SOUTH TEXAS REGIONAL WATER SUPPLY PLAN PHASE 1

DATA COMPILATION AND STRATEGY DEVELOPMENT

Prepared by

Ambiotec Environmental Consultants, Inc.
in Association with
Rice University
Texas A & M University
and
Parsons Engineering Science

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Executive Summary

The South Texas Development Council (STDC) is a council of governments organization representing Webb, Zapata, Jim Hogg, and Starr County. The region lies along the Texas/Mexico border and draws its principal water supply from the Amistad/Falcon Reservoir system of impoundments controlling the lower reaches of the Rio Grande. This system of river controls serves the STDC in addition to other entities upstream as well as the Lower Rio Grande Valley downstream.

With assistance from the Texas Water Development Board (TWDB), the STDC sponsored production of this report to develop water supply planning for the next 30 years. As this report was prepared, information relating to water development, supply, and delivery within the STDC was accumulated and compiled in one place. This data included projections for water availability, demand, and supply prepared by the TWDB. It also included hydrologic, climatic, environmental, and demographic information compiled from state and federal agencies, collegiate sources, and local utility staff. Emphasis was placed on acquisition of local perspectives of STDC stakeholders through an initial meeting process as well as through review of water-related reports submitted by the stakeholders. The aggregate information was resolved into the following key findings.

The STDC will encounter increasing challenges to acquire a secure source of water in the next millenium. The Rio Grande is the lifeblood of the region as it supplies about 97% of the total water demand in the region. The water quality of the Rio Grande is threatened by encroaching concentrations of salinity borne out of the combined effects of upstream saline inflows, an evaporation rate that exceeds the entire municipal and industrial demand, and drought conditions that prevail about 60% of the time. Salinity concentrations are projected to double their 1969 values in Amistad Reservoir by the year 2004. During this same period, the concentration of Falcon Reservoir is projected to increase to almost 900 mg/L.

The water use of the region has evolved with the increasing sophistication of border communities. Although once principally farming and ranching communities, the border areas now feature growing industrial and commercial business that has drawn populations to urban centers along the border (e.g. City of Laredo, Nuevo Laredo, and Rio Grande City). Consequently, there has been a regional shift from agricultural water use to municipal and industrial-type (M&I) uses. Now, the STDC area is one of the fastest growing regions in the United States. Seventy percent of the STDC population exists in Webb County with Laredo growing 30% in size just through the period 1990-1996.

The growth in the M&I sector has far exceeded a decline in agricultural productivity resulting in a growing dominant pattern of water use that emphasizes the M&I sector within the STDC. The same phenomena characterizing the urbanization of STDC has been equally robust in the Lower Rio Grande Valley (LRGV). The LRGV has also sustained rapid urbanization of its region. However, this region holds a much larger share of the total water demand than the STDC.

The water rights within the STDC are only a small part of the system-wide total. They represent less than 7% of the system rights downstream of Amistad Reservoir and STDC's M&I fraction comprises only about 17% of the total M&I rights in the system. In short, there are insufficient M&I water rights to meet projected demand. There appears to be a local surplus of irrigation water rights and the total proportional available water supply (both surface and groundwater) appears to be sufficient to meet STDC M&I demands through the planning period. However, projections of available water are flawed by an unknown groundwater supply and an insecure yield from irrigation water rights (actual available water is less than rights). Furthermore, the assumptions built into agency estimates of firm yield may no longer be valid. Siltation effects in the reservoir system as well as reduced inflows from the Mexican side (due to reservoir construction within the last 20 years) may combine to reduce estimates of firm yield for surface water supplies for the region.

Clearly, water rights are not the only option to secure water. Although significant, water rights may not hold the best option exclusively for the STDC to meet its future anticipated water demand. The reason for this is twofold. First, there may not be water available to meet all M&I demand rights. Second, the price of water will escalate. Although water rights pricing is relatively inexpensive now, it can only be expected to escalate in the future. Quick estimates of the present value of rights and infrastructure needed to meet demand for the next 30 years total about $150 million. This cost ignores the cost effects increasing salinity will have on the overall price of water. Therefore, at some point, alternative options for securing water may become attractive. A wide array of options exists. Options include supply management alternatives that increase storage, reuse existing water supplies, or tap previously unused supplies of water. Demand management options include elements to curtail and conserve water use through public education, pricing practices, structural modifications, regulatory constraints, and improved practices. However, not every community will benefit from the same type of management options. A tailored approach that recognizes demographic, geographic, economic, and infrastructure constraints for each of the communities within STDC should be developed.

The selection of any particular suite of options, their sequencing, and site of application, are all driven by site-specific constraints that vary across the STDC region. This range of needs calls for development of a decision tool that enables input of site-specific constraints with consequent measurement of the costs and benefits as they accrue to different sectors of society. Ideally, the set of options selected would hold the greatest overall benefit to a particular community at the lowest practical costs. The selected approach to derive this type of analysis is the substance of the next phase of work.

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Section 1.0 Introduction

1.1 Plan's Purpose

The increasing demands for water in the growing areas of the STDC will tax the existing supplies of water for the community. There will be a concomitant change in water availability as a consequence of increasing sophistication of Mexican water management, increasing water salinity, and through the periodic effects of drought. A water supply plan must be created that ensures management of the STDC region's water resources for a 30-year planning period. The plan should incorporate both demand and supply management strategies; integrate engineering, economics, institutional, and environmental/regulatory elements; and stress public outreach and education to build consensus among the region's water users and suppliers. An artifact of the plan should be a model or technique for assessing the carrying capacity of the region given a limited supply of water and optimal use of the resource. Similarly, there should be evaluation of techniques to optimize the path of least cost among alternatives in a changing climate of economic and social constraints.

The objective of water supply master plan is to provide the planning area this critically needed blueprint for meeting its water supply objectives for the planning period in a cost effective manner. The master plan will provide the planning area with a number of benefits:

- A flexible strategy that will identify trigger points for the implementation of water supply expansion options;
- A dynamic framework for integrating existing and future engineering studies into a long term water supply strategy; and
- A system for prioritizing and scheduling future water supply infrastructure projects and their corresponding detailed engineering studies.

The proposed Integrated Water Resource Planning (IWRP) approach is designed as an alternative to traditional engineering approaches to water supply planning that are based exclusively on supply side management. The proposed planning effort considers demand management and supply management simultaneously within an open and participatory decision making process in order to develop flexible water supply strategies that minimize costs, maximize net benefits, and are robust to changes in future conditions.

1.2 Planning Process

The proposed plan development consists of three phases. The first phase includes compilation and analysis of background data and development of the scope for the second phase. The second phase involves the development of detailed water supply strategies, screening and evaluation of the strategies, and selection of a preferred strategy. The third phase involves the development of the implementation plan for the selected alternative including permitting and facility design for the short term facility needs. This report describes the results of the first phase.

1.3 Applicable Authority

The STDC is a regional planning entity representing Webb, Zapata, Starr, and Jim Hogg Counties. It was created under regional planning commission enabling legislation, local government code, Section 391.001-391.015.

1.4 Acknowledgements

Development of this plan has been a process of compiling data and information primarily from the Texas Water Development Board and through meetings with the STDC stakeholder groups. We wish to thank the stakeholder groups that took the time to meet with Ambiotec and STDC representatives to support this planning process. The meeting process provided invaluable insight into the issues and constraints confronting the STDC membership. We also acknowledge the Texas Water Development Board for providing data with which to assess the status of STDC's water availability.

1.5 Report Organization

The remainder of the report is organized as follows. Section 2 presents a general overview of the study area. The methodology used to forecast population trends and water demands by sector, together with the population and water demand forecasts for the region are presented in Section 3. An assessment of water supplies in the planning region is presented in Section 4. Water related problems and needs are outlined in Section 5, together with a preliminary prescreening of alternatives, and the outline of the Phase II scope of work.

Section 2.0 Study Area

The South Texas Development Council (STDC) is comprised of the four county area consisting of Jim Hogg, Starr, Webb, and Zapata. The combined area totals over 6600 square miles and is located principally in the Rio Grande Basin along the US/Mexico border. The planning area population currently exceeds 235,000. Over 70% of the area population exists in Webb County with the remainder dispersed through the other three counties which are rural in nature. The planning areas are illustrated in figure 2-1.

Webb County includes the City of Laredo, which is amongst the fastest growing cities in the United States. The influence of the North American Free Trade Agreement has fueled this growth. In addition, Laredo is currently the largest land-based port in the country. More than 60 percent of all US/Mexico trade traffic occurs in this city.

Demographic data provided by DRI/McGraw-Hill also points to a heavy contingent of the population that exists at or below average income levels as well as higher-than-average levels of unemployment. In contrast, the region has 13 commercial banks that hold combined deposit to population ratios of approximately twice the state average. This information strongly shows that the area is regionally strong as a financial center.

The amount of agricultural production in the STDC is relatively low compared with the lower regions of the Rio Grande Basin. Approximately 70,000 acres are under production in agricultural areas between Amistad Reservoir and Falcon Reservoir. Downstream of Falcon Reservoir to the Gulf of Mexico there are approximately 650,000 acres of land in agricultural production. Withdrawals of water for agricultural use therefore appear to be about a tenth of counterpart regions downstream of STDC.

2.1 Planning Area Basins

A map presenting hydrologic features relative to the STDC planning area is presented as figure 2-2. This map includes the major hydrologic basin boundaries, streams, water right diversion points, public water supply sources, as they relate to county boundaries and political communities within the study area. The map is actually a small GIS. All of the map features and boundaries composing the map are represented by digital data contained in a database. This information includes: aquifers, cities, counties, interstate highway, lakes, reservoirs, public water supply system data, streams, water rights, and colonias.

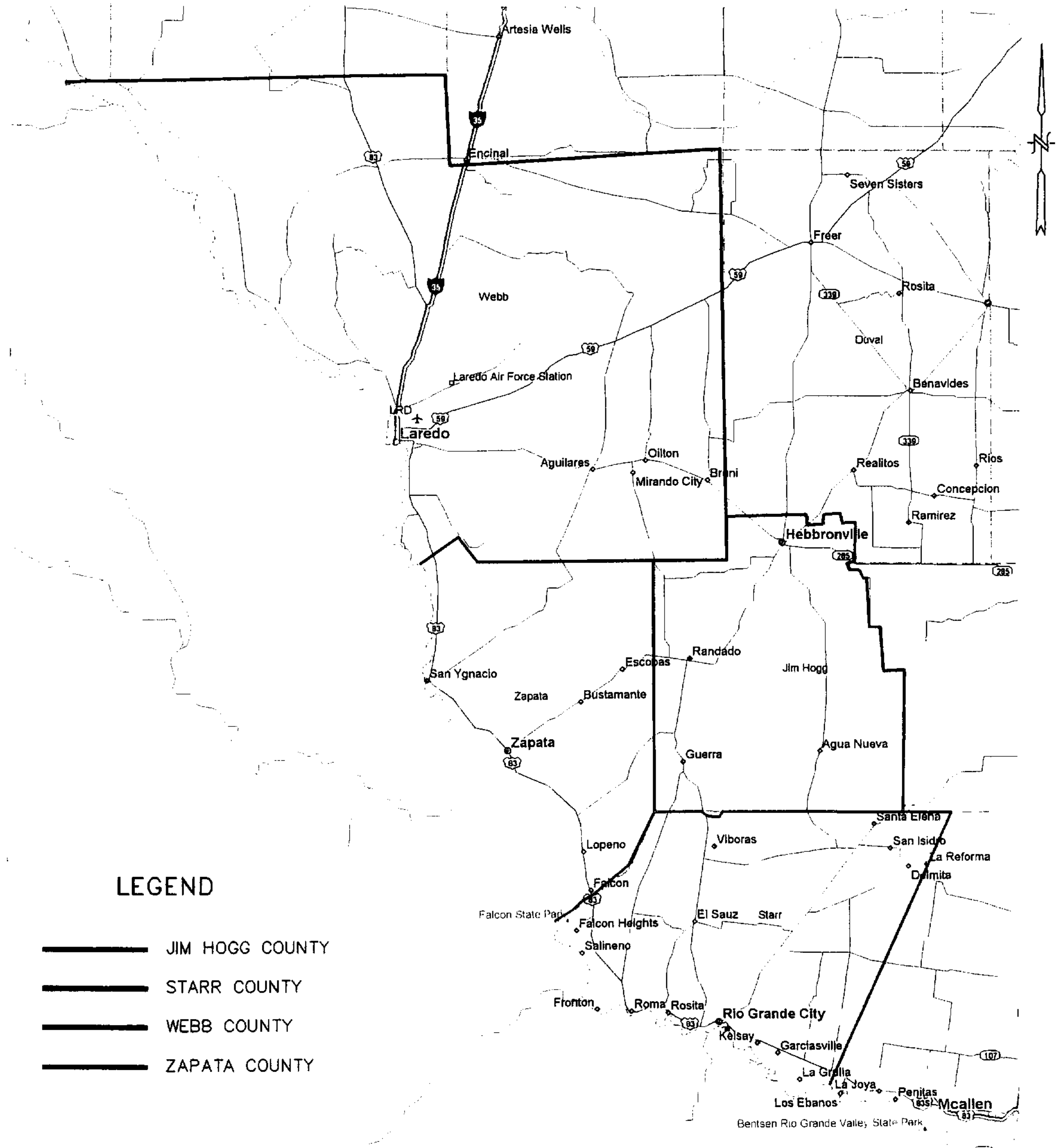
2.2 Basin Overview

The South Texas Development Council Counties lie within the boundaries of three River Basins: Rio Grande, Nueces, and Nueces-Rio Grande. As shown by figure 2-2, the Nueces Basin occupies 40-50% of Webb County. The Nueces-Rio Grande Basin occupies approximately two thirds of Jim Hogg County and about one third of Starr County. There is no significant surface water supply derived from these basins in the STDC region. In fact, according to the 1990 TWDB State Water Plan, export of irrigation water to the Nueces-Rio Grande Basin is the largest basin water demand in the region.

Approximately 97% of the water use within the STDC is derived from the Rio Grande River with the remaining 3% drawn from groundwater resources. In other words, the STDC region derives practically all of its water from the Rio Grande.

2.2.1 Rio Grande Basin

A map of the total Rio Grande Basin that highlights the basin's significant reservoirs, the study area, cities of interest, and other significant geopolitical boundaries is provided as figure 2-3. This figure was constructed from an IBWC map by scanning the original image and highlighting the features of interest. This map can be used as a reference guide in the following discussions.



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Scale 1 in = 16 mi

AMBIOTEC ENVIRONMENTAL CONSULTANTS, INC.
1101 E. Harrison
Harlingen, Texas 78550
4507 Cat Mountain Dr.
Austin, Texas 78731

FIGURE 2-1
STDC PLANNING AREA

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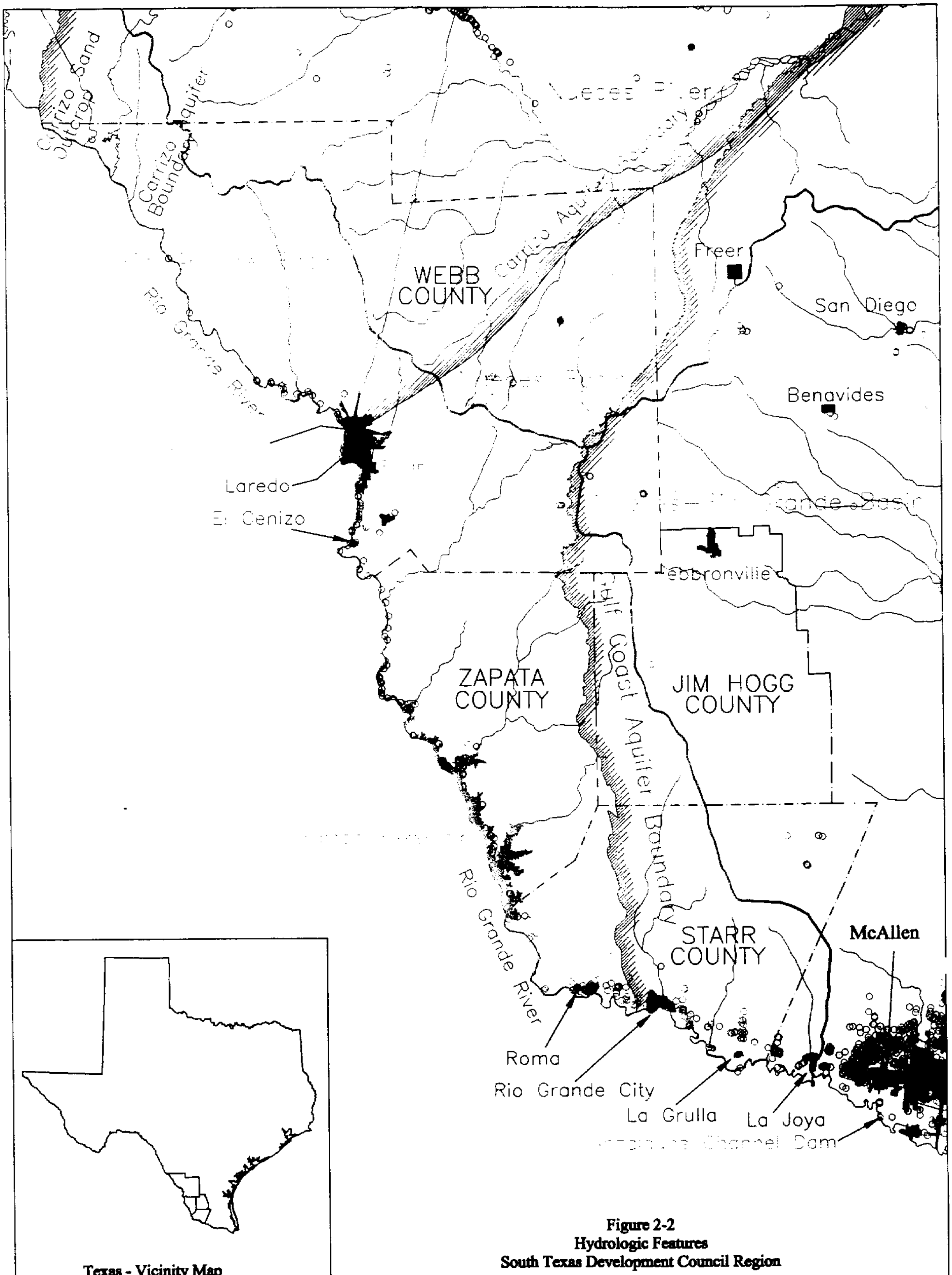


Figure 2-2
Hydrologic Features
South Texas Development Council Region

AMBIOTEC ENVIRONMENTAL CONSULTANTS, INC.
Consulting Engineers and Scientists
4507 Cat Mountain Drive, Suite 101
Austin, Texas 78731-3503
Ph.: (512) 345-2002
Fax: (512) 345-2358
AMBIOTEC

PARSONS
Austin, Texas
PARSONS INFRASTRUCTURE AND TECHNOLOGY
PARSONS ENGINEERING SCIENCE

Legend		
Aquifer Boundary	City	Water right
Watershed Basin	Lake	Public water supply source
Interstate 35	Reservoir	Colonia
Stream		
County Line		

SCALE 1:20,000

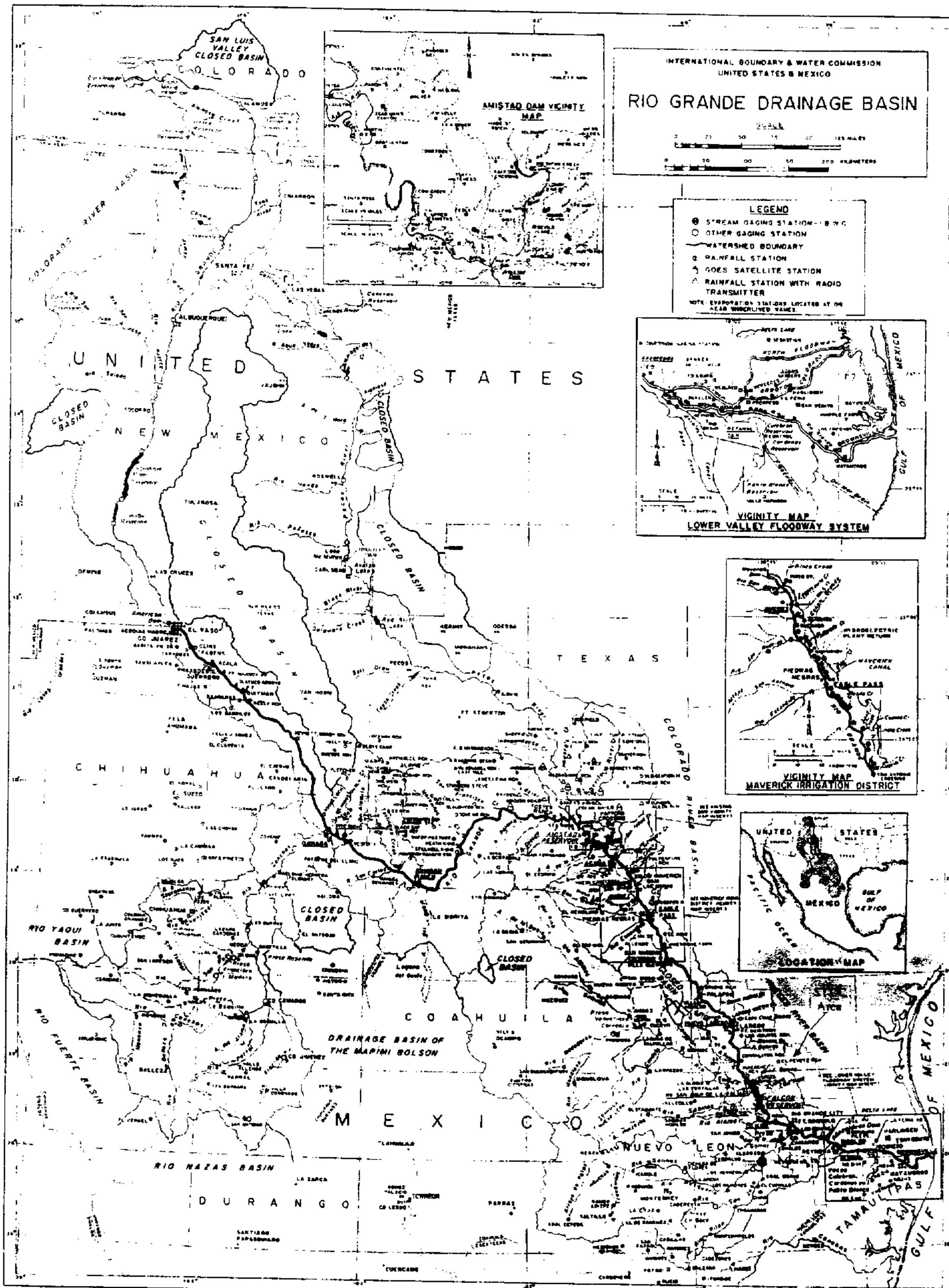


FIGURE 2-3

RIO GRANDE DRAINAGE BASIN FEATURES

The Rio Grande Basin consists of two major watersheds. One originates from the southern slopes of the Colorado Mountains and northern New Mexico, the other from the mountain ranges of Chihuahua, Mexico and the Pecos Basin of southern New Mexico and far west Texas. Although the Rio Grande is shown as a continuous river, the flow from the Colorado Mountains at times diminishes near Fort Quitman approximately 78 miles south of El Paso. The new perennial flow begins at the confluence of the Rio Conchos from the Mexican side, approximately 284 miles downstream from El Paso (See Figure 2-3) (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

The flow of the Rio Grande that originates from the watershed in the southern slopes of the Colorado Mountains and the mountain ranges of northern New Mexico is stored at Elephant Butte dam (design capacity of 2.64 million acre-ft) located in New Mexico. The water is used to irrigate the Mesilla, the El Paso and the Juarez Valleys. The Rio Grande below the El Paso-Hudspeth county line consists mostly of the return flow and occasional excess water and runoff from the adjacent areas. The Bureau of Reclamation designates the Rio Grande between Elephant Butte Dam and Fort Quitman as the middle Rio Grande, whereas in Texas, this section is considered as a part of the Upper Rio Grande reach. In any case, the El Paso to Fort Quitman segment of the Rio Grande consists largely of the tail water of the water supply from Elephant Butte Dam. The annual rainfall in this segment of the Rio Grande Basin averages 7.8 inches, the lowest in Texas. The Rio Conchos from Mexico is the major entry into the Rio Grande below Fort Quitman and flows in just below Presidio (or Ojinaga, Mexico) which is located 282 miles south of El Paso. This flow continues to Amistad Dam (design capacity 5.1 million acre-ft) 310 miles below Presidio. There is no major tributary that flows into the Rio Grande from the U.S. side, until the inflow of the Pecos River at Langtry, TX, and the Devils River at Amistad Reservoir. The flow of the Pecos River is regulated at Red Bluff Lake at the New Mexico-Texas border, and it consists mostly of saline irrigation return flow. The flow of the Pecos River that enters the Rio Grande is a mixture of return flow and runoff from far west Texas. The Bureau of Reclamation designates this segment of the Rio Grande as a part of the lower Rio Grande system, whereas in Texas, this segment is commonly referred to as the Upper Rio Grande reach. The annual rainfall in this section of the Rio Grande averages 10 to 12 inches. The Rio Grande between Amistad Dam and Falcon Reservoir (3.2 million acre-ft) is a long stretch extending 299 miles. There is no major tributary, but there are numerous creeks and draws that discharge to the Rio Grande after storms. In Texas, this segment of the Rio Grande is commonly called the Middle Rio Grande reach. The annual rainfall in this section increases to about 20 inches. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

The Rio Grande below Falcon Reservoir to the Gulf of Mexico is the heart of the Lower Rio Grande, and extends 275 miles. The Rio Salado from Mexico is a major tributary that flows directly into Falcon Reservoir, and the Rio San Juan flows into the Rio Grande below Falcon. There are two major drainage ways on the U.S. side: the Main Floodway and the Arroyo Colorado. The latter is of special importance, because it flows directly into the Laguna Atascosa National Wildlife Refuge. The natural drainage flow is away from the Rio Grande eastward toward the Laguna. This area is outside the Rio Grande Basin, and is a part of the Nueces River Coastal Basin (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

2.2.2 Nueces River Basin

The Nueces Basin is bounded by the Rio Grande Basin on its southern boundary that traverses a line through the middle of Webb County. This basin is of little consequence for surface water supplies in the region. The Webb County portion of the basin contains three creeks that contribute drainage to the Nueces basin: San Casamiro Creek, Dolores Creek, and San Roque Creek. Additionally, a small portion of the headwaters of Cane Creek is also located in the uppermost northeastern border of Webb County. All of these creeks are ephemeral and drain principally undeveloped rangeland. The climatic characteristics of the Nueces River Basin are essentially the same as those of the Rio Grande Basin within Webb County. This portion of the basin lies within the same climatic zone as the rest of the STDC region (Southern).

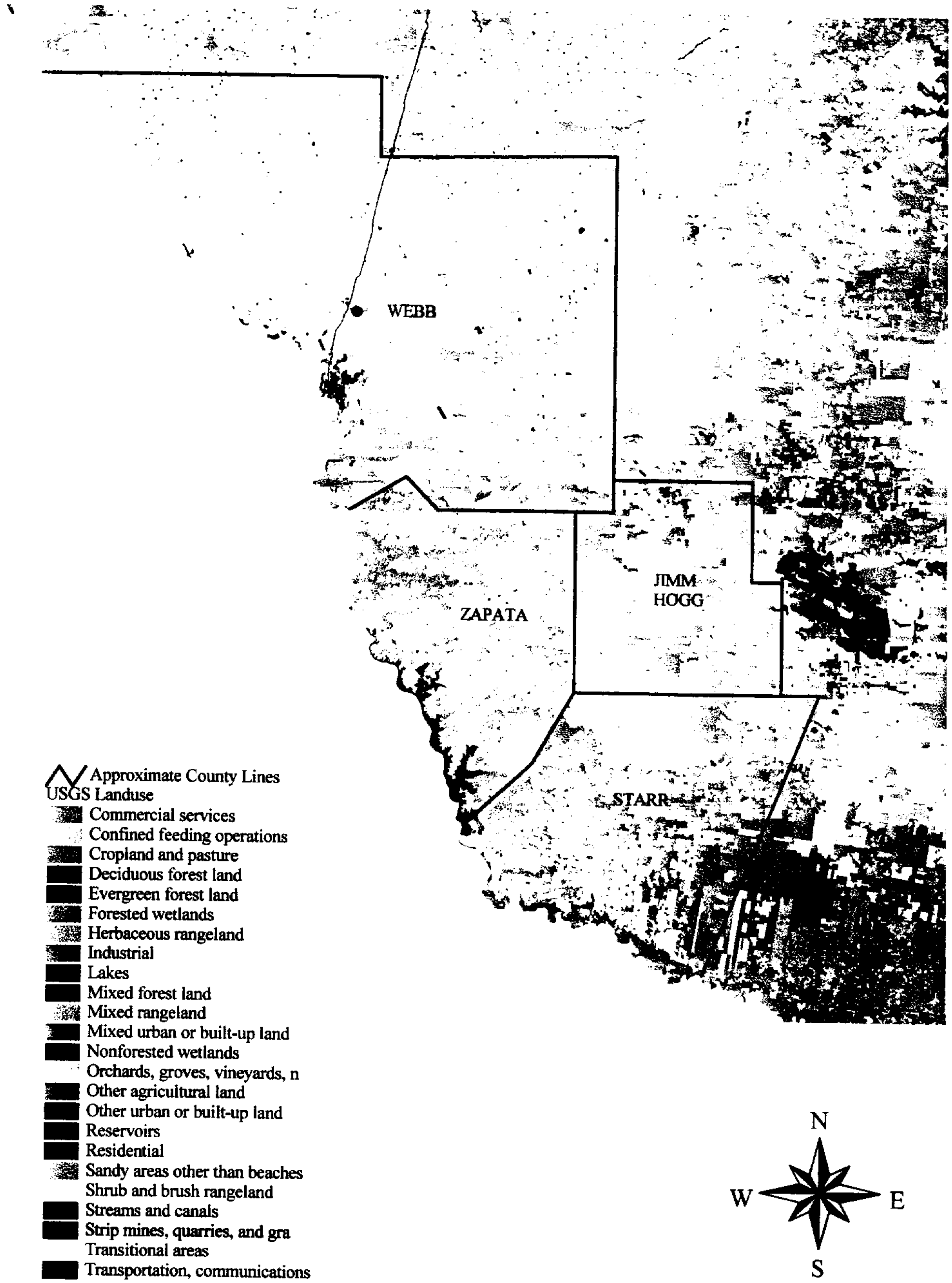
2.2.3 Nueces-Rio Grande Basin

Like the Nueces Basin, the Nueces-Rio Grande Basin is of little consequence from a water supply standpoint for the STDC region. This basin comprises approximately 60% of Jim Hogg County as it borders the Rio Grande Basin in a line traversing the eastern third of the county in a northwest to southeasterly orientation. It also occupies the southeastern corner of Webb County. The STDC portion of the basin holds no distinctions from the climatology of the Rio Grande Basin within this region and is actually located within the same climatologic region (Southern) within the state. Within the STDC, two ephemeral creeks drain principally undeveloped rangeland and drain towards the Texas Gulf Coast: Arroyo Baluarte and Palo Blanco Creek.

2.3 Land Use

The USGS developed digital-ortho quadrangle sheets in both 1:100,000 and 1:250,000 scales. These maps provide the only known consolidated information regarding land use for the region. When contacted to determine the dating of the mapping, a USGS mapping representative maintained the mapping is of 1970s vintage. Evidently, there is no recent data available. The 1:250,000-scale mapping was used to convey land use features for this project. The original quadrangle sheets, called Laredo, Eagle Pass, Crystal City, and McAllen, respectively, embrace a region extending from an area in Northwestern Webb County, south to the Lower Rio Grande Valley. Due to their relative size and resolution, these maps were consolidated into a single map, presented here as figure 2-4. The predominant land use types are various types of rangeland.

Figure 2-4
USGS Land Use for South Texas Development Council



2.4 Water Agencies and Legislation

The STDC region is subject to a number of agency jurisdictions as well as influence by agency activities by virtue of its location within the State of Texas and the USA. It is also subject to interests unique to the border regions of the United States and Mexico due to the proximity of the Mexican border to its membership. Agencies having interest and/or jurisdiction within this area include the following:

- International Boundary and Water Commission
- United States Geological Survey
- Bureau of Economic Geology
- Texas Water Development Board
- Texas Natural Resource Conservation Commission
- United States Environmental Protection Agency
- Comicion Nacional de Agua
- United States Department of Commerce
- Federal Emergency Management Agency
- Border Environment Cooperation Commission
- North American Development Bank
- Texas Department of Commerce
- Texas Department of Agriculture
- New Mexico State University
- Texas A&M University

Among these agencies, the most active from a planning standpoint have been TWDB, TNRCC, IBWC, BUREC, and BECC. The TNRCC, IBWC, and Texas Parks and Wildlife have jointly developed a water quality evaluation of the Rio Grande. After its comprehensive review of the Lower Rio Grande River, BUREC signed a memorandum of understanding to cooperate with the TWDB in water planning projects. Furthermore, BECC and TWDB are charged with supporting the funding process for infrastructure projects to improve water quality, and water and wastewater treatment capacity. Recently, through funding assistance provided by EPA ($100+ million grants), the IBWC has been pursuing upgrade of water and wastewater treatment and delivery projects in Mexico. These projects are, by design, able to meet the BECC criteria for sustainable development. It is anticipated that this process will provide increasing benefits as sanitary sewers are rectified and wastewater treatment plants are constructed to reduce the flow of untreated wastewater to the Rio Grande River. It should be noted that the USGS has also developed an extensive mapping database that can be tapped for graphical information system development.

2.4.1 Surface Water Law

When Texas became a nation over 150 years ago, it replaced the system of Spanish land and water grants with the English *riparian doctrine*. By definition, the riparian doctrine is the fundamental legal rule that all streamside land owners are entitled to the use of "reasonable" quantities of water. With the riparian doctrine, the court settles any disputes concerning how much water is "reasonable". Soon afterwards, Texas joined the Union, taking the exceptional path that all land was property of the State, not the United States. States have considerable latitudes in selecting what water laws they wish to adopt, and Texas chose to maintain the riparian principles it instituted while it was an independent nation.

Toward the end of the 19th century Texas began enacting laws progressively moving the State to the *prior appropriations doctrine* for administering its surface water while generally grandfathering existing water uses relying on Spanish or riparian water rights. Under the appropriations doctrine, water users must obtain a water use permit stating seniority, the amount of allowed water use, and type of use, among other things. Seniority within the appropriations doctrine is fully determined by the date each water use originally commenced. The principle is often tersely stated as "First in time, first in right". In addition to prioritizing water use permits by seniority, appropriative rights differ from riparian rights in that appropriative rights specify water quantities and allow water use by nonriparian (not streamside) landowners.

Water allocation during times of shortage remained disorganized due to the multiple, coexisting systems of water rights. The hardships of this confusion were greatest in the Rio Grande Valley, and the multiyear drought of the mid-1950's caused conflict to erupt into a protracted court case that began with a suit filed by the State in 1956. Eventually, the court case resulted in the judicial adjudication of the Texas portion of Rio Grande water rights in 1969 (*Texas v. Hidalgo County WCID No. 14 et al.*). The outcome of this case was that explicit water rights were assigned to many individuals, water districts, cities, towns, and corporations. These rights are transferable. It has been legally permissible to buy, sell, or lease water within the Amistad/Falcon Reservoir system since State implementation of the court's order in 1971.

The process of *adjudication* effectively severed water resource rights from the land upon which the water had historically been used, thereafter allowing land and water resources to be exchanged independently. Adjudication also quantifies individual water rights in terms of the amount of water each can take, and other conditions may be placed on the rightful exercise of these rights. For example, the right may be conditioned on the maintenance of a minimum instream flow within the river.

Water rights in the Amistad/Falcon Reservoir system are different from surface water rights employed in the rest of the State. In this system, irrigation permits[1] occur in two classes, A and B. Class A permits receive 1.7 times as much water as class B permits. All irrigation water rights are *correlative* in the Amistad/Falcon Reservoir system. That is, these permit holders are on equal footing, sharing equally in times of plenty or drought. Municipal, domestic, and industrial permits have a higher priority than irrigation rights but are correlative among one another. In periods when water supply is insufficient to satisfy all right holders, the shortages are shared equally by irrigators *(Texas Natural Resource Conservation Commission 1995)*. If water supply circumstances were ever to become so severe that irrigation was eliminated, additional shortfalls would be shared equally among municipal, domestic, and industrial users. In periods of unusually high water supply, all right holders are allowed to use water in excess of their entitlements *(Characklis, Griffin, and Bedient 1997)*. During such periods, the State announces that "no charge" pumping can occur in the Amistad/Falcon Reservoir system – meaning that any water use is not debited from the user's water right account.

Surface water policy is different in the rest of the State. By legislative decree in 1967, adjudication of surface water rights commenced for the remainder of the State, proceeding basin-by-basin. Unlike the court-conducted adjudication of Amistad/Falcon Reservoir system water, the rest of the State's surface water was divided among users with a formal, agency-conducted process. Upon completion in the 1980's, Texas had established appropriative surface water rights for the entire state, except for the Amistad/Falcon Reservoir system where rights are correlative. Unlike the water rights of this system, the rest-of-Texas surface water rights are not correlative within use types – they observe seniorities which employ use dates to prioritize competing water interests. Simply put, older water rights are the most senior, and use category (irrigation, municipal) does not affect seniority. For Amistad/Falcon Reservoir system and the majority of the State, surface water supplies are now fully allocated, and new water rights cannot be granted (Texas Natural Resource Conservation Commission 1995).

2.4.2 Compacts

The Rio Grande Compact was an agreement signed into law on May 31, 1939 between the states of Colorado, New Mexico, and Texas. This agreement governs the shared use of water in the region of the Rio Grande Basin that lies upstream from Fort Quitman, Texas. The use of water is tied to a minimum required flow of 790,000 acre-feet/year downstream of Elephant Butte Reservoir and the contingencies for how the states shall respond if environmental conditions preclude this flow or produce a surcharge of water beyond this flow. Through Article XI of this compact, Texas and New Mexico also agreed to indemnify one another from any legal liability that would otherwise be borne through increased salinity in the Rio Grande resulting from irrigation return flows. Out of concern for potential conflicts with other compacts, this compact absolved any relationship between water deliveries made through this contract and demands for water by Mexico. It also declared that there is no relationship between the covenants of the compact agreement and obligations to Mexico (Articles XIV and XVI).

A similar contract was signed into law on June 9, 1949 between Texas and New Mexico called the Pecos River Compact. This agreement apportioned the waters in the Pecos River subbasin located upstream of Girvin, Texas. Apportionment was tied to "the 1947 condition," the hydrologic conditions prevalent in the Pecos River Basin during preparation of the engineering report supporting the agreement. A key provision of this agreement includes a requirement that neither state can diminish the

[1] Valley permits for mining use have the same properties as irrigation permits, including class and seniority. The text emphasizes irrigation for expositional convenience.

flow of the Pecos River as a consequence of "man's activities." In other provisions, all of the flow of the Delaware River was apportioned to Texas, and all floodwaters of the Pecos River were apportioned 50:50 to Texas and New Mexico.

2.4.3 International Agreements

The Lower Rio Grande's status as a major international border has presented difficulties for apportioning available water between Mexico and the United States. Two treaties now clarify each nation's entitlement to water and obligations to deliver tributary flow to the Rio Grande.

The first treaty dated 1906, provided for Mexico 60,000 ac-ft of water annually in the El Paso-Juarez Valley upstream from Fort Quitman, Texas. Under this agreement, if shortages occur in the United States, deliveries to Mexico are to be reduced in the same proportion as deliveries to Mexico.

The "Treaty of February 3, 1944" is the landmark document for dividing Rio Grande and tributary water and for authorizing eventual dam construction. This agreement is the foundation of the water management activities of the International Boundary and Water Commission (IBWC) which is the oversight authority for the basin. The Treaty enabled construction of both Falcon (1953) and Amistad Reservoirs (1968). The IBWC is the operator of both of these facilities, and it operates them in accordance to Treaty-established rules.

The 1944 Treaty allocated to the U.S. (and therefore to Texas) all tributary inflows to the Rio Grande from Texas basins including the Pecos and Devils Rivers, Terlingua Creek, San Felipe Creek, and Pinto Creek. The treaty also allocated one-third the tributary inflows of six Mexican drainages[2], and one-half of all other Rio Grande flows and tributary inflows below Fort Quitman, Texas. Mexico receives all tributary inflows from two major Mexican drainages (Rio San Juan and Rio Alamo), two-thirds of the tributary inflows of six Mexican drainages, and one-half of all other Rio Grande flows and tributary inflows below Fort Quitman, Texas. Under Article 10 of the treaty, Mexico is guaranteed a minimum 1,500,000 acre-feet per year. During years where the United States elects to allocate surplus water, the maximum amount Mexico can take is 1,700,00 acre-feet. Furthermore, Mexico cannot acquire rights to any water in excess of the 1,500,000 acre-feet minimum. Regarding reservoir storage, the United States is apportioned 56.2 percent of Lake Amistad storage and 58.6 percent of Lake Falcon. Mexico receives the balance of the storage in these two reservoirs.

2.4.4 Water Marketing

Since adjudication was completed for the Amistad/Falcon Reservoir system 15-20 years prior to the rest of the State, the earliest water marketing pertains to this region. In fact, surface water marketing remains rare in all areas of Texas except the Amistad/Falcon Reservoir system *(Kaiser 1996, fn. 10)*. Reasons for these phenomena are likely many, but a few can be readily identified. Most surface water markets are "thin" in the State because either (i) water right enforcement has been lax, (ii) groundwater is an available, loosely controlled option, (iii) a single utility, district, or river authority dominates the provision of water in the region, or (iv) the supply of water usually exceeds demand.

Every transfer of surface water rights requires approval of the Texas Natural Resource Conservation Commission. The process is referred to as "amending" a water right *(Chang and Griffin 1992)*, and the Texas approach is not unlike procedures used throughout the western U.S. *(Colby 1995)*. Information is assembled, public notice is given, objections from potentially harmed third parties are invited, and hearings can be held by the Commission. Public notice may be obviated if there is no possibility of third party impairment. Short term leases may be separately regarded by the agency if the exchange is local and intrasectoral (such as from one irrigator to a neighboring irrigator, not from an irrigator to a neighboring city). Local, intrasectoral exchanges tend to have minor impacts on streamflows and therefore minimize third-party considerations.

Because of its earlier adjudication by suit and its unique hydrologic character, special rules have been adopted for water resource administration in those segments of the Amistad/Falcon Reservoir system *(Chang and Griffin 1992)*. The general amendment procedure applies to this system with three notable exceptions. First, water rights cannot be transferred from diversion points downstream of Amistad Reservoir to points upstream of Amistad.

[2] It is specified that the U.S. third shall not be less than 350,000 acre-feet each year as an average in five-year periods from the sum of all six tributaries. They include the Rio Conchos, Rio San Diego, Rio San Rodrigo, Rio Escondido, Rio Salado, and the Arroyo las Vacas.

Second, mailed and published notices regarding proposed transfers are not required. Because of the aridity and drainage of the region, there is a reduced possibility of return flow to the Rio Grande for diversions downstream of Falcon Reservoir. Therefore, diverted water is considered to be completely consumed. Here, water withdrawn from the river either evaporates or drains away from the river, thereby minimizing third party effects of water transfers. For diversions upstream from Falcon, water transfers have a greater possibility of having impacts on third parties, due to altered return flows, but the prevailing policy is to ignore this complication. No public notice concerning potential water market transfers is deemed necessary. For these same reasons, the leasing of water receives summary approval in the region as long as the exchange is intrasectoral (within the same use type; e.g. irrigation).

The third departure from Texas-wide transfer rules is that a portion of a water right is sacrificed in the transfer process. When irrigation (or mining) water rights are obtained by an urban or industrial interest, the water right experiences both an increase in seniority and a decrease in quantity. Every 1.0 acre foot of a Class A water right becomes 0.5 acre-feet of a municipal or industrial water right; and every 1.0 acre foot of a Class B water right becomes 0.4 acre-feet of a municipal/industrial water right. There are three possible explanations, each having some validity, for this water tax on transfers: it compensates for increased seniority; it is an adjustment for the return flow losses that might occur if the new owner makes more intensive use of the water; and/or it is a viable method for correcting the initial overappropriation of system water resources.

The Amistad/Falcon Reservoir system includes many independently operating, water-owning water districts and urban utilities that possess water rights, and the original 1969 adjudication vested many individuals and organizations with water rights. The water market within this system has been relatively vibrant in the sense that exchanges are commonplace. Municipalities have depended on the water market with great success – more than half of contemporary urban water rights were obtained in the water market while avoiding costly water development in an overappropriated river basin.

There is evidence that the majority of past Amistad/Falcon Reservoir system water sales have involved sellers who are private owners of water rights rather than district-held rights *(Chang and Griffin 1992)*. Up to this point in time, irrigation districts have declined to sell any of their water rights to cities. They do, however, lease water to cities and towns while retaining title to water rights—called contract sales in the region. Because of the many past sales (not leases) of water rights to municipal use, the majority of the remaining agricultural rights are owned by irrigation districts. Therefore, it is increasingly true that growing cities and towns have little option but to come to terms with an irrigation district if added municipal water is to be obtained. Consequently, the future may bring about novel agreements between irrigation districts and municipal interests.

The 1996 summer drought and the continued water scarcity of the region have illustrated both the resiliency of the Amistad/Falcon Reservoir system water market and its remaining deficiencies. Prices paid for leased water rights leapt in response to drought conditions, as one would hope and expect. To help foster appropriate levels of stewardship and conservation by end users, price should reflect scarcity. Price is an important and socially useful signal. Presumably, lessors of these high-priced water rights recovered the greater costs by digging into their financial reserves (cities, districts), sacrificing some profit (farmers), or by establishing higher rates for finished water (cities). These consequences are socially desirable for the long term, despite short-term hardships.

An unfortunate aspect of the correlative water rights system used in the Amistad/Falcon Reservoir system is that all irrigation rights are pared back, in terms of water quantities during drought. This is a departure from surface water doctrine employed in the rest of the State. In the rest of Texas, only junior water right owners are constrained during drought circumstances. The deficiency of the correlative system is that more risk-averse irrigators, perhaps citrus and vegetable producers, do not have the option of trading for senior irrigation permits as they might in other areas of the State. However, this deficiency is somewhat ameliorated by the availability of well functioning lease markets. That is when correlative water rights yield little water, risk-averse irrigators can attempt to lease water.

Another deficiency is lax enforcement of water rights on the Mexican side of the border. When two countries have agreed to a division of boundary waters and subsequent policing is differential, some taking of property rights will inevitably occur in times of drought. It bears observation that now it is not institutionally feasible to transfer Mexican water rights to Texas or vice-versa. The Mexican system of water administration is heavily nationalized, and surface water resources are federally owned, so it would be difficult to arrange beneficial water transfers insofar as Mexican water users do not possess transferable water rights to the water they employ.

2.4.5 Recent Policy Modifications

The Texas Legislature acted in support of water marketing in 1993 by creating the Texas Water Bank. Administered by the Board, the Bank was intended as a sort of clearinghouse whereby potential water right sellers and buyers could better find one another. At last report, the Bank had assisted no transactions, perhaps due to the legislatively imposed restrictions that no more than one-half of a water right could be transferred *(Texas Water Development Board 1994)*. These restrictions imply that non-Bank transfers present better terms for water right holders than do Bank transfers. These restrictions were effectively changed by the 1997 Legislature (Senate Bill 1), so the Bank may be more active in the future. Due to the high momentum and low transaction costs of Amistad/Falcon Reservoir system water exchanges, the Texas Water Bank is unlikely to impact water allocation in this region. However, what the bank can facilitate are water exchanges that would otherwise be politically sensitive by maintaining the anonymity of the parties involved. This may turn out to be the greatest feature of the water bank.

The summer drought of 1996 urged institutional changes on many fronts. Water supplies became inadequate in several basins. Texas water users outside of the system began seeing levels of water right enforcement they had not encountered before, yet enforcement was still lax in the sense that senior, downstream users did not always receive their appropriations. Due to absence of planning and preparation for drought, some communities ran out of water. Tensions also developed out of the competition for water between diversionary water uses (such as for irrigation or municipal) and instream environmental demands (such as for species support and waste reception). It was apparent to the water management agencies and to the Legislature that changes were necessary.

2.4.6 Senate Bill 1

Senate Bill 1 of the 1997 legislative session brings many notable reforms. Many of these reforms have surface water implications. The most noteworthy are listed below.

1. River or stream sites of "unique ecological value" or of "unique value for the construction of a reservoir" are to identified by the Board and recommended to the Legislature for protection from other developments.
2. Water conservation plans are to be submitted with all amendment applications.
3. In emergency situations, the State can temporarily transfer water from a right holder to a city. Compensation of "fair market value" and damages to the water right owner is required.
4. A water right may include explicit return flow obligations. If it does not already do so, reuse for beneficial purposes by the owner is unlimited until the residual water is returned to a river or stream.
5. Interbasin transfers involve a more demanding amendment process, and if the amendment is approved, the amended water right becomes junior to all current water rights in the originating basin.
6. Owners may place their surface water rights in the new Texas Water Trust which is established "to hold water rights dedicated to environmental needs, including instream flows, water quality, fish and wildlife habitat, or bay and estuary inflows."
7. Regional planning areas will be represented by a planning board comprised of 11 members representing the following interests: Agriculture, Counties, Electricity Generation, Environmental, Industrial, Municipal, Public, Small Business, River Authorities, Water Districts, and Water Utilities. The TWDB will select the initial board members from nominees placed by the constituency within the region.
8. The original planning board will sanction the preparation of water plan studies that will feed into the state water plan. The original 11-member board will be authorized to select additional members, as deemed appropriate to additionally support the board's activities.
9. Water plans prepared for the region must show how water supply will be obtained and maintained for the standard water uses within the region (e.g. municipal, irrigation, industrial, livestock watering, etc.) for a 50-year planning period. Water availability must be tested for three conditions: the drought of record, 50% of normal flow, and 75% of normal flow. The Texas Natural Resource Conservation Commission will provide the flow conditions. Reservoirs

will be evaluated using firm yield analysis using reasonable sedimentation rates and the assumption that senior water rights will be totally utilized. (Until the TNRCC has these analyses performed for the reservoir(s) of interest, the planning board will be able to prepare estimates of the amount of water that will be available during the test conditions using existing water rights. Note: the TNRCC will not be able to provide these analyses for the first water plan.)

10. Water supply projects designed to meet a designated water demand within the planning region must be included in the water plan strategy demonstrations or face losing TWDB funding. The TWDB may elect to grant exceptions to this requirement based on changed conditions. If it elects to consider funding, TWDB is required to request comments from the rest of the affected region. Implications of this particular provision are to try and ensure that all candidate water projects requiring TWDB funding be incorporated into the regional plan.

There are numerous other provisions that can be found in Senate Bill 1 Final Draft Regional Water Planning Areas and Proposed Rules for State and Regional Planning and Water Planning Grants, December 18,1997. These selected provisions are simply a reminder of the importance and broad implications of the new rules. STDC members are encouraged to familiarize themselves with the full extent of the TWDB rules—particularly the procedural rules governing regional strategy development, public notice, and regional plan approval.

The new directives established by Senate Bill 1 may have profound implications for environmental dimensions of water allocation and, therefore, competing water uses as well. Texas attention to nondiversionary water uses began to gather momentum in 1985. At that time the Legislature required that five percent of the water developed by new reservoirs within 200 miles of the coast must be dedicated to the Parks and Wildlife Department and that any new water rights issued anywhere in the State should be conditioned with respect to instream flow and bay and estuary water needs *(Kaiser and Binion)*. It appears that no such restrictions need appear on water rights issued prior to 1985 which would include the majority of water rights in the Amistad/Falcon Reservoir system and the State. It has been reported that the Commission has been exacting instream flow maintenance restrictions on rights issued since 1985 and on amended rights outside the system *(Kaiser and Binion)*. Since water marketing necessitates water right amendment in the State, the Commission is essentially placing a water tax on water market activities.

