Results to: Gabrielle Grunkemeyer
Address: Nueces River Authority
NRC Bldg., Suite 3100
6300 Ocean Drive
Corpus Christi, TX 78412

NUECES RIVER AUTHORITY

Lab Analysis Request

Phone:	Fax:	Project Name:	Project No.:
361-825-3193	361-825-3195	Nueces River Dissolved Minerals Study	SB-1

Sampling by:
Gabrielle Grunkemeyer, Karen Dodson, and Angela Rodriguez
Jan Sigarek

Sampling Location Identification:	Lab Only	No. Containers	Matrix: Liquid	Matrix: Soil	Preserved with Ice (4° C)		Sampling: Date	Sampling: Time	Calcium 600 215.1	Magnesium 600 242.1	Sodium 600 273.1	Potassium 600 258.1	Sulfate method 600 375.3	Chloride method SM 4500-Cl⁻ B	TDS method 600 310.1	Alkalinity method 310.1	Bromide SM 4500-Br⁻ B	Hardness method 130				
WC1D1-B			X		✓		10-30-00	1050	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
WC1D-1-M			X		✓		10-30-00	1115														
DS1-B			X		✓		10-30-00	1149														
DS1-M			X		✓		10-30-00	1153														
DS1-M (dup.)			X		✓		10-30-00	1156														
			X																			
			X																			
			X																			
			X																			
			X																			
Replicate:			X																			

Relinquished by:	Date	Time	Received By:	Date	Time	Remarks: X = laboratory measurement
[signature]	10-30-00	12:45	C Neske	10-30-00	1245	Field measurements = DO, Conductance, Temperature, pH.

D-1

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-1
9:55 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	820	40.92	Merks	10-31-00
EPA 600 242.1	Magnesium	240	19.74	Merks	10-31-00
EPA 600 273.1	Sodium	2450	106.57	Merks	10-31-00
EPA 600 258.1	Potassium	41	1.05	Merks	10-31-00
	Total Cations		168.28		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	394	6.46	Merks	10-27-00
EPA 600 375.3	Sulfate	1290	26.86	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	4490	126.66	Merks	10-30-00
	Total Anions		159.98		

Ion Ratio (Cation/Anion) --- 1.052

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.00		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	323	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	3040	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	10300	Merks	10-31-00
SM 4500-Br~	Bromide --------------------	14	Moore	10-31-00

Lab. No. M38-4867

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

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CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-2
9:50 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	600	29.94	Merks	10-31-00
EPA 600 242.1	Magnesium	200	16.45	Merks	10-31-00
EPA 600 273.1	Sodium	2180	94.82	Merks	10-31-00
EPA 600 258.1	Potassium	17	0.43	Merks	10-31-00
	Total Cations		141.64		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-0ᴌ
EPA 600 310.1	Bicarbonate	376	6.16	Merks	10-27-00
EPA 600 375.3	Sulfate	1030	21.44	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	3780	106.63	Merks	10-30-00
	Total Anions		134.23		

Ion Ratio (Cation/Anion) --- 1.055

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 6.89		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate -----------------	308	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate -----------------	2320	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	8430	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	13	Moore	10-31-00

Lab. No. M38-4868

Signed: [signature]
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form: S2-26

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CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-3
10:45 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	240	11.98	Merks	10-31-00
EPA 600 242.1	Magnesium	74	6.09	Merks	10-31-00
EPA 600 273.1	Sodium	810	35.23	Merks	10-31-00
EPA 600 258.1	Potassium	24	0.61	Merks	10-31-00
	Total Cations		53.91		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	450	7.37	Merks	10-27-00
EPA 600 375.3	Sulfate	462	9.62	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	1320	37.24	Merks	10-30-00
	Total Anions		54.23		
	Ion Ratio (Cation/Anion) --- 0.994				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.05		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	369	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	904	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	3290	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	2.5	Moore	10-31-00

Lab. No. M38-4869

Signed: Carl Crownover

Carl F. Crownover, Pres.

form: S2-26

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CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: HB-4
10:45 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	217	10.83	Merks	10-31-00
EPA 600 242.1	Magnesium	67	5.51	Merks	10-31-00
EPA 600 273.1	Sodium	860	37.41	Merks	10-31-00
EPA 600 258.1	Potassium	17	0.43	Merks	10-31-00
	Total Cations		54.18		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	454	7.44	Merks	10-27-00
EPA 600 375.3	Sulfate	459	9.56	Merks	11-02-00
SM 4500-Cl- B.	Chloride	1250	35.26	Merks	10-30-00
	Total Anions		52.26		

Ion Ratio (Cation/Anion) --- 1.037

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH ---------------- 7.04		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate	372	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate	818	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C)	3150	Merks	10-31-00
SM 4500-Br-	Bromide	3.5	Moore	10-31-00

Lab. No. M38-4870

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: R-1
10:30 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	94	4.69	Merks	10-31-00
EPA 600 242.1	Magnesium	13	1.07	Merks	10-31-00
EPA 600 273.1	Sodium	84	3.65	Merks	10-31-00
EPA 600 258.1	Potassium	12	0.31	Merks	10-31-00
	Total Cations		9.72		
	Anions:				
EPA 600 310.1	Carbonate	1	0.03	Merks	10-27-00
EPA 600 310.1	Bicarbonate	243	3.98	Merks	10-27-00
EPA 600 375.3	Sulfate	60	1.25	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	132	3.72	Merks	10-30-00
	Total Anions		8.98		
	Ion Ratio (Cation/Anion) --- 1.082				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.39		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	201	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	288	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	530	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	0.3	Moore	10-31-00

Lab. No. M38-4871

Signed: Carl F. Crownover
Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: R-2
11:30 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	99	4.94	Merks	10-31-00
EPA 600 242.1	Magnesium	15	1.23	Merks	10-31-00
EPA 600 273.1	Sodium	109	4.74	Merks	10-31-00
EPA 600 258.1	Potassium	12	0.31	Merks	10-31-00
	Total Cations		11.22		
	Anions:				
EPA 600 310.1	Carbonate	1	0.03	Merks	10-27-00
EPA 600 310.1	Bicarbonate	245	4.02	Merks	10-27-00
EPA 600 375.3	Sulfate	75	1.56	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	174	4.91	Merks	10-30-00
	Total Anions		10.52		

Ion Ratio (Cation/Anion) --- 1.067

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.37		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ---------------	203	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ---------------	309	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) ---------------	640	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	0.4	Moore	10-31-00

Lab. No. M38-4872

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: SP-1
11:59 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	115	5.74	Merks	10-31-00
EPA 600 242.1	Magnesium	79	6.50	Merks	10-31-00
EPA 600 273.1	Sodium	2030	88.30	Merks	10-31-00
EPA 600 258.1	Potassium	28	0.72	Merks	10-31-00
	Total Cations		101.26		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	1004	16.45	Merks	10-27-00
EPA 600 375.3	Sulfate	301	6.27	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	2800	78.98	Merks	10-30-00
	Total Anions		101.70		

Ion Ratio (Cation/Anion) ---- 0.996

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 7.57		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate -----------------	823	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate -----------------	612	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) ---------------	6050	Merks	10-31-00
SM 4500-Br~	Bromide --------------------	8.0	Moore	10-31-00

Lab. No. M38-4873

Signed: Carl F. Crownover
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: SP-2
11:54 AM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	13	0.65	Merks	10-31-00
EPA 600 242.1	Magnesium	6.1	0.50	Merks	10-31-00
EPA 600 273.1	Sodium	473	20.57	Merks	10-31-00
EPA 600 258.1	Potassium	9.5	0.24	Merks	10-31-00
	Total Cations		21.96		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	656	10.75	Merks	10-27-00
EPA 600 375.3	Sulfate	44	0.92	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	415	11.71	Merks	10-30-00
	Total Anions		23.38		
	Ion Ratio (Cation/Anion) --- 0.939				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH ---------------- 8.17		Merks	10-27-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ------------------	538	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ------------------	58	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) ---------------	1360	Merks	10-31-00
SM 4500-Br⁻	Bromide ----------------------	1.0	Moore	10-31-00

Lab. No. M38-4874

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: CP-1
12:40 PM 10-27-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	78	3.89	Merks	10-31-00
EPA 600 242.1	Magnesium	10	0.82	Merks	10-31-00
EPA 600 273.1	Sodium	84	3.65	Merks	10-31-00
EPA 600 258.1	Potassium	8.7	0.22	Merks	10-31-00
	Total Cations		8.58		
	Anions:				
EPA 600 310.1	Carbonate	0	0.00	Merks	10-27-00
EPA 600 310.1	Bicarbonate	215	3.52	Merks	10-27-00
EPA 600 375.3	Sulfate	64	1.33	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	116	3.27	Merks	10-30-00
	Total Anions		8.12		
	Ion Ratio (Cation/Anion) ---		1.057		

EPA 600 150.1	pH --------------- 7.65		Merks	10-27-00
		mg/L		
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	176	Merks	10-27-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	236	Merks	10-31-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	483	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	0.3	Moore	10-31-00

Lab. No. M38-4875

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: WCID1-B
10:50 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	64	2.78	Merks	11-14-00
EPA 600 258.1	Potassium	11	0.28	Merks	11-14-00
	Total Cations		8.45		
	Anions:				
EPA 600 310.1	Carbonate	6	0.20	Merks	10-30-0
EPA 600 310.1	Bicarbonate	229	3.75	Merks	10-30-00
EPA 600 375.3	Sulfate	55	1.15	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	95	2.68	Merks	11-13-00
	Total Anions		7.78		
	Ion Ratio (Cation/Anion) --- 1.086				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.49		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate -----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate -----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) ---------------	458	Merks	10-31-00
SM 4500-Br~	Bromide ---------------------	0.2	Moore	11-16-00

Lab. No. M38-4931

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: WCID1-M
11:15 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	64	2.78	Merks	11-14-00
EPA 600 258.1	Potassium	9.8	0.25	Merks	11-14-00
	Total Cations		8.42		
	Anions:				
EPA 600 310.1	Carbonate	6	0.20	Merks	10-30-00
EPA 600 310.1	Bicarbonate	229	3.75	Merks	10-30-00
EPA 600 375.3	Sulfate	55	1.15	Merks	11-02-00
SM 4500-Cl~ B.	Chloride	94	2.65	Merks	11-13-00
	Total Anions		7.75		
	Ion Ratio (Cation/Anion) --- 1.086				

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.52		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	468	Merks	10-31-00
SM 4500-Br~	Bromide -------------------	0.1	Moore	11-16-00

Lab. No. M38-4932

Signed: Carl F. Crownover

Carl F. Crownover, Pres.

form: S2-26

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: OS1-B
11:46 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	11	0.90	Merks	11-14-00
EPA 600 273.1	Sodium	67	2.91	Merks	11-14-00
EPA 600 258.1	Potassium	10	0.26	Merks	11-14-00
	Total Cations		8.56		
	Anions:				
EPA 600 310.1	Carbonate	7	0.23	Merks	10-30-00
EPA 600 310.1	Bicarbonate	228	3.74	Merks	10-30-00
EPA 600 375.3	Sulfate	52	1.08	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	97	2.74	Merks	11-13-00
	Total Anions		7.79		
	Ion Ratio (Cation/Anion) ---		1.099		

Method Number		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH ---------------- 8.51		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	199	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	270	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	483	Merks	10-31-00
SM 4500-Br⁻	Bromide --------------------	0.3	Moore	11-16-00

Lab. No. M38-4933

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

TEL. 361-884-0371 PO BOX 2552 78403

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
November 29, 2000

NUECES RIVER AUTHORITY
6300 Ocean Drive, NRC 3100
Corpus Christi, TX 78412

Report of Analysis

Identification: OS1-M
11:53 AM 10-30-00

Method Number		mg/L	meq/L	Analyst	Analysis Date
	Cations:				
EPA 600 215.1	Calcium	90	4.49	Merks	11-14-00
EPA 600 242.1	Magnesium	12	0.99	Merks	11-14-00
EPA 600 273.1	Sodium	63	2.74	Merks	11-14-00
EPA 600 258.1	Potassium	13	0.33	Merks	11-14-00
	Total Cations		8.55		
	Anions:				
EPA 600 310.1	Carbonate	7	0.23	Merks	10-30-00
EPA 600 310.1	Bicarbonate	227	3.72	Merks	10-30-00
EPA 600 375.3	Sulfate	57	1.19	Merks	11-02-00
SM 4500-Cl⁻ B.	Chloride	99	2.79	Merks	11-13-00
	Total Anions		7.93		
	Ion Ratio (Cation/Anion) --- 1.078				

		mg/L	Analyst	Analysis Date
EPA 600 150.1	pH --------------- 8.50		Merks	10-30-00
EPA 600 310.1	Total Alkalinity as Calcium Carbonate ----------------	198	Merks	10-30-00
SM 2340 B.	Total Hardness as Calcium Carbonate ----------------	274	Merks	11-14-00
EPA 600 160.1	Total Dissolved Solids (180 Deg.C) --------------	503	Merks	10-31-00
SM 4500-Br⁻	Bromide -------------------	0.2	Moore	11-16-00

Lab. No. M38-4934

Signed: [signature]
Carl F. Crownover, Pres.

form: S2-26

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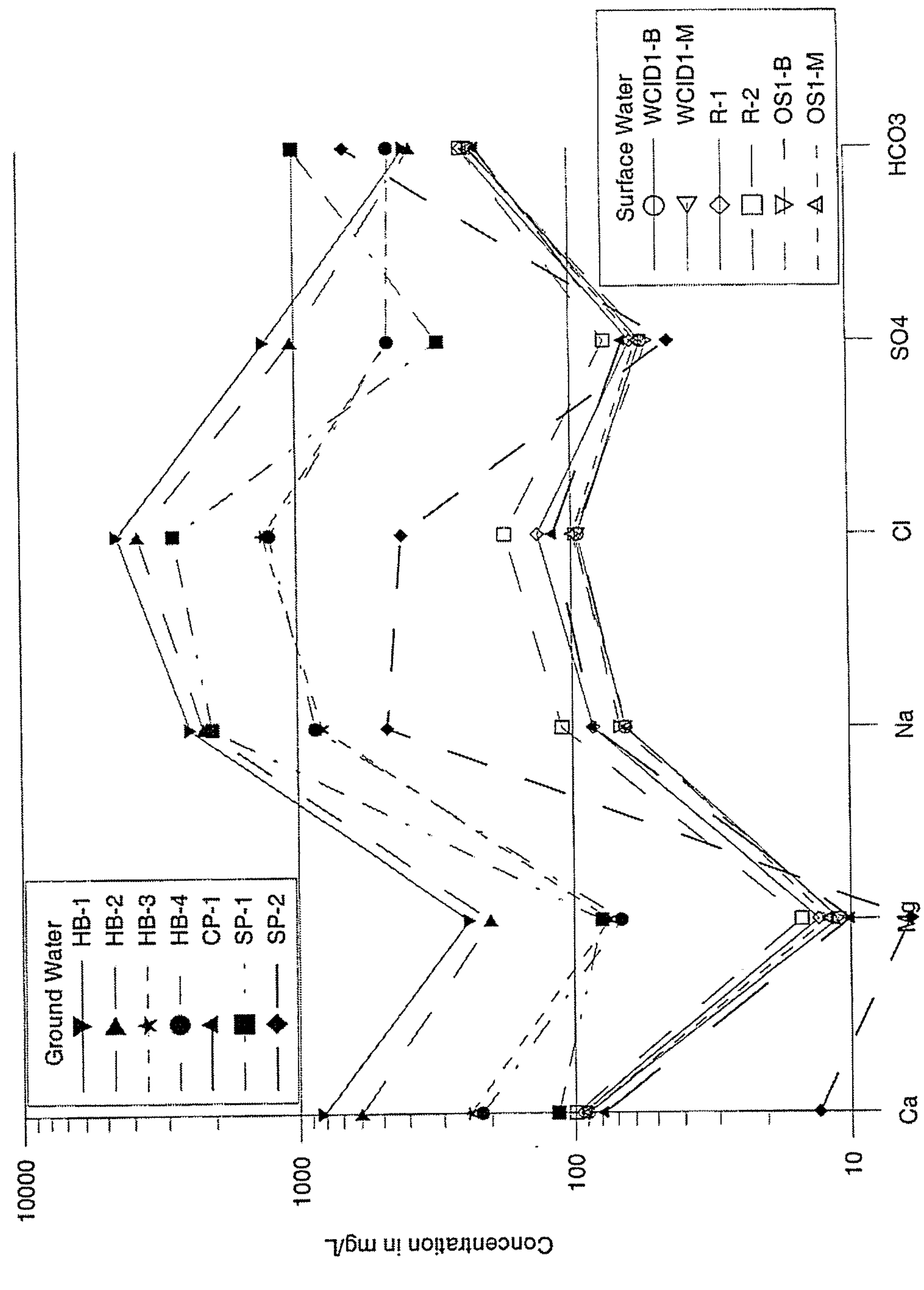
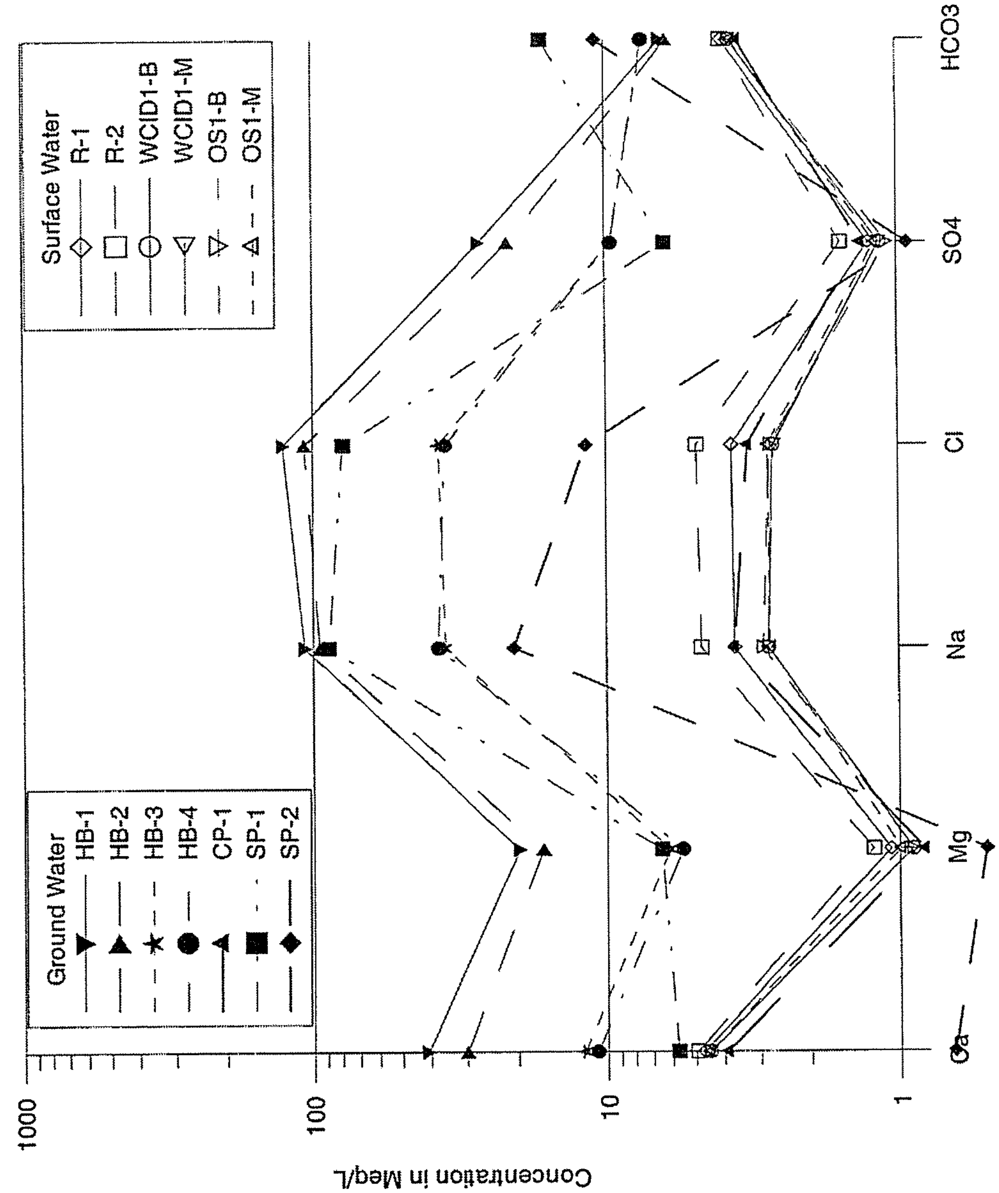
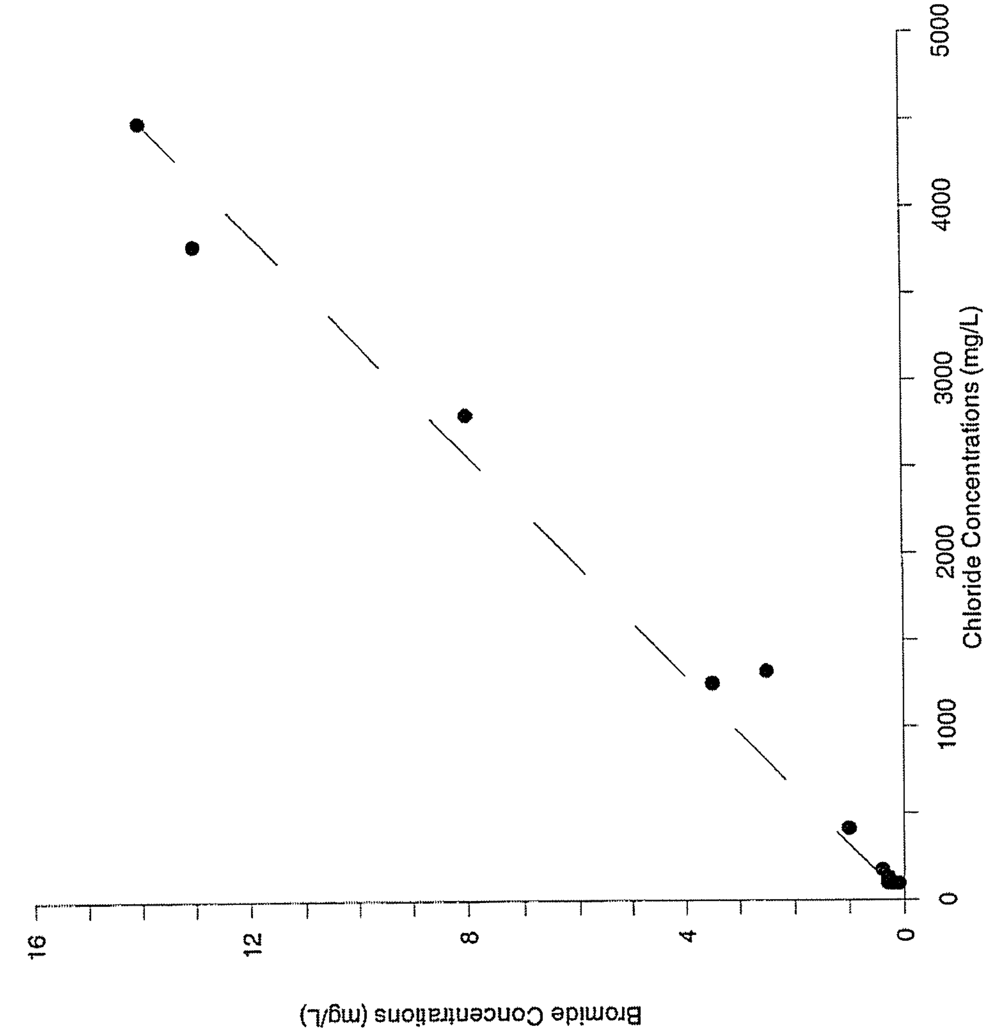
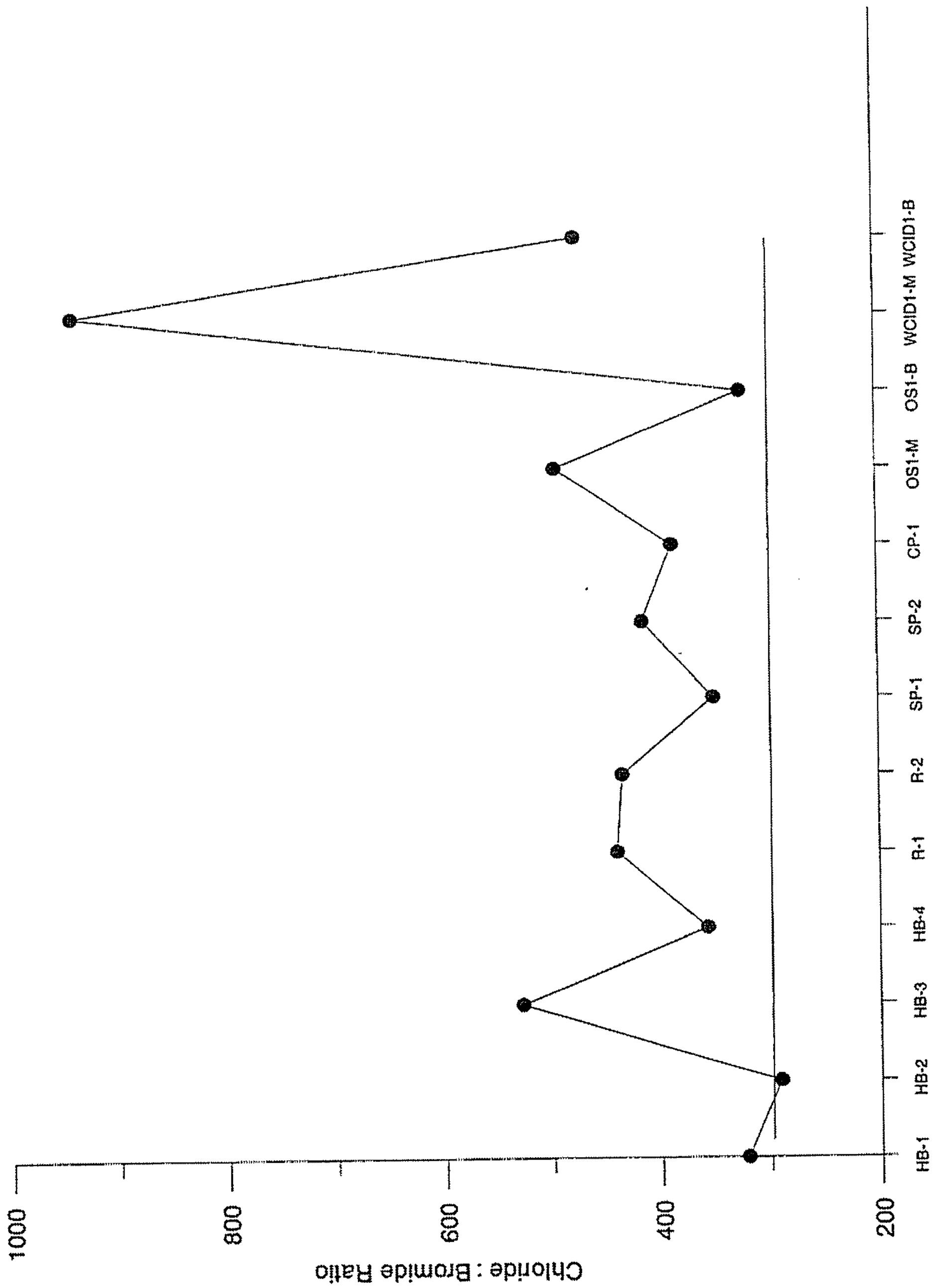
Appendix 9
Sample Results — Graphs


Concentration in mg/L
10000
1000
100
10
Ca
Mg
Na
Cl
SO4
HCO3
Ground Water
HB-1
HB-2
HB-3
HB-4
CP-1
SP-1
SP-2
Surface Water
WCID1-B
WCID1-M
R-1
R-2
OS1-B
OS1-M


Ground Water
HB-1
HB-2
HB-3
HB-4
CP-1
SP-1
SP-2
Surface Water
R-1
R-2
WCID1-B
WCID1-M
OS1-B
OS1-M
Concentration in Meq/L
1000
100
10
1
Ca
Mg
Na
Cl
SO4
HCO3


Bromide Concentrations (mg/L)
16
12
8
4
0
0
1000
2000
3000
4000
5000
Chloride Concentrations (mg/L)


Chloride : Bromide Ratio
1000
800
600
400
200
HB-1
HB-2
HB-3
HB-4
R-1
R-2
SP-1
SP-2
CP-1
OS1-M
OS1-B
WCID1-M
WCID1-B

Appendix J

Ecological Studies Supporting the Benefits of Freshwater Diversions to the Nueces Delta

Ecological Studies Supporting the Benefits Of Freshwater Diversions to the Nueces Delta

Background:

Shortly after the completion of Wesley Seale Dam on the Nueces River in 1958, the City of Corpus Christi and other regional water interests began efforts to identify and develop additional water supplies for the Coastal Bend Region of Texas. These efforts soon lead to the examination of several potential reservoir sites within the Nueces River Basin. By the early 1970's, serious attention was being given to two alternative sites: Choke Canyon on the Frio River just upstream of Three Rivers, Texas and "R&M" on the Nueces River downstream of Wesley Seale Dam. Because of the size of the proposed reservoirs at each site, concern arose over the cumulative effects on freshwater inflows to the Nueces Estuary that would result from either one of these potential reservoirs being operated in conjunction with the existing Lake Corpus Christi reservoir. After the decision was made to build Choke Canyon Dam, attention focused on how to mitigate the anticipated reductions in freshwater inflows that would result.

The City of Corpus Christi and the Nueces River Authority were designated as local sponsors of the Choke Canyon reservoir project. These two entities subsequently contracted with the U.S. Bureau of Reclamation (the "Bureau") to serve as the federal sponsor with the responsibility for designing and constructing the project. Under this arrangement, the local sponsors obtained the State water rights permit for the storage and diversion of water in the project, while the Bureau obtained other permits for the project, including the U.S. Army Corp of Engineers Section 404 permit for construction in "navigable" waters. As a result of the concern expressed by state and federal resource agencies and environmental organizations regarding the impact of the new reservoir and the reservoir system operations on freshwater inflows to the Nueces Estuary, both the state water rights permit and the federal Section 404 permit contained special conditions designed to mitigate these impacts.

However, even though the permits contained these provisions, at that time, the amount and adequacy of information regarding the freshwater inflow needs of the Nueces Estuary was insufficient to answer the basic questions of how much freshwater was sufficient, as well as when and where those amounts would be most effective in protecting the ecological integrity of the Nueces Estuary. These questions gave rise to a series of studies addressing these important issues.

Ecological Studies of the Nueces Estuary:

Both the Bureau's original draft of the Environmental Impact Statement (EIS) for the Choke Canyon project (April, 1972) and the revised draft EIS (August, 1974) seemed to raise more questions regarding the freshwater inflow needs of the Nueces Estuary than they answered. A public hearing on the draft EIS (August,

1974) raised many concerns about these impacts, but the Bureau finalized the EIS in December, 1975 without significantly amending the document to address these concerns.

In 1976, the U.S. Fish and Wildlife Service (FWS), who had prepared the original environmental impact portion of the Bureau's preliminary feasibility report on the project (February, 1969), notified the Bureau that it wanted to modify its 1969 report to better address the issues of freshwater inflows to the Nueces Estuary and mitigatin of wildlife losses resulting from the Choke Canyon project and also requested that the Section 404 permit application be held in abeyance pending completion of its new study. The U.S. National Marine Fisheries Service (NMFS) expressed similar concerns in the context of the Section 404 permit review process. The Bureau, FWS and NMFS began discussions designed to resolve these concerns.

By December, 1976, FWS completed a draft supplement to its 1969 report. This report contained a fairly extensive review of the ecological studies related to the Nueces Estuary published to date, but contained very little new information designed to answer the questions of how much freshwater inflow is necessary to sustain the estuarine functions of the Nueces/Corpus Christi Bay system. It did, however, recommend diversions of river flows and wastewater return flows into the upper Nueces Delta.

The Texas Department of Water Resources (TDWR -now the Texas Water Development Board) was funded by the 64th Texas Legislature, under SB 137, to study the influence of freshwater inflows on the Nueces and Mission-Aransas estuaries. This study developed one of the first comprehensive, quantitative models to be used for determining the influence of freshwater inflows on the estuarine ecosystem. Using physical, chemical and biological indicators, the study analyzed the freshwater inflow needs using an ecosystem model which simulated complex estuarine processes and responses. Based on this analysis, the draft report (November, 1979) made several recommendations regarding freshwater inflow management, including estimates of the monthly amounts of inflows needed to either maintain or enhance the historical commercial fisheries harvest amounts (these harvest amounts served as a measure of estuarine productivity). However, this report considered freshwater inflows to the entire Nueces/Mission-Aransas Bay complex, and did not specifically address the needs to divert any portion of the inflows from the Nueces River into the Nueces Delta.

In August 1980, FWS published a report entitled "Phase 4 Report – Studies of Freshwater Needs of Fish and Wildlife Resources in Nueces-Corpus Christi Bay Area, Texas." This study assessed how the proposed construction of Choke Canyon Reservoir (and the proposed "Harbor Island Deepwater Port") might impact the biological productivity of the estuary. The report identified three major categories of impacts to the Nueces-Corpus Christi Bay System that would result from the "full operation" of the Choke Canyon/Lake Corpus Christi reservoir system:

- Reduction in freshwater spills and inundation frequencies in the Nueces Delta;
- Reduction in nutrient inflow from the Nueces River and deltaic marsh; and
- Increase in upper estuarine salinities during perioed of reservoir refilling.

The Phase 4 report described several management alternatives, including freshwater releases, the diversion of freshwater inflows -- via breaks in the bank of the Nueces River below the Calallen Dam -- in order to allow spills into the Nueces Delta during lower flow events, and the rerouting of wastewater return flows into the upper Nueces Delta marsh areas.

In the 1980's, basic research on the freshwater inflow needs of the Nueces Estuary continued. TDWR expanded its investigations in areas designed to further refine the estuarine model it was developing, and in January 1981published "Nueces and Mission-Aransas Estuaries: A Study of the Influence of Freshwater Inflows." Also in 1981, Espey, Huston and Associates, Inc. published a report on their "Enhancement Potential Determination for the Nueces River/Deltaic Marsh System Study," which evaluated 13 different freshwater diversion schemes. Their report recommended a diversion from the Nueces River into the Upper Rincon Bayou area.

In 1984, FWS released their "Supplemental Fish and Wildlife Coordination Act Report, Choke Canyon Dam and Reservoir, Nueces River Project, Texas," which recommended both the Rincon Bayou Diversion project and freshwater releases to maintain salinity levels in Upper Nueces Bay.

In the late 1980's several researchers at the University of Texas Marine Science Institute (UTMSI) began studies relating the effects of freshwater inflows to changes in various trophic levels in the Nueces Estuary. Much of this information remained unpublished until August 1991, when, as a result of controversy over the first series of mandated freshwater releases that began in 1990, the Texas Water Commission (TWC – now the Texas Natural Resource Conservation Commission) released a report of the "Technical Advisory Committee (TAC - created to assist TWC in formulating a permanent freshwater inflow operating procedure for the Choke Canyon/Lake Corpus Christi reservoir system)." The TAC report contained a series of "Research Summaries" describing the work of the UTMSI investigations, as well as data collected by other state and federal resource agencies. The report also contained an section describing the status and results of the TWDB Texas Bays and Estuaries Program's most current estuarine simulation model for the Nueces/Mission-Aransas Bay system, and a section entitled "Ecological Characterization of Nueces Bay" which was an overview of information collected over the past several decades.

Research on Freshwater Diversions – Studies Leading to Projects

As the TAC process called attention to the need to formulate a long-term operating plan for freshwater inflows to the Nueces Estuary, it also created new interest in using diversion of both freshwater inflows and wastewater return flows as mechanisms to make optimal use of these limited resources. In 1991, the City of Corpus Christi and several other local sponsors initiated what became a two-phased study of the potential to divert freshwater into the Nueces Delta with the objective of reducing requirements to "release" water from the reservoir system. The "Regional Wastewater Planning Study – Nueces Estuary – Phase I Report" was issued in October 1991.

The Phase I report recommended that one or two demonstration projects be developed to evaluate the feasibility of both river diversions and wastewater effluent diversions into the Nueces Delta. It also recommended additional scientific monitoring to routinely collect pertinent data to improve the scientific understanding of the Nueces Delta and Bay ecosystems.

Phase II of the "Regional Wastewater Planning Study – Nueces Estuary" (1992) focused on more detailed planning for the demonstration projects recommended in the Phase I report. It also contained detailed results of studies of primary productivity in the Nueces Delta/Bay system which supported the concept that placing freshwater into marsh systems in the Delta could provide three to five times the levels of primary productivity that same amount of freshwater would produce when discharged into the water column of Nueces Bay via the Nueces River tidal segment.

These two studies provided the impetus for the eventual development of the two freshwater diversion demonstration projects that have been implemented to date: the Bureau's "Rincon Bayou Demonstration Project" and the "Allison Wastewater Treatment Plant Effluent Diversion Demonstration Project," sponsored by the City of Corpus Christi.

The Rincon Bayou Demonstration Project involved the excavation the Nueces Overflow Channel and the Rincon Overflow Channel in 1995, and subsequent monitoring activities through December 1999. While the demonstration project term expired in September 2000, and the Nueces Overflow Channel was subsequently filled in, the project's Concluding Report[1] describes the successes achieved during this relatively short period of time in restoring much of the ecological function of the Rincon Bayou portion of the Nueces Delta. Based on the benefits demonstrated by the Rincon Bayou Demonstration Project and the 2001 Agreed Order, the City reopened the channels and conducts an on-going

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[1] USBR, "Rincon Bayou Demonstration Project, Concluding Report," Volumes I and II, U.S. Dept. of the Interior, et al., September 2000.

monitoring program to facilitate an adaptive management program for freshwater inflows to the Nueces Estuary.[2]

The Allison Wastewater Diversion Project completed a 5-year data collection program in September 2003. The data collection program (1999 to 2003) was conducted by Texas A&M University at Corpus Christi and University of Texas Marine Science Institute. A reduced monitoring program is anticipated for 2005. The City of Corpus Christi is maintaining an extensive monitoring program designed to assess the benefits of the 2 MGD of effluent being discharged into the wetlands of the South Lake area of the Nueces Delta.

[2] City of Corpus Christi, Integrated Monitoring Plan Fiscal Year 2005, January 2005.

Appendix K

Groundwater Conservation District Rules for Bee, McMullen, and Live Oak Counties

Contents

Appendix K.1

Bee Groundwater Conservation District Rules

BEE GROUNDWATER
CONSERVATION DISTRICT

The Rules of the Bee Groundwater Conservation District are hereby published as of the 12TH day of September,2002.

In accordance with Section 59 of Article XVI of the Texas Constitution and with Acts of the 71st Legislature (1989), Ch. 673, S.B. 1777 and Chapters 35 and 36 of the Texas Water Code, the following rules are hereby ratified and adopted as the rules of the District by its Board. Each rule as worded herein has been in effect since the date of passage and as may be hereafter amended.

The rules, regulation, and modes of procedure herein contained are and have been adopted for the purpose of simplifying procedure, avoiding delays, saving expense, and facilitating the administration of the water laws of the State and the rules of the District. To the end that these objectives be attained, these rules shall be so construed.

These rules may be used as guides in the exercise of discretion, where discretion is vested. However, under no circumstances and in no particular case shall they, or any of them be construed as a limitation or restriction upon the exercise of powers, duties, and jurisdiction conferred by law, nor to limit or restrict the amount and accuracy of data or information which may be required for the proper administration of the law.

Table Of Contents

RULE 1 - DEFINITIONS

Definitions of Terms: In the administration of its duties, the Bee Groundwater Conservation District follows the definitions of terms set forth in Chapter 36, Water Code, and other definitions as follows:

(a) "District" shall mean the Bee Groundwater Conservation District, maintaining its principal office in George West, Texas. Where applications, reports and other papers are required to be file with or sent to "the District", this means the District headquarters in Beeville, Texas.

(b) The "Board" shall mean the Board of Directors of the Groundwater Conservation District, consisting of seven (7)duly elected members.

(c) "Groundwater" means water percolating below the surface.

(d) "Groundwater reservoir" means a specific subsurface water-bearing reservoir having ascertainable boundaries and containing groundwater.

(e) "Water" shall mean groundwater.

(f) The term "Well" or "Water Well" shall mean and include any artificial excavation constructed to produce more than 25,000 gallons of water per day.

(g) "Exempt Well" - any artificial excavation constructed to produce or equipped to produce less than 25,000 gallons of water/day. For all purposes herein, an "Exempt Well" shall be exempt from the rules created hereunder, but shall not be exempt from registration/validation requirements created hereunder.

(h) "Open or Uncovered Well" - any artificial excavation drilled or dug for the purpose of exploring for or producing water from the underground reservoir, not capped, covered or plugged as required by these rules.

(I) "Owner" shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, easement, or any other estate in the land.

(j) "Person" shall mean any individual, partnership, firm or corporation.

(k) "Party-at-interest" shall mean any person, whether as an owner, lessor, lessee, tenant or operator, within the boundaries of the District, who is or may be affected by the proceedings of a hearing.

(l) "Plugging" shall mean an absolute sealing of the well bore.

(m) "Pollution" shall mean the alteration or the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the District that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

(n) "Undesirable Water" shall mean water that is injurious to vegetation, to land, or to fresh water, or water that can cause pollution.

(o) "Waste" means any one or more of the following:

(1) withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural, gardening, domestic, or stock raising purposes;

(2) the flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;

(3) escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;

(4) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;

(5) willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creed, natural watercourse, depression, lake reservoir, drain, sewer, street, highway, road or road ditch, or onto any land other than that of the owner of the unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26;

(6) groundwater pumped for irrigation that escapes as irrigation tailwater onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge; or

(7) for water produced from an artesian well, "waste" has the meaning assigned by Section 11.205 of the Texas Water Code.

(p) An "Authorized Well Site" shall be:

(1) The location of a proposed well on an application duly filed until such application is denied, or

(2) The location of a proposed well on a valid permit. (An authorized well site is not a permit to drill).

(q) "Exploratory Hole" - any hole drilled to a depth below the top of any stratum containing groundwater, as groundwater is defined in the Texas Water Code.

(r) "Cement" - as defined by the General Provisions, Chapter 287.2, of the Texas Administrative Code.

(s) "Aquifer" shall mean a geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

(t) "ASR" shall mean Aquifer Storage and Retrieval Project, which is a project with two phases that anticipates the use of a class V aquifer storage well for injection into a geologic formation, group of formations, or part of a formation that is capable of underground storage of appropriated surface water for subsequent retrieval and beneficial use.

(u) "Aquifer Storage Well" shall mean a class V injection well designed and used expressly for the injection of water into a geologic formation, group of formations, or part of a formation that is capable of underground storage of water for later retrieval and beneficial use.

(v) "Artesian Well" shall mean a water well completed in the confined portion of an aquifer such that, when properly cased, water will rise in the well, by natural pressure, above an overlying impermeable stratum.

(w) "Beneficial Use" or "Beneficial Purpose" shall mean use for:

(1) agricultural, gardening, domestic, stock raising, municipal, mining, manufacturing, industrial, commercial, recreational or pleasure purposes;
(2) exploring for, producing, handling, or treating oil, gas, sulfur, or other minerals; or
(3) any other purpose that is useful and beneficial to the users that does not commit waste as defined in section (o) of this rule.

RULE 2 - WASTE

(a) Groundwater shall not be produced within, or used within or without the District, in such a manner as to constitute waste as defined in Rule 1, Section (o) hereof.

(b) Any person producing or using groundwater shall use every possible precaution, in accordance with the latest approved methods, to stop and prevent waste of such water.

(c) No person shall pollute or harmfully alter the character of the groundwater reservoir of the District by means of salt water or other deleterious matter admitted from some other stratum or strata or from the surface of the ground.

(d) No person shall commit waste as that term is defined in Section (o), Rule 1 of the Rules of the Bee Groundwater Conservation District.

(e) Water shall not be produced or used within the District in such a manner or in under such conditions as to constitute waste as defined by Rule 1 hereof. Water shall not be produced from an abandoned or deteriorated well.

RULE 3 - WELL REGISTRATION

Registration is required for all existing and future wells in the District and shall be filed with the District on a form and in a manner required by the District.

Registration includes all wells:

(a) that produce less than 25,000 gallons of water per day;

(b) that produce or will produce water used for Irrigation and/or Agricultural purposes;

(c) that produce or will produce water from the well to be used to supply the domestic needs of ten or fewer households and a person who is a member of each household is either the owner of the well or a person related to the owner or member or the owner's household within the second degree by consanguinity, or an employee of the owner;

(d) that supply of water for hydrocarbon production activities, regardless of whether those wells are producing, that are associated with any well permitted by the Railroad Commission of Texas drilled before or after the effective date of S.B. 1777, Acts of the 71st Legislature, Regular Session 1989, or

(e) that produce or will produce water used for domestic use;

(f) that produce or will produce water used for Industrial and/or Manufacturing purposes;

(g) that produce or will produce water used for Commercial and/or Municipal purposes;

(h) that produce or will produce water for all other uses.

RULE 4 - DEPOSITS

Each application for a permit to drill a well shall be accompanied by a **$25.00 deposit** which shall be accepted by the Manager of the District or authorized personnel in the office of the District. Said deposit shall be returned to the applicant by the District if (1) the application is denied, or (2) if the application is granted, upon the receipt of correctly completed registration and log of the well, or (3) if said permit location is abandoned without having been drilled, upon return and surrender of said Permit marked "abandoned" by the applicant.

In event neither the registration and log of the well nor permit marked abandoned is returned to the District office within three (3) months after approval date of the permit or the extension date thereof, the said deposit shall become the property of the District.

RULE 5 - PERMIT REQUIRED

(a) No person shall hereafter begin to drill or drill a well, or increase the size of a well, or pump therein, which well could reasonably be expected to produce, or a pump designed to produce, in excess of 25,000 gallons of water per day, without having first applied to the Board, and had issued a permit to do so, unless the drilling and operations of the well is exempted by the law or by these rules. Provided that, as set out in Rule 5 (e) hereof, and under certain conditions, an applicant may commence the drilling of a well when his application therefore has been recommended by five directors of the board.

(b) No permit shall be required for the drilling of temporary wells exempt by *of* the Texas Water Code (being generally wells used for the production of oil, gas, or other minerals and water wells used in conjunction therewith).

(c) Applications for permits to drill wells shall be made at the office of the District in Beeville, Texas.

(d) The board of directors will approve the application at a regular or special meeting of the board of directors.

(e) The signatures of five Directors of the District on an application shall constitute a recommendation that the permit be granted. The refusal of five or more Directors to sign the application shall constitute a rejection of the application.

(f) If before the Board officially approves an application to drill a well, a contest shall arise over the application, then the Board may conduct a hearing, upon due notice to both parties, to hear and determine the contest or to determine which of the applications should, in its judgment, be granted.

In the event of a contest, or such conflicting application, no well shall be commenced until the matter is passed upon by the Board. A contest shall be deemed filed when written notification is filed with the Board at its office and the Manager or other authorized personnel shall receive the same. Thereafter, both applicants, or the applicant and the contestant or contestant, after due notice, shall be entitled to a hearing before the board. At such hearing, all parties may introduce pertinent evidence as to why the particular application should be granted or denied, including evidence as to the effect on the water reservoir, the conservation and preservation of water, the prevention of waste, the protection of property rights, and other pertinent matters, which evidence shall be taken into consideration by the Board. The Board shall also take into consideration which of the applicants duly filed his application first.

(g) If any application is not favorably recommended by five of the Directors, the applicant shall have the right to appeal to the Board. Such appeal must be filed with the Manager of the District or written notice by registered mail given fifteen (15) days, from the time that the fifth director declined to sign the application. If no such appeal is taken, the application shall be deemed to have been abandoned by the applicant. Upon receipt of such appeal the Board shall fix a time and place for such hearing and notify the necessary parties thereof in accordance with Rule 19. At least 72 hours notice shall be given by the Board to the necessary parties for said hearing.

(h) On approval of an application, the District shall issue a permit to the applicant. The permittee's right to produce shall be limited to the extent and purposes stated in the permit. The permit shall be valid for a period not to exceed five (5) years, at which time the permit may be renewed. A permit shall not be transferable except when an application has been made to amend the permit to change the name of the permittee within 90 calendar days of the change of ownership of the permitted well. The General Manager may grant such an amendment without notice, hearing, or further action by the Board.

RULE 6 - ISSUANCE OF PERMITS

(a) The Board shall issue or cause to be issued a drilling permit for a well upon proper application executed and filed by the owner containing the matters specified below. An application shall be considered filed when properly made out, completed, signed, tendered and accompanied by the required deposit to the District by the applicant.

Such applications shall be on forms provided by the District and shall be in writing and shall be prepared in accordance with and contain the information called for in the form of application, if any, prescribed by the Board, and all instructions which may have been issued by the Board with respect to the filing of an application. Otherwise, the application will not be considered.

(b) Rules for the filing of applications:

(1) If the applicant is an individual, the application shall be signed by the applicant or his duly appointed agent. The agent may be requested to present satisfactory evidence of his authority to represent the applicant.

(2) If the application is by a partnership, the

applicant shall be designated by the firm name followed by the words "a Partnership", and the application shall be signed by at least one of the general partners who is duly authorized to bind all of the partners.

(3) In the case of a corporation, public district, county or municipality, the application shall be signed by a duly authorized official. A copy of the resolution of other authorization to make the application may be required by the officer or agent receiving the application.

(4) In the case of an estate or guardianship, the application shall be signed by the duly appointed guardian or representative of the estate.

(c) Such applications shall set forth the following:

(1) The name and address of the fee owner of the land upon which the location is made.

(2) A map showing the proposed location of the well to be drilled as provided in the application including the County, the section, block, survey and township; labor and league; and exact number of yards to the nearest nonparallel property lines; or other adequate legal description.

(3) The proposed use of the well to be drilled, whether municipal, industrial, irrigation, or other.

(4) The size of the pump.

(5) The approximate date drilling operation is to begin.

(6) The location of all wells within a quarter of a mile on the proposed location, if any.

(7) An agreement by the applicant that a complete well registration and log will be furnished to the District (on forms furnished by it) by the applicant upon completion of this well and prior to the production of water therefrom (except for

such production as may be necessary to the drilling and testing of such well).

(8) Any additional data as may be required by the Board.

(9) A water conservation plan or a declaration that the applicant will comply with the district's management plan.

(d) Time during which a permit shall remain valid. Any permit granted hereunder shall be valid if the work permitted shall have been completed within two (2) months from the filing date of the application. It shall thereafter be void. Provided, however, that the Board, for good cause, may extend the life of such permit for an additional two (2) months if an application for such extension shall have been made known to the District during the first two (2) month period. Provided, further, that when it is made known to the Board that a proposed project will take more time to complete, the Board, upon receiving written application may grant such time as is reasonably necessary to complete such project.

RULE 7 - REQUIREMENTS OF DRILLER'S LOG, CASING AND PUMP DATA

(a) Complete records shall be kept and reports thereof made to the District concerning the drilling, maximum production potential, equipping and completion of all wells drilled. Such records shall include an accurate driller's log, any electric log which shall have been made and such additional data concerning the description of the well, its potential, hereinafter referred to as "maximum rate of production" and its actual equipment and rate of discharge permitted by said equipment as may be required by the Board. Such records shall be filed with the District Board within 90 days after completion of the well.

(b) No person shall produce water from any well hereinafter drilled and equipped within the District, except that necessary to the drilling and testing of such well and equipment, unless or until the District has been furnished an accurate driller's log, any electric log which shall have been made, and a registration of the well correctly furnishing all available information required on the forms furnished by the District.

RULE 8 - WELL CONSTRUCTION

(a) A well to be drilled subsequent to the date of enactment of this rule shall be drilled in accordance as follows:

A well must be drilled, equipped, and completed so as to comply with the standards set by the Texas Natural Resource Commission and additional rules established by this district.

RULE 9- RADIOACTIVE WASTES, TOXIC AND HAZARDOUS SUBSTANCES AND POLYCHLORINATED BIPHENYLS

(a) None of the following materials or substances may be imported outside the District to a point within the District, nor moved within the District from point to point, for the purpose of temporarily or permanently disposing of such material or substances within the District:

(1) Radioactive Wastes.
(2) Toxic Substances.
(3) Hazardous Substances
(4) Polychlorinated Biphenyls.
(5) Soil, fluids or other materials or substances contaminated with any of the above.

(b) Exclusions: The following are excluded from the Rule and Order: agricultural insecticides, herbicides, or other agri-chemicals.

(c) The following activities are prohibited:

(1) Construction, operation, maintenance or use of waste disposal wells for any of the materials enumerated above.

(2) Construction, operation, maintenance or use of tanks, reservoirs, pits, depressions, sites, landfills or any other manner of storage of the materials or substances enumerated above on either a temporary or a permanent basis within the District.

(d) All persons, firms, corporations, associations of persons or other entities having in their possession or under their care, custody or control within the District any of the materials or substances enumerated above shall report by sworn inventory to the District Office in Bee County, Texas within ten (10) days of acquisition. The report shall include a description of the materials or substances possessed, amount, location, status and whether a plan or schedule has been formulated for the ultimate disposal of the materials or substances.

Within sixty (60) days after the receipt of such report, the Board of Directors shall either approve the report or set the matter down for hearing according to the notice provisions and procedure outlined in Rule 20.

RULE 10 - WELL LOCATION AND COMPLETION

(a) Responsibility

After an application for a well permit has been granted, the well, if drilled, must be drilled within **thirty (30) feet** of the location specified in the permit, and not elsewhere. If the well should be commenced or drilled at a different location, the drilling or operation of such well may be enjoined by the Board pursuant to Chapter 36, Texas Water Code.

All well drillers and persons having a well drilled, deepened, or otherwise altered shall adhere to the provisions of this Rule prescribing the location of wells and proper completion pursuant to Texas Civil Statutes, Article 7621e, titled the Water Well Drillers Act.

RULE 11- SPACING AND PRODUCTION REQUIREMENTS

(a) No well shall be drilled such that said well shall be located closer that one hundred (100) feet to the property line. Spacing of new wells from an existing well shall be one foot per one gallon per minute of production from the new well to maximum of one thousand (1000) gallons per minute. In addition to this maximum, a well producing over one thousand (1000) gallons per minute will be spaced one-half (1/2) foot per one gallon per minute of production in excess of one thousand gallons per minute from an existing well.

EXAMPLES

500 gpm=500 feet
750 gpm=750 feet
1000 gpm=1000 feet
1250 gpm=1125 feet
1500 gpm=1250 feet
1750 gpm=1375 feet

The board may grant exceptions to permit drilling within shorter distances than above described when the Board shall determine that such exceptions are necessary either to prevent waste or to prevent confiscation of property.

(b) For the purpose of preventing waste or confiscation of property, the Board reserves the right in particular subterranean water zones and/or reservoirs to enter special orders increasing or decreasing distances provided by this requirement.

(c) In applying this requirement, no subdivision of property subsequent to the adoption of the original spacing requirement will be considered in determining whether or not any property is being confiscated within the terms of such spacing requirement.

(d) A well or well system may only be permitted to be drilled and equipped for production of a cumulative total of ten (10) gallons per contiguous acre owned or operated.

(e) In no event may a well or well system be operated such that the total annual production exceeds four (4) acre feet of water per acre owned or operated within the same Section.

RULE 12 - EXCEPTION TO SPACING AND PRODUCTION RULE

(a) In order to protect vested property rights, to prevent waste, or confiscation of property, the Board may grant exception to the above spacing and production rules. This rule shall not be construed so as to limit the power of the Board, and the powers stated are cumulative only of all other powers possessed by the Board.

(b) If an exception to the spacing or production rule is desired, the application shall be submitted by the applicant in writing to the District office on forms furnished by the District. The application shall be accompanied by a plat or sketch, drawn to scale of one (1) inch equaling two thousand (2000) feet. The plat or sketch shall show thereon the property lines in the immediate area and shall show accurately to scale the location of the three (3) nearest wells within one-half (1/2) mile of the proposed well location. The application shall also contain the names and addresses of all property owners adjoining the tract on which the well is to be located, within one-half (1/2) mile, and the owners of the three (3) nearest wells within one-half (1/2) mile of the proposed well location. Such application and plat shall be certified by some person actually acquainted with the facts who shall state that all the facts therein are true and correct.

(c) Hearing notices shall state that the application does not meet spacing requirements of the District, and an exception is requested by the applicant.

RULE 13 - REWORKING OR REPLACING OF WELL

(a) An existing well may be reworked, redrilled, or replaced in a manner that will not change the existing well.

(b) No person shall rework, redrill, or reequip a well in a manner that would increase the rate of production of such well as established by Rule 3 above without first having made an application to the Board, and having been granted a permit by the Board to do so; nor shall any person replace a well without a permit by the Board.

(c) The rate of production of a well shall not be hereafter changed to a larger capacity so as to increase the rate of production greater than 25,000 gallons per day of a well without a permit from the Board.

(d) In the event that application meets all requirements, the Board may grant such application without further notice.

RULE 14 - CHANGED CONDITIONS

The decision of the Board on any matter contained herein may be reconsidered by it of its own motion or upon motion showing changed conditions, or upon the discovery of new and different conditions or facts after the hearing or decision of such matter. If the Board should decide to reconsider a matter after having announced a ruling or decision, of after having finally granted or denied an application, it shall give notice to persons who were proper parties to the original action and such persons shall be entitled to a hearing thereon if they file a request therefor within fifteen days from the date of the mailing of such notice.

RULE 15 - FINAL ORDERS OF THE BOARD

The orders of the Board in any non-contested application of proceeding shall become the final order of the Board on the day it is entered by the Board. All orders of the Board in contested applications, appeals or other proceedings shall contain a statement that the same was contested. In such event the order will become final after fifteen (15) days from the entry thereof and be binding on the parties thereto unless a motion for rehearing is filed under Rule 17 hereof.

RULE 16 - RIGHT TO INSPECT AND TEST WELLS

Upon written approval by well owner, any authorized officer, employee, agent, or representative of the District shall have the right at all reasonable times to enter upon the lands which a well or wells may be located within the boundaries of the District, to inspect such well or wells and to read, or interpret any meter, weir box or other instrument for the purpose of measuring production of water from said well or wells or for determining the pumping capacity of said well or wells; and any authorized officer, employee, agent, or representative of the District shall have the right at reasonable times to enter upon any land upon which a well or wells may be located within the boundaries of the District for the purposes of testing the pump and the power unit of the well or wells and of making any other reasonable and necessary inspections and tests that may be required or necessary for the information or enforcement of the rules and regulations of the District.

RULE 17 - AQUIFER STORAGE AND RECOVERY (ASR)

No ASR project may be operated within the District.

RULE 18 - OPEN WELLS TO BE CAPPED

Every owner or operator of any land within the District upon which is located any open or uncovered well is, and shall be, required to close or cap and seal the same **permanently** with a covering capable of sustaining weight of not less than **four hundred (400) pounds**, except when said well is in actual use by the owner or operator thereof; and no such owner or operator shall permit or allow any open or uncovered well to exist in violation of this requirement. Officers, agents and employees of the District are authorized to serve or cause to be served written notice upon any owner or operator of a well in violation of this rule, thereby requesting such owner and/or operator to close or cap such well permanently with a covering in compliance herewith. In the event any owner or operator fails to comply with such request within **ten (10) days** after such written notice, any officer, agent, or employee of the District may go upon said land and close or cap said well in a manner complying with this rule and all expenditures thereby incurred shall constitute a lien upon the land where such well is located, provided, however, no such lien shall exceed **$500** for any single closing. Any officer, agent, or employee of the District, is authorized to perfect said lien by filing of the affidavit by the Texas Water Code as amended. All of the powers and authority granted in such section are hereby adopted by the District, and its officers, agents, and employees are hereby bestowed with all of such powers and authority.

RULE 19 - RULES GOVERNING PROTESTS

(a) **NOTICE OF PROTEST.** In the event anyone should desire to protest or oppose any pending matter before the Board, a written notice of protest or opposition shall be filed with the Board on or before the date on which such application or matter has been set for hearing. For the convenience of the Board, it is urgent that protests be filed at least **ten (10) days** before the hearing date.

(b) **PROTEST REQUIREMENTS:** Protests shall be submitted in writing with a duplicate copy to the opposite parties and shall comply in substance with the following requirements:

(1) Each protest shall show the name and address of the protestant and show that protestant had read either the application or a notice relative thereto published by the Board.

(2) There shall be an allegation of injury to protestant which will result from the proposed action or matter to be considered by the Board.

(3) If the protest is based upon claim of interference with some present right of protestant, it shall include a statement of the basis of protestant's claim of right.

(4) Protestant should call attention to any amendment of the application or adjustment which, if made, would result in withdrawal of the protest.

(c) **CONTESTED APPLICATIONS OR PROCEEDINGS DEFINED:** An application, appeal, motion, or proceeding before the Board is considered contested when either protestants or interveners, or both, files the notice of protest as above set out and appears at the hearing held on the application, motion or proceeding and present testimony of evidence in support of their contentions, or present a question or questions of law with regard to the application, motion or proceedings. Where neither protestants nor interveners so appear and offer testimony or evidence in support of their contentions, or raise a question of law with reference to any pending application, motion or proceeding, the same shall be considered as non-contested.

(d) In the event of a contested hearing, each party shall furnish other parties to the proceeding with a copy of all motions, amendments or briefs filed by him with the Board.

RULE 20 - GENERAL RULES OF PROCEDURE FOR HEARING

(a) **HEARINGS.** Hearings will be conducted in such a manner as the Board deems most suitable to the particular case, and technical rules of legal and court procedure need not be applied. It is the purpose of the Board to obtain all the relevant information and testimony pertaining to the issue before it as conveniently, inexpensively and expeditiously as possible without prejudicing the rights of either applicants or protestants.

(b) **WHO MAY APPEAR:** Any party-at-interest in a proceeding may appear either in person or by attorney or both in such proceedings. At the discretion of the Board, anyone not a party at interest in a proceeding may appear.

(c) **ADMISSIBILITY:** Evidence will be admitted if it is of that quality upon which reasonable persons are accustomed to rely in the conduct of serious affairs. It is intended that needful and proper evidence shall be conveniently, inexpensively, and speedily produced while preserving the substantial rights of the parties to the proceedings.

(d) **TESTIMONY SHALL BE PERTINENT:** The testimony shall be confined to the subject matter contained in the application or contest. In the event that any party at a hearing shall pursue a line of testimony or interrogation of a witness that is clearly irrelevant, incompetent or immaterial, the person conducting the hearing may forthwith terminate such line of interrogation.

(e) **A STIPULATION:** Evidence may be stipulated by agreement of all parties at interest.

(f) **LIMITING NUMBER OF WITNESSES:** The right is reserved to the Board in any proceeding to limit the number of witnesses appearing whose testimony may be merely cumulative.

RULE 21 - REHEARING

(a) Any person whose application is denied, whose contest is overruled, or who is not granted the relief desired, may file with the Board a motion for rehearing within **fifteen (15) days** from the announcement by the Board of its decision or action. The Board shall act thereon within a reasonable time. If such a motion for rehearing is filed and is overruled, the order of the Board shall be final on the date the motion is overruled.

(b) The Board may, in a proper case, find that an emergency exists and that substantial injustice will result from delay. In that event, and upon recitation of such finding, the order of the Board will become final on the date of the announcement of the order by the Board, and no motion for rehearing will be considered thereon.

(c) If an application or contest is denied by the Board, and if the applicant or contestant shall not have had and shall not have been afforded an opportunity for a hearing before the Board, as elsewhere provided by the rules, the applicant or contestant shall be entitled to a hearing before the Board. A written request to the Board for such a hearing, stating such facts, must be filed with the Board within the above fifteen (15) day period. If such motion is in order and is duly filed, the Board shall give notice to the applicant and all proper and necessary parties of the time and place of such hearing, and shall proceed to conduct such a hearing.

RULE 22 - WATER RIGHTS

(1) A permit holder may lease permitted water rights, but a holder of a permit may not lease more than 50 percent of the rights permitted. The user's remaining water rights must be used in accordance with the permit that is granted by the board of directors, and must pass with the transfer of the land.

(2) A permit holder may sell permitted water rights, but a holder of a permit may not sell more than 50 percent of the rights permitted. The user's remaining water rights must be used in accordance with the permit that is granted by the board of directors, and must pass with the transfer of the land

RULE 23 - TRANSPORTATION OF WATER FROM THE DISTRICT

(1) Every person must obtain a permit from the District for the transporting of water by pipeline, channel, ditch, water-course or other natural or artificial facilities, or any combination of such facilities, if such water is produced from wells located, or to be located, within the District, and if all or any part of such water is used, or is intended for use, outside of the boundaries of the District. However, the requirement for a permit hereunder shall not apply to any well currently in operation located within the District prior to the effective date of this Rule.

(a) The permit provided for herein must be applied for and filed with the District in the form or forms promulgated by the District hereunder and such permit must be obtained from the District Prior to the proposed transporting of water, all in accordance with the provisions of this rule.

(b) An application for the transportation of water for which a permit is required under this Rule must:

(1) be in writing and sworn to;

(2) contain the name, post-office address and place of residence or principal office of the applicant;

(3) identify the location of the well from which the water to be transported is produced or to be produced;

(4) describe specifically the proposed transportation facilities;

(5) state the nature and purposes of the proposed use and the amount of water to be used for each purpose;

(6) state the time within which the proposed construction or alteration is to begin;

(7) state the length of time required for the proposed use of water, and the amount of water to be used;

(8) provide information showing the effect of the proposed transportation on the quantity and quality of water available within the District;

(9) identify any other possible sources which could be used for the state purposes, including quality and quantity of such alternate sources;

(10) identify any other liquids that could be substituted for the fresh ground water and possible sources of such liquid including quantity and quality;

(11) transportation of water from the District requires a permit as stated in the district rules. The District shall assess fees of one dollar ($1.00) per acre foot for water used in agriculture, and two and one-quarter cents ($0.0225) per thousand (1000) gallons for all other uses, as chapter 36 of the Texas Water Code. Fees are due the first of each month, and are to be included with the monthly-pumping report.

(c) The application must be accompanied by a map or plat drawn to a scale not less than one inch equals 4,000 feet, showing substantially:

(1) the location of the existing or proposed well; and

(2) the location of the proposed or increased use or uses.

(d) The application must be accompanied by an application fee in the amount of $10,000.00.

(e) The District shall determine whether the application, maps, and other materials comply with the requirements of this Act. The District may require amendment of the application, maps, or other materials to achieve necessary compliance.

(f) The District shall conduct a public hearing on each application within ninety (90) days of the filing of the complete application.

(g) The District shall give notice of the public hearing on the application as prescribed by this Rule, stating:

(1) the name and address of the applicant;

(2) the date the application was filed;

(3) the location and purpose of the well from which the water to be transported is produced or to be produced;

(4) the time and place of the hearing; and

(5) any additional information the District considers necessary.

(h) At the time and place stated in the notice, the District shall hold a public hearing on the application. The hearing may be held in conjunction with any regular or special meeting of the District or a special meeting may be called for the purpose of holding a hearing. Any person may appear at the hearing, in person or by attorney, or may enter his appearance in writing. Any person who appears may present objections to the issuance of the permit. The District may receive evidence, orally or by affidavit, in support or in opposition to the issuance of the permit, and it may hear arguments.

(i) After the hearing, the District shall make a written decision granting or denying the application. The application may be granted in whole or in part. Any decision to grant a permit, in whole or in part, shall require a majority vote of Directors present.

(j) Such application shall not be approved unless the Board of Directors finds and determines that the transporting of water for use outside the District applied for will not substantially affect the quantity and quality of water available to any person or property within the District; that all other feasible sources of water available to the person requesting a permit have been developed and used to the fullest; that no other liquid could be feasibly substituted for the use of fresh groundwater; and that the proposed use, or any part of the proposed use, will not constitute waste as defined under the laws of the State of Texas. In evaluating the application, the District shall consider the quantity of water proposed to be transported; the term for which transporting is requested; the safety of the proposed transportation facilities with respect to the contamination of the aquifer; the nature of the proposed use; the effect of the proposed use of the water to be transported on District residents, taking into account all beneficial use of District residents, including municipal, agricultural, industrial, recreational and other categories; and such other factors as are consistent with the purposes of the District.

(k) On approval of an application, the District shall issue a permit to the applicant. The applicant's right to transport shall be limited to the extent and purposes stated in the permit. A permit shall not be transferable except as provided in Paragraph (o).

(l) The permit shall be in writing and attested by the seal of the District and it shall contain substantially the following information:

(1) the name of the person whom the permit is issued;

(2) the date the permit is issued;

(3) the term for which the permit is issued;

(4) the date the original application was filed;

(5) the destination and use or purpose for which the water is to be transported;

(6) the maximum quantity of water to be transported annually;

(7) any other information the District prescribes.

(m) The permittee shall file with the District quarterly reports describing the amount of water transported and used for the permitted purpose. Such report shall be filed on the appropriate form or forms provided by the District within ten (10) days of the March 31, June 30, September 30, and December 31 next following the commencement of transporting of water, and within ten (10) days of each such quarterly date thereafter.

(n) All transporting facilities for wells subject to the requirements of this Subsection shall be equipped with flow monitoring devices approved by the District and available for District inspection at any time.

(o) A permittee may apply for an extension of any permit granted under this Subsection, or for transfer of a permit to another person. The District shall consider and grant or deny such application for extension or transfer or a permit in the same manner as is provided herein for the application for a permit.

(p) Any permit granted under this Subsection shall be subject to revocation for nonuse or waste by the permittee, or for substantial deviation from the purposes or other terms stated in the permit. Revocation of a permit for nonuse shall require that no water is transported under the permit for a period of five years.

(2) Any person transporting water produced from wells located within the District for use outside of the District, regardless of the amount of water so transported, must register such transporting with the District. Such registration shall be made within one hundred eighty (180)

days after the effective date of this Rule.

(a) Any person subject to the requirements of this Subsection (2) shall file with the District quarterly reports describing the amount of water transported, the destination and use of such water. Such report shall be filed on the appropriate form or forms provided by the District within ten (10) days of the March 31, June 30, September 30, and December 31 next following the commencement of transporting of water and within ten (10) days of each such quarterly date thereafter.

(b) All transporting facilities for wells subject to the requirements of this Subsection shall be equipped with flow monitoring devices approved by the District and available for District inspection at any time.

RULE 24 - REQUEST FOR INJUNCTIVE RELIEF AND ASSESSMENT OF PENALTIES

If it appears that a person has violated, is violating, or is threatening to violate any provision of the District Act or any Board order, rule or permit, the Board may authorize the General Manager to institute and conduct a suit in the name of the District for injunctive relief, or to recover a civil penalty of up to ten thousand dollars (10,000) for each violation, or for both injunctive relief and civil penalties.

RULE 25 - GENERAL RULES

(a) **COMPUTING TIME:** In computing any period of time prescribed or allowed by these rules, by order of the Board, or by any applicable statute, the day of the act, event or default from which the designated period of time begins to run, is not to be included, but the last day of the period so computed is to be included, unless it be a Sunday or legal holiday, in which event the period runs until the end of the next day which is neither a Sunday or a legal holiday.

(b) **TIME LIMIT:** Applications, requests, or other paper or documents required or permitted to be filed under these rules or by law must be received for filing at the Board's offices at

Beeville, Texas, within the time limit, if any, for such filing. The date of receipt and not the date of posting is determinative.

(c) **SHOW CAUSE ORDERS AND COMPLAINTS:** The Board, either on its own motion or upon receipt of sufficient written protest or complaint, may at any time, after due notice to all interested parties, cite any person operating within the District to appear before it in a public hearing and require him to show cause why operating authority or permit should not be suspended, canceled, or otherwise restricted and limited, for failure to comply with the orders or rules of the board or the relevant of the State, or for failure to abide by the terms and provisions of the permit or operating authority itself. The matter of evidence and all other matters of procedure at any such hearing will be conducted in accordance with these rules of procedures and practice.

REPEAL OF PRIOR REGULATIONS

All of the previous rules and regulations of the District have been revised and amended; and except as they are herein republished, they are repealed. Any previous rule or regulation which conflicts with, or is contrary to, these rules is hereby repealed.

SAVINGS CLAUSE

If any section, sentence, paragraph, clause, or part of these rules and regulations should be held or declared invalid for any reason by a final judgment of the courts of this state or of the United States, such decision or holding shall not affect the validity of the remaining portions of these rules; and the Board does hereby declare that it would have adopted and promulgated such remaining portions of such rules irrespective of the fact that any other sentence, section, paragraph, clause, or part thereof may be declared invalid.

BY-LAWS OF THE
BEE GROUNDWATER
CONSERVATION DISTRICT

In accordance with the Legislative act, S.B. 1777, Article XVI, Section 59, of the Texas Constitution and Chapters 35 and 36 of the Texas Water Code, Vernon's Civil Statutes of Texas, the following on the 12TH day of September, 2002, were ratified and adopted for guides to be used with discretion and were adopted for the purpose of simplifying procedures and facilitating the administration of the District.

ESTABLISHMENT OF THE DISTRICT

Definitions:

The Board shall mean the Board of Directors of the Bee Groundwater Conservation District consisting of seven (7) duly elected members, one from each of the seven precincts.

The District shall mean the Bee Groundwater Conservation District maintaining its office in Beeville, Texas; where registrations, reports, and other papers are required to be filed with or sent to the District. The district includes Bee County except for:
(1) the area in the municipal boundaries of the city of Beeville as the boundaries existed on January 1, 1997;
(2) the area in the boundaries of the Pettus Municipal Utility District as the boundaries existed on January 1, 1997; and
(3) the Tynan Water Corporation's service area on January 1, 1997.

Water shall mean groundwater.

Owner shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, easement, or any other estate in the land.

Person shall mean any individual, partnership, firm or corporation.

The word Waste as used shall have the same meaning as defined by the Legislature and the Texas Water Code.

REQUIREMENTS FOR THE BOARD AND PROCEDURES FOR MEETINGS

Candidates:

A person is qualified to serve on the board who has filed an application with the secretary of the board. It must be signed by the applicant or by at least 10 qualified electors of the District, and filed 20 days prior to the election. They must be at least 18 years of age; own land subject to taxation in the District; and is a resident of the county. All procedures for holding the election shall be in accordance with the Texas Election Code Article 6.02 and the act creating the District.

Elections:

Shall be held in odd numbered years on one of the uniform election dates (First Saturday in February, First Saturday in May, Second Saturday in August, or the First Tuesday after the first Monday in November) of the second year after the year in which the District is authorized to be created at a confirmation election, an election shall be held in the district for the election of four directors who shall each serve two-year terms and three directors who shall each serve four-year terms. Thereafter, on the same date in each subsequent second year, the appropriate number of directors shall be elected to the board.

Meetings:

The Board shall hold regular meetings or it may hold other meetings at call of the chairman or at the request of at least four (2) of the directors.

- -a quorum is the majority of the Directors.
- -the Board may elect its own officers yearly.
- -meetings will be held in the District's office.
- -the Board will follow the Roberts Rules of Parliamentary Procedures.
- -the Board may also act as a hearing Board concerning any disputes concerning the Rules and operations of the District.

Board of Directors:

(a) The District is governed by a board of directors composed of seven members. Each director shall occupy a designated place on the board with the places to be designated as Places 1, 2, 3, 4,5,6,and 7.

(b) Except for the initial regular directors each regular director shall serve for a term of four years or until his successor is appointed.

(c) To be qualified for election as a director, a person must be at least 18 years old and be a resident of the district, the precinct, and a landowner in Bee Groundwater Conservation District.

(d) Directors serve a staggered four year term.

(e) A person serving as director is eligible for reelection.

(f) A vacancy on the board shall be filled by appointment of the board for the unexpired term.

(g) The Biannual election for Director shall be the designated date established by law or odd numbered years.

(h) As soon as practicable after a director is elected or appointed, that director shall make the sworn statement prescribed by the constitution for public office.

(i) As soon as practicable after a director has made the sworn statement, and before beginning to perform duties of office, that director shall take the oath of office prescribed by the constitution for public officers.

(j) Before beginning to perform the duties of office, each director shall execute a bond for $10,000 payable to the District and conditioned on the faithful performance of that director's duties. All bonds of the directors shall be approved by the board and paid for by the District.

(k) The sworn statement, bond, and oath shall be filed with the District and retained in its records. A duplicate original of the sworn statement and the oath shall also be filed with the Secretary of State within 10 days after their execution and need not be filed before the new director begins to perform the duties of office.

Board Organization:

(a) The board shall elect one director as president of the board, who shall serve for a term of one year. The president shall preside at meetings of the board and shall perform other duties prescribed by the board.

(b) The board shall elect another director as vice-president of the board, who shall serve for a term of one year. The vice-president shall perform the duties of the president when the president is not present or is otherwise incapacitated.

(c) The board shall elect a secretary of the board. The secretary is the official custodian of the minutes, books, records, and seal of the board and shall perform other duties and functions prescribed by the board. The board, also, shall elect a treasure of the board who shall perform duties and functions prescribed by the board. The offices of secretary and treasurer may be held by one person, and the holder of either office or both offices is not required to be a director. The board may appoint one or more persons who are not directors to be an assistant secretary of the board, and the assistant secretary may perform any duty or function of the secretary of the board, and should be bonded.

(d) Any five regular directors constitute a quorum, and all regular directors are entitled to vote on matters before the board. The district shall act and proceed by and through resolutions adopted by the board, and the affirmation vote of at least five of the regular directors is necessary to adopt any resolution.

(e) The board shall have regular meetings at times specified by resolution of the board, and shall have special meetings whenever called by the president or any four directors.

Code Of Ethics

(a) It shall be the policy of the district that all directors and employees conduct district business in conformity with sound business and ethical practices which will bring continuing respect to the district, and will avoid any questionable conduct that could bring discredit to the district or present even the appearance of conflict of interest.

(b) A board member who is financially interested in a contract to be executed by the district for the purchase, sale, lease, renting, or supplying of property shall disclose that fact to the other directors and may not vote on or participate in discussions during board meetings on the acceptance of the contract.

(c) A board member shall not seek, offer or accept in any fashion benefits or gratuities in any form that could be construed as to cause influence in the exercise of official duties of the district.

(d) No board member shall use his position to secure a special privilege or exemption for himself or others.

POWERS AND DUTIES OF THE DISTRICT

The District has all of the rights, powers, privileges, authority, functions, and duties provided by the general law of this state, including Chapters 35 and 36, Water Code, applicable to underground water conservation districts created under Article XVI, Section 59, of the Texas Constitution. This act prevails over any provision of general law that is in conflict or inconsistent with this Act. Including authority to:

(1) Make and enforce rules to provide for conserving, preserving, protecting, recharging, and preventing waste of the water from the underground water reservoirs that may be enforced by injunction, mandatory injunction, or other appropriate remedies in a court of competent jurisdiction, or;

(2) require permits for the drilling, equipping and completion of wells in the underground water reservoirs and issue permits subject to terms and provisions with reference to the drilling, equipping, and completion of the wells as may be necessary to prevent waste or conserve, preserve and protect underground water;

(3) provide for the spacing of wells producing from the underground water reservoirs and regulate the production from those wells to minimize as far as practicable the drawdown of the water table or the reduction of the artisan pressure, provided, the owner of the land, his heirs, assigns, and lessees are not denied a permit to drill a well on their land and the right to produce underground water form that well subject to rules adopted under this act;

(4) require records to be kept and reports to be made of the drilling, equipping, and completion of wells into any underground water reservoir and the taking and use of underground water from those reservoirs and require accurate driller's logs to be kept of those wells and a

copy of those logs and of any electric logs that may be made of the wells to be file with the District;

(5) acquire land for the erection of dams and for the purpose of draining lakes, draws and depressions, and construct dams, drain lakes depressions, draws, and creeks and install pumps and other equipment necessary to recharge any underground water reservoirs;

(6) have made by registered professional engineers surveys of the underground water of any underground water reservoir and of the facilities for the development, production and use of the underground water, determine the quantity of the underground water available for production and use and the improvements, developments and recharges needed for those underground water reservoirs;

(7) develop comprehensive plans for the most efficient use of the underground water of any underground water reservoir and for the control and prevention of waste that underground water, with the plans to specify in the amount of detail that may be practicable the acts, procedures, performance, and avoidance that are or may be necessary to effect those plans, including specifications;

(8) carry out research projects, develop information, determine limitations, if any, that should be made on the withdrawal of underground water from any underground water reservoir;

(9) collect and preserve information regarding the use of the underground water and the practicability of recharge of any underground water reservoir;

(10) publish plans and information. Bringing them to the notice and attention of the users of the underground water within the District, and encourage their adoption and execution;

(11) contract for, sell and distribute water from a water import authority, or other agency.

(12) contract with other districts with powers similar to those of the district to achieve common goals.

POLICIES

(a) Subject to the law governing the district, the board shall adopt the following in writing:
   (1) a code of ethics for district directors, officers, employed, and persons who are engaged in handling investments for the district;
   (2) a policy relating to travel expenditures;
   (3) a policy relating to district investments that ensures that:
      (A) purchases and sales of investments are initiated by authorized individuals, conform to investment objectives and regulations, and are properly documented and approved; and
      (B) periodic review is made of district investments to evaluate investment performance and security;
   (4) policies and procedures for selection, monitoring, or review and evaluation of professional services;
   (5) policies that ensure a better use of management information, including:
      (A) budgets for use in planning and controlling cost;
      (B) an audit or finance committee of the board, and
      (C) uniform reporting requirements that use "Audits of State and Local Governmental Units" as a guide on audit working papers and that uses "Governmental Accounting and Financial Reporting Standards."

(b) The state auditor may audit the financial transactions of any district if the state auditor determines that the audit is necessary.

ADMINISTRATIVE PROCEDURES

Travel

The districts board or personnel sometimes attend formally scheduled and advance-planned meetings, conferences, symposia, seminars, and short training courses. Such meetings must deal with subjects of interest to the district and have a beneficial effect on the general knowledge or working ability of the board member or employee.

Board members or employees may be reimbursed for their reasonable actual expenses and any other fees or reimbursable expenses associated with such travel.

Board members or employees must submit a claim for reimbursement, supported with documentation, to the board for approval at the following regularly scheduled board meeting.

Administrator and Employees:

The Board may employ a manager and set his/her salary. The Board may delegate any of its powers and duties (Except those of adopting rules, a dissolution resolution, a dissolution order, and those relating to hearings, taxation and bonds) to the manager who may carry out the powers and duties delegated to him/her by the Board. Employment of personnel is subject to the general law of nepotism. The manager with the approval of the Board may employ employees of the Board and set their salaries and hire legal counsel for the Board.

The manager shall with the approval of the Board develop a plan for the District, act as official liaison for the Board between the public and governmental agencies, and prepare budgets.

The manager's position shall be reviewed yearly at the beginning of the Fiscal Year.

Investments and Fund Management

The board shall designate one or more banks inside the district to serve as depository for the funds of the district. All money of the district shall be deposited in the designated bank or banks.
To the extent that funds are not insured by the Federal Deposit Insurance Corporation, they shall be secured in the manner provided by law for the security of county funds.

The districts money may be dispersed only by check, draft order, or other instrument signed by two persons authorized to do so. Authorization to sign district checks is granted to the President, Vice-President, Secretary Treasurer, and Executive Director. All funds dispersed must be approved by the board of directors.

Any contract other than for technical, legal, scientific, or other professional service which will require an expenditure of more than $10,000, or is for a term of six months or more, shall be awarded to the lowest and best bidder. In the event of a catastrophe or calamity of any kind, the district may let contracts necessary to protect and preserve the public health and welfare or the properties of the district without using the bidding procedures.

The Treasurer shall be the chief financial officer and the investment officer.

The board shall insure that the districts investments shall be made with judgment and care, under prevailing circumstances, that a person of prudence, discretion, and intelligence would exercise in the management of the person's own affairs, not for speculation, but for investment, considering the probable safety of capital and the probable income to be derived.

Investment of funds shall be governed by the following investment objectives, in order of priority;
(a) Preservation and safety of principal
(b) Liquidity

(c) Yield

The board may from time to time establish special accounts which have been approved in the budget, to be used by the executive director without prior board approval to hire qualified consultants on quick notice, on any activity which he feels could jeopardize the quality of groundwater in the district. Funds are to be used to gather information only and are not to be used to pursue litigation without prior board approval.

PROFESSIONAL SERVICES POLICY

The district may from time to time contract for professional services. The district shall make the selection based on (1)-demonstrated competence and qualifications to perform the services, and (2) for a fair and reasonable price. The professional fees under the contract must be consistent with and not higher than the recommended practices and fees published by the applicable professional associations and may not exceed any maximum provided by law.

In procuring architectural or engineering services, the district shall first select the most highly qualified provider of those services on the basis of demonstrated competence and qualification, and then attempt to negotiate a contract at a fair and reasonable price. If a contract cannot be negotiated with the most highly qualified provider, the district will end negotiations, select the second most highly qualified provider, and attempt to negotiate a contract with that provider at a fair and reasonable price. The district shall continue the process until a contract is entered into.

TAXATION AND BONDS

The tax and bond provisions of Chapter 35 and 36 of the Water Code as amended apply to the District.

The Board may levy and collect property taxes levied on the property in the District that are necessary to enable the Board to perform the powers and functions given it in the Act.

TAX EXEMPTIONS

The District is not required to pay any tax or assessment on it facilities or any part of its facilities, and the bonds issued under this Act and their transfer and the income from these bonds, including the profits made on the sale of those bonds, are exempt from taxation in this state. The standard county exemptions will be used for local tax purposes.

TAX PROCEDURES

The Bee County tax roll as prepared by the Bee County Appraisal District constitutes the tax rolls of the district.

The district shall enter into a contract with Bee County for the collection of property taxes for the district.

The Bee County Appraisal Board Chief or the Bee County Tax-Assessor may serve as an advisor to the district, without remuneration, for the preparation of the district's budget and the preparation and levying of the district's property taxes.

The board may levy annual taxes not to exceed five (.05) cents on the 100 dollar valuation of all taxable property within the district.

Money of the District shall be deposited in an insured account chosen by the Directors and must be signed by two directors so designated by the board.

ANNEXATION

Additional territory may be added to the District by petition of the landowner under Chapter 35 and 36 of the Texas Water Code, as amended.

AMENDMENT TO BY-LAWS

These by-laws may be altered or amended or the same may be repealed by new by-laws adopted at any regular or special meeting of the Board of Directors of the District, provided that no such action shall be taken at a regular or special meeting unless a copy of proposed new by-laws is submitted in writing to each of the Directors of the District with notice of such meeting, at least ten (10) days before such meeting. No such alterations, amendment or repeal of the by-laws or the adoption of new by-laws shall be valid unless the same shall be by the affirmative vote of at least a two-thirds (2/3) majority of all of the Directors of the District.

DISSOLUTION OF THE DISTRICT

Chapter 36 of the Texas Water Code, as amended, applies to dissolution of the District.

RESOLUTION ADOPTING RULES OF BEE GROUNDWATER CONSERVATION DISTRICT

WHEREAS, The Rules of the Bee Groundwater Conservation District, attached hereto as Attachment A, have been developed for the purpose of conserving, preserving, protecting and recharging that underground water in the District, and this action is taken under the District's statutory authority to prevent waste and protect the rights of owners of interest in groundwater;

WHEREAS, In accordance with Section 59, Article 16 of the Constitution of the State of Texas, and in accordance with the Bee Groundwater Conservation District Act, 71st Leg, 1967 Tex. Gen. Laws 1676(Vernon): Act of May 30, 1983, 68th Leg, ch.484, 1983 Tex. Gen. Laws 2852(Vernon); and the Act of May 17, 1985, 69th Leg, R.S., ch. 438, 1985 Tex. Gen. Laws 2984(Vernon); the following rules are hereby ratified and adopted as the rules of Bee Groundwater Conservation District by its Board of Directors;

WHEREAS, the rules, regulations and modes of procedure contained are adopted for the purpose of simplifying procedure, avoiding delays, saving expense and facilitation the administration of this District and these rules shall be so construed; and

WHEREAS, Under no circumstances, and in no particular case will these Rules, or any part of them, be construed as a limitation or restriction upon the exercise of any discretion, where such exists; nor may they in any event be construed to deprive the Board of an exercise of powers, duties and jurisdiction conferred by law, nor to limit or restrict the amount and character of data or information which may be required for the proper administration of the law.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE BEE GROUNDWATER CONSERVATION DISTRICT THAT:

1) The "Rules of the Bee Groundwater Conservation District" contained in attachment A are hereby adopted.

2) All prior rules are hereby replaced.

3) The General Manager is hereby authorized to take any all action necessary to implement this resolution.

4) These rules take effect September 13, 2002

AND IT IS SO ORDERED

PASSED AND ADOPTED ON THIS 12th DAY OF SEPTEMBER 2002

____

Tyrene Mengers
President

Attest to ____________________________

Mark Sugarek
Secretary

Appendix K.2

McMullen Groundwater Conservation District Rules

McMullen Groundwater Conservation District

The Rules of the McMullen Groundwater Conservation District are hereby published as of November 1, 1999...

In accordance with Section 59, Article XVI of the Texas Constitution and with the Acts of the Legislature (1999), S 1911, and Chapters 35 and 36 of the Texas Water Code, the following rules of the McMullen Groundwater Conservation District are hereby ratified and adopted as the rules of the district by its Board of Directors. Each rule as worded herein has been in effect since the date of passage and as may be hereafter amended.

The rules, regulations, and modes of procedure herein contained are and have been adopted for the purpose of simplifying procedure, avoiding delays, saving expense, and facilitating the administration of the water laws of the State and the rules of the District. To the end that these objectives be attained, these rules shall be so construed.

These rules may be used as guides in the exercise of discretion, where discretion is vested. However, under no circumstances and in no particular case shall they, or any of them, be construed as a limitation of restriction upon the exercise of powers, duties, and jurisdiction conferred by law, nor to limit or restrict the amount and accuracy of data or information which may be required for the proper administration of the law.

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RULE 1 - DEFINITIONS

Definitions of Terms:

In the administration of its duties the McMullen Groundwater Conservation District follows the definition of terms set forth in Chapter 36, Texas Water Code together with other defined terms as follows:

(a) "District" shall mean the McMullen Underground Water Conservation District, maintaining its principal office in Tilden, Texas, the County Seat of McMullen County. Where applications, reports, and other papers are required to be filed with, or sent to "the District" such items should be addressed to the McMullen Underground Water Conservation District, PO BOX 232,Tilden, Texas 78072.

(b) The "Board" shall mean the Board of Directors of the McMullen Underground Water Conservation District, consisting of five (5) members elected by the voters of McMullen County, Texas.

(c) "Underground Water" refers to all that water percolating below the surface of the ground, excluding underground rivers and subterranean streams. For purposes herein "ground water" is synonymous with "underground water".

(d) "Groundwater reservoir" means a specific subsurface water-bearing formation having ascertainable boundaries and containing groundwater.

(e) "Water" as used herein means groundwater or underground water.

(f) "Well" or "water well" shall mean and include any artificial excavation constructed for the production of water. For purposes herein, a well or water well is defined as one which is capable of producing more than 25,000 of water per day.

(g) "Exempt well" refers to any artificial excavation constructed to produce water but which produces less than 25,000 of water per day. For all purposes herein an "Exempt Well" shall be exempt from the rules and regulations created hereunder, but such well shall not be exempt from the registration/validation requirements created hereunder.

(h) "Open or uncovered well" shall mean any artificial excavation drilled or dug for the purpose of exploring for or producing water from an underground reservoir, and left open and not capped, covered, or plugged as required by the rules of the District.

(i) "Owner" shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, or any other estate in the land.

(j) "Person" shall mean any individual, partnership, firm or corporation.

(k) "Party at Interest" shall mean any person, whether as an owner, lessor, lessee, agent or operator, within the boundaries of the District, who is or who may be affected by the proceedings of a hearing.

(l) "Plugging" shall mean the absolute sealing of a well bore by normal and prudent practices relating to such activity.

(m) "Pollution" shall mean the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of any water in the District where such alteration renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to public health, safety, or welfare, or which impairs the usefulness, or the public enjoyment of, the water for any lawful or reasonable purpose.

(n) "Undesirable water" shall mean any water that is injurious to vegetation, to land, or to any fresh water that when commingled with useable water can cause pollution.

(o) "Waste" shall mean any one or more of the following:

(1) withdrawal of ground water from a ground water reservoir at a rate, and in an amount, that causes, or threatens to cause, intrusion into the reservoir of water that is unsuitable for agricultural, gardening, domestic, or stock watering purposes

(2) the flowing or production of water from a well, or wells, when the water produced is not used for a beneficial purpose;

(3) escape of groundwater from a groundwater reservoir to any other reservoir or subsurface strata that does not contain groundwater

(4) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or any other deleterious matter from another stratum , or from the surface of the ground, so that the water in the groundwater reservoir is rendered unfit for use;

(5) willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creek, or natural watercourse, depression, lake or pond reservoir, drain, sewer, street, highway, road, road ditch, or onto land other than that of the owner of the well unless such discharge is authorized by permit, rule, or other order issued under the provisions of Chapter 26 of the Texas Water Code;

(6) groundwater pumped for irrigation purposes that escapes as irrigation tailwater on to land other than that of the owner of the well unless permission has been secured from the owner of the land receiving the discharge of said water;

(7) for water produced from an artesian well, "waste" has the meaning assigned by Section 11.205 of the Texas Water Code. .

(p) "Authorized Well Site" shall be:

(1) The described location of a proposed well as shown on an application to drill or complete duly filed with the District until such application is approved or denied by the District, or

(2) The described location of a proposed well on a valid permit from the District. Note: an authorized well site is not a permit to drill.

(q) "Exploratory Hole" is defined as any hole drilled to a depth so as to penetrate any stratum containing groundwater (as groundwater is defined in the Texas Water Code).

(r) "Cement" is to be used herein as defined by the General Provisions, Chapter 287.2 of the Texas Administrative Code.

(s) "Aquifer" shall mean a geologic formation, group of formations, or a part of a formation that is capable of yielding a significant amount of water to a wellbore or spring.

(t) "ASR" shall mean an Aquifer Storage and Retrieval Project wherein, through a two-stage process, using aquifer storage wells or any other means, water is injected into a geologic formation, group of formations, or a part of a formation capable of water storage, and the subsequent retrieval of such stored water for any beneficial use.

(u) "Aquifer Storage Well" shall mean a Class V well designed and used expressly for the injection and/or withdrawal of water from a geologic formation, group of formations, or any part of a formation capable of water storage and from which stored water can be subsequently retrieved for beneficial use.

(v) "Artesian Well" shall mean a water well completed in the confined portion of an aquifer, such that when properly cased, water will enter the well bore and rise by natural pressure ("head") above an overlying impermeable stratum.

(w) "Beneficial Use or "Beneficial Purpose" shall mean the use of water for:

(1) agricultural, gardening, domestic stock, livestock raising, municipal, mining, manufacturing, industrial, commercial, recreational or pleasure purposes;

(2) exploring for, producing, handling, or treating oil, gas, sulfur, or other minerals, or

(3) any other purpose that is useful and/or beneficial to the users that does not conflict with the term "waste" as defined in Section (o) of this rule.

RULE 2 - WASTE

(a) Groundwater produced within and/or used within or outside the District shall not be used in such a manner as to constitute waste as defined in Rule 1, Section (o) hereof;

(b) Any person producing or using groundwater shall use every possible precaution, in accordance with the latest approved methods, to stop and prevent waste of such water;

(c) No person shall pollute or harmfully alter the character of any groundwater reservoir of the District by means of contamination with salt water or any other deleterious matter from any other strata, or stratum, or from the surface of the ground;

(d) No person shall produce and/or use water within the District in such a manner, or under such conditions, as to constitute waste as defined by Rule 1 hereof.

(e) Water shall not be produced or used within the District from any abandoned or deteriorated well incapable of protecting the quality of underground water reservoirs against pollution and/or contamination.

RULE 3 - WELL REGISTRATION

Registration is required for all future wells in the District and such registration will be filed with the District on a form and in a manner prescribed by the District.

Registered wells include those that:

(1) that produce less than 25,000 gallons of water per day;

(2) that produce, or will produce, water used for irrigation and /or agricultural purposes;

(3) that produce, or will produce, water to be used to supply the domestic needs of ten (10) or fewer households, whether or not such households are occupied by the well owner, his relatives, or his employees,

(4) that supply of water for hydrocarbon production activities, regardless of whether those wells are producing, that are associated with any well permitted by the Texas Railroad Commission and drilled before or after the effective date of S 1911, Acts of the Legislature of the State of Texas, Regular Session 1999, or

(5) that either produce, or will produce water used for domestic purposes.;

(6) that produce, or will produce water used for industrial and/or manufacturing purposes;

(7) that produce, or will produce water used for commercial and/or municipal purposes;

(8) that produce, or will produce water for all other purposes.

RULE 4 - DEPOSITS

Each application for a permit to drill a well that is not an exempt well, shall be accompanied by a $25.00 deposit which shall be accepted by the District at the office of the District. Said deposit shall be returned to the applicant within a reasonable time if (1) the application is denied, or (2) if the application is granted and the applicant furnishes a correctly completed well registration form together with a log of the well, or (3) if said permitted location is abandoned with no well being drilled. and the well permit is returned marked "abandoned".

In the event that neither the registration and log of the well, or permit marked "abandoned" is returned to the District office within three (3) months after approval date of the permit, or the extension date thereof, the said deposit shall become the property of the District.

RULE 5 - PERMIT REQUIRED

(a) Unless the drilling and operations of a well are exempted by state law or by these rules an approved permit from the District is required before work is commenced to drill a new well, or to re-work an existing well for purposes of increasing its depth or size of the wellbore, or to increase the size of a pump on a well which could reasonably be expected to produce in excess of 25,000 gallons per day.. It is provided that, under certain conditions an applicant may commence the drilling of a well when his application has been recommended by three (3) Directors of the District.

(b) No permit shall be required for the drilling of wells exempted by the Texas Water Code (being generally wells used for the production of oil, gas, or other minerals and water wells used in conjunction therewith). However should such well be acquired by the landowner it will be his responsibility to register the well with the District and to furnish all of the appropriate and available information in connection with the well.

(c) Applications for permits to drill or re-work wells shall be made at the office of the District in Tilden, Texas.

(d) The district will approve the application using criteria developed by the Board of directors and these Rules and regulations as a guideline. If a permit is denied then the application will automatically be reviewed by the Board of Directors at the next regularly scheduled board meeting.

(e) The signatures of three (3) Directors of the District on an application will constitute a recommendation that the permit be granted. The refusal of the minimum number of directors to sign the application shall constitute a rejection of the application.

(f) If before an application to drill or re-work a well is officially approved and a permit is issued a contest should arise over the application, the Board after due notice to the parties in contention, may conduct a hearing on the matter. After the arguments have been heard the Board will make a determination as to whether or not to grant a permit for the work.

In the event of a contest over an application, no work on the well will be commenced until the matter is resolved by the Board. A contest shall be deemed filed when written notification opposing the application is filed with the District at its office and the Board of Directors has received same. Thereafter the parties in contention will, after due notice, be entitled to a hearing before the Board of Directors. At such hearing all parties who have previously filed written objections to the application will be allowed to introduce pertinent evidence regarding the submitted application. Evidence to be introduced may include the effect on the water reservoir, the conservation and preservation of ground water supplies, the prevention of waste, the protection of property rights, and other pertinent information bearing on the application in question. All evidence presented will be taken into consideration by the Board of directors In the event of conflicting applications the Board will also consider the completeness of the information supplied as well as the time of filing of the applications.

(g) In the event an application is not favorably recommended by three (3) of the Directors the applicant shall have the right to appeal to the Board. Such appeal must be filed in writing with the District by the applicant within fifteen days (15 days) after notification of the rejection of the application. If no such appeal is timely filed the application will be deemed to have been abandoned by the applicant, If an appeal is timely filed with the District the Board of Directors shall fix a time and place for a hearing of the appeal and shall notify the appropriate parties of the scheduled hearing. The Board shall give the appropriate parties at least seventy-two hours (72 hours) notice of the scheduled hearing.

RULE 6 - ISSUANCE OF PERMITS

(a) The Board shall issue, or cause to be issued, a drilling permit for a proposed well upon receipt of a properly completed and executed application by the owner of said well. The application will be considered filed with the District when it is properly completed, signed, and tendered to the District and accompanied by the required deposit.

All applications for a permit shall be on forms provided by the District, shall be in legible writing, and shall be prepared in accordance with all instructions, and shall contain all of the information requested by the District. Incomplete applications will not be considered by the District.

(b) Rules for the filing of applications with the District:

(1) If the applicant is an individual the application should be signed by that individual or his duly appointed agent. The agent may be requested satisfactory written evidence of his authority to represent the applicant.

(2) If the applicant is a partnership, the applicant will be designated by its full business name followed by the words "a partnership" and their application must be signed by at least one of the general partners who is authorized to act on behalf of, and bind all of the partners. Such signatory party will be asked to furnish written evidence of his authority to bind all of the partners

(3) If the applicant is a corporation, public district or municipality, the application shall

be signed by a duly authorized officer or official. A copy of a properly executed resolution or other authorization designating a signatory party must accompany the signed application when it is presented to the District.

(4) If the applicant is an estate or guardianship the application must be signed by a duly appointed guardian or legal representative of the estate.

(5) All applications must provide the following information:

(a) The full name and legal address of the fee owner of the land on which the well is to be located

(b) A map drawn to scale showing the exact location of the proposed well referenced by distance in feet or yards to the nearest two non-parallel property lines, section lines, survey lines, or any other adequate legal description. Such map should provide a compass orientation (north at the top of the map), should identify all grants, surveys, and sections by their proper name and number. The approximate distance and direction to outside boundary lines of the applicant's property will be shown together with the name of the adjoining property owner. The map must also show the location of all other wells within one-fourth mile (1,320 feet) of the proposed well.

(c) The application will show the proposed depth of the well to be drilled, the outside diameter and length of any casing to be set in the well, the depth interval, volume (in sacks), and a description of all cement placed in the hole.

(d) The application must indicate the size and type of pump to be utilized in the well.

(e) The application must indicate the intended use of the water to be produced from the well, e.g. agricultural, domestic, municipal supply, industrial supply, irrigation, etc.

(f) The application must indicate the approximate date that drilling operations will commence.

(g) The application will contain an agreement by the applicant that a complete drilling and completion history of the well (on forms supplied by the District) together with an electrical log of the well will be furnished to the District after the well is completed <u>and before</u> water is produced from the well (except for the production of water that may be necessary for the drilling and testing of such well).

(h) The application will furnish any other data or information as may be required by the District.

(i) The applicant may be asked to provide a water conservation plan or a declaration that the applicant will comply with the District's Management Plan.

(6) A drilling permit from the District will remain valid for a period of two (2) months from the filing If the permitted work is not started within the two-month period the permit shall become void. It is provided, however that the District may, for good cause shown, extend the permit for an additional two (2) months if an extension has been requested in writing and submitted to the District during the original two (2) month period. If the project has been started, but not completed during the original two month period a written request for additional time to complete the project should be submitted to the District and the District may grant such additional time to complete the work as may be reasonably necessary.

RULE 7 - REQUIREMENTS OF DRILLER'S LOG, CASING AND PUMP DATA

(a) Within sixty days (60 days) after a well is completed accurate records of the work performed must be submitted in written form to the District. Submitted information shall include, but not be limited to, such things as the drilling history, an accurate driller's log, depth drilled, casing and cement record, maximum production potential of the well, the completion and equipping of the well and specific pump information (size and depth set). The potential of the well, hereinafter referred to as "maximum rate of production" and the actual equipment used, the maximum rate of discharge permitted by such equipment may be requested by the District.

(b) No person or entity shall produce water for any reason from any well hereinafter drilled, completed and equipped within the boundaries of the District, except that water necessary to the drilling and completion, and testing of the well and its related equipment, unless all information requested and required by the District shall have been timely filed with the District.

RULE 8 - WELL CONSTRUCTION

(a) Any well drilled within the boundaries of the McMullen Groundwater Conservation District after November 1, 1999 must be drilled, equipped, and completed so as to comply with the standards of the Texas Natural Resources Commission and any additional rules that may be established by the District.