The newly established Texas Water Trust offers an interesting opportunity to further the satisfaction of instream water demands *(SB 1, §15.7031)*. Like the Water Bank, however, the Trust is a redundant institution insofar as people or organizations can hold water rights for any purposes without deposit in the Trust[3]. If the Trust does result in an increase in the amount of State water used for nondiversionary purposes, it may be due to the exemption of Trust-deposited water from cancellation due to nonuse *(SB 1, §11.177(b)(6))*[4].

According to Senate Bill 1, in the absence of explicit return flow obligations recorded on one's water right, a permit holder may completely use and reuse the water until the residual water reenters a watercourse *(SB 1, §11.046)*. The clarified law has the apparent impact of enhancing the power of higher priority water rights vis-à-vis low priority ones and enhancing the power of upstream water rights over downstream water rights.

2.4.7 Institutional Opportunities and Directions

Based on the institutional information assembled here, water availability for the region is shaped predominantly by the 1944 Treaty and the 1969 court decision, *Texas v. Hidalgo County WCID No. 14 et al.* These two policies are subject to interpretation by their separate administrators, the IBWC and the TNRCC. They are also subject to alteration by new legislative initiatives such as those embodied in 1997's Senate Bill 1. While future policy changes are possible, and even likely, the Amistad/Falcon Reservoir system's steady experience with its current laws suggests that further policy evolution will have to conform to the framework now present.

[3] There is a listing of allowed water uses in the Texas Water Code (SB 1, §11.023). After a 10-item list that includes things like "recreation and pleasure" and "game preserves", there is the following catch-all: "State water also may be appropriated, stored, or diverted for any other beneficial use." Thus, diversion is not necessary for there to be a legally recognized use, and private agents are not enjoined from using Texas water rights for environmental purposes.

[4] Texas water rights have long been legally subject to cancellation for ten years of nonuse. The Commission has not exercised this rule. Some noneconomists have been arguing for application of this rule as a means of addressing water overappropriations and instream flow needs (Kaiser and Binion). Cancellation terms are more carefully recorded in Senate Bill 1, so this legal provision may find future application.

It is clear that the surface water resources of the basin are so fully employed that additional surface water development projects are untenable. Action for managing the water resources of the area must therefore emphasize policy paths involving (a) the more productive use of available water and (b) the reallocation of available water across water users. While some policy fine-tuning may be commendable, the region is fortunate to possess a viable water market for aiding the process of reallocation. Not only is reallocation assisted by this market, but the market begins to establish implicit incentives for improving water use efficiencies. That is, to the extent that end water users (such as households and farmers) experience benefits or costs reflective of regional water values, they will tend to adopt appropriate levels of water conservation.

The water market can continue to serve the STDC area as an important instrument for accommodating growth. Sales, short-term leases, long-term contracts, and option contracts all constitute potentially important methods of water reallocation. In the future, sectors of growing water demand may find it attractive to maintain portfolios of these solutions. For example, a city might may have a periodic program of water right purchases shored up by option contracts to insure water supply during severe drought.

In addition, the region may also wish to more fully exploit its existing water rights, as recent policy confirms the power of water right holders to make full use of their diversion entitlements. The absence of return flow obligations for water rights invites water users to carefully examine reuse and recycling techniques. Where economically practical relative to other demand management strategies and to the costs of purchased water, reuse and recycling should be adopted. On the other hand, water right owners do not own their return flows once discharged, so return flows are not transferable under current rules. Therefore, trades involving wastewater discharges do not appear to be feasible at this time.

Section 3.0 Water Demand

The approach to forecasting water demand, supply, and population projections has historically been the responsibility of the TWDB. While other agencies have developed population estimates (e.g., Texas and US Department of Commerce, City of Laredo Planning Department) the TWDB has the convenience of tying population figures to logical and historically-based water demand data. It is essentially this reason that the TWDB data has been used exclusively in the development of this section. Extensive use of models by TWDB in addition to the consensus-building process to develop agreement for specific population and water demand figures by City and by County has become a highly sophisticated process. Documentation of this process has been attempted in the Volume III Technical Planning Data Appendix to the Texas Water Plan. These general approaches have been excepted from the appendix, where appropriate, and are presented herein.

3.1 Population Forecasting Methodology

3.1.1 Population Forecasts

The technique for projecting population is a cohort-component procedure, which uses the separate cohorts (age/sex/race/ethnic groups) and components of cohort change (fertility rates, survival rates, and migration rates) to calculate future populations. Projections of each cohort are then summed to the total population. Cohorts used in the projection process are defined as single-year-of-age (0 to 75) cohorts by sex and race/ethnic groups, which include Anglo, Black, Hispanic, and Other. Anglos are defined as persons of white non-Spanish origin; Blacks are defined as persons of Black non-Spanish origin; Hispanics are defined as persons of Spanish origin of all racial and ethnic groups; and Other is defined as those persons of other race/ethnic groups of non-Spanish or non-Black origin.

Many counties in Texas have special populations generally referred to as "institutional" populations. These groups are assumed not to participate in the same demographic processes as the base population and generally tend to move in and out of these institutional arrangements in fixed intervals. More specifically, these groups are defined as college/university populations, military populations, prison populations, and populations in other institutional arrangements. Institutional populations are removed from the base population for computing future cohort populations, but are added back into the total projected base cohort population at the end of each projection interval.

The components of cohort change include fertility, mortality, and migration - the three fundamental demographic processes that affect population. Fertility rates for each female cohort of reproductive ages are incorporated into the projection procedure for calculating the number of births anticipated to occur between each projection interval. Survival rates for each cohort are used to compute the change in the number of cohorts relating to the number of deaths anticipated to occur between each projection interval. Net migration rates for each cohort are used to compute the change in each cohort due to in- or out-migration in a specific locale. *(Consensus Water Plan, 1996)*. Key assumptions used in developing the population projections are associated with the demographic components of change for each cohort and are described below:

1) Fertility rates for Anglo females are trended downward through the year 2010 and held constant at the 2010 rate through the year 2050; and fertility rates for Black, Hispanic, and Other females are trended downward through the year 2030 and held constant at the 2030 rate through the year 2050.
2) State survival rates by age, sex and race/ethnicity are assumed to follow national trends over the projection period, and are applied to all counties in the State. State survival rates are used at the county level because the number of deaths by single years of age for most of the counties are so small that total mortality levels are almost similar among the counties.
3) Migration rates for State and county by age, sex and race-ethnicity are derived from the 1980-1990 populations using residual migration method. Three migration scenarios are assumed and applied to the same set of fertility and mortality rates to produce projected populations. In addition, a most-likely planning scenario is selected by the Consensus Planning Committee from one of the above three scenarios or, in some cases, computed using a different migration assumption.

The projected county population is allocated to each city of 500 or more population based on each city's historic share of the county population. The rural or "county-other" population is calculated as the residual of the sum of the cities' projected population and the projected county population. *(Consensus Water Plan, 1996)*

3.1.2 Forecasting Scenarios

Three population projection scenarios, based on the varying 1980-1990 migration rates, were selected to project a range of alternative future populations. The three population projection scenarios are presented below:

1) 0.0 Migration: Zero net migration over the projection period. Only the natural increase or decrease in population is assumed.
2) 0.5 Migration: One-half of the 1980-1990 migration rate is assumed to occur over the projection period.
3) 1.0 Migration: The 1980-1990 migration rate is assumed to occur over the projection period.

From this range of population projections, consensus planning staff and the Water Demand/Drought Management Technical Advisory Committee (TAC) approved a "most likely" growth scenario for each of the 254 counties, based on recent and prospective growth trends and their combined professional opinions. *(Consensus Water Plan, 1996)*

3.1.3 Data Sources

The development of the population forecasts incorporated a number of data sources and information files based on the 1990 Census data obtained from Dr. Steve Murdock, Chief Demographer for the Texas State Data Center at Texas A&M University. These data sources included the following:

1) 1990 Population by Cohort (Age, Sex, and Race/Ethnic Groups) Modified for Age and Race/Ethnicity.
2) 1990 Institutional Populations (Prison Populations, College Populations, Military Populations, and Other Populations in Institutional Arrangements).
3) Projected Fertility Rates by Age and Race/Ethnic Groups.
4) Projected Survival Rates by Single Years of Age, Sex, and Race/Ethnic Groups.
5) 1980-1990 Migration Rates by Single-Year Estimates and Cohort.

3.1.4 Updated Modifications

The described methodology immediately preceding this paragraph was modified slightly in a cooperative effort between TWDB, TNRCC, and Texas Parks and Wildlife (TPWD). The exact procedure remains undocumented but involved representatives from the agencies discussing population growth and discussing adjustments to each county's respective population projections. Dr. Steve Murdock also participated in these discussions as a consultant to the group (personal communication Butch Bloodworth, TWDB, November 1997). The result was a "consensus-based" projection of population. Subsequent to the consensus discussions held by the agencies, Dr. Murdock produced additional projections for counties based on the demographic characteristics measured during the 1990-1996 timeframe. Population projections for STDC are based on this growth projection and not the consensus-based population numbers published in the state water plan. The updated numbers recognize the higher-than-average birthrate allocable to the STDC counties and anticipates a migration factor of about 1.5. Given the relatively young population of the STDC counties in contrast to the state average, the mortality rate is also reduced somewhat. Again, the specifics of this modification are not available, however, the estimated population projections appear to predict a more realistic population growth reflective of the trends witnessed in the past 6-10years.*(Consensus Water Plan, 1996)*

3.2 Water Demand Forecasting Methodology

3.2.1 Municipal Water Use

In calculating the water use for a specific city (or similar entity), all water sales to other municipalities, industries, or other utilities were removed from the pumpage or diversion data. The annual population projections developed by the Texas A&M State Data Center were then divided into the remaining flow to yield per capita usage rates for the city. Projected county population was allocated to each city with a population of 500 or more based on each city's historic share of the county population. The rural or "county-other" population was computed as the residual of the sum of the cities' projected population and the total projected county population. This residual was then divided into the remaining flow that was left from allocating flow from the city-specific process.

Given the relatively high growth of the counties within STDC together with the drought-prone tendency of the region, the TWDB added the assumption of advanced conservation to the water use projections. Advanced water conservation assumed that there was a 20% reduction in seasonal high water use, a 20% reduction in dry-year seasonal use, and a savings of 7.5% of the total average yearly water use. Translated into unit rates, this assumption included a deduction of 21.7 gallons from the previously estimated per capita water use rates. For example, if the City of Laredo's historical water use rate was 190 gallons per capita per day, the projections made by the TWDB included water use at a rate of 168.3 gpcd . All of the counties within the STDC were assumed to implement advanced water conservation throughout the state planning period (1990-2050).

3.2.2 Irrigation Water Use

The TWDB developed irrigation water use for the state based on output from a linear programming model designed to optimize farm income. The model, developed by Texas A&M, provided crop-specific relationships between irrigation water required, federal farm programs, crop pricing, fixed production costs, crop yields, deficiency payments, and irrigation delivery systems for each of 14 agricultural regions within the state. Irrigation systems were assumed to be furrow, surge, side roll, low pressure center pivot, high pressure center pivot, and low energy precision application (LEPA)-type systems. Regional Texas A&M irrigation specialists then provided additional information to adjust the efficiency of the irrigation systems for each region based on prevailing climate and soil characteristics in each of the agricultural regions. Model performance was fine tuned with energy prices (affecting pumping costs), cropping patterns, and historical trends in irrigated acreage.

To ensure a reasonable mix of crops that resembles historical cropping patterns, an acreage constraint was placed on each crop within a geographical area based on annual crop acreage 1985-1990. Finally, a water constraint was added to the model to limit the water available for irrigation to the largest quantity of annual water used for irrigation purposes during the period 1974-1990.

Once the most profitable combination of irrigated and dry land crop production was estimated, along with the quantities of water required for that level of production, the regional projections were distributed to the county level by apportioning a county's share of the regional acreage and water use for that county. The county shares were calculated by estimating the county's historical crop acreage as a percent of total regional crop acreage.

The loss of water through conveyance can be considerable. Estimates of loss can range between ten and 55 percent of the total amount of water diverted. The TWDB estimated conveyance loss by examining data from surface water diversions reported to the TNRCC; estimates of on-farm water use from a joint study effort of the Soil Conservation Service (U.S. Department of Agriculture), Texas Soil and Water Conservation Board, TWDB, and other parties; and communications with river authorities, water districts, and irrigation companies. Based on this information, historical conveyance loss estimates were calculated and used as a basis for the conveyance loss factors used in the consensus projections.

The relative proportions of ground and surface water supplies for irrigated agriculture were determined by a water supply allocation process, which required irrigation water demand estimates as an input. The initial estimates of conveyance losses were developed using water supply allocations from the 1990 Water Plan and then subsequently revised. The estimation of irrigation loss was therefore an iterative process contingent on the ultimate prediction of irrigation water use.

The TWDB modeling procedure assumed that production inputs were used in fixed proportions and did not allow for the substitution of inputs as the relative prices of those inputs changed. Consequently, rational decisions by farmers relating to potential savings associated with possible future substitution of production resources and the corresponding profitability of a specific crop production activity would not be fully realized by this modeling constraint.

3.2.2.1 Forecasting Scenarios

Six forecast scenarios were developed to encompass a range of possible economic conditions affecting irrigation water demands. The consensus planning staff, with approval from the Technical Advisory Committee, selected three of the scenarios for use in the Water Plan:

1) Scenario I: Crop yields, crop prices, and production costs were assumed to change over time. Federal farm payments were held constant at current levels during the projection period. There was no further adoption of advanced irrigation technology during the period 1990-2050.
2) Scenario II: Crop yields, crop prices, and production costs were assumed to change over time. Federal farm payments were held constant at current levels over the projection period. The expected level of advanced irrigation technology was adopted.
3) Scenario III: Crop yields, crop prices, and production costs were assumed to change over time. Federal farm program payments were reduced by one-half from current payment levels. An aggressive level of advanced irrigation technology was adopted.

The consensus planning staff and the Technical Advisory Committee selected Scenario II as the "most likely" case for use in the 1996 Update to the Texas Water Plan. (*Water Use Planning Data Appendix, Volume III* 1996 Consensus-Based Update to the Texas Water Plan, TWDB, 1997.)

3.2.3 Livestock Water Use

Livestock water consumption was estimated by TWDB by estimating water consumption for a livestock unit and the total number of livestock. Texas A&M University Agricultural Extension Service provided information on water use rates, estimated in gallons per day per head, for each type of livestock: cattle, poultry, sheep and lambs, and hogs and pigs. The Texas Agricultural Statistics provided current and historical numbers of livestock by livestock type and county. Water use rates were then multiplied by the number of livestock per livestock type per county. In counties where the number of head of livestock was unavailable, historical livestock distribution patterns were assumed. The United States Department of Agriculture, Soil Conservation Service provided information on the source of water supply for range livestock. Water supply for confined livestock operations, such as poultry, hogs, dairy and feedlots, was assumed to be supplied by groundwater sources. Since water used for livestock comprises such a minor use, livestock production was assumed to remain constant after the year 2000.

3.2.4 Mining Water Use

Projections of fresh water use for mineral production were developed for the categories of fuels and nonfuels by the TWDB. Consumptive use of fresh water in mining included data on actual water use in 1990 as well as estimates of water needs in ten-year intervals to the year 2050. Derived from an examination of recent and historical data, trends in production, estimated total mineral reserves currently accessible, and rates of water use, these projections were tabulated by county, river or coastal basin, and climatic zones within basins. They represented the sum of estimated mining water use for the two categories of mineral products: fuels and nonfuels.

Projections of water use were based on projected future production levels for each mineral commodity. This future production was derived from both state and national historic rates, which was constrained by the accessible mineral reserves in the region. Water use projections were based on these projected production levels and historic rates of water use of each mineral or mineral group, moderated by the water requirements of the technological processes used in mining and rates of consumption.

For each category of mineral products, the requirements for mining water were determined as a function of production. Estimates of future production were calculated by analyzing both recent data, and state and national production trends. A water use coefficient, computed from data collected by the TWDBs 1990 Water Use Survey, which reports the quantity of water used in the production of each increment of output, was applied to estimated mineral production levels. A rate of water consumption derived from U.S. Bureau of Mines data was then applied to the total water use for each mineral industry. Tabulations of water use for each basin, zone, and county were prepared to represent the sum of estimated water use for the production of fuels and nonfuels based on historical production and anticipated mineral reserves.

Because projections indicated petroleum production would decline rapidly after the year 2000, estimates of water use in oil production also declined sharply. This decline is overshadowed by the increase in water use for synthetic fuels. Estimates of lignite production for synthetic fuels were distinct from lignite used as fuel in electric utilities. Because different synthetic fuel processes have different water needs, a water use coefficient was derived for those processes anticipated for estimated projects in Texas. The distribution of estimated water use was determined based on the concentration and distribution of mineral reserves. These water demands were added into the fuels category starting in 2020.

The estimates of water use for mining required two basic assumptions. First, it was assumed that the location of mines within the basin zone would remain constant. Second, it was assumed that each region would retain its share of state production. This particular assumption may not remain valid in the STDC region with the exodus of many oil well operations and the slowly exiting uranium excavations in Webb County.

3.3 Current Water Use Patterns

Statewide water use by cities, industries, and the agricultural sector are reported to the Texas Water Development Board (Board) annually. Currently, more than 7,900 public and private water suppliers report annual water use of cities and water sales for municipal and industrial purposes, including the sources of water (aquifer, reservoir, and rivers), for supplying the water needs of each entity. This activity provides the necessary information to monitor local and regional water use patterns and for identifying the statewide water use and supply networks for developing near-term and long-term water resource plans at the local, regional, and statewide levels.

STDC's water use is essentially dominated by the municipal and irrigation sectors with lesser demands from livestock and mining. The remaining sectors of steam power generation, and manufacturing are not a factor in the water budget of the region and are therefore not discussed.

The TWDB has retained records and estimates of the water use by county dating back to 1974. The data is discontinuous as retrieved from the TWDB data bank. However, the data incorporates both population and water use by economic sector for the period 1974 through 1995. The water use portion of this data has been compiled in table 3-1. The data is illustrated by figures 3-1 through 3-4.

Since 1988, Starr County has used 50,000-60,000 ac-ft of water per year (except for 1992-1993). Its primary water demand comes from irrigation sources. Webb County water use is only slightly lower than that of Starr, but appears to be steadily increasing in cycles. In contrast to Starr, its water use is principally municipal. Zapata County water use is practically an order of magnitude lower than Starr and Webb County (5,000-6,800 ac-ft range) with irrigation-type use appearing as the predominant water use type. Since 1974, irrigation water use has declined from 5,000 acre-ft in 1974 to 4,000 ac-ft in 1995. With the exception of 1995, municipal water use has been generally within 1,000 ac-ft of the higher irrigation use and, in 1991-1992 period, actually exceeded irrigation water use. Jim Hogg County reportedly uses the least water of the STDC region. This is likely due to unreported water uses within the region and a preponderance of groundwater-type water use for which there is no documentation. The magnitude of use is approximately one third that of Zapata County. The data for Jim Hogg County show that municipal water use has historically been the principal water use type and has totaled between 600 and 1,000 ac-ft.

The TWDB routinely collects water usage information for communities greater than 1000 population statewide. This information was compiled for all such cities within STDC for the period 1980-1995 (The 1996 data is not available yet.) The information contains references to the various types of water use, the sources for water, and the city population reported for each year. Some cities do not hold all years. This is due to the fact they were below the 1000 population minimum and were not covered. Table 3-2 includes this information sorted by county.

Table 3-1
Historical County Water Use by Water Use Type

County	WU Type	1974	1977	1980	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Jim Hogg	Mun GW	382	537	991	695	690	571	497	497	249	585	818	986	815	775	683
	Mun SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Mun	382	537	991	695	690	571	497	497	249	585	818	986	815	775	683
	Mfg GW	20	21	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mfg SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Mfg	20	21	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr GW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Pwr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irr Gw	129	150	0	450	500	500	500	500	120	150	150	150	31	313	313
	Irr SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Irr	129	150	0	450	500	500	500	500	120	150	150	150	31	313	313
	Min GW	22	0	0	0	119	0	238	217	41	41	28	28	27	27	27
	Min SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Min	22	0	0	0	119	0	238	217	41	41	28	28	27	27	27
	Lvstk GW	657	68	74	70	66	55	50	54	54	52	54	88	88	69	69
	Lvstk SW	73	611	671	640	595	505	459	493	486	480	489	790	790	624	624
	Tot Lvstk	730	679	745	710	661	560	509	547	540	532	543	878	878	693	693
	Tot GW	1,210	776	1,065	1,215	1,375	1,126	1,285	1,268	464	828	1,050	1,252	961	1,184	1,092
	Tot SW	73	611	671	640	595	505	459	493	486	480	489	790	790	624	624
	Tot WatUs	1,283	1,387	1,736	1,855	1,970	1,631	1,744	1,761	950	1,308	1,539	2,042	1,751	1,808	1,716
Starr	Mun GW	782	1,008	163	819	705	1,130	1,123	1,023	681	827	855	686	502	711	698
	Mun SW	2,171	2,518	4,147	5,152	5,306	5,271	4,781	4,953	5,414	5,299	5,586	5,827	6,539	7,132	7,042
	Tot Mun	2,953	3,526	4,310	5,971	6,011	6,401	5,904	5,976	6,095	6,126	6,441	6,513	7,041	7,843	7,740
	Mfg GW	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mfg SW	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Mfg	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr GW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Pwr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irr Gw	0	0	0	500	597	0	0	0	500	434	6,597	2,850	362	300	473
	Irr SW	26,155	25,500	30,855	27,968	22,221	33,222	34,944	50,596	44,961	45,000	36,456	27,000	37,755	45,054	49,253
	Tot Irr	26,155	25,500	30,855	28,468	22,818	33,222	34,944	50,596	45,461	45,434	43,053	29,850	38,117	45,354	49,726
	Min GW	39	414	368	291	282	0	392	382	125	125	234	234	234	235	235
	Min SW	0	0	0	24	550	0	487	444	414	414	744	744	744	744	744
	Tot Min	39	414	368	315	832	0	879	826	539	539	978	978	978	979	979
	Lvstk GW	1,290	150	146	148	151	136	121	126	131	129	133	122	125	106	127
	Lvstk SW	142	1,353	1,322	1,338	1,367	1,232	1,095	1,144	1,188	1,171	1,195	1,098	1,129	947	1,143
	Tot Lvstk	1,432	1,503	1,468	1,486	1,518	1,368	1,216	1,270	1,319	1,300	1,328	1,220	1,254	1,053	1,270
	Tot GW	2,115	1,572	677	1,758	1,735	1,266	1,636	1,531	1,437	1,515	7,819	3,892	1,223	1,352	1,533
	Tot SW	28,468	29,375	36,324	34,482	29,444	39,725	41,307	57,137	51,977	51,884	43,981	34,669	46,167	53,877	58,182
	Tot WatUs	30,583	30,947	37,001	36,240	31,179	40,991	42,943	58,668	53,414	53,399	51,800	38,561	47,390	55,229	59,715

Table 3-1
Historical County Water Use by Water Use Type

County	WU Type	1974	1977	1980	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Webb	Mun GW	440	560	237	327	276	266	229	223	723	505	874	596	1,199	538	1,109
	Mun SW	15,298	17,607	23,461	21,212	22,129	25,346	25,105	24,871	27,182	35,511	34,719	31,757	30,832	36,191	34,419
	Tot Mun	15,738	18,167	23,698	21,539	22,405	25,612	25,334	25,094	27,905	36,016	35,593	32,353	32,031	36,729	35,528
	Mfg GW	321	31	52	14	11	10	0	8	4	2	0	0	11	9	14
	Mfg SW	54	336	240	282	306	149	29	20	28	19	19	2	2	2	3
	Tot Mfg	375	367	292	296	317	159	29	28	32	21	19	2	13	11	17
	Pwr GW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr SW	1,975	1,417	1,716	0	980	1,178	1,315	1,610	1,759	1,504	1,848	1,671	1,813	1,890	1,777
	Tot Pwr	1,975	1,417	1,716	0	980	1,178	1,315	1,610	1,759	1,504	1,848	1,671	1,813	1,890	1,777
	Irr Gw	0	0	0	0	0	0	0	0	168	179	2,093	699	327	228	337
	Irr SW	14,934	9,500	18,150	6,750	5,500	5,000	3,925	8,367	5,694	5,801	3,887	5,658	7,840	7,458	8,081
	Tot Irr	14,934	9,500	18,150	6,750	5,500	5,000	3,925	8,367	5,862	5,980	5,980	6,357	8,167	7,686	8,418
	Min GW	33	368	362	235	129	0	170	318	274	274	397	372	362	279	301
	Min SW	29	0	0	24	24	0	82	97	106	106	114	236	236	223	151
	Tot Min	62	368	362	259	153	0	252	415	380	380	511	608	598	502	452
	Lvstk GW	2,091	252	206	176	178	190	194	204	200	198	203	108	95	122	129
	Lvstk SW	232	2,222	1,827	1,601	1,617	1,722	1,753	1,843	1,817	1,791	1,826	971	850	1,107	1,153
	Tot Lvstk	2,323	2,474	2,033	1,777	1,795	1,912	1,947	2,047	2,017	1,989	2,029	1,079	945	1,229	1,282
	Tot GW	2,885	1,211	857	752	594	466	593	753	1,369	1,158	3,567	1,775	1,994	1,176	1,890
	Tot SW	32,522	31,082	45,394	29,869	30,556	33,395	32,209	36,808	36,586	44,732	42,413	40,295	41,573	46,871	45,584
	Tot WatUs	35,407	32,293	46,251	30,621	31,150	33,861	32,802	37,561	37,955	45,890	45,980	42,070	43,567	48,047	47,474
Zapata	Mun GW	154	190	169	0	58	25	26	29	0	0	0	0	0	0	0
	Mun SW	647	858	1,113	1,744	1,784	1,904	1,740	2,246	1,995	1,852	1,748	1,918	2,251	2,355	2,098
	Tot Mun	801	1,048	1,282	1,744	1,842	1,929	1,766	2,275	1,995	1,852	1,748	1,918	2,251	2,355	2,098
	Mfg GW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mfg SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Mfg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr GW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pwr SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tot Pwr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irr Gw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irr SW	4,588	5,000	4,840	3,300	4,400	4,000	2,458	2,767	1,955	2,229	1,596	1,596	3,299	3,299	4,028
	Tot Irr	4,588	5,000	4,840	3,300	4,400	4,000	2,458	2,767	1,955	2,229	1,596	1,596	3,299	3,299	4,028
	Min GW	14	100	0	0	0	0	0	0	0	0	0	0	0	0	0
	Min SW	0	0	0	0	0	0	0	0	0	0	28	28	27	27	27
	Tot Min	14	100	0	0	0	0	0	0	0	0	28	28	27	27	27
	Lvstk GW	880	102	73	94	83	81	78	82	81	80	82	45	38	51	51
	Lvstk SW	98	914	657	853	748	732	702	744	733	723	737	401	344	463	462
	Tot Lvstk	978	1,016	730	947	831	813	780	826	814	803	819	446	382	514	513
	Tot GW	1,048	392	242	94	141	106	104	111	81	80	82	45	38	51	51
	Tot SW	5,333	6,772	6,610	5,897	6,932	6,636	4,900	5,757	4,683	4,804	4,109	3,943	5,921	6,144	6,615
	Tot WatUs	6,381	7,164	6,852	5,991	7,073	6,742	5,004	5,868	4,764	4,884	4,191	3,988	5,959	6,195	6,666

Figure 3-1
Historical Water Use by Category (Ac-ft)
Jim Hogg County 1974-1995

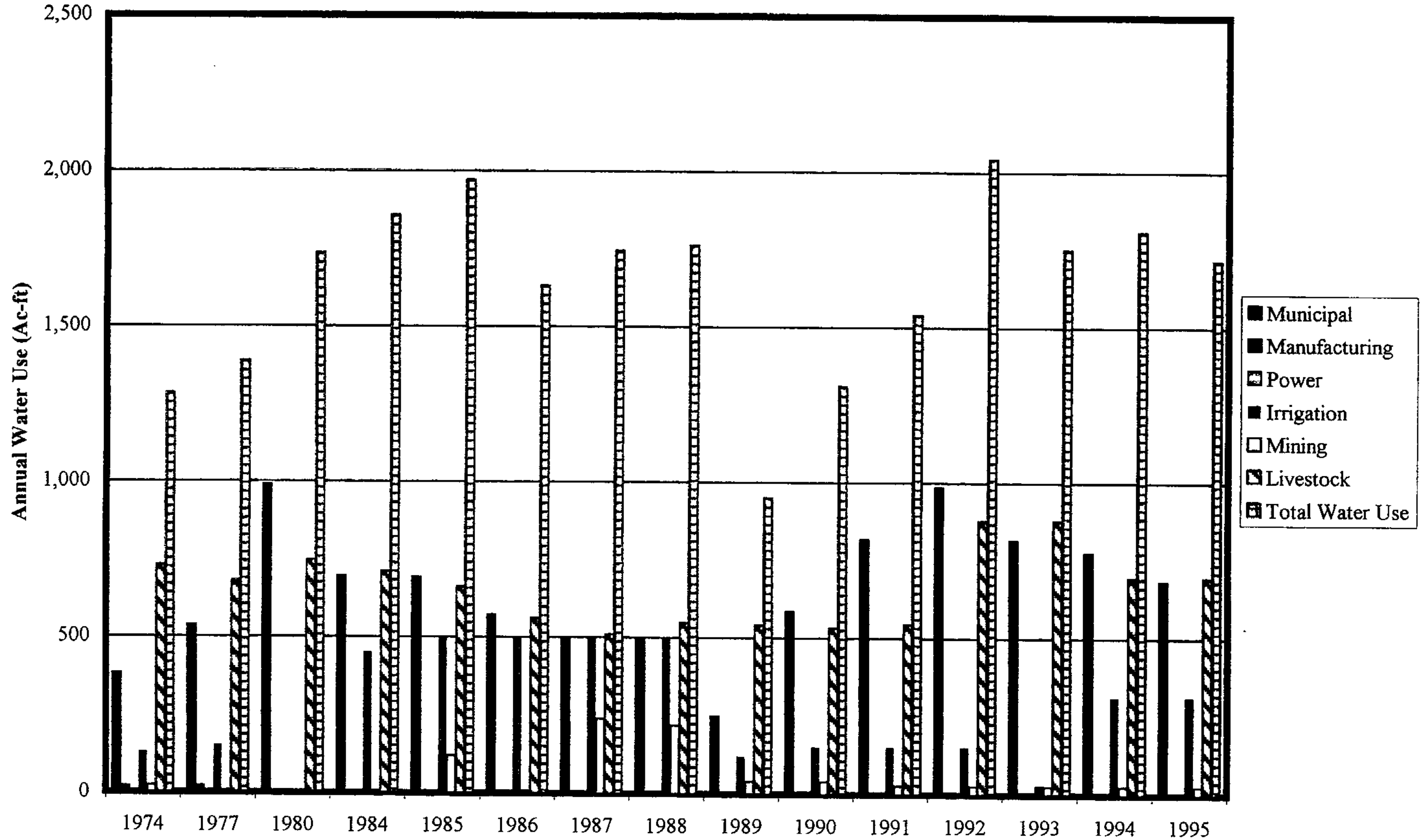


Figure 3-2
Historical Water Use by Category (Ac-ft)
Starr County 1974-1995

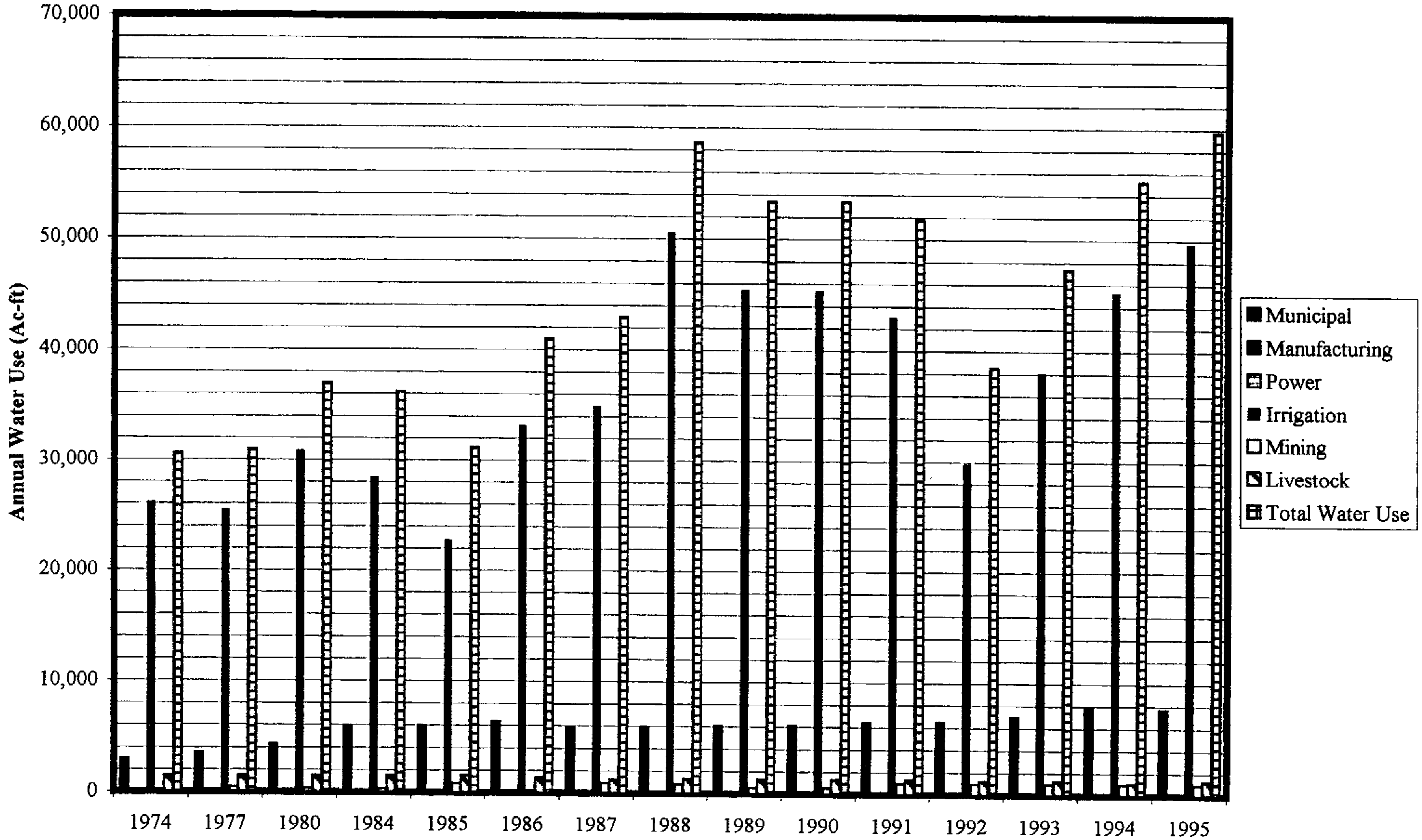


Figure 3-3
Historical Water Use by Category (Ac-ft)
Webb County 1974-1995

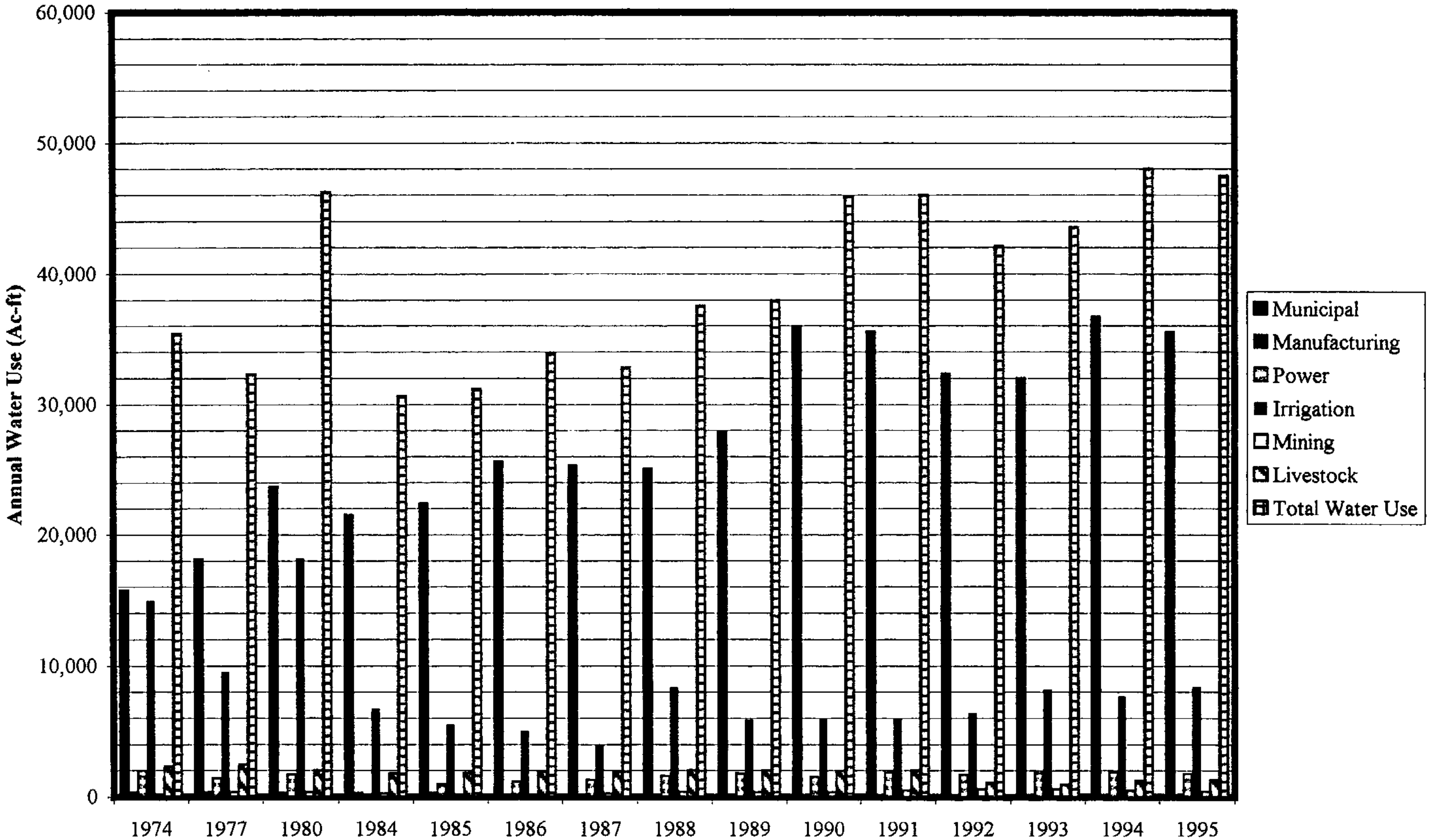


Figure 3-4
Historical Water Use by Category (Ac-ft)
Zapata County 1974-1995

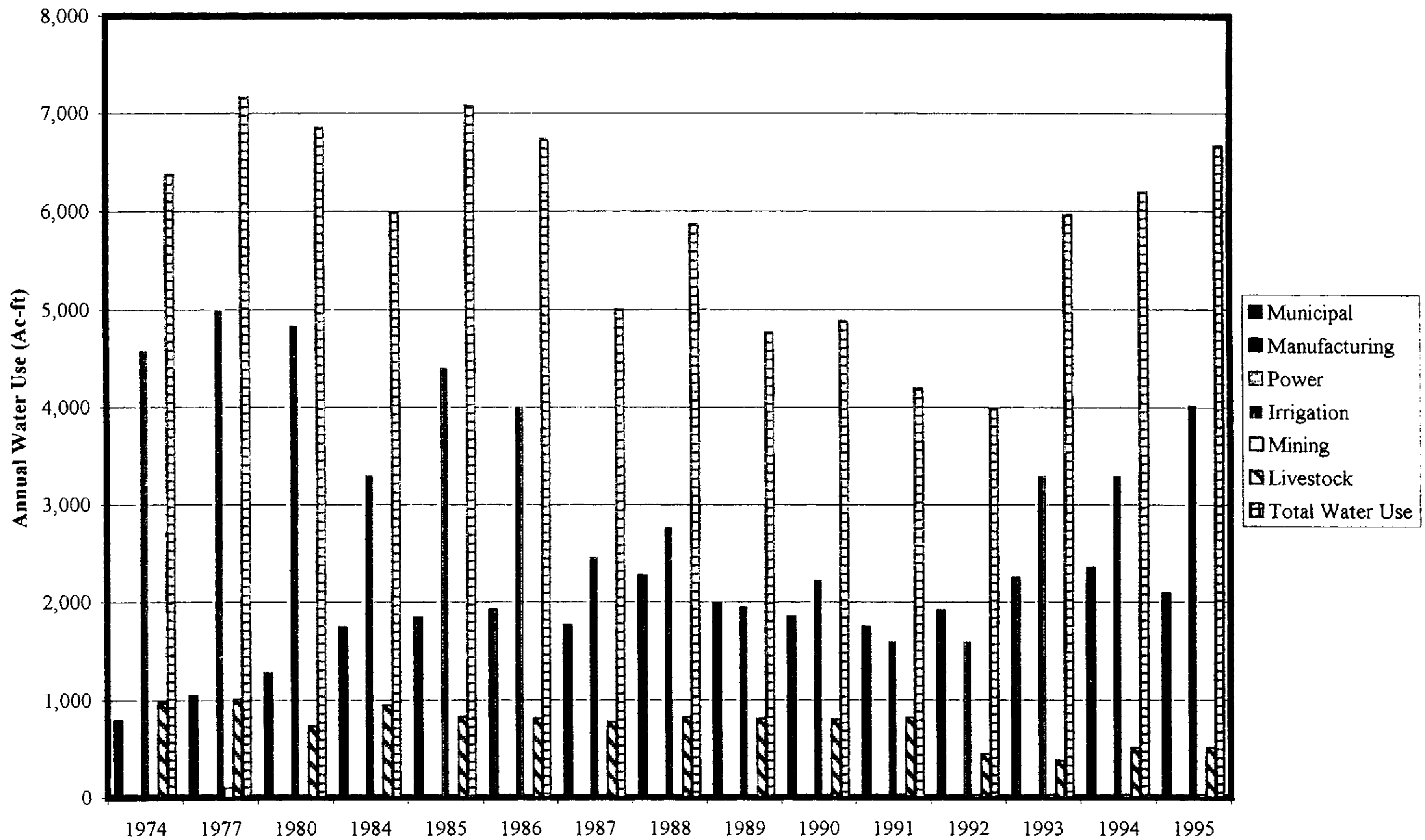


Table 3-2
Water Use 1980-1995 for Cities >1000 Population

Cityname	Cit	Year	Self-Sup	Bot	Total	%Gw	Mun	Ind	Pwr	Raw	Net	Pop	GPCD
Webb County													
Laredo	347	1995	33,660		33,660		11	107	22		33,521	**157,559**	190
Laredo	347	1994	35,555		35,555		12	178	24		35,341	**149,019**	212
Laredo	347	1993	30,299		30,299		10	190	25	189	30,074	**140,688**	191
Laredo	347	1992	31,383		31,383		10	225	27		31,121	**133,470**	208
Laredo	347	1991	34,343		34,343		136	19	29		34,158	**128,433**	237
Laredo	347	1990	33,289	2,300	35,589		322	284	31		34,952	**122,899**	254
Laredo	347	1989	26,995		26,995		115	28	43		26,810	**119,957**	200
Laredo	347	1988	24,687		24,687		113	20	36		24,517	**124,730**	175
Laredo	347	1987	24,848		24,848		530	30			24,288	**120,834**	179
Laredo	347	1986	25,247		25,247		538	149	40		24,520	**117,060**	187
Laredo	347	1985	20,804		20,804		456	307	43		19,998	**112,314**	159
Laredo	347	1984	21,477		21,477		1,982	282	48		19,165	**107,760**	159
Laredo	347	1983	20,410		20,410		1,763	238	44		18,365	**103,742**	158
Laredo	347	1982	22,172		22,172		548	289	50		21,285	**99,874**	190
Laredo	347	1981	20,413		20,413		487	275	50		19,601	**95,555**	183
Laredo	347	1980	22,604		22,604		33	240	48		22,283	**91,449**	218
El Cenizo	770	1995	295	592	886	21	552	0	0	0	427	**1,890**	202
El Cenizo	770	1994				100					241	**1,752**	123
El Cenizo	770	1993				100					230	**1,511**	136
El Cenizo	770	1992				100					157	**1,420**	99
El Cenizo	770	1991				100					201	**1,575**	114
El Cenizo	770	1990				100					141	**1,399**	90
Jim Hogg County													
Hebbronville	268	1995		564	564	100					564	**4,551**	111
Hebbronville	268	1994		619	619	100					619	**4,361**	127
Hebbronville	268	1993		652	652	100					652	**4,590**	127
Hebbronville	268	1992		796	796	100					796	**4,637**	153
Hebbronville	268	1991		657	657	100					657	**4,582**	128
Hebbronville	268	1990		462	462	100					462	**4,465**	92
Hebbronville	268	1989		182	182	100					182	**4,465**	36
Hebbronville	268	1988		398	398	100					398	**4,765**	75
Hebbronville	268	1987		387	387	100					387	**4,901**	70
Hebbronville	268	1986		514	514	100					514	**5,040**	91
Hebbronville	268	1985		640	640	100					640	**4,983**	115
Hebbronville	268	1984		639	639	100					639	**4,926**	116
Hebbronville	268	1983		597	597	100					597	**4,940**	108
Hebbronville	268	1982		636	636	100					636	**4,955**	115
Hebbronville	268	1981		520	520	100					520	**4,815**	96
Hebbronville	268	1980	934		934	100					934	**4,680**	178

Table 3-2
Water Use 1980-1995 for Cities >1000 Population

Cityname	Cit	Year	Self-Sup	Bot	Total	%Gw	Mun	Ind	Pwr	Raw	Net	Pop	GPCD
Zapata County													
Zapata	672	1995	1,647		1,647		113				1,533	**7,762**	176
Zapata	672	1994	1,070	840	1,910		127				1,783	**7,826**	203
Zapata	672	1993	1,824		1,824		112				1,712	**7,523**	203
Zapata	672	1992	1,565		1,565		100				1,465	**7,377**	177
Zapata	672	1991	1,066	342	1,408		47	28			1,333	**7,459**	160
Zapata	672	1990	1,399		1,399			35			1,365	**7,119**	171
Zapata	672	1989	1,397	55	1,452		12	32			1,408	**7,119**	177
Zapata	672	1988	1,395	7	1,402		13				1,389	**4,991**	248
Zapata	672	1987	1,397	55	1,452		11	28			1,413	**4,877**	259
Zapata	672	1986	1,461		1,461		63	28			1,370	**4,765**	257
Zapata	672	1985	1,180	160	1,340		81				1,258	**4,639**	242
Zapata	672	1984	1,249		1,249		136				1,113	**4,516**	220
Zapata	672	1983	1,243		1,243						1,243	**4,475**	248
Zapata	672	1982	1,174		1,174		2				1,173	**4,435**	236
Zapata	672	1981	914		914		2				912	**4,189**	194
Zapata	672	1980	953		953		2				951	**3,806**	223
Starr County													
La Grulla	335	1995	390	422	812						812	**1,764**	411
La Grulla	335	1994	362	393	755						755	**1,646**	409
La Grulla	335	1993	305	332	636						636	**1,566**	363
La Grulla	335	1992		1,103	1,103						1,103	**1,508**	653
La Grulla	335	1991		968	968						968	**1,390**	622
La Grulla	335	1990		768	768						768	**1,335**	514
La Grulla	335	1989		748	748						748	**1,345**	496
La Grulla	335	1988		206	206						206	**1,510**	122
La Grulla	335	1987		319	319						319	**1,515**	188
La Grulla	335	1986		317	317						317	**1,520**	186
La Grulla	335	1985		318	318						318	**1,525**	186
La Grulla	335	1984		290	290						290	**1,530**	169
La Grulla	335	1983		254	254						254	**1,502**	151
La Grulla	335	1982		255	255						255	**1,476**	154
La Grulla	335	1981		218	218						218	**1,405**	139
La Grulla	335	1980		224	224						224	**1,442**	139
Rio Grande City	502	1995		2,429	2,429						2,429	**11,562**	188
Rio Grande City	502	1994		2,939	2,939						2,939	**10,978**	239
Rio Grande City	502	1993		2,229	2,229						2,229	**10,564**	188
Rio Grande City	502	1992		1,516	1,516						1,516	**10,413**	130
Rio Grande City	502	1991		1,454	1,454						1,454	**9,976**	130
Rio Grande City	502	1990		1,663	1,663						1,663	**9,891**	150
Rio Grande City	502	1989		1,615	1,615						1,615	**9,891**	146
Rio Grande City	502	1988		1,845	1,845						1,845	**10,874**	151
Rio Grande City	502	1987		1,731	1,731						1,731	**10,607**	146
Rio Grande City	502	1986		1,846	1,846						1,846	**10,347**	159
Rio Grande City	502	1985		2,432	2,432						2,432	**9,969**	218
Rio Grande City	502	1984		2,774	2,774						2,774	**9,605**	258
Rio Grande City	502	1983		2,550	2,550						2,550	**9,458**	241
Rio Grande City	502	1982		2,572	2,572						2,572	**9,315**	246
Rio Grande City	502	1981		1,900	1,900						1,900	**8,865**	191
Rio Grande City	502	1980	2,046		2,046		392				1,654	**8,887**	166

Table 3-2
Water Use 1980-1995 for Cities >1000 Population

Cityname	Cit	Year	Self-Sup	Bot	Total	%Gw	Mun	Ind	Pwr	Raw	Net	Pop	GPCD
Roma-Los Saenz	515	1995	2,028	358	2,386		963				1,423	**10,535**	121
Roma-Los Saenz	515	1994	1,694	299	1,993		804				1,188	**9,803**	108
Roma-Los Saenz	515	1993	1,681	291	1,972		796				1,176	**9,234**	114
Roma-Los Saenz	515	1992	1,766		1,766		713				1,053	**8,915**	105
Roma-Los Saenz	515	1991	1,701		1,701		596				1,105	**8,438**	117
Roma-Los Saenz	515	1990	1,537		1,537		538				999	**8,059**	111
Roma-Los Saenz	515	1989	1,689		1,689		592				1,097	**7,509**	130
Roma-Los Saenz	515	1988	1,643		1,643		575				1,067	**5,540**	172
Roma-Los Saenz	515	1987	1,459		1,459		511				948	**4,993**	170
Roma-Los Saenz	515	1986	1,343	525	1,868		654				1,214	**4,500**	241
Roma-Los Saenz	515	1985	1,365	25	1,390		753				637	**4,284**	133
Roma-Los Saenz	515	1984	1,227	25	1,252		631				621	**4,078**	136
Roma-Los Saenz	515	1983	1,072		1,072		540				532	**3,873**	123
Roma-Los Saenz	515	1982	1,074		1,074		457				617	**3,679**	150
Roma-Los Saenz	515	1981	908		908		387				522	**3,501**	133
Roma-Los Saenz	515	1980	839		839						839	**3,384**	221

3.4 Current Surface Water Rights

TNRCC online databases and Rio Grande Watermaster records were accessed to compile the most recent listing of water rights for the region. Table 3-3 contains a summary of the water rights as of August, 1997, while Appendix A provides a listing of water rights within the STDC region sorted by type of use and then by county.