RULE 9 - RADIOACTIVE WASTE, TOXIC AND HAZARDOUS SUBSTANCES AND POLYCHLORINATED BIPHENYLS

(a) None of the following materials may be imported from outside the District to any point within the District, nor moved from point to point within the District, for the purpose of disposing of same within the boundaries of the McMullen Ground Water Conservation District:

(1) Radioactive wastes.
(2) Toxic substances.
(3) Hazardous substances.
(4) Polychlorinated biphenyls.
(5) Soil, fluids, or other materials or substances, or containers contaminated with any of the above.

(b) The following materials are specifically excluded from items listed in Rule 9, (a), Items 1 through 5 above: agricultural insecticides, herbicides, are any other agriculture related chemicals.

(c) The following activities are strictly prohibited: within the boundaries of the district: Construction,, operation, maintenance or use of tanks, reservoirs, pits, excavations, depressions, sites, landfills, or any other manner of storage of the materials or substances enumerated above on either a or a permanent basis.

(d) All persons, firms, corporations, associations of persons or other entities having in their possession, or under their care, custody or control any of the above enumerated substances or materials located within the boundaries of the McMullen Groundwater Conservation district shall report by sworn testimony to the District in Tilden, Texas within ten (10) days of acquisition of same The sworn report shall include an inventory and description of the materials or substances possessed, including amount, location, status, and whether a plan or schedule has been formulated for the removal from the District; and ultimate disposal of the materials or substances.

Within sixty (60) days after receipt of such report the District shall either approve the report or set the matter down doe hearing according to the notice provisions and hearing procedure outlined in Rule 20.

RULE 10 - WELL LOCATION AND COMPLETION

(a) After an application for a well permit has been approved by the District, the well, if drilled, must be located no more than **thirty (30) feet** from the well location specified in the permit, and not elsewhere. If the well should be commenced or drilled at a different location outside the specified location tolerance, the drilling or operation of such well may be enjoined by the District pursuant to Chapter 36, Texas Water Code.

(b) All well drillers and persons having a well drilled, deepened, or otherwise altered, shall adhere to the provisions of this Rule prescribing the location of wells and proper completion of same pursuant to Texas Civil Statutes, Article 7621e, entitled the Water Well Drillers Act.

RULE 11 - SPACING AND PRODUCTION REQUIREMENTS

(a) No well shall be located or drilled at a location closer than one hundred (100) feet to an exterior property line. Spacing of new wells from an existing well on the same property shall be no closer than 1,375 feet from an existing well. The Board of Directors of the District may grant an exception to the well spacing rule to allow drilling of wells closer to existing wells when the Board of Directors shall determine that such exceptions are reasonable and necessary to either prevent waste or to prevent confiscation of property.

(b) For the purpose of preventing waste or confiscation of property, the Board of Directors reserves the right in particular underground reservoirs or water zones to enter special orders regarding the spacing of wells.

(c) In the application of this well spacing rule no subdivision of property occurring subsequent to the adoption of the original well spacing plan will be considered in determining whether or not any property is being confiscated by way of the requirements of the spacing rule.

(d) In no event may a well or group of wells be operated such that the total annual production exceeds four (4) acre feet of water per acre owned (Example: 4 acre-feet x 325,872 gallons per acre-foot = 1,303,488 gallons as annual allowable production per acre owned)

RULE 12-EXCEPTION TO SPACING AND PRODUCTION RULE

(a) In order to protect vested property rights, to prevent waste or confiscation of property, the Board of Directors of the District may grant exceptions to the above spacing and production rules. This rule shall not be construed so as to limit the power of the Board, and the powers stated are cumulative only of all other powers possessed by the Board.

(b) If an exception to the spacing or production rule is desired, the requested exception shall be noted on the application The application should be submitted with a sketch map drawn to a scale of 1" = 2,000 feet. The map shall indicate all property boundary lines within one-half mile of the well location with distances from the well location to those property lines and accurately show the names and addresses of the adjoining property owners. Additionally the map will show all wells located within one-half mile of the proposed location, including the names and addresses of the various well owners involved. The map and its accuracy must be certified by some person actually acquainted with the facts pertaining to the proposed well and the location and ownership of property in the vicinity of the proposed well. The application for an exception to the spacing and production rules must contain a statement giving the reasons for the requested exception.

(c) A notice of a time and place of a hearing to consider a requested exception to the well spacing or production rule will be posted by the Board of Directors no less than thirty (30) days, nor more than forty-five (45) days, prior to the scheduled date of the hearing

RULE 13 - REWORKING OR REPLACEMENT OF A WELL

(a) No person shall re-work, re-drill, or re-equip a well in a manner that would increase the rate of production of such well as established by Rule 3 above without first having made application to and having been granted a permit to do so by the Board of Directors. No person shall replace a well without having made application and granted a permit to do so by the Board of Directors.

(b) The rate of production of a permitted well shall not be increased in any manner to a rate of production greater than 25,000 gallons per day without first having made application and been granted a permit by the Board of Directors.

(c) An existing well may be re-worked, re-drilled, or re-equipped in a manner that will not change the productive capacity of the original permitted well. If the application filed for the anticipated work meets all of the application requirements and creates no exceptions to the rules the Board may issue a permit without further notice. However, if such activities are necessary and will create exceptions to the original permit status of the well, then a new application with the noted exception must be filed with the District. The Board of Directors will consider the new application in light of the need for the exception to the original permit and will make a determination as to whether the exception is necessary either to prevent waste or to prevent confiscation of property,

(d) In the event that an application meets all if the requirements the Board may approve the application without further notice.

RULE 14 - CHANGED CONDITIONS

The decision of the Board on any matter herein may be reconsidered by it of its own motion or upon motion showing changed conditions, or upon the discovery of new and different conditions or facts after the hearing after the hearing or decision on such matter. If the Board should decide to reconsider such matters after having announced a ruling or decision, or after having granted or denied an application, it shall give written notice to all persons who were proper parties to the original action and such persons shall be entitled to a hearing thereon provided they file a request therefor within fifteen (15) days from the date if the mailing of such notice.

RULE 15 -FINAL ORDERS OF THE BOARD

The orders of the Board on any non-contested application shall become the final order of the Board on the day it is entered by the Board. All orders of the Board in contested applications, appeals, or other proceedings shall contain a statement that the same was contested. In such event the order shall become final after fifteen (15) days from the entry thereof and be binding on the parties thereto unless a motion for re-hearing is filed under Rule 21 hereof.

RULE 16 - RIGHT TO INSPECT AND TEST WELLS

Upon written approval by a well owner, any authorized officer, agent, or employee, or representative of the District shall have the right at all reasonable times to enter upon any land or lands within the boundaries of the District where any well or wells are located. Such authorized representative shall have the right to inspect any and all wells and to read, and interpret, any meter, well box, or other instrument for the purpose of measuring production of water from said well or wells or for determining the pumping capacity of said well or wells and any authorized representative of the District shall have the right, at any reasonable time to enter upon any land within the boundaries of the District on which a well or wells are located for the purpose of testing the pump and power unit of the well or wells and making any other reasonable and necessary inspections and tests that may be required or necessary for the information and enforcement of the rules and regulations of the District.

RULE 17 - AQUIFER STORAGE AND RECOVERY

No Aquifer Storage and Recovery Project (ASR) may be operated within the boundaries of the McMullen Groundwater Conservation District.

RULE 18 - OPEN WELLS TO BE CAPPED

Every owner or operator of any land within the District upon which is located any open or uncovered well which has become a water well permitted by this District shall, on abandonment of same be required to close or cap and seal **permanently** with a covering capable of sustaining weight of not less than **four hundred (400) pounds,** except when said well is in actual use by the owner or operator thereof; and no such owner or operator shall permit or allow any permanently
abandoned or inactive well or wells to remain open or uncovered to exist in violation of this requirement. Officers, agents, and employees of the District are authorized to serve, or cause to be served, written notice upon any owner or operator of a well in violation of this rule, thereby requesting such owner and/or operator to close or cap such well permanently as described above In the event any owner or operator **fails to comply within ten (10) days** after such written notice any officer, agent, employee of the District may, upon authorization of the Board, go upon said land and close or cap said well in a manner complying with this rule and all expenditures thereby incurred shall constitute a lien upon the land where such well is located, provided however, no such lien shall exceed five hundred dollars **($500.)** for any single closing. Any officer, agent, or employee of the District upon authorization of the Board, is authorized to perfect said lien by filing of an affidavit as described by the Texas Water Code as amended. All of the powers and authority covering such matters by the Texas Water Code as amended are hereby adopted by the McMullen Ground Water Conservation District, and its officers, agents and employees are hereby bestowed with all of such powers and authority.

RULE 19 - RULES GOVERNING PROTESTS

(a) NOTICE OF PROTEST: In the event any person or party should desire to protest or oppose any matter pending before the Board, a written notice of the protest or opposition shall be filed with the Board on or before the date on which such application or matter is to be considered. For the convenience of the Board, any protests must be filed at least five (5) days before the hearing date scheduled for the matter

(b) **PROTEST REQUIREMENTS:** Protests shall be submitted in writing with a duplicate copy to the opposing parties and shall comply in substance with the following requirements:

(1) Each protest shall show the name and address of each protestant and show that the protestant has read the application or a notice relative thereto published by the Board.

(2) There shall be an allegation to protestant which shall result from the proposed

action or matter to be considered by the Board.

(3) If the claim is based on claim of interference of some present right of the protestor, it shall include a statement of the basis of protestor's claim of right

(4) Protestor should call attention to any amendment to the application or adjustment which, if made, would result in the withdrawal of the protest.

(c) **CONTESTED APPLICATIONS OR PROCEEDINGS DEFINED:** An application, appeal, motion, or proceeding before the Board is considered protested when either protestor or intervenor, or both, files the notice of protest as above set out and appears at the hearing held on the application , motion, or proceeding and presents testimony or evidence in support of their contentions, or presents a question or questions of law with regard to the application, motion or proceedings. When neither protestor or intervenors so appear and offer either testimony or evidence in support of their contentions, or raise a question of law with reference to any pending application, motion or proceeding, the same shall be considered as non-contested
(d) In the event of a contested hearing each party shall furnish the other parties to the proceeding with a copy of all motions, amendments or briefs filed by him with the Board.

RULE 20 - GENERAL RULES OF PROCEDURE FOR HEARING

(a) **HEARINGS:** Hearings will be conducted in such a manner as the Board deems suitable for the case and technical rules of legal and court procedure need not be applied. It is the purpose of the Board to obtain all of the relevant information and testimony pertaining to the issue before it as conveniently, inexpensively, and expeditiously as possible without prejudicing the rights of either applicant or protestor.

(b) **WHO MAY APPEAR:** Any party-at-interest in a proceeding may appear either in person or represented by an attorney, or both in such proceedings. At the discretion of the Board anyone not a party-at-interest to the proceedings may appear.

(c) **ADMISSIBILITY:** Evidence will be admitted if it is of reasonable quality upon which reasonable persons are accustomed to rely in the conduct of serious affairs. It is intended that needful and proper evidence shall be conveniently, inexpensively, and speedily produced while substantially preserving the rights of the parties to the proceedings.

(d) **TESTIMONY SHALL BE PERTINENT:** The testimony presented shall be confined to the subject matter contained in the application or contest. In the event that any party in the hearing shall pursue a line of testimony or interrogation of a witness that is clearly incompetent, irrelevant, or immaterial, the person conducting the hearing may forthwith terminate such line of interrogation.

(e) **STIPULATION:** Evidence may be stipulated by agreement of all parties-at-interest

(f) **LIMITING NUMBER OF WITNESSES:** The right is reserved by the Board in any proceeding to limit the number of witnesses appearing whose testimony appears to be merely cumulative.

RULE 21 - REHEARING

(a) Any person whose application is denied, or whose contest is overruled, or who is not granted the relief desired, may file a motion for a rehearing by the Board **within fifteen (15) days** of the announcement by the Board of its decision or motion. The Board shall act thereon within a reasonable time. If such motion for rehearing is overruled the order of the Board shall be final on the date the motion is overruled.

(b) The Board may, in a proper case, find that an emergency exists and that a substantial injustice may result from delay. In that event, and upon recitation of such finding, the order of the Board will become final on the date of the announcement of the order by the Board, and than no motion for a rehearing will be considered thereon.

(c) If an application or contest is denied by the Board, and if the applicant or contestant shall not have been afforded an opportunity for a hearing before the Board, as elsewhere provided by these rules, the applicant or contestant shall be entitled to a hearing before the Board. A written request to the Board for such hearing, stating such facts, must be filed with the Board within the above mentioned fifteen (15) day period. If such motion is in order and duly filed, the Board shall give notice to the applicant and all proper and necessary parties of the time and place of such hearing, and shall proceed to conduct such hearing.

RULE 22 -TRANSPORTATION OF WATER FROM THE DISTRICT

(a) Every person must obtain a permit from the McMullen Groundwater Conservation District for the transportation of water from the district by pipeline, channel, ditch, watercourse, or other natural or artificial facilities or any combination of such facilities. A permit must be obtained if such water is produced , or is to be produced, from wells located within the District and, if all or any part of such water is used or is intended for use outside the boundaries of the District. **However, the requirement for a permit hereunder shall not apply to wells operating and producing water within the boundaries of the District prior to the effective date of this rule.**

(1) The permit required herein must be applied for in the manner prescribed by the District and filed with the District on forms supplied by the District. Such permit must be

obtained prior to the transportation of water, all in accordance with the provisions of this rule.

(2) An application for a permit to transport water must:

(a) be in writing and sworn to;

(b) contain the name and post office address and the place of residence or the principal office of the applicant;

(c) identify the exact location of the well from which produced water is to be transported;

(d) specifically describe the proposed transportation facilities and the destination of the transported water;

(e) state the nature and proposed use and amount of water to be used for each purpose

(f) state the time in which the proposed construction or alteration of facilities is

to begin;

(g) state the length of time required for the proposed use of water and state the volume of water to be used;

(h) state the maximum quantity of water to be transported on an annual basis;

(i) provide information showing the effect of the proposed transported water on the quality and quantity of water available in the District;

(j) identify any other possible sources of water which could be utilized for the stated transportation purpose, including the quality and quantity of water in such alternate sources;

(k) provide any other information the District prescribes

(l) must file a monthly pumping report within the time specified by the District and on a form prescribed by the District;

(m) must agree to pay, within the time and in the manner specified, a fee

assessed by the District of one dollar per acre-foot ($1.00/AF) for any water transported from the District for agricultural purposes and a fee of seventeen cents per one thousand gallons ($0.17/1,000 gal.) for water used for any other purpose, as described in Chapter 36 of the Texas Water Code. .

(3) The application for a permit to transport water from the District must be accompanied by a map drawn to a scale of one inch equals four thousand feet (1" = 4,000 ft.) showing substantially::

(a) the location of the existing and/or proposed wells from which water will be transported;

(b) the location and ownership of any existing wells which will not be involved in the transportation project;

(c) the location and size of the proposed transportation facilities;

(d) the location of the proposed user of the transported water;

(4) The application must be accompanied by an application fee in the amount of ten thousand dollars ($10,000.00).

(5) The District shall determine whether the application, including submitted maps and other required information, complies with the rules of the District. The District may require amendment to the application, maps, or other submitted material in order to achieve the necessary compliance.

(6) The District shall conduct a public hearing within ninety (90) days of the filing of the complete application.

(7) The District shall give public notice of the scheduled date of the hearing as prescribed by this rule, stating:

(a) the name and address of the applicant;

(b) the date the application was filed with the District;

(c) the location of the well or wells which are to be involved in the proposed water transportation project, including the purpose for which the proposed transported water is to be used;

(d) the time and place of the scheduled hearing ten (10) days in advance, and

(e) any additional information deemed by the District to be necessary to the hearing.

(8) At the time and place specified in the notice the District shall hold a public meeting on the application. The meeting shall be held in conjunction with any regular or special meeting o f the Board of Directors of the District or a special meeting may be called for the purpose of considering the application. Any person may appear either by himself, or represented by an attorney, or may register his appearance in writing. Any person who appears may register his objection to the issuance of the permit. The District may receive evidence orally or by written affidavit in support of, or objection to, the issuance of a permit.

(9) Such application shall not be approved unless the Board of Directors determines and finds that the transporting of water for use outside the District would not substantially affect either the quality or the quantity of water for use by any person or property within the District; that all other feasible sources of water available to the person seeking the application have been exhausted; that no other liquid could be reasonably substituted for fresh groundwater; that the use, or any part of the use, would be construed as waste as defined under the laws of the State of Texas. In evaluating the application the District shall evaluate the quantity of water proposed to be transported, the term that is requested for the transportation of water out of the District, the safety of the proposed transportation facilities with respect to the contamination of the aquifer from which water is to be withdrawn, the nature of the proposed use of the transported water, the potential effect of the proposed transportation of water on the residents of the District, taking into account all beneficial use of water by residents of the District, including municipal use, agricultural use, recreational use and other categories of use, and such other factors that are consistent with the purpose of the District.,

(10) Upon approval of an application the District shall issue a permit to the applicant. The applicant's right to transport water from the District shall be limited to the extent and purpose stated in the permit. A permit shall not be transferable accept as provided in paragraph 14 herein.

(11) The issued permit shall be in writing and attested to by the seal of the District and it shall contain substantially the following information:

(a) the name of the person or entity to whom the permit is issued;

(b) the date on which the permit is issued;

(c) the term for which the permit is issued;

(d) the date the original application was filed;

(e) the destination of and the purpose or use of the water to be transported;

(f) the maximum allowable quantity of water to be transported annually from the District;

(g) any other information deemed necessary by the District.

(12) The permittee shall file monthly reports to the District describing the amount of water transported and used for the permitted purpose. Such report shall be filed on the form or forms supplied by the District within ten (10) days following the end of the month in which water was transported.

(13) All transporting facilities subject to the requirements of this Subsection shall be equipped with flow measuring devices approved by the District and such measuring devices will be available to the District for inspection at any time

(14) A permittee may apply for an extension of any permit granted under this Subsection or for transfer of a permit to another person. The District will consider and will either grant or deny such application for extension or transfer of a permit in the same manner as provided for herein for application for a permit.

(15) Any permit granted under this Subsection shall be subject to revocation by reason of non-use or waste by the permittee, or for substantial deviation from the purposes or other terms stated in the permit. Revocation of a permit for reason of non-use shall require that no water is transported under the original permit for a period of five (5) years.

(b) Any party transporting water from wells located in the District for use outside the District, regardless of the amount of water so transported must register such transporting with the District. Such registration must be made within one hundred sixty (160) days of the adoption by the District of this rule.

(1) Any person subject to the requirements of this Subsection (b) shall file quarterly reports with the District describing the amount of water transported, the destination of, and the use of such transported water. Such report must be filed on the form or forms provided by the District within tern (10) days of the March 31, June 30, September 30, and December 31 next following the commencement of the transportation of water, and within ten (10) days of each following quarterly date thereafter.

(2) All transporting facilities for wells subject to the requirements of this Subsection shall be equipped with flow measuring devices approved by the District and such devices shall be available to the District for inspections at all times

RULE 23 - REQUEST FOR INJUNCTIVE RELIEF AND ASSESSMENT OF PENALTIES.

If it appears that a person or operating entity has violated, or is violating, or is threatening to violate any provisions of the Rules and Regulations of the District, or any Board order, rule, or permit, the Board may institute and conduct a suit in the name of the District for injunctive relief, or to recover a civil penalty of up to five thousand dollars ($5,000.00) for each violation, or both injunctive relief and civil penalties.

RULE 24 - GENERAL RULES

(a) **COMPUTING TIME:** In computing any time period allowed or prescribed by these rules, by order of the Board, or any applicable statute, the day of the act, event, or default from which the designated period begins to run, is not to be included, but the last day of the period is to be included unless such day is a Sunday or legal holiday, in which event the period runs until the end of the next day which is neither a Sunday or a legal holiday.

(b) **TIME LIMIT:** Applications, requests, or other paper or documents required or permitted to be filed under these rules, or by law, must be received for filing at the offices of the District at Tilden, Texas within the time limit, if any, for such filing. The date of receipt by the District and not the day of posting is determinative.

(c) **SHOW CAUSE ORDERS AND COMPLAINTS:** The Board either in its own motion, or upon receipt of sufficient written protest or complaint, may at any time, after sufficient notice to all interested parties, cite any person operating within the District to appear before it in a public hearing and require him to show cause why his permit should not be suspended, or otherwise restricted and limited, for failure to comply with the orders or rules of the District or the relevant laws of the State, or for failure to comply with and abide by the terms and provisions of the permit or operating authority itself. The matter of evidence and all other matters of procedure at any such hearing will be conducted in accordance with these rules of practice and procedure.

SAVINGS CLAUSE

If any section, sentence, paragraph, or clause, or any part of these rules and regulations should be held or declared invalid for any reason by a final judgement of the courts of this state, or of the United States, such decision or holding shall not affect the validity of the remaining portion of these rules; and the Board of the District does hereby claim that it would have adopted and promulgated such remaining portions of these rules irrespective of the fact that any other section, sentence, clause, or paragraph, or part thereof, may be declared invalid.

BY-LAWS OF THE

MCMULLEN GROUNDWATER CONSERVATION DISTRICT

In accordance with the Legislative act, SB 1911, and Article XVI, Section 59, of the Texas Constitution and Chapters 50 and 52 of the Texas Water Code, Vernon's Civil Statutes of Texas, the following By-Laws dated the 1st day of November, 1999, were ratified and adopted for guides to be used with discretion and they were adopted for the purpose of simplifying procedures and facilitating the administration of the McMullen Groundwater Conservation District.

ESTABLISHMENT OF THE DISTRICT

Definitions::

The **Board** shall mean the Board of Directors of the McMullen Groundwater Conservation District consisting of five (5) elected members who are known to be landowners in McMullen County, Texas

The **Initial Directors** shall mean the five duly elected directors representing each of the four existing precincts of McMullen County, plus one at-large position.

The **District** shall mean the McMullen Groundwater Conservation District maintaining its office in Tilden, Texas, where registrations, reports, and other papers are required to be filed with, or sent to, the District The District includes all of McMullen County, Texas in its entirety.

Water shall mean any underground water. The term **"groundwater"** is synonymous with **underground** water

Owner shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, easement, or any other estate in the land.

Person shall mean any individual, partnership, firm, or corporation.

The word **waste** shall be used and have the same meaning as defined by the Legislature and the Texas Water Code.

REQUIREMENTS FOR MEMBERSHIP AND MEETINGS PROCEDURE

Candidates::

A person who owns land subject to taxation in McMullen County and who is at least eighteen (18) years of age may be elected by the voters of McMullen County to serve as a director of the McMullen Groundwater Conservation District. At such a time as a permanent district is created by legislative action and subsequently ratified by the voters of McMullen County, initial directors of the permanent district will be elected. Initial director candidates who possess the same qualifications cited above must make application at least twenty days prior to the posted election date. All procedures for holding the election shall be in accordance with the Texas Election Code Article 6.02 and the legislative act creating the district.

Elections:

An election to confirm and ratify the creation of the District shall be held on any uniform election date (third Saturday in January, first Saturday in May, second Saturday in August, or the first Tuesday after the first Monday in November) before the first anniversary of the creation of the district by legislative action. At the same time an election shall be held in the District for the election of two (2) Directors who shall each serve two-year terms and three (3) Directors who shall each serve four year terms. Thereafter on the same date in each subsequent second year, the appropriate number of directors shall be elected to the Board.

Meetings:

The Board shall hold meetings as necessary, but in no event will the Board meetings held less than once each calendar quarter. The Board may hold other meetings at the call of the chairman or at the request of at least two (2) of the directors.

All meetings shall be open to the public, except when the need arises for the Board to meet in executive session, and the meeting date, time, place, and agenda shall be posted by the County Clerk at the appropriate place in the McMullen County Courthouse.

A quorum is the majority of the Directors

The Board may elect its own officers yearly.

The Board will follow the Robert's Rules of Order for Parliamentary Procedure.

The Board may also act as a hearing board concerning any disputes which may arise concerning the Rules and operations of the District.

Board of Directors::

(a) The District is governed by a Board of Directors composed of five (5) members. Each Director shall occupy a designated place corresponding to the county precincts plus one at-large position. These places will be designated as Place 1, 2, 3, 4, and At-Large.

(b) To be qualified for election as a director, person must be at least 18 years old and be a resident of the district and of the precinct he or she is to represent.

(c) Except for the initial directors each regular director shall serve for a term of two (2) years or until his successor is appointed. Three (3) of the initial directors shall be elected for a four year term and two (2) of the initial regular directors shall be elected for a two year term. Following the election of initial directors of the District, subsequent elections will be held on a uniform election date every two years to elect the appropriate number of directors.

(c) A person serving as a director is eligible for re-election.

(d) A vacancy on the board shall be filled by appointment of the board of a qualified individual from the precinct represented by the vacancy.

(e) As soon as practicable after a director is elected or appointed, that director shall make the sworn statement as required by the state constitution for holders of public office

(f) As soon as practicable after a director has made the sworn statement described above, and before beginning to perform duties of office, that director shall take the oath of office prescribed by the state constitution for public officers.

(g) Before beginning to perform the duties of office each director shall execute a bond in the amount of $10,000.00 payable to the District and conditioned on the faithful performance of that director's duties. All bonds of the directors shall be approved by the board and paid for by the District.

(h) The sworn statement, bond and oath shall be filed with the District and retained in its records. A duplicate original of the sworn statement and the oath shall also be filed with the appropriate agencies after their execution and need not be filed before the new director begins to perform the duties of office.

Board Organization::

(a) The board shall elect one director as president of the board, who shall serve for a term of one (1) year, and who shall preside at meetings of the board and shall perform other duties prescribed by the board.

(b) The board shall elect another director as vice-president of the board, who shall serve for a term of one (1) year. The vice-president shall perform the duties of the president when the president is absent or is otherwise incapacitated.

(c) The board shall elect a secretary of the board. The secretary is the official custodian of minutes, books, and seal of the board and shall perform other duties and functions as may be prescribed by the board. The board may also elect a treasurer of the board who shall perform duties and functions of that office and as prescribed by the board. The offices of secretary and treasurer may be held by one person The board, in its discretion, may appoint a non-director to serve as an assistant secretary; any person so appointed shall be bonded in the same manner, and for the same amount, as the directors.

(d) Any three directors will constitute a quorum. All directors are entitled to vote on matters before the board. The district shall act by and through resolutions adopted by the board; the affirmative vote of at least three directors is necessary to adopt any resolution.

(e) The board shall have meetings as necessary but in no event less frequent than quarterly. With the exception of any necessary executive sessions, all meetings of the board will be open to the public and will be timely announced as to date, time, place, and agenda.

POWERS AND DUTIES OF THE DISTRICT

The District has all of the rights, powers, privileges, authority, functions and duties provided by the general laws of the State of Texas, including Chapters 35 and 36 of the Water Code applicable to groundwater conservation districts created under Article XVI, Section 59, of the Texas Constitution.

POLICIES OF THE DISTRICT

(A) Subject to the laws governing the district, the Board of Directors shall adopt the following policies in writing:

(1) A Code of Ethics for district directors, officers, employees and persons who are engaged in handling investments for the District

(2) A policy relating to Director fees and reimbursement for travel expenditures..

(3) A policy relating to conflicts of interest by District officials..

(4) A policy relating to standards of conduct for District officials.

(5) A policy relating to nepotism within the District.

(6) A policy relating to the use of District property

(7) A policy relating to the use of personal vehicles for official business of the District.

(8) A policy relating to procedures for the selection, monitoring, or review and evaluation of professional services.

(9) A policy that insures better use of management information, including:

(a) budgets for use in planning and controlling of costs;
(b) an audit or finance committee of the Board;
(c) uniform reporting requirements that use "Audits of State and Local Governmental Units" as a guide on audit working papers and that uses "Governmental Accounting and Financial Reporting Standards".

(B) A written policy that insures that upon notification to the District of the intention of the state auditor to conduct an audit of the District that all financial records of the District will be promptly made available to the state auditor without exception

ADMINISTRATIVE PROCEDURES

Administrator and Employees:

If it becomes necessary to employ a manager or administrator or any other employees for operation of the District. the Board has the power to employ such person or persons and to set compensation levels, standards and conditions of employment, responsibilities, authority and duties. The Board may delegate any of its powers and duties (except those of adopting rules, making resolutions, issuing a dissolution order, taxation and the issuance of bonds) to an administrative manager who will carry out duties and assume authority delegated to him/her by the Board. Employment of any personnel by the District will be subject to the general law of nepotism and to the nepotism policy established by the Board.

The administrative manager, with Board approval, may develop a management plan for the district as outlined in Chapter 36, Section 1071 of the Texas Water Code. Further, any such manager may prepare District budgets for approval by the Board and may act as official liaison for the Board between the public and governmental

TAXATION AND BONDS

In the event the District becomes a taxing entity, the tax and bond provisions of Chapters 35 and 36 of the Texas Water Code, as amended, will apply to the District.

Taxing authority has been granted to the District by the voters, the Board has the authority to levy and collect property taxes subject to the tax cap specified in the Act creating the district. The Board has the authority to review the granted tax structure so that the District may levy taxes necessary for the District to perform the functions and powers granted to it in the Act. . .

TAX EXEMPTIONS

The District will not be required to pay any tax or assessment on its facilities, or any part of its facilities, or on any bonds issued by the District under the Act; transfer of any bonds and the income from these bonds, including the profits made from the sale of bonds by the District are exempt from taxation in this state. The standard county exemptions used by McMullen County will be used for local tax purposes.

TAX PROCEDURES

In the event the District becomes a taxing entity approved by the voters in the District procedures will be developed for the following:

(a) Identification of taxable property from the McMullen County Appraisal District tax rolls.
(b) Agreements and contracts can be made with McMullen County for the collection of taxes. The McMullen County Appraisal Board Chief may serve as a tax advisor for the preparation of the District's budget and for the preparation for and levying of the District's property taxes.
(c) Tax revenues collected will be deposited in an insured account in a bank chosen by the Board of Directors of the District. Procedures for managing said bank account will be developed by the Board.

AMENDMENT TO BY-LAWS

These by-laws may be altered or amended, or may be replaced in whole or in part by new by-laws adopted at any regular or special meeting of the Board of Directors of the District, provided that no such action be taken unless a copy of the proposed new by-laws is submitted in writing to each of the Directors of the District together with notice of such meeting at least ten (10) days before the date of such meeting and a public hearing is held with proper notice. No such alteration, amendment, or repeal of the existing by-laws, or the adoption of new by-laws shall be valid unless the same shall be made by the affirmative vote of at least a majority of all Directors of the District.

DISSOLUTION OF THE DISTRICT

Chapter 36 of the Texas Water Code, as amended, applies to the dissolution of the District.

RESOLUTION ADOPTING RULES OF THE McMULLEN GROUNDWATER CONSERVATION DISTRICT

WHEREAS, The Rules of the McMullen Groundwater Conservation District, attached hereto as Attachment A, have been developed for the purpose of conserving, preserving, protecting and recharging that underground water in the District, and this action is taken under the District's statutory authority to prevent waste and protect the rights of owners of interest in groundwater;
WHEREAS, In accordance with Section 59, Article 16 of the Constitution of the State of Texas, and in accordance with the McMullen Groundwater Conservation District Act, 71st Leg, 1967 Tex. Gen. Laws 1676(Vernon): Act of May 30, 1983, 68th Leg, ch.484, 1983 Tex. Gen. Laws 2852(Vernon); and the Act of May 17, 1985, 69th Leg, R.S., ch. 438, 1985 Tex. Gen. Laws 2984(Vernon); the following rules are hereby ratified and adopted as the rules of McMullen Groundwater Conservation District by its Board of Directors;
WHEREAS, the rules, regulations and modes of procedure contained are adopted for the purpose of simplifying procedure, avoiding delays, saving expense and facilitation the administration of this District and these rules shall be so construed; and
WHEREAS, Under no circumstances, and in no particular case will these Rules, or any part of them, be construed as a limitation or restriction upon the exercise of any discretion, where such exists; nor may they in any event be construed to deprive the Board of an exercise of powers, duties and jurisdiction conferred by law, nor to limit or restrict the amount and character of data or information which may be required for the proper administration of the law.
NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE McMULLEN GROUNDWATER CONSERVATION DISTRICT THAT:
1) The "Rules of the McMullen Groundwater Conservation District" contained in attachment A are hereby adopted.
2) All prior rules are hereby replaced.
3) The General Manager is hereby authorized to take any all action necessary to implement this resolution.
4) These rules take effect August, 28, 2003.
AND IT IS SO ORDERED
PASSED AND ADOPTED ON THIS 28th DAY OF August, 2003.

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Clifford McTee
President

Attest to ______________________________

J.E. Wheeler Jr.
Secretary - Treasurer

Appendix K.3

Live Oak Underground Water Conservation District Rules

LIVE OAK{PRIVATE }
UNDERGROUND WATER CONSERVATION DISTRICT

The Rules of the Live Oak Underground Water Conservation District are hereby published as of the 11TH day of June,1998, as amended on July 12, 2000.

In accordance with Section 59 of Article XVI of the Texas Constitution and with Acts of the 71st Legislature (1989), Ch. 673, S.B. 1777 and Chapters 35 and 36 of the Texas Water Code, the following rules are hereby ratified and adopted as the rules of the District by its Board. Each rule as worded herein has been in effect since the date of passage and as may be hereafter amended.

The rules, regulation, and modes of procedure herein contained are and have been adopted for the purpose of simplifying procedure, avoiding delays, saving expense, and facilitating the administration of the water laws of the State and the rules of the District. To the end that these objectives be attained, these rules shall be so construed.

These rules may be used as guides in the exercise of discretion, where discretion is vested. However, under no circumstances and in no particular case shall they, or any of them be construed as a limitation or restriction upon the exercise of powers, duties, and jurisdiction conferred by law, nor to limit or restrict the amount and accuracy of data or information which may be required for the proper administration of the law.

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RULE 1 - DEFINITIONS

Definitions of Terms: In the administration of its duties, the Live Oak Underground Water Conservation District follows the definitions of terms set forth in Chapter 36, Water Code, and other definitions as follows:

(a) "District" shall mean the Live Oak Underground Water Conservation District, maintaining its principal office in George West, Texas. Where applications, reports and other papers are required to be file with or sent to "the District", this means the District headquarters in George West, Texas.

(b) The "Board" shall mean the Board of Directors of the Underground Water Conservation District, consisting of five (5)duly elected members.

(c) "Groundwater" means water percolating below the surface.

(d) "Groundwater reservoir" means a specific subsurface water-bearing reservoir having ascertainable boundaries and containing groundwater.

(e) "Water" shall mean groundwater.

(f) The term "Well" or "Water Well" shall mean and include any artificial excavation constructed to produce more than 25,000 gallons of water per day.

(g) "Exempt Well" - any artificial excavation constructed to produce or which produces less than 25,000 gallons of water/day. For all purposes herein, an "Exempt Well" shall be exempt from the rules created hereunder, but shall not be exempt from registration/validation requirements created hereunder.

(h) "Open or Uncovered Well" - any artificial excavation drilled or dug for the purpose of exploring for or producing water from the underground reservoir, not capped, covered or plugged as required by these rules.

(I) "Owner" shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, easement, or any other estate in the land.

(j) "Person" shall mean any individual, partnership, firm or corporation.

(k) "Party-at-interest" shall mean any person, whether as an owner, lessor, lessee, tenant or operator, within the boundaries of the District, who is or may be affected by the proceedings of a hearing.

(l) "Plugging" shall mean an absolute sealing of the well bore.

(m) "Pollution" shall mean the alteration or the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the District that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

(n) "Undesirable Water" shall mean water that is injurious to vegetation, to land, or to fresh water, or water that can cause pollution.

(o) "Waste" means any one or more of the following:

(1) withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural, gardening, domestic, or stock raising purposes;

(2) the flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;

(3) escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;

(4) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;

(5) wilfully or negligently causing, suffering, or allowing groundwater to escape into any river, creed, natural watercourse, depression, lake reservoir, drain, sewer, street, highway, road or road ditch, or onto any land other than that of the owner of the unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26;

(6) groundwater pumped for irrigation that escapes as irrigation tailwater onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge; or

(7) for water produced from an artesian well, "waste" has the meaning assigned by Section 11.205 of the Texas Water Code.

(p) An "Authorized Well Site" shall be:

(1) The location of a proposed well on an application duly filed until such application is denied, or

(2) The location of a proposed well on a valid permit. (An authorized well site is not a permit to drill).

(q) "Exploratory Hole" - any hole drilled to a depth below the top of any stratum containing groundwater, as groundwater is defined in the Texas Water Code.

(r) "Cement" - as defined by the General Provisions, Chapter 287.2, of the Texas Administrative Code.

(s) "Aquifer" shall mean a geologic formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

(t) "ASR" shall mean Aquifer Storage and Retrieval Project, which is a project with two phases that anticipates the use of a class V aquifer storage well for injection into a geologic formation, group of formations, or part of a formation that is capable of underground storage of appropriated surface water for subsequent retrieval and beneficial use.

(u) "Aquifer Storage Well" shall mean a class V injection well designed and used expressly for the injection of water into a geologic formation, group of formations, or part of a formation that is capable of underground storage of water for later retrieval and beneficial use.

(v) "Artesian Well" shall mean a water well completed in the confined portion of an aquifer such that, when properly cased, water will rise in the well, by natural pressure, above an overlying impermeable stratum.

(w) "Beneficial Use" or "Beneficial Purpose" shall mean use for:

(1) agricultural, gardening, domestic, stock raising, municipal, mining, manufacturing, industrial, commercial, recreational or pleasure purposes;
(2) exploring for, producing, handling, or treating oil, gas, sulfur, or other minerals; or
(3) any other purpose that is useful and beneficial to the users that does not commit waste as defined in section (o) of this rule.

RULE 2 - WASTE

(a) Groundwater shall not be produced within, or used within or without the District, in such a manner as to constitute waste as defined in Rule 1, Section (o) hereof.

(b) Any person producing or using groundwater shall use every possible precaution, in accordance with the latest approved methods, to stop and prevent waste of such water.

(c) No person shall pollute or harmfully alter the character of the groundwater reservoir of the District by means of salt water or other deleterious matter admitted from some other stratum or strata or from the surface of the ground.

(d) No person shall commit waste as that term is defined in Section (o), Rule 1 of the Rules of the Live Oak Underground Water Conservation District.

(e) Water shall not be produced or used within the District in such a manner or in under such conditions as to constitute waste as defined by Rule 1 hereof. Water shall not be produced from an abandoned or deteriorated well.

RULE 3 - WELL REGISTRATION

Registration is required for all existing and future wells in the District and shall be filed with the District on a form and in a manner required by the District.

Registration includes all wells:

(a) that produce less than 25,000 gallons of water per day;

(b) that produce or will produce water used for Irrigation and/or Agricultural purposes;

(c) that produce or will produce water from the well to be used to supply the domestic needs of ten or fewer households and a person who is a member of each household is either the owner of the well or a person related to the owner or member or the owner's household within the second degree by consanguinity, or an employee of the owner;

(d) that supply of water for hydrocarbon production activities, regardless of whether those wells are producing, that are associated with any well permitted by the Railroad Commission of Texas drilled before or after the effective date of S.B. 1777, Acts of the 71st Legislature, Regular Session 1989, or

(e) that produce or will produce water used for domestic use;

(f) that produce or will produce water used for Industrial and/or Manufacturing purposes;

(g) that produce or will produce water used for Commercial and/or Municipal purposes;

(h) that produce or will produce water for all other uses.

RULE 4 - DEPOSITS

Each application for a permit to drill a well shall be accompanied by a **$25.00 deposit** which shall be accepted by the Manager of the District or authorized personnel in the office of the District. Said deposit shall be returned to the applicant by the District if (1) the application is denied, or (2) if the application is granted, upon the receipt of correctly completed registration and log of the well, or (3) if said permit location is abandoned without having been drilled, upon return and surrender of said Permit marked "abandoned" by the applicant.

In event neither the registration and log of the well nor permit marked abandoned is returned to the District office within three (3) months after approval date of the permit or the extension date thereof, the said deposit shall become the property of the District.

RULE 5 - PERMIT REQUIRED

(a) No person shall hereafter begin to drill or drill a well, or increase the size of a well, or pump therein, which well could reasonably be expected to produce, or a pump designed to produce, in excess of 25,000 gallons of water per day, without having first applied to the Board, and had issued a permit to do so, unless the drilling and operations of the well is exempted by the law or by these rules. Provided that, as set out in Rule 5 (e) hereof, and under certain conditions, an applicant may commence the drilling of a well when his application therefor has been recommended by three directors of the board.

(b) No permit shall be required for the drilling of temporary wells exempt by *of* the Texas Water Code (being generally wells used for the production of oil, gas, or other minerals and water wells used in conjunction therewith).

(c) Applications for permits to drill wells shall be made at the office of the District in George West, Texas.

(d) The manager will approve the application using criteria developed by the Board of Directors. If a permit is denied by the manager, then the application will automatically be reviewed by the board at the next regular scheduled meeting.

(e) The signatures of three Directors of the District on an application shall constitute a recommendation that the permit be granted. The refusal of three or more Directors to sign the application shall constitute a recommendation or rejection of the application.

(f) If before the Board officially approves an application to drill a well, a contest shall arise over the application, then the Board may conduct a hearing, upon due notice to both parties, to hear and determine the contest or to determine which of the applications should, in its judgment, be granted.

In the event of a contest, or such conflicting application, no well shall be commenced until the matter is passed upon by the Board. A contest shall be deemed filed when written notification is filed with the Board at its office and the Manager or other authorized personnel shall receive the same. Thereafter, both applicants, or the applicant and the contestant or contestant, after due notice, shall be entitled to a hearing before the board. At such hearing, all parties may introduce pertinent evidence as to why the particular application should be granted or denied, including evidence as to the effect on the water reservoir, the conservation and preservation of water, the prevention of waste, the protection of property rights, and other pertinent matters, which evidence shall be taken into consideration by the Board. The Board shall also take into consideration which of the applicants duly filed his application first.

(g) If any application is not favorably recommended by three of the Directors, the applicant shall have the right to appeal to the Board. Such appeal must be filed with the Manager of the

District or written notice by registered mail given fifteen (15) days, from the time that the third Director declined to sign the application. If no such appeal is taken, the application shall be deemed to have been abandoned by the applicant. Upon receipt of such appeal the Board shall fix a time and place for such hearing and notify the necessary parties thereof. At least 72 hours notice shall be given by the Board to the necessary parties for said hearing.

RULE 6 - ISSUANCE OF PERMITS

(a) The Board shall issue or cause to be issued a drilling permit for a well upon proper application executed and filed by the owner containing the matters specified below. An application shall be considered filed when properly made out, completed, signed, tendered and accompanied by the required deposit to the District by the applicant.

Such applications shall be on forms provided by the District and shall be in writing and shall be prepared in accordance with and contain the information called for in the form of application, if any, prescribed by the Board, and all instructions which may have been issued by the Board with respect to the filing of an application. Otherwise, the application will not be considered.

(b) Rules for the filing of applications:

(1) If the applicant is an individual, the application shall be signed by the applicant or his duly appointed agent. The agent may be requested to present satisfactory evidence of his authority to represent the applicant.

(2) If the application is by a partnership, the applicant shall be designated by the firm name followed by the words "a Partnership", and the application shall be signed by at least one of the general partners who is duly authorized to bind all of the partners.

(3) In the case of a corporation, public district, county or municipality, the application shall be signed by a duly authorized official. A copy of

the resolution of other authorization to make the application may be required by the officer or agent receiving the application.

(4) In the case of an estate or guardianship, the application shall be signed by the duly appointed guardian or representative of the estate.

(c) Such applications shall set forth the following:

(1) The name and address of the fee owner of the land upon which the location is made.

(2) A map showing the proposed location of the well to be drilled as provided in the application including the County, the section, block, survey and township; labor and league; and exact number of yards to the nearest nonparallel property lines; or other adequate legal description.

(3) The proposed use of the well to be drilled, whether municipal, industrial, irrigation, or other.

(4) The size of the pump.

(5) The approximate date drilling operation is to begin.

(6) The location of all wells within a quarter of a mile on the proposed location, if any.

(7) An agreement by the applicant that a complete well registration and log will be furnished to the District (on forms furnished by it) by the applicant upon completion of this well and prior to the production of water therefrom (except for such production as may be necessary to the drilling and testing of such well).

(8) Any additional data as may be required by the Board.

(9) A water conservation plan or a declaration that the applicant will comply with the district's management plan.

(d) Time during which a permit shall remain valid. Any permit granted hereunder shall be valid if the work permitted shall have been completed within two (2) months from the filing date of the application. It shall thereafter be void. Provided, however, that the Board, for good cause, may extend the life of such permit for an additional two (2) months if an application for such extension shall have been made known to the District during the first two (2) month period. Provided, further, that when it is made known to the Board that a proposed project will take more time to complete, the Board, upon receiving written application may grant such time as is reasonably necessary to complete such project.

RULE 7 - REQUIREMENTS OF DRILLER'S LOG, CASING AND PUMP DATA

(a) Complete records shall be kept and reports thereof made to the District concerning the drilling, maximum production potential, equipping and completion of all wells drilled. Such records shall include an accurate driller's log, any electric log which shall have been made and such additional data concerning the description of the well, its potential, hereinafter referred to as "maximum rate of production" and its actual equipment and rate of discharge permitted by said equipment as may be required by the Board. Such records shall be filed with the District Board within 90 days after completion of the well.

(b) No person shall produce water from any well hereinafter drilled and equipped within the District, except that necessary to the drilling and testing of such well and equipment, unless or until the District has been furnished an accurate driller's log, any electric log which shall have been made, and a registration of the well correctly furnishing all available information required on the forms furnished by the District.

RULE 8 - WELL CONSTRUCTION

(a) A well to be drilled subsequent to the date of enactment of this rule shall be drilled in accordance as follows:

A well must be drilled, equipped, and completed so as to comply with the standards set by the Texas Natural Resource Commission and additional rules established by this district.

RULE 9- RADIOACTIVE WASTES, TOXIC AND HAZARDOUS SUBSTANCES AND POLYCHLORINATED BIPHENYLS

(a) None of the following materials or substances may be imported outside the District to a point within the District, nor moved within the District from point to point, for the purpose of temporarily or permanently disposing of such material or substances within the District:

(1) Radioactive Wastes.
(2) Toxic Substances.
(3) Hazardous Substances
(4) Polychlorinated Biphenyls.
(5) Soil, fluids or other materials or substances contaminated with any of the above.

(b) Exclusions: The following are excluded from the Rule and Order: agricultural insecticides, herbicides, or other agri-chemicals.

(c) The following activities are prohibited:

(1) Construction, operation, maintenance or use of waste disposal wells for any of the materials enumerated above.

(2) Construction, operation, maintenance or use of tanks, reservoirs, pits, depressions, sites, landfills or any other manner of storage of the materials or substances

enumerated above on either a temporary or a permanent basis within the District.

(d) All persons, firms, corporations, associations of persons or other entities having in their possession or under their care, custody or control within the District any of the materials or substances enumerated above shall report by sworn inventory to the District Office in Live Oak County, Texas within ten (10) days of acquisition. The report shall include a description of the materials or substances possessed, amount, location, status and whether a plan or schedule has been formulated for the ultimate disposal of the materials or substances.

Within sixty (60) days after the receipt of such report, the Board of Directors shall either approve the report or set the matter down for hearing according to the notice provisions and procedure outlined in Rule 20.

RULE 10 - WELL LOCATION AND COMPLETION

(a) Responsibility

After an application for a well permit has been granted, the well, if drilled, must be drilled within **thirty (30) feet** of the location specified in the permit, and not elsewhere. If the well should be commenced or drilled at a different location, the drilling or operation of such well may be enjoined by the Board pursuant to Chapter 36, Texas Water Code.

All well drillers and persons having a well drilled, deepened, or otherwise altered shall adhere to the provisions of this Rule prescribing the location of wells and proper completion pursuant to Texas Civil Statutes, Article 7621e, titled the Water Well Drillers Act.

RULE 11- SPACING AND PRODUCTION REQUIREMENTS

(a) No well shall be drilled such that said well shall be located closer that one hundred (100) feet to the property line. Spacing of new wells from an existing well shall be one foot per one gallon per minute of production from the new well to maximum of one thousand (1000) gallons per minute. In addition to this maximum, a well producing over one thousand (1000) gallons per minute will be spaced one-half (1/2) foot per one gallon per minute of production in excess of one thousand gallons per minute from an existing well.

EXAMPLES

500	gpm=500 feet
750	gpm=750 feet
1000	gpm=1000 feet
1250	gpm=1125 feet
1500	gpm=1250 feet
1750	gpm=1375 feet

The board may grant exceptions to permit drilling within shorter distances than above described when the Board shall determine that such exceptions are necessary either to prevent waste or to prevent confiscation of property.

(b) For the purpose of preventing waste or confiscation of property, the Board reserves the right in particular subterranean water zones and/or reservoirs to enter special orders increasing or decreasing distances provided by this requirement.

(c) In applying this requirement, no subdivision of property subsequent to the adoption of the original spacing requirement will be considered in determining whether or not any property is being confiscated within the terms of such spacing requirement.

(d) A well or well system may only be permitted to be drilled and equipped for production of a cumulative total of ten (10) gallons per contiguous acre owned or operated.

(e) In no event may a well or well system be operated such that the total annual production exceeds eight (8) acre feet of water per acre owned or operated within the same Section.

RULE 12 - EXCEPTION TO SPACING AND PRODUCTION RULE

(a) In order to protect vested property rights, to prevent waste, or confiscation of property, the Board may grant exception to the above spacing and production rules. This rule shall not be construed so as to limit the power of the Board, and the powers stated are cumulative only of all other powers possessed by the Board.

(b) If an exception to the spacing or production rule is desired, the application shall be submitted by the applicant in writing to the District office on forms furnished by the District. The application shall be accompanied by a plat or sketch, drawn to scale of one (1) inch equaling two thousand (2000) feet. The plat or sketch shall show thereon the property lines in the immediate area and shall show accurately to scale the location of the three (3) nearest wells within one-half (1/2) mile of the proposed well location. The application shall also contain the names and addresses of all property owners adjoining the tract on which the well is to be located, within one-half (1/2) mile, and the owners of the three (3) nearest wells within one-half (1/2) mile of the proposed well location. Such application and plat shall be certified by some person actually acquainted with the facts who shall state that all the facts therein are true and correct.

(c) Hearing notices shall state that the application does not meet spacing requirements of the District, and an exception is requested by the applicant.

RULE 13 - REWORKING OR REPLACING OF WELL

(a) An existing well may be reworked, redrilled, or re-equipped in a manner that will not change the existing that such exceptions are necessary either prevent waste or to prevent confiscation of property.

(b) No person shall rework, redrill, or reequip a well in a manner that would increase the rate of production of such well as established by Rule 3 above without first having made an application to the Board, and having been granted a permit by the Board to do so; nor shall any person replace a well without a permit by the Board.

(c) The rate of production of a well shall not be hereafter changed to a larger capacity so as to increase the rate of production greater than 25,000 gallons per day of a well without a permit from the Board.

(d) In the event that application meets all requirements, the Board may grant such application without further notice.

RULE 14 - CHANGED CONDITIONS

The decision of the Board on any matter contained herein may be reconsidered by it of its own motion or upon motion showing changed conditions, or upon the discovery of new and different conditions or facts after the hearing or decision of such matter. If the Board should decide to reconsider a matter after having announced a ruling or decision, of after having finally granted or denied an application, it shall give notice to persons who were proper parties to the original action and such persons shall be entitled to a hearing thereon if they file a request therefor within fifteen days from the date of the mailing of such notice.

RULE 15 - FINAL ORDERS OF THE BOARD

The orders of the Board in any non-contested application of proceeding shall become the final order of the Board on the day it is entered by the Board. All orders of the Board in contested applications, appeals or other proceedings shall contain a statement that the same was contested. In such event the order will become final after fifteen (15) days from the entry thereof and be binding on the parties thereto unless a motion for rehearing is filed under Rule 17 hereof.

RULE 16 - RIGHT TO INSPECT AND TEST WELLS

Upon written approval by well owner, any authorized officer, employee, agent, or representative of the District shall have the right at all reasonable times to enter upon the lands which a well or wells may be located within the boundaries of the

District, to inspect such well or wells and to read, or interpret any meter, weir box or other instrument for the purpose of measuring production of water from said well or wells or for determining the pumping capacity of said well or wells; and any authorized officer, employee, agent, or representative of the District shall have the right at reasonable times to enter upon any land upon which a well or wells may be located within the boundaries of the District for the purposes of testing the pump and the power unit of the well or wells and of making any other reasonable and necessary inspections and tests that may be required or necessary for the information or enforcement of the rules and regulations of the District.

RULE 17 - AQUIFER STORAGE AND RECOVERY (ASR)

No ASR project may be operated within the District.

RULE 18 - OPEN WELLS TO BE CAPPED

Every owner or operator of any land within the District upon which is located any open or uncovered well is, and shall be, required to close or cap and seal the same **permanently** with a covering capable of sustaining weight of not less than **four hundred (400) pounds**, except when said well is in actual use by the owner or operator thereof; and no such owner or operator shall permit or allow any open or uncovered well to exist in violation of this requirement. Officers, agents and employees of the District are authorized to serve or cause to be served written notice upon any owner or operator of a well in violation of this rule, thereby requesting such owner and/or operator to close or cap such well permanently with a covering in compliance herewith. In the event any owner or operator fails to comply with such request within **ten (10) days** after such written notice, any officer, agent, or employee of the District may go upon said land and close or cap said well in a manner complying with this rule and all expenditures thereby incurred shall constitute a lien upon the land where such well is located, provided, however, no such lien shall exceed **$500** for any single closing. Any officer, agent, or employee of the District, is authorized to perfect said lien by filing of the affidavit by the Texas Water Code as amended. All of the powers and authority granted in such section are hereby adopted by the District, and its officers, agents, and employees are hereby bestowed with all of such powers and authority.

RULE 19 - RULES GOVERNING PROTESTS

(a) **NOTICE OF PROTEST.** In the event anyone should desire to protest or oppose any pending matter before the Board, a written notice of protest or opposition shall be filed with the Board on or before the date on which such application or matter has been set for hearing. For the convenience of the Board, it is urgent that protests be filed at least **five (5) days** before the hearing date.

(b) **PROTEST REQUIREMENTS:** Protests shall be submitted in writing with a duplicate copy to the opposite parties and shall comply in substance with the following requirements:

(1) Each protest shall show the name and address of the protestant and show that protestant had read either the application or a notice relative thereto published by the Board.

(2) There shall be an allegation of injury to protestant which will result from the proposed action or matter to be considered by the Board.

(3) If the protest is based upon claim of interference with some present right of protestant, it shall include a statement of the basis of protestant's claim of right.

(4) Protestant should call attention to any amendment of the application or adjustment which, if made, would result in withdrawal of the protest.

(c) **CONTESTED APPLICATIONS OR PROCEEDINGS DEFINED:** An application, appeal, motion, or proceeding before the Board is considered contested when either protestants or intervenor, or both, files the notice of protest as above set out and appears at the hearing held on the application, motion or proceeding and present testimony of evidence in support of their contentions, or present a question or questions of law with regard to the application, motion or proceedings. Where neither protestants nor intervenors so appear and offer testimony or evidence in support of their contentions, or raise a question of law with reference to any pending application, motion or proceeding, the same shall be considered as non-contested.

(d) In the event of a contested hearing, each party shall furnish other parties to the proceeding with a copy of all motions, amendments or briefs filed by him with the Board.

RULE 20 - GENERAL RULES OF PROCEDURE FOR HEARING

(a) **HEARINGS.** Hearings will be conducted in such a manner as the Board deems most suitable to the particular case, and technical rules of legal and court procedure need not be applied. It is the purpose of the Board to obtain all the relevant information and testimony pertaining to the issue before it as conveniently, inexpensively and expeditiously as possible without prejudicing the rights of either applicants or protestants.

(b) **WHO MAY APPEAR:** Any party-at-interest in a proceeding may appear either in person or by attorney or both in such proceedings. At the discretion of the Board, anyone not a party at interest in a proceeding may appear.

(c) **ADMISSIBILITY:** Evidence will be admitted if it is of that quality upon which reasonable persons are accustomed to rely in the conduct of serious affairs. It is intended that needful and proper evidence shall be conveniently, inexpensively, and speedily produced while preserving the substantial rights of the parties to the proceedings.

(d) **TESTIMONY SHALL BE PERTINENT:** The testimony shall be confined to the subject matter contained in the application or contest. In the event that any party at a hearing shall pursue a line of testimony or interrogation of a witness that is clearly irrelevant, incompetent or immaterial, the person conducting the hearing may forthwith terminate such line of interrogation.

(e) **A STIPULATION:** Evidence may be stipulated by agreement of all parties at interest.

(f) **LIMITING NUMBER OF WITNESSES:** The right is reserved to the Board in any proceeding to limit the number of witnesses appearing whose testimony may be merely cumulative.

RULE 21 - REHEARING

(a) Any person whose application is denied, whose contest is overruled, or who is not granted the relief desired, may file with the Board a motion for rehearing within **fifteen (15) days** from the announcement by the Board of its decision or action. The Board shall act thereon within a reasonable time. If such a motion for rehearing is filed and is overruled, the order of the Board shall be final on the date the motion is overruled.

(b) The Board may, in a proper case, find that an emergency exists and that substantial injustice will result from delay. In that event, and upon recitation of such finding, the order of the Board will become final on the date of the announcement of the order by the Board, and no motion for rehearing will be considered thereon.

(c) If an application or contest is denied by the Board, and if the applicant or contestant shall not have had and shall not have been afforded an opportunity for a hearing before the Board, as elsewhere provided by the rules, the applicant or contestant shall be entitled to a hearing before the Board. A written request to the Board for such a hearing, stating such facts, must be filed with the Board within the above fifteen (15) day period. If such motion is in order and is duly filed, the Board shall give notice to the applicant and all proper and necessary parties of the time and place of such hearing, and shall proceed to conduct such a hearing.

RULE 22 - TRANSPORTATION OF WATER FROM THE DISTRICT

(1) Every person must obtain a permit from the District for the transporting of water by pipeline, channel, ditch, water-course or other natural or artificial facilities, or any combination of such facilities, if such water is produced from wells located, or to be located, within the District, and if all or any part of such water is used, or is intended for use, outside of the boundaries of the District. However, the requirement for a permit hereunder shall not apply to any well currently in operation located within the District prior to the effective date of this Rule.

(a) The permit provided for herein must be applied for and filed with the District in the form or forms promulgated by the District hereunder and such permit must be obtained from the District Prior to the proposed transporting of water, all in accordance with the provisions of this rule.

(b) An application for the transportation of water for which a permit is required under this Rule must:

(1) be in writing and sworn to;

(2) contain the name, post-office address and place of residence or principal office of the applicant;

(3) identify the location of the well from which the water to be transported is produced or to be produced;

(4) describe specifically the proposed transportation facilities;

(5) state the nature and purposes of the proposed use and the amount of water to be used for each purpose;

(6) state the time within which the proposed construction or alteration is to begin;

(7) state the length of time required for the proposed use of water, and the amount of water to be used;

(8) provide information showing the effect of the proposed transportation on the quantity and quality of water available within the District;

(9) identify any other possible sources which could be used for the state purposes, including quality and quantity of such alternate sources;

(10) identify any other liquids that could be

substituted for the fresh ground water and possible sources of such liquid including quantity and quality;

(11) transportation of water from the District requires a permit as stated in the district rules. The District shall assess fees of one dollar ($1.00) per acre foot for water used in agriculture, and seventeen cents ($0.17) per thousand (1000) gallons for all other uses, as chapter 36 of the Texas Water Code. Fees are due the first of each month, and are to be included with the monthly-pumping report.

(c) The application must be accompanied by a map or plat drawn to a scale not less than one inch equals 4,000 feet, showing substantially:

(1) the location of the existing or proposed well; and

(2) the location of the proposed or increased use or uses.

(d) The application must be accompanied by an application fee in the amount of $10,000.00.

(e) The District shall determine whether the application, maps, and other materials comply with the requirements of this Act. The District may require amendment of the application, maps, or other materials to achieve necessary compliance.

(f) The District shall conduct a public hearing on each application within ninety (90) days of the filing of the complete application.

(g) The District shall give notice of the public hearing on the application as prescribed by this Rule, stating:

(1) the name and address of the applicant;

(2) the date the application was filed;

(3) the location and purpose of the well from which the water to be transported is produced or to be produced;

(4) the time and place of the hearing; and

(5) any additional information the District considers necessary.

(h) At the time and place stated in the notice, the District shall hold a public hearing on the application. The hearing may be held in conjunction with any regular or special meeting of the District or a special meeting may be called for the purpose of holding a hearing. Any person may appear at the hearing, in person or by attorney, or may enter his appearance in writing. Any person who appears may present objections to the issuance of the permit. The District may receive evidence, orally or by affidavit, in support or in opposition to the issuance of the permit, and it may hear arguments.

(i) After the hearing, the District shall make a written decision granting or denying the application. The application may be granted in whole or in part. Any decision to grant a permit, in whole or in part, shall require a majority vote of Directors present.

(j) Such application shall not be approved unless the Board of Directors finds and determines that the transporting of water for use outside the District applied for will not substantially affect the quantity and quality of water available to any person or property within the District; that all other feasible sources of water available to the person requesting a permit have been developed and used to the fullest; that no other liquid could be feasibly substituted for the use of fresh groundwater; and that the proposed use, or any part of the proposed use, will not constitute waste as defined under the laws of the State of Texas. In evaluating the application, the District shall consider the quantity of water proposed to be transported; the term for which transporting is requested; the safety of the proposed transportation facilities with respect to the contamination of the aquifer; the nature of the proposed use; the effect of the proposed use of the water to be transported on District residents, taking into account all beneficial use of District residents, including municipal, agricultural, industrial, recreational and other categories; and such other factors as are consistent with the purposes of the District.

(k) On approval of an application, the District shall issue a permit to the applicant. The applicant's right to transport shall be limited to the extent and purposes stated in the permit. A permit shall not be transferable except as provided in Paragraph (o).

(l) The permit shall be in writing and attested by the seal of the District and it shall contain substantially the following information:

(1) the name of the person whom the permit is issued;

(2) the date the permit is issued;

(3) the term for which the permit is issued;

(4) the date the original application was filed;

(5) the destination and use or purpose for which the water is to be transported;

(6) the maximum quantity of water to be transported annually;

(7) any other information the District prescribes.

(m) The permittee shall file with the District quarterly reports describing the amount of water transported and used for the permitted purpose. Such report shall be filed on the appropriate form or forms provided by the District within ten (10) days of the March 31, June 30, September 30, and December 31 next following the commencement of transporting of water, and within ten (10) days of each such quarterly date thereafter.

(n) All transporting facilities for wells subject to the requirements of this Subsection shall be equipped with flow monitoring devices approved by the District and available for District inspection at any time.

(o) A permittee may apply for an extension of any permit granted under this Subsection, or for transfer of a permit to another person. The District shall consider and grant or deny such application for extension or transfer or a permit in the same manner as is provided herein for the application for a permit.

(p) Any permit granted under this Subsection shall be subject to revocation for nonuse or waste by the permittee, or for substantial deviation from the purposes or other terms stated in the permit. Revocation of a permit for nonuse shall require that no water is transported under the permit for a period of five years.

(2) Any person transporting water produced from wells located within the District for use outside of the District, regardless of the amount of water so transported, must register such transporting with the District. Such registration shall be made within one hundred eighty (180) days after the effective date of this Rule.

(a) Any person subject to the requirements of this Subsection (2) shall file with the District quarterly reports describing the amount of water transported, the destination and use of such water. Such report shall be filed on the appropriate form or forms provided by the District within ten (10) days of the March 31, June 30, September 30, and December 31 next following the commencement of transporting of water and within ten (10) days of each such quarterly date thereafter.

(b) All transporting facilities for wells subject to the requirements of this Subsection shall be equipped with flow monitoring devices approved by the District and available for District inspection at any time.

RULE 23 - REQUEST FOR INJUNCTIVE RELIEF AND ASSESSMENT OF PENALTIES

If it appears that a person has violated, is violating, or is threatening to violate any provision of the District Act or any Board order, rule or permit, the Board may authorize the General Manager to institute and conduct a suit in the name of the District for injunctive relief, or to recover a civil penalty of up to five thousand dollars (5,000) for each violation, or for both injunctive relief and civil penalties.

RULE 24 - GENERAL RULES

(a) **COMPUTING TIME:** In computing any period of time prescribed or allowed by these rules, by order of the Board, or by any applicable statute, the day of the act, event or default from which the designated period of time begins to run, is not to be included, but the last day of the period so computed is to be included, unless it be a Sunday or legal holiday, in which event the period runs until the end of the next day which is neither a Sunday or a legal holiday.

(b) **TIME LIMIT:** Applications, requests, or other paper or documents required or permitted to be filed under these rules or by law must be received for filing at the Board's offices at George West, Texas, within the time limit, if any, for such filing. The date of receipt and not the date of posting is determinative.

(c) **SHOW CAUSE ORDERS AND COMPLAINTS:** The Board, either on its own motion or upon receipt of sufficient written protest or complaint, may at any time, after due notice to all interested parties, cite any person operating within the District to appear before it in a public hearing and require him to show cause why operating authority or permit should not be suspended, canceled, or otherwise restricted and limited, for failure to comply with the orders or rules of the board or the relevant of the State, or for failure to abide by the terms and provisions of the permit or operating authority itself. The matter of evidence and all other matters of procedure at any such hearing will be conducted in accordance with these rules of procedures and practice.

REPEAL OF PRIOR REGULATIONS

All of the previous rules and regulations of the District have been revised and amended; and except as they are herein republished, they are repealed. Any previous rule or regulation which conflicts with, or is contrary to, these rules is hereby repealed.

SAVINGS CLAUSE

If any section, sentence, paragraph, clause, or part of these rules and regulations should be held or declared invalid for any reason by a final judgment of the courts of this state or of the United States, such decision or holding shall not affect the validity of the remaining portions of these rules; and the Board does hereby declare that it would have adopted and promulgated such remaining portions of such rules irrespective of the fact that any other sentence, section, paragraph, clause, or part thereof may be declared invalid.

BY-LAWS OF THE
LIVE OAK UNDERGROUND
WATER CONSERVATION DISTRICT

In accordance with the Legislative act, S.B. 1777, Article XVI, Section 59, of the Texas Constitution and Chapters 50 and 52 of the Texas Water Code, Vernon's Civil Statutes of Texas, the following on the 12TH day of Feb., 1991, as amended on July 12, 2000, were ratified and adopted for guides to be used with discretion and were adopted for the purpose of simplifying procedures and facilitating the administration of the District.

ESTABLISHMENT OF THE DISTRICT

Definitions:

The Board shall mean the Board of Directors of the Live Oak Underground Water Conservation District consisting of five (5) duly elected members, one from each of the four county precincts and one at-large.

The District shall mean the Live Oak Underground Water Conservation District maintaining its office in George West, Texas; where registrations, reports, and other papers are required to be filed with or sent to the District. The district includes Live Oak County in its entirety.

Water shall mean underground water.

Owner shall mean and include any person, firm, partnership or corporation that has the right to produce water from the land either by ownership, contract, lease, easement, or any other estate in the land.

Person shall mean any individual, partnership, firm or corporation.

The word Waste as used shall have the same meaning as defined by the Legislature and the Texas Water Code.

REQUIREMENTS FOR THE BOARD AND PROCEDURES FOR MEETINGS

Candidates:

A person is qualified to serve on the board who has filed an application with the secretary of the board. It must be signed by the applicant or by at least 10 qualified electors of the District, and filed 20 days prior to the election. They must be at least 18 years of age; own land subject to taxation in the District; and is a resident of the county. All procedures for holding the election shall be in accordance with the Texas Election Code Article 6.02 and the act creating the District.

Elections:

Shall be held in even numbered years on one of the uniform election dates (Third Saturday in January, First Saturday in May, Second Saturday in August, or the First Tuesday after the first Monday in November) of the second year after the year in which the District is authorized to be created at a confirmation election, an election shall be held in the district for the election of two directors who shall each serve two-year terms and three directors who shall each serve four-year terms. Thereafter, on the same date in each subsequent second year, the appropriate number of directors shall be elected to the board.

Meetings:

The Board shall hold quarterly meetings on the 2nd Thursday of month or it may hold other meetings at call of the chairman or at the request of at least two (2) of the directors.

-a quorum is the majority of the Directors.
-the Board may elect its own officers yearly.
-meetings will be held in the District's office.
-the Board will follow the Roberts Rules of Parliamentary Procedures.
-the Board may also act as a hearing Board concerning any disputes concerning the Rules and operations of the District.

Board of Directors:

(a) The District is governed by a board of directors composed of five members. Each director shall occupy a designated place on the board with the places to be designated as Places 1, 2, 3, 4, and At Large Respectively.

(b) Except for the initial regular directors each regular director shall serve for a term of four years or until his successor is appointed.

(c) To be qualified for election as a director, a person must be at least 18 years old and be a resident of the district and the precinct.

(d) Directors serve a staggered four year term.

(e) A person serving as director is eligible for reelection.

(f) A vacancy on the board shall be filled by appointment of the board for the unexpired term.

(g) The Biannual election for Director shall be the designated date established by law or even numbered years.

(h) As soon as practicable after a director is elected or appointed, that director shall make the sworn statement prescribed by the constitution for public office.

(i) As soon as practicable after a director has made the sworn statement, and before beginning to perform duties of office, that director shall take the oath of office prescribed by the constitution for public officers.

(j) Before beginning to perform the duties of office, each director shall execute a bond for $10,000 payable to the District and conditioned on the faithful performance of that director's duties. All bonds of the directors shall be approved by the board and paid for by the District.

(k) The sworn statement, bond, and oath shall be filed with the District and retained in its records. A duplicate original of the sworn statement and the oath shall also be filed with the Secretary of State within 10 days after their execution and need not be filed before the new director begins to perform the duties of office.

Board Organization:

(a) The board shall elect one director as president of the board, who shall serve for a term of one year. The president shall preside at meetings of the board and shall perform other duties prescribed by the board.

(b) The board shall elect another director as vice-president or the board, who shall serve for a term of one year. The vice-president shall perform the duties of the president when the president is not present or is otherwise incapacitated.

(c) The board shall elect a secretary of the board. The secretary is the official custodian of the minutes, books, records, and seal of the board and shall perform other duties and functions prescribed by the board. The board also shall elect a treasure of the board who shall perform duties and functions prescribed by the board. The offices of secretary and treasurer may be held by one person, and the holder of either office or both offices is not required to be a director. The board may appoint one or more persons who are not directors to be an assistant secretary of the board, and the assistant secretary may perform any duty or function of the secretary of the board, and should be bonded.

(d) Any three regular directors constitute a quorum, and all regular directors are entitled to vote on matters before the board. The district shall act and proceed by and through resolutions adopted by the board, and the affirmation vote of at least three of the regular directors is necessary to adopt any resolution.

(e) The board shall have regular meetings at times specified by resolution of the board, and shall have special meetings whenever called by the president or any three directors.

Code Of Ethics

(a) It shall be the policy of the district that all directors and employees conduct district business in conformity with sound business and ethical practices which will bring continuing respect to the district, and will avoid any questionable conduct that could bring discredit to the district or present even the appearance of conflict of interest.

(b) A board member who is financially interested in a contract to be executed by the district for the purchase, sale, lease, renting, or supplying of property shall disclose that fact to the other directors and may not vote on or participate in discussions during board meetings on the acceptance of the contract.

(c) A board member shall not seek, offer or accept in any fashion benefits or gratuities in any form that could be construed as to cause influence in the exercise of official duties of the district.

(d) No board member shall use his position to secure a special privilege or exemption for himself or others.

POWERS AND DUTIES OF THE DISTRICT

The District has all of the rights, powers, privileges, authority, functions, and duties provided by the general law of this state, including Chapters 35 and 36, Water Code, applicable to underground water conservation districts created under Article XVI, Section 59, of the Texas Constitution. This act prevails over any provision of general law that is in conflict or inconsistent with this Act. Including authority to:

(1) Make and enforce rules to provide for conserving, preserving, protecting, recharging, and preventing waste of the water from the underground water reservoirs that may be enforced by injunction, mandatory injunction, or other appropriate remedies in a court of competent jurisdiction, or;

(2) require permits for the drilling, equipping and completion of wells in the underground water reservoirs and issue permits subject to terms and provisions with reference to the drilling, equipping, and completion of the wells as may be necessary to prevent waste or conserve, preserve and protect underground water;

(3) provide for the spacing of wells producing from the underground water reservoirs and regulate the production from those wells to minimize as far as practicable the drawdown of the water table or the reduction of the artisan pressure, provided, the owner of the land, his heirs, assigns, and lessees are not denied a permit to drill a well on their land and the right to produce underground water form that well subject to rules adopted under this act;

(4) require records to be kept and reports to be made of the drilling, equipping, and completion of wells into any underground water reservoir and the taking and use of underground water from those reservoirs and require accurate driller's logs to be kept of those wells and a

copy of those logs and of any electric logs that may be made of the wells to be file with the District;

(5) acquire land for the erection of dams and for the purpose of draining lakes, draws and depressions, and construct dams, drain lakes depressions, draws, and creeks and install pumps and other equipment necessary to recharge any underground water reservoirs;

(6) have made by registered professional engineers surveys of the underground water of any underground water reservoir and of the facilities for the development, production and use of the underground water, determine the quantity of the underground water available for production and use and the improvements, developments and recharges needed for those underground water reservoirs;

(7) develop comprehensive plans for the most efficient use of the underground water of any underground water reservoir and for the control and prevention of waste that underground water, with the plans to specify in the amount of detail that may be practicable the acts, procedures, performance, and avoidance that are or may be necessary to effect those plans, including specifications;

(8) carry out research projects, develop information, and determine limitations, if any, that should be made on the withdrawal of underground water from any underground water reservoir;

(9) collect and preserve information regarding the use of the underground water and the practicability of recharge of any underground water reservoir;

(10) publish plans and information. Bringing them to the notice and attention of the users of the underground water within the District, and encourage their adoption and execution;

(11) contract for, sell and distribute water from a water import authority, or other agency.

(12) contract with other districts with powers similar to those of the district to achieve common goals.

POLICIES

(a) Subject to the la governing the district, the board shall adopt the following in writing:
   (1) a code of ethics for district directors, officers, employed, and persons who are engaged in handling investments for the district;
   (2) a policy relating to travel expenditures;
   (3) a policy relating to district investments that ensures that:
      (A) purchases and sales of investments are initiated by authorized individuals, conform to investment objectives and regulations, and are properly documented and approved; and
      (B) periodic review is made of district investments to evaluate investment performance and security;
   (4) policies and procedures for selection, monitoring, or review and evaluation of professional services;
   (5) policies that ensure a better use of management information, including:
      (A) budgets for use in planning and controlling cost;
      (B) an audit or finance committee of the board, and
      (C) uniform reporting requirements that use "Audits of State and Local Governmental Units" as a guide on audit working papers and that uses "Governmental Accounting and Financial Reporting Standards."

(b) The state auditor may audit the financial transactions of any district if the state auditor determines that the audit is necessary.

ADMINISTRATIVE PROCEDURES

Travel

The districts board or personnel sometimes attend formally scheduled and advance-planned meetings, conferences, symposia, seminars, and short training courses. Such meetings must deal with subjects of interest to the district and have a beneficial effect on the general knowledge or working ability of the board member or employee.

Board members or employees may be reimbursed for their reasonable actual expenses and any other fees or reimbursable expenses associated with such travel.

Board members or employees must submit a claim for reimbursement, supported with documentation, to the board for approval at the following regularly scheduled board meeting.

Administrator and Employees:

The Board may employ a manager and set his/her salary. The Board may delegate any of its powers and duties (Except those of adopting rules, a dissolution resolution, a dissolution order, and those relating to hearings, taxation and bonds) to the manager who may carry out the powers and duties delegated to him/her by the Board. Employment of personnel is subject to the general law of nepotism. The manager with the approval of the Board may employ employees of the Board and set their salaries and hire legal counsel for the Board.

The manager shall with the approval of the Board develop a plan for the District, act as official liaison for the Board between the public and governmental agencies, and prepare budgets.

The manager's position shall be reviewed yearly at the beginning of the Fiscal Year.

Investments and Fund Management

The board shall designate one or more banks inside the district to serve as depository for the funds of the district. All money of the district shall be deposited in the designated bank or

banks.
To the extent that funds are not insured by the Federal Deposit Insurance Corporation, they shall be secured in the manner provided by law for the security of county funds.

The districts money may be dispersed only by check, draft order, or other instrument signed by two persons authorized to do so. Authorization to sign district checks is granted to the President, Vice-President, Secretary Treasurer, and Executive Director. All funds dispersed must be approved by the board of directors.

Any contract other than for technical, legal, scientific, or other professional service which will require an expenditure of more than $10,000, or is for a term of six months or more, shall be awarded to the lowest and best bidder. In the event of a catastrophe or calamity of any kind, the district may let contracts necessary to protect and preserve the public health and welfare or the properties of the district without using the bidding procedures.

The Treasurer shall be the chief financial officer and the investment officer.

The board shall insure that the districts investments shall be made with judgment and care, under prevailing circumstances, that a person of prudence, discretion, and intelligence would exercise in the management of the person's own affairs, not for speculation, but for investment, considering the probable safety of capital and the probable income to be derived.

Investment of funds shall be governed by the following investment objectives, in order of priority;
(a) Preservation and safety of principal
(b) Liquidity
(c) Yield

The board may from time to time establish special accounts which have been approved in the budget, to be used by the executive director without prior board approval to hire qualified consultants on quick notice, on any activity which he feels could jeopardize the quality of groundwater in the district. Funds are to be used to gather information only and are not to be used to pursue litigation without prior board approval.

Professional Services Policy

The district may from time to time contract for professional services. The district shall make the selection based on (1) demonstrated competence and qualifications to perform the services, and (2) for a fair and reasonable price. The professional fees under the contract must be consistent with and not higher than the recommended practices and fees published by the applicable professional associations and may not exceed any maximum provided by law.

In procuring architectural or engineering services, the district shall first select the most highly qualified provider of those services on the basis of demonstrated competence and qualification, and then attempt to negotiate a contract at a fair and reasonable price. If a contract cannot be negotiated with the most highly qualified provider, the district will end negotiations, select the second most highly qualified provider, and attempt to negotiate a contract with that provider at a fair and reasonable price. The district shall continue the process until a contract is entered into.

Administrator and Employees:

The Board may employ a manager and set his/her salary. The Board may delegate any of its powers and duties (Except those of adopting rules, a dissolution resolution, a dissolution order, and those relating to hearings, taxation and bonds) to the manager who may carry out the powers and duties delegated to him/her by the Board. Employment of personnel is subject to the general law of nepotism. The manager with the approval of the Board may employ employees of the Board and set their salaries and hire legal counsel for the Board.

The manager shall with the approval of the Board develop a management plan for the District as outlined in Chapter 36 Section 1071 of the Texas Water Code, act as official liaison for the Board between the public and governmental agencies, and prepare budgets.

The manager's position shall be reviewed yearly at the beginning of the Fiscal Year.

TAXATION AND BONDS

The tax and bond provisions of Chapter 35 and 36 of the Water Code as amended apply to the District.

The Board may levy and collect property taxes levied on the property in the District that are necessary to enable the Board to perform the powers and functions given it in the Act.

TAX EXEMPTIONS

The District is not required to pay any tax or assessment on it facilities or any part of its facilities, and the bonds issued under this Act and their transfer and the income from these bonds, including the profits made on the sale of those bonds, are exempt from taxation in this state. The standard county exemptions will be used for local tax purposes.

TAX PROCEDURES

The Live Oak County tax roll as prepared by the Live Oak County Appraisal District constitutes the tax rolls of the district.

The district shall enter into a contract with Live Oak County for the collection of property taxes for the district.

The Live Oak County Appraisal Board Chief may serve as an advisor to the district, without remuneration, for the preparation of the district's budget and the preparation and levying of the district's property taxes.

The board may levy annual taxes not to exceed five (.05) cents on the 100 dollar valuation of all taxable property within the district.

Money of the District shall be deposited in an insured account chosen by the Directors and must be signed by two directors so designated by the board.

ANNEXATION

Additional territory may be added to the District by petition of the landowner under Chapter 35 and 36 of the Texas Water Code, as amended.

AMENDMENT TO BY-LAWS

These by-laws may be altered or amended or the same may be repealed by new by-laws adopted at any regular or special meeting of the Board of Directors of the District, provided that no such action shall be taken at a regular or special meeting unless a copy of proposed new by-laws is submitted in writing to each of the Directors of the District with notice of such meeting, at least ten (10) days before such meeting. No such alterations, amendment or repeal of the by-laws or the adoption of new by-laws shall be valid unless the same shall be by the affirmative vote of at least a majority of all of the Directors of the District.

DISSOLUTION OF THE DISTRICT

Chapter 36 of the Texas Water Code, as amended, applies to dissolution of the District.

RESOLUTION ADOPTING RULES OF THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT

WHEREAS, The Rules of the Live Oak Underground Water Conservation District, attached hereto as Attachment A, have been developed for the purpose of conserving, preserving, protecting and recharging that underground water in the District, and this action is taken under the District's statutory authority to prevent waste and protect the rights of owners of interest in groundwater;

WHEREAS, In accordance with Section 59, Article 16 of the Constitution of the State of Texas, and in accordance with the Live Oak Underground water Conservation District Act, 71st Leg, 1967 Tex. Gen. Laws 1676(Vernon): Act of May 30, 1983, 68th Leg, ch.484, 1983 Tex. Gen. Laws 2852(Vernon); and the Act of May 17, 1985, 69th Leg, R.S., ch. 438, 1985 Tex. Gen. Laws 2984(Vernon); the following rules are hereby ratified and adopted as the rules of Live Oak Underground Water Conservation District by its Board of Directors;

WHEREAS, the rules, regulations and modes of procedure contained are adopted for the purpose of simplifying procedure, avoiding delays, saving expense and facilitation the administration of this District and these rules shall be so construed; and

WHEREAS, Under no circumstances, and in no particular case will these Rules, or any part of them, be construed as a limitation or restriction upon the exercise of any discretion, where such exists; nor may they in any event be construed to deprive the Board of an exercise of powers, duties and jurisdiction conferred by law, nor to limit or restrict the amount and character of data or information which may be required for the proper administration of the law.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT THAT:

1) The "Rules of the Live Oak Underground Water Conservation District" contained in attachment A are hereby adopted.

2) All prior rules are hereby replaced.

3) The General Manager is hereby authorized to take any all action necessary to implement this resolution.

4) These rules take effect June 11, 1998.

AND IT IS SO ORDERED

PASSED AND ADOPTED ON THIS 12th DAY OF JulY,2000

Scott Bledsoe III
President

Attest to

Lonnie Stewart
Secretary - Treasurer

Appendix K.4

Live Oak Underground Water Conservation District Management Plan

Mr. Kevin Ward
Executive Administrator
Texas Water Development Board
1700 N Congress
Austin, Texas 78711-3231

Dear Mr. Ward,

The Live Oak Underground Water Conservation District (LOUWCD) is pleased to submit to the Texas Water Development Board (TWDB) a copy of our amended and adopted Management Plan in accordance with chapter 36.1073 as mandated by Senate Bill 1 of the 75 Texas Legislature. The Live Oak Underground Water Conservation District Management Plan (LOUWCD MP) was adopted by the LOUWCD Board of Directors at their quarterly meeting on June 11, 1998, by unanimous consent. In addition, a certified copy of the LOUWCD Board of Directors resolution adopting the plan is also attached. This plan was revised at the regular meeting of the LOUWCD July 26,2005, by unanimous vote of all directors.

The LOUWCD, established in 1991, has historically had an excellent working

relationship with the TWDB and it is our hope that we can count on your support as we

implement the enclosed plan, it is the intent of our Board of Directors that we will begin implementation of this plan immediately to facilitate the success of our efforts.

The LOUWCD MP was developed during open meetings of the Board of Directors in accordance with all notice and hearing requirements stated in the District's

procedures. Documentation that notice and hearing requirements were followed

is presented in a separate attachment. The following cross-references are

provided as a means of documenting the completeness of our Management Plan

as applicable to the statutory requirements of Senate Bill 1 and TAC Chapter 356.

During preparation of the LOUWCD Management Plan, (LOUWCD MP) all planning efforts were coordinated with the Nueces River Authority, as mandated by

36.1071 (a) and TAC 356.6(a)(4). Documentation of this coordinated effort,

including the resolution acknowledging this coordination, is included in this packet for your review. 36.1071(a)(1) is addressed in LOUWCD MP Section 2.0.

36.1071(a)(2) is addressed in LOUWCD MP Section 1.0.

36.1071(a)(3) Is addressed in LOUWCD Section titled SB-1 Management Goals
Determined Not-Applicable 1.0

36.1071(a)(4) is addressed in LOUWCD MP Section 4.0.
36.1071(a)(5) is addressed in LOUWCD MP Section titled SB-1 Management Goals

Determined Not Applicable 2.0

The requirement of 36.1071(e)(1) is met by the submission of the LOUWCD MP to the TWDB.
36.1071(e)(2) is addressed in LOUWCD Section 3.0.
36.1071(a)(6) is addressed in LOUWCD MP Section 4.0
36.1071(a)(7) is addressed in LOUWCD MP Section 5.0
36.1071(e)(3)(A) is addressed in LOUWCD MP Section titled Topography, Drainage and Groundwater Resources of Live Oak County.
36.1071(e)(3)(B) is addressed in LOUWCD MP Section titled Projected Water Supplies in Live Oak County
36.1071(e)(3)© is addressed in LOUWCD MP Section titled Projected Demands for Water in Live Oak County and in LOUWCD MP Section 3.0.
36.1071(e)(3)(D) is addressed in LOUWCD MP Section titled Projected Demands for Water in Live Oak County.
36.1071(e)(4) is addressed in LOUWCD MP Section titled Potential Demand and Supply Issues and Solutions.

Recently we provided your staff with a copy of our District Rules. In accordance with the requirements of 36.1071(f) we are attaching an additional copy of the District Rules in a separate enclosure. These District Rules were adopted by the LOUWCD Board of Directors at the regularly scheduled meeting on July 1, 1997, and will be used during the implementation of the LOUWCD MP.

36.1071(g) and TAC 356.6(a)(5) will not be applicable at this time, but will be addressed in five years in 2010 when the LOUWCD MP must be recertified.

The LOUWCD MP will be in force for 10 years from the date of certification. If there is any other documentation we can provide to the TWDB that will ensure the prompt certification of the Live Oak Underground Water Conservation District Management Plan, please do not hesitate to call me or my staff. I look forward to working with you and your staff throughout the implementation of the various elements of Senate Bill 1 and Senate Bill 2.

Sincerely,

Scott Bledsoe III, President

DISTRICT MISSION

The Live Oak Underground Water Conservation District will strive to develop, promote, and implement water conservation, augmentation, and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the district.

TIME PERIOD FOR THIS PLAN

This plan becomes effective upon certification by the Texas Water Development Board and remains in effect until a revised plan is certified or ten years, which ever is earlier.

STATEMENT OF GUIDING PRINCIPLES

The district recognizes that the groundwater resources of the region are of vital importance. The preservation of this most valuable resource can be managed in a prudent and cost effective manner through regulation and permitting. This management document is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of district activities.

General Description

The District was created by the citizens of Live Oak County through election, November,1991. The current Board of Directors are Scott Bledsoe III - Chairman, Mark Katzfey - Vice-Chairman, Lonnie Stewart - Secretary and Treasurer, Edward Pawlik , and C.F. Horton, Live Oak Underground Water Conservation District (LOUWCD) has the same areal extent as that of Live Oak County. The county has a vibrant economy dominated by agriculture and petroleum. The agriculture income is derived primarily from beef cattle production, wheat, corn, sorghum, and cotton, with some sheep and goat ranching.

Location and Extent

Live Oak County, consisting of 1,072 square miles, is located in South Texas. The county is bounded on the east by Bee, San Patricio, and Karnes counties, on the north by Atascosa county, on the west by McMullen County, and on the south by Jim Wells County. George West, which is centrally located in the county, is the county seat. Three Rivers, the only other municipality in the county, is located in the northern portion of the county.

Topography , Drainage and Groundwater Resources of Live Oak County

Live Oak County is on the Gulf Coastal Plain in southern Texas. Most the 1,072 square miles of the county are devoted to farming and ranching which provide the principal income for the 9,000 inhabitants. The production of oil is also an important industry.

The principal water-bearing formations underlying the county are the Carrizo sand, Oakville sandstone, Lagarto clay, and Goliad sand, and range in age from Eocene to Pliocene. The formation dip toward the coast at rates ranging from less than 20 to about 140 feet to the mile.

About 2,150,000 gallons per day of ground water was withdrawn in 1957 from approximately 1,000 wells in the county. Some irrigation, municipal, and stock supplies were obtained from surface-water sources. In Live Oak County the water-bearing sands above a depth of 2,000 feet contain approximately 20 million acre-feet of fresh and slightly saline water. Even though it may be impractical to recover much of the stored water, the rate of withdrawal could be increased several times more than the 1957 rate without appreciably depleting the water available from storage for many decades. A large but unestimated amount of fresh to slightly saline water occurs in the Carrizo sand in the northern and northwestern parts of the county at depths as much as 6,000 feet. Most of the water in the Carrizo sand in Live Oak County is more than 4,000 feet below land surface and therefore is too deeply buried to be economically developed for most uses.

Most of the ground water in Live Oak County is substandard in quality for municipal, industrial, and irrigation uses. However, because better water is not available in most areas in the county, substandard water has been used successfully by users of all three categories. Generally the Goliad sand contains water of better quality than that in any formation except the Carrizo sand. In favorable areas properly constructed wells in the Carrizo, Oakville, Lagarto, and Goliad may yield 1,000 gallons per minute or more. Yields from wells tapping the other water-bearing formations generally are small and the water commonly is suitable only for stock.

Most of Live Oak County is rolling to moderately hilly, although some areas are nearly flat. The altitude ranges from about 460 feet in the southwestern part of the county to about 90 feet near Lake Corpus Christi. The county is drained by the Nueces River and its tributaries, the Frio and Atascosa Rivers, with the exception of a small, elongated area near the Bee County line which is drained by tributaries of the Aransas River.

The water-bearing formations in Live Oak County are continually recharged by the infiltration of a small part of the precipitation, which falls on the more permeable strata.

However, most of the precipitation that falls in the county runs off in steams, evaporates, or is transpired by plants. The remaining water, probably less than five percent, may reach the zone of saturation where it moves slowly toward an area of discharge such as a well, natural outlet, or, under artesian pressure, it may seep or percolate slowly upward into overlying beds. Recharge could be enhanced by several methods: brush control, additional precipitation, and additional tanks to catch runoff from excessive precipitation.

GAM runs for Live Oak County
All numbers are in Acre-Feet

Aquifer	2010 X-Flow in	2010 X-Flow out	2010 Recharge	2020 X-Flow in	2020 X-Flow out	2020 Recharge
Chicot	198	-271	1355	210	-266	1355
Evangeline	2010	-1017	3586	2133	-1004	3586
Burkeville Confining System	88	-38	159	93	-38	159
Jasper	1741	-612	326	1813	-558	325
Total	4036	-1937	5425	4249	-1866	5424
Sparta	23	-16	0	23	-17	0
Weches formation	91	-47	0	97	-49	0
Queen City	16	-91	0	18	-98	0
Recklaw formation	93	-112	0	97	-119	0
Carrizo sand	1001	-578	0	980	-539	0
Upper Wilcox formation	36	-190	0	43	-171	0
Middle Wilcox formation	59	-41	0	54	-38	0
Lower Wilcox formation	797	-310	0	758	-301	0
Total	2116	-1385	0	2070	-1332	0

TWDB GAM run 5-18-2005, and TWDB GAM run 4-08-2005

Estimated total usable groundwater available from the GAM for the central part of the Gulf Coast aquifer located in Live Oak County

Aquifer	Specific yield[1]	Area ($mile^2$)	Average thickness	Volume (acre-feet)[3]
Evangeline	0.1[2]	284[4]	370	6,665,000
Burkeville	0.005	587	290	540,000
Jasper	0.05	869	433	12,040,000
Total	-	-	-	**19,245,000**

1 From GAM for the central part of the Gulf Coast aquifer
2 Carr and Meyer (1985)

3 Rounded to the nearest 1,000 acre-feet
4 Does not include two cells that went dry in the model simulation

Estimated total storage volume from the GAM for the southern part of the Carrizo-Wilcox aquifers located in Live Oak County

Aquifer	Specific yield[1]	Area (mile^2)	Average thickness	Volume (acre-feet)[2]
Carrizo	0.15	366	830	28,973,000

1 From GAM for the southern part of Carrizo-Wilcox aquifers. [2] Rounded to the nearest 1,000 acre-feet

Surface Water Resources of Live Oak County

There are two surface impoundments used to supply water other than for livestock consumption, Choke Canyon and Lake Corpus Christi. The average annual supply from these impoundments is 241,000 acre-feet, however, the calculated firm yield is 252,000 acre-feet. For planning calculations the impoundments will be assumed to supply 162,500 acre-feet per year by the year 2050. These figures came form the City of Corpus Christi. The owners and operation is the Nueces River Authority and the City of Corpus Christi within all reaches of the Nueces River in Live Oak County. The City of Corpus Christi is the major user of surface water in Live Oak County with the City of Three Rivers and the petrochemical plant, Diamond Shamrock

WUG	Source Type	Source Name	2000	2010	2020	2030	2040	2050
George West	Groundwater	Gulf Coast Aquifer	605	605	605	605	605	605
Three Rivers	Surface Water	Nueces River Run-Of-River	700	700	700	700	700	700
Three Rivers	Surface Water	Surface water- Lakes	3,363	3 363	3,363	3 363	3,363	3,363
County-Other	Groundwater	Gulf Coast Aquifer	672	672	672	672	672	672
Irrigation	Groundwater	Carrizo-Wilcox Aquifer	171	171	171	171	171	171
Irrigation	Groundwater	Gulf Coast Aquifer	337	337	337	337	337	337
Livestock	Surface Water	Livestock Local Supply	801	801	801	801	801	801
Livestock	Groundwater	Gulf Coast Aquifer	523	523	523	523	523	523
Manufacturing	Surface Water	Nueces River Run-Of-River	800	800	800	800	800	800
Manufacturing	Groundwater	Gulf Coast Aquifer	895	895	895	895	895	895
Mining	Groundwater	Carrizo-Wilcox Aquifer	2,228	2,228	2,228	2,228	2,228	2,228
Mining	Groundwater	Gulf Coast Aquifer	1,718	1,718	1,718	1,718	1,718	1,718
Total Projected Water Supply (acre-feet per year) =			**12,813**	**12,813**	**12,813**	**12,813**	**12,813**	**12,813**

Source: Table 12, 2002 State Water Planning Database, Table 5, Regional water plan

Groundwater Use in Live Oak County

Historical Groundwater Pumpage (acre-feet per year)
Live Oak Underground Water Conservation District

Year	Municipal	Manufacturing	Power	Irrigation	Mining	Livestock	Total
1974	541	0	0	1,724	61	961	3,287
1977	760	344	0	900	1,401	522	3,927
1980	1,147	1,097	0	450	1,428	404	4,526
1984	979	993	0	1,100	250	545	3,867
1985	923	1,049	0	2,550	1,260	450	6,232
1986	1,076	965	0	1,110	0	535	3,686
1987	1,079	198	0	1,049	1,713	577	4,616
1988	985	28	0	1,419	2,422	603	5,457
1989	1,290	57	0	841	2,385	594	5,167
1990	1,324	203	0	1,500	2,385	585	5,997
1991	1,307	455	0	2,123	4,207	597	8,689
1992	1,067	809	0	1,796	4,626	662	8,960
1993	1,271	769	0	486	4,632	611	7,769
1994	1,337	769	0	193	4,684	496	7,479
1995	1,233	729	0	518	4,684	527	7,691
1996	1,841	753	0	486	4,684	863	8,627
1997	1,222	857	0	486	3,779	501	6,845
1998	1,719	352	0	486	3,105	396	6,058
1999	1,634	351	0	486	3,105	415	5,991
2000	1,540	809	0	2,649	3,105	416	8,519

NOTE: Pumpage data from TWDB's Water Use Survey database

TWDB: 05/19/2005

Recommended Groundwater Strategies

Source Name	2000	2010	2020	2030	2040	2050
Gulf Coast Aquifer	361	346	332	332	337	350
Gulf Coast Aquifer	313	261	1,953	1,764	1,113	1,031
Gulf Coast Aquifer	213	213	213	213	213	213
Carrizo-Wilcox Aquifer	471	641	0	0	0	0
Carrizo-Wilcox Aquifer	471	641	0	0	0	0

Source: Table 12, 2002 State Water Planning Database

Projected Demands for Water in Live Oak County

RWPG	WUG	River Basin	Category	2000	2010	2020	2030	2040	2050
N	George West	Nueces	Municipal	560	567	563	566	571	584
N	Three Rivers	Nueces	Municipal	439	438	434	436	441	448
N	County-Other	Nueces	Municipal	1,033	1,018	1,004	1,004	1,009	1,022
N	Irrigation	Nueces	Irrigation	3,097	2,878	2,674	2,485	2,309	2,145
N	Livestock	Nueces	Livestock	1,324	1,324	1,324	1,324	1,324	1,324
N	Manufacturing	Nueces	Manufacturing	1,021	1,088	1,137	1,171	1,261	1,345
N	Mining	Nueces	Mining	4,888	5,228	1,395	1,980	2,833	2,915
Total Projected Water Demand (acre-feet per year) =				**12,362**	**12,541**	**8,531**	**8,966**	**9,748**	**9,783**

Source: Table 12, 2002 State Water Planning Database, Table 5, Regional water plan

This management planning document is based upon the estimates provided by the Texas Water Development Board and will be used until alternatives are generated.

Projected Water Availability

RWPG	Source Name	Source Type	River Basin	2000	2010	2020	2030	2040	2050
N	Carrizo-Wilcox Aquifer	Groundwater	Nueces	2,399	2,399	2,399	2,399	2,399	2,399
N	Gulf Coast Aquifer	Groundwater	Nueces	4,750	4,750	4,750	4,750	4,750	4,750
N	Livestock Local Supply	Surface Water	Nueces	801	801	801	801	801	801
N	Nueces River Run-Of-River	Surface Water	Nueces	1,500	1 500	1 500	1 500	1 500	1,500
Total Projected Water Availability (acre-feet per year) =				**9,450**	**9,450**	**9,450**	**9,450**	**9,450**	**9,450**

Source: Table 12, 2002 State Water Planning Database

Projected Population

RWPG	WUG	2000	2010	2020	2030	2040	2050	2060
N	George West	2,524	2,816	3,061	3,155	3,079	2,831	2,548
N	Three Rivers	1,878	2,096	2,278	2,347	2,291	2,107	1,896
N	Choke Canyon WS	2,250	2,511	2,729	2,812	2,745	2,524	2,271
N	El Oso WSC	1,000	1,116	1,213	1,250	1,220	1,122	1,009
N	McCoy WSC	443	494	537	554	540	497	447
N	County-Other	4,214	4,702	5,111	5,268	5,143	4,727	4,253
Total Projected Population =		**12,309**	**13,735**	**14,929**	**15,386**	**15,018**	**13,808**	**12,424**

RWPG	WUG	River Basin	2000	2010	2020	2030	2040	2050
N	George West	Nueces	2,872	3,066	3,204	3,304	3,400	3,499
N	Three Rivers	Nueces	1,978	2,078	2,163	2,224	2,287	2,341
N	County-Other	Nueces	5,169	5,382	5,587	5,738	5,896	6,017
Total Projected Population =			**10,019**	**10,526**	**10,954**	**11,266**	**11,583**	**11,857**

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan.

The District will adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available.

Methodology for Tracking the District's Progress in Achieving Management Goals

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning December 31, 2005. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. The Board will maintain the report on file, for public inspection at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

Management of Groundwater Supplies

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. A monitor well observation network shall be established and maintained in order to evaluate changing conditions of groundwater supplies (water in storage) within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The District will undertake, as necessary and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the Board.

The District will adopt rules to regulate groundwater withdrawals by means of well spacing and production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

In pursuit of the Districts mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts, which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Boards discretion, amend or revoke any permits after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code (TWC) 36.102.

LIVE OAK UNDERGROUND
WATER CONSERVATION DISTRICT
MANAGEMENT PLAN

MISSION STATEMENT

The mission of the Live Oak Underground Water Conservation District is to protect and assure a sufficient quantity of quality water for our constituents use.

We value:

*Collection and maintenance of data on water quantity and quality
*Efficient use of groundwater
*Conjunctive water management issues
*Development and enforcement of water district rules concerning conservation of ground water.

GOALS , OBJECTIVES , AND ACTION STEPS

Goal 1.0. Collection and maintenance of data on water quantity and quality

1.1. Measurement of water quantity and quality

a. Take measurements of depth to water level below the land surface on strategic wells on an annual basis.
b. Take water samples for chemical analysis on strategic wells on an annual basis.
c. Reports annually, water quality and quantity data.

Performance standard: measure depth of water on 1 well annually

measure chemical analysis of 4 wells annually

1.2. Measurement of pollution sources and wells

a. Identify wells that are polluted and take appropriate action.
b. Identify sources of pollution and take appropriate action.
c. Provide information to the public about wells that are polluted and the sources of pollution.

Performance standard investigate 100% of complaints of well pollution annually

Goal 2.0 Efficient use of groundwater

2.1. School education

a. Provide speakers to address water topics.
b. Distribute water resource education packets for use in the classroom

Performance standard: contact teacher or principle of 1 school annually

2.2. Farm education

a. Provide speakers to address water topics at farm meetings.

b. Distribute water resource education packets to farm leaders and farmers.

Performance standard: contact 1 farm group annually

2.3. Home education

a. Provide speakers to address water topics.

b. Distribute water resource education packets to community people.

Performance standard: contact 1 civic group annually

Goal 3.0 Conjunctive water management issues

3.1 Attend meeting with surface water entities in the district, to include but not limited to; conjunctive use, emergency response, drought contingency planning.

3.2 Evaluate existing historical data and data derived from new monitoring programs to enhance understanding of aquifer/surface-water relationships.

3.3 Evaluate the impact of surface-water usage on groundwater resources within the District as needed. Provide comments regarding surface-water rights requests for those requests effecting the groundwater resources of the district.

3.4 Coordinate with other entities on regional planning efforts.

Performance standard: district representative will attend 1 meeting with surface water entities annually.
district representative will attend 1 meeting concerning regional water planning annually.

Goal 4.0 Drought Conditions

4.1 Participate in the South Texas Weather Modification Program.

4.2 Evaluate the performance of the weather modification program.

Performance standard: district representative will attend 1 meeting of the South Texas Weather Modification Assn. Annually.

Goal 5.0 Conservation

5.1 Provide information to area residents about water conservation.

5.2 Provide information to agriculture users about water conservation.

Performance standard: Provide water conservation pamphlet to 1 district resident annually.

SB-1 MANAGEMENT GOALS DETERMINED NOT -APPLICABLE

Goal

1.0 Control and prevention of subsidence.

The rigid geologic framework of the region precludes significant subsidence from occurring.

Goal

2.0 Cooperative resolution of natural resource management issues.

The district has no documented occurrences of endangered or threatened species dependent upon groundwater resources.

RESOLUTION

Whereas, the Live Oak Underground Water Conservation District has held the appropriate public hearings, and;

Whereas, the District has presented the management plan to the county officials and the Nueces River Authority.

Whereas, the District has followed the rules set forth by SB 1 and the TWDB.

Now, Therefore be it Resolved, that the Live Oak Underground Water Conservation District voted to pass the District management plan.

In favor 4 Against 0

Passed and Approved this 26th day of July, 2005.

Scott Bledsoe III, President

Attest by: Lonnie Stewart

Lonnie Stewart, Secretary

Appendix L

Cumulative Effects of Water Management Strategies

L.1 Cumulative Effects of Regional Water Plan Implementation

Available hydrologic models have been used to quantify the cumulative effects of implementation of the Coastal Bend Regional Water Plan (Region N) through the year 2060. Models include the South-Central Carrizo System model (SCCS),[1] Gulf Coast Groundwater Availability Models (Gulf Coast GAMs),[2,3] Nueces River Basin Water Availability Model (Nueces WAM),[4] and Lower Nueces River Basin Bay and Estuary Model (NUBAY).[5]

The cumulative effects are quantified through long-term simulation of natural hydrologic processes including precipitation, streamflow, aquifer recharge, springflow, and evaporation as they are affected by human influences such as aquifer pumpage, reservoirs, sedimentation, diversions, and the discharge of treated effluent. Another complex component of this hydrologic system is the operation of the TCEQ Bay and Estuary Agreed Order that describes how the City of Corpus Christi operates the Choke Canyon Reservoir / Lake Corpus Christi System (CCR/LCC) with respect to reservoir levels and pass-through requirements for the Nueces bay and estuary.