Table 3-3
Summary of Water Rights In STDC Region
(Effective August, 1997)

Type	Jim Hogg	Starr	Webb	Zapata	Amount (Ac-ft)
Municipal & Ind.		4,564.01	45,716.68	2,444.7	52,725.4
Irrigation		45,194.65	29,070.5	10,385.75	84,650.91
Mining		144.88	1,639.56	440	2,224.432
Hydroelectric		1,200,000			1,200,000(1)
TOTAL		**49,903.54**	**76,426.92**	**1,3270.45**	**140,448.74**

(1) A non-consumptive right without call on water and not reflected in the total.

The largest water rights holder is the City of Laredo. The combined water rights for this City total 43,520.683 ac-ft/yr or about 86% of the total municipal water rights and about 31% of the total water rights for the STDC region. Jim Hogg by contrast has no surface water rights and relies solely on groundwater.

The water rights in the STDC region are a small part of the system wide rights. They represent less than 7% of the total water rights in the system below Amistad. System-wide, the majority of the total water rights, approximately 86%, are held by the irrigation sector. By far the largest share of the irrigation water rights is held in the Lower Rio Grande Valley. Irrigation water rights in the Lower Rio Grande Region represent 88% of the total irrigation rights in the system and 75% of the total water rights below Amistad (including all types of use). By contrast, **the irrigation rights in the STDC region represent less than 4% of the total system water rights.** In terms of municipal and Industrial (M&I) rights, the STDC again shares a smaller percentage. **M&I rights in the STDC region are approximately 17% of the total M&I rights in the system.** This comparison provides a compelling argument for STDC's water development strategy. If only a small fraction of the irrigation water use of the system could be diverted to the STDC (through increased efficiencies, water rights purchases/leases, or other mutually beneficial programs), a significant portion of the region's water demand could be met.

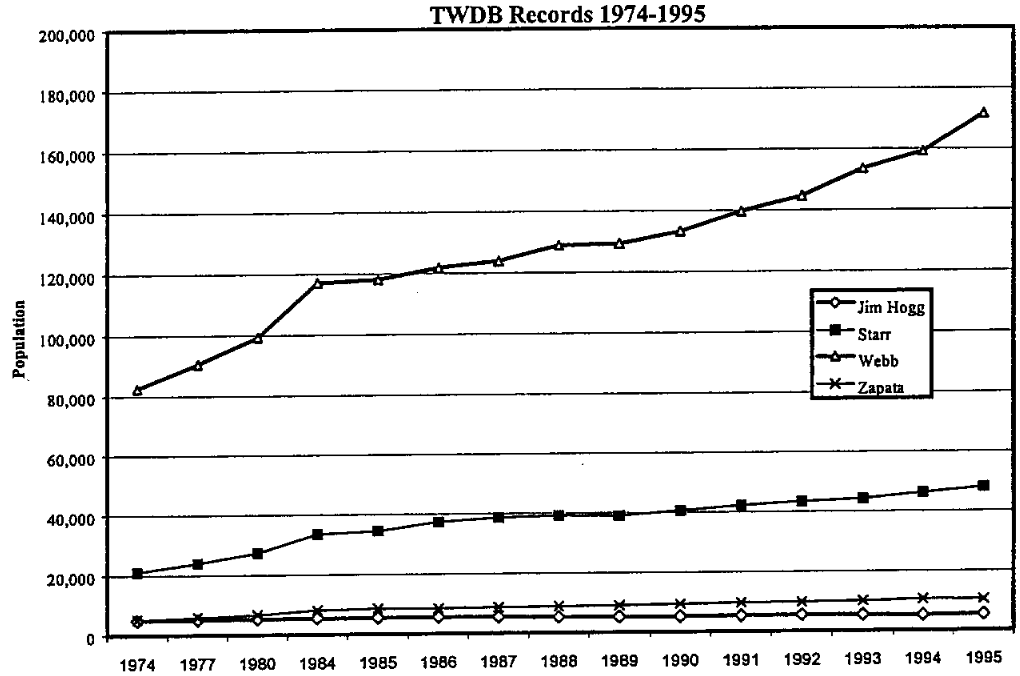
3.5 Current Population Trends

The Texas Water Development Board compiles the populations of all Texas Counties on an annual basis. Records were obtained that showed the historical water use by county per water use type for the period 1974-1995. A component of this information was historical population data. The population data were stripped out of the electronic records to provide table 3-4 compiling the population figures and Figure 3-5 illustrating the comparative population growth of the individual counties.

Table 3-4
Historical Population Recorded by TWDB for STDC 1974-1995

County	1974	1977	1980	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Jim Hogg	4,853	5,008	5,168	5,376	5,390	5,500	5,400	5,200	5,115	5,109	5,262	5,360	5,332	5,091	5,334
Starr	21,044	23,954	27,266	33,511	34,453	37,300	38,600	39,200	38,944	40,518	42,180	43,349	44,210	46,225	48,068
Webb	82,451	90,465	99,258	117,176	118,124	121,900	123,900	128,900	129,373	133,239	139,660	144,566	153,538	159,095	171,574
Zapata	5,149	5,842	6,628	8,151	8,476	8,400	8,600	8,800	8,972	9,279	9,598	9,714	9,958	10,416	10,388

Figure 3-5
Historical Population for STDC
TWDB Records 1974-1995



3.6 Water Demand Forecasts

The projected water demand for the STDC area compiled by the TWDB is provided in table 3-5. Plots showing the relative water demand by county for each demand sector using the most likely scenario for water demand projected by the 1997 Consensus Update to the Texas Water Plan are provided by figures 3-6 through 3-10. Figure 3-11 incorporates the totals for all supply, demand (LRGVDC irrigation demand was assumed equal to 1995), and water rights and incorporates them into a single figure. This figure shows that the amount of water rights exceeds the anticipated water available and during extended drought conditions, the region would likely be short of its total water needs.

3.6.1 Population Forecasts

The Texas Water Development Board prepared population estimates in its 1996 Consensus Water Plan as provided in table 3-5. The selected population scenario, dubbed "most likely" is designated as M_ML. The most likely population estimates are not fully documented but stem from group discussions held between representatives from the TWDB, TNRCC, Texas Parks and Wildlife, with assistance from Dr. Steve Murdock, Texas Data Center.

Figure 3-6
Jim Hogg County Water Demand Projections

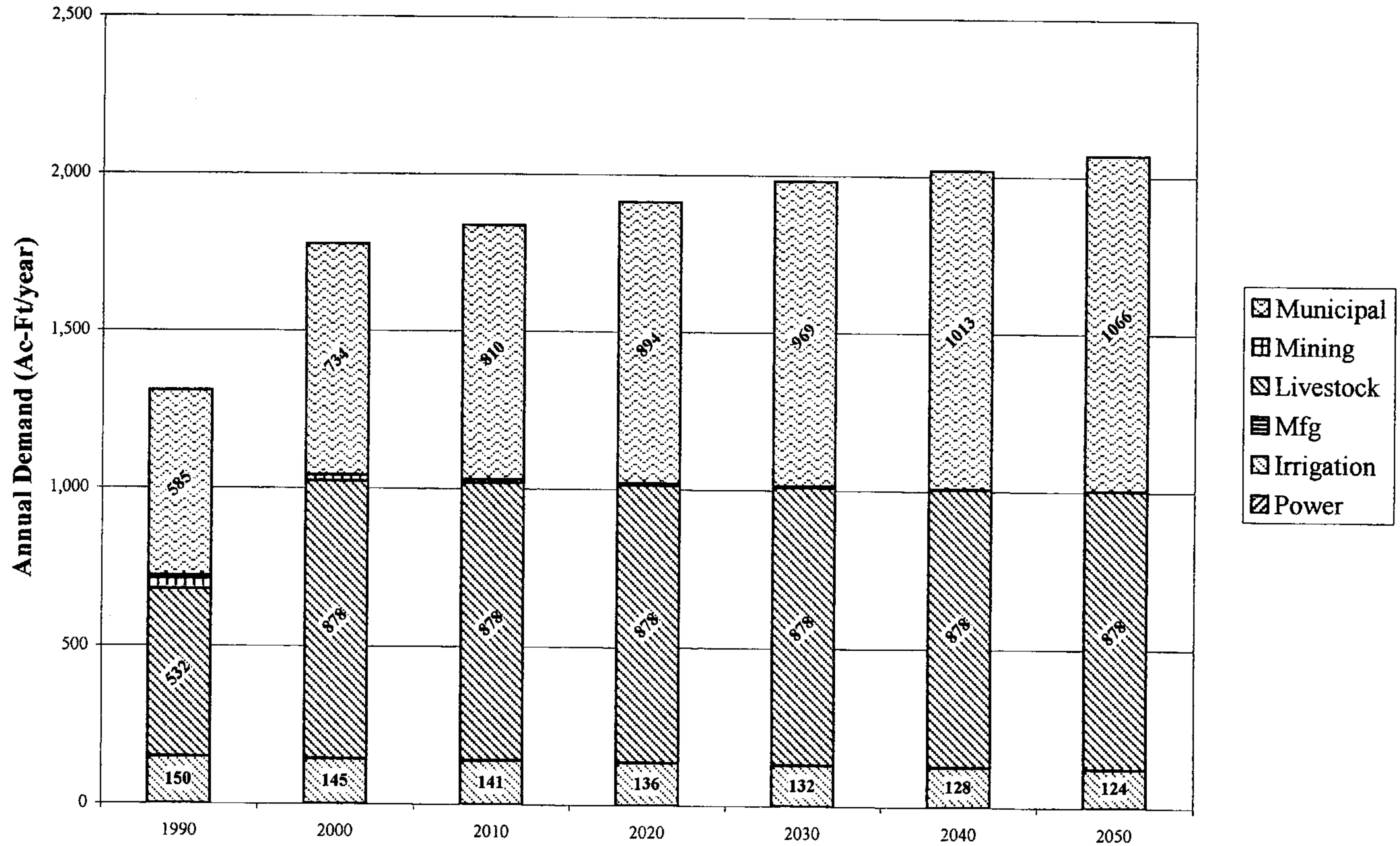


Figure 3-7
Starr County Water Demand Projections

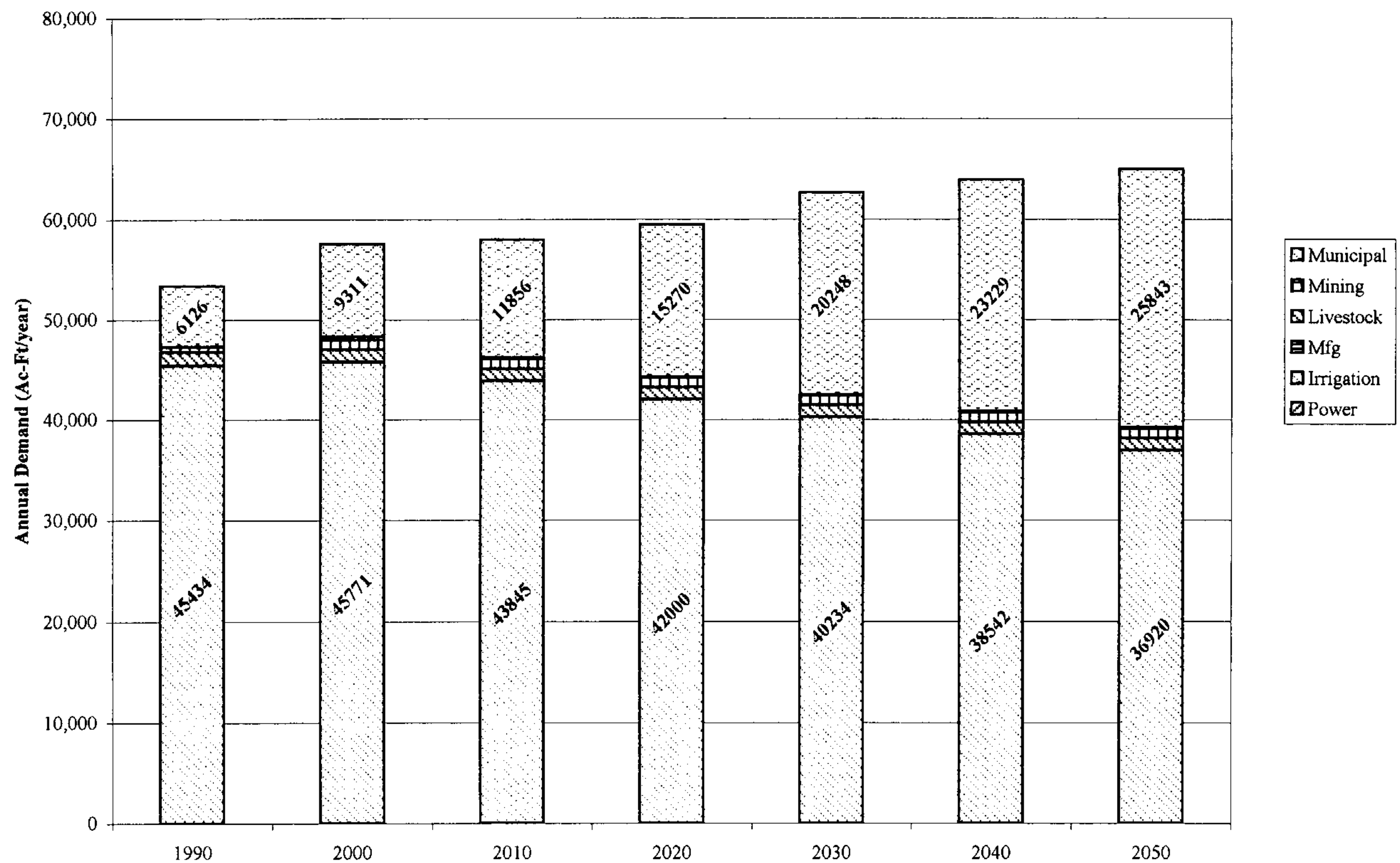


Figure 3-8
Webb County Water Demand Projections

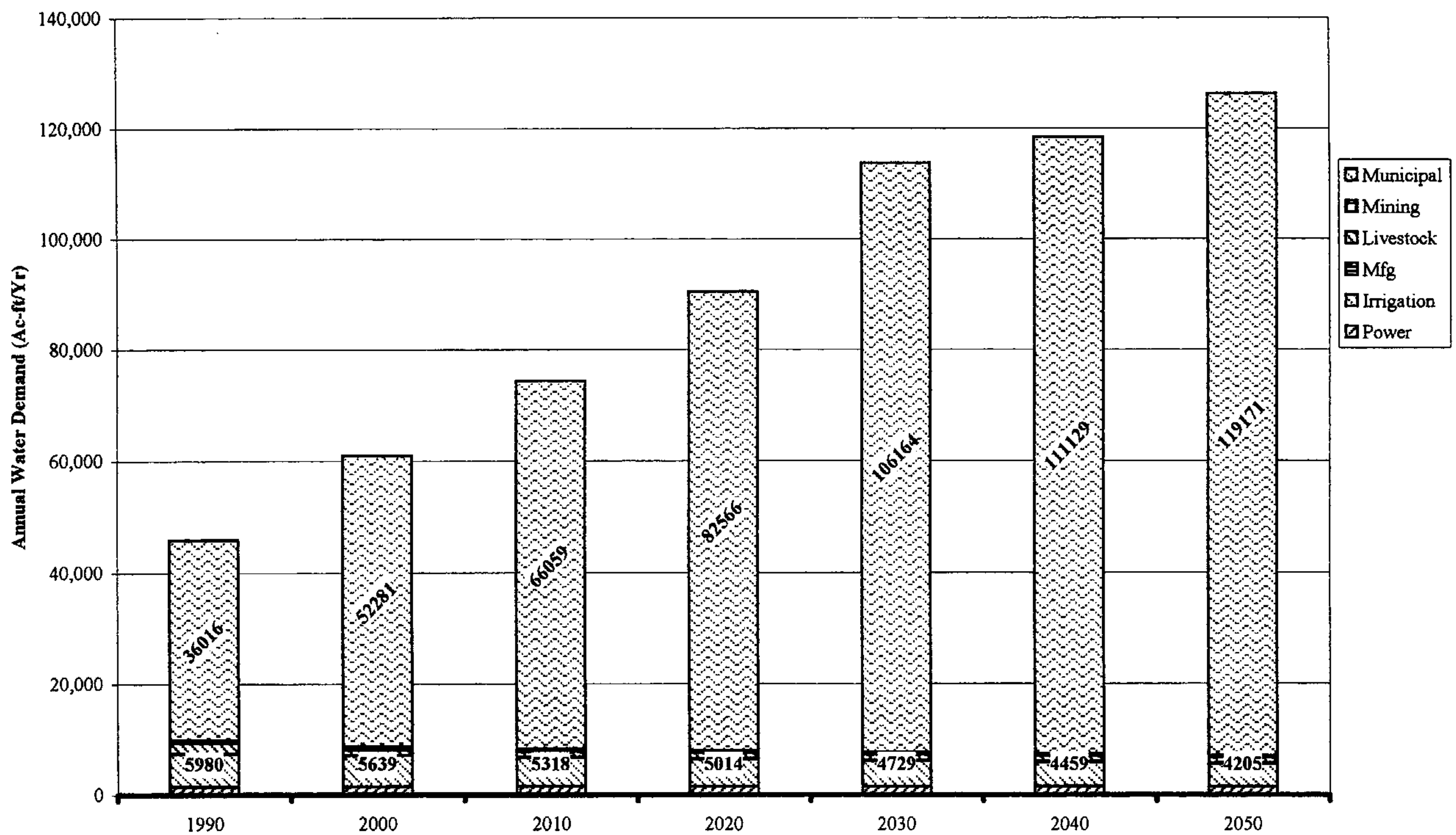


Figure 3-9
Zapata County Water Demand Projections

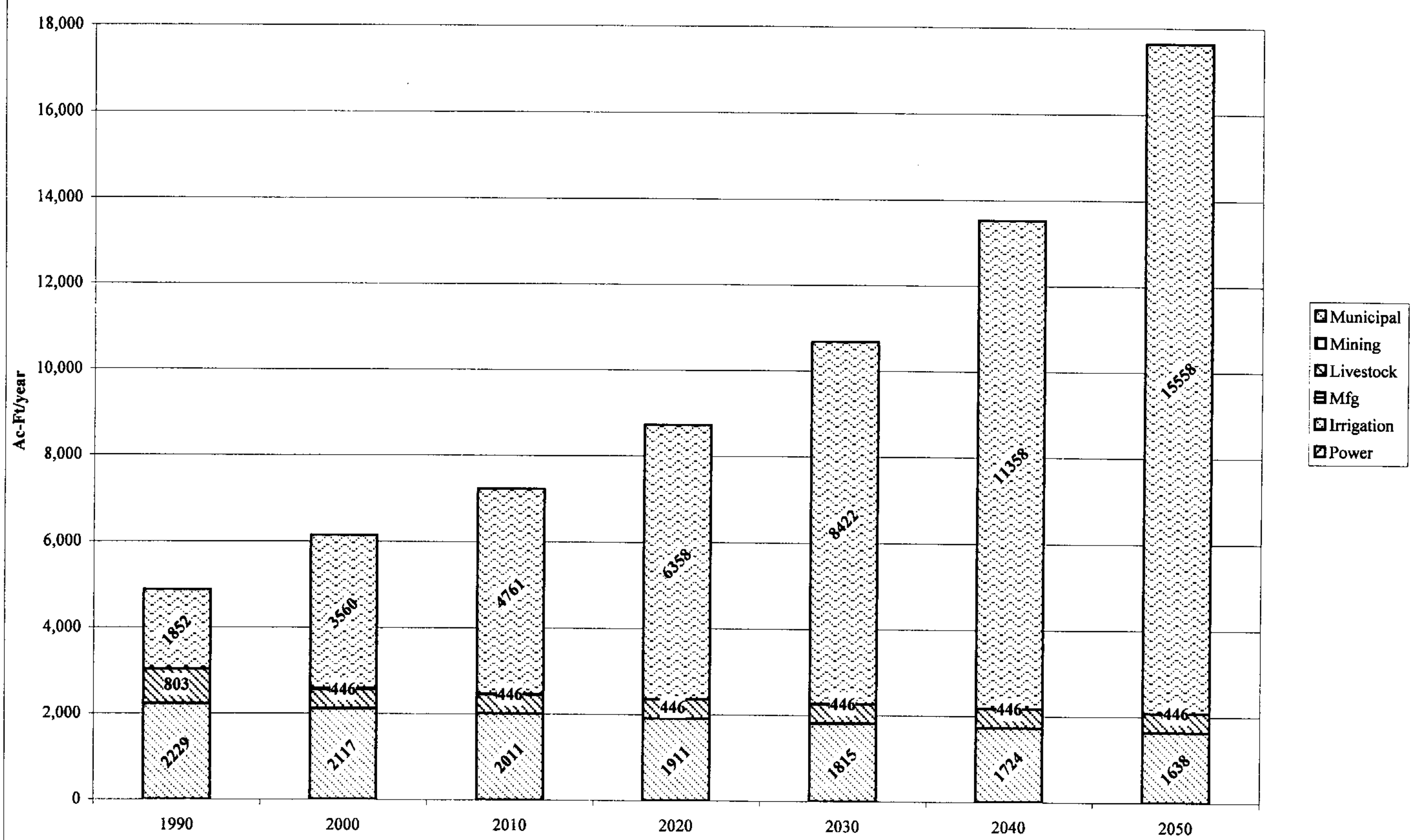


Figure 3-10
STDC Total Projected Water Demand by Sector

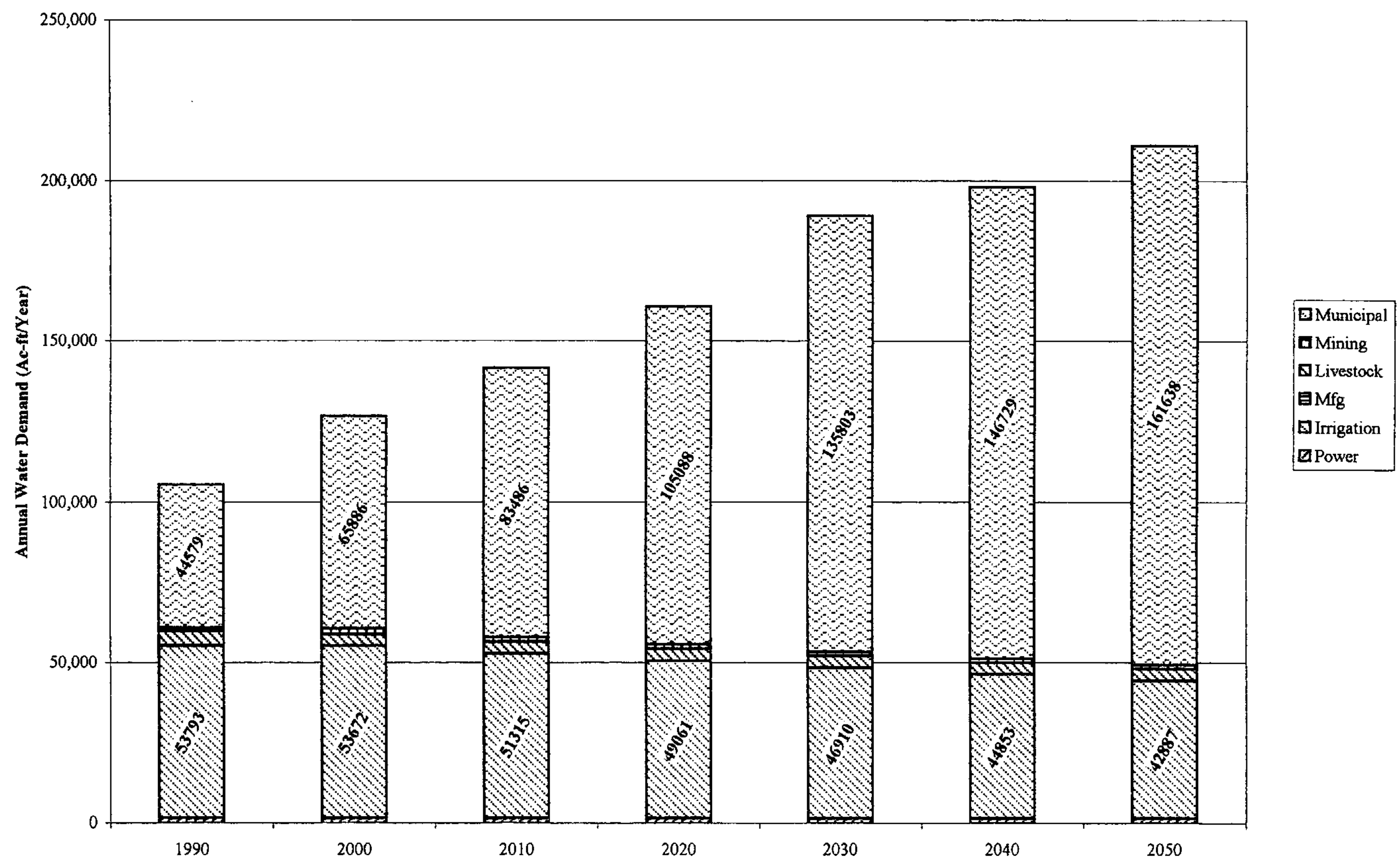


Figure 3-11
Estimated Demand for STDC/LRGVDC Regions

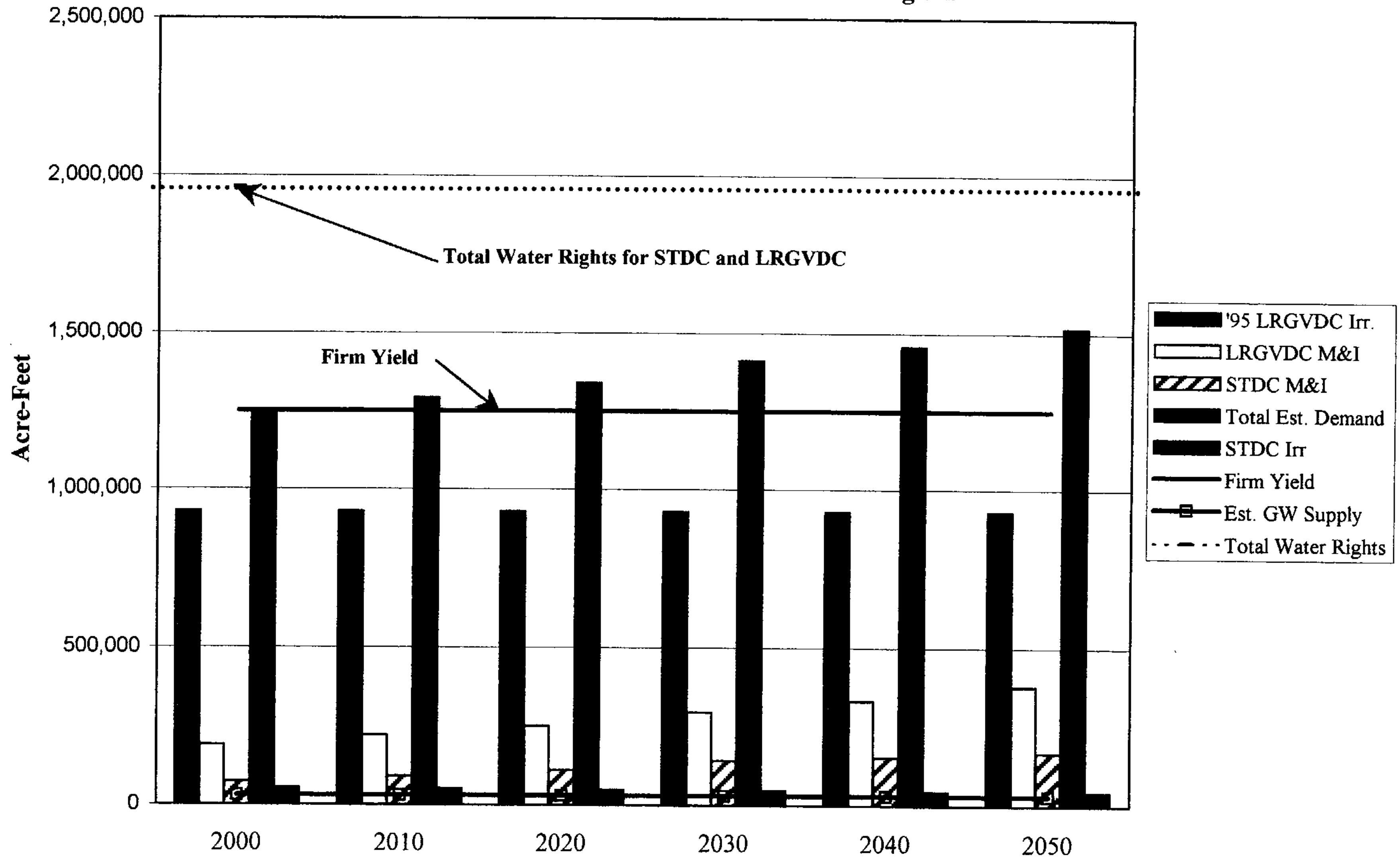


Table 3-5
1996 Consensus Water Plan Population Estimates

TWDB Population Projections by County 2000-2050

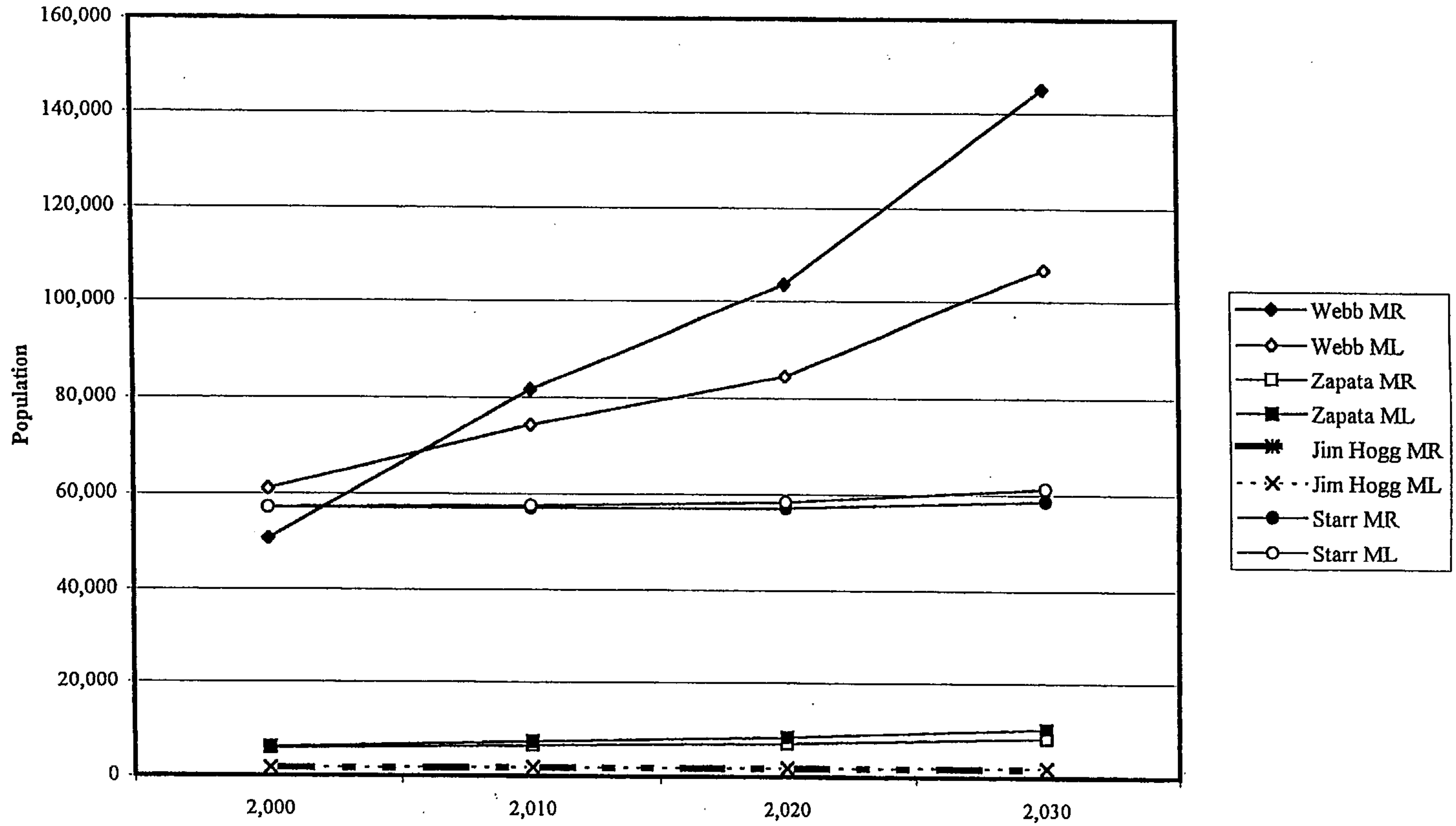
County	Scenario	1990	2000	2010	2020	2030	2040	2050
Webb	M_00	133,239	165,304	193,689	224,849	256,490	284,588	308,215
Webb	M_05	133,239	176,690	222,355	275,351	334,587	361,968	397,214
Webb	M_10	133,239	186,626	249,739	326,479	425,935	447,962	487,141
Webb	M_ML	133,239	202,873	271,481	354,901	463,015	486,960	529,549
Webb	M_MR	133239	163561	301566	443189	641973		
Zapata	M_00	9,279	10,373	11,596	12,731	13,496	14,214	14,836
Zapata	M_05	9,279	11,606	14,632	18,070	21,581	25,985	29,546
Zapata	M_10	9,279	13,328	18,900	26,399	35,353	48,159	66,036
Zapata	M_ML	9,279	13,328	18,900	26,399	35,353	48,159	66,036
Zapata	M_MR	9279	12038	15938	20879	26904		
Jim Hogg	M_00	5,109	5,740	6,332	6,904	7,208	7,524	7,813
Jim Hogg	M_05	5,109	6,176	7,401	8,717	9,791	10,499	11,238
Jim Hogg	M_10	5,109	6,641	8,349	10,363	12,370	13,593	14,849
Jim Hogg	M_ML	5,109	6,176	7,401	8,717	9,791	10,499	11,238
Jim Hogg	M_MR	5,109	5,840	6,662	7,368	7,905		
Starr	M_00	40,518	51,455	62,519	74,844	88,812	103,076	120,062
Starr	M_05	40,518	57,899	80,028	108,820	145,805	169,221	187,771
Starr	M_10	40,518	64,312	98,382	147,989	213,231	246,948	280,980
Starr	M_ML	40,518	57,899	80,028	108,820	145,805	169,221	187,771
Starr	M MR	40,518	55,561	74,164	96,456	123,209		

Three scenarios were developed based on different assumptions of counting migration patterns. (Excerpt from Vol. III Consensus-Based Update to the Texas Water Plan). The fourth scenario was developed subsequent to the Water Plan update.

1) M_00 assumes zero migration.
2) M-05 and M-10 assume 50% and 100% of the 1980-1990, respectively.
3) M_ML is the most likely scenario chosen from one of the above three scenarios and/or adjusted to reflect public comments on anticipated population growth. The M_ML scenario was chosen by the Consensus Planning Staff (TWDB, TNRCC, TPWD) based on historical and recent growth trends and public input to represent the most reasonable scenario for water resource planning.
4) M_MR is the population projection estimate most recently prepared (12/97) by Dr. Steve Murdock for these counties and assumes a 1.5 migration factor reflective of the migration and birth patterns observed during the 1990-1994 timeframe. In contrast to the previous estimates, the projection was carried only to the year 2030. This particular version appears to be more reflective of the recent explosive growth trend observed within Webb County. However, it should be considered cautiously since the type of growth Laredo has experienced is not likely to be sustained for a 30-year period.

Comparing the two highest estimates for the planning period, the MR scenario estimates Webb County population to be 641,973 in 2030 versus the previous estimate of 463,015 in the ML scenario—a 38.7% increase. In contrast, the remaining counties' populations are lowered by 23.9%, 19.3%, and 15.5% for Zapata, Jim Hogg, and Starr County, respectively. Note that the estimated population increase predicted for Webb County was not offset by counterpart reductions in the other STDC counties. This means that there was an estimated net influx of population into Webb County in the revised scenario. A graphical comparison of the two "high case" population estimates is provided by figure 3-12.

Figure 3-12
Comparison of Population based on 1.0 vs 1.5 Migration Factors



3.6.2 Demand Forecasts

The water demand projections calculated by the TWDB using high-case population estimates which include assumptions for implementation of advanced conservation practices are provided in table 3-6. This table corresponds to the TWDB's estimate of the most likely water demand as endorsed for the 1996 Consensus Water Plan. Given the negotiated amounts of demand that were developed through the consensus building process, totals for each county within STDC are not truly additive. This is evidenced by the difference between the "Total" and "Sum" columns.

Examination of the demographics of the STDC region suggests that population growth is truly the most compelling factor influencing water demand in the region. Irrigation influences, while significant are not increasing appreciably nor are any of the other sectors that could influence population growth. Thus, municipal water demand should be key in estimating future total water demand by county.

Table 3-7 resolves the municipal demand component imbedded in TWDB projections for water use. This table was created to show how the municipal component of water use influences total water use projections for the region. The most likely version of municipal population and projected water use are listed by county. The most likely scenario of water use presumes that the region will sustain below-average rainfall and will implement advanced conservation measures to reduce water demand. The unit rates for reduction in demand are also reflected in the table. In all counties except Webb, there was an increase in unit water demand computed between the 1990 and 2000 decades. The explicit reason for this projected increase is unknown and will require further investigation if needed in the future. Unit demand rates for municipal water use were computed based on total county population. There was insufficient data available to support extrapolation of city population beyond historical values. Straight-line extrapolation of city trends predicted values significantly lower than "most-likely" total county population values. Since the algorithm(s) for projection of city populations was (were) not available, the computed unit values for water demand the gross technique for estimating unit water demand underestimates actual unit rates for water consumption.

Population trends measured during 1990-1994 were resolved into population projections by the Texas Data Center. These population projections are shown in table 3-7 for comparison with the most likely (TWDB/TNRCC/TPWD consensus values). These projections are based on a migration factor of 1.5. To acquire this "new" water demand, previous projected municipal water demand was deducted from the "sum" column. Next, the previously projected municipal demand was divided by the total projected county population for the years 2000 through 2030. This yielded unit values for municipal demand (ac-ft/cap/yr). The unit values were then multiplied by the revised population estimate to produce a revised municipal water demand which was then added back to the summed total water demand. Results show a significant increase in projected total water demand through the planning period. A plot presenting the summed water demand for all uses by county and the comparative water demands for the 1.0 and 1.5 migration factored estimates is provided by figure 3-13. However, use of the 1990-1994 based projections is not recommended. Growth rates observed during the baseline period cannot be sustained through the 30-year planning period.

Table 3-6
TWDB Projections for Water Demand Using Conservation and Most_Likely Scenario for Growth (Ac-Ft/Yr)

Webb County Summary

Year	Power	Irrigatio	Mfg	Livestock	Mining	unicipa	Total	Sum
1,990	1,504	5,980	21	1,989	380	36,016	45,890	45,890
2,000	1,500	5,639	33	1,079	489	52,281	61,021	61,021
2,010	1,500	5,318	38	1,079	390	66,059	74,384	74,384
2,020	1,500	5,014	43	1,079	312	82,566	84,484	90,514
2,030	1,500	4,729	49	1,079	268	106,164	106,796	113,789
2,040	1,500	4,459	57	1,079	248	111,129	111,118	118,472
2,050	1,500	4,205	65	1,079	255	119,171	118,722	126,275

Zapata County Summary

Year	Power	Irrigatio	Mfg	Livestock	Mining	unicipa	Total	Sum
1,990	0	2,229	0	803	0	1,852	4,884	4,884
2,000	0	2,117	0	446	20	3,560	6,156	6,143
2,010	0	2,011	0	446	6	4,761	7,336	7,224
2,020	0	1,911	0	446	3	6,358	8,381	8,718
2,030	0	1,815	0	446	1	8,422	10,227	10,684
2,040	0	1,724	0	446	0	11,358	12,910	13,528
2,050	0	1,638	0	446	0	15,558	16,712	17,642

Jim Hogg County Summary

Year	Power	Irrigatio	Mfg	Livestock	Mining	unicipa	Total	Sum
1,990	0	150	0	532	41	585	654	1,308
2,000	0	145	0	878	19	734	1,776	1,776
2,010	0	141	0	878	9	810	1,838	1,838
2,020	0	136	0	878	5	894	1,913	1,913
2,030	0	132	0	878	3	969	1,982	1,982
2,040	0	128	0	878	1	1,013	2,020	2,020
2,050	0	124	0	878	0	1,066	2,068	2,068

Starr County Summary

Year	Power	Irrigatio	Mfg	Livestock	Mining	unicipa	Total	Sum
1,990	0	45,434	0	1,300	539	6,126	53,399	53,399
2,000	0	45,771	0	1,220	1,284	9,311	57,191	57,586
2,010	0	43,845	0	1,220	1,085	11,856	57,608	58,006
2,020	0	42,000	0	1,220	1,046	15,270	58,443	59,536
2,030	0	40,234	0	1,220	1,009	20,248	61,264	62,711
2,040	0	38,542	0	1,220	999	23,229	62,467	63,990
2,050	0	36,920	0	1,220	1,027	25,843	63,297	65,010

STDC Totals

Year	Power	Irrigatio	Mfg	Livestock	Mining	unicipa	Total	Sum
1,990	1,504	53,793	21	4,624	960	44,579	104,827	105,481
2,000	1,500	53,672	33	3,623	1,812	65,886	126,144	126,526
2,010	1,500	51,315	38	3,623	1,490	83,486	141,166	141,452
2,020	1,500	49,061	43	3,623	1,366	105,088	153,221	160,681
2,030	1,500	46,910	49	3,623	1,281	135,803	180,269	189,166
2,040	1,500	44,853	57	3,623	1,248	146,729	188,515	198,010
2,050	1,500	42,887	65	3,623	1,282	161,638	200,799	210,995

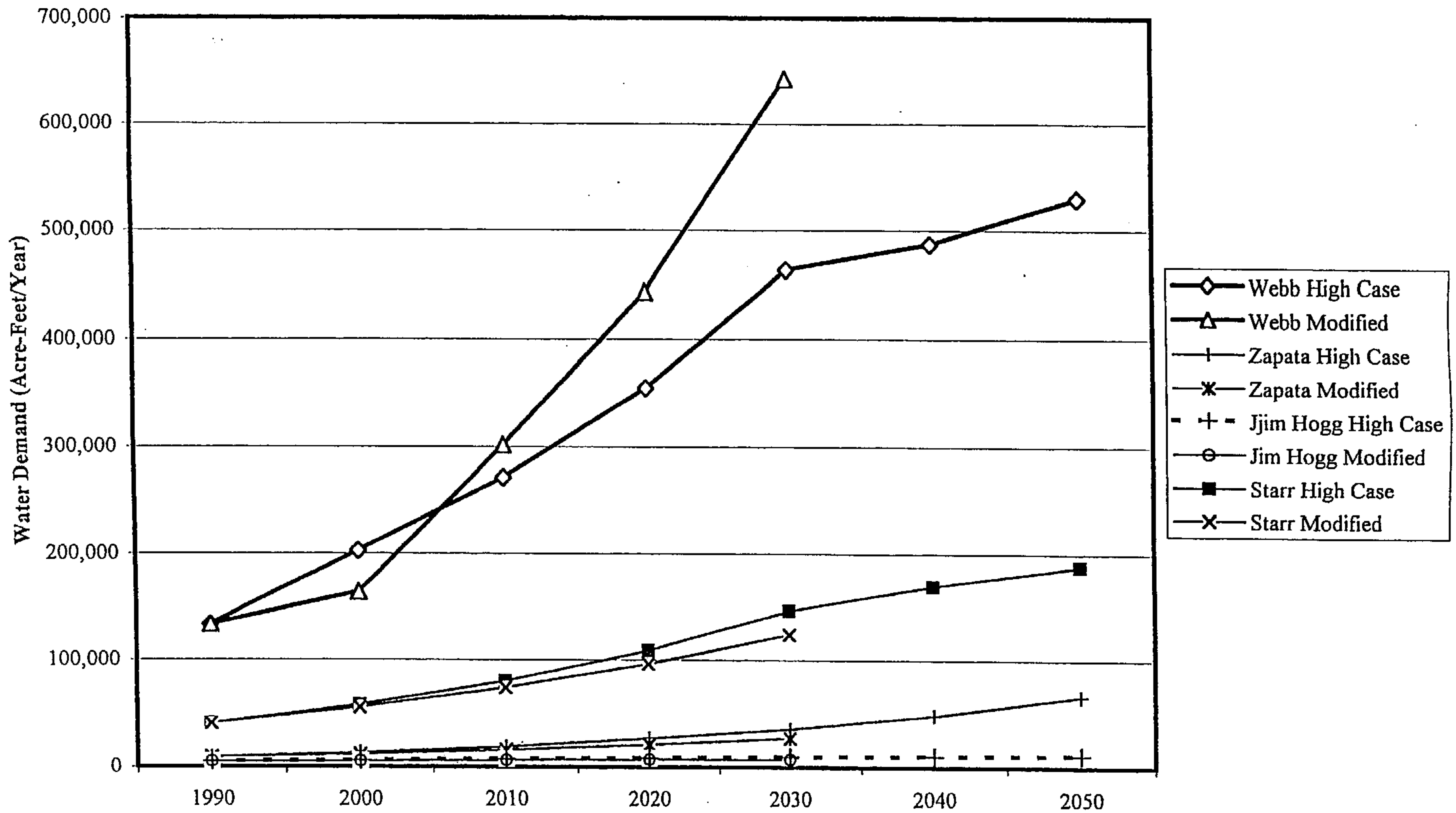
Table 3-7

Projected County-wide Water Use with Definition of Alternative Municipal Projected Water Use and Estimated Conservation Savings

	Projected M_L Total County Water Use (Ac-ft/Yr)	Projected Municipal M_L WU (Ac-ft/Yr)	Sum WU Less Mun. (Ac-ft/Yr)	Projected M_L Pop	Projected M_R Pop	Per Capita M_L WU gpcd	Conservation Savings gpcd	Alternative Municipal M_R WU (Ac-ft/Yr)	Projected M_R Total County Water Use (Ac-ft/Yr)
Webb									
1990	45,890	36,016	9,874	133,239	133239	241	0	36,016	45,890
2000	61,021	52,281	8,740	202,873	163561	230	11	42,150	50,890
2010	74,384	66,059	8,325	271,481	301566	217	13	73,380	81,705
2020	90,514	82,566	7,948	354,901	443189	208	10	103,106	111,054
2030	113,789	106,164	7,625	463,015	641973	205	3	147,197	154,822
2040	118,472	111,129	7,343	486,960		204	1		
2050	126,275	119,171	7,104	529,549		201	3		
Zapata									
1990	4,884	1,852	3,032	9,279	9279	178	0	1,852	4,884
2000	6,143	3,560	2,583	13,328	12038	238	-60	3,215	5,798
2010	7,224	4,761	2,463	18,900	15938	225	14	4,015	6,478
2020	8,718	6,358	2,360	26,399	20879	215	10	5,029	7,389
2030	10,684	8,422	2,262	35,353	26904	213	2	6,409	8,671
2040	13,528	11,358	2,170	48,159		211	2		
2050	17,642	15,558	2,084	66,036		210	0		
Jim Hogg									
1990	1,308	585	723	5,109	5109	102	0	585	1,308
2000	1,776	734	1,042	6,176	5840	106	-4	694	1,736
2010	1,838	810	1,028	7,401	6662	98	8	729	1,757
2020	1,913	894	1,019	8,717	7368	92	6	756	1,775
2030	1,982	969	1,013	9,791	7905	88	3	782	1,795
2040	2,020	1,013	1,007	10,499		86	2		
2050	2,068	1,066	1,002	11,238		85	1		
Starr									
1990	53,399	6,126	47,273	40,518	40,518	135	0	6,126	53,399
2000	57,586	9,311	48,275	57,899	55,561	144	-9	8,935	57,210
2010	58,006	11,856	46,150	80,028	74,164	132	11	10,987	57,137
2020	59,536	15,270	44,266	108,820	96,456	125	7	13,535	57,801
2030	62,711	20,248	42,463	145,805	123,209	124	1	17,110	59,573
2040	63,990	23,229	40,761	169,221		123	1		
2050	65,010	25,843	39,167	187,771		123	0		

Notes:
1) Water use (WU) projections incorporate assumptions that advanced conservation is implemented in the counties of STDC region
2) Division of municipal water use by county population is technically incorrect. However, rural population in these counties is deemed relatively insignificant with respect to calculation of unit consumption rates, especially for future growth conditions.
3) The alternative municipal water use figures based on 1990-1994 population trends are presented to show the relative effect on total water demand by population growth if it were sustained through the planning period. These water use rates are not recommended.
4) Abbreviations: M_L = 1996 consensus-based value termed "most likely"; M_R = alternative based on 1990-1994 growth trends estimated by the Texas Data Center; gpcd = gallons per capita per day; ac-ft/yr = acre-foot per year; pop = population

Figure 3-13
Comparison Between Water Demand Estimates for STDC
Using 1.0 and 1.5 Migration Factors



Section 4.0 Water Supply

4.1 Amistad-Falcon Reservoir System

The principal source of water supply in the region is provided by the Amistad and Falcon reservoirs. Amistad reservoir is located upstream of Ciudad Acuña/Del Rio. It was constructed in 1968 and has a storage capacity of approximately 5,269,600 ac-ft. Falcon is located downstream of Nuevo Laredo/Laredo. Its construction was completed in 1953 and it holds approximately 3,972,470 ac-ft. Recent water supply modeling by a private consultant, RJ Brandes & Co., Inc., on the Amistad-Falcon reservoir system used reservoir system inflows and outflows supplied by IBWC to estimate the firm yield of the system. This information was reflective of a period before six reservoir structures were completed on the Mexican side of the Rio Grande. Results of the modeling suggest a firm yield of 1,250,000 ac-ft for the drought of record (occurring in the 1950s). While this estimate is subject to peer review and change, it is the best estimate currently available. Furthermore, given the influence of Mexican reservoirs in the Rio Grande Basin, the actual firm yield is likely to be lower than that predicted (*RJ Brandes, Personal communication, December, 1997*).

4.1.1 Main Flow of the Rio Grande

The International Boundary and Water Commission (IBWC) maintains excellent records of the main flow of the Rio Grande at various gauging stations. Table 4-1 shows the records of means, maximum and minimum annual streamflows at selected locations averaged over the periods of 21 years, starting at 1969, one year after the construction of Amistad Dam.

The water released from Elephant Butte Dam has averaged 688 thousand acre-ft annually. A large portion of this flow is diverted to irrigate crop lands in New Mexico. The remainder and return flow then reach El Paso at an annual rate of 447,081 acre-feet. As the flow reaches American Diversion Dam, 270,000 acre-feet has been diverted annually to the American canal which is the main supply canal for the El Paso Valley. The diversion to Mexico has amounted to 53,127 ac-ft annually (below the 60,000 ac-ft diversion agreed to in the 1906 treaty), which is used along with other sources including shallow groundwater and municipal sewage to irrigate the Juarez Valley. After diversion, the flow of the Rio Grande is reduced to 127,000 ac-ft annually. The flow gradually increases again due to the collection of return flow and municipal sewage water discharged from several plants from El Paso and adjacent communities. The sewage water from Cd. Juarez is discharged into irrigation canals and, to a limited extent, to drainage ditches, but not directly into the Rio Grande. When the flow reaches Fort Quitman, storm runoff from small creeks is added to the flow of the Rio Grande.

The Rio Conchos that originates from the Mapimi drainage basin of the State of Chihuahua carries an average annual flow of about 743,000 ac-ft at the point of inflow into the Rio Grande near Ojinaga, Mexico (Table 4-1). This flow is slightly greater than the annual release from Elephant Butte Dam, and forms the main flow of the Rio Grande in the stretch between Presidio and Amistad Dam. The Pecos River and the Devils River contribute 224,000 and 289,000 ac-ft annually to the flow of the Rio Grande, respectively. All of these flows are stored at Amistad International Reservoir.

The discharge from Amistad Dam has averaged 1.686 million ac-ft annually since its construction in 1968 (Table 4-1). About half of this release is taken into the Maverick Canal located 17.4 miles south of Del Rio for hydraulic power generation and irrigation. The return flow from the power plant goes right back into the Rio Grande, and the remainder is used for irrigation through the Maverick Extension Canal. The combination of the base flow, return flow, and the inflow from creeks bring the flow of the Rio Grande back to over 2.056 million ac-ft annually at Eagle Pass. The diversion below Eagle Pass but above Laredo is minimal, and the Rio Grande gains flow and reaches about 2.356 million ac-ft annually at Laredo. Below Laredo, there are several rivers and streams that flow into the Rio Grande. The Rio Salado from Mexico is one of the larger rivers and has contributed to the flow of the Rio Grande at an annual rate of about 386,000 ac-ft. The combined flow reaches 2.489 million ac-ft annually at Falcon International Reservoir. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995)

Table 4-1
Annual Flow of the Rio Grande and Tributaries at Selected Gauging Stations 1969-1989 (per IBWC)

Stations	River or canal	Annual Flow in 10^3 Ac-ft/yr Ave.	Max.	Min.
Elephant Butte Release, NM	Rio Grande	688	1,446	302
El Paso, TX	Rio Grande	447	1,320	135
American Canal, TX	Diversion	-271	-432	-107
Mexican Canal, TX	Diversion	-53	-67	-15
El Paso after Diversion	Rio Grande	127	665	21
Fort Quitman, TX	Rio Grande	138	722	9
Near Ojinaga, Chihuahua	Rio Conchos	743	1,711	359
Presidio, TX	Rio Grande	919	1,785	486
Foster Ranch, TX	Rio Grande	1,200	2,214	616
Langtry, TX	Pecos River	224	1,097	96
Pafford Crossing, TX	Devils River	289	713	73
Amistad Dam Release, TX	Rio Grande	1,686	3,595	420
Maverick Canal, TX	Diversion	-913	-1,093	-463
Power Plant Return, TX	Return Flow	678	896	170
Maverick Extension, TX	Diversion	-142	-215	-42
Eagle Pass, TX	Rio Grande	2,056	3,783	711
Laredo, TX	Rio Grande	2,356	3,922	988
Las Tortillas, Tamaulipas	Rio Salado	386	2,420	49
Falcon Dam Release, TX	Rio Grande	2,489	4,234	1,153
Camargo, Tamaulipas	Rio San Juan	355	1,735	7
Rio Grande City, TX	Diversion	-239	-347	-152
Anzalduas Canal, Tamaulipas	Diversion	-974	-1,555	-540
Anzalduas Dam, TX	Diversion	-208	-325	-122
Progreso,TX	Diversion	-435	-709	-269
San Benito, TX	Diversion	-109	-163	-54
Brownsville, TX	Rio Grande	965	2,667	135

* *The negative sign indicates diversion*

Note: Table is from *Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995. The dimensions of units of measure have been converted from metric to English units

Below Falcon, the Rio San Juan (about 355,000 ac-ft/yr) flows into the Rio Grande from the Mexican side at Camargo. The Rio Grande water is diverted between Rio Grande City and Anzalduas Dam at a rate of about 239,000 ac-ft/yr for irrigation (Table 4-3). The major diversion to Mexico is at Reynosa. The U.S. side of the diversions are at Anzalduas Dam, Progreso and San Benito at a combined diversion flow of about 752,000 ac-ft per year. When the Rio Grande reaches Brownsville, the flow decreases to 965,000 ac-ft/year (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

4.1.2 Surface Inflow into the Rio Grande

The records of the surface flow that enters the Rio Grande are also maintained by the IBWC. A summary of the surface flow records (averaged over 1969 through 1989), including springs, is shown in table 4-2. In the El Paso-Ft. Quitman segment, the main inflow is the Rio Grande entering from New Mexico and municipal sewage from El Paso. There is no recorded inflow from the Mexican side in this segment of the Rio Grande.

The Fort Quitman to Amistad Dam segment has four inflows from the U.S. side and the Rio Conchos from the Mexican side (Table 4-2). The Rio Conchos accounts for 56 percent of the recorded inflow, and the Devils River 22 percent and the Pecos River 17 percent in this segment of the Rio Grande. There is a net increase in flow of the Rio Grande between Presidio and Amistad Dam by about 232,100 ac-ft which is not accounted for by these recorded inflows.

The unaccounted flow was divided in proportion to the drainage areas for the Texas side (7,700 sq. miles) and the Mexican side (6,000 sq. mi.) between Fort Quitman (or Colonia Luis Leon) and Amistad. The total annual inflow from the U.S. side was estimated to be 704,000 ac-ft, and that from the Mexican side 844,000 ac-ft in this section of the Rio Grande.

The Amistad-Falcon segment starts with the inflow of Arroyo de Los Jaboncillos, four springs and three creeks near Cd. Acuña from the Mexican side, followed by the inflow of four Mexican rivers, which include the Rio Salado (Table 4-2). The recorded total surface inflow from the Mexican side amounts to 828,000 ac-ft annually in this segment of the Rio Grande, and the Rio Salado accounts for 47 percent of the inflow. The recorded inflow from the Texas side, which includes irrigation return flow from the Maverick Irrigation District, amounts to about 306,000 ac-ft annually. In addition, municipal sewage from Eagle Pass and Laredo provides an additional inflow of 9,800 ac-ft per year. Sewage water is also discharged from the Mexican side into the Rio Grande (e.g., from Nuevo Laredo). The exact quantities are unknown, but are probably comparatively small in quantity.

The Rio Grande gains flow between Amistad and Falcon Dams by about 803,000 ac-ft/yr (Table 4-1). The net diversion at the Maverick power plant is about 142,000 ac-ft, which is then channeled into the Maverick Irrigation District. Additional diversions to Eagle Pass and Laredo are estimated at about 9,800 ac-ft. The diversion to Mexico is not recorded, but is estimated at 21,250 ac-ft based on irrigated acreages. The gain in flow plus the diverted quantity is estimated at 1.527 million ac-ft/yr, which approximately equals the estimated total inflow of 1.5 million ac-ft/year (Table 4-2). Seventy-three percent of the inflow in this segment of the Rio Grande originates from the Mexican side.

The Falcon to the Gulf Coast segment has a topographical slope where a large portion of the Rio Grande river bed is higher than the elevation of the drainage basin on the Texas side. The general direction of surface flow is toward the Laguna Atascosa and the Laguna Madre away from the Rio Grande. The inflow into the Rio Grande is thus from the Mexican side, (chiefly from the Rio San Juan, and San Juan drainage), and is recorded to be about 513,300 ac-ft annually. The reduction in flow of the Rio Grande between Falcon Dam and Brownsville averages 1.524 million ac-ft annually (Table 4-1), while the recorded plus some estimated diversion amounts to 2.025 million ac-ft annually (Table 4-3). The recorded diversion exceeds the total inflow of 521,000 ac-ft, (Table 4-3) by 1.504 million ac-ft, which coincides with the measured reduction in flow.

Overall, the recorded surface inflow in the Texas side amounts to 1.5 million ac-ft and that from the Mexican side 2.185 million ac-ft annually, which is roughly 1 to 1.5 ratio in favor of the Mexican side. This ratio, however, excludes subsurface inflow into the Rio Grande. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995)

4.1.3 Water Use

The quantity of water diverted from the Rio Grande surface flow is also recorded by the IBWC. The figures presented herein do not include groundwater use, but only the direct withdrawal from the Rio Grande.

4.1.3.1 Agricultural Use

Irrigated crop production dominates the use of the Rio Grande surface flow. The water released from Elephant Butte Dam is used to irrigate 87,000 acres of crop land in New Mexico (Table 4-3). The remainder plus return flow from New Mexico is then used to irrigate crop land in the El Paso and Juarez Valleys. The reported irrigated crop land area for the El Paso Valley in 1989 was 42,500 acres which is about two-thirds of the irrigable lands. Some lands are now classified as residential areas, or commercial lots, and others have salted out or are not being cropped. Low density residential areas with the holdings of one hectare or greater actually receive allocation of the Rio Grande water, as the water right is tagged to the ownership of the land within the district boundary. The source of irrigation water below Acala (Hudspeth County) is predominately return flow, and occasional excess spills from the El Paso Irrigation District. When these water supplies are curtailed, shallow groundwater is used to supplement irrigation. The use of the Rio Grande water for agricultural purposes is limited to about 4,942 acres between Fort Quitman and Amistad (Table 4-3). However, an estimated area of 318,860 acres in Mexico is irrigated by the Rio Conchos before the water reaches the Rio Grande. Likewise, the Pecos river water is used to irrigate 13,343 acres in Texas and additional unlisted areas of 35,000 acres in New Mexico. Agricultural uses of the Rio Grande water between Amistad and Falcon are concentrated in the Maverick Irrigation District (40,277 acres) on the Texas side. On the Mexican side, the Rio Salado is used to irrigate 63,010 acres before reaching the Rio Grande. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

The major agricultural uses of the Rio Grande are below Falcon, totaling 768,234 acres on the Texas side and 517,922 acres plus 203,856 acres of tributary-irrigated areas on the Mexican side (Table 4-3). The irrigated area below Falcon accounts for 88 percent of the Rio Grande irrigated area on the Texas side, and 96 percent of the land irrigated directly by the Rio Grande on the Mexican side. The cropped area changes depending on the year, but these changes do not affect the overall picture of the agricultural water uses. The total water use for agriculture from El Paso to the Gulf Coast averaged 1.528 million ac-ft per year on the Texas side, and 1.11 million ac-ft per year on the Mexican side with corresponding irrigated areas of 876,958 acres and 539,420 acres, respectively. The combined agricultural use of the surface water of Rio Grande is 2.640 million ac-ft/yr, as compared to the combined estimated inflow of 3.686 million ac-ft/yr. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995)

4.1.3.2 Municipal and Industrial Uses

The total municipal water use from the surface flow of the Rio Grande amounts to 80,100 ac-ft/yr on the Texas side, and 40,050 ac-ft/yr on the Mexican side averaged over the last 10 years (Table 4-4). This amounts to 5 percent and 3 percent of the agricultural uses directly from the Rio Grande, respectively. The major industrial use of the Rio Grande water is at the Laredo Power Plant which consumes about 1,226 ac-ft/year.

The actual water use for municipal and industrial purposes is greater due to additional groundwater uses. The City of El Paso, for example, has been using 89,900 ac-ft/yr, of which 19,600 ac-ft comes from the Rio Grande. The Texas Department of Water Resources estimated in 1990 that the total municipal uses along the Texas side of the Rio Grande were 282,800 ac-ft/yr, or three times the surface water withdrawals directly from the Rio Grande. Municipal water uses are projected to grow with increasing population along the border and/or, with depletion of groundwater reserves (Eaton and Hurlbut, 1992).

4.1.3.3 Recreation and Wildlife Enhancement

There is no simple way to assess the quantity of water used for recreation and wildlife enhancements. All three major reservoirs, Elephant Butte, Amistad, and Falcon are used extensively for outdoor recreational activities. The quantity of water evaporating from these reservoirs alone is substantial: 15,530, 47,400, and 64,570 ac-ft/yr at the maximum water surface of 18,533, 66,717, and 88,956 acres at Elephant Butte, Amistad and Falcon, respectively. The evaporation deficit at these dams is 100, 85 and 86 inches per year, respectively. The evaporation from these three reservoirs alone amounts to a quantity greater than the municipal water use from the Rio Grande.

Table 4-2
Annual Surface Inflow to the Rio Grande (including Irrigation Return Flow) 1969-1989 per IBWC

Inflow from the US	10^3ac-ft/year
El Paso - Fort Quitman	
Rio Grande, NM	447
El Paso sewage	25
	472
Fort Quitman - Amistad	
Above Presidio	0
Alamito Creek	15
Terilingua Creek	46
Pecos River	224
Devils River	289
Recorded total	573
Unaccounted	131
Estimated total	704
Amistan - Falcon	
Springs & Creeks near Del Rio	17
San Felipe Springs & Creeks near De. Rio	165
Pinto Creek below Del Rio	11
Return Flow	
above Eagle Pass	42
below Eagle Pass	70
Estimated subtotal	306
Sewage	
Eagle Pass	2
Laredo	10
Estimated total	318
Falcon - the Gulf	
Brownsville Sewage	7
TOTAL (El Paso - the Gulf)	1,500

Inflow from Mexico	10^3ac-ft/year
	10^3ac-ft/year
Cd. Juarez - Col Luis Leon	
Cd. Juarez sewage	0
	0
Col Luis Leon - Amistad	
Above Col Luis Leon	0
Rio Conchos	743
Subtotal	743
Unaccounted	101
Estimated total	844
Amistad - Falcon	
Arroyo de Los Jabocillos	38
Springs & Creeks near Cd. Acuna	39
Rio San Diego near Jimenez	178
Rio San Rodrigo at El Moral	125
Rio Escondido at Villa de Fuente	62
Rio Salado near Las Tortillas	386
Estimated Total	828
Falcon - the Gulf	
Rio Alamo at Cd. Mier	98
Rio San Juan at Camargo	355
San Juan return flow	60
	513
TOTAL (Cd. Juarez - the Gulf)	2,185

Note: Table is from Flow, Salts, and Trace Elements in the Rio Grande, TR-169, July 1995. The Dimensions of units of measure have been converted from metric to English units.

Table 4-3
Recorded or Estimated Diversions from the Rio Grande for Agricultural Uses (1969-1989) with Reported Irrigation Areas in 1989 (per IBWC data)

Diversions	Diversion (10^3 ac-ft/yr)			Irrigation (1000 acres)		
	Texas	Mexico	Total	US	Mexico	Total
Elephant Butte - El Paso	-		0	-	(87) [1]	0
(35.2)						
El Paso - Fort Quitman						
El Paso - Acaia	271	53	321	42.5	13.6 #	56.1
Acaia - Fort Quitman	-	-	-	17.5	0	17.5
Fort Quitman - Amistad						
(Rio Conchos above Ojinaga)	-	-	-	0	(318.8)	(318.8)
Presidio	8 [2]	0	8 [2]	2.5	0	2.5
Presidio - Langtry	2 [2]	6 [2]	8 [2]	0.7	1.7	2.5
(Pecos River)	-	-	-	(13.3)	0	(13.3)
(Devils River)	-	-	-	(0)	0	(0)
Rio Grande irrigated	11 [2]	6 [2]	16 [2]	3.2	1.7	4.9
Tributary irrigated	-	-	-	(13.3)	(318.8)	(332.1)
Amistad - Falcon						
(San Felipe Creek)	-	-	-	(1.7)	0	(1.7)
(Rio San Diego)	-	-	-	0	(8.2)	(8.2)
(Rio San Rodrigo)	-	-	-	0	0	0
Del Rio - Laredo	215	21 [2]	236	40.3	4	44.2
Laredo - Falcon	28 [2]	8 [2]	36 [2]	5.2	2.2	7.4
(Rio Salado)	-	-	-	0	(63)	(63)
Rio Grande irrigated	243	29 [2]	272 [2]	45.5	6.2	51.6
Tributary irrigated	-	-	-	0	(71.2)	(71.2)
Falcon - the Gulf						
(Rio Alamo)				0	(7.9)	(7.9)
(Rio San Juan)				0	(196)	(196)
Falcon - Rio Grande city	10	11 [2]	20 [2]	4.4	4.7	9.1
Rio Grande city - Anzalduas	239	29 [2]	268	178.9	22.7	201.6
Anzalduas Canal	208	974	1,182	162.6	484.6	646.7
Progreso Intake	435	6 [2]	441	327.9	4.2	332.1
San Benito Intake	109	2	111	92.7	1.7	94.4
Brownsville Diversion	2	0	2	2.2	0	2.2
Rio Grande irrigated	1,002	1,022	2,025	768.2	517.9	1286
Tributary irrigated	-	-	-	(0)	(203.9)	(203.9)
Total (El Paso - the Gulf)						
Rio Grande irrigated	1,527	1,111	2,638	877	539.4	1416
Tributary irrigated	-	-	-	(13.3)	(593.8)	(607.1)

1 Numbers in Paranthesis indicate irrigated areas before reaching the Rio Grande below El Paso.

2 Estimated from irrigated areas.

Note: Table is from *Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995. The dimensions of units of measure have been converted from metric to English units

Table 4-4
Estimated Direct Agricultural and Muncipal/Industrial Diversions from the Rio Grande River
(per IBWC Data)

	Agricultural *		Municipal **		
IBWC Segment	US (10^3ac-ft/year)	Mexico (10^3ac-ft/year)	US (10^3ac-ft/year)	Mexico (10^3ac-ft/year)	Communities
El Paso - Fort Quitman	271	53	20	0	El Paso
Fort Quitman - Amistad	11	6	0	0	
Amistad - Falcon	243	29	11	2	Del Rio - Cd. Acuna
			4	7	Eagle Pass - Pie Negra
			22	28	Laredo - Nuevo Laredo
			37	38	
Falcon - the Gulf	1,002	1,022	2	0	New Zapata
			2	0	Roma
			2	0	Rio Grande City
			19	0	Brownsville
			24	2	
Total	1,527	1,111	80	40	

** 1969 - 1989 data*

*** 1979 - 1989 data*

Note: Table is from *Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995. The dimensions of units of measure have been converted from metric to English units

Waterways along the Rio Grande and its tributaries, including drainage ditches, are habitats to many wildlife species. The evapotranspiration losses from these wetlands are likely to reach substantial quantities, although these are not measured as such. In the section of Elephant Butte Dam to El Paso, for example, the densely vegetated areas along the Rio Grande floodways are estimated at 37,065 acres. The unit evapotranspiration rate from these vegetated areas exceeds that of agricultural lands, and is estimated to reach 59 inches per year. The evapotranspiration losses occurring in this segment of the waterways alone can amount to 183,900 ac-ft per year. (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995).

4.2 Water Allocations

The TNRCC and its predecessor agencies have been empowered to control releases from Falcon Reservoir through judgements rendered in the Lower Rio Grande Valley Water Case. This case, formally called State of Texas, et. al. vs. Hidalgo County Water Control and Improvement District No. 18, et. al., established a 60,000 ac-ft/yr storage reserve in Falcon Reservoir to meet municipal and industrial demands. In addition, a 155 ac-ft/yr reserve was allocated to domestic uses. Furthermore, 742,808.6 acres of land lying downstream from Falcon Reservoir were allocated both Class A and Class B irrigation rights. Class A rights were assigned to 641,221 acres with the remainder assigned Class B rights.

The highest priority was assigned to municipal and industrial rights while a weighted priority system was developed which allocated the remaining surface water supply for irrigation needs. Allocation of water rights is administered through an accounting system that monitors releases from Amistad and Falcon reservoirs. Class A rights accrue water in storage at a rate 1.7 times that of Class B rights. During periods of reduced inflow to the reservoir system, the net effect of this allocation protocol is to distribute the shortage among all water accounts with Class A rights holders receiving the greater share of water than Class B rights holders.

4.3 Reservoir System Operation Rules

30 TAC §303 rules: "Operation of the Rio Grande" were adopted and periodically amended by the TNRDD to provide a storage reserve of 225,000 ac-ft/yr for municipal, industrial, and domestic uses. This storage reserve is commonly termed the "municipal pool." An operating reserve is also provided which fluctuates continuously between 380,000 ac-ft and 275,000 ac-ft depending on the conservation storage volume in the reservoir system. The operating reserve accommodates contingencies in actual delivered water as a consequence of the following three influences:

1) Water losses due to evaporation, conveyance and seepage;
2) Storage adjustments that result from US/Mexico water treaty delivery commitments; and
3) Emergency water demands.

4.3.1 Allotment Calculations

The operating reserve is calculated monthly by the TNRCC Watermaster. Calculations involve the following steps:

1) If total US storage less 225,000 ac-ft (municipal pool) is greater than zero go to step two to calculate the operating reserve, otherwise forego the remaining steps and only municipal use is allowed.
2) From the remaining storage, deduct the end-of-month account balances for all lower and Middle Rio Grande irrigation and mining allottees.
3) From the remaining storage deduct the operating reserve determined in accordance with §303.21(b)(2)

The remaining storage is allotted to the irrigation and mining water rights on the basis of class. Class A allottees receive 1.7 times the amount received by Class B allottees. Rules call for additional constraints on the allotment process. Irrigation allottees cannot accumulate in storage more than 1.41 times their annual authorized diversion right. Further, an irrigation allottee's water account balance is reduced to zero if its water is not used within a period of two consecutive years.

4.3.2 Allotment Charges

Much like a utility, the TNRCC Watermaster maintains accounts for each of the water rights holders in the Middle and Lower Rio Grande that monitor daily, weekly, and monthly accumulated diversions. Monthly and annual statements are issued to all water rights holders as backup for charges levied on the basis of diversions. Charges accrue to the allottees for diversions according to the following schedule:

1) Diversions are charged at actual amounts if the amount of diversion is ±10% of the amount requested.
2) Diversions are charged at 90% of the amount requested if the actual amount diverted is less than 90% of the amount requested.
3) Diversions are charged at actual amount diverted if actual diversions exceed 110% of the amount requested.

From the calculations, it is clear that excess flows can become available in amounts that exceed the constraints on diversions by water rights holders. During these periods, water may be diverted to water rights holders without charge. However, the TNRCC Watermaster establishes the periods in which no charge water is diverted based on all the measured influences on the Amistad-Falcon Reservoir system and TNRCC orders governing "no-charge" diversions.

4.4 Precipitation Patterns

The water supplies of a region are affected by the amount of precipitation available to contributing catchments. Analysis of historical precipitation patterns is therefore a contributing factor in the calculations of available water. In this study, the historical data compiled by the national climatic data center (NCDC) was accessed and evaluated.

The NCDC holds data for climatic zones within the country as well as individual weather stations. The weather data associated with the individual weather stations was spotty, so the climatic zone data was acquired. The Southern Climatic Zone of Texas, referenced by figure 4-1 was accessed for precipitation data. The period of record (January 1,1895 through January 1, 1998) was secured and the climatic zone data from the Southern Climatic Zone isolated for analyses. The data consisted of monthly rainfall accumulations for the region. The values were totaled and statistics performed on the monthly and annual totals. Results are presented in Figures 4-2 and 4-3.

Figure 4-2 presents the running 30-year annual average rainfall compared with the total annual rainfall and 30-year monthly average rainfall. Results show that the rainfall pattern is consistent for the region. The 30-year average monthly rainfall was approximately 1.9 inches. Total annual rainfall ranged from 32.18 inches to 9.02 inches per year over the 104-year period of record. The 30-year annual average rainfall ranged from a low of 16.10 inches per year to a high of 19.46 inches per year. Based on the results of the plot, the 30-year average rainfall appears to have increased from its lowest point occurring during the 1960s. However, the rainfall averages are in a range that is typical of arid to semi-arid land.

Gross monthly rainfall is hardly a good estimate of the typical rainfall for the area. Typically, this would be characterized by the frequency of a 24-hour storm or storm data from even shorter durations (possibly as short as 15 minutes). However, it offers the best information readily available. Figure 4-3 presents the frequency of non-exceedance of monthly rainfall for the Southern Climatic Zone. This data shows that the 50-percentile rainfall is only 1.19 inches. This value compares with the 30-year average monthly rainfall of about 1.9 inches per month.

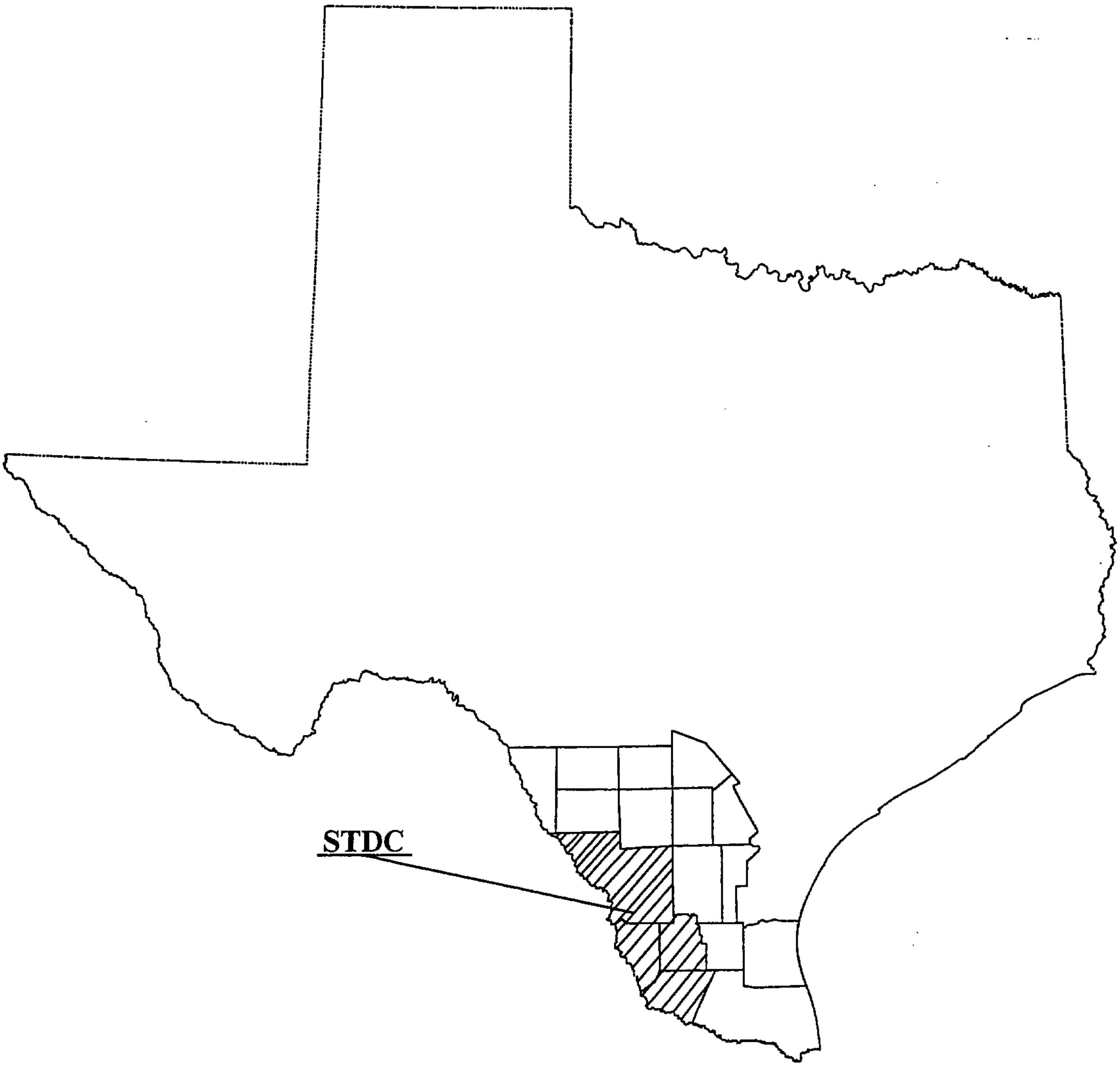


Figure 4-1

Southern Climatic Region of Texas

Figure 4-2
Historical Rainfall Patterns for the Southern Climatic Zone of Texas
(1895-1997)

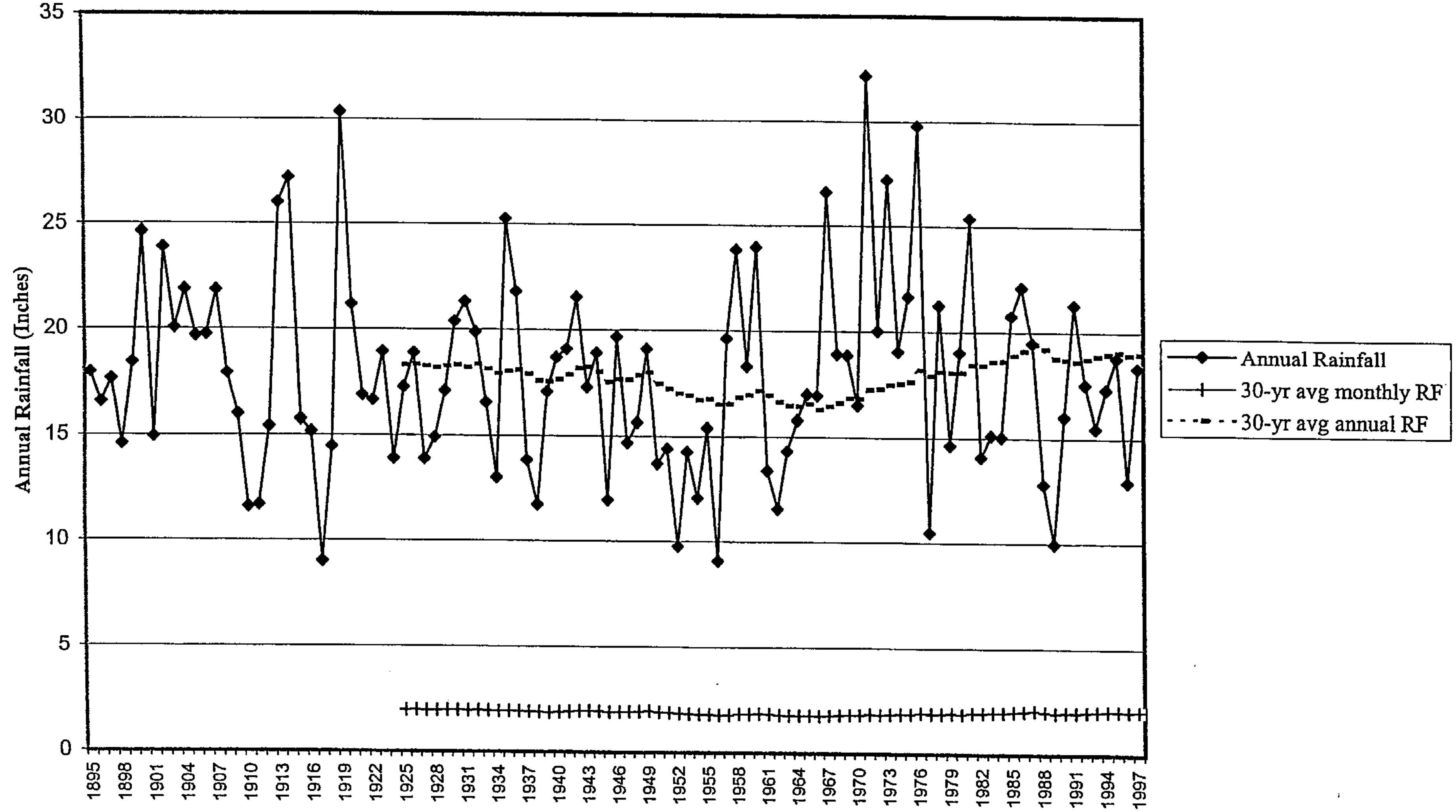
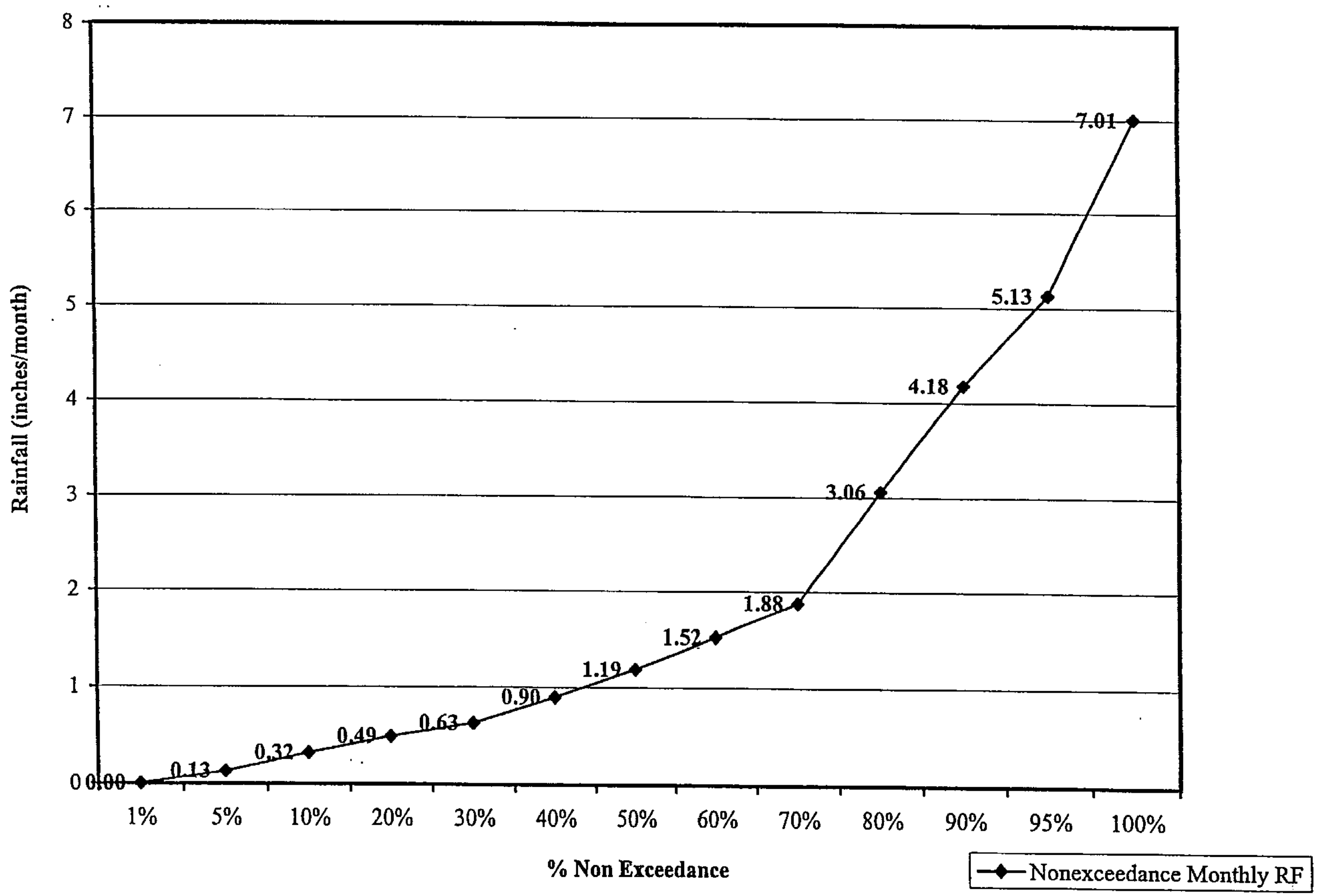


Figure 4-3
Southern Climatic Region of Texas (1895-1997)



4.5 Groundwater Availability

Review of the TWDB water level publication report files indicated that 112, 46, 14, and 65 representative wells for Webb, Zapata, Jim Hogg, and Starr Counties, respectively. Investigation of literature describing the groundwater availability for the STDC region yielded very little in the way of definitive evaluations for groundwater yield in the area. Ironically, there was no information found that thoroughly investigated the groundwater sources in Jim Hogg County. This county relies almost exclusively on groundwater supplies for support of its water demand. Similarly, there was no information found regarding the yield available from groundwater in Zapata County. In general, literature sources were identified for water supply in Webb and Starr Counties.

The water bearing characteristics of aquifer sources in the Webb County region are provided by table 4-5. The orientation of these geologic units through Webb County is indicated in figure 4-4 and figure 4-5, respectively. The aquifers listed, however, are not a comprehensive list. Of the 112 wells listed in the TWDB well inventory, about 37% were found in the Laredo Formation, 22% were found in the Carrizo formation, and 21% was found in the Catahoula formation (not shown). The remaining wells were distributed evenly (approximately 2-3 wells per source) among the following aquifer groups: undifferentiated Carrizo-Willcox (not shown), Yegua, El Pico Clay, Goliad Sand (not shown),-Queen City Sand of the Claiborne Group(not shown), Catahoula Tuff and Jackson Group (not shown). Eight wells had unknown sources and one well was located in the Gulf Coast Aquifer (not shown). The TWDB defined the extent and water bearing potential of the Carrizo Aquifer in Webb County in TWDB report 210 titled *Groundwater Resources of the Carrizo Aquifer in the Winter Garden Area of Texas, Volume 1*, by Klemt, Duffin, and Elder, September 1976. In this report, the downdip extent of fresh to slightly saline water was drawn from approximately from the intersection of FM 1472 with IH-35 to the northeastern tip of Webb County (see figure 4-6). Fresh to slightly saline water was defined as water having less than 3,000 mg/L total dissolved solids (TDS) content. An area of fresh water (having less than 1,000 mg/L TDS) was drawn approximately half the western distance between the saline water line and the northwestern tip of Webb County (see figure 4-6). Additionally, the area located within the freshwater line was identified as a candidate area for development of additional water supplies through the year 2020 (blue area in northwestern Webb County on figure 4-7).

4.5.1 Carrizo-Wilcox Formation

Despite having some common geology with the other parts of the Winter Garden area, there is a significant difference between aquifer characteristics of Webb County and those of other Counties within the Winter Garden area. These differences were best shown by Klemt, et.al. when he compared the largest County values for maximum coefficient of permeability (gallons per day per foot^2) and maximum coefficient of transmissibility (gallons per day per foot). In this comparison, Webb County had the lowest coefficient of permeability at 70 gpd/ft^{2}and the lowest maximum coefficient of transmissibility at 7,000 gpd/ft. These values compared with maximum coefficient of permeability of 500 for Frio and Wilson Counties and a maximum coefficients of transmissibility of 317,000 gpd/ft, and 301,000 gpd/ft for Atascosa and Wilson Counties, respectively.

In general, groundwater quality in Webb County reflects relatively high concentrations of sulfate and chlorides and TDS. Other problematic substances observed in the TWDB well data for Webb County included concentrations of boron, nitrate, barium, calcium carbonate hardness, bromide, and arsenic. Examples of the sample concentrations of TDS, chloride and sulfate with respect to the Carrizo aquifer fresh water and fresh to slightly saline water lines is shown by figure 4-7.

McCoy cited relatively intense oil well drilling operations in Webb County with the attendant concerns for brine contamination. He used a computer screening analysis to evaluate chemical ratios of chloride/sulfate, chloride/sodium, and reported concentrations of chloride, bromide, iodide, and strontium in 879 analyses of 620 wells in the area. Results of the analysis showed that one well in Webb County had probable brine contamination. The well is located in the northwest part of the county about midway between FM1472 and US 83 and about 8 miles downdip of the outcrop of Carrizo sand. Although evidence of widespread contamination was not found, McCoy indicated the following conditions could mask the actual occurrence of contamination: 1) contaminated areas may have gone undetected due to a lack of sample results; 2) contamination may be so slight as to go unnoticed in sampled analyses; and 3) severely contaminated wells have probably been abandoned and may be unavailable for sampling.

Table 4-5
Water-Bearing Characteristics of the Eocene Deposits in the Study Area

System	Series	Group	Geologic Unit: West of Frio River	Geologic Unit: East of Frio River	Hydrologic Unit: West of Frio River	Hydrologic Unit: East of Frio River	Approximate Thickness (In Feet): West of Frio River	Approximate Thickness (In Feet): East of Frio River	Character of Rock: West of Frio River	Character of Rock: East of Frio River	Water-Bearing Properties: West of Frio River	Water-Bearing Properties: East of Frio River
Tertiary	Eocene	Jackson	Undifferentiated				0 - 500		Clay, tuff, sandstone and siltstone.		Yields small quantities of slightly to moderately saline water in the outcrop area.	
		Claiborne	Yegua Formation				700 - 1,000 +		Clay, silt with interbedded thin lignites and sandstones. Some minor beds of limestone and oyster shells are found.		Yields small quantities of slightly to moderately saline water in the outcrop area.	
			Laredo Formation	Cook Mountain Formation	Laredo Aquifer		600 - 700	400 - 500	Glauconitic sand and clay. Some gypsiferous clay and impure limestones.	Fossiliferous clay and shale. Some interbedded sandstone and limestone.	Yields small to moderate quantities of fresh to moderately saline water.	Yields small quantities of slightly to moderately saline water.
				Sparta Sand		Sparta Sand		40 - 200		Medium to fine sand. Some interbedded clay.		Yields small to moderate. quantities of fresh to moderately saline water.
			El Pico Clay	Weches Formation			700 - 1,500	50 - 200	Clay with interbedded sandstones, claystones, and lignite coal lenses.	Fossiliferous, glauconitic shale and sand.	Yields small quantities of slightly to moderately saline water.	Not known to yield water.
				Queen City Sand		Queen City Aquifer		500 - 1,400		Marine, medium to fine sand with interbedded clay and shale.		Yields small to moderate quantities of fresh to slightly saline water.
			Bigford Formation	Reklaw Formation	Bigford Aquifer		200 - 900	200 - 400	Sands with interbedded silts and shales. Plant remains are abundant.	Clay with interbedded glauconitic sand.	Yields small to moderate quantities of fresh to very saline water.	Yields small quantities of slightly to moderately saline water to wells in or near the outcrop.
			Carrizo Sand		Carrizo Aquifer		150 - 1,200		Coarse to fine sand, massive, cross-bedded with a few partings of carbonaceous clay.		Principal aquifer in the study area. Yields moderate to large quantities of fresh to slightly saline water.	
		Wilcox	Indio Formation	Wilcox Group Undif.	Wilcox Aquifer		0 - 2,800		Interbedded sand, clay, and silt with discontinous beds of lignite. The shale and clay sometimes contain gypsum.		Yields small to moderate quantities of fresh to slightly saline water.	
		Midway	Kincaid Formation	Midway Group Undif.			0 - 300		Shale, sandstone and limestone.		Not known to yield water.	

- Yields of Wells, in gallons per minute (gal/min): Small, less than 50 gal/min; moderate, 50-500 gal/min; large, more than 500 gal/min.
- Quality of Water, in milligrams per liter (mg/l) dissolved solids: Fresh, les than 1,000 mg/l; slightly saline, 1,000-3,000 mg/l; moderately saline, 3,000-10,000 mg/l; very saline, 10,000-35,000 mg/l.

References: Barnes 1974, 1976a, 1976b, 1977)
Guevara and Garcia (1972)
Hamlin (1988)
Hargis (1985)
[illegible]

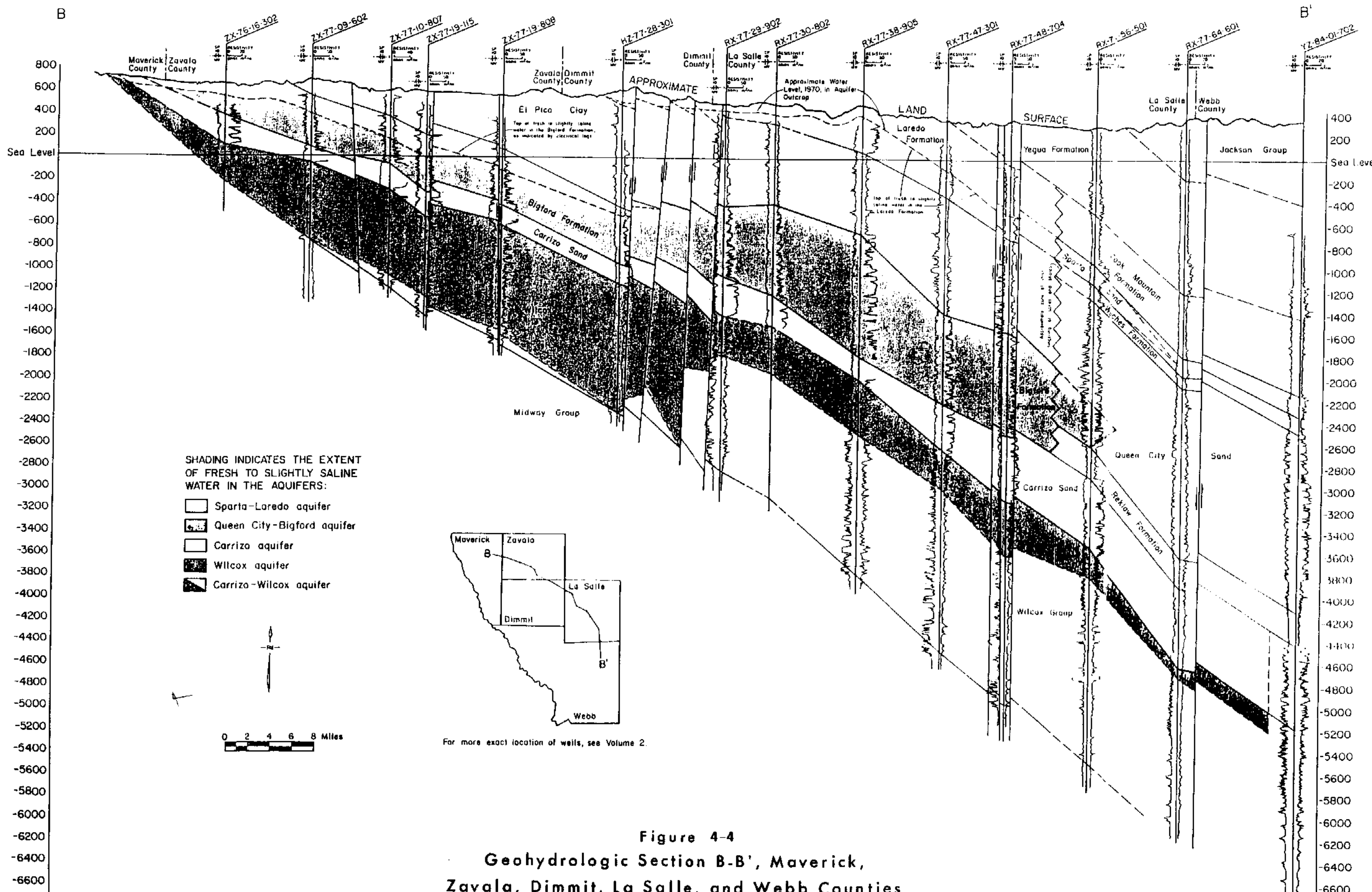
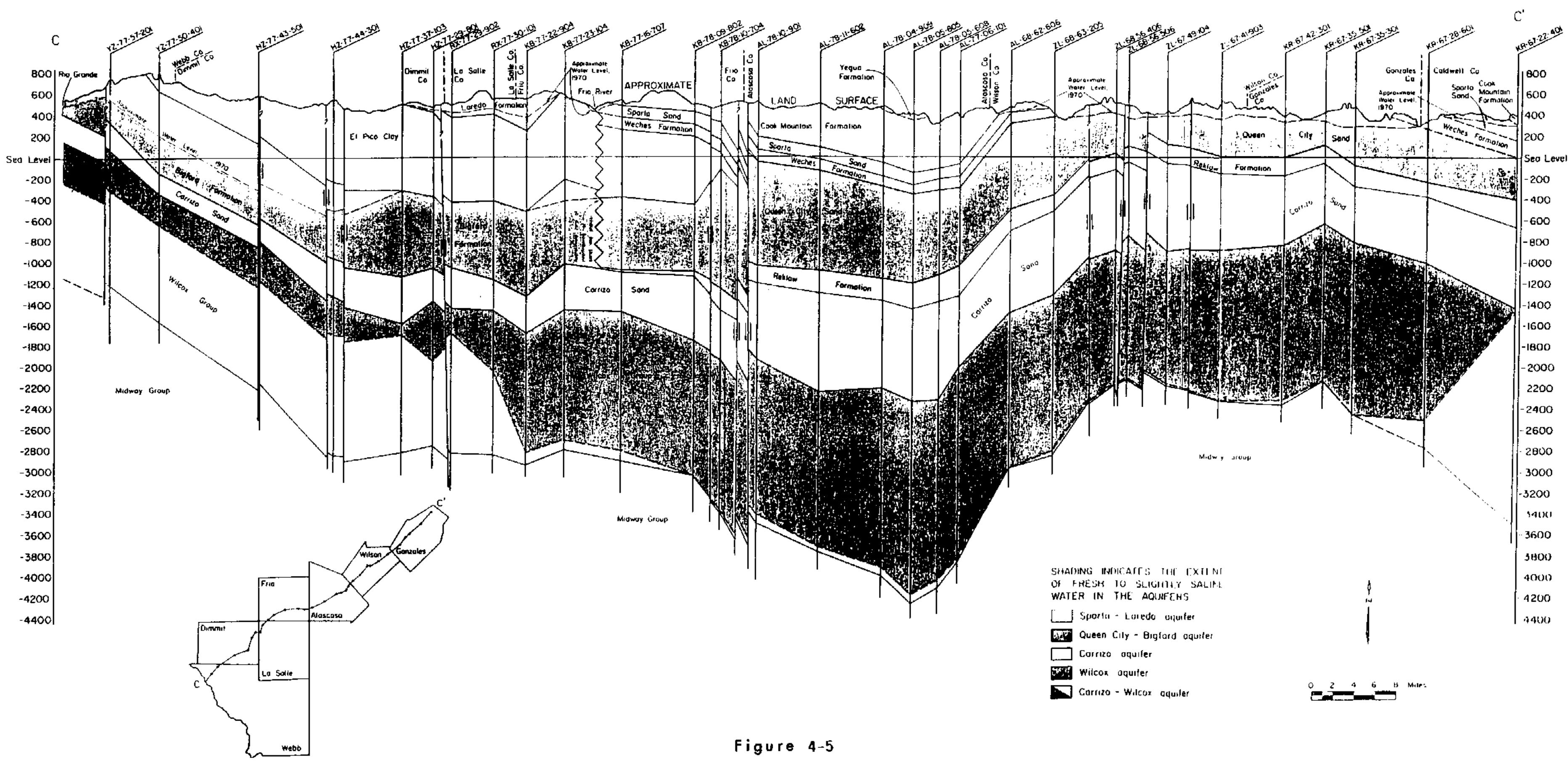


Figure 4-4

Geohydrologic Section B-B', Maverick, Zavala, Dimmit, La Salle, and Webb Counties



For a more exact location of wells, see Volume 2

Figure 4-5
Geohydrologic Section C-C', Webb, Dimmit, La Salle, Frio, Atascosa, Wilson, and Gonzales Counties

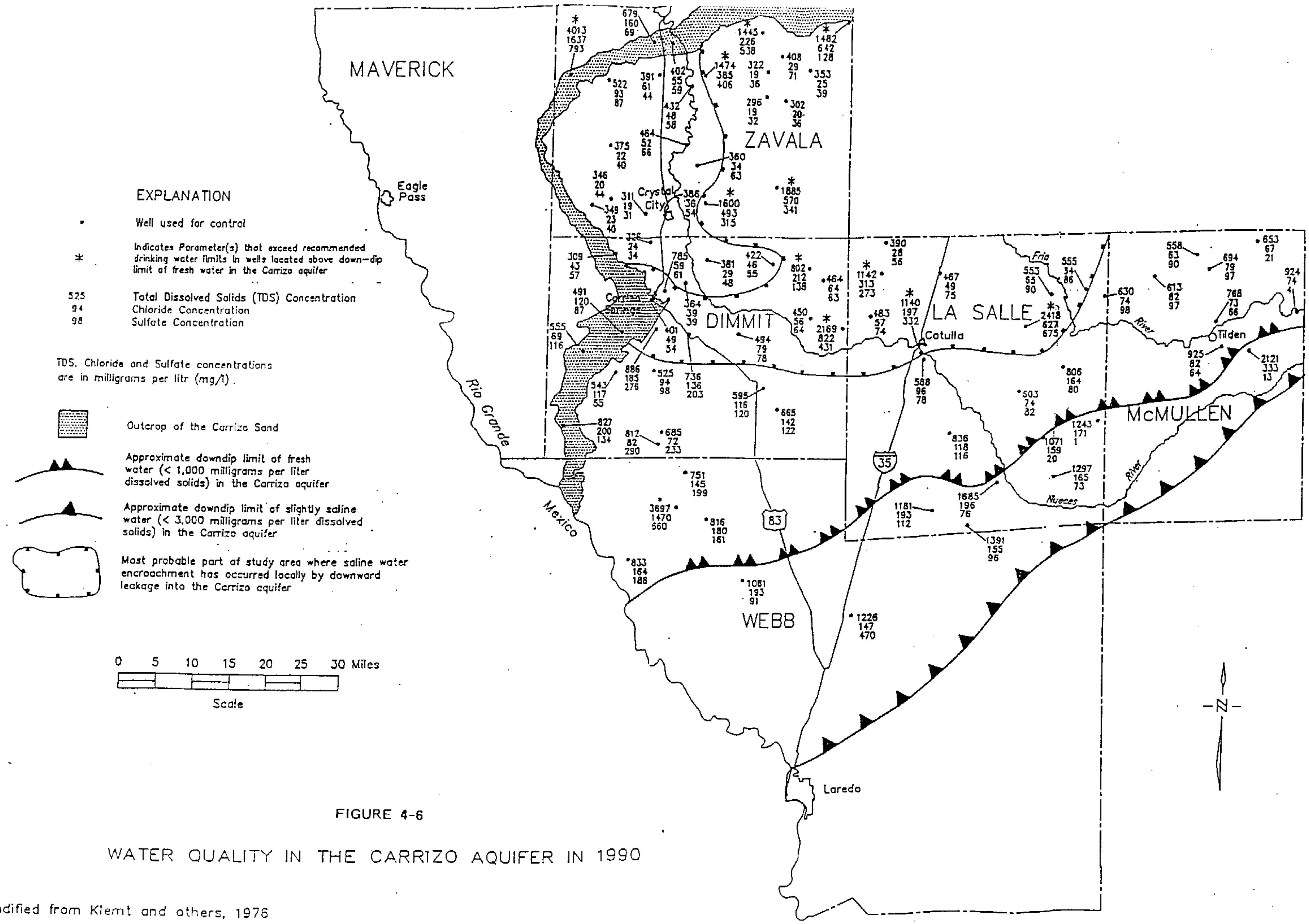


FIGURE 4-6

WATER QUALITY IN THE CARRIZO AQUIFER IN 1990

Modified from Klemt and others, 1976

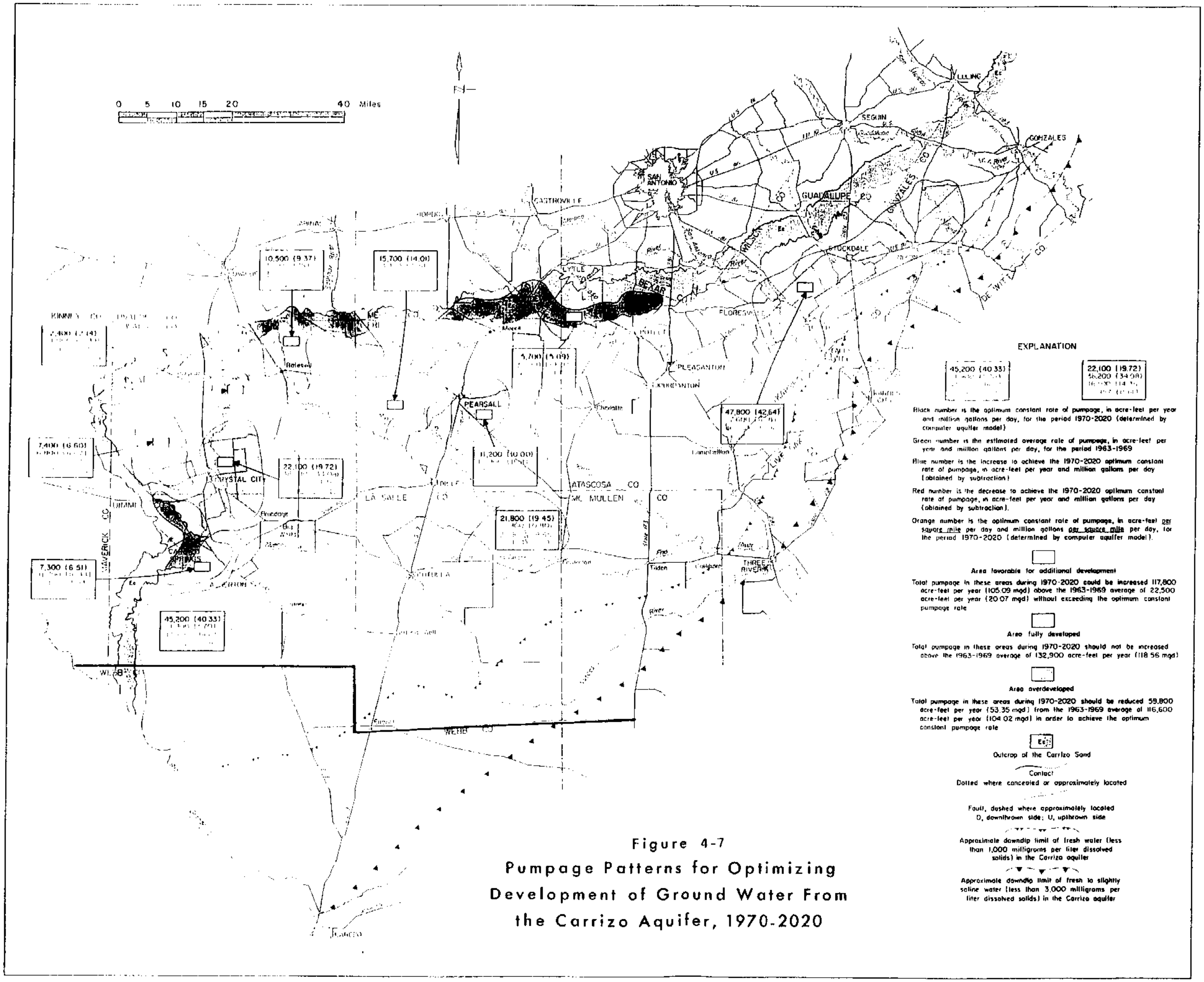


Figure 4-7
Pumpage Patterns for Optimizing Development of Ground Water From the Carrizo Aquifer, 1970-2020

4.5.2 Gulf Coast Aquifers

Aquifer regions in Starr County have been mapped by TWDB and compiled in TWDB Report 316, *Evaluation of Groundwater Resources in the Lower Rio Grande Valley*, by T. Wes McCoy, January 1990. This report shows that the Lower Rio Grande is composed of two major geologic settings: 1) the Eocene-to-Pleistocene age Gulf Coast sediments that extend throughout the Texas Gulf Coast; and 2) the alluvial Rio Grande sediments that overlay the older Gulf Coast sediments. Illustration of this geology is presented in table 4-6.