L.1.1 Groundwater

Cumulative effects of plan implementation on the groundwater supplies for the Coastal Bend Region were evaluated as part of the planning process and are addressed in Section 4C.7 of the report. The maximum drawdown in the Evangeline Aquifer near the San Patricio Municipal Water District and City of Corpus Christi wellfields is approximately 50-feet in Bee, San Patricio, and Refugio Counties as shown in Section 4C.7. These projects do not exceed the drawdown criteria adopted by the CBRWPG.

[1] HDR Engineering, Inc., "South Central Carrizo System Groundwater Model, SAWS Gonzales-Carrizo Project," San Antonio Water System, November 2004.
[2] Texas Water Development Board, Groundwater Availability Model for the Central Gulf Coast Aquifer System: Final Report and Numerical Simulations Through 1999," Texas Water Development Board, 2004.
[3] Waterstone Environmental Hydrology and Engineering. Inc., "Groundwater Availability of the Central Gulf Coast Aquifer – Numerical Simulations to 2050, Central Gulf Coast, Texas," Contract Draft Report, 2003.
[4] HDR Engineering, Inc., "Water Availability in the Nueces River Basin," TNRCC, October 1999.
[5] HDR Engineering, Inc., "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, January 1999.

L.1.2 Surface Water

Potential cumulative effects of implementation of the 2006 Coastal Bend Regional Water Plan on instream flows and freshwater inflows to bays and estuaries have been assessed for selected locations in the Nueces River Basin. These locations are shown in Figure L-1 and include Nueces River at Cotulla, Frio River at Choke Canyon, Reservoir, Nueces River at Three Rivers, Nueces River at Mathis and the Nueces Estuary. The cumulative effects are shown for the following three conditions:

- Baseline conditions
- Year 2060 conditions without Region L's proposed recharge dams,
- Year 2060 conditions with Region L's proposed recharge dams.

<u>Baseline Conditions</u>

The baseline for consideration of effects on flows reflects current sedimentation conditions for CCR/LCC, full utilization of existing water rights, a safe yield demand of the CCR/LCC system (approximately 163,000 acft/yr leaving a 7% reserve of overall system storage), a Year 2000 Lake Texana supply delivered through the Mary Rhodes Pipeline of 41,840 acft/yr, and treated effluent discharge percentages representative of current conditions.

<u>Year 2060 Conditions without Region L's proposed recharge dams</u>

The implemented plan conditions include the Year 2060 sedimentation conditions for CCR/LCC, full utilization of existing water rights, a 2060 safe yield demand of the CCR/LCC system (approximately 158,000 acft/yr leaving a 7% reserve of overall system storage), a firm Lake Texana supply delivered through the Mary Rhodes Pipeline of 41,840 acft/yr plus the interruptible supply of 12,000 acft/yr, 35,000 acft/yr of supply from the Garwood project delivered through the Mary Rhodes pipeline, 11,000 acft/yr of supply from Refugio county groundwater delivered through the Mary Rhodes pipeline and treated effluent discharge representative of 2060 conditions.

Year 2060 Conditions with Region L's proposed recharge dams

Another aspect that was taken into consideration for 2060 conditions is the effect that the Edwards Aquifer Type II recharge enhancement projects under consideration by Region L could have on the reduction of streamflows in the Coastal Bend Region. The locations of the proposed recharge dams are shown on Figure L-2. The reduction of streamflows become evident in the reduced yield of the CCR/LCC system (approximately 5,600 acft/yr) and the reduction in inflows to the Nueces Bay and Estuary system and are shown in Figures L-3 to L-7. These reductions are made evident in the summarization graphs presented below for each of the control points evaluated and show that mitigation of these projects will be necessary.

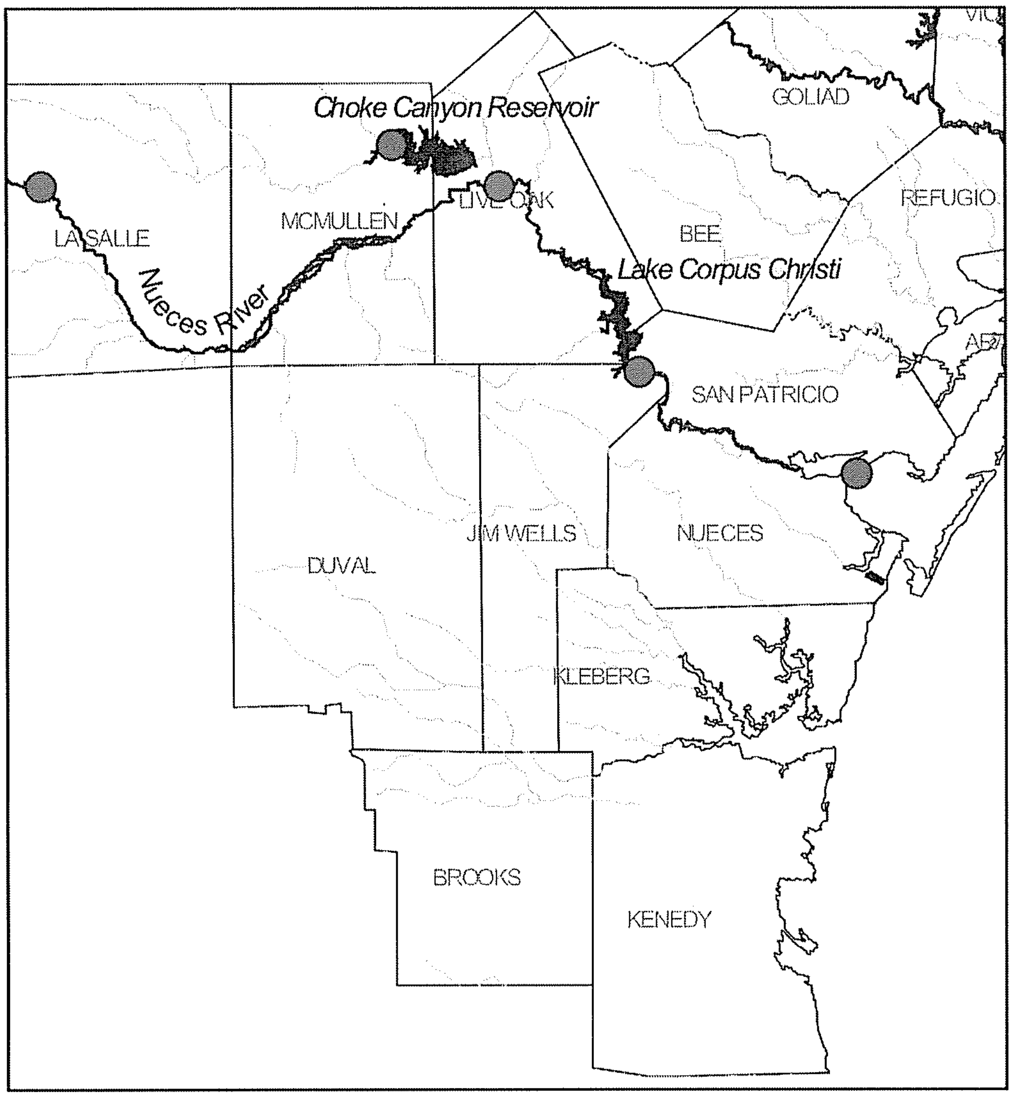


Figure L-1. Selected Locations for Evaluating Cumulative Effects

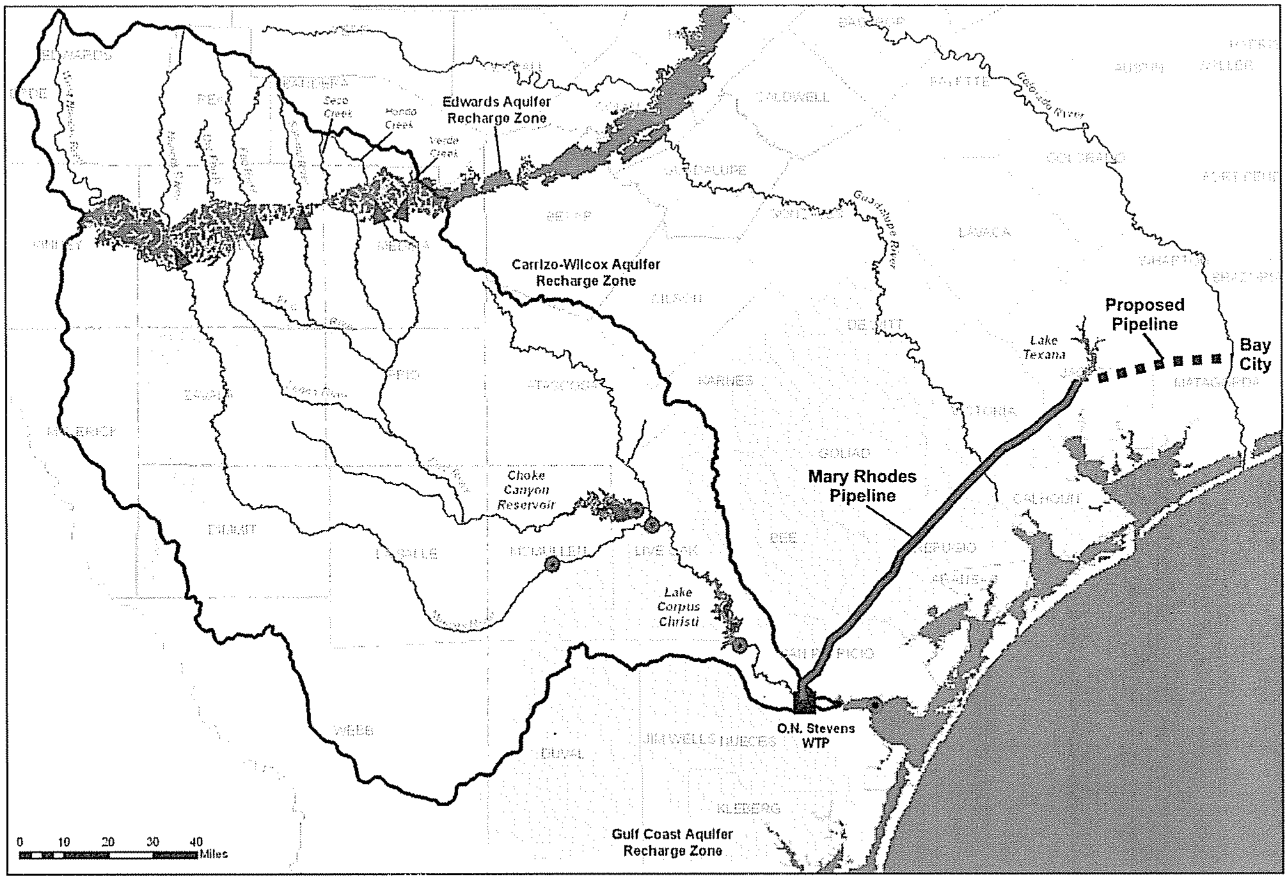
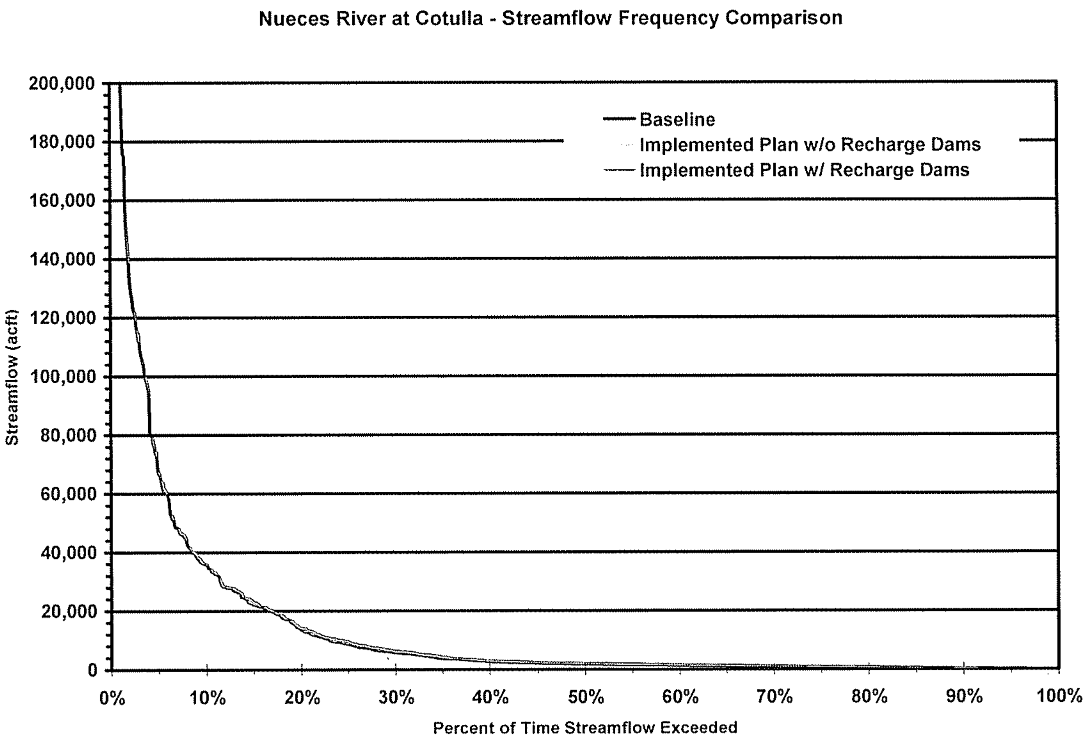


Figure L-2. Locations of Projects for Cumulative Effects Analysis

Most of the strategies being implemented for the 2006 Coastal Bend Regional Water Plan are unique in that they do not directly affect the hydrologic components of the Nueces River Basin. The Garwood water, the interruptible Texana water and the groundwater are all supplies that originate outside the basin. Therefore the only significant impacts seen from the implementation of these projects is the direct increase in flows to the bay and estuary from the increase in return flows. There are only minimal impacts from these projects on any of the streamflow locations previously mentioned. The significant factor impacting the streamflows in the Nueces basin are the reduction in storage capacity in the CCR/LCC reservoirs due to sedimentation and the resulting loss of yield, and from the implementation of the recharge enhancement structures. The reduction in reservoir yield reduces water supply releases made from the reservoirs and the volume of return flows entering the bay and estuary system. These impacts are shown in Figures L-3 – L-7. Figure L-8 shows a comparison of the percent storage trace of the combined storage of CCR and LCC for the baseline and the two 2060 plan scenarios.

L.1.3 Results

For all locations presented in the figures, the median monthly streamflow values were reduced from the baseline run except the Nueces River at the Nueces Estuary. The reason for the estuary not declining, was the amount of increased return flows introduced to the system from the new out-of-basin sources brought online in the plan. The reason for the decline in streamflows across the basin can be attributed to the impacts of Region L's proposed upstream recharge enhancement projects. The two 2060 plan scenarios show a reduction in reservoir system storage that results from both the loss of capacity from increased sediment and loss of inflows from the recharge enhancement projects. These results show the importance of Region L and N's continuing to work on appropriate mitigation for the recharge dams prior to their implementation.



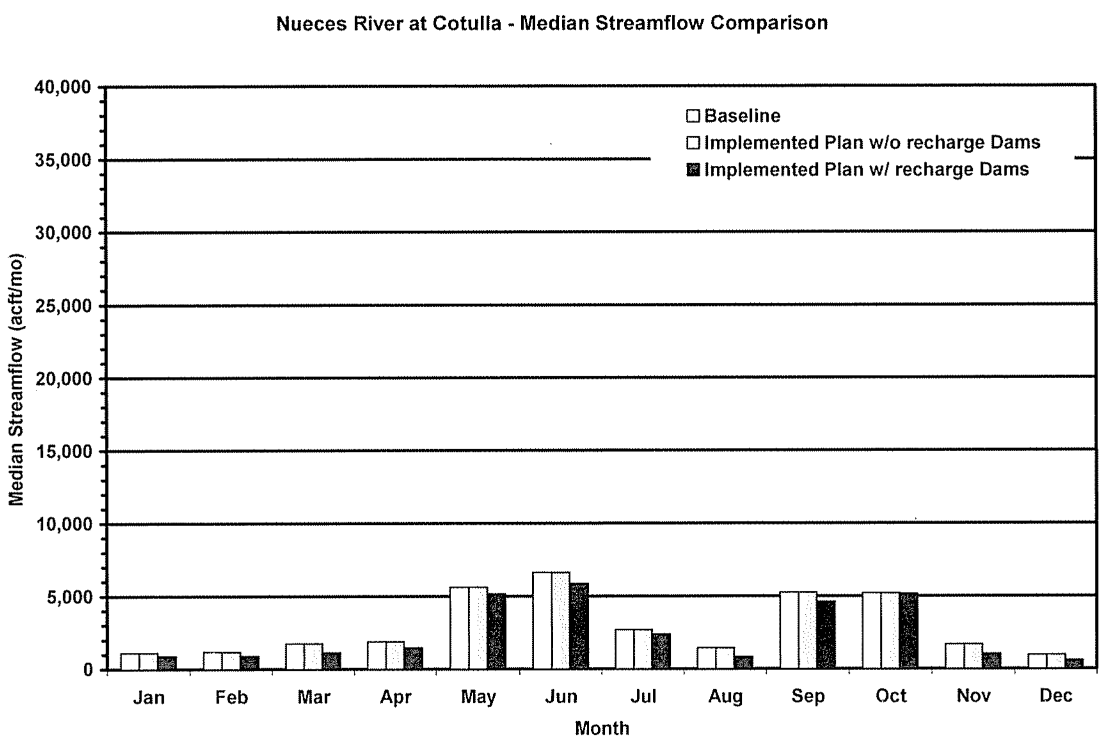
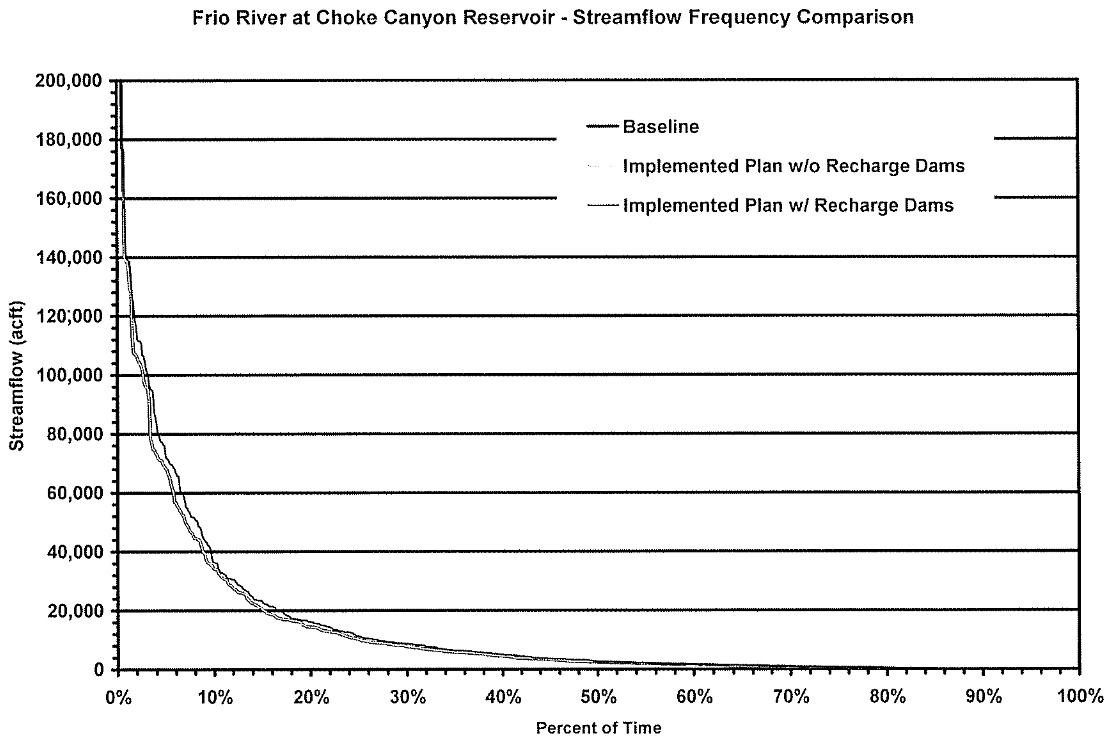


Figure L-3. Nueces River at Cotulla



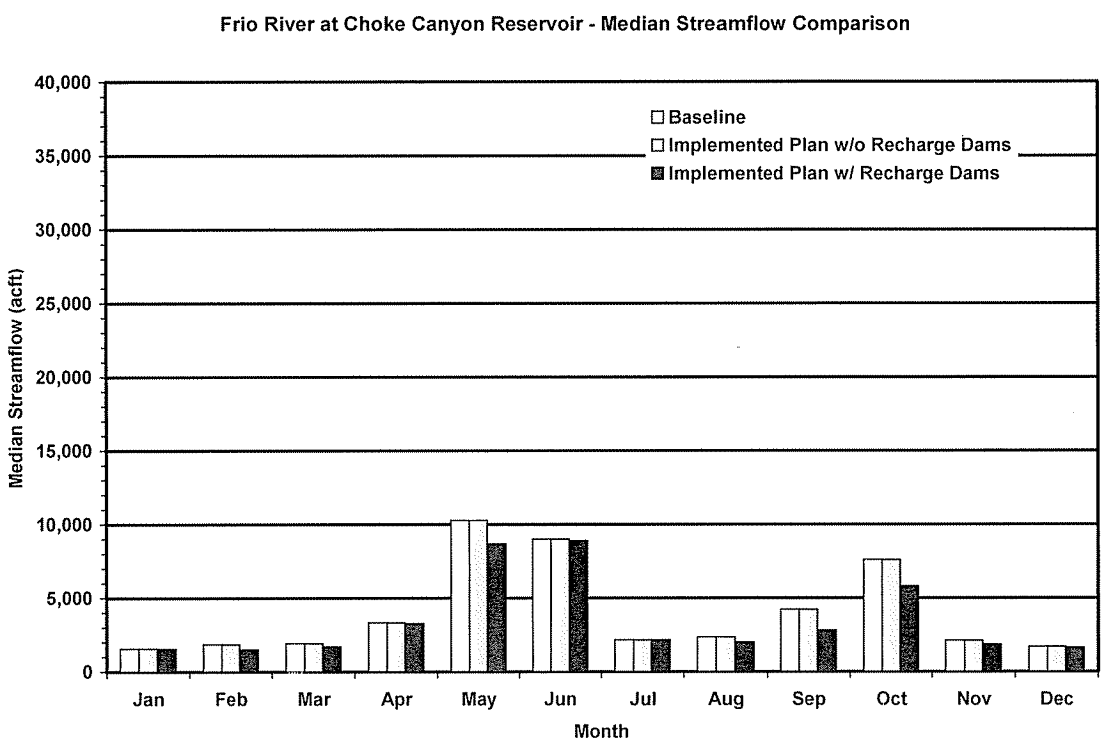
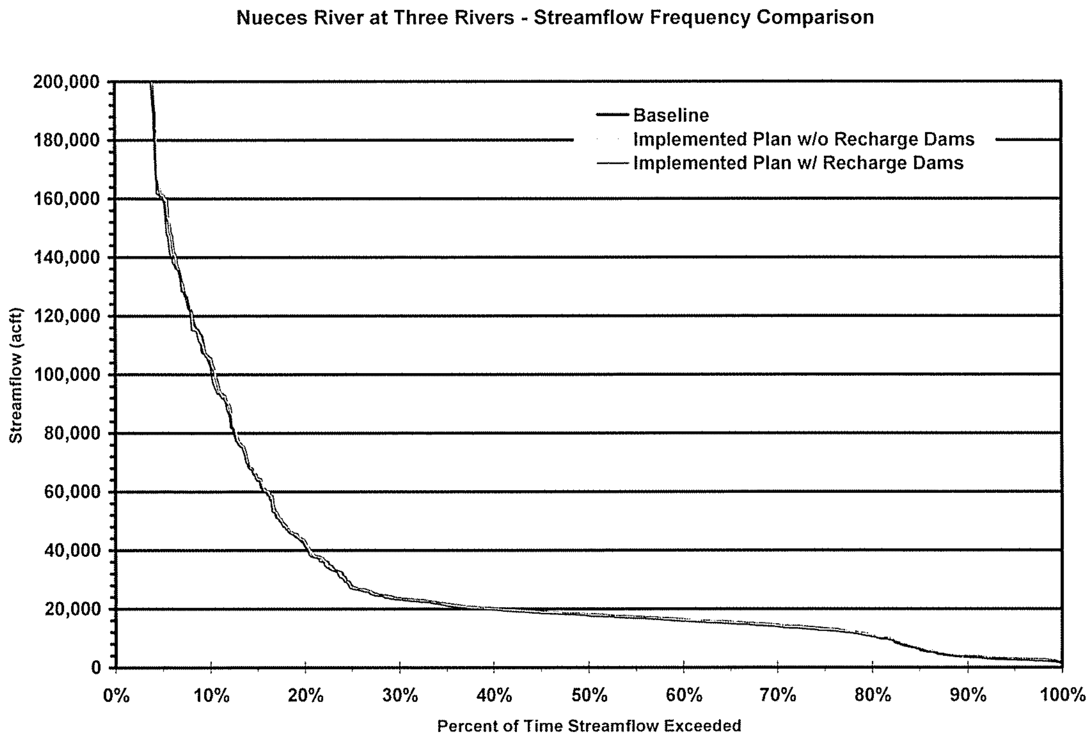


Figure L-4. Frio River at Choke Canyon Reservoir



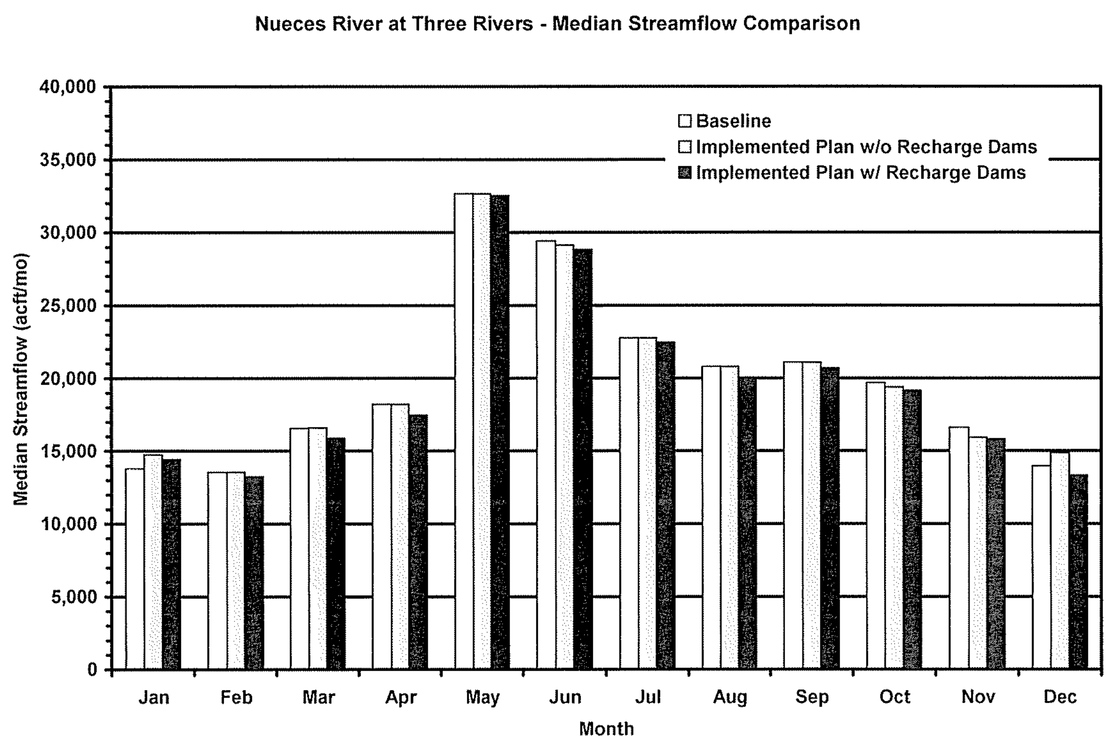
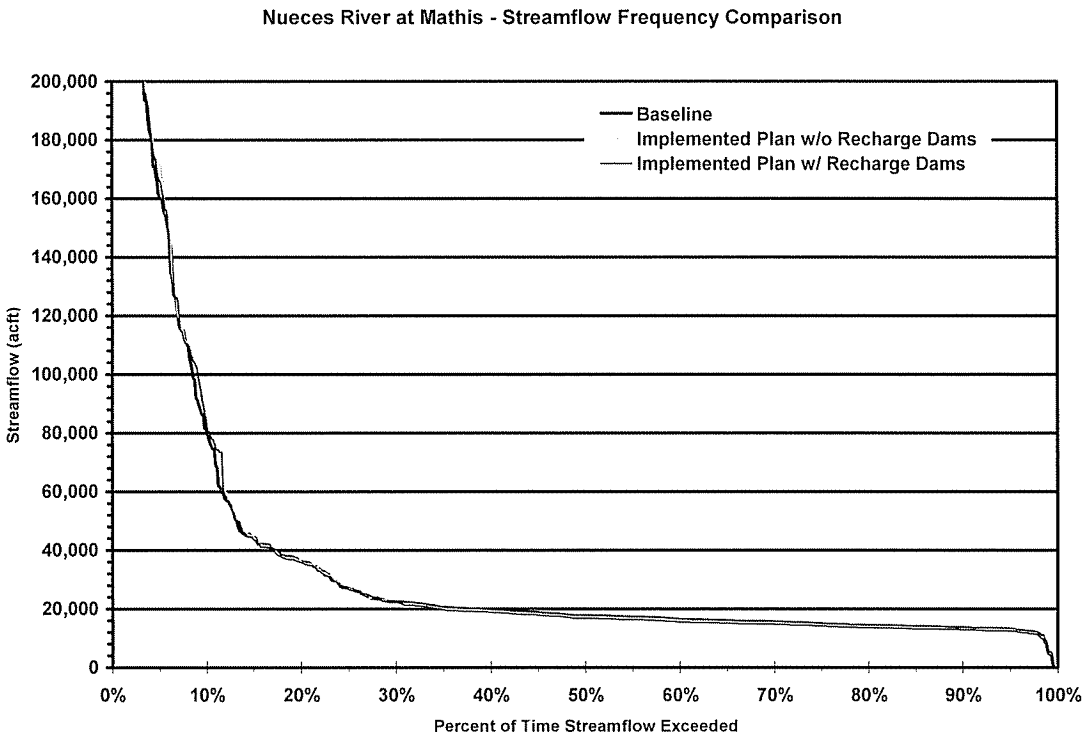


Figure L-5. Nueces River at Three Rivers



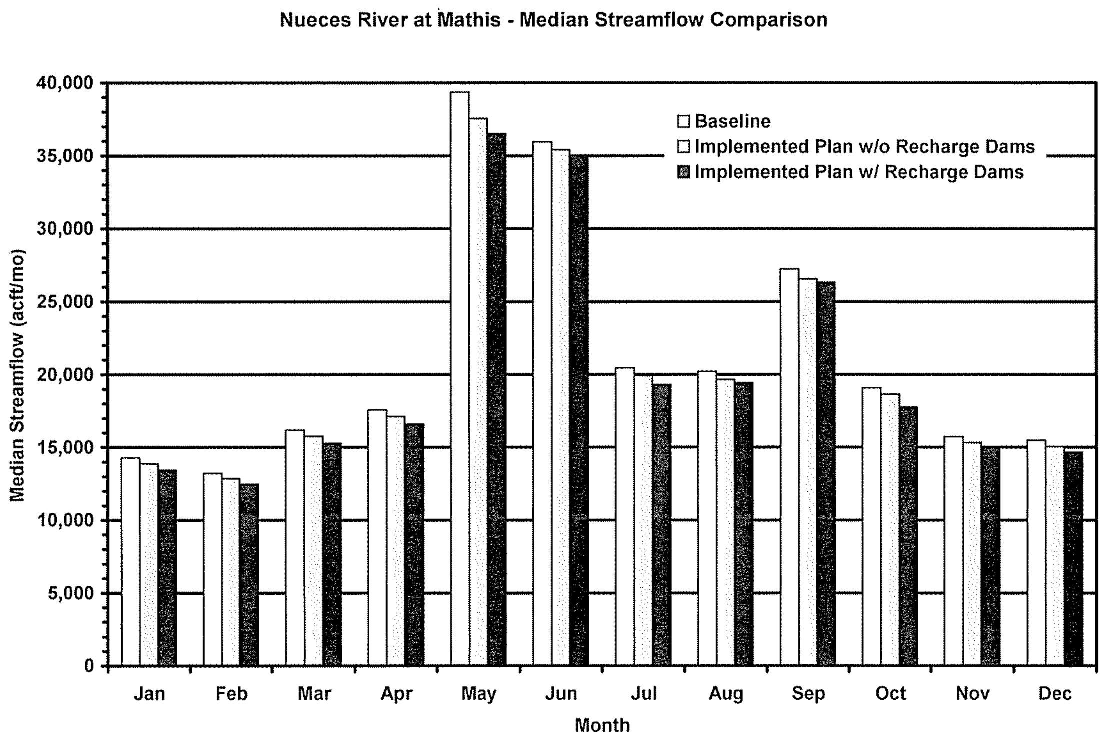
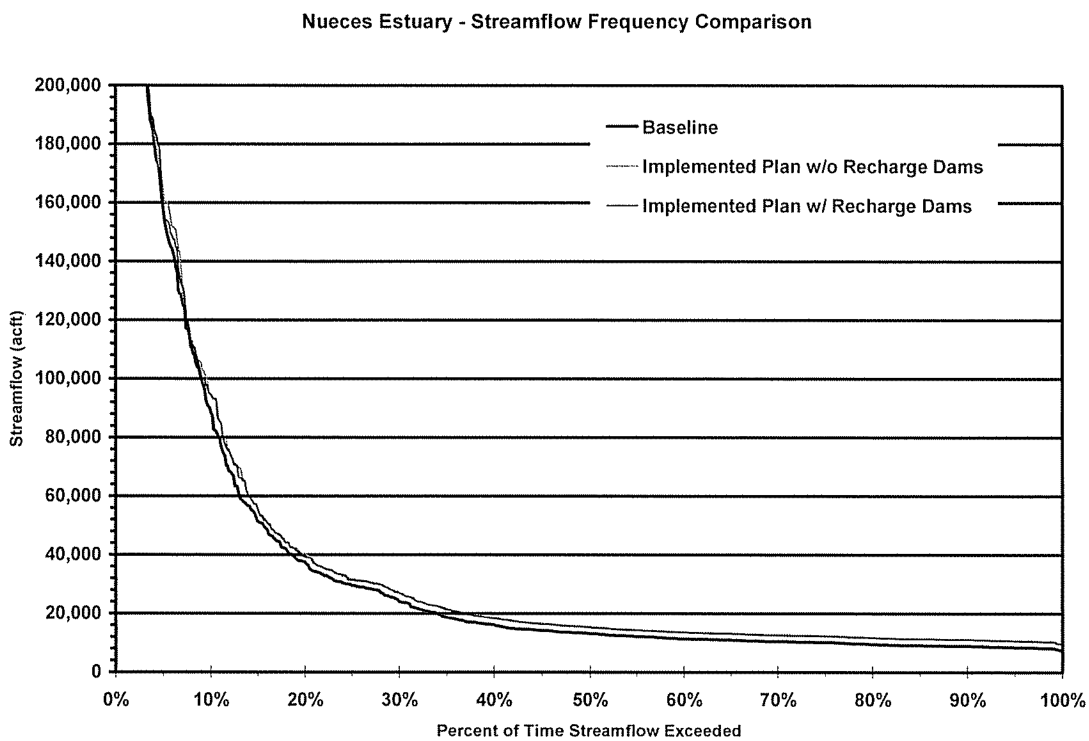


Figure L-6. Nueces River at Mathis



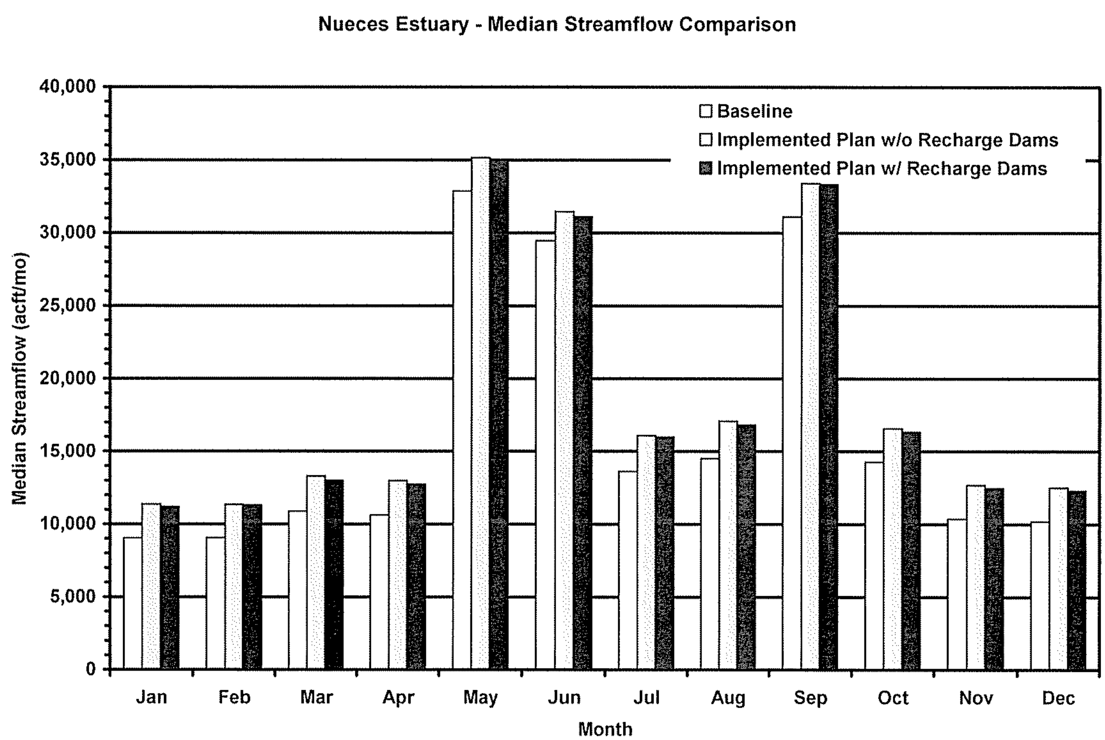


Figure L-7. Nueces River at the Nueces Estuary

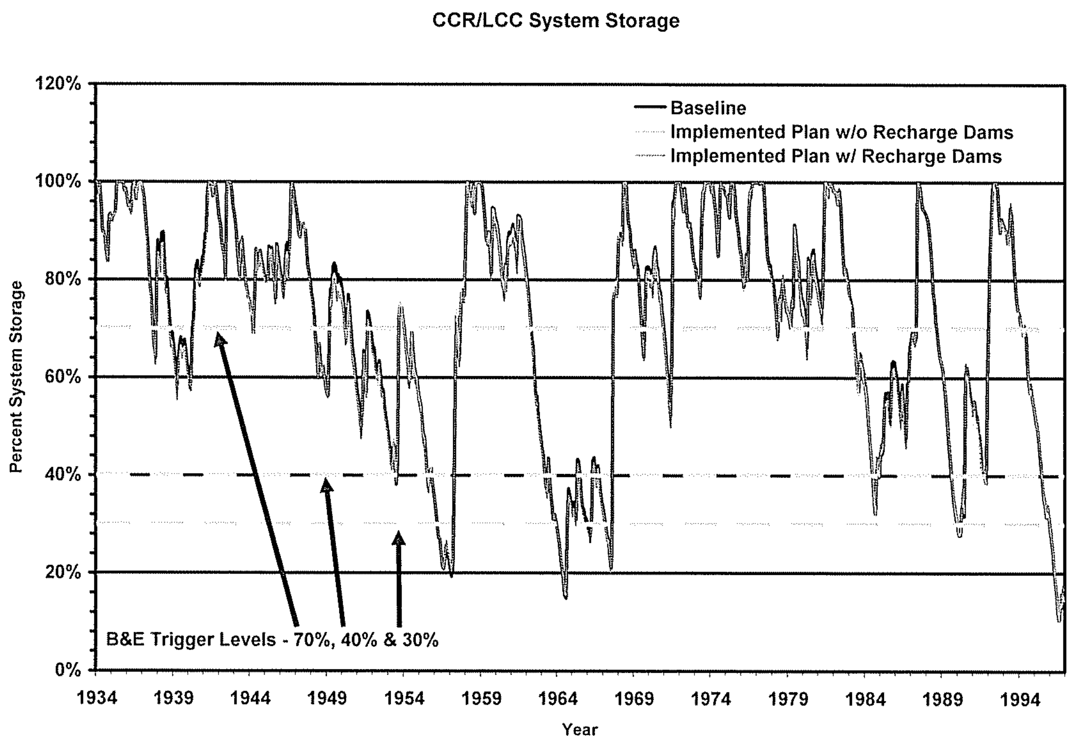


Figure L-8. CCR/LCC System Storage Comparison

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Appendix M

TWDB Infrastructure Financing Survey Form and Survey Responses

<u>*Contents*</u>

Appendix M.1

TWDB Infrastructure Financing Survey Form

SAMPLE SURVEY TO OBTAIN INFRASTRUCTURE FINANCING INFORMATION FROM POLITICAL SUBDIVISIONS WITH NEEDS

(Information to be completed before survey is sent)

Regional Water Planning Group ____________________________

Political Subdivision (WUG or WWP)_________________________

Recommended Project/Strategy	***Implementation Date***	***Capital Cost to be paid by Political Subdivision***	***ID# from DBO7***
TOTAL COST OF CAPITAL IMPROVEMENTS		$	

(Information to be provided by the Political Subdivision)

Are you planning to implement the recommended projects/strategies?

□ ***YES*** □ ***NO***

If 'no,' describe how you will meet your future water needs.

____

____

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by your Regional Water Planning Group?

Please indicate:

1) Funding source(s)[1] by checking the corresponding box(es) and

2) Percent share of the total cost to be met by each funding source.

□ %_________ Cash Reserves

□ %_________ Bonds

□ %_________ Bank Loans

□ %_________ Federal Government Programs

□ %_________ State Government Programs

□ %_________ Other_______________

% _________ TOTAL -- (Sum should equal 100%)

If state government programs are to be utilized for funding, indicate the programs and the provisions of those programs.

____

____

[1]Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

Person Completing this Form:

Name	Title	Phone
____________	____________	____________

Appendix M.2

Infrastructure Financing Survey Responses

— City of Corpus Christi
— San Patricio Municipal Water District

City of Corpus Christi
Infrastructure Financing Response

Region N Water Planning Group
Recommended Water Management Strategies and Infrastructure Financing Survey
Please return by ***September 28, 2005***

Political Subdivision (WUG or WWP) ***City of Corpus Christi***

Recommended Project/Strategy[1]	*Implementation Date*	*Capital Cost to be paid by Political Subdivision*	*ID# from DB07*
Reclaimed Wastewater Supplies	Current Implementation	$1,500,000[2]	N5
Gulf Coast Aquifer Supplies	by 2010	$29,733,000[3]	N7
Garwood Pipeline	by 2030	$54,156,000	N14
Voluntary Redistribution and USCOE Nueces Feasibility Projects	by 2020; full implementation by 2040[4]	$114,293,900[5]	N12
Stage II Lake Texana	by 2060	$82,332,000[6]	N13

[1] Manufacturing and mining conservation recommended, but is not included in list since it does not require capital costs for implementation.
[2] Total cost for Allison Demonstration Project.
[3] Capital cost subject to change based on production and well capacity and potential cost share by other entities. Cost based on drilling 11 wells to supply up to 18,000 acft/yr.
[4] Implementation of CCR/LCC pipeline by 2020, with desalination plant and offchannel reservoir by 2040.
[5] Capital cost estimate includes off-channel reservoir, CCR/LCC Pipeline, and Seawater Desalination Projects, with cost reduction of 65 percent due to Federal participation.
[6] Cost includes construction of dam and delivery to Lake Texana.

TOTAL COST OF CAPITAL IMPROVEMENTS	$ 54,285,504*

Note: The total water supplied by all water management strategies exceeds projected water needs and it is anticipated that not all water management strategies will be implemented. Total cost is based on average unit cost of strategies and amount of water needed to meet projected water demands.

Are you planning to implement the recommended projects/strategies?
☐ *YES* ☐ *NO*

If 'no,' describe how you will meet your future water needs.

If 'yes', how do you plan to finance the proposed <u>total cost of capital improvements</u> identified by your Regional Water Planning Group?
Please indicate: 1) Funding source(s)[1] by checking the corresponding box(es) and
2) Percent share of the total cost to be met by each funding source.

	Source to be Used	Percent (%)
Cash Reserves		
Bonds	49,002,982	90%
Bank Loans		
Federal Government Programs		
State Government Programs	5,282,522 *	10%
Other ______		
TOTAL -- (Sum should equal 100%)	54,285,504	100%

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

(Please see back of page)

If state government programs are to be utilized for funding, indicate the programs and the provisions of those programs.
State Participation in Regional Water and Wastewater Facilities Program

Ronald F. Massey

Person Completing this Form:

Name: Ronald F. Massey | Title: Asst. Pub Wks Dir | Phone: 361-826-3217

Please return completed form to:

Ms. Rocky Freund
Nueces River Authority
6300 Ocean Drive NRC 5865
Corpus Christi TX 78412
Phone: (361)825-3193
Fax: (361)825-3195

* $54,285,504 is discounted 10% to account for State Participation Program portion of funding of Texana II.

Post-it® Fax Note 7671
Date 09/26 | # of pages ▶ 2
To MAX | From ROCKY
Co./Dept. | Co.
Phone # | Phone #
Fax # | Fax #

San Patricio Municipal Water District Infrastructure Financing Response

Region N Water Planning Group
Recommended Water Management Strategies and Infrastructure Financing Survey
Please return by ***September 28, 2005***

Political Subdivision (WUG or WWP) ***San Patricio Municipal Water District***

Recommended Project/Strategy[1]	***Implementation Date***	***Capital Cost to be paid by Political Subdivision***	***ID# from DB07***
Reclaimed Wastewater Supplies	Current Implementation	$1,500,000[2]	N5
Gulf Coast Aquifer Supplies	by 2010	$29,733,000[3]	N7
Garwood Pipeline	by 2030	$54,156,000	N14
Voluntary Redistribution and USCOE Nueces Feasibility Projects	by 2020; full implementation by 2040[4]	$114,293,900[5]	N12
Stage II Lake Texana	by 2060	$82,332,000[6]	N13

[1] Manufacturing conservation recommended, but is not included in list since it does not require capital costs for implementation.
[2] Total cost for Allison Demonstration Project.
[3] Capital cost subject to change based on production and well capacity and potential cost share by other entities. Cost based on drilling 11 wells to supply up to 18,000 acft/yr.
[4] Implementation of CCR/LCC pipeline by 2020, with desalination plant and offchannel reservoir by 2040.
[5] Capital cost estimate includes off-channel reservoir, CCR/LCC Pipeline, and Seawater Desalination Projects, with cost reduction of 65 percent due to Federal participation.
[6] Cost includes construction of dam and delivery to Lake Texana.

TOTAL COST OF CAPITAL IMPROVEMENTS	$ 54,285,504*

Note: The total water supplied by all water management strategies exceeds projected water needs and it is anticipated that not all water management strategies will be implemented. Total cost is based on average unit cost of strategies and amount of water needed to meet projected water demands.

Are you planning to implement the recommended projects/strategies?
☐ ***YES*** ☐ ***NO***

If 'no,' describe how you will meet your future water needs.

____

____

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by your Regional Water Planning Group?
Please indicate: 1) Funding source(s)[1] by checking the corresponding box(es) and
2) Percent share of the total cost to be met by each funding source.

	Source to be Used	**Percent (%)**
Cash Reserves		
Bonds	Open Market	100%
Bank Loans		
Federal Government Programs	______	______
State Government Programs	______	______
Other ______	______	______
TOTAL – (Sum should equal 100%)	______	______

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

(Please see back of page)

Rocky,

The only project that would be funded and completed by the District would be the Gulf Coast Aquifer supply. This is still in the study phase and will be so until mid 2006. If we were to go ahead the funding would come from private bond placement.

The other projects would be funded through water rates from all raw water customers with the City of Corpus Christi completing the initial funding.

Don Roach

Appendix N

Comments Received on Initially Prepared Regional Water Plan and Responses to Comments Received

Contents

Appendix N.1
Responses to Initially Prepared Plan Comments

Public Comment

Bob Warren

- *Section 4B Water Supply Plans*

Comment (1): Would like to know the cost estimate of projects.
Response: Total, annual, and unit costs are included in Section 4B Water Supply Plans for each water user group with projected needs. Unit costs are also shown in the Executive Summary (Table ES-3 & Table ES-4). Two additional columns will be added to Table ES-3 "Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers" and Table ES-4 "Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas" to show total and annual costs.

- *Section 4C Water Management Strategies*

Comment (2): Why not consider pipeline between Lake Corpus Christi and Calallen Water Treatment Plant?" (WMS 03- Manufacturing Water Conservation and Nueces River Water Quality)
Response: A pipeline from Lake Corpus Christi to Calallen Dam is considered in WMS 3- Manufacturing Water Conservation and Nueces River Water Quality (N-3). Treated water for this water management strategy costs $700 and $800 per acft.

Dr. Patrick Hubert

- *Section 7- Environmental factors*

Comment (1): Section 7 does not include language regarding monitoring on uranium mining operations.
Response: The following text will be added to Section 7: "The CBRWPG recognizes the need to protect groundwater quality and recommends routine water quality monitoring near in situ uranium mining and deep well injection operations."
The plan currently has two other references associated with uranium mining operations. Section 1.4 lists "deterioration of groundwater quality and increasing concerns of possible arsenic and uranium contamination attributable to uranium mining activities" as an identified threat to agricultural and natural resources. Section 8.1 provides two legislative and policy recommendations regarding uranium mining operations : 1) TCEQ is urged to amend rules and regulations to require routine water quality monitoring, by a non-partisan third-party, of mining operations and enforcement of water quality standards, including in situ mining and those with deep well injection practices., and 2) The Texas Legislature is urged to prohibit in-situ mining in aquifers that serve as drinking water sources for residents and livestock.

Texas Parks and Wildlife (TPWD)- 7 comments

- *Section 7- Environmental factors*

Comment (1): There is little mention of coastal/estuarine aquatic resources (e.g., commercial or recreational fisheries species) dependent on freshwater inflows or problems from lack thereof; identify natural resources dependent on inflows
Response: The following text will be added: "The 2001 Agreed Order includes operational procedures for Choke Canyon Reservoir and Lake Corpus Christi and requires passage of

inflows to the Nueces Bay and Estuary based on maximum harvest studies and inflow recommendations to maintain the health of the Nueces Estuary. According to the TPWD, the maximum harvest flow to the Nueces Bay and Estuary produced slightly higher harvests of red drum, black drum, spotted sea trout, and brown shrimp but slightly decreased amounts of blue crab."

Comment (2): For groundwater areas, emphasis should be on protecting springs.
Response: The following text will be added: "Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region. According to *Springs of Texas- Volume I* by Gunnar Brune, there are 18 small springs in the Coastal Bend Region with flows between 0.28 and 2.8 cfs and a number of these springs produce saline, hard, alkaline spring water. These are the largest documented springs in the Coastal Bend Region. Before Year 1965, the region relied heavily on groundwater for irrigation resulting in decreased water levels and springflow. Since then, irrigation water demands have been substantially reduced due to reduced irrigated acreage and more efficient irrigation practices, which would presumably have less of an adverse impact on existing local springs."

Comment (3): Cautions against depending completely on return flows to meet environmental inflows into the estuary.
Response: The plan considers return flows, as well as pass-throughs from the CCR/LCC system to the Nueces Bay and Estuary based on the 2001 Agreed Order, to meet environmental inflows needs for the estuary. Also, the Rincon Bayou Overflow Channel has been reopened to provide freshwater to the Nueces Delta. Return flows currently amount to approximately 52% of water supplied from Choke Canyon/Lake Corpus Christi/Lake Texana system.

- *Section 4C- Water Management Strategies*

Comment (4): The TPWD questions whether treated wastewater to Delta can increase productivity by five, with Allison Demonstration Project. (WMS 05- Reclaimed Wastewater Supplies)
Response: Section 4C.5 considers biological productivity factors based on findings of previous studies, in addition to showing anticipated additional yield without biological productivity factors. The water supply plans for Nueces and San Patricio Manufacturing users (Sections 4B.11 and 4B.12) include supplies from reclaimed wastewater *without* using productivity multipliers (i.e. supply of 250 acft is based on yield recovery of 2-MGD Allison Demonstration Project as compared to 8.8-MGD project without productivity factors, as described in Table 4B.11-7 and Table 4B.12-5 footnotes).

Comment (5): The TPWD is concerned that with CCR/LCC system supporting majority of consumptive uses that minimum amount of inflow is all the bay will receive, except for flood condition.
Response: There have been extensive studies performed, including those by TPWD, TWDB, TAMU-Corpus Christi, and NEAC, to determine freshwater inflows necessary to support overall health of the Nueces Bay and Estuary. The results of these studies were used to establish reservoir operating procedures, required by the 2001 Agreed Order.

Comment (6): The TPWD is concerned about impacts associated with one way pipeline from CCR to LCC, since instream flows will be reduced downstream of CCR. (WMS 10- Pipeline Between Choke Canyon Reservoir and Lake Corpus Christi)
Response: According to the TWDB, regional planning is a reconnaissance level effort, and a detailed investigation of project impacts is beyond the scope and mandate of SB1. The impacts of the pipeline from CCR to LCC, if implemented, will be more extensively studied during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

- *Section 8- Unique Stream Segments and Reservoir Sites*

Comment (7): The TPWD is disappointed that plan does not recommend nomination of any stream segments as unique.
Response: The CPRWPG decided not to recommend nomination of unique stream segments because the implications of making this designation are unknown.

Texas Wildlife Association- 1 comment

- *Section 4C- Water Management Strategies*

Comment (1): Suggests consideration of voluntary land stewardship as water management strategy. (WMS 15- Brush Management)
Response: The following text will be added to Section 4C.15 describing voluntary land stewardship: "Brush management is one of many land management practices, collectively referred to as "voluntary land stewardship", that can provide water supply at its origin. Voluntary land stewardship includes (but is not limited to) absorbing rainfall, reducing run-off, using prescribed fire properly, planning and managing grazing, brush management, managing erosion, wildlife and habitat management, and protecting springs and creek banks. With an optimal, voluntary land stewardship program, floods are reduced, aquifers are replenished, and water is released more slowly and steadily into streams, rivers, lakes and bays. Although this water management strategy specifically addresses supplies attributable to brush management, additional water supply benefits, including additional inflow to reservoir systems, may be achieved with a comprehensive land stewardship program."

TWDB

Level 1 comments[1]- 23 comments

- *Executive Summary*

Comment (1): Summarize key report findings and recommendations regarding WMSs for the entire region.
Response: Table ES-5 summarizes the key report findings. It identifies which water user groups have projected needs, quantifies their needs, and summarizes recommended water management strategies to meet their needs for all water user groups in Region N. The following rows will be appended at the end of the table to summarize the total amount of projected water needs for the entire region.

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[1] Includes comments/questions to be addressed in order to meet statutory, agency rule, and contract requirements. The 17 editorial comments provided by TWDB are included in next section.

To Add to Table ES-5
Water Plan Summary for Coastal Bend Region

	Demand (acft)			Need (Shortage) (acft)		
Total Needs by Water User Type	**2010**	**2030**	**2060**	**2010**	**2030**	**2060**
Municipal	111,495	132,063	151,474	(566)	(753)	(2,395)
Manufacturing	63,820	73,861	88,122	(409)	(656)	(43,092)
Steam Electric	7,316	16,733	27,664	-	-	-
Mining	14,413	16,640	19,114	(1,802)	(4,471)	(7,572)
Irrigation	20,072	17,077	13,365	(627)	(514)	(373)
Livestock	8,838	8,838	8,838	-	-	-
Region N Total	**225,954**	**265,212**	**308,577**	**(3,404)**	**(6,394)**	**(53,431)**

Comment (2): Calculate average GPCD for 2000 and 2060 weighted by population.
Response: Revise based on comment. "Average per capita municipal water use in 2000 was 165 gallons per capita per day and is projected to decrease to 152 gallons per capita per day by 2060 due to built-in savings for low flow plumbing fixtures. This results in a reduction of 13,313 acft/yr in municipal water demand in 2060."

- *Section 1*

Comment (3): Revise GPCDs for WUGs based on TWDB calculation. (WMS-01 Municipal Water Conservation)
Response: The text will be revised based on comment. Differences were primarily attributable to rounding.

- *Section 2*

Comment (4): Revise demand increase between year 2000 and 2060.
Response: The text will be revised based on comment: "As shown in Table 2-3, total water use for the region is projected to increase by 102,641 acft/yr between 2000 and 2060, from 205,936 acft/yr to 308,577 acft/yr, a 49.8 percent rise."

Comment (5): Reconcile Rounding Differences in Water Demands by River Basin between IPP and DB07.
Response: DB07 has been revised to reflect Water Demands by River Basin presented in IPP.

Comment (6): The year 2000 water use estimates and projected water demands in 2010 through 2060 for Wholesale Water Providers (WWPs) should be reported by river basin.
Response: Table 2-11 will be revised to include 2000 water use and projected water demands in 2010 through 2060 *by river basin* for each wholesale water provider.

Comment (7): Reconcile Rounding Differences in Water Demand Projections for Wholesale Water Providers between IPP and DB07.
Response: DB07 has been revised to reflect Water Demands by River Basin presented in IPP.

- *Section 3*

Comment (8): Provide contractual and non-contractual obligations throughout the 50-year planning horizon.
Response: The following text will be added to Section 3.1.6: "The City of Corpus Christi has contractual obligations to provide consumptive water use plus up to 10% growth each year to City of Alice, City of Beeville, City of Mathis, Nueces County WCID #4 (Port Aransas), Violet WSC, and South Texas Water Authority. The City of Corpus Christi is contracted to provide up to 3,363 acft/yr to City of Three Rivers and up to 40,000 acft/yr to San Patricio Municipal Water District. Furthermore, the City of Corpus Christi provides water supply to meet needs of Manufacturing, Mining, and Steam and Electric water users in Nueces County. SPMWD and STWA meet water needs of their customers (Figure 3-3). Nueces County WCID #3 meets water needs of City of Robstown and City of North San Pedro and has contractual obligations to provide up to 291 acft/yr to River Acres WSC."

Comment (9): Verify water rights in Nueces River Basin and authorized diversion based on TCEQ water rights database"
Response: The text will be revised: "A total of 256 water rights exist in the Nueces River Basin with a total authorized diversion and consumptive use of 539,691 acft/yr.[2] In the Nueces River Basin, four water rights (1.5 percent) make up 483,444 acft/yr (89.5 percent) of the authorized diversion volume. The remaining 252 water rights primarily consist of small municipal, industrial, irrigation and recharge rights distributed throughout the river basin."

Comment (10): Verify number of water rights in coastal basins based on TCEQ water rights database.
Response: The number of water rights in coastal basins was verified to be 99. Footnote (2) listed above will be added to the text.

Comment (11): Verify diversions in the coastal basins, within CBRWP Area, and industrial diversions based on TCEQ water rights database.
Response: The text will be revised: "Combined, there are approximately 99 water rights in these two coastal basins authorizing diversions of about 1,838,600 acft/yr. Approximately 1,738,000 acft (94 percent) of the combined authorized diversions are from within the Coastal Bend Region Planning Area, and of these rights, 1,699,000 acft (98 percent) are industrial diversions for steam-electric and manufacturing processes from the bays and saline water bodies along the coast."

- *Section 4B- Water Supply Plans*

Comment (12): Drought contingency must be recommended as a water management strategy for certain water user groups with a need and must be considered for all water user groups with a need. If not recommended, please provide reasons for not adopting drought management strategies.
Response: The following text will be added to *Section 4B.1 Summary of Water Management Strategies:*

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[2] The number of water rights and corresponding authorized diversion amounts are based on the Texas Commission on Environmental Quality's Water Rights Database dated November, 2003.

Drought Management is not a recommended water management strategy to meet projected water needs in Coastal Bend Region, in part because it cannot be demonstrated to be an economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Coastal Bend Region shows total losses[3] (Table 4B.1-1) due to unmet water needs (shortages) of $29,471 per acft/yr in 2010 increasing to $289,582 per acft/yr in 2060.

Table 4B.1-1.
Projected Water Needs (Shortages) and Business, Personal Income, and Tax Losses from Unmet Water Needs in Coastal Bend Region

Year	*Projected Water Need (Shortage) (acft/yr)*	*Total Losses* ($millions/yr)*	*Cost per acft*
2010	3,404	100	$29,471
2020	4,691	153	$32,635
2030	6,394	224	$34,984
2040	19,794	1,714	$86,590
2050	35,796	5,309	$148,326
2060	53,431	15,473	$289,582
* Sum of business losses, personal income losses, and taxes lost (TWDB Table E-1)			

Source: TWDB, "Socioeconomic Impacts of Unmet Water Needs in the Coastal Bend Water Planning Area", May 2005

Clearly, the cost for water to meet projected water needs is only a fraction of the total loss associated with business, personal income, and tax revenue losses from not having the quantities of water needed. For example, in 2010 business losses are $21,103 per acft of shortage, income losses are $6,369 per acft, and tax losses are $999 per acft[4],
while short-term costs of water for recommended water management strategies in the 2006 Regional Water Plan range from $69/acft/yr for Municipal Conservation (using more water efficient showerheads and aerators), up to $3,612/acft/yr[5] for modifying industrial intake structures near Calallen Pool.

The Water Conservation water management strategies recommended in the 2006 Regional Water Plan, together with the other water management strategies appear to the CBRWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration. The uncertainty and the cost associated therewith is not acceptable to the CBRWPG, thus Drought Management is not included as a recommended water management strategy. However, the CBRWPG recommends that entities with drought management plans implement their plans during droughts.

Comment (13): Describe the process used to identify potentially feasible water management strategies approved by the planning group on January 8, 2004.
Response: The following text will be added to Section 4B.1: "The potentially feasible water management strategies selected by the CBRWPG for the 2006 Plan, are based on those identified

[3] Includes business production and sales impacts, personal income losses, and tax losses identified by TWDB.
[4] Calculated based on TWDB Table ES-1 and total projected regional water needs.
[5] Unit cost has been adjusted to include treatment. Cost for treatment is estimated at $225 per acft.

in the 2001 Plan, in addition to new projects identified by Wholesale Water Providers and other water user groups. Results from studies since the 2001 Plan, such as new volumetric survey of Lake Corpus Christi, assisted in the selection process of potentially feasible water management strategies."

Comment (14): Costs associated with redistribution should include a purchase cost for water made available from voluntary redistribution of surface water rights.
Response: Unit cost of $500 per acft assumed to be comparable to cost of treated Garwood water. The revised table is:

Table 4B.9-6.
Recommended Plan Costs by Decade for Live Oak-Manufacturing

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Surplus/(Shortage) (acft/yr)	(337)	(483)	(559)	(615)	(657)	(764)
Voluntary Redistribution of City of Three Rivers surplus						
Supply From Plan Element (acft/yr)	337	483	559	615	657	764
Total Annual Cost ($/yr)	$168,500	$241,500	$279,500	$307,500	$328,500	$382,000
Total Unit Cost ($/acft)	$500	$500	$500	$500	$500	$500

Comment (15): U.S. Army Corps of Engineers Nueces River Feasibility Projects costs are shown as if a federal subsidy has already been provided. Although subsidized costs can be included in the table, the table should reflect full costs for comparison with other strategies.
Response: Recommended water management strategies associated with the USACOE Nueces River Feasibility Projects are evaluated individually in Volume II (Section 4C.10 Pipeline Between Choke Canyon Reservoir and Lake Corpus Christi, Section 4C.11 Off-Channel Reservoir, and Section 4C.17 Seawater Desalination). Each water management strategy summary includes full costs for comparison with other strategies.

- *Section 4C- Water Management Strategies*

Comment (16): Evaluation of water management strategies must include "consideration of the provisions in Texas Water Code, for interbasin transfers of surface water. At a minimum this consideration shall include a summation of water needs in the basin and in the receiving basin, based on needs presented in the applicable approved regional water plan." This evaluation is needed for the Stage II of Lake Texana Strategy. (WMS 13- Stage II of Lake Texana)
Response: The following text will be added to Section 4C-13: "For the Coastal Bend Region, Stage II Lake Texana is recommended as a water management strategy to meet projected Year 2060 shortages for City of Corpus Christi and SPMWD customers. Water supply from Stage II of Lake Texana requires an interbasin transfer from Lavaca Region (Region P) to the Coastal Bend Region. In accordance with Texas Water Code provisions, the projected shortage in the Lavaca Region for year 2000 is 55,755 acft/yr, decreasing to 31,979 acft/yr in Year 2060.[6] The shortages are projected by Region P to be met by groundwater supplies. The CBRWPG

[6] Lavaca Regional Planning Group Draft Regional Water Plan, June 2005

recommends a supply of 23,000 acft/yr from Stage II of Lake Texana to meet a portion of the regional need of 53,431 acft/yr in Year 2060."

Comment (17): Include quantification of environmental factors for the operation of a siphon. (WMS 03- Manufacturing Water Conservation and Nueces River Water Quality Issues)
Response (17): The following text will be added to Section 4C.3.3: "Construction of the siphon system will include up to eight intake structures placed in the Nueces River. As the water volumes to be moved by this system will be relatively small (ca. 6 MGD, an intake stream of about 1.2 cfs at each of the eight intakes), the intake structures will be small. Disturbance of riparian and riverine habitats due to construction of eight intake structures is expected to total substantially less than one acre. Construction of the approximately 1.7 mile long pipeline to the upper end of Segment 2101 (Nueces River Tidal) will disturb about 6.7 acres of ground cover within a 30 foot wide construction easement. Impacts to riparian areas can be minimized by locating the pipeline outside of the very narrow wooded corridor that lines the left bank of the Nueces River in this reach.

Operation of the siphon system will result in changes in the ambient Nueces River TDS concentrations that are within the tolerance limits of the freshwater fish and invertebrate species of the lower Nueces River. Likewise, the relatively small discharge of Nueces River bottom water into the tidal segment will still be well within the generally accepted freshwater range (i.e., <2,500 mg/l), and will mix with brackish bay waters through tidal action, as is the case with existing Nueces River flows over Calallen Dam."

Comment (18): Base cost estimates on second quarter 2002 prices and not second quarter 2000 prices. (N 03- Manufacturing Water Conservation and Nueces River Water Quality Issues)
Response: Typographical error, table heading will be revised. Cost estimates included are based on second quarter 2002 prices.

Comment (19): Include in cost estimates the costs for the source of water supply, concentrate disposal, environmental and archeology studies/mitigation and power costs. (N 07- Gulf Coast Aquifer Supplies/ Brackish Groundwater Desalination)
Response: Table 4C-7.3 will be revised to include average costs for source of water supply, concentrate disposal, environmental and archeology study and power costs.

Comment (20): The overall analysis for regional aquifer storage and recovery is that it results in limited firm yield. Clarify if potential combinations of strategies involving ASR that were proposed for evaluation in the Supplemental Scope of Work Item 1, Task 5 also have limited firm yield. (N-8 Potential Aquifer Storage and Recovery from Gulf Coast Aquifer)
Response: The following text will be added after the last paragraph on page 4C.8-8:
"The potential ASR project was also evaluated in conjunction with other proposed water management strategies, such as the CCR/LCC Pipeline, off-channel reservoir, and over drafting the system with interruptible water from Lake Texana. The results of the additional analysis were very similar to those developed when ASR was operated without any additional water management strategies. The same limitations were identified when operated conjunctively as those when it is operated independently. The ASR system as proposed in the analysis was unable to provide any meaningful water supply benefits whether operated in a stand-alone mode

or conjunctively with other water management strategies. The additional yield in the conjunctive model runs was attributable to the other water management strategy not the ASR project."

Comment (21): Describe how senior water rights are protected in the analysis of water management strategies in pipeline between Choke Canyon Reservoir and Lake Corpus Christi (N-10) and off-channel reservoir (N-11). (N-10 Pipeline between CCR/LCC; N-11 Off-Channel Reservoir)
Response (21): For CCR/LCC Pipeline, the following text will be added to the last paragraph in the first section: "CCR is required to continue its release of 33 cfs for senior water rights and environmental considerations even with the pipeline in operation to deliver water supply releases."

For Off-Channel Reservoir, the following text will be added to the following at the end of the second paragraph in the first section: "The modeling analysis that was utilized in evaluating this option, and all other water management strategies of the Lower Nueces River Basin, has embedded logic that applies strict application of the prior appropriation doctrine to ensure that senior water rights are protected in all scenarios."

Comment (22): Describe the two model runs used to determine the increase in water supply provided by a large capacity pump station at Three Rivers located just below the confluence of the Nueces and Atascosa Rivers and operated in conjunction with the CCR to LCC pipeline. (N-10 Pipeline between CCR/LCC)
Response: Add the following text: "The analysis for the pump-back showed that unlike the off-channel reservoir project described in section 4C.11, which has the benefit of catching storm flows in LCC for later diversion over a long period of time, the pump back option could only divert the storm flows for a period of a few days as it traveled downstream. This resulted in significantly less flow being diverted into CCR, than could be diverted into the off-channel reservoir. The results of the pump-back option analysis indicated that from hydrological and operational standpoints this option was not efficient in producing the desired additional water supply."

Comment (23): Clarify which of the two desalination water management strategies; seawater desalination or combined seawater and brackish groundwater desalination are being recommended by the planning group. (TWDB)
Response: The CBRWPG recommended a 25 mgd seawater desalination plant with 29 mile pipeline.

Level 2 comments[7]- 17 comments

- *Executive Summary*

Comment (1): The description of County-Other in the plan should reflect that the County-Other category includes persons residing outside of cities and also outside water utility boundaries.
Response: The text will be revised based on comment.

[7] TWDB comments of editorial nature, which includes suggestions that might be considered to clarify or help enhance the plan.

- *Section 3*

Comment (2): For Section 3.1.7, change last line reference from "major water provider" to "wholesale water provider".
Response: The text will be revised based on comment.

Comment (3): Revise formatting with Table 3-3, so that numbers are more legible.
Response: The table format will be revised based on comment.

- *Section 4*

Comment (4): With respect to project impacts, the report could note that regional planning is a reconnaissance level effort, and a detailed investigation of impacts is beyond the scope and mandate of SB1. Impacts, costs and benefits of large-scale projects such as reservoirs or major diversions would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.
Response: Noted. This response will be used to address comments provided by others.

Comment (5): Numerous strategies are listed for the Aransas County-Other (Section 4B.2) category for a need of approximately 1,527 acre-feet/year in year 2050. Since this appears to reflect strategies selected for San Patricio MWD, perhaps the strategy that should be shown is securing, through contract, water from this supplier.
Response: Tables 4B.2-2 and 4B.2-3 will be revised based on comment.

Comment (6): For Section 4B.11.14, revise county reference to Nueces County instead of Live Oak County.
Response: The text will be revised based on comment.

- *Section 4C- Water Management Strategies*

Comment (7): For Table 4C.1-2, change reference to the Coastal Bend Water Planning Region.
Response: The text will be revised based on comment.

Comment (8): Consider changing the reference for the TWDB publication *A Guidebook for Reducing Unaccounted-for Water* to the new title, *Water Loss Manual.*
Response: The reference will be revised based on comment.

Comment (9): On page 4C.5-28, consider providing a complete reference for "2005 Integrated Monitoring Plan."
Response: A footnote will be added: "City of Corpus Christi, Integrated Monitoring Plan Fiscal Year 2005, January 2005."

Comment (10): On page 4C.7-41, there is a reference to a Section 4CV.7.1 which is not included in the document.
Response: The text will be revised to reflect Section 4C.7.1.

Comment (11): On page 4C.8-2, consider including a description of the Rockport Local Facility.
Response: Figure 4C.8-1 will be revised to remove reference to the Rockport Local Facility.

Comment (12): On page 4C.9-6, consider revising the discussion points in this note to reflect the update to the model prepared under this contract.
Response: The text will be revised for footnotes on page 4C.9-6 and 4C.9-7: "…In addition, due to sediment deposition in Choke Canyon Reservoir and Lake Corpus Christi, the model allows for a variety of sediment conditions ranging from the 1990 storage volumes in the lakes to the projected 2060 system storage capacities. The model has been developed and updated through a series of projects since 1991. During this planning cycle, the model was updated to include the new drought of record and currently operates on a 1934 to 2003 period of record (HDR, et al., "Nueces Estuary Regional Wastewater Planning Study, Phase 1," City of Corpus Christi, et al., November 1991; HDR, et al., "Nueces Estuary Regional Wastewater Planning Study, Phase 2," City of Corpus Christi, et al., March 1993; HDR, "Water Supply Update for City of Corpus Christi Service Area," City of Corpus Christi, January 1999; HDR, Supplemental Funding Work Item for 2006 Coastal Bend Regional Water Plan, 2005).

Comment (13): For Table 4C.11-1, identify measurement unit for the off-channel capacity column.
Response: The unit "acre-ft" will be added to the Off-Channel Capacity column in Table 4C.11-1.

Comment (14): On page 4C.12-3, consider reevaluating the price per acre-foot of water for this strategy based on more recent transaction costs and check to see if this site is adequate to identify the strategy referred to.
Response: The unit cost will be revised from $495 per acft to $505 per acft, based on estimated cost of Garwood water. The one time purchase price and annual costs will be revised accordingly.

Comment (15): For Table 4C.1-3, provide the source of the data in the "typical" columns or explain how it was calculated.
Response: A footnote will be added to explain how *typical* water savings was calculated: "Calculated based on potential savings identified by GDS Associates divided by number of people potentially affected, as reported in "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas," Texas Water Development Board, GDS Associates, Austin, Texas, July, 2003."

- *Section 10- Plan Adoption*

Comment (16): On page 10-2, change terminology to indicate a public hearing on the IPP occurred on July 14, 2005, rather than public meeting.
Response: The text will be revised based on comment.

- *Appendices*

Comment (17): List at the front of Appendix E, which conservation and drought contingency plans are included.
Response: The cover sheet for Appendix E will be updated to include list: City of Corpus Christi, San Patricio Municipal Water District, and South Texas Water Authority.

NWF, Environmental Defense, Sierra Club- 63 comments

- *Executive Summary*

Comment (1): Does not summarize the total amount of the projected water needs for the whole region."

Response: Table ES-5 presents all water user groups with their projected shortages and recommended water management strategies to meet needs. Additional rows will be appended at the end of the table to summarize the total amount of projected water needs. ***NOTE: See comment addressed earlier for TWDB Level 1 Comment (1) for recommended changes in table.***

Comment (2): Include discussion of total capital costs or annual costs for meeting projected needs.

Response: Total capital cost and annual costs columns will be added to Table ES-3 "Potential Water Management Strategies to Meet Long-Term Needs for Wholesale Water Providers" and Table ES-4 "Potential Water Management Strategies to Meet Long-Term Needs for Local Service Areas".

Comment (3): The executive summary, and the overall plan, seem to be lacking a concise listing of the recommended strategies. Different parts of the document suggest that different strategies are being recommended.

Response: Executive summary presents concise listing of recommended strategies in Table ES-5. Also, Section 4B Water Supply Plans present the same concise list of recommended strategies for each water user group to meet projected water shortages.

Comment (4): Suggest description of each potential water management strategy.

Response: In an attempt to make Executive Summary succinct, full descriptions of each water management strategy are included in Section 4C.

Comment (5): The CBRWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even through not specifically recommended in the plan. This would suggest that projects to increase diversion from existing supply sources or additional TCEQ permitting decisions should be considered consistent even if not evaluated in the regional plan. This is not reasonable approach and is not consistent with legislative direction.

Response: The context of the statement is with respect to repairing and replacing water treatment plants, pipelines, and water storage facilities. Impacts, costs and benefits of major diversions would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (6): Recommends only the development of the amount of supply required to meet projected needs rather than the development of an estimated 210,000 acre-feet of supply.

Response: The list of recommended water management strategies for each water user group with a need is presented in Section 4B. The list(s) often include supplies exceeding shortages in case water growth patterns and demands exceed TWDB projects or contractual supplies are reduced (as footnoted in Table 4B.11-7). It is understood that not all projects will be implemented, and that projects will be selected from the recommended list(s) to meet needs.

Comment (7): Social and Economic Impacts of Not Meeting Projected Water Needs assumes that water needs are left entirely unmet. This estimates impacts that would result under a worst-case scenario pursuant to which no additional supplies are provided and on attempt is made to mitigate impacts. Suggest that the planning group make clear that these figures represent a type of worst-case scenario and acknowledge the source of these projections.
Response: The text will be revised based on comment: "Socioeconomic impacts of unmet needs were evaluated by the TWDB and costs of unmet needs were provided to represent regional impacts of leaving water needs entirely unmet, representing a worst-case scenario."

- *Section 1*

Comment (8): No information provided about the criteria used by the planning group in determining that no springs in the region are major for water supply or natural resource protection purposes. There is not information regarding the potential impacts of proposed increased groundwater withdrawals on springs.
Response: A similar comment was addressed earlier for a TPWD comment. The following text will be added to Section 1.2.3: "Due to most areas having an underlying impervious clay layer, there has not been much opportunity for springs to form in the Coastal Bend Region. According to *Springs of Texas- Volume I* by Gunnar Brune, there are 18 small springs in the Coastal Bend Region with flows between 0.28 and 2.8 cfs and a number of these springs produce saline, hard, alkaline spring water. These are the largest documented springs in the Coastal Bend Region."

Comment (9): Clarify "shortage of freshwater and economically accessible groundwater attributable to increased irrigation demands" as a threat to agricultural resources or natural resources or both? Add more information about the nature of the threat.
Response: The CBRWPG recognizes potential shortages of freshwater and economically accessible groundwater attributable to increased irrigation demands as a potential threat to agricultural and natural resources. Localized groundwater pumping may result in water level declines and potential intrusion of saline groundwater into freshwater zones and land surface subsidence. Other neighboring regions that experience high groundwater use may have impact to nearby wells in the Coastal Bend Region. Water level declines may increase energy needed to pump water to user. A more detailed description of potential impacts is provided in Section 4C.7 in the discussion of environmental and implementation issues.

Comment (10): Should include significant wetlands and discussion of species occurring in habitats dependent on seeps and springs or rivers and streams and estuaries.
Response: Section 1.5 includes a list of endangered and threatened species of the Coastal Bend Region, including locations of their habitats. The following text will be added to Section 1.5: "The 2001 Agreed Order includes operational procedures for Choke Canyon Reservoir and Lake Corpus Christi and requires passage of inflows to the Nueces Bay and Estuary based on maximum harvest studies and inflow recommendations to maintain the health of the Nueces Estuary. According to the TPWD, the maximum harvest flow to the Nueces Bay and Estuary produced slightly higher harvests of red drum, black drum, spotted sea trout, and brown shrimp but slightly decreased amounts of blue crab."

Comment (11): Include basic information on City of Corpus Christi's water conservation and drought contingency plan.
Response (11): The City of Corpus Christi's drought contingency plan is included in Table 1-4 City of Corpus Christi Drought Management Plan (which includes water conservation measures) and the City's water conservation goals are included in Section 1.12.

- *Section 2*

Comment (12): Petroleum refining water use is defined as 46 gallons of water per barrel and 35 gallons per barrel. Verify.
Response: Typographical error has been corrected in Sections 2.3 and 4C.5 to reflect that Corpus Christi area petroleum refineries use between 35 and 46 gallons of water per barrel of crude oil refined.

Comment (13): Steam Electric seems to be overstated. Question reasonableness of procedure that TWDB used to calculate steam and electric water demands.
Response: TWDB provides the water demand estimates for steam-electric water users. Additional description of proposed water demand increases is attributable to new 1200 MW plant in Nueces County, listed as a future project by ERCOT, as presented in text.

- *Section 3*

Comment (14): Request mentioning that most water rights issued prior to 1985 do not include environmental flow conditions. The Certificate of Adjudication 21-3214 is an exception to that general rule.
Response: The text will be revised based on comment: "...Other restrictions may include a maximum diversion rate and instream flow restrictions to protect existing water rights and provide environmental flows for instream needs and needs of estuary systems, although most water rights issued prior to 1985 do not include such conditions. An important exception to the rule is Certificate of Adjudication Number (CA#) 21-3214 for Choke Canyon Reservoir, which represents approximately 75% of the Nueces River Basin water rights and requires instream flows and freshwater flows for the Nueces Estuary."

Comment (15): Clarify sediment conditions for safe yield identified in Table 3-3.
Response: The table will be revised to reflect CCR/LCC safe yield Year 2060 conditions (200,000 acft/yr) and footnote 1 will be changed to indicate firm yield using 2060 sediment conditions for all other water rights.

- *Section 4B- Water Supply Plans*

Comment (16): Include drought management measures.
Response: Additional text recommended, as addressed above in TWDB Level 1 Comment (12).

- *Section 4C- Water Management Strategies*

Comment (17): Encourage Region N to adopt: "For municipal water user groups with water use of 140 gpcd and greater, reduction of per capita water use by 1 percent per year until the

level of 140 gpcd is reached, after which, the rate of reduction is ¼ percent per year for the remainder of the planning period." (N-01 Municipal Water Conservation)
Response: The CBRWPG considered Task Force recommendations of 140 gpcd during the planning process, as well as recognizing areas where water use is strongly influenced by tourism and transient visitors. The CBRWPG adopted a recommendation that water user groups with water use greater than 165 gpcd reduce consumption by 15 percent by Year 2060.

Comment (18): The discussion of drought contingency and water conservation plans acknowledges only the drought contingency portion, and plans must also include water conservation measures that apply at all times. Regional groups must include consideration of more stringent water conservation and drought management measures than those required pursuant to Texas Water Code Sections 11.1271 and 11.272. 165 gallons per capita per day is not an acceptable target for the year 2060. Prohibition on wasting water, water conservation pricing and water-wise landscape design are not included in the recommended conservation techniques. (N-01 Municipal Water Conservation)
Response: Prohibition on wasting water, water conservation pricing and water-wise landscape design was included in the list of BMPs for municipal entities for the Coastal Bend Region. Since specific quantities of water saved and costs were unavailable for these BMPs, they were not included in calculating the average cost of municipal conservation.

Comment (19): No citation is given for "the City of Corpus Christi currently uses less water than comparable cities in the central Region of Texas and is currently among the lowest in the state, for all climatological regions." (N-01 Municipal Water Conservation)
Response: The statement will be removed from the text.

Comment (20): Revise "many of the conservation measures recommended will reduce inflows to the Nueces Bay and Estuary" to state "*Some of the* indoor conservation measures recommended could reduce the amount of treated wastewater available to send to the Nueces Bay and Estuary during low flow times." In Table 4C.1-8 revise to state "Some impact due to decreased return flow *which could be offset by possible positive impact resulting from higher reservoir levels*." (N-01 Municipal Water Conservation)
Response: The text will be revised based on comment.

Comment (21): Manufacturing water conservation section addresses numerous highly variable approaches. Evaluation of impacts should be considered for each separate strategy. Use of pipeline from LCC to Calallen should identify impact on channel losses for freshwater inflow releases and affects on bank storage, and could greatly increase channel losses when freshwater inflow releases were made from the reservoir. Pipeline would likely have impact on river corridor between Lake Corpus Christi and Calallen, affecting the water quality of remaining water in river bed. (N-03 Manufacturing Water Conservation and Nueces River Water Quality Issues)
Response: Additional text will be added to Section 4C.3.3 to include environmental impacts associated with operation of a siphon (see TWDB comment and response presented above). With respect to project impacts, regional planning is a reconnaissance level effort, and a detailed investigation of impacts is beyond the scope and mandate of SB1. Impacts, costs and benefits of projects, if implementing, will undergo additional and extensive evaluation during permitting

under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (22): Unclear which strategy is recommended. (N-03 Manufacturing Water Conservation and Nueces River Water Quality Issues)
Response (22): The manufacturing water conservation strategy recommended for manufacturing users in Nueces and San Patricio Counties is Option 1-Blending of Lake Texana Water with Nueces River Water, as indicated in footnote for Tables 4B.11-7 and 4B.12-5.

Comment (23): Recommend including Industrial BMPs as presented in Mining Water Conservation heading. (N-03 Manufacturing Water Conservation and Nueces River Water Quality Issues)
Response: The Task Force list of industrial BMPs (included on page 4C.4-5 in the Initially Prepared Plan) will be added to Section 4C.3.1.3.

Comment (24): Consider levels of zinc in wastewater discharges into Nueces Bay, particularly for industrial discharges. (N-05 Reclaimed Wastewater)
Response: Table 4C.5-8 will be revised to include zinc as a water quality concern for wastewater discharges.

Comment (25): Quantify environmental benefits associated with wastewater release projects. (N-05 Reclaimed Wastewater)
Response: Environmental benefits associated with wastewater release projects, such as Allison Demonstration Project, are described in Sections 4C.5.6.2 and 4C.5.6.3.

Comment (26): Describe how Campbellton Well project will affect aquifer over the long term and include quantitative evaluation. (N-06 Carrizo Aquifer Supplies)
Response: The Campbellton well project is not a recommended water management strategy. Additional studies would need to be competed prior to considering this as a recommended strategy.

Comment (27): Identify groundwater-surface water interaction associated with discharge of freshwater into the coastal estuaries. Add potential adverse impacts to surface streams in Evaluation Summary. (N-07 Gulf Coast Aquifer)
Response: The evaluation summary tables will be revised to include: "May slightly decrease instream flow and discharge of freshwater into coastal estuaries due to local groundwater-surface water interaction". The following text will be added to Section 4C.7.1.3 "The pumping of groundwater from the Gulf Coast Aquifer could have a very slight negative impact on baseflow in the downstream reaches of streams in these areas. However, many of the streams are dry most of the time; thus, no measurable impact on wildlife along the streams is expected.

Comment (28): Up to 25% of recharge to the Gulf Coast Aquifer in nearby Wharton and Matagorda counties ends up as freshwater discharge to near-coast waters.[8] (N-07 Gulf Coast Aquifer)
Response: The following text will be added to Sections 4C.7.2.8 and 4C.7.3.3: "A previous study estimates up to 25% of recharge to the Gulf Coast Aquifer in nearby Wharton and Matagorda counties ends up as freshwater discharge to near-coast waters.[8]"

Comment (29): The plan describes 250 feet below predevelopment levels as "long-term (sustainable) yields" but gives little further detail. Withdrawals proposed here are of such a magnitude that they just meet the regional water planning group's drawdown targets. As soon as the next five-year increment is added to the planning horizon, the planning group will be faced with either redefining the acceptable drawdowns (that is, increasing them) or lowering the acceptable pumping levels in that decade.
Response: The following text will be added to Section 3.4.1: "The issue of determining future acceptable drawdown (past Year 2060) should be considered in future planning cycles."

Comment (30): Provide additional information about potential impacts to agricultural users. (N-07 Gulf Coast Aquifer)
Response: Shortage of freshwater and economically accessible groundwater attributable to increased irrigation demands was listed as possible identified threat to agricultural users

Comment (31): Amount of inflow credit that might be extended is unclear and predicted yield increase is highly speculative (N-9 Modifying Existing Reservoir Operating Policy and Safe Yield Analyses)
Response: Section 4C.5 considers biological productivity factors based on findings of previous studies, in addition to showing anticipated additional yield without biological productivity factors. The water supply plans for Nueces and San Patricio Manufacturing users (Sections 4B.11 and 4B.12) include supplies from reclaimed wastewater *without* using productivity multipliers (i.e. supply of 250 acft is based on yield recovery of 2-MGD Allison Demonstration Project as compared to 8.8-MGD project without productivity factors, as described in Table 4B.11-7 and Table 4B.12-5 footnotes). *Note: See response provided above for a similar comment by TPWD Comment (4).*

Comment (32): Should mention significance of the location of increased wastewater discharges, since most would be returned to the lower portion of the estuary system where potential benefits are reduced. (N-9 Modify Existing Reservoir Operating Policy and Safe Yield Analyses)
Response: The following text will be added to Section 4C.9.3.1: "The location of treated effluent discharges is important to consider when evaluating the benefits to the Nueces Delta and Estuary. Effluent discharges returned to the upper portions of the Nueces Bay and Estuary will have greater potential benefits."

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[8] Dutton, A.R., and Richter, B.C., 1990. "Regional geohydrology of the Gulf Coast Aquifer in Matagorda and Wharton Counties, Texas: Development of a numerical model to estimate the impact of water management strategies", The University of Texas at Austin and Bureau of Economic Geology.

Comment (33): Frequency of larger inflow events would be decreased while amount of inflow during driest periods would be increased. Reduction of higher inflows would have substantial impact of estuary. (N-10 CCR/LCC Pipeline)
Response: These impacts will be studied more extensively during the USCOE Nueces Feasibility Study. Impacts, costs and benefits of projects, if implementing, will undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (34): Consider freshwater inflow impacts and location of inflows entering the system. Clarify basis of no additional permit conditions for purpose of protecting environmental flows would be required (N-11 Offchannel Reservoir)
Response: These impacts will be studied more extensively during the USCOE Nueces Feasibility Study. Impacts, costs and benefits of projects, if implementing, will undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (35): The NWF does not read the initially prepared plan as including the potential off-channel reservoir near Lake Corpus Christi as a recommended strategy. (N-11 Off-channel reservoir)
Response: The off-reservoir is recommended to meet City of Corpus Christi and SPMWD projected customer needs in Year 2040 through Year 2060. This strategy is included in the Voluntary Redistribution and USCOE Nueces Feasibility Study strategy. It enables the Wholesale Water Provider(s) and region to continue study of potential impacts of projects through state/federal funding participation.

Comment (36): For "utilization of unused City of Three Rivers' supply", acknowledge impacts associated with water out of the reservoir system that would not otherwise be used that would have impacts on downstream flows. (N-12 Voluntary Redistribution of Available Supplies and USACOE Nueces Feasibility Studies)
Response: The instream flow description in Table 4C.12-1 will be revised to read "Negligible. Utilization of surface water supplies that would not otherwise be used may have a minimal to low impact on downstream flows."

Comment (37): For use or purchase of underutilized Nueces County WCID #3 Water Right, acknowledge impacts associated with water out of the reservoir system that would not otherwise be used that would have impacts on downstream flows. (N-12 Voluntary Redistribution of Available Supplies and USACOE Nueces Feasibility Studies)
Response: The instream flow description in Table 4C.12-2 will be revised to read "Negligible. Utilization of surface water supplies that would not otherwise be used may have a minimal to low impact on downstream flows."

Comment (38): Recommendation to proceed with Stage II of Lake Texana has not been justified in the plan. (N-13 Stage II of Lake Texana)

Response: The City of Corpus Christi is considering Stage II of Lake Texana in their future water supply plans. Stage II of Lake Texana has been recommended in the plan to meet City of Corpus Christi and SPMWD projected customer needs beginning in Year 2060.

Comment (39): The water efficiency measures included in Region N's initially prepared plan do not achieve levels of water savings needed to support authorization of new interbasin transfers of surface water. (N-13 Stage II of Lake Texana)
Response: The CBRWPG's adopted municipal water conservation targets for the region (reducing consumption by 15% by Year 2060 for entities using greater than 165 gpcd) is considered the highest practicable level of water conservation and efficiency achievable. The water use in the Coastal Bend Region is strongly influenced by tourism and transient visitors.

Comment (40): Clarify how releases made from Lake Texana would exceed mitigation requirements and enhance productivity of certain species in the bay and estuary. (N-13 Stage II of Lake Texana)
Response (40): The text will be revised: "In 1997, a study[9] was conducted by the LCRA to estimate target and critical freshwater inflow needs for the Matagorda Bay System from the Colorado River. Target inflow is defined based on criteria established for salinity and nutrient inflow, in addition to necessary long-term inflow to produce 98% of maximum population for nine key estuarine species. Critical freshwater inflow is the minimum inflow, based on salinity levels, necessary to provide for fish habitat during drought conditions. Recent studies of Matagorda Bay and Lavaca-Colorado Estuary[10] indicate that releases to the bay and estuary (from 1941-1987), on average, exceed target inflow by over 50% with an average inflow of 3,080,301 acft as compared to a target inflow of 2,000,100 acft.[11] These inflows, which include releases from Lake Texana, exceed mitigation requirements and may enhance the productivity of certain species in the bay and estuary."

Comment (41): Should acknowledge that assessment of Freshwater Inflow Needs for the Matagorda Bay System is undergoing a revision. Future analyses may require additional provisions, beyond the Consensus Criteria, to minimize the potential for the cumulative impacts. (N-13 Stage II of Lake Texana)
Response: The following text will be added to the preceding comment: "The Freshwater Inflow Needs for the Matagorda Bay System is currently undergoing a revision which should be considered in future water planning efforts."

Comment (42): IPP understates potential for adverse impacts on instream flows and freshwater inflows to bays and estuaries. Acknowledge and discuss the findings of the LCRWPG IPP showing interruptible water during drought periods reducing to 5,500 acft in 2060, supporting that the Garwood Project would have significant adverse impact on freshwater inflows, particularly during dry conditions. (N-14 Garwood Pipeline)

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[9] LCRA, "Freshwater Inflow Needs of the Matagorda Bay System," December 1997.
[10] TWDB, "Texas Bay and Estuary Program- Matagorda Bay and Lavaca-Colorado Estuary", 1998.
[11] The monthly average inflow exceeds target monthly inflow for all months, except April which is slightly less than target levels.

Response: The evaluation summary in Table 4C.14-5 recognizes possible impacts to Colorado River and Lavaca-Colorado Estuary associated with utilization of Garwood water rights. Additional text will be included to qualify possible adverse impacts during drought conditions.

Comment (43): NWF cautions against using "average" flows for evaluations. Update with data and predictions of future trends in inflows to the Bay. (N-14 Garwood Pipeline)
Response: With respect to project impacts, this regional planning report is a reconnaissance level effort, and a detailed investigation of impacts is beyond the scope and mandate of SB1. Impacts and benefits associated with the Garwood project would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (44): Review potential for land stewardship to increase inflows into the reservoir system. (N-15 Brush Management)
Response: The following text will be added to Section 4C.15 describing voluntary land stewardship: "Brush management is one of many land management practices, collectively referred to as "voluntary land stewardship", that can provide water supply at its origin. Voluntary land stewardship includes (but is not limited to) absorbing rainfall, reducing run-off, using prescribed fire properly, planning and managing grazing, brush management, managing erosion, wildlife and habitat management, and protecting springs and creek banks. With an optimal, voluntary land stewardship program, floods are reduced, aquifers are replenished, and water is released more slowly and steadily into streams, rivers, lakes and bays. Although this water management strategy specifically addresses supplies attributable to brush management, additional water supply benefits, including additional inflow to reservoir systems, may be achieved with a comprehensive land stewardship program." *Note: This response was provided above for a similar comment from Texas Wildlife Association.*

Comment (45): Consider environmental and energy implications. Discuss complications of constructing a concentrate disposal pipeline. Discuss disposal of concentrate in Oso Bay for combined seawater and brackish groundwater option.
Response: Section 4C.17 (Volume II) includes descriptions of environmental and implementation issues for seawater and brackish groundwater desalination and includes discussions on concentrate disposal and energy. These impacts will be studied more extensively during the USCOE Nueces Feasibility Study. With respect to project impacts, regional planning is a reconnaissance level effort, and a detailed investigation of impacts is beyond the scope and mandate of SB1. Impacts, costs and benefits of large-scale desalination project, if implemented, will undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state, or local regulations.

Comment (46): Discuss impacts of pumping large amounts of groundwater for brackish groundwater desalination. (N-17 Seawater Desalination)
Response: The environmental impacts of pumping groundwater for brackish groundwater desalination, including slight reductions on baseflow in downstream reaches and possible land

surface subsidence is described in Section 4C.17.3. Section 4C.17.5 discusses implementation issues associated with developing brackish groundwater supplies.

Section 6- Water Conservation and Drought Management Recommendations
Comment (47): Include drought management as a water management strategy (i.e. identify some water needs that are nonessential and not plan to meet those needs during critical droughts or present "dry-year option" for irrigator to receive cash payment for not irrigating during drought conditions.
Response: As noted in a response to TWDB Level 1 Comment (12) regarding drought management: "The Water Conservation water management strategies recommended in the 2006 Regional Water Plan, together with the other water management strategies appear to the CBRWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration. The uncertainty and the cost associated therewith is not acceptable to the CBRWPG, thus Drought Management is not included as a recommended water management strategy. However, the CBRWPG recommends that entities with drought management plans implement their plans during droughts."

Section 7- Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources
Comment (48): Do not feel that regional plan supports level of information necessary to support such a finding.
Response (48): Additional voluntary analyses conducted on cumulative effects of water management strategies referenced in Section 7 and included in Appendix L support long-term protection of instream flow and inflows to the Nueces Estuary.

Comment (49): Consider Current, Natural, and Water Plans-Without Surface Water Imports from Other Basins scenarios.
Response: On October 27th, 2005, the CBRWPG considered a request by National Wildlife Federation for additional cumulative effects analysis of current, natural, and future conditions-without interbasin imports. The CBRWPG decided not to approve the scope of work for the addition analysis of the cumulative effects of the water management strategies to the Nueces Estuary.

Comment (50): Justify selection of water management strategies included in Cumulative Effects analysis for Year 2060.
Response: The water management strategies considered in the cumulative effects analysis provided water supply sufficient to meet projected 2060 water demands for the City of Corpus Christi and their customers. The cumulative effects analysis also showed the impact of recharge structures in Region L.

Comment (51): Cumulative effects analysis does not provide an adequate basis for evaluating the ecological significance of protected flow levels. Without information about ecological effects, plan is inadequate in demonstrating consistency with long-term protection of the state's natural resources.

Response: The recommended water management strategies were analyzed according to the 2001 Agreed Order for freshwater inflows to the Nueces Bay and Estuary. Furthermore, each water management strategy summary in Volume II contains an assessment of potential environmental impacts. The CBRWPG does not endorse the assumptions in Bays in Peril report that NWF used to conduct their ecologically-based assessments.

Comment (52): Environmental flows should be recognized as a water demand and plans should seek to provide reasonable levels of environmental flows.
Response: This comment is noted and should be discussed in future water supply planning efforts.

Comment (53): Depleting groundwater sources will not be consistent with long-term protection of state water resources.
Response: The CBRWPG adopted criteria for acceptable water level drawdowns. This criteria was adhered to during analysis of groundwater availability, and when drawdown levels exceeded criteria, pumping was curtailed to acceptable drawdown levels (thus resulting in a shortage).

Section 8- Legislative Recommendations, Unique Stream Segments, and Reservoir Sites
Comment (54): Rephrase water reuse statement to say "water re-use should be promoted, wherever practical, taking into account appropriate provision for protection of downstream water rights, domestic and livestock uses, and environmental flows."
Response: The text will be revised based on comment.

Comment (55): Consider interbasin transfers to the repeal of "additional application requirements for interbasin transfers included in Senate Bill 1" should be narrowed.
Response: A CBRWPG subcommittee engaged in a thoughtful, time-intensive effort to develop the CBRWPG legislative and regional policy recommendations. The subcommittee recommendations were discussed in detail at the May 12, 2005 meeting and approved by the CBRWPG.

Comment (56): Request for planning group to provide information regarding the basis for the decision not to recommend stream and river segments for designation.
Response: The CPRWPG decided not to recommend nomination of unique stream segments because the implications of making this designation are unknown. *Note: This comment was addressed earlier in response to TPWD comment.*

Appendix D
Comment (57): Include schematic and illustration of net drawdown map. Include one similar to that included on page 4C.7-15.
Response: Appendix D will be revised to include drawdown maps as shown in Section 4C.7.

Comment (58): Add itemization or discussion of assumed local pumping that would occur in Refugio, Goliad, or other Region L counties.
Response: The following text will be added to Appendix D: "The annual pumping for local supply in Goliad County (Region L) is predicted to increase from 1,920 acre-ft/yr in 2000 to 2,501 acre-ft/yr in 2060. The annual pumping for local supply in Refugio County (Region L) is

expected to decline from 2,358 acre-ft/yr in 2000 to 1,690 acre-ft/yr by 2060.[12] Graphs that include the projected pumping trend by aquifer for each Region L county can be found in the Region L Plan."

Comment (59): Explain how LGWSP year by year pumping schedule is derived.
Response: The LGWSP pumping schedule is determined based on modeled surface water availability for each year and water demands, as described on page D-14. The following text will be added to clarify: In Refugio County, 61 percent of the total LGWSP pumping was proportioned to sixteen 1,000-gpm wells spaced approximately 3,000-feet apart. In Victoria County, 24 percent of the total LGWSP pumping was proportioned to seven 1,000-gpm wells spaced at approximately 3,000 feet. In Goliad County, the remaining 15 percent of the total LGWSP pumping was proportioned to five 800-gpm wells spaced approximately 2,500 feet apart.[12]

Comment (60): Explain how impacts of proposed major projects could be underpredicted if drought occurs during a different timeperiod than that modeled (i.e. 2056 to 2060).
Response: Additional GAM runs would be necessary to determine the impact of proposed project during different timeperiods. This detailed investigation is beyond the scope and mandate of SB1. If CBRWPG is interested, such studies can be included in future water planning efforts.

Appendix E
Comment (61): Request including model water conservation plan and drought contingency plans.
Response: The City of Corpus Christi, SPMWD, and STWA plans are included as models. Section 3 summarizes drought contingency plans for other local entities.

Appendix E.1 & E.2 & E.3
Comment (62): City of Corpus Christi, SPMWD, and STWA water conservation plans and drought contingency plans do not appear to be current.
Response: The water conservation and drought management plans included in the plan are the most current ones available: City of Corpus Christi (2001); San Patricio Muncipal Water District (May 2005); South Texas Water Authority (April 2005).

Appendix L
Comment (63): Consider including presentation of a map of drawdowns and time series plots of drawdowns at representative points for groundwater management strategies (to coincide with Appendix D).
Response: The description of the cumulative effects analysis (Appendix L) is intended to provide a succinct description of the impact of water management strategies on Nueces River instream flows and freshwater inflows to the Nueces Bay and Estuary. A drawdown map of impacts associated with groundwater projects is included in Section 4C.7. The following text will be added to Appendix L: "The maximum drawdown in the Evangeline Aquifer near the San Patricio Municipal Water District and City of Corpus Christi wellfields is approximately 50-feet

[12] HDR, South Central Texas Regional Water Initially Prepared Plan, June 2005.

in Bee, San Patricio, and Refugio Counties as shown in Section 4C.7. These projects do not exceed the drawdown criteria adopted by the CBRWPG."

Appendix N.2
Public Comments

REC'D SEP 19 2005

Coastal Bend Regional Water Planning Group

6300 Ocean Drive, NRC 3100, Corpus Christi, Texas 78412
Phone: 361-825-3193; Fax: 361-825-3195

MEMORANDUM

To: Kristi Shaw

From: Rocky Freund

Date: September 16, 2005

Re: IPP Comments

Enclosed are the written comments I have received for Region N's Initially Prepared Plan.

Public Comment Form
Coastal Bend Regional Water Planning Group

Date: 8-8-05
Name: Bob WARREN
Address: 1310 PRINCE DR. C.C. TX.
Email: JRW6871536@AOL.Com

Would you like to be included on our mailing list? ✓

Comment: Would Like to Know the Cost Estimate of Projects

Question(s): Why Not Consider pipe Line Between Lake Corpus Christi & Cavallo Water Treatment Plant?