The important aquifers in Starr County include the Oakville Sandstone, which is an undifferentiated Miocene formation that outcrops in northwestern Hidalgo County and eastern Starr County, and the Chicot Aquifer, which consists of Quaternary-age alluvial deposits of the Rio Grande. Average production for wells in the Oakville Sandstone is 120gpm, with average transmissivity at 6,850 gpd/ft (McCoy, 1990 *op.cit.*). Geophysical logs presented in the same report (Figures 4-8 and 4-9) show that there are several fresh-to-slightly saline sands in the aquifers that occur principally in Starr County within the Oakville Sandstone.

Groundwater quality is generally poor within the Oakville Sandstone and alluvial deposits. TDS concentrations generally exceed 1,000 mg/L and often exceed 3,000 mg/L. Additionally, chloride and sulfate concentrations often exceed the TNRCC recommended drinking water standards. There also appears to be elevated concentrations of Calcium, Magnesium, and Sodium with counterpart elevated concentrations for bicarbonate, sulfate, and chloride. (McCoy, 1990, *op.cit.*).

4.5.3 Rio Grande Alluvium

In its report to the Lower Rio Grande Valley Development Council (*Integrated Water Plan, Phase 1*), Turner Collie and Braden reported that groundwater was produced from Rio Grande Alluvium up to 5 miles north of the river. It also reported that since the river quality is better than groundwater quality, and since groundwater quality declined with increasing distances from the river, the river was essentially responsible for recharging the alluvium. The Alluvium was divided into three zones: a shallow zone (less than 75 feet in depth); middle zone (75 to150 feet in depth), and lower zone (150 feet to 225 feet in depth). Decades of irrigation and use of irrigation drainage wells was reported responsible for high TDS with high concentrations of nitrate in the shallow groundwater. A citation to Preston, 1983 reported that the best quality groundwater was in the lower zone.

4.5.4 Potential for Groundwater Development

McCoy identified the Oakville Sandstone in Starr County as a potential site for additional water development but cautioned against the potential problems with sulfate concentrations exceeding recommend drinking water limits of 300 mg/L. Certainly, the abundance of water, despite its poor quality offers the potential for augmenting source for surface water when demineralized. The cost to render the water acceptable for potable use will become attractive at a time when either a blending or complete treatment scheme is cost effective and/or a necessary safeguard to ensure adequate water supply is available.

Klemt, et.al. suggested that the pumpage from the Carrizo aquifer could be 117,800 ac-ft/yr in the Winter Garden area without exceeding the optimum maximum pumpage rate predicted by the TWDB model. This model used specified water-level decline criteria to demonstrate the ability of the aquifer to meet projected groundwater withdrawals through the year 2020. The model did not permit water levels to drop more than 400 feet below the land surface or the top of the Carrizo aquifer. However, for the model to meet these specified water-level decline criteria, groundwater withdrawals imposed in the model had to be manipulated in a manner that did not reflect actual conditions. The resulting predictions of available water were probably exaggerated (*TWDB Report 334 Evaluation of the Groundwater Resources of the Western Portion of the Winter Garden Area,* Texas, by T. Wes McCoy, October 1991). McCoy also mentioned that the potential for conjunctive use "was only a possibility on a limited, localized scale" due to the absence of a major (surface) water supply. The context of his statement regarding "lack of a major surface water supply was applicable to Zavala, Dimmit, La Salle, and the north central portions of Webb county, not to the border region. More realistic yields from wells in the Carrizo formation within Webb County appear to be approximately 650-700 ac-ft/year based on reported groundwater pumping for Webb County through the period 1980-85 (see excerpt table 3 from TWDB Report 334, op.cit., presented herein as table 4-7). One cautionary note: do not attempt to compare the water use numbers of this table with the overall water use numbers reported by the TWDB by county and water use sector. They will not match. The water use numbers reported in table 4-7 refer specifically to Report 334 study area which includes subareas of of the Carrizo Wilcox aquifer and supporting surface water conveyances in Maverick, Webb, and Zavala Counties.

Table 4-6 – Stratigraphic and Hydrologic Section of the Lower Rio Grande Valley Area

Era	System	Series	Stratigraphic Units	Character of material	Hydrologic Units	Water-Bearing Characteristics*
CENOZOIC	Quaternary	**Recent**	Alluvium	Sand and silt	Chicot Aquifer	Yields moderate to large quantities of fresh to slightly saline water near the Rio Grande in Cameron and Hidalgo Counties.
		Pleistocene	Fluviatile Terrace Deposits	Gravel, and silt and clay.		
			Beaumont Foundation	Mostly clay with some sand and silt.		Yields moderate to large quantities of fresh to moderately saline water.
			Lissie Formation	Clay, silt, sand, gravel, and caliche		
	Tertiary	**Pleistocene Or Pliocene**	Uvalde Gravel	Chert, occurs as terrace gravel in western Starr County	Evangeline Aquifer	Yield moderate to large quantities of fresh to slightly saline water.
		Pliocene	Goliad Formation	Clay, sand, sandstone, marl, caliche, limestone, and conglomerate.		
		Miocene	Miocene Formations Undifferentiated	Mudstone, claystone, sandstone, tuff, and clay.		Yields moderate quantities of slightly to moderately saline water in northwestern Hidalgo and eastern Starr Counties.
		Eocene	Eocene Formations Undifferentiated	Sandstone and clay.		Yields small quantities of slightly to moderately saline water.

* Yields of wells: small =<50 gallons per minute; moderate = 50 to 500 gallons per minute; large =>500 gallons per minute.
Chemical Quality of Water: fresh =<1,000 milligrams per liter (mg/l); slightly saline = 1,000 to 3,000 mg/l; moderately saline = 3,000 to 10,000 mg/l.

Table 4-7

Historical (from 1980) and Projected (from 1990) Water Use by Use Categories[1*] (In Acre-Feet)

County	Year	Public Supply Ground	Public Supply Surface	Irrigation Ground	Irrigation Surface	Other[2] Ground	Other[2] Surface	Totals Ground	Totals Surface
Dimmit	1980	2,779	0	19,051	4,305	1,433	125	23,263	4,430
	1985	2,212	0	20,821	1,462	1,384	157	24,417	1,619
	1990	*2,803		*16,800		*1,715		*21,318	
	2000	*3,342		*15,120		*1,897		*20,359	
	2010	*3,892		*14,168		*2,029		*20,089	
La Salle	1980	998	0	10,759	2,604	181	719	11,938	3,323
	1985	996	0	3,003	583	74	943	4,073	1,526
	1990	*1,099		*8,400		*1,064		*10,568	
	2000	*1,212		*7,560		*1,238		*10,010	
	2010	*1,303		*7,084		*1,238		* 9,625	
Maverick	1980	19	0	2,240	0	132	34	2,341	34
	1985	21	0	1,500	0	162	29	1,681	29
	1990	*22		*356		*197		*575	
	2000	*23		*362		*228		*633	
	2010	*24		*396		*228		*648	
McMullen	1980	78	0	0	0	512	593	590	593
	1985	129	0	0	0	457	282	586	282
	1990	*156		*0		*1,187		*1,343	
	2000	*162		*0		*1,270		*1,432	
	2010	*163		*0		*1,281		*1,444	
Webb	1980	198	985	0	11,616	132	1,171	330	13,772
	1985	229	1,783	0	3,520	114	1,037	343	6,340
	1990	*1,878		*5,376		*1,549		*8,803	
	2000	*2,302		*4,838		*1,795		*8,935	
	2010	*2,526		*4,534		*1,795		*8,855	
Zavala	1980	2,068	0	81,800	25,070	1,518	793	85,386	25,863
	1985	2,154	0	94,200	5,454	1,130	1,018	97,484	6,472
	1990	*2,547		*85,200		*2,551		*90,298	
	2000	*2,799		*76,680		*3,064		*82,542	
	2010	*2,900		*71,852		*3,351		*78,103	
Totals	1980	6,140	985	113,850	43,595	3,908	3,435	123,898	48,015
	1985	5,741	1,783	119,524	11,019	3,321	3,466	128,586	16,268
	1990	*8,505		*116,132		*8,268		*132,905	
	2000	*9,840		*104,580		*9,492		*123,912	
	2010	*10,808		* 98,034		*9,922		*118,764	

1–Water use for the years 1980 and 1985 are based on reported and site–specific computed use.
*–Water use for the years 1990, 2000, and 2010 are based on 1989 Texas Water Development Board Revised High Series projections used in the 1990 Texas Water Plan update. Projections do not separate ground–water and surface water use.
2–Other includes manufacturing, mining, and livestock uses.

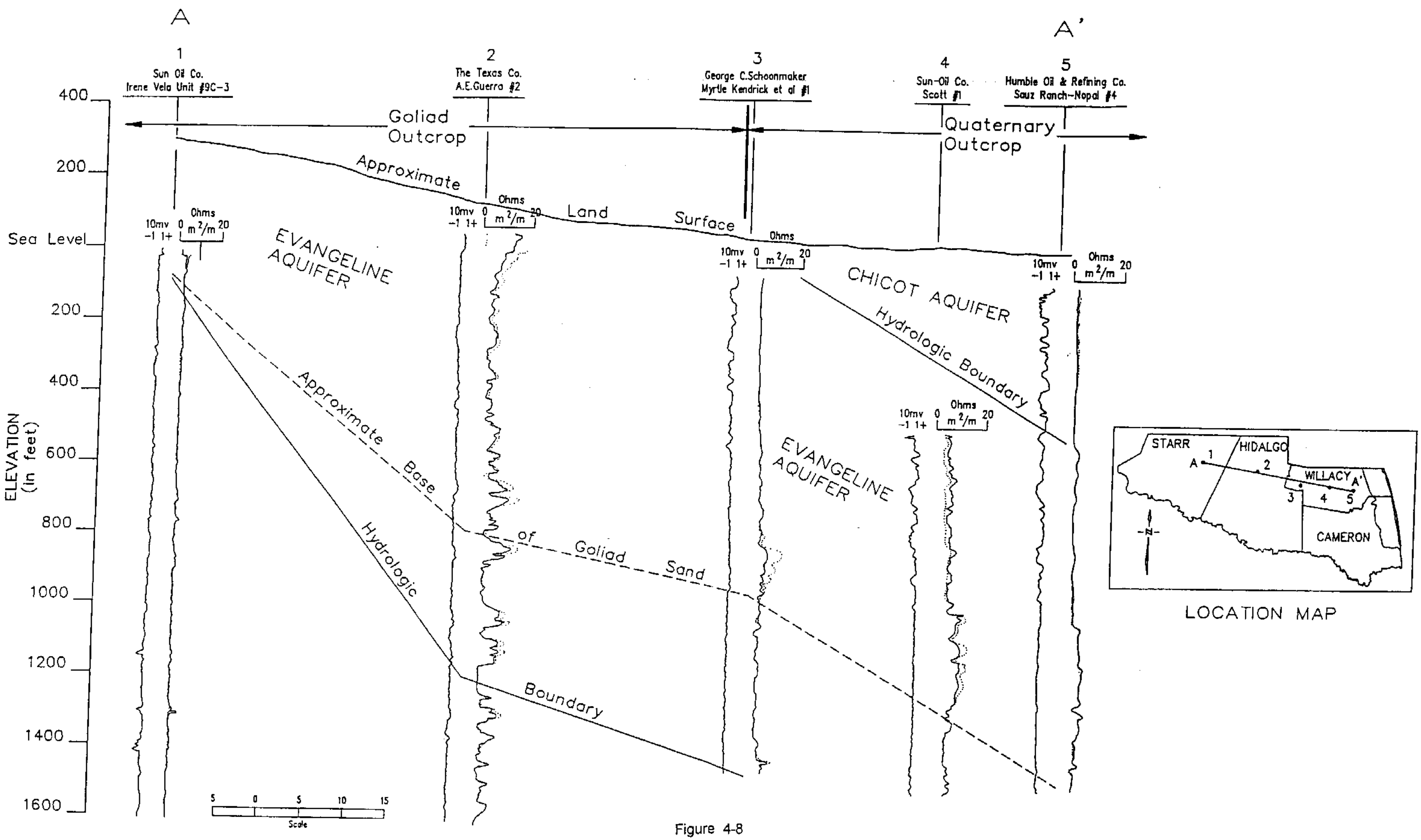


Figure 4-8

STRATIGRAPHIC CROSS-SECTION A-A'
LOWER RIO GRANDE VALLEY

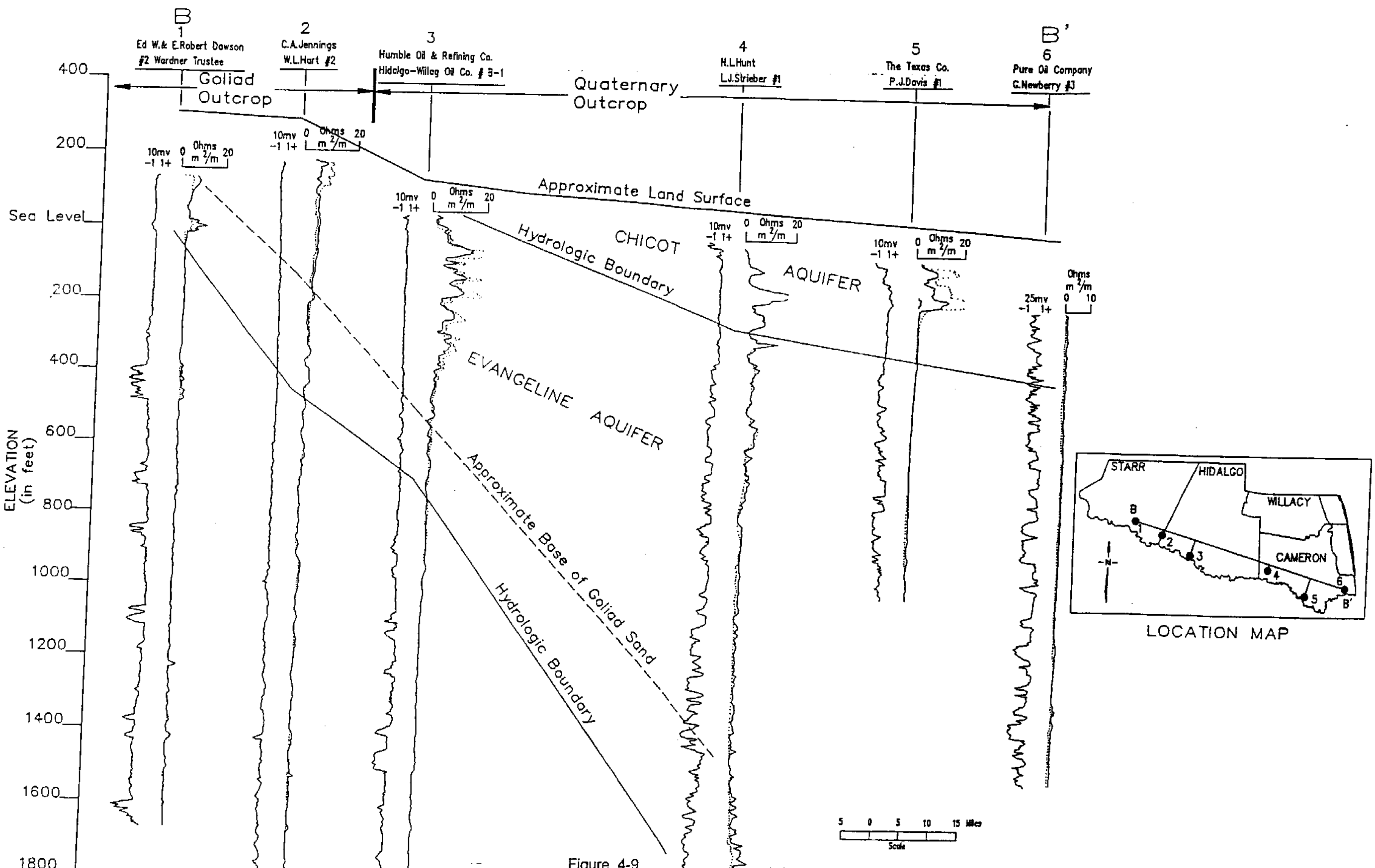


Figure 4-9

STRATIGRAPHIC CROSS-SECTION B-B'
LOWER RIO GRANDE VALLEY

The limitations on potential groundwater development in Webb County are not limited to the Carrizo aquifer. Water from the Wilcox aquifer is suitable for irrigation use, but since the Wilcox aquifer occurs at a greater depth downdip of its outcrop area than the Carrizo, it is generally not used. Low transmission capacities, coupled with generally high Salt Adsorption Ratios, and a high salinity combine to preclude any major development of groundwater from either the Bigford, Queen City, Laredo, or Sparta aquifers (McCoy, 1991).

Potential means of increasing recharge to the Carrizo aquifer include water catchment structures on the outcrop area, injection wells, and brush clearing. Artificial recharge has been attempted in pilot studies by Klemt, et. al. 1976. However, mechanics of avoiding siltation effects, entrained air, and algal influences, must be evaluated and remedied before adoption of a full-scale program. Further research in this arena is required. In terms of brush clearing, Hoffman (1967), Rechenthin, and Smith (1967) found that a mesquite stand shading 50% of the soil used nine inches per month during the growing season. Replacement of such species through restoration of natural grasslands would promote conservation of available soil moisture and consequent deep percolation to aquifers. However, such a strategy would likely involve evaluation of impacts to species diversity in the area. The US Bureau of Reclamation (*op.cit., December 1995*) cited USFWS concerns and desires for increased regulations regarding reductions in habitat as a consequence of brush clearing for agricultural purposes. Lake Casa Blanca

4.6 Lake Casa Blanca

Although not available to the entire STDC region, Lake Casa Blanca, constructed by Webb County, provides a significant source of water for the City of Laredo and Webb County. The lake impounds flows from Chacon Creek in Webb County and has been permitted with the TNRCC. The impoundment is operated under TNRCC permit No. 3115, application number A2858, and has been determined safe enough to pass the probable maximum flood under the National Dam Safety program, inventory number 2267. The impoundment holds 90,357 ac-ft at its maximum capacity at elevation 470 and about 20,000 ac-ft at its conservation pool elevation. The impoundment' elevation-area-capacity curve, as used during the dam safety analysis is provided in table 4-8.

Table 8
Lake Casa Blanca Reservoir Characteristics

Elevation (Ft MSL)	Capacity (Ac-Ft)	Area (Acres)
400	0	0
410	250	25
415	560	85
420	1190	194
425	2,350	270
430	3,900	374
435	6,400	672
440	10,080	1,100
445	17,300	1,530
450	26,300	1,980
455	37,663	2,525
460	51,983	3,163
465	69,491	3,840
470	90,359	4,507

The capacity of this reservoir is significant in that it comprises about 59% of the total municipal consumption of water by the City of Laredo in 1995. This water use includes non-potable functions such as yard watering, water main breaks, leaks, etc. Therefore, if this source were used exclusively as a potable water source during a period of extreme drought, its value would lie in isolating its use to a strictly potable water resource.

4.7 Treated Water Supply

A list of public water supply entities located within the STDC was obtained from the TNRCC. Table 4-8 provides this list, organized by treatment system type and then by County. This table indicates a total of 31 water supply facilities. Twenty of these facilities are classified as community water systems, four are classified as non-community water systems, and seven are classified as non-community, non-transient water systems.

Table 4-9

Public Water System Identification List

County	PWS ID	Treatment Objective	Water Source	Source Code	Number of Wells	System Name	Owner Type	Service Area	Public Water Supply Type	Interstate Carrier	Retail Population	Retail Connections	Number of Meters	Interconnections with Other Systems	Average Temp	Production Capacity (MGD)	Average Daily Consumption	Total Storage (MG)	Elevated Storage (MG)	Booster Pump Capacity (MGD)	Pressure Tank Capacity (MG)	Auxiliary Production Capacity (MGD)	Deficiency Score	Activity Code
Community Water Supply Systems																								
JIM HOGG	1240001	D	GCA	G	1	JIM HOGG COUNTY WCID NO 2	4	R1	C	N	4500	1747	1682	0	82.7	1.224	0.602	1.75	0.25	4.78	0	0	20	A
JIM HOGG	1240001	D	GCA	G	1	JIM HOGG COUNTY WCID NO 2	4	R1	C	N	4500	1747	1682	0	82.7	1.224	0.602	1.75	0.25	4.78	0	0	20	A
STARR	2140003	D	RGR	S	0	FALCON RURAL WATER SUPPLY CORP	5	R1	C	N	3120	1040	885	0	83.8	0.72	0.333	0.325	0.083	2.304	0	0.007	3	A
STARR	2140004	D	RGR	S	0	UNION WATER SUPPLY CORPORATION	4	R1	C	N	4857	1619	1321	1	83.8	2.364	0.399	0.483	0.25	5.328	0	0	3	A
STARR	2140006	D	RGR	S	0	LA GRULLA CITY OF	4	R1	C	N	4344	148	1448	1	83.8	2.004	0.726	0.827	0.351	2.88	0	0	0	A
STARR	2140007	D	RGR	S	0	ROMA CITY OF	4	R1	C	N	14100	4700	4685	0	83.8	2.64	2.13	1.158	0.5	6.638	0	0.008	4	A
STARR	2140016	Z	RGR	P	0	RIO WATER SUPPLY CORPORATION	5	R1	C	N	1860	620	620	0	83.8	0.432	0.264	0.043	0	0.648	0	0.003	3	A
STARR	2140018	T	RGR	S	0	STARR COUNTY WCID NO 2	4	R1	C	N	12594	4198	4198	0	83.8	3.519	2.164	4.49	0.45	8.928	0	0	3	A
STARR	2140028	N	RGR	P	0	EL SAUZ WATER SUPPLY CORPORATION	5	R1	C	N	1252	302	302	0	83.8	0	0.112	0.15	0.05	0.288	0	0	0	A
STARR	2140029	D	RGR	P	0	EL TANQUE WATER SUPPLY CORPORATION	4	R1	C	N	999	333	333	0	0	0	0.123	0.299	0.045	0.684	0.468	0	0	A
WEBB	2400001	T	RGR	S	0	LAREDO CITY OF	4	R1	C	N	160000	37583	36420	0	81.5	60.48	35.2	35.16	9	132.3	0	0.02	3	A
WEBB	2400003	D	CW	G	3	BRUNI RURAL WATER SUPPLY CORP	5	R1	C	N	363	106	106	0	81.5	0.144	0.028	0.178	0	0	0	0.0026	12	A
WEBB	2400006	D	CW	G	4	OILTON RURAL WATER SUPPLY CORP	5	R1	C	N	400	110	110	0	81.5	0.048	0.04	0.1	0	0.288	0	0.0025	14	A
WEBB	2400022	D	RGR	S	0	WEBB COUNTY WATER UTILITIES	4	R1	C	N	4794	1598	1598	0	0	1.865	0.836	0.56	0.11	4.32	0	0.005	4	A
WEBB	2400025	D	CW	W	0	MIRANDO CITY WATER SUPPLY CORP	5	R1	C	N	460	210	210	0	0	0	0.12	0.193	0.193	0	0	0	11	A
ZAPATA	2530002	D	FL	S	0	ZAPATA COUNTY WATERWORKS	4	R1	C	N	9000	3100	2800	0	85	3.024	1.407	2.494	1.49	3.372	2.088	0	7	A
ZAPATA	2530003	D	RGR	S	0	SAN YGNACIO MUNCIPAL UTILITY DIST	4	R1	C	N	933	311	311	0	85	0.864	0.152	0.545	0.21	0.144	0	0	0	A
ZAPATA	2530004	D	FL	S	0	SIESTA SHORES WCID	2	R1	C	N	1250	472	472	0	85	0.504	0.126	0.164	0	1.44	0	0.008	7	A
ZAPATA	2530022	D	RGR	P	0	RAMIRENO WATER SUPPLY CORPORATION	5	R1	C	N	70	56	56	0	85	0	0.015	0.039	0.039	0	0	0	0	A
ZAPATA	2530023	D	FL	P	0	ZAPATA COUNTY WCID 16E	4	R1	C	N	35	110	110	0	0	0	0.04	0.065	0	0.72	0	0.005	3	A
Non-community Water Supply Systems																								
STARR	2140025		RGR	P	0	FALCON STATE RECREATION AREA	3	T1	N	N	150	150	0	0	0	0.144	0.013	0.04	0	0.144	0	0.0023	3	A
WEBB	2400024	D	CW	G	1	EL PRIMERO TRAINING CENTER	2	R2	N	N	44	16	0	0	0	0.058	-0.001	0.025	0	0.086	0	0.0005	14	A
ZAPATA	2530017	P	FL	S	0	COX CAMP	2	T1	N	N	25	38	0	0	85	0.024	0.001	0.002	0	0.086	0	0.0003	18	A
ZAPATA	2530024	D	FL	S	0	TWIN COVE MOBILE HOME & RV PARK	2	R2	N	N	10	40	0	0	0	-0.001	-0.001	0	0	0	0	4E-05	119	A
Non-Transient, Non-Community Water Supply Systems																								
STARR	2140002	D	FL	S	0	FALCON VILLAGE	1	R1	P	N	41	39	39	0	83.8	0.35	0.055	0.25	0.1	0.684	0	0	0	A
STARR	2140017	D	GCA	G	2	SAN ISIDRO INDEPENDENT SCHOOL DIST	4	S1	P	N	430	12	0	0	83.8	0.288	0.013	0.05	0	0.288	0	0.002	6	A
STARR	2140031	D	RGR	P	0	STARR COUNTY MEMORIAL HOSPITAL	4	S2	P	N	100	10	1	0	0	0.173	0.04	0.064	0	0.173	0	0.001	0	A
STARR	2140032	N	RGR	P	0	LOCKHEED MARTIN-USAF AEROSTAT SITE	1	S2	P	N	31	2	0	0	0	0	0	0.002	0	0.029	0	0.0002	7	A
WEBB	2400009	D	CW	G	1	WEBB CONSOLIDATED SCHOOLS - BRUNI	4	S1	P	N	250	25	0	0	81.5	0.129	0.007	0.021	0	0.203	0	0.0005	18	A
WEBB	2400009	D	CW	G	1	WEBB CONSOLIDATED SCHOOLS - BRUNI	4	S1	P	N	250	25	0	0	81.5	0.129	0.007	0.021	0	0.203	0	0.0005	18	A
WEBB	2400023	D	CW	W	0	WEBB CONSOLIDATED SCHOOLS - OILTON	4	S1	P	N	160	16	1	0	0	0.072	0.003	0.001	0	0.072	0	3E-05	3	A
																82.42								

GCA = Gulf Coast Aquifer
RGR = Rio Grande River
CW = Carrizo-Wilcox Formation
FL = Falcon Lake

Section 5.0 Water Related Problems, Practices, Needs and Alternatives

This section analyzes the information of the previous sections, and outlines the path forward to evaluate how best to secure the water supply needed for the next 50 years. The remainder of this section presents a summary of water related problems, current projects and practices in the region, common options available to meet water demand, potential alternatives, and the proposed phase II scope of work.

5.1 Water Related Problems

This section presents a summary of water related problems in the STDC region. Problems associated with water demand versus supply are presented in section 5.1.1. Associated environmental concerns including water quality are presented in section 5.1.2. Additional issues presented in sections 5.1.3 through 5.1.6 include drought effects, Mexico's influence, institutional constraints, and socioeconomic conditions. Last, stakeholder perceptions of water related problems and problems with utility operations are outlined in sections 5.1.7 and 5.1.8, respectively.

5.1.1 Water demand versus water supply

This section addresses the issue of available water demand versus water supply for the planning region. The analysis is presented for municipal/industrial and irrigation sector demands, the two principal uses in the region. The demand and supply figures are based on demand forecasts that already include conservation measures as discussed in section 3.

5.1.1.1 Municipal and Industrial (M&I) Use

This section evaluates the potential problems with meeting municipal and industrial (M&I) demands by comparing demands versus currently available water rights, existing supplies and treatment capacities. The M&I sector demands estimated by the TWDB were adjusted to account for the observed difference between the sum of the sector demands and the consensus totals presented in section 4. The adjustment was performed by taking the unadjusted sector demands in table 3.6 and multiplying each by the ratio of the consensus total to the unadjusted sum of the individual sectors.

M&I demand versus water rights

The relationship between STDC demands and existing M&I water rights in the region and by county are given in Tables 5-1 and 5-2, respectively. As indicated in Table 5-1 below, the annual M&I demand in the STDC region is expected to grow from about 44,300 ac-ft in 1990 to approximately 154,000 ac-ft in 2050. The M&I water rights in the region total approximately 53,000 ac-ft. In the absence of additional water rights, the aggregate STDC M&I demand will exceed available water rights before the year 2000. The excess demand will grow from about 13,000 ac-ft in 2000, which represents a 20% deficit, to over a 65% deficit in the year 2050.

Table 5-1
STDC M&I Demand versus Water Rights (Ac-ft)

Year	M&I Demand	M&I Rights	Excess Demand	% Demand Deficit
1990	44,323	52,725		
2000	65,720	52,725	12,995	20%
2010	83,355	52,725	30,630	37%
2020	100,250	52,725	47,525	47%
2030	129,463	52,725	76,737	59%
2040	139,747	52,725	87,022	62%
2050	153,889	52,725	101,164	66%

The pattern of M&I demand exceeding currently available water rights is repeated at the county level as shown in Table 5-2. In 1990, Jim Hogg and Starr County's water rights allocation exceeded M&I demand (Jim Hogg County has no surface water rights). The largest demand occurs in Webb County and accounts for over 75% of the total demand in the region. By the year 2050, Webb County's current water rights would meet approximately 40% of the M&I demand; while Starr County's and Zapata County's water rights would meet less than 20% of its demand.

Table 5-2
M&I Demands versus Water Rights by STDC County (Ac-ft)

	Webb County		Zapata County		Jim Hogg County		Starr County	
Year	**M&I Demand**	**M&I Rights**	**M&I Demand**	**M&I Rights**	**M&I Demand**	**M&I Rights**	**M&I Demand**	**M&I Rights**
1990	36,037	45,717	1,852	2,445	293	-	6,126	4,564
2000	52,314	45,717	3,568	2,445	734	-	9,247	4,564
2010	66,097	45,717	4,835	2,445	810	-	11,775	4,564
2020	77,106	45,717	6,112	2,445	894	-	14,990	4,564
2030	99,686	45,717	8,062	2,445	969	-	19,781	4,564
2040	104,284	45,717	10,839	2,445	1,013	-	22,676	4,564
2050	112,104	45,717	14,738	2,445	1,066	-	25,162	4,564

M&I Demand versus Existing Surface and Groundwater Supply

Table 5-3 shows the relationship between M&I demand and existing surface and groundwater supplies without regard to treatment capacity or water quality. The surface water supply figure is estimated by taking the Amistad-Falcon firm yield of 1,250,000 ac-ft and allocating it between the STDC and Lower Rio Grande Valley (LRGV) proportionally to the ratio of the STDC M&I demand to the total M&I demand. The table indicates that the total potential available water supply is sufficient to meet the STDC M&I demands until the year 2050 if the needed water rights are available for sale/conversion and are purchased. Surface water supplies are sufficient to meet the future M&I demands without use of groundwater. Ultimately, the optimal sequencing of surface and groundwater resources to meet the M&I demand will depend on a number of factors including relative surface/groundwater quality, transportation costs, and the cost of acquiring additional water rights.

Table 5-3
STDC M&I Demand versus Existing Surface and Groundwater Supplies (Ac-ft)

Year	M&I Demand	Firm Surface Supply	Groundwater Supply	Total Supply
1990	44,323	314,974	56,840	371,814
2000	65,720	321,913	56,840	378,753
2010	83,355	325,405	56,840	382,245
2020	100,250	323,728	56,840	380,568
2030	129,463	355,593	56,840	412,433
2040	139,747	312,960	56,840	369,800
2050	153,889	288,377	56,840	345,217

M&I Demand versus Existing Treatment Capacity

Table 5-4 shows the relationship between M&I demand and existing treatment capacity. The current region-wide treatment capacity is approximately 82.4 MGD of which 62.9 MGD is located in Webb County. The table indicates that excess region-wide treatment capacity is available until approximately the year 2015. Review of the treatment capacity for Webb County shows a similar pattern as indicated in Table 5-5. Given the long lead times associated with capacity expansions, and the regulatory requirements that trigger the planning of expansions prior to reaching capacity, the increases in treatment capacity would be required closer to the year 2000 when M&I demand exceeds approximately 75% of capacity. The costs of treatment will depend on the source water quality and the intended uses. Given the potential for increasing salinity of surface water supplies, the cost of treatment could increase in the future.

Table 5-4
STDC M&I Demand versus
Existing Treatment Capacity (Ac-ft/yr)

Year	M&I Demand	Treatment Capacity	Excess Demand	% Demand Deficit
1990	44,323	92,306	(47,983)	
2000	65,720	92,306	(26,586)	
2010	83,355	92,306	(8,951)	
2020	100,250	92,306	7,944	8%
2030	129,463	92,306	37,156	29%
2040	139,747	92,306	47,441	34%
2050	153,889	92,306	61,583	40%

Table 5-5
Webb County M&I Demand versus
Existing Treatment Capacity (Ac-ft/yr)

Year	M&I Demand	Treatment Capacity	Excess Demand	% Demand Deficit
1990	36,037	70,462	(34,425)	
2000	52,314	70,462	(18,148)	
2010	66,097	70,462	(4,365)	
2020	77,106	70,462	6,644	9%
2030	99,686	70,462	29,224	29%
2040	104,284	70,462	33,822	32%
2050	112,104	70,462	41,642	37%

5.1.1.2 Irrigation Demand

Unlike M&I demands, irrigation demands do not exceed the existing water rights. In fact, there is a significant surplus of irrigation water rights that could be converted to help meet the excess M&I demands in the region. The relationship between irrigation demand and irrigation water rights is presented in Table 5-6. Echoing TWDB assumptions, the table indicates that irrigation demand declines over the 60 year period from 1990 to 2050. There are a number of factors contributing to this decline in irrigation demand. These include a decline in the number and size of farms, and more efficient irrigation systems. Large quantities of excess water rights are projected in Webb and Zapata counties as indicated in Table 5-7. Although Starr County is the largest irrigation water user in the planning area, the excess water rights in Webb and Zapata account for the majority of the excess irrigation water rights in the region.

Table 5-6
STDC Irrigation Demand versus Water Rights (Ac-ft)

Year	Irrigation Demand	Irrigation Rights	Excess Demand	% Irrigation Demand Deficit
1990	53,793	84,651	(30,858)	-57%
2000	53,672	84,651	(30,979)	-58%
2010	51,315	84,651	(33,336)	-65%
2020	49,061	84,651	(35,590)	-73%
2030	46,910	84,651	(37,741)	-80%
2040	44,853	84,651	(39,798)	-89%
2050	42,887	84,651	(41,764)	-97%

Table 5-7
Irrigation Demands versus Water Rights by STDC County(Ac-ft)

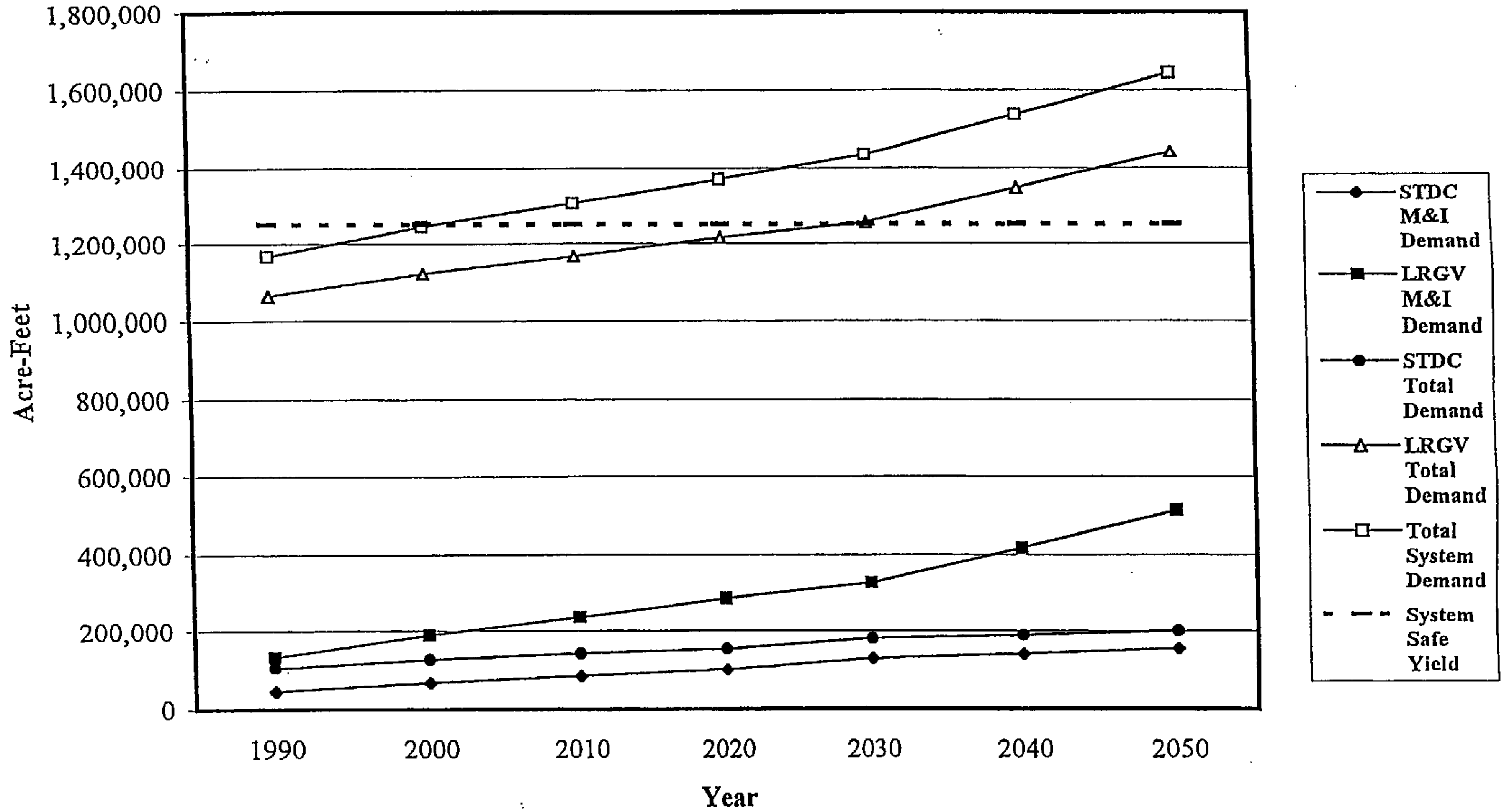
Year	Webb County		Zapata County		Jim Hogg County		Starr County	
	Irrigation Demand	Irrigation Rights	Irrigation Demand	Irrigation Rights	Irrigation Demand	Irrigation Rights	Irrigation Demand	Irrigation Rights
1990	5,980	29,071	2,229	10,386	150	-	45,434	45,195
2000	5,639	29,071	2,117	10,386	145	-	45,771	45,195
2010	5,318	29,071	2,011	10,386	141	-	43,845	45,195
2020	5,014	29,071	1,911	10,386	136	-	42,000	45,195
2030	4,729	29,071	1,815	10,386	132	-	40,234	45,195
2040	4,459	29,071	1,724	10,386	128	-	38,542	45,195
2050	4,205	29,071	1,638	10,386	124	-	36,920	45,195

Having irrigation water rights, however, does not guarantee the availability of the supply. The Amistad-Falcon system is currently over-appropriated. Water rights below Amistad exceed the system firm yield (1,250,000 ac-ft) by over 900,000 acre-ft. Even if the irrigation water rights exist, the surface supply may not be available. Figure 5-1 illustrates the relationship between total water demand in the region, including the LRGV, versus existing surface water supplies. The figure indicates that the total water demand starts to exceed the system firm yield by the year 2000. The total LRGV demand itself starts to exceed the system firm yield around the year 2030. This is even more of a concern since the graph does not include the demands of the region above the STDC and below Amistad.

To assess the impact of the system over-appropriation on the STDC irrigation sector, an estimate was made of available surface and groundwater irrigation supplies. The available irrigation surface supply in the STDC region was approximated by taking the difference between the LRGV and STDC M&I demands from the system firm yield, and multiplying the difference by the ratio of the total existing irrigation rights in the STDC region and the total existing irrigation rights below Amistad. The results are presented in Table 5-8. The table indicates that the surface supply by itself is inadequate to meet the irrigation demands. This result is conservative, as the municipal demands of the region above STDC and below Amistad were not included. The total supply, however, assuming that the groundwater is available and of appropriate quality, would be sufficient to meet the irrigation demand through the planning period.

It should be noted that estimate of available surface supply for irrigation is at best an approximation given the complex factors involved. It is presented only for the purposes of providing a broad indication of the potential shortfalls in the irrigation

Figure 5-1
STDC/LRGV Region
Demands versus System Firm Yield



sector in the STDC region. Additionally, the firm yield estimate, which was based on the drought of record in the 1950's, may overestimate the firm yield. Influences that could effectively reduce this estimate include increasing hydrologic controls in Mexico (more dams constructed since the 1950s), increasing per capita water use by Mexican citizenry, and the increased heat (and consequent increases in evaporation and increased salinity) that might result from climatic changes through the planning period.

Table 5-8
STDC Irrigation Demand versus Existing Surface and Groundwater Supplies (Ac-ft)

Year	Irrigation Demand	Est. Surface Supply Available for Irrigation	Groundwater Supply	Total Supply
1990	53,793	48,507	56,840	105,347
2000	53,672	44,926	56,840	101,766
2010	51,315	41,990	56,840	98,830
2020	49,061	38,969	56,840	95,809
2030	46,910	35,898	56,840	92,738
2040	44,853	31,243	56,840	88,083
2050	42,887	26,326	56,840	83,166

5.1.2 Environmental Issues

5.1.2.1 Water Quality

The water quality of the Rio Grande Basin has been studied extensively in recent years to assess concentrations of salts, conventional pollutants, and toxics. Findings related to salinity and toxic materials are material to this report. Past data has indicated increasing levels of fecal coliform as an indicator of declining water quality. However, through the construction of new wastewater treatment facilities in Nuevo Laredo, as well as active programs for wastewater treatment improvements administered by the Border Environmental Cooperation Commission, these influences are not considered to be of long term significance.

Salinity

The Texas Natural Resources Conservation Commission and its predecessor agency the Texas Water Commission completed intensive salt balance studies in 1988 and (with cooperation with IBWC and CNA) in 1993. These studies were incorporated into analyses by Miyamoto, Fenn, and Swietlik, (*Flow, Salts, and Trace Elements in the Rio Grande*, TR-169, July 1995). This report found that the salt load to the Amistad Reservoir was approximately 1.84 million tons per year (based on 1969-1989 data from IBWC). The saline flow from Fort Quitman and the Pecos River was found to contribute 48% of the salt load while delivering only 21% of the flow. Salinity levels were observed to be increasing due to the specific influences of the Pecos River, Rio Salado, and tailwater from Fort Quitman. These three water sources were found to contribute 50% of the salt load and only 26% of the Texas/Mexico flow in the Rio Grande River.

The report observed that due to these salinity loads, concentrating effects of evaporation, and low flow contributions from non-point sources, the salinity levels of the Rio Grande were increasing (not in equilibrium). Furthermore, the salinity levels in Amistad Reservoir were estimated to double from their 1969 levels by the year 2004 (increasing at a rate of 15 mg/L per year), with Falcon Reservoir concentrations reaching 885 mg/L by the year 2000.

This report relied on data observed before the existing drought and after the drought of record occurring during the 1950s. Implicitly, it can be assumed that the salt load has only increased with continued low flows to this reservoir system. Also, evidence of a non-equilibrium state for salinity concentrations suggests increasing costs for water treatment and counterpart lowered yields for certain types of crops (e.g. citrus).

Toxics

The TNRCC has participated in a Binational Toxic Substances Study of the Rio Grande River and is currently authoring a technical report covering the study's results. This study, conducted by TNRCC, IBWC, and CNA, utilized regulatory screening levels for protection of aquatic life, human health, toxic concentrations considered for federal criteria and other criteria to screen water samples collected from the Rio Grande. Appendix B of the 1996 "Regional Assessment of Water Quality in the Rio Grande Basin" included a preliminary summary table of findings from the toxics study. This table included evaluations for water, sediment, and fish tissue. The water portion of the table could relate to impacts to both drinking water supply as well as impacts to aquatic life. Detected sample concentrations of evaluated constituents found below the screening level were not reported in the appendix. Sites showing a high potential for causing toxic chemical impacts to the STDC region's water supply are listed below in table 5-9 along with the constituents of concern.

Table 5-9
Potential Constituents of Concern for Drinking Water

Site Number	Description	Parameter Class	Paramter
10a	Manadas Creek, Laredo	Metals	Antimony, Thallium
11a	Zacate Creek, Laredo	Metals	Selenium
11c	Arroyo el Coyote, Nuevo Laredo	Metals Organics Other	Arsenic, Selenium Bis(2-ethylhexyl) pthalate Unionized Ammonia
12	Rio Grande, Laredo/Nuevo Laredo	Metals	Silver

Tabulated results suggest that the public water supply could be threatened if detected constituents were found in sufficiently high concentrations. However, the table did not include the specific concentrations and included unionized ammonia. Typically, unionized ammonia has implications for aquatic wildlife viability and not human health. This fact suggests that the data may have more relevance to aquatic life than drinking water supply. Given the absence of details available for these results, it is recommended that a copy of the future report from TNRCC regarding the toxics study be acquired to secure needed clarification regarding how to react to this data.