Please answer during meeting: ✓

Please answer via mail/email: ______

*If you need more room, please use back of card

1. Pipe Line Between Choke Canyon Reservoir And Lake Corpus Christi

2. OFF-Channel Reservoir Near Lake Corpus Christi.

I Would Recommend these Two Projects

Appendix N.3
Comment Letter No. 1
(TWDB)

15

TEXAS PARKS & WILDLIFE

September 12, 2005

Mr. Rocky Freund
Nueces River Authority, Coastal Bend Division
6300 Ocean Drive, Unit 5865
Corpus Christi, TX 78412-5865

Dear Ms. Freund:

Thank you for the opportunity to review and comment on the 2005 Initially Prepared Regional Water Plan (IPP) for the Coastal Bend Region N. Texas Parks and Wildlife Department (TPWD) acknowledges the time, money and effort required to produce the regional water plan as mandated by Senate Bill 1 of the 75th Legislature. A number of positive steps have been taken since the first planning cycle to advance the issue of environmental protection. For example, the regional water planning groups were faced with a new requirement under 31 TAC §357.7(a)(8)(A), to perform a "quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico" when evaluating water management strategies. TPWD recognizes that each region's unique natural resources, water management strategies and funding limitations dictated the level of quantitative analysis for each regional plan. Nonetheless, TPWD feels strongly that quantification of environmental impacts is a critical step in planning for our state's future water needs while also protecting environmental resources.

TPWD staff has reviewed the IPP to determine if the following questions were addressed:

- Does the plan include a quantitative reporting of environmental factors including the effects on environmental water needs, habitat?
- Does the plan include a description of natural resources and threats to natural resources due to water quantity or quality problems?
- Does the plan discuss how these threats will be addressed?
- Does the plan describe how it is consistent with long-term protection of natural resources?
- Does the plan include water conservation as a water management strategy? Reuse?
- Does the plan recommend any stream segments be nominated as ecologically unique?
- If the plan includes strategies identified in the 2000 regional water plan, does it address concerns raised by TPWD at that time?

In general the Region N IPP includes a quantitative reporting of environmental factors. The plan does include a description of the Coastal Bend natural resources that mentions "birds", major "ecosystems", and threatened and endangered species but there is little mention of coastal/estuarine aquatic resources (e.g., commercial or recreational fisheries species, waterfowl, etc.) dependent on freshwater inflows or problems from lack thereof. While this section does set the foundation for the functional role of freshwater inflows, namely lowering salinity; adding nutrients, and delivering sediments, it falls short of identifying the natural resources dependent on these same flows. For areas in the Region where groundwater is the primary source of water supply, emphases should be placed on protecting springs that support fish and wildlife.

The Coastal Bend Region deserves credit for being on the forefront of water conservation. TPW especially supports the Region's consideration of brush control/management as an additional means of conserving water if done in a manner that can also benefit wildlife habitat. TPW cautions against depending completely on return flows to meet environmental inflows into the estuary system. Treated effluent is missing the necessary sediment component which is important for maintaining nursery function for the important fish and shrimp species. TPW staff is not convinced that treated wastewater delivered to the Nueces Delta can be expected to increase productivity by a factor of five. The results of the Allison Demonstration Project clearly show that there is little to no far-field correlation between productivity and effluent diverted into the Delta regions of Nueces Bay.

It is disappointing that the plan does not recommend nomination of any stream segments as ecologically unique. The Region N IPP does recommend that additional environmental field studies of potentially unique stream segments and potential unique reservoir sites on the Aransas River and Copano Creek provided additional clarification is provided by the Texas Legislature regarding the repercussions of identifying a stream segment as unique.

While most of the 2005 Plan is a well written report that provides sufficient detail covering water resources (specific to municipal, manufacturing, irrigation, steam-electric, and livestock), several concerns still remain. It appears that because the majority of consumptive uses are assumed to be met by the Choke Canyon Reservoir/Lake Corpus Christi (CCR/LCC) system, the needs of the environment are assumed to be met. In one sense this is good in that there is some amount of water that is almost guaranteed for bay and estuary inflows. In another sense, it can be a negative, because that same minimum amount of inflow is all the bay will ever receive, save for a flood condition. The region should consider this in the next revision of the plan. TPW staff is also concerned about the potential impacts associated with the one-way pipeline since instream flows will decrease in the river below CCR. More detailed evaluations of the impacts of reduced flow to the river habitat are needed.

Thank you for your consideration of these comments. It is clear that the region is looking for opportunities to meet its charges. Please be assured that TPWD will continue to work with the region to explore all possibilities to meet future water supply needs and assure the ecological health of the region's aquatic resources.

Sincerely,

Larry D. McKinney, Ph.D.
Director of Coastal Fisheries

LDM:CL:dh

Appendix N.4
Comment Letter No. 2
(TWA)

Texas Wildlife Association

"Working for tomorrow's wildlife ... TODAY!"

401 Isom Rd., Suite 237 • San Antonio, TX 78216 • 210/826-2904 • 800/839-9453 • FAX 210/826-4933

September 21, 2005

Ms. Carola Serrato
Chairman, Region N Water Planning Group
South Texas Water Authority
P.O. Box 1701
Kingsville, Texas 78364

Dear Ms. Serrato:

Thank you for leading Texas' vital water planning efforts. At the Texas Wildlife Association (TWA), we support customized solutions created as close to the affected resource as possible; therefore, we appreciate your planning committee's ongoing commitment to the resources in your care.

The TWA is a non-profit organization representing private land stewards, land managers, hunters and anglers from across the state of Texas. Our members care for and control more than 30 million acres of rangeland and wildlife habitat that are key components of Texas' upstream watersheds. The involvement of private land stewards is critical in establishing Texas' long-term water policies.

As you finalize your regional plan, we would be remiss if we did not bring voluntary land stewardship to your attention again. The relationship between the land's condition and the quality and quantity of water available to Texans is inextricably linked. In fact, good land stewardship encompasses a myriad of activities far beyond brush control. (For an all-encompassing definition and discussion of land stewardship, please see the attached Handout A and the November 2005 edition of "At Issue" written by Robert L. Cook, Executive Director of the Texas Parks & Wildlife Department.) Private landowners who optimize the condition of their land are effectively engaged in water ranching, in addition to the more visible activities of raising cattle or managing wildlife.

Open space land is Mother Nature's sponge, capturing water for both our underground and surface supplies. The land's condition determines how much water is captured for our aquifers, rivers, lakes, streams, bays and estuaries or how much water is lost to detrimental run-off and evaporation.

Incorporating good land stewardship into any water plan makes sense because, voluntary land stewardship is:

***Complementary:** Optimizing the condition of Texas' rural water catchments (also known as watersheds) ensures the increased effectiveness of any other water supply strategies that may be implemented. Years of scientific research has shown that effective, efficient rural water catchments will provide more water, better water and more options for water planners. Good land stewardship is the foundation upon which all other water supply strategies should rest.

Regional Water Planning Group Chairman
September 21, 2005
Page 2

***Cost-effective:** Improving the condition of the state's rural water catchments is relatively inexpensive. The cost for generating additional water through voluntary land management practices is dozens of dollars per acre-foot, and sometimes it's no-cost. Other proposed methods generate additional water at the cost of hundreds or thousands of dollars per acre-foot.

***Sustainable:** Responsible, voluntary land stewardship is a sustainable practice. Once people begin to implement the best management practices necessary to optimize the range in their particular location, those practices can continue uninterrupted.

***Efficient:** Good, voluntary land stewardship does not make more rain; it just makes the most of what we receive. Obviously, a well-managed landscape with 75 percent rainfall efficiency captures more usable water than a poorly managed one with 25 percent efficiency. With 75 percent rainfall efficiency, the landscape could benefit from increased water percolation and vigorous plant performance. With 25 percent rainfall efficiency, the landscape will operate under drought conditions even in years with normal rainfall.

***Environmentally Sensitive:** Good, voluntary land stewardship practices not only optimize the rural water catchments, but also provide exceptional wildlife habitat while conserving our state's remaining open space land. Good, voluntary land stewardship solves problems rather than creates them.

***Multi-faceted:** Good, voluntary land stewardship practices are not a "one size fits all" proposition. Each ecological region may require a different set of management practices to achieve the best results, and we will see more immediate results in some ecological regions than in others. Fortunately, this creates a great deal of flexibility, allowing prioritization and long-term planning.

While brush management can be part of good land stewardship, it is not the only option for rangeland management and improvement; therefore, Best Management Practices (BMPs) should be part of any cost-share, public-private program and/or contract. The BMPs should consistently include range re-seeding and livestock deferment to successfully establish native vegetative stands as well as good follow-up grazing management.

***Governable:** In order to promote even better land stewardship, policy makers should consider implementing Best Government Practices (BGPs). BGPs, as used in other states, provide a wide range of options that might include: increased cost-shares at targeted, prioritized water enhancement sites; increased technical assistance in range and wildlife management planning; a system of Purchases of Development Rights to keep priority properties together under good management; and reduced valuations, tax breaks, or other incentives for participation in water enhancement management practices.

Voluntary land stewardship is the logical place for water management to begin because land stewardship affects the water supply at its origins, not just at its destination. We find it difficult to understand why people charged with water management focus their efforts on destination and demand, while virtually ignoring the issues of origination and supply. If we maximize the effects of the rainwater that falls from the sky, then the answers to questions of demand are much more easily answered.

Water harvesting provides one example of water-induced tunnel vision. In most water plans, a great deal of space is dedicated to water harvesting, collecting the rainwater that falls on roofs – roofs that are generally measured in square feet. But yet, these same plans ignore the millions of acres of "unroofed" rangeland that are the foundation for the region's water catchment. Why? The rainwater harvested from rural grasslands, savannahs, forests, and wetlands is not as easily visible as that collected from urban rooftops.

Ground and surface water supplies originate with the rain that falls on the land and is captured by a complex, large-scale process involving plants, soil and animals. When the process functions optimally, floods are reduced, aquifers are replenished, and water is released more slowly and steadily into streams, rivers, lakes and eventually our bays and estuaries. If the land is in good condition, the quality and quantity of water – both surface and underground – available to citizens reflect that condition. When the process is working well across millions of acres of open, rural land the contribution to the state's water supply can be tremendous.

Interestingly, when conscientious land stewards ably manage their resources as they do every day, they are ranching water just as surely as they are ranching cattle, sheep, goats or wildlife. Unfortunately, this contribution is overlooked or misunderstood. We must include voluntary land stewardship – on a grand scale – as one of the foundation solutions for water issues in Texas.

When it comes to water policy, good land stewardship is like the first step on a staircase. The staircase will stand if you remove the last step, a middle step or even the second step, but the staircase will come crashing down if there is no first step. Please help Texas ensure that this very vital first step is in place as the foundation of planning for our future.

To help you incorporate voluntary land stewardship into your plan, we have taken the liberty of enclosing our report, "Texas' Looming Water Crisis: Recognizing Land Stewardship's Untapped Potential," which we believe would fit your purposes well. Please use the information to help Texans secure their future.

If you have any questions, please do not hesitate to contact us using the information below.

Yours for a clean and enjoyable outdoors,

Kirby Brown

Kirby L. Brown
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Texas Wildlife Association
"Working for tomorrow's wildlife ... TODAY!"
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Handout A

What is Voluntary LAND STEWARDSHIP?
(It's a lot more than just brush control...)

- Absorbing Rainfall/Reducing Run-Off/Increasing Base-Flow
- Using Prescribed Fire Properly
- Planning and Managing Grazing (Including Deferment...)
- Managing Brush Appropriately (It's never controlled, and some of it's important for wildlife!)
- Managing Erosion
- Reseeding With Natives (As Necessary...)
- Wildlife and Habitat Management Plans
- Managing and Restoring Riparian Areas
- Protecting Springs and Creek Banks
- Increasing Bio-Diversity
- Conserving Rare Species
- Limiting Habitat Fragmentation with Appropriate Estate Planning
- Being a Good Neighbor
- Contributing to Your Community
- Conserving Aquifer Recharge Areas
- Managing Exotic Species (Flora and Fauna) as Appropriate
- Investigating Existing and New Incentive Programs (PDRs, CRP, GRP, LIP, etc.)
- Being Open to New Ideas, Constantly Evaluating Plans/Methods, and Adjusting as Indicated
- Getting Informed, Getting Involved, VOTING, etc.

Land stewardship shifts thinking and vocabulary because good land stewardship allows the land to catch water instead of shed it.

Rural land is a water CATCHMENT not a waterSHED!!!!

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AT ISSUE

FROM THE PEN OF ROBERT L. COOK

Land. They say they're not making any more of it, you know, and they say there is less and less of it everyday. If you love the outdoors, and nature, and seeing critters and beautiful sunsets, and hearing bullfrogs and katydids, you know what I mean. People have fought and died over land, and ranched and plowed and lived off the land since the beginning of time. Every day, more land washes downstream to the oceans, the mountains become a little less rugged, and we who cherish the land so deeply pave over and build homes and offices atop another 2,800 acres of land in Texas every single week. The folks at the United States Department of Agriculture tell us that between 1982 and 1997, 2.2 million acres of rural land in Texas were converted to "urban uses." You can bet it is worse today. I'm scared to ask.

I reckon that some folks think that the only things that land is good for is either cows or some undistinguishable crop of who knows what, or for folks like me who love to tromp around in the brush and breathe fresh air. Who needs all that, right? Take a wild guess where that rib-eye and baked potato that you eat tonight comes from, or how that cotton that you wear on your back got there. Whichever it was that came first, both the chicken and the egg were produced on the farm and both required a lot of cracked milo and corn before they reached your refrigerator. And for those of you who sneer at us meat-eaters, I hope that you will pause momentarily to consider what an immense effort and expense is required to produce your diet of whole grain, granola bars, fresh fruit and "farm-raised" vegetables.

Private landowners in Texas are critical to our livelihood, our lifestyle and our welfare. Land conservation programs are essential to our food and water supply.

Maybe if we realized how dependent we all are on rural, undeveloped land, it would help us understand the need to preserve and protect that land. OK, try this: "the land" that we're talking about here is where your water comes from! That's right, the water that you drink, and bathe in, and wash your dishes with is produced on our land. Since water initially falls from the sky, some folks don't see how land fits into the equation. Unless you've got a cistern to catch the water that runs off your roof, your water comes from the land. Every drop of water that we require in our homes, industry, agriculture and for fish and wildlife falls back to earth in the wonderful cycle of evaporation, rainfall and snow. Some of it soaks deep into the soil to replenish our aquifers; some of it filters through the grasslands and then flows down our rivers and through our lakes where we harvest it and use it. Then the cycle starts all over again. We all need, use and benefit from "the land".

Private landowners in Texas are critical to our livelihood, our lifestyle and our welfare. Land conservation programs and agricultural conservation easements that keep rural land in farm and ranch production are essential to our food and water supply. The Texas Farm and Ranchland Conservation Program, which was recently enacted by the Texas Legislature to help keep rural land in the hands of farmers and ranchers in Texas, and to encourage, support and reward good land stewardship, is a great new program for our state. In addition, it is important to remember that Texans need more rural, undeveloped parkland and wildlife lands where public access for hiking, camping, boating, biking, hunting, fishing and outdoor recreation use is welcomed and encouraged for current and future generations.

You know what they say: Life is better outdoors.
Get outdoors, enjoy.

Robert L. Cook

EXECUTIVE DIRECTOR

Texas Parks and Wildlife Department mission statement:

To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations.

Appendix N.5
Comment Letter No. 3
(TWDB)

September 28, 2005

Ms. Carola Serrato, Co-Chair
Coastal Bend Regional Water Planning Group
c/o South Texas Water Authority
P.O. Box1701
Kingsville, TX 78364

Ms. Rocky Freund
Nueces River Authority, Coastal Bend Division
6300 Ocean Drive, Unit #5865
Corpus Christi, TX 78412-5865

Mr. Scott Bledsoe III, Co-Chair
Coastal Bend Regional Water Planning Group
P.O. Box 3
Oakville, TX 78060

Re: Texas Water Development Board Comments for the Coastal Bend Regional Water Planning Group (Region N) Initially Prepared Plan, Contract No. 2002-483-459

Dear Mmes. Serrato and Freund and Mr. Bledsoe:

Texas Water Development Board (TWDB) staff completed a review of the Initially Prepared Plan (IPP) submitted June 2, 2005 on behalf of the Coastal Bend Regional Water Planning Group. The two sets of attached comments ("A" addresses the IPP, and "B" the electronic database) follow a format similar to those used in developing the prior regional plans, including:

- Level 1: Comments and questions that must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements; and
- Level 2: Comments and suggestions for consideration that may improve the readability and overall understanding of the regional plan,

Also, the TWDB's statutory requirement for review of potential interregional conflict will not be completed until all applicable data and information has been provided by any potentially affected planning group. TWDB's streamflow assessment, based on full implementation of the region's IPP, will be provided under separate cover.

Ms. Carola Serrato
Mr. Scott Bledsoe, III
Ms. Rocky Freund
September 28, 2005
Page 2

Title 31, Texas Administrative Code (TAC) §357.11(b) requires the regional water planning group to consider timely agency and public comment. Section 357.10(a)(3) of the TAC requires the final adopted plan include summaries of all timely written and oral comments received, along with a response explaining any resulting revisions or why changes are not warranted.

If you have questions, please contact Carolyn Brittin at (512) 475-0933.

Sincerely,

William F. Mullican III
Deputy Executive Administrator
Office of Planning

Attachments

c w/atts.: Mr. Ken Choffel, HDR Engineering, Inc.

Attachment A

Coastal Bend Initially Prepared Plan – Region N

LEVEL 1. Comments and questions *must be satisfactorily addressed* in order to meet statutory, agency rule, and/or contract requirements.

Executive Summary

1. IPP Chapter, Page, Paragraph: Executive Summary: The key report findings and recommendations regarding WMSs are not summarized for the entire region. *[Title 31, Texas Administrative Code (TAC) §357.10(a)(2)]*

2. Executive Summary, page ES-10, Box in the 1st Paragraph: It appears that the average GPCDs for 2000 and 2060 are not weighted by population. For example, simply averaging only two GPCDs, one of a large city and another of a small town, does not represent the actual overall GPCD since it ignores the relative population sizes. The overall average GPCD for the region should be calculated, not by averaging the individual city GPCDs, but by using the total municipal water demand divided by the total population for the entire region. The correctly projected GPCD should be 165 for the year 2000 and 152 for the year 2060. In addition, the total savings for the region in 2060 due to the plumbing fixtures (shown as 12,880 acft/yr in the IPP) is not correctly calculated. The correct figure should be 13,313 acft/yr. *[Title 31, TAC §357.7(a)(2)(C)]*

Chapter 1

3. Ch 1.3, page 4C.1-3, Table 4C.1-1: The GPCDs for the following WUGs are slightly different than the GPCDs used in calculating the TWDB approved demand projections. Please correct using the correct GPCDs shown as below. *[Contract Exhibit "B," Section 4.2.4]*

Table 4C.1-1 Municipal Water User Groups Projected Per Capita Water Use

Water User	County	Source	2000	2010	2020	2030	2040	2050	2060
County-Other	Kenedy	IPP	99	96	94	90	90	88	88
		TWDB	***100***	96	94	***91***	***89***	88	88
County-Other	Brooks	IPP	103	99	96	92	91	89	87
		TWDB	103	99	96	***93***	***90***	89	***89***
Choke Canyon WSC	McMullen	IPP	143	142	140	139	137	134	134
		TWDB	143	***141***	***139***	***138***	137	***136***	***136***
El Oso WSC	Bee	IPP	167	163	163	160	158	156	157
		TWDB	***169***	***165***	***162***	***159***	***157***	156	***156***

Chapter 2

4. Ch 2.3, Page 2-4, Last Paragraph: The demand totals in 2000 and 2060 listed are the same as the TWDB approved demand totals. However, the demand increase between the year 2000 (205,936 acft) and 2060 (308,577 acft) cited as 102,701 acft/yr should be 102,641 acft/yr. *[Title 31, TAC §357.5(d)(1)&(2)]*

5. Ch 2.3, Page 2-7, Table 2-3; Ch 2.3.1, Page 2-10, Table 2-4; Ch 2.3.2, Page 2-16, Table 2-7; Ch 2.3.2, Page 2-17, Table 2-8; Ch 2.3.3, Page 2-19, Table 2-9: The following water demands totaled by river basins are different than the amounts in the DB07 planning database. The discrepancies appear to be due to rounding or the reallocation of demands between river basins. Please revise, or coordinate with TWDB staff to ensure that data in the IPP report is the same as that in the DB07 database as required. *[Title 31, TAC§357.7(a)(2)(A)(iv)]*

- **Table 2-3 Costal Bend Region total Water Demand**

River Basin	Source	D2000	D2010	D2020	D2030	D2040	D2050	D2060
NUECES	IPP	38,214	40,749	50,576	53,816	57,286	61,033	65,637
	DB07	38,217	***40,747***	***45,729***	***48,151***	***50,619***	***53,147***	***56,267***
NUECES-RIO GRANDE	IPP	137,622	152,734	164,339	175,110	184,816	193,843	203,406
	DB07	137,622	***152,737***	***169,188***	***180,778***	***191,485***	***201,729***	***212,777***
SAN ANTONIO-NUECES	IPP	30,097	32,471	34,749	36,286	37,408	38,378	39,534
	DB07	30,097	***32,470***	***34,747***	***36,283***	***37,406***	38,378	***39,533***

- **Table 2-4 Municipal Water Demand**

River Basin	Source	D2000	D2010	D2020	D2030	D2040	D2050	D2060
NUECES	IPP	10,017	10,832	11,628	12,184	12,521	12,698	12,821
	DB07	10,017	***10,831***	11,628	12,184	12,521	12,698	12,821
NUECES-RIO GRANDE	IPP	74,787	83,683	92,369	99,570	105,617	111,198	115,677
	DB07	74,787	***83,684***	92,369	99,570	105,617	111,198	115,677

- **Table 2-7 Steam-Electric Water Demand Projections by Basin**

River Basin	Source	D2000	D2010	D2020	D2030	D2040	D2050	D2060
NUECES	IPP	3,768	3,133	10,977	12,834	15,097	17,855	21,218
	DB07	3,768	3,133	***6,129***	***7,366***	***8,429***	***9,969***	***11,847***
NUECES-RIO GRANDE	IPP	5,031	4,183	3,335	3,899	4,586	5,425	6,446
	DB07	5,031	4,183	***8,183***	***9,567***	***11,254***	***13,311***	***15,817***

- **Table 2-8 Mining Water Demand Projections**

River Basin	Source	D2000	D2010	D2020	D2030	D2040	D2050	D2060
NUECES	IPP	5,046	6,350	7,068	7,515	7,963	8,414	8,814
	DB07	5,046	***6,349***	7,068	***7,518***	***7,964***	8,414	***8,815***
NUECES-RIO GRANDE	IPP	5,876	6,925	7,509	7,875	8,239	8,609	8,938
	DB07	5,876	***6,926***	***7,510***	***7,874***	8,239	8,609	8,938
SAN ANTONIO-NUECES	IPP	975	1,138	1,210	1,250	1,288	1,324	1,362
	DB07	975	1,138	***1,209***	***1,248***	***1,287***	1,324	***1,361***

- **Table 2-9 Irrigation Water Demand Projections by Basin**

River Basin	Source	D2000	D2010	D2020	D2030	D2040	D2050	D2060
NUECES	IPP	6,971	6,284	5,678	5,129	4,637	4,197	3,804
	DB07	6,971	6,284	***5,679***	5,129	4,637	4,197	3,804
NUECES-RIO GRANDE	IPP	8,100	7,585	7,123	6,715	6,347	6,019	5,723
	DB07	8,100	***7,586***	***7,123***	***6,716***	***6,348***	6,019	5,723
SAN ANTONIO-NUECES	IPP	6,900	6,203	5,810	5,233	4,719	4,254	3,838
	DB07	6,900	***6,202***	***5,809***	***5,232***	***4,718***	4,254	3,838

6. Ch 2.4, page 2-21, Table 2-11: The year 2000 water use estimates and the projected water demands in 2010 through 2060 for Wholesale Water Providers (WWPs) should be reported by river basin. *[Title 31, TAC §357.7(a)(2)(B)]*

7. Ch 2.4, page 2-21, Table 2-11: The following water demand projections for WWPs listed in the IPP are slightly different than the amounts in the DB07, possibly due to rounding. Please revise, or coordinate with TWDB staff to ensure that the data in the IPP report is the same as the DB07 database as required. In addition, the City of Ingleside on the Bay may have been added to the City of Ingleside. The two WUGs should be listed separately. *[Title 31, TAC §357.7(a)(2)(B)]*

Table 2-11 Water Demand Projections for Wholesale Water Providers

- **City of Corpus Christi**

NUECES County	Source	2010	2020	2030	2040	2050	2060
MINING	IPP	1,375	1,453	1,494	1,534	1,572	1,612
	DB07	***1,376***	***1,454***	1,494	1,534	1,572	1,612
Total Water Demand	IPP	172,901	191,489	203,570	215,161	226,658	239,505
	DB07	***172,902***	***191,490***	203,570	215,161	226,658	239,505

- **San Patricio Municipal Water District**

ARANSAS County	Source	2010	2020	2030	2040	2050	2060
COUNTY-OTHER	IPP	1,524	1,686	1,740	1,687	1,575	1,491
	DB07	1,524	1,686	1,740	1,687	***1,576***	***1,492***
Total Water Demand	IPP	28,684	33,046	36,722	39,925	42,724	45,742
	DB07	28,684	33,046	36,722	39,925	***42,725***	***45,743***

<u>Chapter 3</u>

8. Chapter 3, Page 3-10: Provide contractual and non-contractual obligations throughout the 50-year planning horizon. *[Contract Exhibit "B," Section 5.1]*

9. Section 3.1.3, page 3-6, 3rd paragraph: The IPP states that "A total of 269 water rights exist in the Nueces River Basin with total authorized diversion and consumptive use of 591,117 ac-ft/yr." However, according to the TCEQ water right database, the total number of water rights in Nueces River Basin is 256 with total authorized diversion of 539,363 ac-ft/yr. Please reconcile and revise these numbers, if appropriate. *[Contract Exhibit "B," Section 3.1]*

10. Section 3.1.4, page 3-9, 1st paragraph, line 9: The IPP reports 99 water rights in the two coastal basins. However, according the TCEQ water right database shows 89 water rights. Please reconcile and revise these numbers, if appropriate. *[Contract Exhibit "B," Section 3.1]*

11. Section 3.1.4, page 3-9, 1st paragraph, line 10 through line 12: The IPP reports several authorized diversion numbers: 1,841,000 ac-ft /yr in the coastal basins; 1,737,000 ac-ft /yr from within the Coastal Basin; and 1,717,000 ac-ft /yr of industrial diversions. However, according the TCEQ water right database, these numbers should be 1,783,480 ac-ft/yr, 1,685,303 ac-ft/yr, and 1,673,398 ac-ft/yr, respectively. Please revise these numbers, if appropriate. *[Contract Exhibit "B," Section 3.1]*

<u>Chapter 4</u>

12. Chapter 4: Drought contingency must be recommended as a water management strategy for certain water user groups with a need and must be considered for all water user groups with a need. If not recommended, please provide reasons for not adopting drought management strategies for each WUG with a need. *[Title 31, TAC §357.7(a)(7)(B) and Texas Water Code §11.1272]*

13. Chapter 4: Describe the process used to identify potentially feasible water management strategies approved by the planning group on January 8, 2004. *[Title 31, TAC §357.5(e)(4)]*

14. Chapter 4B, Page 4B.9-5, Table 4B.9-6: Costs associated with redistribution should include a purchase cost for water made available from voluntary redistribution of surface water rights. *[Title 31, Texas Administrative Code §§357.7(a)(7)(D) and 357.7(a)(8)(A)(i), and Contract Exhibit "B," Section 4.2.9]*

15. Chapter 4B, Page 4.B-12-7, Table 4B.12-5, Note 6: U.S. Army Corps of Engineers Nueces River Feasibility Projects costs are shown as if a federal subsidy has already been provided. Although subsidized costs can be included in the table, the table should reflect full costs for comparison with other strategies. *[Title 31, TAC §357.7(a)(8)(E)]*

16. Vol. II, Chapter 4C.13, Page 4C.13-5: Evaluation of water management strategies must include "consideration of the provisions in Texas Water Code, for interbasin transfers of surface water. At a minimum, this consideration shall include a summation of water needs in the basin of origin and in the receiving basin, based on needs presented in the applicable approved regional water plan." This evaluation is needed for the Stage II of Lake Texana strategy. *[Title 31, TAC §357.7 (a)(8)(F) and Texas Water Code §11.085(k)(1)]*

17. Volume II, Section 4C.3.3, page 4C.3-28: Include quantification of environmental factors for the operation of a siphon. *[Title 31, TAC §357.7(a)(8)(A)(ii)]*

18. Vol. II, Chapter 4, Table 4C.3-2, page 4C.3-29 and Table 4C.3-2, page 4C.3-32: Base cost estimates on second quarter 2002 prices and not second quarter 2000 prices. *[Contract Exhibit "B," Section 4.2.9]*

19. Vol. II, Chapter 4, page 4C.7-21: Include in cost estimates the costs for the source of water supply, concentrate disposal, environmental and archeology studies/mitigation and power costs. *[Contract Exhibit "B," Section 4.2.9]*

20. Volume II, 4C.8-8, second paragraph: The overall analysis for regional aquifer storage and recovery (ASR) is that it results in limited firm yield. Clarify if potential combinations of strategies involving ASR that were proposed for evaluation in the Supplemental Scope of Work Item 1, Task 5 also have limited firm yield. *[Contract Supplemental Scope of Work Item 1, Task 5]*

21. Volume II, Sections 4C.10 and 4C.11: Describe how senior water rights are protected in the analysis of water management strategies N-10 (pipeline between Choke Canyon Reservoir and Lake Corpus Christi) and N-11 (off-channel reservoir). *[Title 31, TAC §357.5(e)(3) and §358.3(b)(9)]*

22. Volume II, Page 4C.10-1: Describe the two model runs used to determine the increase in water supply provided by a large capacity pump station at Three Rivers located just below the confluence of the Nueces and Atascosa Rivers and operated in conjunction with the CCR to LCC pipeline. *[Contract Supplemental Scope of Work]*

23. Vol. II, Chapter 4C, Pages 4C.17-1 to 17-24: Clarify which of the two desalination water management strategies; seawater desalination or combined seawater and brackish groundwater desalination are being recommended by the planning group. . *[Title 31, TAC §357.5(e)(2)]*

LEVEL 2. Comments and suggestions that *might be considered* to clarify or help enhance the plan.

Executive Summary

24. Page ES-7, 2nd paragraph: The description of County-Other in the plan should reflect that the County-Other category includes persons residing outside of cities and also outside water utility boundaries.

Chapter 3

25. Chapter 3, Page 3-13, under heading **3.1.7, Wholesale Water Providers,** last line: Change the reference from "major water provider" to "wholesale water provider."

26. Chapter 3, Table 3-3, Page 3-16: There appears to be a formatting problem with this table that makes it difficult to read the numbers that overlap.

Chapter 4

27. Chapter 4, general comment: With respect to project impacts (environmental, third-party etc.), the report could note that regional planning is a reconnaissance level effort, and a detailed investigation of impacts is beyond the scope and mandate of SB1. Impacts, costs and benefits of large-scale projects such as reservoirs or major diversions would, if implemented, undergo additional and extensive evaluation during permitting under Section 404 of the Clean Water Act, the National Environmental Protection Act and any other applicable federal, state or local regulations.

28. Chapter 4B, Page 4B.2-5: Numerous strategies are listed for the Aransas County—Other category for a need of approximately 1,527 acre-feet/year in the year 2050. Since this appears to reflect strategies selected for San Patricio MWD, perhaps the strategy that should be shown is securing, through contract, water from this supplier.

29. Chapter 4B, Page 4B.11-13, Section 4B.11.14, last sentence: The appropriate county reference appears to be Nueces County instead of Live Oak County.

30. Volume II, Page 4C.1-5, Table 4C.1-2: Change reference from South Central Texas Water Planning Region to the Coastal Bend Water Planning Region.

31. Vol. II, Chapter 4C, page 4C.1-9, paragraph 3: The TWDB publication *A Guidebook for Reducing Unaccounted-for Water* is now called *Water Loss Manual.* Consider changing this reference.

32. Volume II, Page 4C.5-28: Consider providing a complete reference for "2005 Integrated Monitoring Plan." A note on page 4C.5-2 refers to a "Final Integrated Monitoring Plan Fiscal Year 2005."

33. Volume II, Page 4C.7-41, Section 4C.7.3.4, third line: There is a reference to a Section 4CV.7.1 which is not included in the document.

34. Volume II, Page 4C.8-2: Consider including a description of the "Rockport Local Facility."

35. Page 4C9-6, Note 10: The discussion points in this note do not appear to be current given the update to the model prepared under this contract. Please consider revising the note.

36. Volume II, Page 4C.11-3, Table 4C.11-1: Identify measurement unit for the off-channel capacity column.

37. Volume II, Page 4C.12-3: Consider reevaluating the price per acre-foot of water for this strategy based on more recent transactions costs. *Note: Check to see if this site is adequate to identify the strategy referring to.*

38. Vol. II, Chapter 4C, page 4C.1-7, Table 4C.1-3: Provide the source of the data in the "Typical" columns or explain how it was calculated.

Chapter 10

39. Chapter 10, page 10-1, near middle of the page: Change terminology to indicate a public hearing on the IPP occurred on July 14, 2005, rather than public meeting.

Appendices

40. Appendix E-1: List at the front of this appendix which conservation and drought contingency plans are included.

Appendix N.6
Comment Letter No. 4
(NWF, Environmental Defense, and Sierra Club)

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September 20, 2005

Ms. Carola Serrato, Chair
Mr. Scott Bledsoe, III, Chair
Region N Water Planning Group
c/o Nueces River Authority, Coastal Bend Division
6300 Ocean Drive, Unit 5865
Corpus Christi, Texas 78412-5865

Re: Comments on Initially Prepared 2006 Regional Water Plan for Region N

Dear Ms. Serrato, Mr. Bledsoe, and Planning Group Members:

The National Wildlife Federation, Lone Star Chapter of the Sierra Club, and Environmental Defense appreciate the opportunity to provide written comments on the Initially Prepared Regional Water Plan for Region N. We consider the development of comprehensive water plans to be a high priority for ensuring a healthy and prosperous future for Texas and we appreciate the contributions you have made towards that goal.

As you know, our organizations have provided, either individually or collectively, periodic input during the process of developing the plan. These written comments will build upon those previous comments in an effort to contribute to making the regional plan a better plan for all residents of the Coastal Bend region and for all Texans.

Our organizations appreciate the amount of effort that has gone into developing the draft Plan for Region N. We recognize that the draft Plan is subject to revision prior to adoption and is subject to continued revision in the future and provide these comments with such revisions in mind. Your consideration of these comments will be appreciated.

I. BACKGROUND AND OVERVIEW

Our organizations support a comprehensive approach to water planning in which all implications of water use and development are considered. Senate Bills 1 and 2 (SB1, SB2), and the process they established, have the potential to produce a major, positive change in the way Texans approach water planning. In order to fully realize that promise, water plans must provide sufficient information to ensure that the likely impacts and costs of each potential water management strategy are described and considered. Only with that information can regional planning groups ensure compliance with the overarching requirement that "strategies shall be selected so that cost effective water management strategies which are consistent with long-term protection of the state's water resources, agricultural resources, and natural resources are adopted." 31 TAC § 357.7 (a)(9).

Complying with this charge is essential in order to develop genuine plans that are likely to be implemented as opposed to a list of potential, but expensive and damaging, projects that likely will produce more controversy than water supply.

This document includes two types of comments. We consider the extent to which the initially prepared plan complies with the requirements established by SB1 and SB2 and by the Texas Water Development Board (TWDB) rules adopted to implement those statutes. In addition, our comments address important aspects of policy that might not be controlled by specific statutes or rules. We recognize that the financial resources available to the planning group are limited, which may restrict the ability of the group to fully address some issues as much as you would like. These comments are provided in the spirit of an ongoing dialogue intended to make the planning process as effective as possible.

We strongly support the state's water planning process and we want the regional water plans and the state plan to be comprehensive templates that can be endorsed by all Texans. Key principles that inform our comments are summarized below, followed by specific comments keyed to different aspects of the initially prepared plan.

Principle I: Maximize Water Efficiency
We strongly believe that improved efficiency in the use of water must be pursued to the maximum extent reasonable. New provisions included in SB2 and TWDB rules since the first round of planning mandate strengthened consideration of water efficiency. New water supply sources that are potentially environmentally damaging and expensive should not be considered unless, and until, all reasonable efforts to improve efficiency have been exhausted. In fact, that approach is now mandated. The Texas Water Code, as amended by SB1 and SB2, along with the TWDB guidelines, establishes stringent requirements for consideration and incorporation of water conservation and drought management. As you know, Section 16.053 (h)(7)(B), which was added after completion of the first round of regional planning, prohibits TWDB from approving any regional plan that doesn't include water conservation and drought management measures at least as stringent as those required pursuant to Sections 11.1271 and 11.1272 of the Water Code. In other words, the regional plan must incorporate at least the amount of water savings that are mandated by other law. In addition, the Board's guidelines require the consideration of more stringent conservation and drought management measures for all other water user groups with water needs.

Consistent with TWDB's rules for water planning, we consider water conservation measures that improve efficiency to be separate and distinct from reuse projects. We agree that reuse projects merit consideration. However, the implications of those projects are significantly different than for water efficiency measures and must be evaluated separately. Section 31 TAC § 357.7 (a)(7)(A) of the TWDB rules sets out detailed requirements for evaluation of water management strategies consisting of "water conservation practices." Section 357.7(a)(7)(B) addresses water management strategies that consist of drought management measures. The separate evaluation of water management strategies that rely on reuse is mandated by 31 TAC § 357.7 (a)(7)(C).

The Coastal Bend region is in a relatively dry area of a relatively dry state and it only makes sense for the region to plan to use water as efficiently as possible. Region N has incorporated water conservation into the initially prepared regional plan, but much more needs to be done. For municipal use, Region N's stated goal that all water user groups with a per capita usage rate of over 165 gallons per capita per day (gpcd) should reduce by 15% is not nearly as strong as it should be. While average municipal gpcd throughout Region N is not terribly high, the average disguises the fact that many municipalities in Region N still have high usage rates and, thus, the potential for significant water savings. We do acknowledge that the planning group has recommended that all groups meet this less stringent goal, not just groups with needs.

We encourage Region N to adopt the municipal water conservation goal adopted by Region L:

> "For municipal water user groups (WUGs) with water use of 140 gpcd and greater, reduction of per capita water use by 1 percent per year until the level of 140 gpcd is reached, after which, the rate of reduction of per capita water use is one-fourth percent (0.25) per year for the remainder of the planning period; and
>
> For municipal WUGs having year 2000 water use of less than 140 gpcd, reduction of per capita water use by one-fourth percent per year."

These excerpts are from Initially Prepared 2006 South Central Texas Regional Water Plan (SCTR Plan) at p. 6-1. Region K also has fairly strong water conservation goals. Both Region K & L distinguish between reuse and true water efficiency measures.

TWDB rules are clear in requiring that a regional plan must, for each WUG for which a new interbasin transfer is recommended, include "a conservation water management strategy, pursuant to § 11.085 (l), that will result in the highest practicable level of water conservation and efficiency achievable." See 31 TAC § 357.7 (a)(7)(A)(iii) (emphasis added). The water efficiency measures included in Region N's initially prepared plan do not achieve the levels of water savings needed to support the authorization of new interbasin transfers of surface water.

Principle II: Limit Nonessential Use during Drought
Drought management measures aimed at reducing demands during periods of unusually dry conditions are important components of good water management. As noted above, Senate Bill 2 and TWDB rules mandate consideration and inclusion in regional plans of reasonable levels of drought management as water management strategies. It just makes sense to limit some nonessential uses of water during times of serious shortage instead of spending vast sums of money to develop new supply sources simply to meet those nonessential demands.

Because drought management measures are not included as water management strategies, Region N's initially prepared plan does not comply with applicable requirements.

Principle III: Plan To Ensure Environmental Flows
New rules applicable to this round of planning require a quantitative analysis of environmental impacts of water management strategies.[1] Environmental flows provide critical economic and ecological services that must be maintained to ensure consistency with long-term protection of water resources and natural resources, which also is required before a regional water plan can be approved. See § 16.053 (h)(7)(C) of the Texas Water Code and 31 TAC § 357.7 (a)(13). An initial critical step towards assessing consistency with long-term protection is an analysis of the overall impact of existing water rights and recommended water management strategies on environmental flows. That analysis should consider both changes in flow patterns and the biological significance of such changes. *Although Appendix L does include some analyses of flow alterations, those analyses do not provide an adequate basis for evaluating the ecological significance of projected flow levels. Without information about ecological effects, the initially prepared plan does not include information adequate to demonstrate consistency with long-term protection of the state's natural resources.*

Even a good quantitative analysis that shows little additional adverse impact on environmental flows, however, would not automatically demonstrate consistency of the regional plan with long-term protection of natural resources. If existing water rights, when used as projected, would cause serious disruption of environmental flows resulting in harm to natural resources, merely minimizing additional harm from new strategies would not produce a water plan that is consistent with long-term protection of natural resources or that would protect the economic activities that rely on those natural resources.

As you know, the National Wildlife Federation (NWF) undertook an analysis of the effect of existing water rights on freshwater inflows to the Nueces Estuary. We acknowledge the ongoing discussions between the planning group and NWF about undertaking a revised comprehensive analysis of the expected impacts of existing water rights and proposed water management strategies on freshwater inflows. We strongly support the inclusion of such an analysis in the plan and believe that it would provide information critical to a meaningful assessment of the consistency of the regional water plan with long-term protection of the state's natural resources (more on this below).

In addition, we believe that environmental flows should be recognized as a water demand and plans should seek to provide reasonable levels of environmental flows. As an example, we would note that the initially prepared plan for the Lower Colorado River Basin (Region K) does include such recognition of environmental flows as a water demand.

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[1] The rules require that each potentially feasible water management strategy must be evaluated by including a quantitative reporting of "environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico." 31 TAC § 357.7 (a)(8)(A)(ii).

Principle IV: Minimize New Reservoirs
New reservoirs should be considered only after existing sources of water, including water efficiency and reuse, are utilized to the maximum extent reasonable. When new reservoirs are considered, adverse impacts to regional economies and natural resources around the site must be minimized and the reservoir must be shown to be consistent with long-term protection of the state's water, agricultural, and natural resources.

Alternative sources that would be less damaging and less costly are available; therefore the apparent recommendation to proceed with Stage II of Lake Texana has not been justified in the plan. We do not read the initially prepared plan as including the potential off-channel reservoir near Lake Corpus Christi as a recommended strategy. However, if it were to be recommended, additional analyses are required regarding its potential impacts.

Principle V: Manage Groundwater Sustainably
Wherever possible, groundwater resources should be managed on a sustainable basis. In our terminology, a sustainable basis means that in the long-term (well beyond the current planning horizon) withdrawals must be balanced with recharge while also maintaining adequate natural discharges such as seeps and significant springs. Mining groundwater supplies will, in many instances, adversely affect surface water resources and constitute a tremendous disservice to future generations of Texans. Generally speaking, depleting groundwater sources will not be consistent with long-term protection of the state's water resources, natural resources, or agricultural resources.

The Region N IPP calculates groundwater availability based on allowing significant drawdowns for the Gulf Coast aquifer (up to 125 feet below predevelopment levels in the unconfined aquifer and up to 250 feet below predevelopment levels in the confined aquifer). The plan describes these levels of drawdown as "long-term (sustainable) yields" but gives little further detail. The problem of labeling that approach sustainable becomes apparent even in considering the next scheduled round of regional planning. As discussed on page 3-20, the withdrawals proposed here are of such a magnitude that they just meet the regional water planning group's drawdown targets (up to 250ft). Thus, as soon as the next five-year increment is added to the planning horizon, the planning group will be faced with either redefining the acceptable drawdowns (that is, increasing them) or lowering the acceptable pumping levels in that decade.

Although the initially prepared plan uses the term "sustainable yield," it does not appear to be recommending an approach that is sustainable long-term. We urge the planning group to adopt a true sustainability goal for groundwater management and to provide additional information about the implications of the proposed groundwater management approach for the Gulf Coast aquifer and what it could mean for the region long-term (i.e., beyond the planning horizon).

Principle VI: Facilitate Short-Term Transfers
Senate Bill 1 directs consideration of voluntary and emergency transfers of water as a key mechanism for meeting water demands. Water Code Section 16.051 (d) directs that rules governing the development of the state water plan shall give specific consideration to

"principles that result in the voluntary redistribution of water resources." Similarly, Section 16.053 (e)(5)(H) states that regional water plans must include consideration of "voluntary transfers of water within the region using, but not limited to, regional water banks, sales, leases, options, subordination agreements, and financing arrangements...." Thus, there is a clear legislative directive that the regional planning process must include strong consideration of mechanisms for facilitating voluntary transfers of existing water rights within the region, particularly on a short-term basis as a way to meet drought demands.

In addition, emergency transfers are intended as a way to address serious water shortages for municipal purposes. They are a way to address short-term problems without the expense and natural resource damage associated with development of new water supplies. Water Code Section 16.053 (e)(5)(I), as added by SB1, specifically directs that emergency transfers of water, pursuant to Section 11.139 of the Water Code, are to be considered, including by providing information on the portion of each non-municipal water right that could be transferred without causing undue damage to the holder of the water right. Thus, the water planning process is intended as a mechanism to facilitate voluntary transfers, particularly as a means to address drought situations, by collecting specific information on rights that might be transferred on such a basis and by encouraging a dialogue between willing sellers and willing buyers on that approach. Generally, the IPP seems to do a good job of considering voluntary transfers of water and we commend the planning group for looking at those possibilities.

II. PAGE-SPECIFIC COMMENTS

EXECUTIVE SUMMARY

The regional water planning process is intended to be an open, public process. However, it is not reasonable to expect that most members of the general public will be able to spend the time to read the plan in its entirety. Thus, a comprehensive executive summary is critical for educating members of the public about the contents of the plan and directing them to issues of particular interest to them.

We urge the planning group to revisit the executive summary. As drafted, it lacks concise summaries of vital information about the plan. For example, it does not summarize the total amount of the projected water needs for the whole region. (This figure does not come to light until well into Chapter 4.) That total could be determined from adding up all the entries in Table ES-5, but it should be made much more accessible than that. The executive summary also fails to include a discussion of the total capital costs or annual costs for meeting projected needs using the recommended strategies. Indeed, the executive summary, and the overall plan, seem to be lacking a concise listing of the recommended strategies.

Some unit cost information for potential strategies is provided in Figure ES-11, but deriving an estimate of total costs is not easily accomplished using that information, particularly because recommended strategies are not identified. Indeed in reviewing the

IPP, we struggled to identify a clear list of recommended strategies. Different parts of the document suggest that different strategies are being recommended.

The executive summary does not adequately describe the potential strategies. Although they are listed in Tables ES-3 and ES-4, there isn't enough information to understand what the various strategies entail. Those tables do summarize "environmental issues/special concerns," but the information provided is extremely difficult to interpret.[2] In particular, additional information is needed for those strategies that are actually recommended. In short, the executive summary fails adequately to summarize the regional plan.

Some other regions, such as Region D, have a better model for the executive summary; it goes through the plan chapter by chapter and summarizes the main points of each chapter. Reading the executive summary of the Region D IPP, for example, serves to provide a good orientation to the entire plan. As drafted, the executive summary of the Region N IPP does not accomplish that same purpose.

(Page ES-16) Water Supply Strategies to Meet Needs
The IPP includes summary statements about future projects that, in the view of the planning group, should be considered "consistent" with the regional water plan. We believe these statements are much too broad. The IPP states, with respect to TWDB funding decisions: "The CBRWPG considers projects that do not involve the development of or connection to a new water source to be consistent with the regional water plan even though not specifically recommended in the plan." That language suggests that projects involving increased diversion from existing supply sources, such as a reservoir, river, or aquifer, should be considered consistent even if not evaluated and recommended in the regional plan. The same issues arise with respect to the statement relating to TCEQ permitting decisions to the effect that, within the planning region, consistency with the regional plan should not be a significant factor. That is not a reasonable approach and is not consistent with legislative direction. It would subvert the purposes of the planning process.

Although we do not disagree that many projects such as repair and upsizing of pump stations, wastewater treatment plants, and storage structures for treated water should be considered consistent with the plan, even if not separately listed, we are not aware that problems have arisen with those types of projects being considered inconsistent. Similarly, we agree that permit applications such as those dealing with most temporary diversions should not be required to be specifically listed in the regional plan, but are unaware that serious problems have arisen in the approval process for such applications regarding consistency with regional water plans. Regardless, the language in the IPP is much too broad.

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[2] As noted in our comments below, many of these strategies raise environmental concerns not acknowledged in Table ES-3.

Table ES-3 lists potential water management strategies providing a total of up to 200,000 + acre-feet per year of new water supplies.[3] Table ES-4 lists additional strategies providing up to about 12,500 acre-feet per year.[4] By contrast, the total projected "need" for Region N in 2060 is 46,084 acre-feet as shown in Table 4A-24 (page 4A-56). We are unable to locate a summary or other information listing which strategies actually are recommended.

Although the planning process is designed to result in the assessment of a wide range of potentially feasible management strategies, the ultimate directive is to produce a plan for meeting projected needs. The TWDB rules direct that the planning groups shall "provide **specific recommendations of water management strategies** based upon identification, analysis, and comparison of all water management strategies the regional water planning group determines to be potentially feasible so that the cost effective water management strategies which are environmentally sensitive are considered and adopted…." 31 TAC § 357.5(e)(4) (emphasis added). Those specific recommendations are lacking. The IPP includes an analysis and comparison of potentially feasible water management strategies, but does not appear to take the step of clearly recommending which strategies should be used. That is a critical shortcoming. The IPP seems to constitute more a list of potentially feasible strategies than a plan for meeting needs.

The need for specific recommendations aimed at meeting the projected needs is confirmed in at least one other section of the TWDB rules:

> Regional plan development must include "**specific recommendations of water management strategies to meet the needs** in sufficient detail to allow state agencies to make financial or regulatory decisions to determine consistency of the proposed action before the agency with an approved regional water plan. Strategies shall be selected so that cost effective water management strategies which are consistent with long-term protection of the state's water resources, agricultural resources, and natural resources are adopted." 31 TAC § 357.7(a)(9) (emphasis added).

The IPP does not seem to include a clear statement about the total amount of water supply that the regional planning group is recommending to be developed from this list of potential strategies. In other words, the planning group should make clear that it is recommending only the development of the amount of supply required to meet projected needs rather than the development of an estimated 210,000 acre-feet of supply. To plan for over 400% more water than is needed would be directly inconsistent with TWDB's rules directing that the planning process be based on population and demand projections approved by TWDB. *See* 31 TAC § 357.5 (d). Water is a limited resource in the state. Both the water and state funds for development must be shared equitably. Using common

[3] Unfortunately, the Table does not include a total so the reader is forced to add up the individual entries. For many strategies, the additional supply is given as a range and for others no supply amount is provided.
[4] Again, as for Table ES-3, no total is provided and for many strategies no estimated supply amount is provided

assumptions for planning across all planning regions is one way to help achieve that equity. Planning for demand significantly in excess of projections is not equitable and does not meet regulatory requirements.

We understand the desire of the planning group to have the flexibility of alternative strategies. However, the regional plan is not set in stone. The very reason that plans are updated every five years is to allow for adjustments on an incremental basis. If recommended projects aren't moving forward when a future plan is adopted, recommendation of different strategies may be appropriate at that time. Similarly, if population and demand projections have changed at that point, appropriate adjustments in recommendations should be made. In the rare case that changes to a plan would be needed more quickly than every five years, the plan can be amended

Nor does a possible future drought worse than the drought of record justify planning for such a large excess supply. In fact, SB1 is quite specific in directing the use of the "drought of record" as the appropriate target for planning. *See* Tex. Water Code Ann. § 16.053 (e)(4). Besides, with the adoption of a safe yield approach for the Lake Corpus Christi/Choke Canyon Reservoir/Texana system, the region already has designed in a cushion of about 22,000 acre-feet of yield for such an eventuality (see IPP at page 1-3).

(Page ES-28) Social and Economic Impacts of Not Meeting Projected Water Needs
The calculations referred to in this discussion all assume that water needs are left entirely unmet. That should be made clear. As drafted, that qualification is stated only as applying to the second-last sentence. These calculations estimate impacts that would result under a worst-case scenario pursuant to which no additional supplies are provided and no attempt is made to mitigate impacts. In reality, in the event of such a shortage, water would be diverted from nonessential uses to essential uses. The effect of such movements of water would be to dramatically reduce the economic impacts reported here. We urge the planning group to make clear that these figures represent a type of worst-case scenario involving the failure to meet any of the projected needs and the failure to mitigate impacts. Furthermore, the source of these projections should be acknowledged.