5.1.2.2 Safe Drinking Water Act Impacts

Published data from 1994 *Assessment of Water Quality in the Rio Grande Basin*, TNRCC AS-34, October 1994 (predecessor document to the 1996 assessment referenced last section), showed definitive impacts to public water supply systems at Webb County CSD-Bruni and Bruni Water Works, PWS ID 2400009, and 2400003, respectively. The drinking water of these two utilities was found to exceed the maximum contaminant level for arsenic. The report also implied that sources of bromide within the basin could be problematic for compliance with Safe Drinking Water Act rules for disinfection by-product controls. Candidate sources for bromide were listed as saline seeps and hot springs, oil field wastes, pesticides, fertilizers, and wastewater discharges.

Regulation of disinfection by-products in water plants is in evolution. Based on published EPA schedules for implementation of regulations, public water systems will have to control carcinogenic and mutagenic disinfection by-products (DDBPs) formation in water plants. One of the most effective means for controlling formation of these substances in water plants is to control the quality of source water to reduce or eliminate precursor materials in the raw water feed. Sources of precursor materials include decaying organic matter from detritus, free chlorine, and relatively high levels of organic matter in wastewater discharges.

Secondary drinking water standards, which include limitations for chloride and sulfate salts, were also identified as a challenge within the STDC area. The most problematic sources were in shallow water wells utilized by smaller public water supply systems. Although dropped in 1994, the promulgation of primary sulfate drinking water standards would (eventually) impact the treatment required in such systems.

5.1.2.3 Endangered Species

The U.S. Fish and Wildlife Service (USFWS) recently issued a Recovery Plan for the endangered Rio Grande Silvery Minnow (RGSM) (USFWS, January 1998 [Draft]). One of the primary objectives of the Recovery Plan is to re-establish the RGSM in at least three areas of its historic range.

The RGSM was historically found throughout the Rio Grande and Pecos Rivers, but is currently found only in the Middle Rio Grande reach of New Mexico. In the Recovery Plan, the USFWS partitioned the Rio Grande and the Pecos River into reaches based on geomorphic and flow characteristics. Six reaches were identified as suitable for re-establishment of the RGSM (in priority order). The fourth reach listed is the reach of the Rio Grande located just downstream of Amistad Reservoir to just upstream of Falcon Reservoir, the reach on which Laredo is located (Recovery Plan, appendix B, op.cit.).

Designation of this reach as one of future re-establishment attempts of the RGSM may potentially affect river operations and maintenance projects on the reach. Based on the objectives and measures identified in the Recovery Plan, the USFWS would work to establish and implement scenarios that would benefit the RGSM, within the current framework of river operations of this reach. Depending on the results of these efforts, potential future requirements in this reach could include the following:

1. Development and implementation of a Habitat Conservation Plan (HCP) for activities on the river that may affect the RGSM;
2. Establishment of minimum instream flow goals or requirements to protect the RGSM;
3. Dedication of water rights to species needs;
4. Dedication of upstream storage to support RGSM maintenance/survivability flows; or
5. Modification of operating and maintenance rules to protect or enhance the species and its habitat.

It is not clear if the fourth-level priority area will receive any significant attention. However, this program should certainly be monitored to determine any potential impacts to existing or future water development programs and strategies.

Development of a listing of endangered species for the STDC counties was accomplished during a recent study by the Bureau of Reclamation (*Lower Rio Grande Basin Study, Texas Summary of Water Resources, Ecological Resources, and Socioeconomic Conditions*, December 1995). In this report, a literature search was performed as well as a review of USFWS documents. Table 5-10 excerpts the federal listing threatened or endangered species as well as candidate species for listing under the Endangered Species Act. The list classifications are abbreviated as E, T, C1, or C2, corresponding to endangered, threatened, Category 1, or Category 2, respectively. Category 1 species are species that are currently not protected under the ESA but for which the USFWS has sufficient information to support their listing as threatened or endangered. Category 2 species are not protected under the ESA, are species that may deserve listing, but are species that have insufficient data to support development of their listing.

5.1.3 Drought Influences

Drought influences have affected the region continuously and will have to be considered in future water planning. Although criticized in recent years, the Palmer Drought Index remains one of the best overall indicators of drought. The index was developed in 1965 by Wayne C. Palmer, Office of Climatology US Weather Bureau, Washington, D.C. (*Meteorological Drought*, Research Paper 45, US Department of Commerce, February 1965).

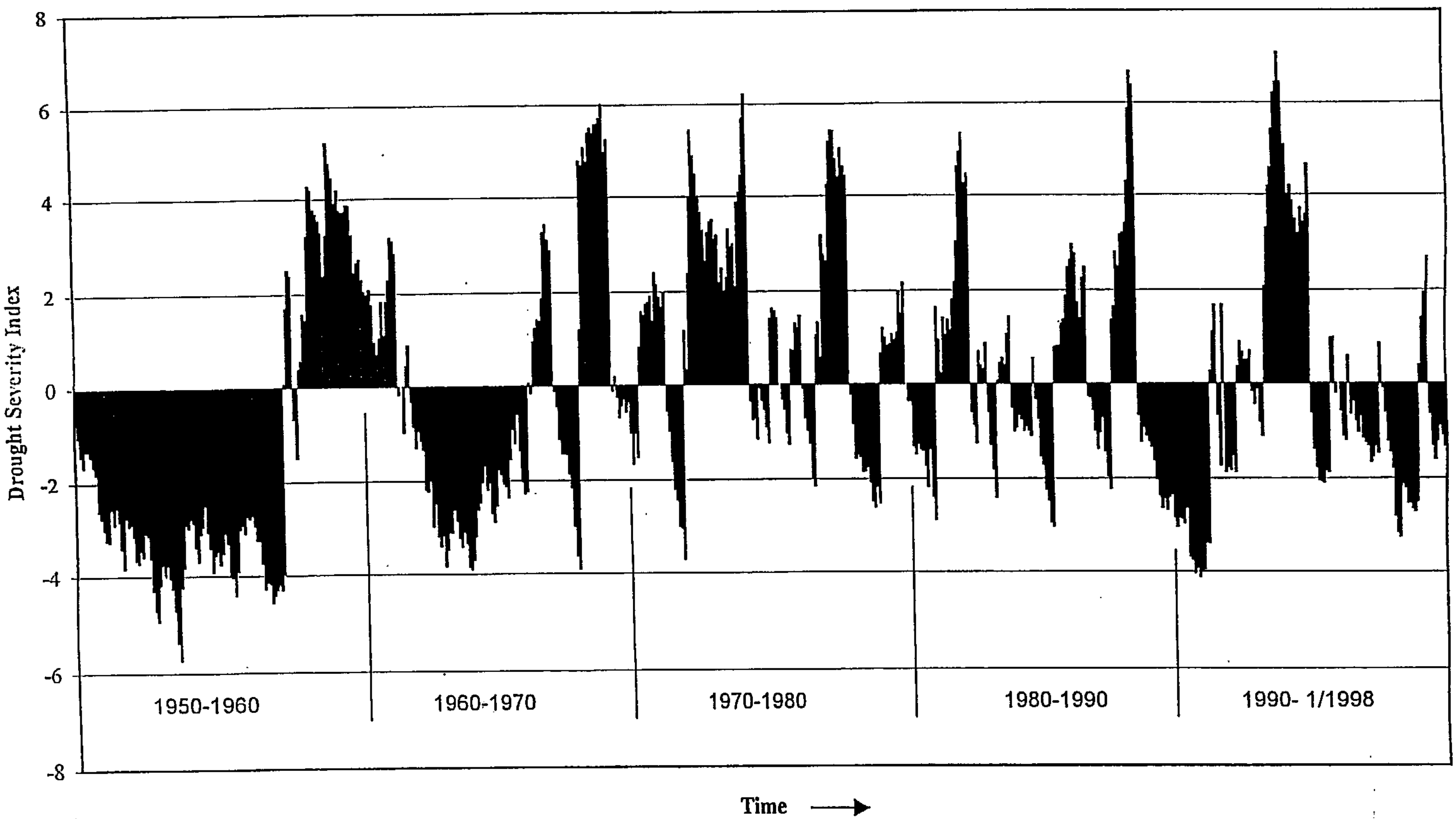
The Palmer index relies on the continuum of precipitation for its calculation. It essentially develops a water balance based on precipitation, evaporation, antecedent moisture condition, and moisture loss rates. The index ranges from wetter than normal conditions (+4) through extreme drought conditions (-4). Severe drought conditions are indicated by Palmer index values less than –2. The National Climatic Data Center (NCDC) maintains thorough climatic data for designated climatic regions of the United States. This data includes climatic region 9 of Texas (Southern Region) and information dating back to 1895.

To illustrate the influence of drought for the region, the NCDC was contacted and calculated the Palmer Drought Index data acquired for the period 1950 through January 1998. This data was compiled in figure 5-2. Calculations performed on the data show that the percentage of time severe drought (less than -2 drought index value) was exceeded was 64.4%, 32.3%, 9.1%

Table 5-10
Endangered Species of Concern in STDC Counties

Speicies	Class	Webb	Zapata	Jim Hogg	Starr
Ashy dogwood (Thymophylla tephroleuca)	E	☑	☑		☑
Audubon's oriole (Icterus graduacauda audubonii)	C2	☑	☑	☑	☑
Brownsville common yellowthroat (Geothlypis trichas insperata)	C2				☑
Cactus ferruginous pygmy owl (Glaucidium brasiliarum cactorum)	C1				☑
Correlis's fals dragon-head (Physostegia correllii)	C2		☑		
Coue's rice rat (Oryzomys couesi aquaticus)	C2				☑
Ferruginous hawk (Buteo regalis)	C2	☑			☑
Fitch's hedgehog cactus (Echinocereus reichenbachii var. fitchii)	C2		☑	☑	
Gulf Coast hog-nosed skunk	C1	☑	☑	☑	☑
Interior Least Tern (Sterna antillarum athalassos)	E	☑	☑		☑
Jaguarundi (Felis yagouaroundi)	E		☑		☑
Johnston's frankenia (Frankenia johnstonii)	E		☑		☑
Loggerhead shrike (Lanius ludovicianus)	C2	☑	☑	☑	☑
Long-billed curlew (Numenius americanus)	C2		☑		☑
Maccart's whitlow-wort (Paronchyia maccartii)	C2	☑			
Marble-fruited prickly pear (Opuntia engelmannii var. flexospina)	C2	☑	☑		☑
Nickel's pincushion (Coryphanta sulcata var. nickelsiae)	C2	☑			
Northern gray hawk (Buteo nitidus)	C2	☑	☑	☑	☑
Ocelot (Felis pardalis)	E	☑	☑	☑	☑
prostrate milkweek (Asclepias prostrata)	C2		☑		☑
Reticulate collared lizard (Crotaphytus reticulatus)	C2	☑	☑	☑	☑
Rio Grande lesser siren (Siren intermedia texana)	C2	☑	☑		☑
Runyon's huaco (Manfreda longiflora)	C2				☑
Sennett's hooded oriole (Icterus cucullatus sennettii)	C2	☑		☑	☑
Small papillosus (Echinocereus papillosus var. angusticeps)	C2			☑	
Star Cactus (Echinocactus asterias)	E				☑
Texas horned lizard (Phrynosoma cornutum)	C2	☑	☑	☑	☑
Texas olive sparrow (Arremonops rufivirgatus rufivirgatus)	C2		☑		☑
Tropical parula (Parula pitiayumi cornutum)	C2				☑
Walker's manioc (Manihot walerae)	E				☑
Yellow-spined glory of Texas (Thelocactus bicolor var. flavidispinus)	C2				☑
Zapata bladderpod (Lesquerella thamnophila)	C1		☑		☑

Figure 5-2
Monthly Drought Severity Index
(January 1950-January 1998)



24.6%, and 13.9%, corresponding to 1950-1960, 1960-1970, 1970-1980, 1980-1990, and 1990-Jan 1998, respectively. Computations performed on the 1950-1998 period of record show that severe (or worse than severe) drought conditions occurred 29.6% of the time. It should be noted that this data references the entire climatic region of the Southern Region and not that of the STDC specifically. The relative location of STDC within the Southern Climatic Region is provided by figure 4-1.

5.1.4 Mexico's Influence

Mexico's management of water along the border is entirely different than in the United States. Instead of the ownership of water by individuals, water is owned by the state and not subject to the same type of water marketing environment that flourishes in the STDC region. Without ownership of water by individuals or businesses, there is not the same attention to the efficient management of the resource as is paid in the United States. Opportunities for water trading with Mexico are reduced to government-level discussions regarding allocation in the context of the 1944 Treaty.

Mexico's standard of living and per capita water consumption has been less than that in neighboring communities of the United States. As the standard of living in Mexico increases, the per capita water demand will also increase. Additionally, international projects along the U.S./Mexico border are increasing the percentage of the population served by municipal water supply systems. This increased demand together with new impoundments may both be contributing factors that collectively act to reduce Mexican inflows to the Rio Grande. This can only exacerbate the continuing trend of increasing salinity in the Rio Grande.

5.1.5 Regulatory/Institutional Constraints

There are a number of regulatory/institutional constraints that impact the efficiency of the allocation of the region's water in a number of ways. One obvious constraint is the TNRCC rule that limits irrigation allottees from accumulating more than 1.41 times their annual authorized diversion right. Another rule discourages conservation of water by reducing the allottee's account to zero if its account diversion is not used within a period of two consecutive years. Still a third constraint is the legislative mandate that requires water districts to operate as non-profit organizations. Water Districts, while allowed to sell water to any entity, cannot charge more than it costs to acquire and deliver the water. In practice, this constraint has ensured an artificially low price for water and de-emphasized conservation practices. Moreover, all three of these constraints affect the irrigation water use sector due to its relatively high water use compared with other sectors.

The heaviest water user over the entire Amistad-Falcon system is the irrigation sector. In the LRGVDC region alone, irrigation of farmland requires around 80% of the total water consumption downstream of Falcon Reservoir. A relatively small change (say 10%) in the water consumption of this sector would be sufficient to meet the projected municipal demands in the STDC region through the year 2050. Such changes would likely be possible in a water market unencumbered by the current water district pricing practices.

5.1.6 Influences of Poverty

The STDC includes areas that are among the most poverty-stricken zones in the USA. The persistence of poverty requires special care and consideration of water development options to ensure project sustainability. Any new projects that are considered within poverty-stricken areas naturally consider available grants and or subsidies to reduce the overall debt load. Ambiotec retained a former assistant to the Governor's office for economically distressed areas to develop a candidate list of potential funding sources to support future projects. The contractor's deliverable is included in this document as appendix B.

Poverty stricken areas such as colonias and similar unincorporated communities can have significant water quality impacts over time through discharge of non-point source-type wastes. Such wastes can include, but are not limited to decaying refuse, improperly disposed chemicals (such as fertilizers, herbicides, and pesticides), cleaners, spent oils, releases to the ground from latrine areas, and malfunctioning septic tanks. These small but significant sources of pollution can be an insidious component contributing to water quality impacts, particularly in drought-prone regions. The materials build up or are concentrated from the absence of rain. Then, in the presence of high intensity, short duration rainfall, the wastes can be transferred to water courses and, ultimately, to the Rio Grande. Such waste loads would not necessarily be detected during dry periods (low flow events) that are typically monitored by the state during intensive water quality surveys. While the state and local community health departments have responsibility to monitor these areas, in many cases, there may not be sufficient attention paid to potential water quality impacts from these types of non-point sources. Quantification of the potential impacts of such areas is recommended for any future water quality protection program.

5.1.7 Local Concerns

Meetings were held with the STDC stakeholders to learn, first-hand, how water problems were perceived in the community. Through arrangements made by STDC, meetings were held with representatives from each of the counties as well as the City of Laredo. Concerns voiced during the meeting process are summarized here by county in the sections presented below.

5.1.7.1 Jim Hogg County

The following list relates concerns and observations that were identified during the meeting held with representatives from Jim Hogg County.

1) The water supply in the area is exclusively groundwater. Many of the old wells are starting to run dry. "Played out" wells appear to be most abundant on properties located off SH 16 towards Zapata.
2) There are uranium deposits in the area and they are believed to affect the quality of well water. The extent of the uranium influence is unknown and the actual water quality impacts have not been quantified.
3) There is flat demand on the water system since the area is not growing. (Given the absence of increasing population, there is an implicit question about the viability of the community and its ability to fund new infrastructure.)
4) There is not a known plan to provide a secure source of water for the area for the next 50 years.
5) Some of the area is served by Water Control and Improvement District No. 2. This district is reported to have utilized different equipment in its water supply wells. When a breakdown in the water supply system occurs, the lack of redundancy and backup equipment hinders the District's ability to provide water.
6) Ground water is reported to be located in the 300-350' depth range from the surface. The depth to groundwater makes it difficult for individual residents to afford construction of wells.
7) Every summer there is heavy water demand. This demand is so high that it leaves inadequate water pressure to permit showering (sometimes for several days).

5.1.7.2 Starr County

The following list relates concerns and observations that were identified during the meeting held with representatives from Starr County.

1) There is a concern about both Amistad and Falcon Reservoirs drying up and a counterpart desire to find an alternative long-term source for water.
2) Concern was expressed about the flooding impacts to the Roma-Los Saenz area and how this study would work to improve the situation.
3) There is a need for documentation of available aquifers and appropriate conservation practices.
4) Concern was expressed for the impacts to groundwater quality that may result from oil well drilling and pumping in the area that has continued for 24 years.
5) Concern was expressed for duplication of effort regarding water planning efforts in the region by area water purveyors. It was desired that any future planning incorporate the information that was compiled or developed from previous studies.
6) The population of Starr County and that of Rio Grande City was reported to be increasing. The WD (Starr County WCID No. 2) cannot keep up with demand. Peripheral communities are developing relatively rapidly and the WD is obliged by state mandate to grant service. It was reported that strategies to discuss moratoria on development appeared to be stymied by TNRCC's insistence to provide service to these communities. (It was not reported that Starr County WCID No. 2 actually sought to acquire the responsibility to provide service to the areas that it is now obliged to serve.)
7) Small unincorporated communities in the area do not have water rights and must purchase them annually. Like annual migration events, at a certain time of the year, the WD starts attempting to purchase water from other water rights holders. (The need for acquisition of additional long-term water rights is obvious.) The most significant near-term activity should be to clarify the state's mandate for service to these new communities and to explore

optional community programs to limit growth contingent upon having sufficient water rights and treatment capacity.

8) Water rights costs have doubled in the last several years. Recent pricing is quoted at approximately $2,200/Ac-ft after conversion ($1,100 before conversion) for a Class A water right.
9) Clarification of the jurisdictions within the Starr County area is needed. (One approach might be to create a single entity having the responsibility for water supply. However, the stiff competition among area water purveyors would be a significant obstacle for success of this strategy.)

5.1.7.3 Zapata County

The following list relates concerns and observations that were identified during the meeting held with representatives from Zapata County.

1) There is concern about the construction of a dam in the Laredo area. Concerns appeared to stem from belief that available upstream flows would be reduced or terminated after the dam's construction.
2) The existing groundwater source was thought to be endangered by pollution from waste disposal activities, including salt water injection (from oil well drilling activities). There was reported evidence of a residential well contaminated by the Campbell Wells disposal site (disposal under the jurisdiction of the Texas Railroad Commission). There are numerous oil wells in the area that may have contributed to contamination of area water wells. (There was no sited evidence backing this concern.)
3) It was reported that 85% of the tax base was due to oil and gas properties. Given this high percentage of tax revenues, there was a voiced concern about affecting this industrial group with increased controls.

5.1.7.4 Webb County (includes City of Laredo)

The following list relates concerns and observations that were identified during the meetings held with representatives from Webb County and the City of Laredo, respectively.

1) A major initiative exists for finding an alternative source of water.
2) A subsurface investigation being conducted by the USGS study in Webb County is believed to provide guidance regarding groundwater availability.
3) There may be a potential to tap the Trans-Texas project. The City of Corpus Christi has reported that San Antonio has dropped out of the project. Their share of the project is now available and may be pursued by Webb County.
4) Weather modification is a candidate water supply option. Approximately $4.8 million was reported slated for funding of weather modification studies/projects in '98. The program used for the Webb County area should be sufficiently broad to incorporate interests and funding by other counties located outside STDC, i.e. Pearsall, and Jordanton Counties, etc. (Status of this project, its award, and coverage were not reported.)
5) Desalination should be considered.
6) The transfer of agricultural water to municipal and industrial needs in the Webb County area should be considered in an overall water supply strategy.
7) The cost share and corresponding supply have yet to be resolved between Laredo and Webb County regarding the water and wastewater infrastructure. Both Laredo and Webb County have respective Certificates of Convenience and Necessity (CCNs). The CCN system allows for an entity to become the purveyor of water for a designated geographic region. Since both the City and the County have CCNs, City residents are taxed for County projects because the City is a subset of the County. The County's CCN was acquired to supply service to outlying areas in the county that were not able to connect to the City's system. (The biggest challenge appears to find a way to supply the growing county needs while allowing the City to grow its normal course. A marriage or consolidation of the two entities (e.g. a City/County Authority) would seem expedient for long-term development of the resource.
8) The major objective of the regional water plan should be to develop a credible path forward regarding cost-effective water management options. The various influences affecting any particular option may render that option ineffective after a certain point in time.
9) The use of a binational rain-making strategy for the STDC region appears appropriate.

10) The regional water plan should distinguish strategy appropriate to the various regions within STDC.
11) There is a central concern for cost sharing within Webb County. Anything that is proposed in the way of new infrastructure or programs should recognize the cost-benefit relationships of such a program.

5.1.8 Water Utility Problems

1) A questionnaire attempting to compile common utility problems was forwarded through the STDC to all utilities within the STDC region. This questionnaire attempted to identify utility issues ranging from capacity and regulatory problems to water quality problems. Of the utilities polled, nine responded. One was left out of the summary because the responses pointed to virtually no problems and offered no substantive comments of clarification. The summary is supplied herein as table 5-11.
2) Results of the table clearly show that both Roma and Webb County need a lot of new infrastructure. Evidently, both are in the process of securing the improvements needed. Roma has acquired a $29 million in funding to acquire water rights, and provide new and improved water and wastewater service to 68 colonias located within its CCN. Webb County has a similar project planned that has yet to be implemented. Starr County WCID No. 2 apparently needs additional water treatment capacity amounting to 1.6 MGD. Also interesting was the reporting by Zapata County Water Works. Despite reported needs in practically every category of the questionnaire, only one comment regarding needed fire protection pressures was submitted. Further investigation into this specific community's needs appears warranted.

5.2 Current Projects and Practices

As part of the meetings held with the STDC stakeholders, inquiries were also made about current and planned infrastructure improvements and practices. As each meeting was completed, requests were made to acquire all relevant water-related planning and engineering reports from each of the stakeholder groups. These reports, compiled below in section 5.2.1, were reviewed for information that might weigh on strategies developed during this project. They were also reviewed to develop an understanding of water management practices within the region.

Additionally, the history of projects funded by the primary funding agencies in STDC, including the Texas Department of Housing and Community Affairs (TDHCA) and the TWDB, was also compiled. Lists of these projects are provided in section 5.2.2. In addition, an investigation of utility conservation practices was conducted of TWDB files. Since the TWDB requires a conservation plan and drought contingency plan be filed for entities receiving Board funding, this was a logical place to search for consolidated information. This search excluded utilities that may have conservation goals and practices in place but have not sought funding from the TWDB. A summary of the reporting information filed with the TWDB is provided in section 5.2.5. The water management practices of the STDC region include both past practices and future practices, as articulated by goals and plans.

5.2.1 Previous Water-Related Studies

Documents were solicited from each of the stakeholder groups during preliminary interviews to acquire an understanding of community needs and practices. Each group provided documents that were reviewed and incorporated with other literature and interview sources to develop the water management practices section 5.3.3. The following listing compiles (by forwarding entity) the documentation of past planning or engineering projects in the region.

Including the documents received from the stakeholder groups, a wide range of information sources was collected during the course of this project. Topics included: conceptual-level planning, technical demographic data, institutional issues for water management, infrastructure development, engineering projects, regulatory evaluations, water quality assessments, hydraulic data for the Rio Grande, funding documents, and prototypes for economic cost structures to enhance the value of water in the region. Both structural and non-structural issues were discussed, although the majority of documents collected emphasized structural-type approaches. A list of the documents compiled for this report is provided in table 5-12.

Table 5-11
Responses to Utility Issues Questionnaire

	Question	Laredo (L)	City of Roma (R)	Webb County Utilities (W)	Falcon State Park (F)	Union WSC (U)	Zapata County Water Works	Starr Co. WCID No.2 (S)	San Ygnacio MUD (Y)	Comments
1	Additional Storage Capacity- is it needed? If so, how much?	Y	Y	Y	N	N	Y	N	N	L: CIP requires keeping up with growth;R: Additional 200,000 being addressed under Roma's EDAP project. W: elevated 200,000 needed for El Cenizo and Rio Bravo;
2	Difficulty Meeting Safe Drinking Water Act Requirements	N	Y	Y	N	N	N	N	N	R: Chlorine dioxide/chloramine systems recently installed. Start-up February, 1998. W: NTU and THM requirements
3	System components are old and need replacement	Y	Y	Y	Y	N	Y	N	N	L: Being addressed through CIP 198-03. R: All being addressed under Roma's EDAP project. W: WTP needs updating or replacement. Water distribution line replacement in El Cenizo and Rio Bravo with 8" or larger. F: Electric components and pump are 12+ years old
4	Inadequate disinfection or disinfection by-products a problem	N	Y	Y	N	N	Y	N	N	W: Existing chlorination system will have to be replaced with chloramination process by 1999.
5	Inadequate treatment capacity--indicated if more production capacity is necessary or if new unit operations are needed and what kind	N	Y	Y	N	N	Y	Y	N	R: EDAP project will include: raw water pump station, new chemical feed systems, three upflow solids contact units, tow filter cells, and related appurtenances. W: Wastewater treatment capacity needed now. Water and wastewater capacity needed at full development. S: Current plant rated at 3.4MGD needs to be upgraded to 5MGD
6	Inadequate System pressure to customers--indicate what is needed, if known	N	Y	Y	N	N	Y	N	N	R: All being addressed under Roma's EDAP project. W: Elevated tank Z: Correct sizing of distribution pipes & lack of fire protection in areas.
7	Inadequate operators--need better tratining, more, or better certified operators	N	N	Y	N	N	Y	N	N	W: More and better trained operators needed.
8	Portions of service area do not receive water--need additional distribution system to service area	Y	Y	Y	N	N	Y	N	N	L: Casa Verde and some dwellings along Mines Rd. Include colonias along Hwy 59; W: Need additional distribution system. R: Some colonia areas require extension of distribution system
9	Water supply shortage--need additional water rights, water conveyance systems, agreements with other providers having excess capacity--indicate which, if any.	N	Y	Y	N	Y	Y	N	N	L: Need secondary sources of water; R: About 2,060 ac-ft of water rights will be acquired under Roma's EDAP project. W: Need more water rights F: Concern about enough water in reservoir during drought to service water rights
10	Well water quality is marginal--need another well, deeper well, alternative water source, or new treatment system--indicate which, if any, of these are indicated.	Y	*	Y	N	N	Y	Y	N	*R: N/A; W: Yes to all the above. F: N/A lake is only source. U: No water wells. S: N/A
11	Instrumentation and control of water treatment or distribution system is old, out-of-date, broken,or non-existent--indicate which applies and what if needed.	N	Y	Y	N	N	Y	N	N	R: I&C systems will be rennovated and updated under the water treatment plant expansion/distribution improv. projects funded under EDAP. W: It is old and out of date. A modernized system is required.
12	Indicate if water tastes bad, corrodes pipes, or smells bad--indicate which (if odor, indicate what kind of smell)	N	N	Y	N	N	N	N	N	R: Minor problems will be addressed under the WTP project. W: Slight chlorine smell.

Table 5-12
Inventory of Documents and Information Collected for STDC Project

Document/Data	Comments
Lower Rio Grande Basin Study, Texas Summary of Water Resources, Ecological Resources, and Socioeconomic Conditions, BUREC, Austin, TX 12/95	Valverde County to Cameron County, Texas along the US/Mexico Border (Rio Grande River)
Lower Rio Grande Basin Study, Texas Working Document: "A Report of Interim Activities for Fiscal Year 1993" BUREC, Austin, TX,	Valverde County to Cameron County, Texas along the US/Mexico Border (Rio Grande River)
"Statewide Watershed Management Approach for Texas The TNRCC Framework for Implementing Water Quality Management" prepared by the Office of Water Resource Management with assistance by the Cadmus Group, Inc., Durham, North Carolina, March 1997	Watershed management approach statewide
"Rio Grande/Rio Bravo Dam Project Oversight," May, 1997 by Mercurio Martinez, Co. Judge	Dam project presentation for Webb County
"EID Supplement for Water and Wastewater Improvements City of Roma, Starr County, TX" March 21, 1997 by Hibbs and Todd	EPA –required environmental impacts evaluation
"EID for Water and WW Improvements," March, 1997 by Hibbs & Todd, Abilene, Texas	EID for EDAP W/WW improvements, Roma TX
"Starr County Water and Wastewater Regional Study" prepared by Nelson Corporation, Dallas, TX June, 1990	Starr County
Water for Texas-Today and Tomorrow A 1996 Consensus-Based Update to the Texas Water Plan Volume III Water Use Planning Data Appendix prepared by TWDB, TNRCC, TP&W, June 1996	Methodology for planning numbers
"Water Supply Study for Starr County WCID 2" Funded by TWDB, prepared by the Nelson Corporation, Dallas, TX February, 1993	Starr County WCID 2
Water for Texas-Today and Tomorrow A Consensus-Based Update to the Texas Water Plan Volume II Technical Planning Appendix prepared by TWDB, TNRCC, TP&W, June 1997	Includes description of salient legislation passed in the 1997 state legislature, characterization of major aquifers in the state, and an overview of planning, management, and basin characteristics in the state, including a prediction about the need for future reservoirs and conveyance projects
"Application for Grant Assistance to Prepare a Water and Wastewater Facility Plan for Southwest Webb County" Prepared by Rust Lichliter/Jameson August, 1995	EDAP program at the TWDB
"Integrated Water Plan, Phase 1 for Lower Rio Grande Development Council" by TC&B, 6/97	TWDB Phase 1 process for counterpart water management plan for LRGDC (Hidalgo, Willacy, and Cameron Counties, Texas)
"Webb County Facility Plan for El Cenizo, Rio Bravo, and La Presa (Colonias), Webb County." Prepared by Dannenbaum Engineering Corporation, March, 1997	Webb County Colonias
Internet Data for EDAP Communities-Areas included in projects funded for construction, April, 1966	Webb County, Zapata County
Internet Data for EDAP Populations included in state and federally funded projects EDAP-eligible Counties,7/3/97	All counties in STDC

Document/Data	Comments
Internet Data: County Population estimates 1990-2050 by TWDB; Acquired 7/3/97	All counties in STDC
Internet data: Water Use Projections for STDC, 7/3/97	Livestock, Steam electric power, mining, mfg uses
Preliminary SOW and Budget for Phase II, LRGDC project, April 23, 1997	Plans for the second phase of work counterpart study
Water Rights Holders Listing, February 29,1996	STDC -Wide
"Funding Sources Report" by Andrea Abel, 8/97	Funding sources for phase 2 of the project
STDC Grant Application	Application for planning funds to support phase 1 regional water resources planning effort
Issues Paper for Phase 2 planning presented to LRGDC; focuses primarily on channel dam	LRGDC project
"Shared Water, Different Dreams" by Santos Gomez, Pacific Institute for Studies in development, environment, and security, April 1997	Water resources management issues connected with San Diego/Tijuana area
"Water Wars" by Homer Jones, Texas Business, 2/27/98	Issues related to unregulated pumping of groundwater in the state; need for new legislation
Interlocal Agreement between Webb County and the colonias of Rio Bravo	
Interlocal Agreement between Webb County and the City of Laredo, 1995	Webb County/Laredo EDAP arrangement
Literature search of TNRCC files that references the City of Laredo population, mapping, etc.	Litsrch.txt
AutoCAD map of the City of Laredo	Filename: Laredo.DWG
Challenges in the Binational Management of Water Resources in the Rio Grande/Rio Bravo, by David Eaton, David Hurlbut, 1992	Water Issues for Rio Grande River/Laredo area
Water Bulletin 65, IBWC, 1964	Rio Grande Flow Data
Legal and Institutional Barriers to Water Marketing in Texas, Ron Kaiser, TWRI, 11/94	Water Marketing on Rio Grande River
Flow, Salts, and Trace Elements in the Rio Grande: A Review, Miyamoto, Fenn, and Swietlik, TWRI TR-169, July 1995	Water Quality Issues in the Rio Grande
1994 Regional Assessment Water Quality in the Rio Grande Basin, Report AS-34 Watershed Management Division, TNRCC, 10/94	Toxics Assessment in Rio Grande River
"Texas Water Savers" vol.1, no,1, Spring, 1994	Laredo Conservation Measures.
"Wastewater Interceptor South Plant to Chacon Creek, Frontera Ass. Int'l., Inc. (no date)est 12/94	WW Interceptor Basis of Design for Laredo
"Report on Water System Analysis", 4/95 by Black and Veatch	Water Service improvements, Laredo
"Facility Engineering Plan the City of Roma Starr County, Texas for Water and Wastewater Improvements," by Vera Engineering and Hibbs and Todd, November, 1996	Presented the conceptual layout and funding justification of a large capital improvements program for Roma, Texas including 68 different colonias. Project included water rights purchase.
"Final Design Report for Filter Renovation and Capacity Increase", CDM 3/93	Laredo Jefferson St. WTP Capacity Improvements
"Water Supply Study for Starr Co. WCID No. 2", The Nelson Corporation, 2/93	WSP investigation for Starr Co. WCID no.2
"City of Laredo, Texas Wastewater Master Plan", November, 1996 by CDM	WW Master Plan
Step 1 Report, Feasibility Investigation Aquifer Storage and Recovery", CH2MHill, 10/96	ASR Options-Laredo: Needs further investigation to become feasible.; Potential Water Stm Improvements.

Document/Data	Comments
Groundwater Availability in Texas Estimates and Projections, Texas Department of Water Resources, Report 238 by Muller and Price, September 1979.	Protocols for estimation of groundwater supplies from the states major and minor aquifers
"Valuing and Managing Water Supply Reliability," Griffin and Mjelde, Texas A&M University, December 1997	An approach for managing water supply based on the expectation of shortfalls instead of completely meeting all water needs

5.2.1.1 STDC

1) *Lower Rio Grande Basin Study, Texas A Summary of Water Resources, Ecological Resources, and Socioeconomic Conditions*, prepared by US Bureau of the Interior, December 1995. This report included summary descriptions of title resources within the Rio Grande Basin from Val Verde County downstream to Cameron County.

2) *Environmental Information Document Supplement for Proposed Water and Wastewater Improvements* City of Roma, Starr County Texas, prepared by Hibbs and Todd, Abilene, Texas March, 1997. This document was produced in response to federal environmental impacts analysis attached to any new facilities projects. The projects described by the report included evaluation of alternative wastewater treatment processes ranging from trickling filters and facultative ponds to activated sludge-type processes. The report addressed collection system extensions to colonias and unsewered areas in the City of Roma, Texas. Expansion of existing water treatment facilities and water distribution system facilities was also addressed. It was determined that expansion of the existing plant was the best option; that local groundwater sources, ranging from 1,000 to 5,000 TDS and containing high concentrations of boron and nitrate were not suitable for irrigation or for human consumption; and that the Rio Grande was the "only real viable source of water supply for the City of Roma."

5.2.1.2 Webb County

1) *Webb County Facility Plan for El Cenizo, Rio Bravo, and La Presa*, prepared by Dannenbaum Engineering, March 1997. This document evaluated approaches for providing conventional water and wastewater service to 5 colonias located in Webb County: El Cenizo, Rio Bravo, La Presa, One River Place, and El Milagro. The plan incorporated estimates of population and water demand projected through the period 2016. A conservation plan presenting the goals of the collective areas was also included. Webb County was noted to have a continuous leak detection, location, and repair program, and the communities were cited as not being in a circumstance to implement any type of reuse program. Copies of the conservation plan and corresponding new plumbing code ordinance for the county were provided. They showed that the County Commissioners Court approved both ordinance and plan on January 11, 1996. An emergency water demand management plan was also included in the facility plan. Features of this plan included a description of a newly planned connection with the City of Laredo, increased storage, and planned demand management strategies to be implemented in each of three phases. Strategy of the plan incorporated curtailment of certain types of water use, dissemination of public information, and phased reductions in the water system's capacity corresponding to 50, 75, and 100%. Although allowed, there were no stipulated emergency water rates or specific surcharges to ensure compliance with the demand management plan.
2) *Application for Grant Assistance to Prepare a Water and Wastewater Facility Plan for Southwest Webb County*, prepared by Webb County and Rust Lichliter/Jameson, August 1995. Document was the predecessor document to item 1 report. Communities listed included the same communities as in item 1 together with brief site plans of the planning areas.

5.2.1.3 Starr County

1) *Facility Engineering Plan for the City of Roma Starr County, Texas for Water and Wastewater Improvements*, November, 1996. Prepared by Vera Engineering, Inc. in association with Hibbs and Todd, this plan outlined the improvements needed to bring adequate water and wastewater service to the City and a 68-colonia area located within the City's ETJ and within the boundaries of the City's Certificate of Convenience and Necessity. The design population for improvements was 23,301. Principal wastewater improvements include extension of collection system service to 5,190 existing households and 2,608 new connections. Wastewater plant improvements will be added to increase capacity 2 MGD to 2.36 MGD total treatment capacity (entirely new plant). Water improvements included a 200,000 gallon storage tank, treatment plant capacity expansion 3.65 MGD to 5.15 MGD with conversion of disinfection processes from chlorine gas to chlorine dioxide, retrofit of main distribution booster pump station, and increasing capacity of distribution lines east and west of the City. In addition, 2,058.8 ac-ft of water rights were also planned for purchase. Combined funding for these projects totaled about $29 million with 10 million allocated for water improvements and $19 million allocated for wastewater

improvements. This document also presented preliminary engineering of needed unit operations as well as financial breakdowns needed for application to EDAP and low interest loan programs.

2) *Water Supply Study for Star County W.C.I.D. No. 2* prepared by The Nelson Corporation, February 1993. The stated purpose of this plan was to evaluated existing and potential water supply facilities, treatment and distribution services, potential water supply sources, and to formulate supply, treatment, and distribution alternatives for the period 1990 through 2020. The plan named the title water service supplier in addition to El Sauz WSC , Rio WSC, and El Tanque WSC water providers. A recommendation was made to increase the capacity of the existing Starr Co. WCID treatment facility to 7.16 MGD through construction of modular additions. Water rights purchases were recommended to support 80% of the estimated water demand forecast for 2010. The remainder of the projected needed water was suggested to be obtained by acquiring "no charge water" or additional water purchases. The population growth of the combined service areas of the water providers was reported to average 3.7% per annum during the past 20 years. Also, the 1987 per capital income for the planning area was reported to be $3,464. This income level precluded construction of needed improvements without grant assistance from the TWDB and Farmers Home Administration. The concept of a Super District was proposed for purposes of debt consolidation and to expose water suppliers to additional funding options not currently available to WCIDs and WSCs. No additional water sources were identified. The Rio Grande was reported to be "the only logical source of municipal water in the planning area."

3) *Starr County Water and Wastewater Regional Study*, prepared by Starr County Water Development Board with support from The Nelson Corporation, June 1990. This document cited planned water and wastewater treatment system improvements to support the municipal growth for 9 communities. These communities included the following: Starr County WCID No. 2, City of Roma-Los Saenz, City of La Grulla, Union WSC, Falcon Rural WSC, La Joya WSC, Rio WSC, El Tanque WSC, and El Sauz WSC. The Rio Grande was indicated to remain as the primary source of water for Starr County. This report offered the same strategy reported in item 1 above regarding how to support acquisition of needed water. A total of 6,217 ac-ft/year of water rights (80%) was recommended to be purchased with the remainder being comprised by water sales, free pumping, and conservation activities. A total 15.75 MGD additional water treatment capacity was reported to be needed with 3.2 million gallons of water storage. Costs for the recommended water rights, treatment, storage, and distribution facilities were estimated at approximately $28.2 million. A total of 5.37 MGD of non-regional wastewater plant service areas were recommended for the areas of Fronton, Salineño, and Falcon Heights at a cost of approximately $23.9 million. The debt incurred for supplying the water distribution systems was reported to be financed by the homeowners and developers while the wastewater collection systems were estimated to be retired by the service providers. The new wastewater service areas recommended by the study did not have ready ownership or operators identified. Improvements within the service areas of El Tanque and El Sauz were reported to require dramatic increases in existing rates (implying that they might not be sustainable). Similarly, improvements recommended for San Isidro could not be justified without financial assistance. The report also recommended a Master District or Authority entity to be created as a preferred approach for funding improvements, to consolidate debt, and to manage facilities. A drought contingency and water conservation plan was presented that contained the following features: education program; meter testing; adoption of a plumbing code by Roma-Los Saenz and La Grulla; and reductions of unaccounted water. The reduction of unaccounted water was especially important since both El Tanque and El Sauz were cited as having water overflowing from their storage tanks. It was also reported that although some water suppliers were not monitoring their unaccounted water, among those that did, at least one entity had as much as 33% unaccounted water. A target of 15% was recommended.

5.2.1.4 Laredo

1) *1984 Report on Water System Analysis*, prepared by Black and Veatch, April 1985. This report highlighted the characteristics of the Laredo Water System as of 1984. Key findings included per capita water use of 105gpcd, a projected average daily water demand of 38 MGD with peak hourly demand of 78 MGD, characterization of the distribution system infrastructure, and unaccounted water of 25.7% in 1981. Recommendations included construction of a new 15 MGD treatment plant, additional pumping and storage capacity, evaluation of a SCADA system, and modification of pressure zones within the distribution system.

2) *Report on North Laredo Water System Study*, prepared by Black and Veatch, 1989. The focus of this report was to evaluate the newly developing areas North of Laredo that were exclusive of the 1984 evaluation. Recommendations included the addition of a new elevated tank to serve the development.

3) *Jefferson Street Water Treatment Plant Filter Renovation and Capacity Increase Final Design Report*, prepared by CDM, March 1993. This report recognized the filtration bottlenecks in the Jefferson treatment works and presented necessary infrastructure improvements to increase plant capacity. An assessment of compliance factors with the Safe Drinking Water Act was included with comparisons of plant performance data.
4) *Wastewater Interceptor South Plant to Hwy 59 Chacon Creek Watershed*, prepared by Frontera Associates, Int'l., Inc. (no date). This report included population estimates to the year 2025 with wastewater unit flows of 85 gpcd. The report cited the absence of individual high water use commercial/industrial entities in the Laredo area that discharge to the sanitary sewer system. The report cited 1995 Laredo combined wastewater flows of 13.5 MGD including a characterization of wastewater flows according to landuse type. The Chacon Creek collection system had a reported capacity of 3.36 MGD. Residential flows held the highest unit flow in the collection system at 612 gallons/acre. It was reported that wastewater flow estimates based on landuse type exceeded those based on population projections by a factor of 2:1. The report opted for projections based on population.
5) Memorandum from NRS Consulting Engineers with Report Corrections and Water Quality Data, June 20, 1995. This document contained report corrections and wastewater sampling data.
6) *Final Engineering Report Reverse Osmosis System for the Santa Isabel Water Well in the City of Laredo*, prepared by NRS Consulting Engineers, August 1995. Report identified a reverse osmosis treatment plant designed to produce 300 gpm (in final phase) with initial production of 100 gpm. Pretreatment processes recognized the need for control of strontium, barium, calcium carbonate control, sulfate control, and scale inhibition. Post treatment processes included pH adjustment and calcium chloride addition. A blending strategy for treated and untreated water was used. Brine disposal was a hauling operation by independent contractor. Water system function was to be monitored by the Jefferson Street SCADA system.
7) *City of Laredo Wastewater Master Plan*, prepared by CDM, November 1996. This document evaluated the City of Laredo's major collection system lines using the Hydra model. In general, infiltration inflow effects were not found significant in the system. Trouble spots were primarily in the Zacate Creek watershed. Service extensions to the existing collection system were recommended along with estimated capital improvement costs. A treatment capacity/effluent quality schedule was presented for 4 treatment plants, including the future Northwest WWTP.
8) *Step 1 Report Feasibility Investigation Aquifer Storage and Recovery System*, prepared by CH2MHill, October 1996. This report identified different alternatives for application of ASR technology for the City of Laredo. Findings suggested that ASR would be most effective if treated water was stored in an ASR system. The costs comparing this option to water rights purchases were shown slightly more expensive. Geochemical limitations of ASR were a concern and required additional research to justify application of the technology.

5.2.2 Previously Funded Projects

Due to rapid population growth in the region, projects have been conducted to identify and to characterize the constraints and approaches for delivering a secure source of water to entities within the STDC. The two most common agencies funding this development have been the Texas Department of Health and Community Affairs and Texas Water Development Board. These agencies were contacted to acquire lists of water development projects funded in the STDC study area. Two tables are provided as table 5-13 and 5-14, corresponding to TDHCA and TWDB projects, respectively.

5.2.3 Common and Innovative Utility Practices

From project documentation literature and interviews compiled during this project, an understanding of the major water management practices of the region has been developed. With the exception of Laredo, the communities within STDC region utilize supply-side water management practices. Planning and infrastructure are designed and planned to meet anticipated growth in communities. There is still a wide array of conservation opportunities yet to be pursued. All of the communities within the STDC practice conventional water treatment. Most of the communities' water supply systems rely on surface water from the Rio Grande. Exceptions to this are small communities located outside the service area of surface water supply entities and those that have no access to surface water supplies (e.g. Jim Hogg County WCID No. 2). A review some of the questionnaire respondents' facility operations was conducted to better understand typical practices. Only 5 of the 9 respondents were contacted for additional questions covering the following areas: Water management, Facility Planning, Charges, Conservation, and Comments. The results are presented in table 5-15.

Webb County and the City of Laredo have initiated demineralization projects to tap available groundwater supplies. These systems are currently in development. Some of the more innovative programs for water management are covered in the following sections.

5.2.3.1 Wastewater Treatment

Wastewater treatment for STDC communities is typically activated sludge-type processes with use of small on-site systems for individuals in rural communities. The City of Laredo is considering sludge management practices that eliminate landfilling of sludge with conversion to beneficial reuse of sludge. Through its ASR program, the City has also investigated the costs of indirect reuse of water. This particular option was found more expensive than water treatment followed by ASR.

5.2.3.2 Webb County Dam

Webb County has proposed a small dam project located approximately 3 miles upstream from the Laredo Central Power and Light Company facilities. Initial projections include provisions for a compacted earthen dam with a height of approximately 31 feet with an impoundment of about 9 miles in length. The proposed benefits of the dam are primarily generation of electric power and recreation. However, the preliminary report for the dam also suggests that it will provide additional water availability and improved water quality (Webb County and Parsons Brinkerhoff, April, 1997). Since the project is just in conceptual stages, many of the technical issues regarding its construction have yet to be developed. The water supply and quality issues mentioned herein are but a few of the issues that will be addressed with a successful project.

5.2.3.3 Aquifer Storage and Recovery (ASR) and Reverse Osmosis (RO)

The City of Laredo is the focal point for alternative approaches for water management within the STDC. To date, the City has completed the first phase of an aquifer storage and recovery investigation and is currently piloting a reverse osmosis plant. There was no information provided by the City for the pilot osmosis project. However, a report was issued for the first phase of Aquifer Storage and Recovery testing (CH2MHill, October, 1996). A review of this report compiled the following issues.

Table 5-13 here Community Development Block Grant Water Projects Completed (and Pending) in the Counties of Webb, Zapata, Starr, and Jim Hogg Data as January 6, 1998

Table 5-13

Community Development Block Grant Water Projects Completed in the Counties of Webb, Zapata, Starr, and Jim Hogg

Data as of January 6, 1998

County	Grant Recipient	Contract No.	Project Description	Completed	Contract Amount
Starr	La Grulla Program Year 1993	703449	Multi-activity project included the installation of 11 hydrants, a new lift station, 660' of force main, the purchase of a bulldozer with compressor for solid waste disposal, and the purchase of 170.59 acre feet of water rights.	March 4, 1997	$334,599.00
	Roma Program Year 1993	703789	Multi-activity project included the installation of 4,400' of 6" water line, 18 hydrants, 2 waterline stoppers, 1,500' of sewer line, street paving with calcite base, hot mix surface & curb & gutter, 1,200' of gas lines, and a park concession facility.	August 6, 1996	$334,599.00
	Roma Program Year 1995	715691	Roma addressed public utility improvements and installed surface pavement on unpaved streets. Project included 6,300' of 6" water line, 12 hydrants, 5,000' of water service line, 2,840' of 8" sewer line, 3 manholes, 52 service connections, 2,240' of 2" gas line, 52 risers/stops/couplings, 13,490' of asphalt surface pavement, caliche base, excavation and 26,980' of curb & gutter.	July 15, 1997	$568,006.00
	Starr County Program Year 1994	714185	County utilized grants to rehabilitate an estimated 21 owner-occupied housing units in the Olivia Lopez de Gutierrez, West Alto Bonito & De la Garza areas. Public water service shall be provided to Ranchitos del Norte area through the installation of 14,100' of line and 11 meter/connections.	November 24, 1997	$500,000.00
Webb	Webb County Program Year 1993	703939	Multi-activity project for the Oilton Community included a 178,000 gallon standpipe water storage tank with piping/controls, the purchase of a fire truck and fire warning siren, and the construction of a baseball field, tennis and basketball courts and other park improvements.	August 21, 1996	$334,600.00
					$2,071,804.00

Table 5-13 (cont'd)

Pending Community Development Block Grant Water Projects in the Counties of Webb, Zapata, Starr, and Jim Hogg

Data as of January 6, 1998

County	Grant Recipient	Contract No.	Project Description	Estimated Completion	Contract Amount
Starr	La Grulla Program Year 1995	715421	La Grulla installed 1,300' of 8" water line, including boring and casing, 2 turbine pumps for the water plant ponds, 1,300' of 6" sewer force main, 1,500' of 8" sewer line, 10,600' of street paving (6" caliche base and asphalt surface), a fire station building and parking lot, and a concrete parking lot for Community Center No. 2.	December 31, 1997	$568,007.00
	La Grulla Program Year 1996	716060	La Grulla installed 9,023' of 6" water line, 14 hydrants, 22 service reconnections, including associated street repairs;It also installed 2.250' of fencing around the city's landfill site; and purchased a new fire truck. The City also acquired property for the expansion of the landfill site.	October 2, 1998	$356,032.00
	Roma Program Year 1996	716749	Roma replaced water, sewer, and gas lines and install pavement on unpaved streets. Improvements included 8,550' of water line, 4,780' of water service line, 17 hydrants, 5,150' of sewer line, 25 manhole, 135 sewer connections, 1,800' of gas line, caliche road base, asphalt pavement, and curb/gutter.	August 22, 1998	$385,000.00
	Starr County Program Year 1996	716205	Starr County provided water and sewer service access to Las Lomas' residents (through the payment of water and sewer service connection fees) to Texas Water Development Program. Water and sewer systems were EDAP-financed. Funds from this project were used to operate a housing rehabilitation program in the Salineno area that rehabilitated 13 homes; installed 15 septic tank systems in the Escobares area; and installed drainage improvements in the Tierra Linda area (included 1,620' of drainage pipe.)	October 2, 1998	$500,000.00
Webb	Webb County Program Year 1993	703155	Larga Vista is a demonstration project using multiple financial resources to provide water service to unserved residents, sewer service, street paving, controlled drainage, a housing rehabilitation program (paid through Colonia Construction Fund), a neighborhood park, and a community/services center building.	July 31, 1997	$1,000,000.00
	Webb County Program Year 1996	716235	Through this project, Webb County anticipates providing water service to residents of Las Lom I & II, Colorado Acres, Los Arcos, Los Centenarios, Los Fresnos, and Los Nopalitos-Los Mesquites areas. The project includes installation of a water storage and supply system including a water well, a 50,000 gallon storage tank, a reverse osmosis water treatment plant, a potable water dispenser, and evaporation tank for brine discharges.	October 2, 1998	$500,000.00
					$3,309,039.00

Table 5-14
TEXAS WATER DEVELOPMENT BOARD PROJECTS
South Texas Development Council Entities

Project	Applicant	County	Date	TWDB Program	Grants ($)	Loans ($)	Purpose
20916	Del Mar CD	Webb	02/28/1978	Development Fund	0	812,000	Wastewater
21191	Jim Hogg Co. WCID #	Jim Hog	application	State Revolving Fund	0	0	Wastewater
10277	La Grulla	Starr	application	Economically Distressed Are	0	0	Facilities Planning
20835	Laredo	Webb	07/21/1981	Development Fund	0	2,500,000	Wastewater
01456	Laredo	Webb	08/28/1985	Construction Grants Progra	3,294,966	0	Wastewater
20836	Laredo	Webb	10/18/1989	State Revolving Fund	0	1,700,000	Wastewater
10045	Laredo	Webb	04/18/1996	Economically Distress Areas	197,202	0	Facilities Planning
01961	Laredo	Webb	01/20/1996	Construction Grants Progra	8,200,000	0	Water & Wastewater
31130	Laredo	Webb	11/16/1995	Regional Planning & Project	200,000	0	Water Research
35144	Laredo	Webb	09/19/1996	Regional Planning & Project	100,000	0	Water Supply Plan
38053	Laredo	Webb	10/17/1996	Regional Planning & Project	260,000	0	Flood Prot Plan
10242	Rio WSC	Starr	04/17/1997	Economically Distressed Are	52,132	0	Facilities Planning
20852	Roma	Starr	05/09/1969	Development Fund	0	100,000	Water Supply
01313	Roma	Starr	06/28/1970	Construction Grants Progra	602,804	0	Wastewater
20853	Roma	Starr	11/19/1987	Development Fund	0	700,000	Water Supply
38047	Roma	Starr	10/19/1995	Regional Planning & Project	36,900	0	Flood Prot Plan
10043	Roma	Starr	02/17/1996	Economically Distressed Are	22,500	0	Facilities Planning
			08/20/1997	Combination	4,490,380	5,555,000	Water Supply
			08/20/1997	Combination	14,747,320	4,185,000	Wastewater
10156	Siesta Shores WCID	Zapata	11/20/1996	Economically Distressed Are	814,377	0	Water Supply
35143	South Texas Dev Cou	Webb	02/20/1997	Regional Planning & Project	100,000	0	Water Supply Plan
20857	Starr Co STW CD	Starr	05/11/1989	Development Fund	0	200,000	Water Conservation
40135	Starr Co STW CD	Starr	04/30/1990	Agricultural Conservation	3,933	0	Water Conservation
20847	Starr Co WCID #2	Starr	02/22/1968	Development Fund	0	418,000	Water Supply
20848	Starr Co WCID #2	Starr	08/20/1973	Combination	1,082,178	475,000	Wastewater
20849	Starr Co WCID #2	Starr	03/16/1989	Development Fund	0	600,000	Water Supply
20851	Starr Co WCID #2	Starr	05/21/1992	State Revolving Fund	0	2,310,000	Wastewater
35084	Starr Co WCID #2	Starr	12/12/1991	Regional Planning & Project	22,500	0	Water Supply Plan
10044	Starr Co WCID #2	Starr	02/17/1994	Economically Distressed Are	15,000	0	Facilities Planning
			10/19/1995	Economically Distressed Are	416,644	173,000	Water Supply
			10/19/1995	Economically Distressed Are	560,271	0	Wastewater
35038	Starr County	Starr	02/16/1989	Regional Planning & Project	50,000	0	Water & WW Plan
10197	Webb County	Webb	08/20/1997	Colonies Program Managem	49,200	0	Management Program
10201	Webb County	Webb	11/16/1995	Economically Distressed Are	75,000	0	Facilities Planning
10199	Webb County	Webb	01/18/1996	Economically Distressed Are	1,570,120	0	Wastewater
20858	Zapata Co WCID - H	Zapata	04/19/1990	Development Fund	0	760,000	Water Supply
01291	Zapata County	Zapata	02/06/1988	Construction grants Program	981,748	0	Wastewater
35105	Zapata County	Zapata	02/17/1996	Regional Planning & Project	30,000	0	Water & WW Plan
10159	Zapata County	Zapata	02/16/1995	Economically Distressed Are	51,000	0	Facilities Planning
	Totals				**38,026,175**	**20,488,000**	

Table 5-15
Common Utility Practices

Utility	Water Management	Facility Planning	Charges	Conservation	Comments
Zapata Water Works	Raw water is obtained from the Rio Grande (Falcon Lake) pumped by WW owned pumps through conveyance facilities to the treatment system	A USDA grant ($450,000) to improve the intake facilities including piping, stilling well and pumps has been approved. Construction should begin in the later part of '98. A grant package has recently been submitted to the TWDB ($9m) to upgrade and expand lines & treatment system.	The WW charges $7.50/4000gal plus $1.87/1000gal over the base up to 19,999/gal, $2.00/1000gal over 19,999gal up to 29,999gal and $2.50/1000 over 30,000gal. A rural water supply system is charged $1.00/1000gal up to the contract limit of 3.0m gal/mo.	The WW has a plan outlining multitiered responses to varying drought conditions. Notices are included with bills, published in area newspapers and posted in public places. In addition, waterworks personnel have presented conservation based programs to local schools	The following comments were given in order of Issues listed on orginal form. (1) the need exists for an additional wetwell (450,000gal cap.) to relieve overloading during high demand periods, (3)(a) raw water pumps need upgrading along with replacement of existing 10" & 12" lines from the lake to the plant with a 24" line to increase volume of flow, (b) an additional clarifier & filter are needed to upgrade plant capacity, (c) new lab building is needed to adequately house testing equipment currently required, & (d) replacement of 2" & 4" distribution lines, (4) modernized disinfection system needed to ensure continued adherence to all requirements, (5 & 6) covered above, (7) "no comment", (8) covered above, in addition, the Medina subdivision is not currently beight served, (9) additional water rights are needed to provide for future growth, (11) covered above.
La Grulla	Raw water is obtained from the Rio Grande (3mi. S. of La Grulla) & pumped by City facilities to the treatment plant.	No formal planning relative to increasing treatment capacity on-going at this time. A plant expansion to 2.0mgd was completed 4 yrs ago.	A faxed rate sheet to be provided.	The City does not conduct formal conservation activities. Notices relative to the need to conserve are posted & included with bills during periods of extreme shortages.	The City has not responded to the survey questions; however, a response is being formulated and will be submitted as soon as possible.

Table 5-15
Common Utility Practices

Utility	Water Management	Facility Planning	Charges	Conservation	Comments
City of Roma	Raw water is obtained from the Rio Grande (1/4mi. upstream from the Intl. Bridge) and pumped by city facilities to the treatment plant.	The City has been approved for TWDB EDAP funding ($29m - $10water, $29sewer); however, the completion date is '05. No engineer has been selected. The proposed projects should remedy problem areas identified in the survey.	The City will provide a rate schedule.	The City has both water shortage and drought plans. Both are actively enforced. Notice is given thru TV and included in the billing process. No educational programs exist at this time. Plans do include developing such programs.	The City provided adequate comment in the survey response.
Falcon Rural Water Supply	Raw water is obtained from the Rio Grande (3mi. downstream from Falcon Dam) pumped by WSC facilities to the treatment plant. In addition to entity owned water rights, water is purchased from other water districts.	The FHA has approved funds for expanding the treatment facilities. The final plans are to be completed and construction initiated during the later part of '98. Efforts are currently underway to obtain additional water rights needed in the near future.	The WSC charges $11.00/2000gal plus $2.00/1000gal over the base for residential customers. Commercial rates are $13.00/2000gal plus $3.00/1000gal over the base. Falcon State Park is served by this system.	The WSC does not conduct formal conservation activities. Notices relative to the need to conserve are sent to the customers during periods of extreme shortages.	The following comments were given in order of Issues listed on orginal survey form. (5) Treatment facilities are reaching maximum capacity. Expansion of treatment system is needed. (9) Additional water rights are needed in order to adequately serve growing population.
Starr County WCID No. 2	Raw water is obtained from the Rio Grande (1/2mi. upstream from the Intl. Bridge) pumped by district owned pumps thru WCID conveyance facilities to the treatment system.	No formal planning relative to increasing treatment capacity on-going at this time; however, the WCID has been holding discussions with their engineer to initiate the planning process.	The WCID charges $10.50/4000gal & an additional $2.55/1000gal over the base. Rural Water Supply Systems are charged $0.90/1000gal up to agreed contract volume (up to 2.0mg/mo.) & an additional $1.00/1000gal over the contract limit.	The WCID does not conduct formal conservation activities. Notices relative to the need to conserve are posted & included with bills during periods of extreme shortages.	The WCID provided adequate comment in the orginal survey response.

ASR Applications

Potential applications of ASR in the Laredo community include aquifer storage of raw, potable, or treated wastewater effluent for recovery at appropriate times. Based on a review of the City's water demand and water rights, it was assumed that the City needed 10MGD of additional storage to meet a 3-month supply of water during critical conditions. Candidate ASR applications included to meet this 10 MGD production included:

1. Storage of drinking water for use during periods of drought and/or poor water quality in the Rio Grande;
2. Storage of drinking water to normalize water treatment plant operations, delay WTP construction, and reduce the need for storage /pumping infrastructure in areas of high water demand;
3. Storage of raw water to optimize water use for water rights issues;
4. Treatment of reclaimed water for potable drinking water sources; and
5. Storage of RO-treated groundwater for net increase of City's water supply.

The report stated that the purchase of water rights was the least expensive option for acquisition of additional water. However, the compelling issue not addressed (and beyond the scope of the report) was what would happen if the rights were available, but the water was not.

A major obstacle to implementation of ASR in the Laredo community is a lack of understanding of the geology in candidate application areas. Further investigation is needed to quantify the storage and recovery characteristics of suitable aquifer zones; compatible geochemistry; and pumping and recovery efficiencies.

Recent interviews with the TWDB suggest this agency remains skeptical of the cost effectiveness of ASR technology for Laredo. It is clear that future funding opportunities from TWDB will be predicated on demonstration of the cost-effectiveness of this technology.

Reverse Osmosis Pilot Study

The City of Laredo has entered a pilot program to develop desalination facilities at the Santa Isabel well located west of the City off Mines Road. Originally designed to treat 100 gpm, the desalination plant membranes were fouled when the existing well was made deeper to expand the volume of pumping capacity. Evidently, the increased depth also increased the total dissolved solids of the source water. Originally, influent waters were near 1,500 mg/l total dissolved solids. When the well was drilled deeper, the source water approached 3,000 mg/L TDS. The current expenditure on the system is reported to be approximately $1,250,000 and the system needs a number of improvements to be successful.

5.2.4 Conservation Measures

5.2.4.1 Laredo

The City of Laredo has also embarked on a significant campaign to increase its efficient management of water. From 1988 to 1991, the average daily per capita water use in Laredo was 146 gpcd (compared to a statewide average of 174 gpcd and an average of 188 gpcd for the South Texas region). Even so, in 1994, the City set a goal of a 10% reduction in per capita use over the next five years.

Laredo's main reason for implementing conservation was that the City's water treatment plant was not large enough to provide adequate water supplies for area residents. Laredo has now upgraded its water treatment facility with an elevated storage system, booster station upgrades and repair, and new and expanded distribution system lines. Other non-structural measures that Laredo is taking to reduce wasted water include a new metering system, upgraded computerized monitoring and control systems, and the adoption of additional ordinances controlling waste.

The first issue of "Texas Water Savers," published during the spring of 1994 highlighted conservation program work conducted by Laredo. The article included mention of the following programs.

- Public awareness and education programs on conservation,
- Revised plumbing codes,
- Retrofit or replacement of inefficient water use devices,
- Rate structures that encourage conservation,
- Universal metering, meter repair and replacement,
- Xeriscaping, water audits, leak detection, recycling and reuse. (*Texas Water Savers*, vol. 1, no.1, 1994).

5.2.4.2 Other STDC Community Conservation Efforts

Beyond the conservation activities documented for Laredo, a search of TWDB records was performed to identify communities that held conservation plans, drought contingency plans, and related reporting. Additionally, interviews were conducted with respondents to the utility questionnaire to amplify on their respective conservation activities. Results of the investigation are compiled below by utility.

City of Roma

1) Has a Water Conservation Plan and Drought Contingency Plan in place. This plan stresses a voluntary program of compliance and does not stipulate specific drought circumstances or phased demand management rates intended to alter water use.
2) Has a stipulated goal to reduce water use by 10%. Reported unaccounted for water is estimated to be 18-23% of the total utility water use.

Starr County WCID No. 2

1) Has a Water Conservation Plan and Drought Contingency Plan in place. The drought contingency plan includes an appendix that identifies punitive rates between $10 and $200/day that will be levied against non-compliant water users.
2) The drought contingency plan has specific trigger points that incite three different responses to drought conditions corresponding to mild, moderate, and severe conditions. A water conservation rate structure has been set.
3) The goal of the conservation plan is to reduce water use by 15% or 21 gpcd. The goal of the drought contingency plan is to reduce water use by 35% or 49 gpcd.
4) A plumbing code has not been implemented.
5) The District has implemented public education programs to discourage excessive use of water.
6) Unaccounted water has been reported to range from 5-20% of the Districts water demand.

Zapata County Waterworks

1) Has a drought contingency and water conservation plan in place. Plan emphasizes public education.
2) The drought contingency plan has specific trigger points that incite three different responses to drought conditions corresponding to mild, moderate, and severe conditions. A water conservation rate structure has been set. A reopener clause in the trigger points section allows for annual revision of such points, as necessary.
3) The District doesn't have a plumbing code ordinance, but encourages water conserving plumbing fixtures.
4) Reported unaccounted for water has been reported between 5 and 18.2%.

5.3 Common methods available to meet water demands

Methods available to meet water demands can be classified into two general types: Supply management and demand management alternatives. As the name implies, supply management options increase the available water supply. Demand management alternatives, on the other hand, affect the demand for water. Traditional approaches to water supply management have focused on the supply side. The value of demand management options has gained recent support and is becoming a more important component of water management strategies. In particular, the water demands developed by the TWDB, and included in this report, implicitly incorporate conservation practices in the forecasts.

The following list outlines common available methods to meet water demand. The outline includes both demand management and supply management options. The supply management options are divided into three general subclasses: New or expanded facilities, improved operations, and inter-sector transfers. New or expanded facilities expand supply through the construction of storage, pumping and transportation, conventional treatment, and advanced treatment projects for surface water, ground water and wastewaters. Supply can also be expanded by improving the operations of utilities that supply water. While water transfers do not necessarily increase the total supply, water transfers can redistribute the water to users and result in increases in supply for given users, sectors, or basin. Demand management options include conservation/education programs, conservation pricing, structural modifications, regulatory programs and improved practices.

5.3.1 Supply Management

5.3.1.1 New or Expanded Facilities

1) 5.3.1.1.a. Surface Water
    - Storage
        - On-Channel Storage
        - Off-channel storage
            - Excess Rio Grande flows
            - Municipal Stormwater/flood control capture
    - Pumping/Transmission of Raw Water
    - Conventional Water Treatment
    - Advanced Water Treatment
        - Long term trend toward increasing salinity and general deterioration of water quality in the river
        - Short term increases in salinity during drought periods.
    - Distribution of treated water
2) 5.3.1.1.b Groundwater
    - Pumping/Transmission of Raw Groundwater
    - Conventional Water Treatment
    - Advanced Groundwater Treatment
        - Typically low quality/high saline content of groundwater resources in the area
    - Distribution.
3) 5.3.1.1.c Wastewater
    - Treatment/Reuse Facilities
    - Aquifer Storage and Recovery
    - Collection

5.3.1.2 Improved Operations

1) 5.3.1.2.a Surface Water
    - Reduced Storage (reservoir) Losses
    - Reduced Raw Water Pumping and Transmission Losses
        - Municipal
        - Agricultural
    - Improved Treatment Efficiency
    - Reduced Treated Water Distribution Losses
        - Municipal
        - Agricultural
    - Source Protection
    - Treaty/Compact Monitoring
    - Improved off-channel stormwater capture

2) 5.3.1.2.b Groundwater
- Reduced Storage (reservoir) Losses
- Reduced Raw Water Pumping and Transmission Losses
  - Municipal
  - Agricultural
- Improved Treatment Efficiency
- Reduced Treated Water Distribution Losses
  - Municipal
  - Agricultural
- Conjunctive Use of Surface and Groundwater
- Artificial Recharge
- Aquifer Protection
- Perfection of Groundwater Rights

3) 5.3.1.2.c Wastewater
- Reduced Collection System losses
- Return Flow Credits (regulatory changes)

5.3.1.3 Water Transfers

1) 5.3.1.3.a. Same Basin Inter-Sector Transfers
- Acquisition of Water Rights
- Contract Purchases
- Water Rights Leases
- Cooperative Agricultural Utility/Municipal Utility Investments that Share Benefits of Supply Enhancing Projects
  - Agricultural Reuse of Treated Municipal Wastewater
  - Improvements in the Operations of Water Districts Funded by Municipal Investments
- Removal of institutional constraints that provide disincentives to efficient water markets/transfers

2) 5.3.1.3.b. Interbasin transfers
- Surface Water
- Groundwater
  - Potential for significant political and environmental issues.

3) 5.3.1.3.c. International Transfers within Rio Grande Basin
- Cooperative Agricultural Utility/Municipal Utility Investments that Share Benefits of Supply Enhancing Projects
  - Agricultural Reuse of Treated Municipal Wastewater
  - Improvements in the Operations of Water Districts Funded by Municipal Investments
  - Treatment of Mexican wastewater in US in return for use of treated wastewater.
- Removal of institutional constraints that provide disincentives to efficient water markets/transfers (Judged politically infeasible in the past. Future options could be explored).

5.3.2 Demand Management

5.3.2.1 Conservation Education Programs for Sector Users

1) 5.3.2.1.a Municipal users
2) 5.3.2.1.b Industrial users
3) 5.3.2.1.c Agricultural users

5.3.2.2 Conservation Pricing

1) 5.3.2.1.a Municipal users
2) 5.3.2.1.b Industrial users
3) 5.3.2.1.c Agricultural users

5.3.2.3. Structural Modifications

1) 5.3.2.3.a Municipal users
   Plumbing retrofits
   Plumbing requirements for new developments
   Municipal reuse
2) 5.3.2.3.b Industrial users
   Industrial reuse
   Leak detection
3) 5.3.2.3.c Agricultural users
   Efficient Irrigation Systems
   Improved Crop Selections
   Tailwater capture and reuse.

5.3.2.4. Regulatory Programs

1) 5.3.2.4.a. Municipal Ordinances
   Landscape Ordinances
   Plumbing codes requiring more efficient water use devices
   Water Use Restrictions

2) 5.3.2.4.b Removal of Institutional Constraints that provide disincentives to Conservation (e.g., water charges proportional to amount used rather than flat prices).

5.3.2.5 Improved Practices

1) 5.3.2.5.a Municipal users
   Cooperative Municipal Utility/Domestic User Investments that Share Benefits of Conservation Projects

2) 5.3.2.5.b Industrial users
   Cooperative Municipal Utility/Industrial User Investments that Share Benefits of Conservation Projects

3) 5.3.2.5.c Agricultural users
   Cooperative Municipal/Agricultural Utility/Agricultural User Investments that Share Benefits of Conservation Projects
   Metering

5.4 Needs and Alternatives

This section outlines potential alternatives to address the water supply problems identified in section 5.1 within the context of the issues outlined in section 5.2 through 5.3. A summary of the principal issues discussed include:

1) Municipal water demand is the fastest growing sector of water use. Counterpart water uses are flat to declining. Current M&I water rights are not adequate to meet the growing M&I demand over the planning period. Municipal demand, however, can be met by the currently available Amistad-Falcon reservoir system if the water rights are available for conversion and purchase. A water rights acquisition strategy alone is not likely to be the most economically efficient strategy, and could lead to serious economic disruptions. Therefore, it should be considered as an integral part of an overall strategy that combines other demand and supply management options.
2) The major municipal demand is clustered about the urban centers in the region. Laredo is the largest urban center and shows the heaviest sustained growth through the period. Satellite communities have developed in the past but their expansion and development will be limited by available water supplies. Despite its size, Laredo is relatively isolated from other significant urban areas within STDC (e.g. Hebbronville, Rio Grande City, etc.). This means that water supply augmentation programs should be tailored to individual areas—not a single program force fit onto non-existent or inappropriate needs.
3) The region endures severe drought almost 30% of the time, and drought conditions 60% of the time. There is no expectation of any significant increase in area rainfall patterns through the planning period. The effect of climatic change over the planning is uncertain.

4) There is a trend of increasing salinity in the Rio Grande. There are also identified groundwater sources having brackish to saline water quality. With increasing water conservation measures, return flows will diminish and will tend to concentrate already increasing total dissolved solids concentrations in the Rio Grande. Increased salinity will also increase the treatment needs to render the water suitable for different uses.
5) The populace of the region is relatively poor. Emphasis should clearly be given to finding the most cost effective approaches to development of additional water supplies.
6) Development of Mexico's economy will stimulate increased demands for water as the local standard of living increases. Increasing water use and management sophistication in Mexico can be expected to reduce the existing volume of return flows to the Rio Grande.
7) Agricultural demands in the area will decrease over the planning period creating a surplus of irrigation water rights in the region. Since the Amistad-Falcon system is over-appropriated, however, the system's firm yield is insufficient to meet the agricultural demands. Estimated groundwater sources could be available to supplement the surface supply, but would likely require additional treatment costs. Options available to the agricultural sector include conservation, and development of cooperative investment strategies with municipalities to fund conservation measures.

The proposed alternatives can be grouped into four general types: Alternatives that provide additional surface water or groundwater sources; transfers (leasing/purchase) of water rights; demand management/conservation; and improved operations.

5.4.1 Transfers

5.4.1.1 Acquisition of Agricultural Water /Cooperative Municipal and Agricultural Investment Strategies

Conversion of agricultural water for municipal use is one of the principal sources of additional supplies for the municipal sector since agriculture represents the largest water use in the region. Agricultural demands in 1995 accounted for approximately 85% of the total LRGV and STDC region demand. Of the two regions, the LRGV agricultural demand was by far the most significant, accounting for almost 80% of the total system demand. Therefore, investigation of alternatives for tapping a fraction of this water is essential. There are both direct and indirect ways to tap this water. Both should be evaluated. Direct ways include simply the direct purchase of the water rights from candidate agricultural water right holders and water rights leases. Indirect approaches include the co-investment between municipal and agricultural sectors in water conservation measures, with the resulting water savings shared between them. Specific alternatives include:

1) Water right purchases
    a) Directly from irrigation water districts
    b) Directly from individual water users
    c) Potential partial trades of treated wastewater for irrigation rights
2) Cooperative Municipal/Agricultural water conservation investments
    a) Reduction in transmission losses from Rio Grande Diversion points
    b) Improved farm utilization
    c) Tail water capture and reuse
    d) Irrigation scheduling
3) Water Rights Leases
    a) Cash amount to offset capital expenditures and required profits
    b) Special leases during droughts (part of contingency agreements)
4) Dry-year Options and Water Delivery Contracts

Water right prices vary considerably in the area and range from $300 up to reportedly $2000/ac-ft (after conversion) depending on the location and the class; while structural investments for efficient water delivery systems can easily reach into the millions of dollars. Determining the best agricultural water acquisition strategies will require analytical decision tools, data collection, and data analysis platforms such as graphical information system (GIS) databases. Components of the database would include location, cropping patterns, soils, water delivery infrastructure, climatology, water pricing, and demographics related to the farming population. This data would be integrated with market water pricing, farm prices, land costs, costs of operation to identify candidate sites that can be targeted for a variety of alternative programs designed to tap agricultural water.

The programs could include preliminary designs for potential engineering works, conservation projects, evaluation of cropland viability, including quantification of the effects of salinity on farm pricing, and strategies for acquisition of water rights. In all cases, preliminary costs would be developed as input to the decision tool.

An equally important element of this strategy is the development of incentives to create the agricultural/municipal partnerships that will be required to meet the future region demands in the least economically disruptive manner. Conflicts between agricultural and municipal sectors can seriously hamper effective solutions. Development of effective incentive strategies can help to minimize the potential conflicts that could derail sensible, fair and cost effective water management strategies.

A novel example of this cooperative investment strategy was developed between California's Imperial Irrigation District (IID) and the San Diego County Water Authority (SDWA). The circumstances of the agreement are similar to STDC's in that the City of San Diego required additional water to meet its growing needs. Its source of water (90%) was the Municipal Water District (MWD) of Southern California. The District needed capital to implement conservation practices within its supply areas as well as additional water supplies. The result of negotiations between the Water Authority and District provide for the following major terms:

1. IID will transfer to SDWA conserved agricultural water for at least 45 years. Either party can extend the agreement by 30 years.
2. Water transfers will total 20.000 ac-ft in the first year and increment in subsequent years until a minimum volume of 130,000 ac-ft and a maximum of 200,000 ac-ft.
3. If IID determines there is a surplus of water available, it can transfer up to 100,000 ac-ft per year.
4. Pricing for the water paid to IID is based on the pricing paid to MWD. Basically, from the MWD price for water, delivery costs of transporting the water through the MWD aqueduct system are deducted. The price is then discounted at a rate of 25% the first year, and declining gradually to 5% in the 17th year where the discount is made firm.
5. If SDWA experiences water shortages during the course of the agreement, SDWA will pay IID a shortage performance premium for additional water received.
6. Pricing will not be able to fluctuate more than 25% over any ten year period. Also, pricing reviews are permitted at 10-year cycles.
7. Only water produced from agricultural conservation is allowed to be used for the transfers. Permanent following of land is not permitted. (This is an important feature that should be considered in the Starr County and the Lower Rio Grande Valley. The IID can get its water back in 75 years if SDWA doesn't build an aqueduct connecting IID to San Diego counties.
8. Reductions of water could occur at 2% per year and would be used to support projected municipal and industrial growth. If IID constructs an aqueduct connecting to IID, then IID loses the recapture provision and the agreement for water lasts 125 years.

It is commonly accepted that retirement of agricultural land to support increasing municipal growth is a logical path for increasing water supplies. However, patterns in world markets could change dramatically that practice. For example, the growth and increasing sophistication of the Pacific Basin countries could place a demand in the marketplace for increased agricultural production. Agricultural products ranging from beef, poultry, and pork to increased grains, and food crops could all act to dramatically increase the value of farmland and corresponding water rights. World market pricing could therefore have economic implications for future water pricing. A decision tool would be needed to integrate linkages between market pricing for agricultural goods, and the price of water.

Decision matrices developed to assess various candidate agricultural water source options should have a set of guiding criteria that prioritize the weight given to each option. Development of such criteria is expected to be iterative, and to include some of the following issues:

1) Demographics of irrigation districts
2) Economic value of crops
3) Amount of water available from the land on which the project is considered
4) Expected willingness of landowners and/or district staff to negotiate for water transfers
5) Estimated value of water to the irrigation district and/or landowners
6) Market value of water
7) Quality of water
8) Farm subsidy impacts
9) Other considerations, to be developed.

5.4.1.2 Mexico Transfers/Cooperation

Mexico has (and will continue to have) a significant impact on the quality and quantity of water available in the Rio Grande. Urbanization of communities along the border will lead to increased demands for water and programs to acquire the water. It is important to develop a thorough understanding of the Mexican agenda for water development in the region. Opportunities for cooperative programs for water development taking advantage of federally funded programs for new infrastructure, should be explored. It is recommended that a series of meetings be developed with the IBWC, CILA, and the Mexican Commission for Water (CNA) to pursue this process. Any candidate programs for water development borne out of the meeting process could be identified, and pending sufficient data available, evaluated with the decision tool. The potential for cooperative water conservation investments in the agricultural sector should be a priority in any discussions, as well as the potential for treating Mexican wastewater in return for its reuse in the U.S. Any of these actions would require binational agreement.

5.4.2 Demand Management/Conservation

Demand Management/Conservation is a critical component of the mix of alternative strategies that will be investigated. Water conservation modifies demand, not supply, and it is important to recognize that demand can be managed. Moreover, the analyses assessing the water supply problems in section 5.1 were based on water demand figures that included implicitly the implementation of conservation measures. Demand management/conservation options in the M&I sector include public education programs, summer watering restrictions, industrial/commercial recycling, plumbing retrofit programs, new construction conservation plumbing fixture requirements, and conservation pricing. In the agricultural sector, demand management/conservation options include more efficient irrigation techniques, better irrigation management practices, and conservation pricing.

Savings attributable to public education and conservation water rates have been documented to reach up to a combined 15% (9% public education and 6% for conservation pricing). Plumbing retrofit programs can produce savings ranging from 6 to 10 gpcd, while new construction plumbing retrofit programs can range from 13 gpcd to 26 gpcd.

Innovative partnerships between municipalities and municipal/industrial users, and municipalities/irrigation districts and irrigation users present untapped opportunities for financing the implementation of conservation practices in both sectors. In the case of municipal users, utilities can forego the capital and operational costs of additional capacity expansions by helping to finance the conservation practices of its users. In the case of agriculture, municipal utilities and irrigation districts both, can also avoid additional expansion costs by investing in the application of conservation technologies by irrigation users including efficient irrigation practices, facilities for capture and reuse of tailwater, and research in the use of drought tolerant and less water consumptive crops.

The majority of irrigation districts do not meter their individual water users. Charges are based on estimated rather than actual use. The introduction of metering for irrigation users could also provide incentives for conservation practices. At the same time, even with meters, pricing strategies should be conservation oriented.

A thorough evaluation of market costs and a determination of the pricing levels needed to support various levels of conservation, consumption, and alternative use strategies should be evaluated. Costs and benefits of each of the possible conservation practices should also be evaluated. This information should become an input to the decision tool enabling cost implications of selected strategies to be evaluated.

5.4.3 New or expanded Supplies

5.4.3.1 Innovative Treatment to Increase Water Supplies

There is an increasing trend in Rio Grande River salinity, prevalence of high salt concentrations in available groundwater, and the potential for wastewater reuse in the region. Together, these influences are a compelling argument to begin efforts to add desalination treatments to existing and new water treatment works.

Groundwater treatment, wastewater recovery and Aquifer Storage and Recovery (ASR) have each been considered individually in past studies. For example, a 1995 study sanctioned by the City of Laredo indicated that 4.6 billion gallons of wastewater (approximately 14,000 ac-ft) are discharged annually from the Zacate wastewater treatment plant. Assuming conservatively that a wastewater reuse facility would operate at 70% recovery, such a facility could potentially increase available resources by 20%. However, in addition to costs, there are clearly regulatory and consumer education issues associated with such a reuse scheme. These non-cost issues are likely to impact significantly the manner in which reuse is implemented in conjunction with other options for expanding water resources such as groundwater treatment and ASR. Moreover, the technologies for realizing these options and the markets for these technologies have matured considerably over the last 5 to 10 years and are likely to produce significant changes in both technical feasibility and cost. For example, the costs of modern desalination plants producing potable water lies within the reported range of costs reportedly paid within the STDC ($0.74 to $3 per thousand gallons). In addition, desalination may actually provide a technology that adds reliability to the water supply through treatment of both surface and groundwaters within the same facility. Recent trends in increased salinity in the Amistad Reservoir suggest that salinity levels may exceed 1,000 ppm by the year 2000. By comparison, the total dissolved solids in the Laredo formation average approximately 2,000 ppm. It is therefore essential that these options be revisited in an integrated context that includes up-to-date cost estimates of current technologies which allows for the evaluation of substitutability of the region's water resources.

Preliminary engineering designs should be developed to consider the different applications for desalination of water within STDC. Source waters could include groundwater, Rio Grande River water, and wastewater effluent. Cost curves should also be developed for desalination technologies including reverse osmosis as well as pressure driven membrane processes (microfiltration, ultrafiltration, and nanofiltration). Engineered applications of these technologies will be developed for various applications as front-end, polishing, or multi-source facilities. Least-cost options curves relating to treated volume, quality of produced water, and cost will be developed for each application scenario or blending scheme.

Optimization of existing water treatment plant unit operations should also be considered as a mechanism to achieve compliance with Safe Drinking Water Act. The cost of compliance will be compared using various control strategies, including membrane technologies to develop a least-cost estimate for meeting existing and proposed state and federal rules. Within existing regulations, small systems are defined as those supporting a population of 10,000 to 3,300. Systems having populations less than 3,300 are not anticipated to need this work. Based on the compiled facilities listing provided in table 4-8, candidate utilities to be evaluated would include Union Water Supply Corporation, La Grulla, City of Roma, Starr County WCID No. 2, City of Laredo, Webb County Utilities, and Zapata County Water Works. Considerations are expected to include elimination of DDBPs, sulfate control, radionuclide control (as appropriate), and turbidity controls designed to consistently produce 0.1-0.2 NTU water. Some communities such as Bruni, Texas may also be evaluated with to determine if alternative technology treatments could cause removal of arsenic and thus become economically attractive.

5.4.3.2 Additional Surface Sources

With the exception of channel dam proposed for the Brownsville area, which itself is the subject of controversy for both hydrologic and environmental concerns, the development of new major on-channel storage facilities is unlikely in view of current hydrologic, environmental and political concerns. The channel dam, even if approved, however, would not likely benefit this region. Although the treaty of 1944 between the US and Mexico governing the waters of the Rio Grande provides for one more major reservoir on the Rio Grande, any new reservoir would require bi-national agreement. Although there is a proposal for an on-channel dam in Webb-County, its use is specified to be primarily hydroelectric generation and recreation and not water supply development.

Off-channel storage of stormwater could provide additional supplies in urban areas. Off-channel storage would also be beneficial in capturing excess Rio Grande flows due to intervening floodwaters that would otherwise go unused due to current lack of storage facilities. This alternative would require the evaluation of the costs of additional storage facilities and treatment, together with estimates of the potential storage/yields of the new facilities. The level of treatment would need to be evaluated for different end uses.

5.4.3.3 Additional Groundwater Sources

There is relatively poor definition of local aquifers as well as undefined assessments of the level of water well contamination within the STDC. Webb County has engaged the USGS to refine groundwater information within the county. However, there was not evidence of counterpart studies being planned or contemplated for Starr, Jim Hogg, or Zapata County. Efforts should be expended to better define available aquifer conditions about communities in these regions. A well survey, oil well drilling log investigation, investigation of TNRCC contaminated site data files, and water well sampling should be performed to acquire refined information on the availability, reliability, and relative quality of groundwaters to be tapped. Candidate sites for well retrofit and/or new well construction should be identified together with preliminary costs to provide alternative pumping, treatment, storage, and distribution systems. Comparisons could be made between costs of local on-site systems versus regional systems, as appropriate. Additional input information for this sector of decision model development would be projected local population growth patterns, economic indices, and comparisons with developed estimated pricing to provide alternative surface water delivery systems.

Within this sector of analysis, available costs and information for aquifer storage and recovery technology applications together with developed costs for alternative treatment and delivery schemes will be integrated into the decision tool. Although the existing cost analysis performed in Webb County was fairly extensive in its consideration of alternatives, the analyses did not consider the intrinsic value (cost) of the water that would be tapped /stored. The decision tool will refine these analyses through consideration of water values as well as developing an estimate of the cost at which the ASR options would actually be less expensive than purchase of water rights. While ASR does not produce any additional water, it can optimize the amount of water used through elimination of evaporation losses, and inefficient distribution of system waters (can eliminate excessive pumping costs, and costs of local storage). These issues should be reconsidered pending a finding that the technology is viable during the course of the next phase of work.

5.4.3.4 Weather Modification

When observing the results of a twenty-year program of weather modification implemented outside of San Angelo, Senator Junell of San Angelo was compelled to sponsor legislation-providing funding for this technology in the state. Currently, the STDC region has an allocation of 4.25 cents per acre allocated to its designated region for weather modification programs in 1998. Although the availability of this money will expire around April 1998 without matching funds, 4.5 cents per acre is allocated from the biennial funding process for 1999. Furthermore, it is anticipated that a bill will be introduced during the 76th legislature to enact a $1 tax on every acre-foot of water sold in the state to fund expanded programs for weather modification in the state. Anticipated revenues from this activity alone suggest about $50 million will be made available annually for funding of weather modification activities.

STDC stakeholders have been present to witness the benefits of weather modification in presentations made by the TNRCC. It is clear that this technology holds certain promise in increasing overall soil moisture in the region. Results are not immediate and catastrophic rainfalls are not characteristic of the precipitation spawned by application of condensation nuclei (silver iodide or hygroscopic flares). Typically, observable results take a minimum of two to 5 years to become apparent.

An apparent difficulty in pursing weather modification is its relatively intangible benefits. The program is begun with the expectation that recipients will enjoy flowing streams, increased crop yields, and more water in the reservoir. Due to the delay between initiation of the programs and realization of benefits, non-subscribers are somewhat reluctant to begin the process.

One way to eliminate some of the guesswork is to quantify the potential benefits as they might accrue within the STDC. This could be performed by using benchmark studies performed in West Texas and extrapolating the costs and results to the

STDC region. The benefits, both direct and indirect, would then be valued in the context of a range of water market costs and made another alternative for additional water supply evaluated by a decision tool.

5.4.4 Improved Operations

5.4.4.1 Improved Reservoir Operations

The LRGV Phase II study is addressing the potential improvements in operational efficiency of the Amistad/Falcon reservoir system. Issues involve optimization of release patterns, including inter-reservoir transfers and power generation releases. Some aspects not addressed, however, including sinkhole losses in Amistad. There are known sinkholes in Amistad during period of low storage. The potential exists for the existence of other sinkholes in the system. The extent of losses from sinkholes has not been quantified and should be addressed.

5.4.4.2 Return Flow Credits

This is more of a factor in the Middle Rio Grande as opposed to the LRGV where the watershed is very small on the US and the majority of the wastewater flows do not return to the Rio Grande. This would also require international agreements between Mexico and the US regarding ownership of the return flows. Otherwise it is an unmeasured gain and would be split 50/50 between Mexico and the US as pre treaty provisions. Historically legislation to allow the City of Laredo has been opposed by the Lower Rio Grande Valley. The potential benefits to this region could be significant and efforts to quantify the benefits and costs of this option as a basis to promote and support the passing of this legislation should be pursued.

5.4.4.3 Reduction in Delivery Losses In Raw Water Conveyance Systems

Reduction in water losses from the point of diversion to the point delivery can be significant and could provide additional water savings in both the municipal and agricultural sectors. Innovative partnerships between municipal and agricultural entities have been discussed above. In the case of the municipal sector, additional benefits could also accrue by developing systems specifically designed to carry the smaller municipal demands. The current conveyance systems were designed to deliver large volume agriculture water. In times of drought and severe drought, which this area experiences 30% and 60% of the time, respectively, the existing facilities for delivering irrigation water are inefficient for delivering the smaller municipal quantities. Larger volumes that are subject to greater losses are used strictly to transport the municipal water.

Water Audits

Municipal water utilities have many opportunities for losses to occur in their treatment/distribution systems. Depending on the size of the system and loss rates, recovery of losses could be an effective capacity (and revenue) boosting activity. Often, it is considered too expensive to investigate losses (the investigation costs more than the benefits derived). While this may be true when there are ample supplies of water and drought is not a question, water budget audits may make sense in the STDC case.

Screening studies are recommended to compare system capacities to metering and pressure data to estimate system losses. Estimated losses could then be related to scenarios of different water pricing to demonstrate at what level of pricing loss recovery could be cost effective. In the event pressure and flow data are not available, temporary monitoring projects designed to evaluate gross system response should be implemented to support input to the decision tool and evaluations of alternatives to boost water supply.

Source Protection

The emphasis on new sources has historically diverted attention from the protection of current sources. Water quality deterioration of surface source can and will extract additional costs to the use of existing sources. Increasing salinity of the Rio Grande waters is of particular concern, especially during drought and low flow conditions. The costs and benefit of source protection programs for surface and groundwater supplies should be addressed. These efforts should also include the evaluation of the relative effects of waste loads to the region, including from Mexico, to ensure protection of the region's water supply. They should include the integration of source protection programs with the TNRCC's mandated Total Maximum Daily Load (TMDL) program that has yet to be implemented within the River Basin. This program could also involve evaluation of nonpoint source-type pollutant potential from low-income areas as described in section 5.1.6.

Compact/Treaty Monitoring

The sharing of water between the different jurisdictions in the upper reaches of the Rio Grande has been problematic for over 100 years. Recently, it was estimated that Texas should have received approximately 400,000 ac-ft/year that it didn't get from sharing agreements between Texas and New Mexico and New Mexico and Colorado *(Harvey Hutchinson, personal communication, January 1998).* Evidently, there are a number of wells that are interfering with the flow of the Rio Grande, but are not being calculated into the depletions that are allowed under the Rio Grande Compact. The largest of the wells lies in the San Luis Basin in Colorado, where the Rio Grande originates. Texas is likely insensitive to this loss of water due to its fundamental lack of regulation of groundwater. However, there are groundwater control regulations in both New Mexico and in Colorado that could be used to support a case to suspend the pumping operations and free the water due Texas.

Covenants incorporated into the Rio Grande Compact and 1944 Treaty could be used to pursue this potential release of water to Texas. A database sufficient to demonstrate this effect should be created from available river operations data in New Mexico and Colorado. A simple spreadsheet program would be adequate to compile the data and then to estimate effects of this release of water on the STDC region. Pursuit of the clarification of water not released to Texas is recommended as a component of the next phase of the project with evaluations of impacts of the findings using a decision tool.

The same spreadsheet model used to monitor flows from the upper regions of the Rio Grande could also be used to test the compliance of the US and Mexico with its 1944 treaty agreements. It is recommended that this ancillary set of data and calculations be collected to demonstrate the potential impacts of reservoir operations on the STDC.

5.4.5 Decision/Screening Tool

A key, and final element in the development of an effective long-term water resource plan for the STDC region is the development of a decision/screening tool. This tool would predict the best combination of the alternatives outlined above, as well as specify project sequencing in time and location. Piecemeal studies of disparate options, such as water right acquisitions, water reuse and water conservation, are not especially helpful. What is required is an integrated evaluation together with a consistent selection criterion. Moreover, since some alternatives impact water supply costs while others impact benefits received by water users, the decision/screening tool should be developed so that it: (1) allows the selection of the sequence of alternatives that yield the maximum economic benefits to the region; (2) allows the evaluation of the economic benefits from points of view of the different players in the region; (3) provides a screening process to complement the economic benefits of the alternatives by considering environmental, socio-economic and regulatory criteria in an open public participation process; and (4) provides an explicit consideration of the uncertainties in the planning effort (e.g., demands, climatic change) to facilitate the development of robust water management strategies.

5.5 Phase II Scope of Work

The objective of the proposed scope of work is to plan and implement projects for effectively managing water resource demands in the STDC region. A number of potential alternatives have been identified in section 5.4. The important question is how to screen, select and sequence the alternatives both in time and space to meet the water supply needs of the planning area in an economically efficient manner..

The proposed approach is based on the development and implementation of a integrated resource plan (IRP). The proposed (IRP) approach emphasizes the integration of supply management as well as demand management options within a planning framework that recognizes economic benefits and costs, as well as environmental impacts within an open and participatory decision making process. The proposed scope of work consists of ten tasks and is preliminary. Task 1 of the scope involves the review of the scope of work with the different stakeholders in the planning region. Changes developed during the review will be incorporated into a modified scope.

SCOPE OF WORK

Task 1. Define Plan Objectives

- 1.1 Identify different stakeholders in the region
- 1.2 Identify goals and objectives for the different stakeholders in the region
- 1.3 Develop draft measurable criteria based on goals and objectives identified in task 1.2
- 1.4 Prepare draft plan scope to address stakeholder objectives and measurable criteria developed in tasks 1.2 and 1.3.
- 1.5 Distribute draft evaluation criteria and plan scope to stakeholders
- 1.6 Develop final criteria and plan scope based on stakeholder comments.

Task 2. Define baseline conditions for the planning region

- 2.1 Water treatment and delivery system conditions
  - 2.1.1 Baseline infrastructure conditions
  - 2.1.2 Baseline financial conditions
  - 2.1.3 Baseline rate structures
  - 2.1.4 Baseline regulatory compliance
- 2.2 Baseline environmental conditions
  - 2.2.1 Baseline water quality conditions
  - 2.2.2 Environmental constraints
- 2.3 Baseline Socio-Economic Conditions
- 2.4 Water institutional organizations

Task 3. Develop baseline and future demands for each of the demand (e.g., municipal/industrial, agricultural) sectors in the region.

- 3.1 Identify demand sectors.
- 3.2 Establish target levels of reliability and water quality.
- 3.3 Develop sector demands (average and peak) for alternative target levels of reliability and quality.
- 3.4 Forecast sector demands developed in task 3.3 for the planning horizon period.

Task 4. Develop preliminary screening alternative supply options for each supply source in the planning region.

- 4.1 Identify existing and potential water supply sources.
- 4.2 Perform preliminary screening of alternative options available for developing each supply source
- 4.2.1 Identify structural (supply side) options available for augmenting supply sources.
- 4.2.2. Evaluate alternative options identified in task 4.2.1.
- 4.2.2.1 Evaluate technical feasibility for each option identified in 4.2.1
- 4.2.2.2 Evaluate incremental supply yields for each option identified in task 4.2.1
- 4.2.2.3 Evaluate benefits and costs for each option identified in task 4.2.1
- 4.2.2.4 Identify and evaluate environmental impacts for each option identified in task 4.2.1
- 4.2.2.5 Identify and evaluate societal impacts for each option identified in task 4.2.1
- 4.2.2.6 Identify and evaluate regulatory feasibility for each option identified in task 4.2.1
- 4.2.2.7 Perform preliminary screening of alternatives for effectiveness and feasibility
- 4.3 Select candidate supply side options for each supply source.

Task 5. Develop preliminary screening alternative demand management options for each demand source in the planning region.

5.1 Identify existing and potential water demand sectors.
5.2 Perform preliminary screening of alternative demand management options available for each demand sector
5.2.1 Identify demand management options available for augmenting supply sources.
5.2.2. Evaluate alternative options identified in task 5.2.1.
5.2.2.1 Evaluate technical feasibility for each option identified in 5.2.1
5.2.2.2 Evaluate incremental water savings for each option identified in task 5.2.1
5.2.2.3 Evaluate benefits and costs for each option identified in task 5.2.1
5.2.2.4 Identify and evaluate environmental impacts for each option identified in task 5.2.1
5.2.2.5 Identify and evaluate societal impacts for each option identified in task 5.2.1
5.2.2.6 Identify and evaluate regulatory feasibility for each option identified in task 5.2.1
5.2.2.7 Perform preliminary screening of alternatives for effectiveness and feasibility and select candidate options.
5.3 Select candidate demand management options for each demand sector.

Task 6. Develop and evaluate water supply strategies that maximize net economic benefits under alternative jurisdictional scenarios for current conditions.

6.1 Develop alternative water supply strategies consisting of the integration of the supply and demand management alternatives identified in tasks 4 and 5 under current conditions.
6.2 Evaluate the cost effectiveness of each of the strategies identified in 6.1 under alternative viewpoints, including a) individual cities/ratepayers; b) individual county levels; c) sub-region levels; and d) regional level.
6.3 Rank alternatives according to incremental costs and benefits.

Task 7. Compare alternatives identified in Task 5 with current conditions to identify the impact of existing institutional, regulatory and technological constraints.

7.1 Compare current conditions with the alternatives baseline alternatives developed in Task 6.
7.2 Determine economic inefficiencies associated with current conditions vis-a-vis developed baseline alternatives. If inefficiencies are sufficiently high, identify the institutional, technological, regulatory constraints that restrict the development of the more efficient alternatives.
7.3 Develop alternative strategies that address the applicable institutional, technological, and regulatory constraints identified in Task 7.2.

Task 8. Develop and evaluate alternative water supply strategies at the city, county, sub-region and regional level to meet the region's water demands over the planning horizon taking into account the modification developed in Task 7.

8.1 Develop alternative water supply strategies to meet the region's water demands over the planning period, including the sequencing of implementation and financing strategies.
8.2 Evaluate each of the strategies developed identified in tasks 8.1 under alternative viewpoints, including a) individual cities/ratepayers; b) individual county levels; c) sub-region levels; and d) regional level.
8.2.1 Evaluate the incremental benefits and costs of each alternative strategy.
8.2.1.1 Evaluate incremental costs
8.2.1.2 Evaluate incremental benefits
8.2.1.3 Evaluate rate impacts
8.2.1.4 Evaluate equity impacts
8.2.2 Identify and evaluate environmental impacts for each alternative strategy.
8.3 Develop preliminary rankings of alternatives according to impact analysis in task 8.2 and criteria developed in task 1.
8.4 Prepare Draft Report summarizing alternative strategies, impacts and preliminary rankings.

Task 9. Present alternative strategies and impacts to planning area stakeholders.

- 9.1 Develop Public Participation Plan
- 9.2 Prepare background information and presentation materials
- 9.3 Conduct public participation meetings with planning area stakeholders.

Task 10. Finalize alternative strategies/rankings.

- 10.1 Revise alternative strategies to incorporate comments received from stakeholders in task 9.
- 10.2 Revise evaluations of alternatives.
- 10.3 Finalize alternative strategies and rankings.
- 10.4 Develop Scope of Work for Phase III.
- 10.5 Prepare Phase II final report.