SECTION 1, PLANNING AREA DESCRIPTION

(Page 1-5) Section 1.2.3 Major Springs
Since the first round of planning, the TWDB rules have been revised to require consideration of springs important for natural resource protection. *See* 31 TAC § 357.7 (a)(1)(D). A spring that is not important for water supply purposes, because of its size or the quality of the water, still may be important for natural resource protection. The IPP provides no information about the criteria used by the planning group in determining that no springs in the region are major for water supply or natural resource protection purposes. Also, no information is provided regarding the potential impacts of proposed increased groundwater withdrawals on springs.
(Page 1-10) 1.4 Identified Threats to Agricultural and Natural Resources
This section should provide far more information about groundwater resources, their current states and projected rates of depletion. The IPP simply states, "In the 2001 plan,

the CBRWPG identified continuing groundwater depletion as a threat to agricultural and natural resources." No more information is given. Presumably, the planning group continues to recognize that threat. Additional discussion about the nature of the threat and the locations affected is needed.

The bullet items are unclear. For example, the first item states: "Shortage of freshwater and economically accessible groundwater attributable to increased irrigation demands." Is this being identified as a threat to agricultural resources or natural resources or both? The issue should be stated more clearly, with more information about the nature of the threat.

(Page 1-11) 1.5 Resource Aspects and Threatened, Endangered, and Rare Species of the Coastal Bend Region

This section should provide information about significant wetlands associated with seeps or springs and with rivers, streams, and estuaries. Such information would provide a baseline against which to assess proposed water management strategies that would be located within the boundaries of the Region. This information is needed to assess the implications of the plan for long-term protection of natural resources and to provide a meaningful quantitative evaluation of potential water management strategies.

The information on endangered or threatened species would be much more useful if it highlighted and discussed species, including key species not listed as threatened or endangered, occurring in habitats dependent on seeps and springs or rivers and streams and estuaries. Those are the habitats and the species most likely to be affected by water management decisions.

(Pages 1-22 and 1-23) Assessment of Water Conservation and Drought Preparation

Although we acknowledge the timing issues that make it difficult for the initially prepared plans to include the new quantified target goals for water conservation and drought contingency plans, in this instance more information should be provided. For the Coastal Bend Regional Planning Area, the City of Corpus Christi's plans dominate water use in the area. Whether through direct sales or via wholesale contracts, the City's plans apply to most water use in the area. It should be possible to include basic information from the City's plans.

SECTION 2

(Page 2-13) Section 2.3.2 Manufacturing Water Demand

The information provided here about water use for petroleum refining (46 gallons of water per barrel of crude oil refined) is inconsistent with the information provided at page 4C.5-17 (35 gallons per barrel). That inconsistency should be corrected and the calculated water demands should be verified using the correct figure.

(Page 2-15) Section 2.3.3 Steam Electric Water Demand

This demand appears to be potentially overstated. Water demand for steam electric power generation is projected to increase 214% during the planning period. By contrast, water demand for municipal use is projected to increase only about 52% and for manufacturing water use only about 62%. Given the likelihood that these are the primary categories of use that would drive demand for electrical power, some additional explanation of the projected water demand is needed.

We recognize that these projections are noted as coming from the Board. The planning group may not be able to change them, but it could, and should, provide further explanation for this seemingly anomalous projected growth in water demand. We also note that the TWDB projections, as we understand them, include a projected .5% increase per year in per capita energy demand. Given advances in energy efficiency and escalating fuel prices, we question the reasonableness of the assumption of such continued escalation in per person use of electricity.

SECTION 3

(Page 3-3) Although the information about environmental conditions in water rights is reasonably accurate, it would be more informative to note that most water rights issued prior to 1985 do not include such conditions. Certificate of Adjudication 21-3214 is an important exception to that general rule. Environmental flow conditions are one mechanism for providing water to meet environmental water needs. Environmental water needs are important not just for supporting fish and wildlife resources but the large-scale economic activities, such as commercial and recreational fishing businesses and nature tourism activities along with the hotels, stores and restaurants that benefit from those activities, that are dependent on those resources.

SECTION 4

(Page 4A-2) Section 4A.2.1 Surface Water Allocation.

Here the IPP lists the safe yield of the LCC-CCR/Texana system as 200,000 acft/yr in 2060. By contrast, the figure of 205,000 acft/yr, the year 2010 yield, is used in Table 3-3 (page 3-16) and at page ES-10. However, in Table 3-3, footnote 1 refers to 2050 sediment conditions while footnote 3 refers to 2010 conditions and both footnotes appear to apply to the same yield figure. This is quite confusing.

(Page 4C.1-1) Section 4C. 1. Municipal Water Conservation

In the last sentence of the first paragraph, the discussion of Drought Contingency and Water Conservation Plans required to be submitted to TCEQ acknowledges only the drought contingency portion of the plans. Those plans also must include water conservation measures that apply at all times, not just drought contingency measures designed to achieve additional short-term savings during times of serious shortage.

In the first sentence of the second paragraph, the text is slightly inconsistent with the changes made to Water Code concerning water conservation and water planning. The Water Code (Section 16.053 (h)(7)(B)) requires that regional water plans must **include** water conservation and drought management provisions that are at least as stringent as those required pursuant to Sections 11.1271 and 11.272 of the Water Code. In addition, regional groups must include **consideration** of more stringent water conservation and drought management measures, but, with adequate explanation, may choose not to include those more stringent measures. See § 357.7 (a)(7)(A)(ii) of the Board's rules.

We appreciate the clear presentation of information about per capita municipal water use in Table 4C.1-1 and the accompanying text.

We commend the City of Corpus Christi for its past efforts and successes with water conservation. However, 165 gallons per capita per day (gpcd) is not an acceptable target for the year 2060. It simply is not reasonable to assume that we will not make significant progress in water efficiency over the next 50 years. For example, federal requirements for improved energy efficiency in clothes washers will result in water savings not presently accounted for in Table 4C.1-1 or elsewhere in the IPP. The Region B IPP notes, in accounting for the effect of those federal clothes washer efficiency requirements that will go into effect in 2007, there will be a projected reduction in water use of 5.6 gallons per person per day as a result of purchasing new more-efficient washing machines (see Region B IPP at page 4-18). We urge the planning group both to adopt stronger water conservation recommendations and to account for the automatic savings that will result from the federal washing machine efficiency standards.

Basic measures such as a prohibition on wasting water, water conservation pricing, and water-wise landscape design are not included in the recommended conservation techniques. These are extremely low-cost conservation techniques that can be implemented relatively easily and we encourage the planning group to include them in its recommendations.

The IPP states, at page 4C.1-4, that "[t]he City of Corpus Christi currently uses less water than comparable cities in the central Region of Texas and is currently among the lowest in the state, for all climatological regions." No citation is given for that statement and the basis for it is not clear. In the 2002 State Water Plan, the water use rate for the City of Corpus Christi falls in the upper end of the "intermediate use" category for the 40 largest cities in Texas (see Table 5-4 in Water for Texas-2002 (TWDB 2002). Fourteen cities are shown with higher year 2000 use rates and 25 are shown with lower year 2000 use rates.

We know, from example, that significantly lower municipal per capita water use rates are feasible even today in South Texas. The City of San Antonio has already reduced its municipal water use to about 132 gpcd from a use level of about 213 gpcd in a period of around 20 years. This reduction was achieved through water efficiency measures without accounting for reuse.

(Page 4C.1-5) Section 4C. 1-2
We commend the RWPG for recommending water conservation for all groups, regardless of need. However, the actual targets set by the group should be much stronger.

Region N should consider adopting a water efficiency goal similar to the one adopted by Region L, which is as follows:

> "For municipal water user groups (WUGs) with water use of 140 gpcd and greater, reduction of per capita water use by 1 percent per year until the level of 140 gpcd is reached, after which, the rate of reduction of per

capita water use is one-fourth percent (0.25) per year for the remainder of the planning period; and

For municipal WUGs having year 2000 water use of less than 140 gpcd, reduction of per capita water use by one-fourth percent per year."

These excerpts are from Initially Prepared 2006 South Central Texas Regional Water Plan (SCTR Plan) at p. 6-1.

The planning group, to its credit, is proposing water efficiency savings of up to approximately 2,415 ac-ft/yr by 2060. However, there is potential for much more water efficiency savings. The Table "IPP, N - Comment 1" below, illustrates the potential savings if just six WUGs with water use greater than 140 gpcd, were to implement water efficiency measures to reduce demand to a low but quite achievable target level of 140 gpcd.

Table IPP, N Comment 1 – Calculation of additional savings through municipal water efficiency measures for the six most populous Water User Groups with net water use >140 gpcd at the 2060 time frame.

Water User Group (WUG) name	Population[1]	Region N IPP net water use rate with proposed additional efficiency measures[2] (gpcd)	target demand per person (gpcd)	revised Total Demand of WUG[3] (ac-ft/yr)	additional savings (ac-ft/yr)
CORPUS CHRISTI	470,523	165	140	73,787	13,175
KINGSVILLE	29,248	141	140	4,587	32
NUECES COUNTY WCID #4	28,521	165	140	4,473	798
ALICE	22,524	211	140	3,532	1,787
BEEVILLE	14,885	157	140	2,334	284
PORT ARANSAS	14,348	361	140	2,250	3,544
totals	580,049			90,963	17,808

Note: 1) there are other WUGs with populations greater than some entries here (eg. Ingleside and Portland), but their net water use rates are proposed to be less than 140 gpcd; 2) these net gpcd values reflect the basic use rates with savings due to Plumbing Code embedded (original Region N/TWDB demand) plus savings from additional conservation as summarized in Table 4C.1-4 of the Initially Prepared Plan. 3) revised demand based on target demand per person and population.

In fact, if all Coastal Bend Region municipal water user groups were to achieve a 140 gpcd level through water efficiency measures by 2060, it would represent savings of 24,347 acre-feet per year. This alone would meet roughly half of the region's projected deficit of 46,000 acre-feet and generally at reasonable costs. In particular, some of this conserved water could be used to offset the predicted 2060 shortage of 37,893 ac-ft/yr in the manufacturing sector (section 4C.3). This reallocation of conserved water is similar to that underlying the statement in section 4C.3 (pg 4C.3-1) that conserved manufacturing water could be used for "other beneficial purposes."[5]

The Coastal Bend Region plan apparently lists at least one new interbasin transfer, referred to as Stage II of Lake Texana, as a recommended water management strategy.[6] That strategy would provide water for a variety of water user groups. For an interbasin transfer to be authorized, the users of the water must be shown to be implementing water conservation plans resulting in "the highest practicable level of water conservation and efficiency achievable." *See* Texas Water Code §11.085 (l)(2). Without including additional conservation measures resulting in a municipal per capita use rate of 140 gpcd or lower, that test is not met. TWDB's rules, recognizing this prerequisite for authorization of an interbasin transfer, require that the regional plan also include that requisite level of water conservation for water management strategies involving new interbasin transfers. 31 TAC § 357.7(a)(7)((A)(iii). Thus, because the IPP does not include the requisite levels of water conservation, the IPP does not comply with the requirements for approval.

(Page 4C.1-11) Section 4C.1.3. Environmental Issues
Our organizations support municipal water conservation as the best and most efficient way to meet the water needs of a growing population without causing undue harm to the environment. It is true that treated municipal wastewater is a significant source of freshwater for the Nueces Estuary. However, that does not mean that increased municipal water conservation would necessarily have a negative impact on the bay, as this section states. The ultimate impact on inflows is a function of many factors.

If the region uses water in a significantly more efficient manner, then less water would be diverted to begin with. As a result, the reservoirs would remain fuller more of the time and pass-throughs would be available to be sent to the bay more frequently which could offset the reduction in return flows. Water conservation could also obviate the need for various new water supply projects that could adversely affect inflows. Additionally, much potential for water conservation lies in increasing the efficiency of, or reducing, outdoor water use. Water used outside the home, for example to maintain landscaping, does not generally end up as treated wastewater.

Therefore, the statement "many of the conservation measures recommended will reduce inflows to the Nueces Bay and Estuary" is too broad. It would be more accurate to say, "Some of the indoor conservation measures recommended could reduce the amount of treated wastewater available to send to the Nueces Bay and Estuary during low flow times."

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[5] Although we did not locate a clear list of recommended strategies, the IPP at pp. 4B.11-13 and 4B.12-7_ does include the possibility of such voluntary transfers as a possible strategy for meeting the shortages for mining and manufacturing demands.

[6] See IPP at pages 4B.11-12 and 4B.12-7 including Stage II of Lake Texana in listing of "one potential plan" to meet needs.

Similarly, in the environmental factors section of Table 4C.1-8, it would be more accurate to say "possible negative impact due to potential for decreased return flows which could be offset by possible positive impact resulting from higher reservoir levels."

(Page 4C.1-12) Section 4C.1.5 Implementation Issues
The text notes that retrofit programs can be expensive and may not be priorities. Although it is true that retrofit programs are often more expensive than other conservation programs, they are very cost-competitive with many other water management strategies included in the IPP.

(Page 4C.3-1) Section 4C.3 Manufacturing Water Conservation and Nueces River Water Quality
Although packaged as one strategy, this section addresses numerous highly variable approaches. Only by using an extremely broad definition can all of those approaches be considered to constitute water conservation. The various approaches have dramatically differing costs and potential impacts.

And, although the cost issues are treated separately, the impact evaluations are all lumped into Table 4C.3-5. As a result, those evaluations are not particularly meaningful and certainly do not constitute the type of quantitative analyses required by Section 357.7 (a)(8)(A)(ii). It generally is not possible to identify which potential impact relates to which potential approach. This is a significant problem because the types and extent of impacts vary dramatically between the different options. For example, a pipeline from Lake Corpus Christi to the Calallen Pool would have dramatically different impacts than blending of Lake Texana water. Unit costs, by contrast, are presented separately and clearly for each option in Table 4C.3-6. That same type of presentation is required for the evaluation of impacts.

It also is unclear what strategy or combination of strategies is actually being recommended. All of the strategies are lumped under the "manufacturing water conservation" heading. Section 4B.12.12.3 summarizes the potential plan for meeting manufacturing needs in Nueces and San Patricio Counties as including "manufacturing water conservation." Unfortunately, the reader is left to guess what strategy or strategies are being evaluated, what strategy within that category is being considered or recommended, and in what amount (Table 4B.12-4 simply indicates the amount from manufacturing conservation would be up to 2,050 acre-feet). As a result, it is not possible to comment meaningfully on the evaluation.

Strikingly, none of the strategies considered involves the types of manufacturing conservation best management practices evaluated and recommended by the Water Conservation implementation task force. Those BMPs generally involve changes in the manufacturing process rather than changes in the water supply. Those BMPs should be evaluated and considered. Those BMPs are listed and considered under the Mining Water Conservation heading (Section 4C.4) even though almost all of them fit logically under the manufacturing conservation category and comparatively poorly under the mining conservation category.

In particular, the potential pipeline from Lake Corpus Christi to the O.N. Stevens WTP seems to be a poor fit for the manufacturing water conservation label. The main purpose of this project seems to be preventing channel losses (estimated at 16,500 acft/yr) and therefore increasing overall supply rather than increasing manufacturing water efficiency (estimated at up to 6,600 acft/yr in 2060).

The pipeline also could have a major impact on channel losses for freshwater inflow releases from Lake Corpus Christi and on the amount of freshwater reaching Upper Nueces Bay. The use of the pipeline likely would dramatically affect bank storage and, by extension, could greatly increase channel losses when freshwater inflow releases were made from the reservoir. That impact does not appear to have been considered. This project therefore should be listed, considered, and assessed independently from manufacturing water conservation.

Far more discussion of the environmental impacts of this project is needed. This project would be expected to have a significant impact on the river corridor between Lake Corpus Christi and the Calallen Pool. It also could dramatically affect the water quality of the amount of water that remained in the river bed.

(Page 4C.5-1) Section 4C.5 Reclaimed Wastewater Supplies
Our organizations believe that reuse can play an important water supply role. However, the amount of reuse appropriate in any particular location can only be determined through careful evaluation of the implications specific to that situation.

The discussion on page 4C.5-29 regarding water quality impairment due to levels of zinc raises the issue of the need to consider water quality issues in assessing the potential increased reliance on wastewater return flows to supply freshwater inflows for Upper Nueces Bay. Certainly as part of the TMDL process, levels of zinc in wastewater discharges into Nueces Bay must be considered, particularly for industrial discharges.

Section 4C.5 lumps together several entirely separate reuse strategies into one category. The planning process requires a meaningful, quantitative evaluation that is lacking here. If the project costs and potential yields are not available, then the project should not be listed as a potential water management strategy.

The wastewater release project described in Section 4C.5.6 is described as having environmental benefits, but these aren't documented quantitatively. There is simply not enough detail available on this project available to merit its inclusion as a potential supply strategy. As a result, the analysis provided in Table 4C.5-8 is not adequate to provide the quantitative evaluation required by 31 TAC § 357.7 (a)(8)(A)(ii) and needed to demonstrate compliance with the requirement for a showing of consistency with long-term protection of the state's natural resources.

(Page 4C.6-1) Section 4C.6 Carrizo-Wilcox Aquifer Supplies
The discussion of the impacts of Cambellton Wells should include discussion of how this project would affect the aquifer over the long term. The Evaluation Summary does

mention that this project "will result in lowering of groundwater levels over time" but gives no specifics. A quantitative evaluation is explicitly required by 31 TAC § 357.7 (a)(8)(A)(ii) and is needed to demonstrate compliance with the requirement for a showing of consistency with long-term protection of the state's water resources, agricultural resources, and natural resources.

Section 4C.7 Gulf Coast Aquifer Supplies
All the several subsections here and in Appendix D dealing with groundwater supplies that may be available from the Gulf Coast Aquifer fail to address an important groundwater-surface water interaction: discharge of freshwater into the coastal estuaries. Recent estimates are that up to 25% of recharge to the Gulf Coast Aquifer in nearby Wharton and Matagorda counties ends up as freshwater discharge to near-coast waters.[7]

Section 4C.7.1 Conjunctive Use of Groundwater Supplies from Refugio County
(Page 4C.7-4) Section 4C.7.1.3 Environmental Issues. This discussion does not acknowledge the potential for adverse impacts to surface streams that is acknowledged for other versions of pumping from the Gulf Coast Aquifer. Such impacts appear likely and should be acknowledged. The other discussions downplay the potential for adverse impacts by noting that "many streams are dry most of the time; thus no measurable impact to wildlife along the streams is expected" (see page 4C.7-22). However, that would only serve to make any streams that do flow more often that much more important to fish and wildlife resources and potentially to small livestock operations. No information is provided about stream impacts related to this project. Additional information about such streams and the potential loss of baseflow is needed. Section 357.7 (a)(8)(B) of the Board's rules requires consideration of "groundwater surface water interrelationships."

No substantive information is provided about potential impacts to agricultural users in the area. The Summary Sheet, on page 4C.7-8, indicates that there may be a slight increase in pumping costs for agricultural users. However, there does not seem to be any discussion of potential costs for other activities that might be required such as deepening wells.

More quantitative information is needed about the impact on levels in the Gulf Coast Aquifer. Information is included in Section 4C.7.3 about anticipated drawdowns (Fig. 4C.7-15) but that information is not referenced here and it is not clear exactly what is included in the analysis depicted in Figure 4C.7-15.

Section 4C.7.2. Groundwater Alternative for Small Municipal and Rural Water Systems and Irrigation, Mining, and Manufacturing Water Users for the Coastal Bend Region
(Page 4C.7-22) The discussion seeks to downplay the potential for adverse impacts by noting that "many streams are dry most of the time; thus no measurable impact to wildlife

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[7] Dutton, A.R., and Richter, B.C., 1990 Regional geohydrology of the Gulf Coast Aquifer in Matagorda and Wharton Counties, Texas: Development of a numerical model to estimate the impact of water-management strategies: The University of Texas at Austin, Bureau of Economic Geology.

along the streams is expected." However, that would only serve to make any streams that do flow more often that much more important to fish and wildlife resources and potentially to small livestock operations.

No substantive information is provided about potential impacts to agricultural users in the area. The Summary Sheet, on page 4C.7-35, indicates that there may be a slight increase in pumping costs for agricultural users. However, there does not seem to be any discussion of potential costs for other activities that might be required such as deepening wells. The Summary Sheet also should be moved up one page so it appears before the first page of the next section.

More quantitative information is needed about the impact on levels in the Gulf Coast Aquifer. Information is included in Section 4C.7.3 about anticipated drawdowns (Fig. 4C.7-15) but that information is not referenced here and it is not clear exactly what is included in the analysis depicted in Figure 4C.7-15.

Section 4C.7.3. Central Gulf Coast GAM Analysis for Future Water Supply Projects in Bee, San Patricio, and Refugio Counties
(Page 4C.7-37) The discussion again seeks to downplay the potential for adverse impacts by noting that "many streams are dry most of the time; thus no measurable impact to wildlife along the streams is expected." However, that would only serve to make any streams that do flow more often that much more important to fish and wildlife resources and potentially to small livestock operations.

This analysis of the potential cumulative impacts of the various projects listed in Figure 4C.7-11 is very useful. We commend the planning group and its consultant for including it. However, in Figure 4C.7-13, the information would be easier to interpret if the various wellfields were identified to indicate which project they correspond to.

4C.9.3 CCR/LCC System Yield Recovery
4C.9.3 This concept involves diverting wastewater so that it would be discharged closer to the head of the Nueces Estuary in exchange for reducing the quantity of pass-throughs of freshwater from the LCC/CCR system. Although we agree that the concept is worthy of further consideration, it is not nearly well-enough developed to be included as an actual water management strategy. Much more study and analysis is required before an actual proposal can be developed. Certainly the increased reliance on relatively constant return flows and the corresponding reduction in seasonality of inflow patterns must be carefully considered. Similarly, the amount of actual productivity benefit that might be achieved and, by extension the amount of inflow credit that might be extended, is extremely unclear at this juncture. The predicted yield increase, as a result, is highly speculative.

It is not possible to determine how much of the predicted yield increase is due solely to the increased effluent discharge into Upper Nueces Bay as opposed to the change in trigger levels. The evaluations here consider a lower system storage "trigger" ranging from 40% to 60%, at which point pass-throughs of flows from the reservoir system to

Nueces Bay cease. As noted in the IPP, under the current TCEQ Order the corresponding trigger is 30%. Changes to these trigger levels are certain to be most controversial and, will face an uncertain prospect for approval. One particular issue that requires analysis is the potential for the change in trigger levels to allow the complete capture of moderately sized inflow events which might have the effect of significantly lengthening the duration between freshwater inflow events capable of "freshening" Nueces Bay.

(Page 4C.10-1) Section 4C.10 Pipeline between Choke Canyon Reservoir and Lake Corpus Christi (N-10)
This project has interesting potential for reducing channel losses between the reservoirs. However, the implications (for groundwater impacts, water quality, streambank vegetation, and other issues) of moving that amount of flow out of channel are potentially significant and largely unknown at this point. With respect to impact on inflows to the Nueces Estuary, the picture is a complicated one. As shown in Figure 4C.10-4, the frequency of larger inflow events would be decreased while the amount of inflow during the driest periods would be increased.

As previous studies have shown, the current reduction in some of these higher inflows has had a very significant impact on the estuary (see Irlbeck, M.J. and G. H. Ward, 2000. Analysis of the Historic Flow Regime of the Nueces River into the upper Nueces Delta and of the Potential Restoration Value of the Rincon Bayou Demonstration Project, in US Bureau of Reclamation, Rincon Bayou Demonstration Project: Concluding Report). Also, there is no mention of the significance of the location of the increased wastewater discharges. As exemplified by the proposed project in 4C.9.3, the location where inflows enter the system can be quite significant. Under current configurations, wastewater discharges likely would be returned in the lower portions of the estuary system where the potential benefits are reduced.

This strategy merits further consideration but additional analysis is needed before its impacts can be meaningfully assessed.

(Page 4C.11-1) Section 4C.11 Off-Channel Reservoir near Lake Corpus Christi
As stated previously, because of the scale of potential adverse impacts, new reservoirs should be considered only after existing sources of water, including improved water efficiency measures, are utilized to the maximum extent reasonable.

The freshwater inflow impacts of this project do not appear to have been adequately considered. It appears that a major potential impact from the project would be reductions in freshwater inflow delivered to the upper end of the estuary system. As is acknowledged in various other portions of the IPP, the location of freshwater inflows to the estuary system is very important. However, for this project analysis, it appears that the evaluation only looks at total inflows to the system without considering where the inflows would enter the system.

The analysis also appears to assume that no additional permit conditions for the purpose of protecting environmental flows would be required. The basis for that assumption is far from clear. The analysis of total freshwater inflows (Figure 4C.11-4) indicates that the occurrence of moderately sized inflow events would be reduced. That figure does also indicate slightly increased total inflows to the estuary system during times of very low inflows. As the Agreed Order recognizes, both the timing and size of inflow events are critical. The chart of median inflows illustrates (Figure 4C.11-4) that this project would push the system even farther from a natural pattern of inflow events, with defined seasonal peaks, and towards a pattern relying more on relatively constant return flows. As part of the consideration of an application for new permit or permit amendment, consideration of appropriate conditions to protect environmental flows would be required. It appears that the yield analysis was done without taking into account such new requirements. That does not paint a realistic picture or comply with TWDB rules. In particular, additional analysis is needed regarding the expected impact on freshwater inflows into upper Nueces Bay.

We do not understand this to be a strategy recommended for implementation. More analysis of potential impacts is needed before it could be meaningfully assessed and considered.

(Page 4C.12-1) 4C.12 Voluntary Redistribution of Available Supplies and U.S. Army Corps of Engineers Nueces Feasibility Studies (N-12)

(Page 4C.12-1) Section 4C.12.2.1 Utilization of Unused City of Three Rivers' Supply
The proposed voluntary redistribution of the portions of supply that are not going to be used by the City of Three Rivers seems like a very appropriate approach. However, we believe the analysis of potential impacts is somewhat inaccurate. The use of water out of the Reservoir system that would not otherwise be used will have impacts on downstream flows. Those impacts likely would not be very significant, but they should be acknowledged.

(Page 4C.12-3) Section 4C.12.2.2 Use or Purchase of Underutilized Nueces County WCID #3 Water Right
The analysis of these proposed transactions is lacking in substance. Again, the approach may be worthwhile. However, there would be adverse impacts on instream flows as a result of the previously unused portion of the water right being used. Those impacts must be acknowledged and discussed.

(Page 4C.12-5) Section 4C.12.2.3 Trades/Transfers with South Central Texas Region
Most of these are highly speculative strategy concepts. Because of their speculative nature, it is not possible to provide a meaningful analysis of the impacts, costs, or potential yield as required by Section 357.7(a)(8) of the Board's rules. As a result, the strategy concepts that have not otherwise been adequately analyzed as stand-alone projects do not qualify for inclusion as water management strategies.

(Page 4C.13-1) Section 4C.13 Stage II of Lake Texana
Without a major commitment to improved water efficiency, a new interbasin transfer, such as this one, simply is not available to the region because the recommended levels of

water conservation will not result in "the highest practicable level of water conservation and efficiency achievable." That is a prerequisite to the authorization of a new interbasin transfer and it is a necessary prerequisite for including a new interbasin transfer as a recommended water management strategy in the regional water plan. Section 11.085 (l)(2) of the Water Code establishes the permitting standard and Section 357.7 (a)(7)(A)(iii) of the TWDB rules establishes the standard for planning. The IPP fails to include the requisite level of water efficiency and, thus, fails to meet applicable requirements for recommending the interbasin transfer as a water management strategy.

New reservoirs should be considered only after existing sources of water, including water efficiency and reuse, are utilized to the maximum extent reasonable.

Contrary to the asserted "negligible impact to Lavaca Bay" characterization (Table 4C.13-7 on page 4C.13-19), Lake Texana II has the potential to cause significant adverse impacts to the Lavaca-Matagorda Estuary System. There are many other supplies available to the region that should be explored before this one.

The IPP includes the following completely unfounded statement:
"Recent studies of Matagorda Bay[fn], indicate that releases made from Lake Texana exceed the mitigation requirements and in some cases enhance the productivity of certain species in the bay and estuary" (IPP at page 4C.13-2). The footnote references the December 1997 study by the Lower Colorado River Authority entitled *Freshwater Inflow Needs of the Matagorda Bay System*. We are unable to find any support in that document for the statements in the IPP. First, the "releases" from Lake Texana are actually limited pass-throughs of inflows. It is difficult to understand how the pass-throughs of inflows exceed mitigation requirements or, for that matter, what "mitigation requirements" are being referred to. To the extent that mitigation requirements exist, they require the pass-through of inflows.

Similarly, it is difficult to understand the contention that the releases "enhance productivity of certain species in the bay and estuary." Again, these simply are partial pass-throughs of naturally occurring inflows. It is difficult to understand just what is being enhanced. Perhaps this is an attempt to refer to analyses showing that different species are favored by different salinity regimes. However, any fair characterization must note that where some species might be favored, it happens at the expense of other species. The claim of enhancement is unfounded.

Finally, the conclusion that release requirements may be less restrictive than the Consensus Criteria also is without basis. In particular, the discussion should acknowledge that the assessment of Freshwater Inflow Needs for the Matagorda Bay System currently is undergoing a revision. The initial document reflecting the results of that assessment acknowledged that it was based on limited data. In addition, because there is already an existing reservoir that adversely affects inflows to Lavaca Bay, particularly during dry periods, there is a great likelihood that additional provisions, beyond the Consensus Criteria, will be needed to minimize the potential for the cumulative impacts of the reservoirs to deprive the estuary of needed inflows.

(Page 4C.14-1) Section 4C. 14 Garwood Pipeline
The IPP grossly understates the potential for adverse impacts on instream flows and freshwater inflows from this strategy. The Garwood Pipeline has the potential to negatively impact the river downstream of the diversion point as well as the Matagorda Bay System. The IPP characterizes the impacts to the Lavaca-Colorado Estuary as "negligible." IPP at p. 4C.14-19 (Table 4C.14-5). The IPP fails to provide any basis for that contention and, in fact, the contention is inaccurate.

The *Water Management Plan for the Lower Colorado River Basin* establishes target and critical flow levels, both for instream flows in the Colorado River and for freshwater inflows to the Lavaca-Colorado Estuary. However, that Management Plan does not ensure that the flows will be available. In fact, the vast majority of the environmental flows are to be met, if at all, through the availability of "interruptible water." Interruptible water consists primarily of flows available during wet periods and flows available because existing water rights are not fully used. As water demands within the Colorado basin increase over time, less and less interruptible water will be available. The Initially Prepared Lower Colorado River Water Planning Group Water Plan (LCRWPG) includes a table outlining the predicted availability of interruptible water over the planning horizon.

Table 4.28, on page 4-26 of the LCRWPG IPP, shows that the availability of interruptible water during drought periods goes from an annual average of about 240,000 acre-feet in 2010 to about 5,500 acre-feet in 2060. As a result, the Lavaca-Colorado Estuary would often not receive the needed target flows or the essential critical inflows. The critical inflows are intended to provide "a fishery sanctuary habitat during droughts" from which organisms could repopulate the bay during wetter conditions. *Water Management Plan for the Lower Colorado River Basin* (page 35) Lower Colorado River Authority. The loss of the 35,000 acre-feet/year that is proposed for diversion from Region N's Garwood project would have a significant adverse impact on freshwater inflows, particularly during dry conditions. Accordingly, that impact must be acknowledged and discussed.

The characterization about the impacts of the relocation of the mouth of the Colorado River (page 4C.14-11) is overstated. It also appears to consider only "average" inflow. Use of "average" flows for evaluations is of questionable utility because large flow events will skew the calculation. The cited reference predicting the increase in average inflow has little bearing upon the highly significant concerns about the amount of inflows in the low to medium range that currently are most critical to water management decisions on the Colorado River. *See* LCRA, Freshwater Inflow Needs of the Matagorda Bay System, 1997).

The diversion of the mouth of the Colorado River will not determine inflows to the bay. The actual amount of inflow into Matagorda Bay will be dependent on rainfall and on water management undertaken in the Colorado River basin. In fact, projected water demands and proposed diversions likely will result in a dramatic reduction of inflows from the Colorado River to Matagorda Bay rather than the increase predicted on page 4C.14-11. In addition, the reference cited for that contention is very outdated and consists of predictions made before the fact about the likely impacts of diverting the mouth of the river. The diversion of the mouth of the river occurred years ago and actual data and predictions of future trends in inflows to the Bay are now available.

(Page 4C.15-1) Section 4C.15 Brush Management (N-15)
Land stewardship is a broader term that includes brush management as one of its components. Land stewardship is a concept that has been strongly championed by the Texas Wildlife Association. We encourage the group to examine that broader concept as a strategy worthy of consideration. In particular, given the referenced reduction in inflows into the reservoir system, a comprehensive review of the potential for land stewardship practices to reverse that yield decline may be merited.

(Page 4C.17-1) Section 4C.17 Seawater Desalination (N-17)
Seawater desalinization certainly is worthy of consideration as a potential water supply strategy for the state of Texas. However, there are many environmental and energy implications that need to be carefully considered. The sensitivity of this option to issues of the cost and availability of large quantities of electrical power is not discussed in any detail. That is a very significant issue for a large-scale desalination plant, particularly given recent trends in fossil fuel prices. For the seawater only option, the complications of constructing a concentrate disposal pipeline are not adequately discussed. The issue is acknowledged at page 4C.17-24, but without any elaboration on potential environmental impacts. For the combined seawater and brackish groundwater option, the issue of disposal of the concentrate in Oso Bay is not adequately discussed. Similarly, the impacts of pumping of large amounts of groundwater require further consideration.

(Page 6-1) Section 6 Water Conservation and Drought Management Recommendations
We applaud the planning group for including water conservation but, as noted above, we believe more can, and should, be done.

Drought management is a required water management strategy at least for those entities required, pursuant to Section 11.1272 of the Water Code, to develop drought contingency plans. *See* 31 TAC § 357.7 (a)(7)(B). In addition, more stringent drought management measures must be considered. Thus, water management strategies must be included at least equal to the levels required pursuant to Section 11.1272. If the planning group chooses not to include additional drought management measures beyond those levels, it must provide a valid reason for doing so. The initially prepared plan does not provide a valid basis for such a choice.

We urge the planning group to give further consideration to drought management as a water management strategy. The regional planning process is focused on water availability during critical drought conditions. Those conditions are extremely rare, but it is only prudent to plan for them. On the other hand, there is a serious question of whether developing new water supplies that would always be available but would be needed only during the recurrence of a critical drought is always the best approach. One alternative is to identify some water needs that are nonessential and not plan to meet those needs during a recurrence of critical drought conditions. Thus, for example, a municipal drought contingency plan might call for cutting back on lawn watering (allowing watering only at a frequency adequate to keep plants alive rather than green and thriving), car washing, or filling of swimming pools. That reduced demand then can be calculated and accounted for as a water management strategy for meeting part of the "need" for water during drought periods.

The "dry-year option" is another type of drought management approach. An irrigator can enter into an agreement not to irrigate during identified drought conditions in exchange for a cash payment. The water not used for irrigation can be applied to another use, such as municipal or industrial, during that period. The money saved by not having to develop a new water supply source to meet both the irrigation need and the municipal need during critical drought years likely would be more than sufficient to compensate the irrigator for lost production.

Section 7 Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources

TWDB may not approve a regional plan unless it is able to make an affirmative finding that the regional plan is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources. *See* Texas Water Code Section 16.053 (h)(7)(C). The initially prepared plan does not provide the level of information necessary to support such a finding. The necessary information is lacking for assessing the impact on natural resources located within the region and also for assessing the impact on resources located outside the region but affected by the proposed strategies in the initially prepared plan.

We believe the initially prepared plan for the South Central Region (Region L) contains a good example of an analysis of the issue of consistency. Although we believe some improvements are needed in that analysis and we are in discussions with that planning group about the potential to add an ecological aspect to the consideration of the freshwater inflows issue, it represents an excellent attempt to take a cumulative look at the impacts of the proposed plan.

We acknowledge the analyses contained in Appendix L entitled the "Cumulative Effects of Water Management Strategies." Those analyses do provide information about flow changes, but only by looking at changes from some future condition. We believe it is essential to evaluate changes from current conditions or some other identifiable baseline that the public can understand. If is difficult to appreciate the significance of a change from one potential future condition to some other potential future condition because none of us have experienced either. If the purpose is to understand the practical implications of the changes, the future condition needs to be compared against some condition we have experienced or against some established biological criteria.

Thus, we believe that different baseline conditions should be used to allow for a meaningful comparison. We also are confused about the selection of water management strategies described as being included in the Year 2060 analysis in Appendix L. From the description on page L-2, it appears that the Lake Texana interruptible supply of 12,000 acft/yr was not included in the baseline analysis, although those supplies are otherwise described as currently being in place. The only new strategies, besides the 12,000 of interruptible supplies, listed as being included for the Year 2060 analysis are 35,000 acft/yr from the Garwood project, 11,000 acft/yr of groundwater from Refugio County, and increased effluent discharges. If these are the recommended water management strategies for the plan, the remainder of the document should indicate that. As discussed above, other portions of the document seem to indicate that additional projects are being recommended.

Impacts to freshwater inflows to the Nueces Estuary are of particular importance in the Coastal Bend Region. We believe more complete consideration, particularly of impacts to those inflows, is necessary in order to have a truly comprehensive regional water plan and to demonstrate compliance with applicable requirements.

Among the most pertinent of those requirements are the following:

- Water Code § 16.053(h)(7)(C), a <u>new requirement</u> for this round of planning. It requires the Texas Water Development Board (TWDB) to affirmatively determine, as a prerequisite to approving a regional water plan, that the plan is "consistent with long-term protection of the state's water resources, agricultural resources, and natural resources..."
- 31 TAC §§ 357.5(l) and 357.7(a)(1)(L), TWDB rules that direct planning groups to "consider environmental water needs *including instream flows and bay and estuary inflows*" and to identify threats to natural resources due to water quantity problems.
- 31 TAC § 357.7 (a)(8)(A)(ii), a <u>new TWDB rule for this round of planning</u> that requires RWPGs to include in their evaluation of water management strategies a *quantitative reporting* of environmental factors, including effects on environmental water needs.

In October of 2004, the National Wildlife Federation released a report called *Bays in Peril: A Forecast for Freshwater Inflows to Texas Estuaries.* It is, as the title suggests, a forecast of future conditions. The report used a standard TCEQ water availability model (WAM) run for the Nueces River to forecast inflows to the estuary if all the existing water permits were fully used and if reuse of wastewater were increased to 50%. The report then evaluated the predicted inflows against each of two ecologically significant criteria: a drought criterion and a freshwater pulse (or higher flows) productivity criterion. Both of those criteria were based on the results of the state's freshwater inflows studies.[8]

The NWF report, and a follow-up letter to Region N in March of this year, acknowledged that, particularly for the drought criterion, the future scenario should be refined. In

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[8] See Pulich Jr., W., J. Tolan, W. Y. Lee, and W. Alvis, 2002. *Freshwater Inflow Recommendation for the Nueces Estuary.* Texas Parks and Wildlife Department.

particular, it is possible that the level of wastewater reuse assumed in the NWF analysis may not be pursued in the near future in Region N due to provisions in the TCEQ Administrative Order that governs freshwater inflow requirements to the Corpus Christi Bay system. Currently, pursuant to that Order, credits are given to the City of Corpus Christi for wastewater discharges as an offset to releases from the reservoir system. Other elements of the water management strategies included in the IPP may also affect freshwater inflows somewhat differently than the conditions assumed under the standard WAM scenario used in *Bays in Peril.*

NWF has proposed to work cooperatively with the Region and its consultants to devise an alternative representation of future inflows that reflects anticipated levels of water use and reuse and wastewater discharge with the regional water plan implemented. We acknowledge that discussions are under way to accomplish that result. The expectation is that, instead of the standard analysis used in *Bays in Peril* which assumes full use of existing permits and 50% reuse of wastewater, NWF and representatives of the planning group would jointly produce an analysis that looks at the water usage levels, including potential wastewater reuse or other new projects, the planning group considers most likely for 2060 conditions. Our belief is that the inclusion of such an analysis in the regional plan would substantially satisfy new requirements in this round of planning for "... quantitative assessments of environmental factors" as they relate to consideration of impacts to freshwater inflows and would provide information needed for a meaningful assessment of consistency of the regional plan with long-term protection of the state's natural resources.

An outline of NWF's proposed approach for accomplishing the joint evaluation is attached to this comment letter.

(Page 8-1) Section 8 Legislative Recommendations, Unique Stream Segments, and Reservoir Sites

General Policy Statement: The general policy stated here seems reasonable. We would request that the planning group consider a minor revision to the language relating to reuse. As drafted, it provides "water re-use should be promoted, wherever practical, taking into account permit requirements for return flows for environmental needs." We would suggest that the provision be reworded to read similarly to the following: "water re-use should be promoted, wherever practical, taking into account appropriate provision for protection of downstream water rights, domestic and livestock uses, and environmental flows." Although the protection of downstream water rights and domestic and livestock uses likely is viewed as inherent in the statement, we believe it should be made explicit. In addition, because most permits, having been issued before 1985, do not directly address environmental needs, we suggest that the narrow reference to "permit requirements" be changed to a broad reference to "appropriate provision for protection of environmental flows."

Interbasin Transfers: We believe that many of the protections contained in Section 11.085 and related to interbasin transfers are critically important and should be maintained. The broad reference to the repeal of all of the "additional application requirements for interbasin transfers that were included in Senate Bill 1" cuts too broadly. Many of those additional protections would be even more important in the absence of the junior priority provision. We urge the planning group to consider a narrower statement.

Section 8.2 Identification of River and Stream Segments Meeting Criteria for Unique Ecological Value

We are disappointed the planning group again declined to recommend stream and river segments for designation. We request that the planning group at least provide some information about the basis for that decision.

Appendix D – Projected Groundwater Availability through 2060 using the Central Gulf Coast Groundwater Availability Model

The analysis approach portrayed here is generally well-founded and thorough. For instance, we support the explicit recognition that predicting effects on the aquifer requires integrating the probable effects of projects in several regional plans. Also, combining the outputs from two distinct groundwater models and including separate descriptions of impacts from local supply pumping versus the major project pumping is helpful. Another positive feature is the explicit recognition of the need to reduce recharge assumptions during drought conditions (page D-4).

However, there are a still several major issues which are either unclear or potentially faulty and thus undermine the value of the information for assessing the plan's consistency with long-term protection of water resources and natural resources. These issues are separate and distinct from the previously discussed concern over the planning group's selection of acceptable water level declines.

1) Failure to include clear portrayal of effects - While other sections of the plan state that the results of the simulations here conform with the permissible water level declines the planning group has adopted (page 3-20 or 4C.7-13), there is no portrayal of those results here. Figure D-3, which is schematic and illustrative, would lead the reader to believe that a net drawdown map is to follow. But, no such map is included. We urge the planning group to include here the same type of map that is included at page 4C.7-15 (Figures 4C.7-4 and 4C.7-5). From the description accompanying Figures 4C.7-4 and 4C.7-5, it appears they may reflect only the impacts of local pumping. In the interest of informed decision-making, we urge the planning group to portray the expected results of the various strategies fully and clearly. It appears that the analysis already has been done.

2) Missing itemization or possible omission of some local pumping. In the section discussing Local Supply Pumping, there is no itemization or discussion of assumed local pumping that will occur in Refugio, Goliad or other Region L counties. This pumping could be substantial. For instance, the tallied Local Supply Pumping for Bee and San Patricio Counties totals about 8,500 ac-ft/yr in 2060. This is in the same ballpark as the proposed major project pumping of 11,000 ac-ft/yr proposed for these same counties (page D-13). It is unclear if there was an assumption of no local pumping in the Region L counties for modeling purposes, or whether the amount of that pumping was just omitted from the discussion.

3) Possible under-prediction of pumping effects and potential water level declines. As shown on Figure D-17 and in accompanying text, the pumping from the LGWSP is anticipated to be highly variable. However, there is no explanation of how the year-by-year pumping schedule of Table D-2 is derived. The schedule appears to be synched with an assumed drought occurring in the 2020-2023 period in which the maximum groundwater withdrawals occur with annual maximums (=41,400 ac-ft) and the maximum 4-year cumulative total (=142,512 ac-ft). Thus, this maximum pumping is portrayed as occurring relatively early in the planning period, starting in 2020. This is only 10 years after the proposed Region N wellfields (page D-13) begin withdrawing an additional 11,000 ac-ft/yr.

It is impossible to know when the next drought of record will occur. As a result, unless the effects of the drought will be the same regardless of when it is assumed to occur, multiple portrayals are needed to assess the potential effects of pumping during such a drought period. For this project, it does not seem plausible to assume that the effects would be the same regardless of when drought conditions occurred. Pumping is predicted to result in increasing groundwater declines over time, with the maximum decline equaling 250ft. When assessing the transient effects of water level declines associated with temporary drought conditions, the assumed period when those maximum pumping levels occur is critical in predicting the extent of the water level declines. Specifically, the water level declines will be different (greater) if the maximum 4-year total (142,512 ac-ft) is withdrawn later in the simulation, for instance in the 2056-2060 time period, especially since the proposed Corpus Christi wellfield pumping 7,000 ac-ft/yr (page D-13) could also be active. Thus, the potential effects on the water levels of the Gulf Coast Aquifer due to the combined pumping for the local supply and the proposed major projects appear to be under-predicted.

Appendix E
The model water conservation plan and drought contingency plans are not included. We urge the planning group to include model plans that incorporate at least the water conservation measures recommended by the planning group and to include recommended minimum levels of water savings to be achieved through both water conservation and drought management measures.

Appendix E.1
The City of Corpus Christi plan for water conservation and drought contingency included in this Appendix does not appear to be current. New requirements that went into effect in May of this year require specific, quantified target goals for water conservation plans and drought management plans. We urge the planning group to include a version of the plan that demonstrates compliance with current requirements.

Appendix E.2
The San Patricio Municipal Water District water conservation plan and drought contingency plan included in this Appendix do not appear to be current. New requirements that went into effect in May of this year require specific, quantified target goals for water conservation plans and drought management plans. We urge the planning

group to include a version of the plans that demonstrates compliance with current requirements.

Appendix E.3
The South Texas Water Authority plan for water conservation and drought contingency included in this Appendix does appear to be current. Although stated somewhat ambiguously, page 4 of the document includes a statement of quantified 5-year and 10-year targets, at least for municipal water use. We were not able to locate specific, quantified targets in the drought contingency portion of the document. New requirements that went into effect in May of this year require specific, quantified target goals for water conservation plans and drought management plans. We urge the planning group to include a version of the plan that demonstrates compliance with current requirements.

Appendix L Cumulative Effects of Water Management Strategies
The cumulative effects analysis for surface water flows is a good start. As discussed above, some additional analyses should be added. In addition, discussion of cumulative effects of all recommended groundwater based water management strategies should be included. The information presented in Appendix D indicates that such an analysis has been performed, but as noted earlier, the results are not clearly portrayed. In particular, we encourage the presentation of a map(s) of drawdowns and time series plots of drawdowns at representative points. That information is needed to allow potentially affected persons to understand the implications of the proposed strategies and to support a determination of consistency with long-term protection of the state's agricultural resources, water resources, and natural resources.

Thank you for your consideration of these comments and please feel free to contact us if you have any questions. We look forward to a continuing positive dialogue with the planning group during this and future planning cycles.

Sincerely,

Myron J. Hess   Mary E. Kelly   Ken Kramer

Myron Hess
National Wildlife Federation

Mary Kelly
Environmental Defense

Ken Kramer
Sierra Club, Lone Star Chapter

cc: Carolyn Brittin, TWDB
Bill Mullican, TWDB
Kevin Ward, TWDB
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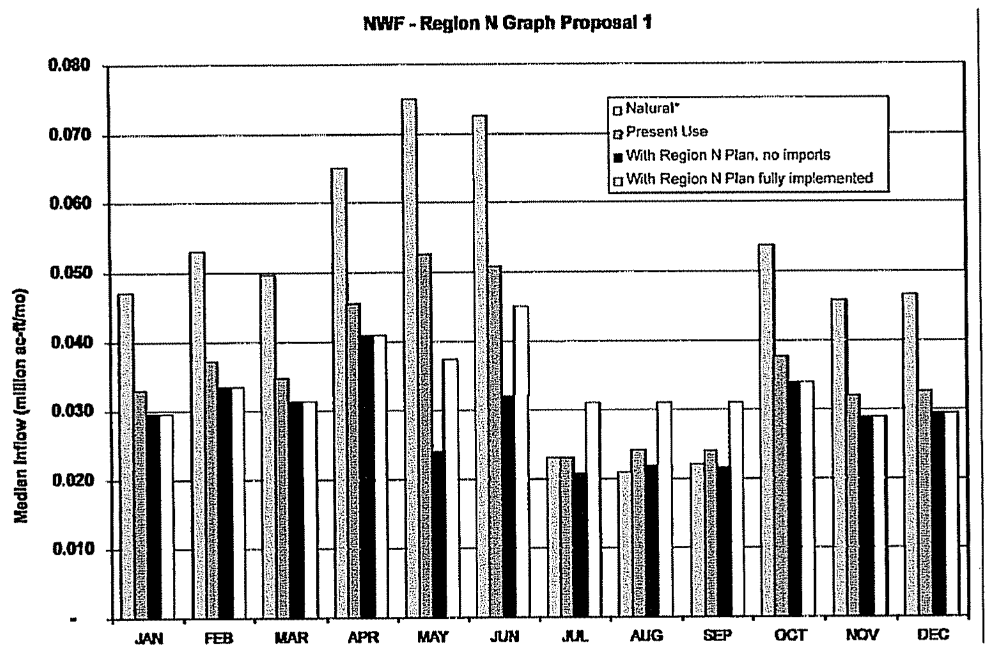
ATTACHMENT I
SUMMARY OF PROPOSAL BY NATIONAL WILDLIFE FEDERATION FOR PROCESS FOR JOINT EVALUATION OF FRESHWATER INFLOW IMPACTS

NWF proposes a three-step process as outlined below.

Step 1 –Predict Freshwater Inflows for Baseline(s) and with Regional Plan Using WAMs

Using the Nueces River WAM, we would jointly predict monthly inflows to the Nueces estuary for 'baseline' conditions and for future conditions with the regional water plan in place. Proposed baselines for comparative purposes are: a) the WAM's "Natural" inflows, representing conditions prior to significant alteration and b) "present use" conditions. Proposed future condition scenarios are c) future conditions with the regional water plan fully implemented except for surface water imports from river basins affecting other estuary(ies); and d) future conditions with the regional water plan fully implemented in all regards. We recommend using two future scenarios, one "with imports" and one "without imports," because such imports likely are detrimental to the estuary system of the import source and are more uncertain in terms of permitting issues. An evaluation of the effects on the source water estuary should be undertaken also, but may prove to be beyond the scope of what can be accomplished in the available time period.

Below is an example graphic depicting flow changes, in this case the median monthly inflows to the Nueces estuary, that would be illustrative of this step. The numerical values here are not significant and are provided only for illustrative purposes.



Step 2 – Perform Ecologically-Based Freshwater Inflow Assessments

For the freshwater inflows calculated for each scenario above, we would perform tabulations for the two ecologically-based assessments as used in the *Bays in Peril* report. The two ecologically-based assessments rely, in part, upon the freshwater inflow recommendations of the Texas Parks & Wildlife Department (TPWD) and the TWDB[1] . The first assessment focuses upon spring / early summer freshwater inflow pulses. The second assessment is focused on six-month periods of continuous low flows falling within the months of March through October (which represent a time of significant biological activity in the estuary).

Step 3 – Present the Results in Final Regional Water Plan

Finally, a summary of the two ecologically-based assessments for the each of the four scenarios would be developed for inclusion in the regional water plan. This would include appropriate graphics and / or tables to summarize the key findings. The preferred approach, if those analyses showed troubling results, would be to consider different combinations of water management strategies in an attempt to meet water needs while avoiding large-scale impacts to inflows. However, given the current timing constraints, the regional water planning group may not be able to consider such alternatives during this round of planning. In that event, we would hope subsequent action would be taken to modify the plan to minimize such impacts. If the analyses do not predict problems then the information would be used to demonstrate a careful consideration of impacts and of consistency with long-term protection of natural resources.

[1] TPWD & TWDB, "Freshwater Inflow Recommendation for the Nueces Estuary of Texas" Sept. 2002.