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Appendix A
TNRCC Recorded Water Rights Effective August 11, 1997

Name	WR Number	Type	County	Use	Amount in Ac-Ft/Yr	Remarks
FALCON RURAL WATER SUPPLY CORPORATION	000675	6	Starr	1	14.000	PURPOSE, PLACE & POFD 6-11-75
RICHARD GARZA ET UX	002430	6	Zapata	1	1.500	9/7/88
LENDOL C BARKER ET UX	002426	6	Zapata	1	1.500	AMEND 9/18/86
JUAN A & ROSA MARIA GUEVARA	002810	6	Zapata	1	1.500	
DONALD L HAYES ET UX	002426	6	Zapata	1	1.500	RATE SEE 2421, AMEND 11/9/84
ALBERT J LONG	002423	6	Zapata	1	1.000	8/16/88
JAMES W WOLFE	002807	6	Zapata	1	3.500	
FAR POINT ESTATE	002752	6	Zapata	1	3.000	
DELUXE HOMES INC	002803	6	Zapata	1	4.000	
DAVID W WEILER ET UX	002719	6	Zapata	1	5.000	
DAVID G DELORME ET UX	002808	6	Zapata	1	8.000	
DAVID G DELORME ET UX	002809	6	Zapata	1	8.000	
BEULAH M BALLARD	002801	6	Zapata	1	9.500	
ZAPATA COUNTY WATER WORKS	002802	6	Zapata	1	14.000	
DOYLE FLYING SERVICE INC	002806	6	Zapata	1	16.000	
CITY OF LAREDO	002783	6	Zapata	1	50.000	OUT OF 124 AC FT, AMEND 4/9/92
INTERNATIONAL BOUNDARY & WATER COMM	003270	1	Zapata	1	150.000	
SIESTA SHORES WCID	000346	6	Zapata	1	165.000	AMENDED 7/25/97: USE 3 TO 1 & DIV POINT
SAN YGNACIO MUD	002785	6	Zapata	1	234.000	AMEND 7/14/87, 4/19/91
ZAPATA COUNTY WATER WORKS	002804	6	Zapata	1	1,770.200	AMEND 6/10/87,10/22/92,8/11/95,2/16/96
CLARENCE HOLT ET UX	002435	6	Webb	1	0.500	
MR & MRS A C DURIVAGE	002428	6	Webb	1	1.000	RATE SEE 23-2421, AMEND 7/14/87
CITY OF LAREDO	002717	6	Webb	1	3.000	RATE 23-2715, 6/17/88
CITY OF LAREDO	002722	6	Webb	1	27.000	9/29/88
BRISCOE RANCH INC	002694	6	Webb	1	50.000	STOCKRAISING
CITY OF LAREDO	002716	6	Webb	1	59.000	AMEND 1/26/88
CITY OF LAREDO	002436	6	Webb	1	100.000	RATE SEE 23-2740, 2/26/90
CITY OF LAREDO	002723	6	Webb	1	100.000	RATE 23-2722, 9/18/86
CITY OF LAREDO	002729	6	Webb	1	103.000	11/29/84,6/18/86,9/18/86
CITY OF LAREDO	002750	6	Webb	1	162.000	5/25/84, 9/18/86
CITY OF LAREDO	002707	6	Webb	1	198.000	AMEND 6/22/88
WEBB COUNTY	002720	6	Webb	1	307.000	AMEND 12/23/86, 8/31/87, 10/17/97
CITY OF LAREDO	002739	6	Webb	1	340.000	6/18/86
CITY OF LAREDO	002731	6	Webb	1	529.000	11/29/84,6/18/86,9/18/86
CITY OF LAREDO	002738	6	Webb	1	700.000	AMEND 9/18/86
CITY OF LAREDO	002732	6	Webb	1	800.000	RATE 2730, 6/18/86
CITY OF LAREDO	003997	6	Webb	1	40,042.683	LAST AMENDED 4/18/97
VAQUILLAS RANCH CO LTD	003929	1	Webb	1		DOMESTIC & LIVESTOCK
CITY OF LAREDO	003997	6	Webb	1		LAST AMENDED 4/18/97
CITY OF LAREDO	003997	6	Webb	1		LAST AMENDED 4/18/97
CITY OF ROMA	000730	6	Starr	1	7.380	AMEND 5/2/86
FALCON RURAL WATER SUPPLY CORPORATION	000603	6	Starr	1	10.000	PURPOSE, PLACE & POFD 6-11-75
FALCON RURAL WATER SUPPLY CORPORATION	000646	6	Starr	1	10.000	PURPOSE, PLACE & POFD 6-11-75
TOWN OF GARCENO	000862	6	Starr	1	13.000	
TOWN OF FRONTON	000861	6	Starr	1	13.000	
FALCON RURAL WATER SUPPLY CORPORATION	000673	6	Starr	1	20.000	PURPOSE, PLACE & POFD 6-11-75
FALCON RURAL WATER SUPPLY CORPORATION	000699	6	Starr	1	25.000	CHANGE PLACE & PURPOSE OF P OF D
SUNNYDEW WATER SUPPLY CORPORATION	000138	6	Starr	1	50.000	11/14/86 (HIJ). AMND N: 1/21/92. CO 245.
UNION WATER SUPPLY CORPORATION	000640	6	Starr	1	79.000	AMEND 12-1-86
UNION WATER SUPPLY CORPORATION	000251	6	Starr	1	125.000	AMENDED 1/3/97: USE 3 TO USE 1 & PLACE
CITY OF LA GRULLA	000863	6	Starr	1	466.553	AMEND 6/88,7/89,4/91,2/96,10/11/96
CITY OF ROMA	000814	6	Starr	1	775.000	AMEND 5/2/86
STARR COUNTY WCID NO 2 MUD	000851	6	Starr	1	2,956.081	3&7&8/87.10/88.9&10/89.12/95.7/12/96(3).
CENTRAL POWER & LIGHT CO	002727	6	Webb	2	2,194.500	AMEND 9/18/86, 2/7/97
CENTRAL POWER & LIGHT CO	002727	6	Webb	2		AMEND 2/7/97. 731 AF OF THE 2195.
FLOYD ADAMS ET UX	002429	6	Zapata	3	1.000	RATE SEE 23-2421, AM 10/25/83
C O RIVES	002718	6	Zapata	3	1.000	FOR RATE SEE 23-2715
TROY D WELDON	002431	6	Zapata	3	2.000	RATE 23-2421, 08/31/83, 5/2/88
HOMERO ELIZONDO ET UX	002800	6	Zapata	3	3.000	AMEND 4/2/93
ELENA F STOKES	002804	6	Zapata	3	4.750	AMEND 2/14/89, 10/22/92
HORACE OWENS	002792	6	Zapata	3	5.000	SEE 2790 RATE
CYRUS B REYNOLDS ET UX	002725	6	Zapata	3	5.000	
CESAR A MORALES ET UX	002781	6	Zapata	3	5.000	SEE 23-2782 FOR RATE
GREGORIO DAMIAN & MARIA GOMEZ	002652	6	Zapata	3	6.000	AMEND 5/18/88
W K KING	002783	6	Zapata	3	29.000	SEE 23-2782 FOR RATE, AMEND4/92
ROSA C MARTINEZ	002787	6	Zapata	3	30.000	
REFUGIO RAMIREZ ET AL	002797	6	Zapata	3	47.000	
ROBERT MULLER LTD	002796	6	Zapata	3	49.000	
FERNANDO GUTIERREZ ET AL	002781	6	Zapata	3	51.000	RATE SEE 23-2782, AMEND 8/7/84
OSCAR GUTIERREZ	002800	6	Zapata	3	56.000	
SALVADOR GARCIA	002658	6	Zapata	3	58.000	
KNAPP-SHERRILL CO	002778	6	Zapata	3	75.000	
JORGE & IRMA CANALES URIBE	002793	6	Zapata	3	76.000	AMEND 5/18/88
MARIA EVA URIBE RAMIREZ	002791	6	Zapata	3	86.000	SEE 23-2790 FOR RATE
ROWENA M DILLON TRUSTEE OF MCNEEL	002779	6	Zapata	3	122.000	AMEND 10/31/84
REFUGIO RAMIREZ ET AL	003313	1	Zapata	3	140.000	
GUADALUPE MARTINEZ ET AL	002788	6	Zapata	3	168.000	
DELFINO LOZANO JR ET AL	002784	6	Zapata	3	171.000	
HAGCO BUILDING SYSTEMS INC ET AL	002794	6	Zapata	3	221.000	
ROBERTO VIDAURRI	002775	6	Zapata	3	230.200	AMEND 5/92, 6/93
MARIA LUISA VIDAURRI STOTT	002775	6	Zapata	3	250.200	AMENDED 2/92, 73/95
GERARDO VIDAURRI ET AL	002775	6	Zapata	3	260.200	
AMANDA G RASH	002799	6	Zapata	3	317.000	AMEND 5/31/85
MARIA VIDAURRI HERBST ESTATE	002775	6	Zapata	3	495.400	AMEND 12/1/86, 4/12/94
EL CAMPO FARM COMPANY	002786	6	Zapata	3	854.000	SEE 23-2787 FOR RATE
EL CAMPO FARM COMPANY	002786	6	Zapata	3	854.000	SEE 23-2787 FOR RATE
LANNIE MECOM	002780	6	Zapata	3	1,025.000	AMEND 1/30/95
ZAPATA-~~FENDER~~ LLC	~~002777~~	6	Zapata	3	1,299.000	
TEXAS A&M UNIVERSITY SYSTEM	002776	6	Zapata	3	1,353.000	
KNAPP-SHERRILL CO	002778	6	Zapata	3	2,036.000	
T C MILLER	002432	6	Webb	3	1.000	RATE 23-2421, 9/29/83
T C MILLER	002435	6	Webb	3	1.000	AMEND 9/29/83, CLASS A
ROMEO R RAMIREZ	002435	6	Webb	3	1.000	
RAUL R ESPARZA	002435	6	Webb	3	1.000	
MR & MRS PARIS A MIMS	002427	6	Webb	3	1.000	FOR RATE SEE 23-2421
MONTE E MCDANIEL	002435	6	Webb	3	1.000	
M L CAVE	002435	6	Webb	3	1.000	AMEND 5/17/84, CLASS A
LAM INVESTMENTS CO	002435	6	Webb	3	1.000	RATE SEE 23-2421
JOSEPH E MILLS	002435	6	Webb	3	1.000	AMEND 9/20/83, CLASS A
JAVIER REYES ET UX	002435	6	Webb	3	1.000	AMEND 5/3/84, CLASS A
JAMES L JARRETT ET UX	002435	6	Webb	3	1.000	AMEND 8/31/84, CLASS A
J E BRAVO	002421	6	Webb	3	1.000	7/3/84,8/16/86,6/26/86
GAYLEN GILBREATH	002425	6	Webb	3	1.000	RATE SEE 23-2421,; 8/83, 9/94
FREDERICK J KILIAN ET UX	002435	6	Webb	3	1.000	AMEND 3/20/83, CLASS A
DAN AUGUST RICHTER	002435	6	Webb	3	1.000	
CHARLES L WALTER & RUTH F WALTER	002434	6	Webb	3	1.000	RATE 23-2421, 3/22/88
C E & EVELYN DEYO	002433	6	Webb	3	1.000	RATE 23-2421, AMEND 2/18/88
ALBERT & FRANCES MUEHSAM	002424	6	Webb	3	1.000	RATE 23-2421, AMEND 2-17-84
A T DODD	002435	6	Webb	3	1.000	
JAIME GONZALEZ ET AL	002422	6	Webb	3	2.000	TO BE AMENDED
HECTOR F LOPEZ	002435	6	Webb	3	2.000	
ADAM LOPEZ	002435	6	Webb	3	2.000	
THOMAS G WILSON	002701	6	Webb	3	3.000	SEE 23-2700 FOR RATE
CYRIA O CONVERSE	002422	6	Webb	3	3.000	
JULIO PEREZ ESTATE	002737	6	Webb	3	4.000	

Appendix A
TNRCC Recorded Water Rights Effective August 11, 1997

Name	WR Number	Type	County	Use	Amount in Ac-Ft/Yr	Remarks
CLEMMACO LTD	002711	6	Webb	3	4.298	TO BE AMENDED
RICHARD E HAYNES ET AL	002422	6	Webb	3	5.000	
PATRICIA B SANDITEN	002704	6	Webb	3	8.500	
JOHN E & BETTY JEAN FITZGIBBON	002702	6	Webb	3	9.000	SEE 23-2700 FOR RATE
AGUSTIN VELA	002771	6	Webb	3	9.000	AMEND 12/15/86
LEYENDECKER MATERIALS INC	002435	6	Webb	3	10.000	
LEONEL GONZALES	002422	6	Webb	3	10.000	
ONE RIVER PLACE HOMEOWNERS ASSN	002754	6	Webb	3	12.000	
ADAM VOLPE	002421	6	Webb	3	13.000	
GARY WAYNE WILKINSON	002700	6	Webb	3	14.000	
ARTURO VOLPE	002704	6	Webb	3	15.000	
THOMAS G WILSON	002700	6	Webb	3	17.000	AMEND 11/23/92
PABLO HERNANDEZ	002753	6	Webb	3	19.000	
ONE RIVER PLACE HOMEOWNERS ASSN	002766	6	Webb	3	20.000	
JAMES HAYNES JR	002704	6	Webb	3	20.000	AMEND 2/10/86
INTERNATIONAL BANK OF COMMERCE	002704	6	Webb	3	20.000	
AUGUST C RICHTER ET UX	002700	6	Webb	3	20.000	
ANZON INC	002733	6	Webb	3	24.000	
WEBB COUNTY	002422	6	Webb	3	25.000	TO BE AMENDED
CANDELARIO SOLIS	002724	6	Webb	3	25.000	
LAREDO MUNICIPAL JR COLLEGE DIST	002742	6	Webb	3	31.000	AMEND 8/28/91
BRASK-DUMONT RANCH INC	002421	6	Webb	3	32.000	
GARY WAYNE WILKINSON	002703	6	Webb	3	33.000	SEE 23-2700 FOR RATE
CITY READY MIX INC	002700	6	Webb	3	36.000	
JAVIER EMILIO GARZA ET AL	002711	6	Webb	3	36.035	
ADAM VOLPE	002421	6	Webb	3	37.000	AMEND 6/26/85
HOLDING INSTITUTE INC	002735	6	Webb	3	39.000	
RICHARD E HAYNES ET AL	002716	6	Webb	3	40.000	1/29/85,8/16/86,10/28/86
ARMADILLO CONSTRUCTION CO INC	002704	6	Webb	3	42.000	RATE 23-2700, 5/2/88
SHERRY R LEWIS ET AL	002812	6	Webb	3	50.000	
RALPH VALLS	002760	6	Webb	3	50.000	
PATRICIA B SANDITEN	002422	6	Webb	3	52.000	TO BE AMENDED
RANDOLPH SLAUGHTER ET AL	002743	6	Webb	3	56.000	
GEORGE F LINK	002750	6	Webb	3	75.000	
FLORENCE G ARCE	002711	6	Webb	3	75.667	AMENDED 4/29/94
NIXON RANCH PARTNERSHIP	002710	6	Webb	3	80.000	AMEND 8-19-93
EFIGENIA C VDA DE MARTINEZ	002770	6	Webb	3	87.000	
VIMOSA II	002422	6	Webb	3	94.000	TO BE AMENDED
FRANCIS RICHTER FARM PARTNERS	002748	6	Webb	3	100.000	
LAWRENCE A MANN TRUSTEE	002422	6	Webb	3	118.000	RATE 23-2421, 7/83, 6/89
THE HAIZLIP RANCH LP	002705	6	Webb	3	120.000	
ARTURO VOLPE ET UX	000770	6	Webb	3	125.000	AMEND 8/12/94
JULIA B MULLER RUHLMAN	002712	6	Webb	3	145.000	
SANTA ROSA FARM LTD ET AL	002761	6	Webb	3	150.000	SEE 23-2762 RATE; AMEND 8/94
MINES ROAD DEVELOPMENT LC	002715	6	Webb	3	175.000	
JOSE M RUIZ	002767	6	Webb	3	180.000	SEE 23-2766 FOR RATE
VAQUILLAS RANCH CO LTD	003910	1	Webb	3	200.000	1599.41-AC TR - SC
ESTATE OF ANTONIO R SANCHEZ	002782	6	Webb	3	200.000	AMEND 10/5/88, 12/20/96:LEASE AGREEMENT
JESUS ENRIQUE BRIONES	002774	6	Webb	3	207.000	
GERALDINE MCCANN SISCO	002774	6	Webb	3	207.000	
ENRIQUETA L ZIMMERMAN	002774	6	Webb	3	207.000	
ANA ALICIA PENA BECERRA ET AL	002774	6	Webb	3	207.000	
FRED M BRUNI	002697	6	Webb	3	225.000	AMEND 12/18/91, 5/31/96
JAMES ROBERT MULLER	002713	6	Webb	3	236.000	
VERA W HAERING	002758	6	Webb	3	248.000	
CASSO LTD	002755	6	Webb	3	250.000	
J C TREVINO JR	002751	6	Webb	3	254.000	
MICHAEL ALLAN MACMAHON ET AL	002756	6	Webb	3	255.000	AMEND 11/2/87
HORACIO ACEVEDO ET AL	002757	6	Webb	3	260.000	RATE SEE 23-2653
JULIA B MULLER RUHLMAN	002712	6	Webb	3	264.000	
ALBERT F MULLER JR	002713	6	Webb	3	264.000	AMEND 1/29/85
MARY H MILLER	002773	6	Webb	3	311.000	
KILLAM DEVELOPMENT CORPORATION	002721	6	Webb	3	337.000	
ROBERT F HAIZLIP	002706	6	Webb	3	344.000	AMEND 1/24/91. JOINTLY OWNS 344 & 40 AF.
MAURICE M ALEXANDER ET AL	002699	6	Webb	3	450.000	AMEND 10/17/94
WINFIELD LTD	002759	6	Webb	3	500.000	
SANTA ROSA FARM LTD ET AL	002761	6	Webb	3	500.000	SEE 23-2762 RATE
KILLAM DEVELOPMENT CORPORATION	002759	6	Webb	3	500.000	
CARLOS Y BENAVIDES JR ET AL	002759	6	Webb	3	500.000	
MANDEL PROPERTIES LTD	002698	6	Webb	3	580.000	AMEND 10/13/95
COUNTY OF WEBB	002744	6	Webb	3	600.000	LAKE CASA BLANCA
GREAT LAKES INVESTMENTS INC	002782	6	Webb	3	613.000	AMEND 6/30/86
SALINAS INVESTMENTS	002762	6	Webb	3	660.000	
H B O'KEEFE ESTATE	002764	6	Webb	3	800.000	
RANCHO BLANCO CORPORATION	002772	6	Webb	3	900.000	AMEND 11/4/85, 10/11/94, 8/25/95
5D INC	002696	6	Webb	3	990.000	AMENDED 1-2-85
CLARK FARMS LTD	002769	6	Webb	3	1,101.000	SEE 23-2770 FOR RATE. AMENDED 4/25/97
LASKER O'KEEFE HEREFORD	002768	6	Webb	3	1,350.000	
LAREDO NATIONAL BANK TRUSTEE	002763	6	Webb	3	1,500.000	SEE 23-2729 FOR RATE
BARBARA T FASKEN	002714	6	Webb	3	2,220.000	AMEND 9/7/88
TED S SCIBIENSKI	002695	6	Webb	3	2,554.000	AMEND 07/24/92
RANCHO BLANCO CORPORATION	002772	6	Webb	3	2,812.000	USE IMPOUNDED WATER FOR REC,AMND 8/
BRASK-DUMONT RANCH INC	002421	6	Webb	3	3,071.000	AMEND 9/89, 5/91, 6/93
ROBERT S PHELPS	002706	6	Webb	3		AMEND 1/24/91. JOINTLY OWNS 344 & 40 AF.
CENTRAL POWER & LIGHT CO	002727	6	Webb	3		AMEND 2/7/97. 731 AF OF THE 2195.
BENANCIO RODRIGUEZ ET AL	000766	6	Starr	3	0.760	
MANUEL REYES	000766	6	Starr	3	1.710	
MOISES CHAPA ET AL	000624	6	Starr	3	2.133	
MARCELO CHAPA	000624	6	Starr	3	2.133	
GILBERTO CHAPA ET AL	000624	6	Starr	3	2.133	
DORA CHAPA	000624	6	Starr	3	2.133	
JOSE ROEL GONZALEZ	000682	6	Starr	3	2.417	
TOMAS MOLINA	000727	6	Starr	3	2.500	AMEND 11/7/90
MARTIN MOLINA	000727	6	Starr	3	2.500	AMEND 11/7/90
RAFAEL G PENA ET AL	000652	6	Starr	3	2.900	
JOSE G SANDOVAL	000773	6	Starr	3	3.000	
MARIA C MONTALVO	000624	6	Starr	3	3.691	
FIDENCIO GUERRA	000683	6	Starr	3	4.000	
FRANCISCO GARZA ET UX	000652	6	Starr	3	4.125	
BIG RIVER DAIRIES INC	000766	6	Starr	3	4.580	
MONTY S TOMLINSON ET UX	000138	6	Starr	3	5.000	AMND N: 1/21/92. CO 245.
CIRIO C ROSA	000611	6	Starr	3	5.000	
CHARLES WHITTLE	000138	6	Starr	3	5.000	AMND N: 1/21/92. CO 245.
PABLO SEPULVEDA	000776	6	Starr	3	6.000	
BIG RIVER DAIRIES INC	000779	6	Starr	3	7.000	
BLAS CHAPA	000624	6	Starr	3	7.939	
ROBERTO LUIS NARANZO	000665	6	Starr	3	8.000	
RIQUERIO ALVAREZ	000609	6	Starr	3	8.000	
IDOLINA MUNOZ RAMON	000757	6	Starr	3	8.000	
EDUARDO MARINES	000721	6	Starr	3	8.000	CHG POD&PLACE 5/81, AMEND 10/05/90
DESIDERIO VERA	000794	6	Starr	3	8.000	
H P GUERRA JR ET AL	000685	6	Starr	3	9.000	
RAFAELA T BARRERA	000730	6	Starr	3	9.250	AMEND 5/2/86
LUIS H PENA	000730	6	Starr	3	9.250	AMEND 5/2/86
TEXAS DEPT OF TRANSPORTATION	000598	6	Starr	3	10.000	

Appendix A
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Name	WR Number	Type	County	Use	Amount in Ac-Ft/Yr	Remarks
SILVESTRE G GARZA	000664	6	Starr	3	10.000	
SEVERO PEREZ ET UX	000749	6	Starr	3	10.000	
RENE MOLINA	000727	6	Starr	3	10.000	AMEND 11/7/90
JUANITA A MUNOZ	000624	6	Starr	3	10.500	AMENDED 6/10/94
JUAN GARZA	000655	6	Starr	3	10.000	
JOEL ALVAREZ	000619	6	Starr	3	10.000	
DOMINGO PORRAS ET AL	000752	6	Starr	3	10.000	
JOSE REYES	000759	6	Starr	3	11.000	
SIXTO R SALINAS ET UX	000246	6	Starr	3	11.487	AMEND 9/7/94
OSCAR JESUS VILLARREAL	000624	6	Starr	3	12.877	
BLAS VILLARREAL	000624	6	Starr	3	12.877	
BELINDA RODRIQUEZ ET AL	000624	6	Starr	3	12.877	
JESUS ALVAREZ ET UX	000602	6	Starr	3	13.000	
AUGUSTIN & ASCENCION B GUERRA	000680	6	Starr	3	13.000	
ROSITA GRAVEL INC	000633	6	Starr	3	15.000	SUBJECT TO AMENDMENT
ROGELIO HERRERA	000624	6	Starr	3	15.000	AMENDED 10/4/91
RAFAEL VALADEZ SOTO	000786	6	Starr	3	15.200	
J G ROLANDO RUIZ	000769	6	Starr	3	15.500	AMEND 5/8/92
GUILLERMO GUERRA	000684	6	Starr	3	15.500	
STARR-CAMARGO BRIDGE COMPANY	000652	6	Starr	3	15.150	
ROGERIO GARZA ET AL	000665	6	Starr	3	17.000	
UNITED STATES DEPT OF INTERIOR	000693	6	Starr	3	18.000	
ELOY ERASMO ESCOBAR	000632	6	Starr	3	18.000	
CIRIO C ROSA	000743	6	Starr	3	18.000	
LIBRADA P MUNIZ	000737	6	Starr	3	19.000	
WILFRIDO GARZA	000667	6	Starr	3	20.000	
RENE E BARRERA	000615	6	Starr	3	20.000	
MARCO GARCIA	000008	6	Starr	3	20.000	AMENDED 5/10/96
EULOGIO & TOMAS GARCIA	000639	6	Starr	3	20.000	
JOEL F SALINAS ET UX	000788	6	Starr	3	21.000	
ARTURO GARZA	000606	6	Starr	3	21.000	
MARTA R SEPULVEDA ET AL	000799	6	Starr	3	22.000	
JOSE ALVAREZ	000748	6	Starr	3	23.000	
RAFAELA G CHAPA	000624	6	Starr	3	23.706	
SANTOS GARZA	000663	6	Starr	3	25.000	
ROSALIO REYES	000760	6	Starr	3	25.000	
JUAN DE DIOS GARCIA HEIRS	000644	6	Starr	3	25.000	
FREDERICK J MARGO ET AL	000747	6	Starr	3	25.000	
FRANCISCO G VILLARREAL	000662	6	Starr	3	25.000	
FLAVIA GARZA MUNOZ	000657	6	Starr	3	25.000	
EUGENIO PEREZ ESTATE	000745	6	Starr	3	25.000	
ARTURO GARZA	000631	6	Starr	3	25.000	
RENE G SMITH	000658	6	Starr	3	26.000	
BOONE LA GRANGE ET AL	000750	6	Starr	3	26.000	
ROLANDO GARZA	000647	6	Starr	3	27.000	
EULALIO GONZALEZ ET AL	000674	6	Starr	3	28.000	
CITY OF ROMA	000732	6	Starr	3	28.000	
AMERICO ELOY GARCIA	000799	6	Starr	3	28.000	
RENE MOLINA	000728	6	Starr	3	29.000	AMEND 11/7/90
VIDAL G GARZA	000666	6	Starr	3	30.000	
SABINO ALVAREZ ET AL	000610	6	Starr	3	30.000	
PEDRO CASTILLO ESTATE	000621	6	Starr	3	30.000	
FELIX T MARTINEZ	000722	6	Starr	3	30.000	
ESTATE OF OLIVIA L GUTIERREZ	000710	6	Starr	3	30.000	
DOMINGO MUNIZ ET AL	000736	6	Starr	3	30.000	
CONRADO RODRIGUEZ ET AL	000763	6	Starr	3	30.000	
BANNWORTHS INC	000660	6	Starr	3	30.000	
ZARAGOZA GARCIA	000649	6	Starr	3	33.000	
H P GUERRA JR	000686	6	Starr	3	33.000	
EDUARDO R IZAGUIRRE ET AL	000698	6	Starr	3	33.000	
BOONE LA GRANGE ET AL	000713	6	Starr	3	33.000	
RAFAEL G PENA ET AL	000704	6	Starr	3	33.350	
MANUEL PORRAS	000753	6	Starr	3	33.350	
LUIS GUERRA	000704	6	Starr	3	33.350	
MANUEL PORRAS	000754	6	Starr	3	34.000	
NAPOLEON SEPULVEDA ET AL	000775	6	Starr	3	35.000	
IGNACIA GUTIERREZ	000707	6	Starr	3	35.000	
ADALBERTO HINOJOSA	000692	6	Starr	3	35.000	
ROBERT GEORGE HALTINER ET AL	000708	6	Starr	3	38.000	
RAUL GONZALEZ	000670	6	Starr	3	38.000	
MARCOS L GARZA ET AL	000651	6	Starr	3	38.000	
CESARIO MONTALVO ET AL	000731	6	Starr	3	38.000	
BOONE LA GRANGE	000712	6	Starr	3	38.000	AMEND 6/16/92, TERM
SERAFIN GUERRERO ET AL	000706	6	Starr	3	40.000	
GUADALUPE ALVAREZ ET AL	000607	6	Starr	3	40.000	
REYNALDO MORENO ET AL	000733	6	Starr	3	44.000	
MANUEL BARRERA	000614	6	Starr	3	45.000	
EVANGELINA PEREZ SALINAS ET VIR	000771	6	Starr	3	45.000	
TEXAS PARKS & WILDLIFE DEPT	000762	6	Starr	3	50.000	
SERVANDO DE LA GARZA	000605	6	Starr	3	50.000	
EVERARDO GARCIA JR ET UX	000774	6	Starr	3	50.000	
J E TREVINO ET AL	000789	6	Starr	3	55.000	
PEDRO A CHAPA ET UX	000623	6	Starr	3	59.000	
NOE MUNIZ	000738	6	Starr	3	60.000	
MARY LUND MCCALL ET AL	000719	6	Starr	3	60.000	
NARCISO SOLIS HEIRS	000784	6	Starr	3	63.000	
HERALDO ESCOBAR	000634	6	Starr	3	63.000	
E D PALMER ET UX	000190	6	Starr	3	65.575	
J D ESPARZA	000068	6	Starr	3	69.731	
TOMAS VALADEZ ET AL	000659	6	Starr	3	70.000	
ESTATE OF OLIVIA L GUTIERREZ	000709	6	Starr	3	70.000	
AMERICO ELOY GARCIA	000765	6	Starr	3	70.000	
SINFORIANA G DOYNO ET AL	000626	6	Starr	3	75.000	
SILVESTRE GARZA GONZALEZ	000678	6	Starr	3	77.000	
TEODORO HINOJOSA JR ET AL	000693	6	Starr	3	82.000	
JOSE MARIA VERA ET AL	000796	6	Starr	3	85.000	
JOSE G VILLARREAL ET UX	000797	6	Starr	3	87.000	AMEND 3/30/84
RAMON ELIZONDO JR ET AL	000630	6	Starr	3	88.000	
MARCOS L GARZA ET AL	000661	6	Starr	3	88.000	
LEONARD J & JOSEPHINE KOBERNAT	000758	6	Starr	3	88.000	
JOSE MARIA GUERRA ET AL	000689	6	Starr	3	88.000	
BASILIO GARZA ESTATE	000650	6	Starr	3	88.000	
ESTATE OF NATALIA L HINOJOSA	000696	6	Starr	3	93.000	
ROEL ANGEL MOLINA ET AL	000727	6	Starr	3	95.000	AMEND 11/7/90
PEDRO LOPEZ SR ESTATE ET AL	000716	6	Starr	3	97.000	
WILLIAM J THOMAS ET AL	000636	6	Starr	3	97.500	AMEND 1/30/86, 1/21/92
MEADOWS FOUNDATION INC	000756	6	Starr	3	100.000	
JESUS L VILLARREAL	000798	6	Starr	3	100.000	
HILARIO BARRERA ET AL	000768	6	Starr	3	100.000	
RUPERTO BARRERA	000618	6	Starr	3	113.000	
HENRIETTA J A JITKOFF	000138	6	Starr	3	115.000	AMND N: 1/21/92
CITY OF LYFORD	000068	6	Starr	3	115.000	
RENE G SMITH	000780	6	Starr	3	119.000	
V H GUERRA	000702	6	Starr	3	120.000	
UNITED STATES DEPT OF INTERIOR	000653	6	Starr	3	125.000	

Appendix A
TNRCC Recorded Water Rights Effective August 11, 1997

Name	WR Number	Type	County	Use	Amount in Ac-Ft/Yr	Remarks
MARTIN CRUZ LUERA	000772	6	Starr	3	125.000	
MARTIN A CANALES JR	000620	6	Starr	3	125.000	
DIONICIO R ESPARZA ET UX	000068	6	Starr	3	126.394	5 76, 1/79, 5/90, CO 214, BOX
FRANCISCO E GARCIA	000641	6	Starr	3	138.000	
BANNWORTHS INC	000741	6	Starr	3	143.000	
JULIAN GARZA ET UX	000656	6	Starr	3	150.000	
J C GUERRA	000687	6	Starr	3	153.000	
ABEL N GONZALEZ	000672	6	Starr	3	172.500	
ROEL RAMIREZ	000755	6	Starr	3	192.000	AMEND 7/15/86, 10/05/90
SANTA CARRERA ESTATE ET AL	004556	6	Starr	3	193.000	
MENDEL POGELL	000751	6	Starr	3	193.000	
SNOWMASS INC	000138	6	Starr	3	195.000	AMND N: 1/21/92. CO 031. TO BE AMENDED.
BANNWORTHS INC	004557	6	Starr	3	200.000	
ANGELICA P FIERROS ET AL	000744	6	Starr	3	205.000	AMEND 11/07/90
HORTENSIA G MARGO TRUSTEE	000726	6	Starr	3	207.500	
AARON L SHIELDS	000008	6	Starr	3	230.000	
PABLO A RAMIREZ INC	000742	6	Starr	3	250.000	
HUBERT R HUDSON ET AL	000697	6	Starr	3	250.000	AMEND 7/24/92
OLIVIA GARCIA DE RAMOS ET AL	000645	6	Starr	3	275.000	AMEND 11/07/90
JOEL GUERRA ET AL	000688	6	Starr	3	283.000	
PEDRO LONGORIA ET AL	000648	6	Starr	3	296.000	
RENE MOLINA ET AL	000729	6	Starr	3	298.000	AMEND 11/7/90
STARR PRODUCE COMPANY	000711	6	Starr	3	300.000	
A E LONGORIA ET AL	000715	6	Starr	3	348.000	AMEND 11/2/87
UNITED STATES DEPT OF INTERIOR	000600	6	Starr	3	375.000	
ROSENDO BARRERA ET AL	000616	6	Starr	3	375.000	
HENRIETTA J A JITKOFF	000138	6	Starr	3	382.500	AMND N: 1/21/92
E W SCHRADER	000761	6	Starr	3	448.000	
AGNES O BROWNE TRUSTEE ET AL	000251	6	Starr	3	490.000	AMEND 4/2/93
UNITED STATES DEPT OF INTERIOR	000836	6	Starr	3	495.000	11/29/78-SEE BOX & CO 108
E & S FARMS	000627	6	Starr	3	500.000	AMEND 4/30/93
E & S FARMS	000599	6	Starr	3	500.000	
JOHN A SHUFORD ET UX	000778	6	Starr	3	530.000	AMEND 12/18/87
MARTHA R CLOPTON TRUST	000625	6	Starr	3	625.000	
JOHN WILLIAM CLOPTON	000625	6	Starr	3	625.000	
J H GUERRA ESTATE ET AL	000690	6	Starr	3	655.000	AMEND 7/14/87
MARIA S PECK ET AL	000638	6	Starr	3	750.000	
JOHN HANCOCK MUTUAL LIFE INS CO	000711	6	Starr	3	822.000	
MARGO BROTHERS	000720	6	Starr	3	888.000	
ANNETTE KATZ COTTINGHAM ET AL	000601	6	Starr	3	1,029.980	AMEND 2/23/87
STARR PRODUCE COMPANY	000767	6	Starr	3	1,146.220	AMENDED 10/31/89, 10/10/97
STARR PRODUCE COMPANY	000787	6	Starr	3	1,250.000	
ANNETTE KATZ COTTINGHAM ET AL	000601	6	Starr	3	1,287.000	
SOUTH PADRE DEVELOPMENT INC	000138	6	Starr	3	1,394.250	AMND N: 1/21/92. CO 214.
GRIFFIN & BRAND OF MCALLEN INC	000679	6	Starr	3	1,440.000	
FRONTON COOPERATIVE IRRIGATION ASSN	000635	6	Starr	3	1,445.000	
ELMORE & STAHL INC ET AL	000570	6	Starr	3	1,631.462	
STARR PRODUCE COMPANY	000190	6	Starr	3	1,889.360	AMENDED 2/15/95, 9/12/97
STARR PRODUCE COMPANY	000777	6	Starr	3	3,750.000	
JOHN HANCOCK MUTUAL LIFE INS CO	000711	6	Starr	3	4,956.500	AMEND 3/28/90
GRIFFIN & BRAND OF MCALLEN INC	000679	6	Starr	3	5,286.000	AMEND 3/22/88, 8/20/90
STARR PRODUCE COMPANY	000767	6	Starr	3	6,008.011	AMENDED 10/31/89, 10/10/97
JOEL RUIZ ET UX	002736	6	Zapata	4	4.000	AMEND 9/10/85 REVERTS 1/1/90 IRR
MARIA LUISA VIDAURRI STOTT	002775	6	Zapata	4	10.000	AMND 2/92,7/95,7/97.REVERTS TO 3 IN 2000
MARIA EVA URIBE RAMIREZ	002791	6	Zapata	4	10.000	AMEND 7/12/90
JOEL RUIZ ET UX	002708	6	Zapata	4	20.000	FOR RATE 23-2707, AMEND 10/30/84
MARIA VIDAURRI HERBST ESTATE	002775	6	Zapata	4	25.000	AMENDED 4/94. EXP 12/31/99(REVERTS TO 3)
LANNIE MECOM	002780	6	Zapata	4	25.000	AMEND 1/30/95
TONYA DUMAS	002726	6	Zapata	4	30.000	AMEND 10/15/91, 1/29/96. 3 COUNTIES.
ROBERTO VIDAURRI	002775	6	Zapata	4	30.000	
HORACE OWENS	002792	6	Zapata	4	40.000	AMEND 2/91, 1/29/96:ALSO COS 108 & 240
KENNETH OWENS	002726	6	Zapata	4	66.000	RATE 23-2422, 8/31/87.
ROWENA M DILLON TRUSTEE OF MCNEEL	002779	6	Zapata	4	80.000	AMEND 1/4/90
ESTATE OF ANTONIO R SANCHEZ	000487	6	Zapata	4	100.000	3/16/87,8/31/87,9/15/88,7/2/89
CHRISTINE MCKEE	002422	6	Webb	4	1.000	AMEND 6/20/87. USE 4 IN ZAPATA & WEBB.
J & B CONTRACTORS INC	002704	6	Webb	4	2.000	AMEND 3/29/94
UNION PACIFIC OIL & GAS CO	002747	6	Webb	4	5.000	AMEND 6/16/92
FLORENCE G ARCE	002711	6	Webb	4	5.000	AMENDED 4/29/94. EXP 12/31/99
ESTATE OF ANTONIO R SANCHEZ	002782	6	Webb	4	10.000	AMEND 10/5/88, 12/20/96:LEASE AGREEMENT
BORDER ENERGY SERVICES INC	002782	6	Webb	4	10.000	AMEND 1/22/90, 11/27/95, 12/29/95
LOUIS C LECHENGER ET AL	002812	6	Webb	4	20.000	AMEND 4/14/88
LAREDO SAND & GRAVEL CO	002699	6	Webb	4	20.000	
HACHAR REAL ESTATE COMPANY	002422	6	Webb	4	23.000	AMEND 6/30/86
SANTA ROSA FARM LTD ET AL	002761	6	Webb	4	25.000	AMEND 10/20/88
MAURICE M ALEXANDER ET AL	002699	6	Webb	4	30.000	AMEND 10/17/94
ROBERT F HAIZLIP	002706	6	Webb	4	40.000	AMEND 1/24/91. JOINTLY OWNS 344 & 40 AF.
CLARK FARMS LTD	002769	6	Webb	4	45.000	2/87,1/90,4/97. USE 4 REVERTS 4/25/2007
RODOLFO GARCIA	002742	6	Webb	4	62.000	
RODOLFO GARCIA	002734	6	Webb	4	75.000	
TRANSTEXAS GAS CORPORATION	002761	6	Webb	4	100.000	AMENDED 08/01/97. 8 COUNTIES.
MANDEL PROPERTIES LTD	002698	6	Webb	4	100.000	AMEND 10/13/95
GREAT LAKES INVESTMENTS INC	002782	6	Webb	4	100.000	AMEND 6/30/86
CITY READY MIX INC	002700	6	Webb	4	100.000	AMEND 10/15/91, 11/23/92
ALICE SOUTHERN EQUIP SERVICE INC	002747	6	Webb	4	115.000	AMEND 7 & 11/93; 3, 8 & 12/94/5 MORE COS
MICHAEL ALLAN MACMAHON ET AL	002756	6	Webb	4	120.000	6/18/90
DOUGLAS M BRICE	002700	6	Webb	4	131.557	AMEND 3/13/95
BARBARA T FASKEN	002714	6	Webb	4	200.000	
RANCHO BLANCO CORPORATION	002772	6	Webb	4	300.000	AMEND 11/2/87,9/25/89,10/11/94,8/25/95
ROBERT S PHELPS	002706	6	Webb	4		AMEND 1/24/91. JOINTLY OWNS 344 & 40 AF.
CENTRAL POWER & LIGHT CO	002727	6	Webb	4		AMEND 2/7/97. 731 AF OF THE 2195.
ROSITA GRAVEL INC	000068	6	Starr	4	7.500	
KCS RESOURCES INC	000068	6	Starr	4	25.000	
KEVIN D HILES	000714	6	Starr	4	112.375	AMND 3/8/96,8/23/96.DIV POINT 4 COUNTIES
SOUTH TEXAS ELECTRIC CO-OP INC	005066	1	Starr	5	1,200,000.000	AMEND 12/14/87. POWER POOL WITH MEDIN
MEDINA ELECTRIC COOPERATIVE INC	005066	1	Starr	5		AMEND 12/14/87. POWER POOL WITH S.TX.EI
RADCLIFFE KILLAM ET AL	003732	1	Webb	7	848.000	DOMESTIC, LIVESTOCK
Total					**1,345,608.741**	

Note: South Texas Electric Co-op and Killiam Radcliffe et.al. are non-consumptive rights without call on water but are reflected in the total.

Appendix B

Potential Funding Sources
For
The South Texas Development Council (STDC)
Water Resource Project

Potential Funding Sources

for

The South Texas Development Council (STDC) Water Resource Project

prepared by

Andrea Abel

for

Ambiotec Environmental Consultants, Inc.

July, 1997

Andrea Abel • 706 East 47th Street • Austin, Texas 78751 • (512) 451-0834

CONTENTS

Potential Funding Sources for The City of Brownsville Resaca Project and The South Texas Development Council (STDC) Water Resource Project

Disclaimer: Some of the information contained in this document is taken directly from informational publications from the various agencies and organizations.

I. International Entities

I.A. Border Environment Cooperation Commission

Address: BECC
P.O. Box 22168
El Paso, Texas 79913

Blvd. Tomás Fernández #7940, Piso 6
Cd. Juárez, Chihuahua, México C. P. 32470

The BECC is located in Ciudad Juárez, Chihuahua, México, but they have mailing addresses in both Ciudad Juárez and El Paso.

Fax: (011-52-16) 29-23-97

Contact: Tracy Williams, Public Outreach Coordinator, (011-52-16) 29-23-95, twilliams@cocef.interjuarez.com

Homepage: cocef.interjuarez.com

Description: The BECC offers Project Certification for water, wastewater, municipal solid waste, and other related projects located in the U.S.-Mexico border region. Projects certified by BECC qualify for financing from the North American Development Bank (NADBank), EPA, and other sources. However, BECC certification does not guarantee NADBank financing. BECC does not directly fund the construction of projects. Any project funded by the NADBank with EPA funds must have BECC certification.

Water supply projects may include, but are not limited to:

- potable water treatment
- water supply systems and water distribution
- water pollution prevention
- projects to improve or restore the quality of water resources

Wastewater treatment projects may include, but are not limited to:

- wastewater collection systems
- wastewater treatment plants
- water reuse systems
- systems for treatment and beneficial use of sludge

Municipal solid waste projects may include, but are not limited to:

- landfills
- solid waste collection and disposal systems
- reduction, reuse, or recycling of waste
- waste-to-energy projects

Criteria for project certification include the following components:

1. Human health and environment;
2. Technical;
3. Financial;
4. Community participation; and
5. Sustainable development.

Projects must be located within the 100 kilometer zone of the U.S.-Mexico border region.

Projects that incorporate a large number of sustainable development characteristics, beyond the certification criteria required for project certification, are good candidates for BECC High Sustainability Recognition. While pursuing such recognition is optional, it may be helpful in attracting grant funds from sources interested in supporting sustainable development.

The application process for BECC certification runs from 3-6 months. Much of this is dependent on what type of work already has been accomplished, i.e., if there is an existing environmental assessment. After an application is received a 45 day notice is put out and the project is then considered at the next quarterly meeting of the BECC board.

BECC received $10 million from the U.S. EPA for a Technical Assistance Program to provide direct grants for project development to be funded by the NADBank including:

1. Comprehensive planning;
2. Financial evaluation;
3. institutional strengthening of technical, financial and human resources capabilities of communities;
4. Sustainable environment; and
5. Regional master planning.

Funding has not been released yet from EPA to the BECC. However, in anticipation of the funding, BECC is accepting letters from potential applicants. Given its regional master planning aspect, the STDC project would be a prime candidate for funding. The best route would be for the STDC to send a letter to BECC outlining the project and describing the intended accomplishments of the project, i.e., what infrastructure projects would be the end results. The application would be strengthened with the eventual submission of resolutions from the county commissioners courts and city councils included in the projects.

These planning grants can be any size but are generally $50,000-$60,000. However, a regional master plan such as the STDC project could be considerably more.

Grants over $50,000 need approval of the BECC board of directors. Grants over $500,000 need additional approval of the EPA.

The BECC also can certify Private Sector Projects, i.e., one not sponsored by a political subdivision. This may be of interest if Ambiotec wishes to pursue projects on its own.

A private sector project must address the human health and environmental needs of the surrounding community and not just the requirements of industrial or commercial installations related to pollution control. All certification criteria are applicable to private sector projects.

While desirable in many cases, creating jobs, alleviating unemployment, generating tax revenues, advancing technology, generating business, creating income, or spurring investment should be considered ancillary benefits of a project; no single one of these aspects, or any combination of them is sufficient to warrant BECC certification, if human health and environmental needs are not
satisfied.

The project must provide a "substantial community benefit" based on total project cost. The formula for determining this benefit must be systematic and equitable for both the applicant and the surrounding community. The funds or services to be used for providing a "substantial community benefit" through environmental infrastructure projects must be managed with the input of local government and local community representatives and through an accountable and transparent structure.

Categories of Private Sector Projects:

Public/Private Partnerships. Public entity and private company work formally and jointly on public environmental infrastructure projects, such as so called "build, operate and transfer" (BOT) projects where, for example, the private sector builds and operates a municipal wastewater treatment facility and after a stipulated period of time turns it over to the local entity. These types of partnerships are encouraged by the Agreement and obviously benefit the community-at-large.

Private-only projects designed specifically to address local communities or regional infrastructure needs. For example, a private company builds and operates a landfill for the disposal of municipal solid wastes generated by the community, and the facility's planning, capital, construction, and operation and maintenance costs are paid totally or partially through user fees. The larger community benefit is clear. To qualify for this category, project sponsors would need to demonstrate public support for the project through the public meetings and participation as part of the BECC certification process, as well as formal acknowledgment from the local, state, and federal authorities that the proposed facility would serve a public environmental infrastructure need.

Private-only projects designed specifically to address the private sponsor's own pollution problems. For example, a private industry which builds a wastewater treatment facility for wastewater generated by itself. It is this category of private-only projects which must also address the human health and environmental needs of the surrounding community in the event the project sponsor wishes to secure the BECC's staff time, resources, and certification.

Constraints:
BECC has a list of pre-qualified consultants for projects brought before the board. A request for qualifications (RFQ) was listed in *Congress Business Daily* last year. The BECC plans on doing this again sometime in the near future. Ambiotec might want to answer the RFQ. In the meantime, BECC can make exceptions if the firm already has been hired for the project as Ambiotec has been for both of these projects.

In its first few years, BECC has been slow to certify projects. As political pressure increases, the BECC is being forced to act more quickly.

For this and many other programs, it is the environmental assessment that can delay completion of a funding application.

I.B. North American Development Bank

Address: NADBank
700 North St. Mary's, Suite 1950

San Antonio, Texas 78205

Fax: (210) 231-6232

Homepage: nadbank.org/english.html? (Much of this homepage is under construction at the current time.)

Contact: Steve Walder, Senior Credit Analyst, (210) 231-8000

Description: The primary purpose of the Bank is to facilitate the development of environmental infrastructure projects in the U.S.-Mexico border region. The Bank also provides support for community adjustment and investment throughout the United States and Mexico in support of the purposes of the North American Free Trade Agreement (NAFTA). All BECC certified projects are eligible for financing and other support from the NADBank.

In addition to financing, the Bank may provide financial advisory services to border communities to develop projects. The financial advice and guidance that the Bank can provide communities and project sponsors in designing and structuring projects is a key factor in the effectiveness of Bank programs. The Bank, along with the BECC, will also play a catalytic role in encouraging border communities to engage in long-term planning for their environmental infrastructure needs and to establish effective and sustainable methods of operation.

The Bank will act as the lead bank, similar to the role played by an investment bank, by securing needed equity, grants and/or other forms of financing from a variety of public and private sources on a project-by-project basis.

The Bank may extend financing through direct loans and guaranties. Its lending policies are designed to provide financing that:

1. complements commercial financing; or
2. cannot be obtained from other sources on reasonable terms and conditions on a timely basis.

All financing by the Bank will be provided at rates necessary to protect Bank resources for the benefit of current and future border residents.

NADBank Institutional Development Cooperation Program (IDP) receives at least $2 million per year to assist public utilities with capacity building and institutional strengthening. Bank hires consultants to strengthen utility districts via management. Laura Brown is the Senior Project Officer for this grant program.

The Transition Fund can buy down interest rates. This addresses the issue of rate shock and assists in alleviating rate increases over a 7 year period. This grant fund has $20 million and must be used in combination with loans. Tom Fink, Chief Financial Officer, handles this program.

The Border Environmental Infrastructure Fund has been capitalized with $170 million in EPA grant funds. Applicants must meet an affordability index based on community's ability to pay: existing debt, cost of project and O&M.

The NADBank is in a position where it must make loans quickly to avoid an even bigger congressional battle as NAFTA comes up for reauthorization. Thus, they want BECC certified projects which can hit the ground running.

Constraints: Must have BECC certification to qualify for any NADBank programs. Environmental Assessments also are necessary. Both of these components can slow down the process considerably.

I.C. North American Fund for Environmental Cooperation, Commission for Environmental Cooperation

Address: Commission for Environmental Cooperation
393 rue St.-Jacques West
Bureau 200
Montreal, Quebec, Canada H2Y 1N9

Fax: (514) 350-4314

Contact: Marcos Silva, Network and Information Services, (514) 350-4357, msilva@ccemtl.org

Homepage: cec.org

Description: The Commission for Environmental Cooperation is the trinational entity established under the North American Free Trade Agreement (NAFTA) to handle environmental disputes and remediation. The North American Fund for Environmental Cooperation (NAFEC) has one annual grant cycle with a total of $2,000,000 Canadian available. Grant requests should not exceed $100,000 Canadian. Projects should be community based, with cooperative and equitable partnerships. Furthermore, projects should emphasize sustainability, and link environmental, social and economic issues. Multi-year requests are acceptable.

Outlined below is the funding cycle established for 1997:

- January-March: Preproposals (2 pages) are accepted. Those proposals which are accepted will be invited to submit full proposals;
- Mid-May: Full proposals invited;
- Mid-June: Full proposals submitted;
- Mid-August: Grants announced;
- September: Projects begin.

NAFEC will not fund: 1) activities which by law should be done by government; 2) administrative expenses (those not directly related to the project) exceeding 15 percent of the total request; 3) regular organizational activities.

Constraints: This information is for FY1997 only. Any proposals would have to be for the FY1998 funding cycle. Application is restricted to non-governmental, non-profit or community-based organizations, although a for -profit organization can be a partner. NAFEC funds will go only to grassroots level efforts. Selecting a non-profit partner for either of these projects would be dependent on the specific project.

While the BECC and the NADBank were created to certify and fund infrastructure projects in the U.S.-Mexico border region, the CEC has responsibility over the United States, Canada, and Mexico in their entireties. Border projects are not given priority over other projects.

II. Federal Entities

II.A. U.S. Environmental Protection Agency

Address: U.S. Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas Texas 75202-2733

Fax: (214) 665-7373

Homepage: www.epa.gov/earth1r6/6bo/6bo.htm

II.A.1. Contact: Oscar Ramirez, Deputy Director of Border Office & Water Quality Protection Division, (214) 665-7101

Description: The Water Quality Protection Division in Region 6 received approximately $200,000 - $500,000 to fund planning grants for border water and wastewater projects. Each project must receive sponsorship from Region 6. The best route for a border municipality to receive sponsorship is to work with the Texas Natural Resource Conservation Commission or the Texas Water Development Board. In other words, to facilitate projects, EPA generally passes through funding to TNRCC or TWDB for them to distribute. Therefore, Ambiotec would need to shop around for a sponsor such as EDAP (Fernando Escárcega, Director) or Regional Planning and Projects Planning (Carolyn Brittin) at TWDB or the Water Division (Sally Gutierrez, Deputy Director for Water) at TNRCC.

Constraints: Cannot be used for construction. Funds for FY1997 have been depleted. EPA will announce FY1998 funding in the fall.

II.A.2. Contact: Gina Weber, U.S.-Mexico Coordinator, (214) 665-8188

Description: Border communities and non-profits may apply for <u>Border XXI</u> grants. These grants are available for any border environmental projects which promotes the goals of Border XXI -- the on-going, binational, environmental planning initiative between the United States and Mexico. Goals for Border XXI are based on the binational workgroups for air, water, pollution prevention, hazardous waste, environmental health, and information resources. Individual grants are up to $40,000. Preliminary proposals must be submitted to EPA.

Constraints: Funds for FY1997 have been depleted. EPA should know FY1998 funding levels by October. Changes in funding could change the amount of individual grants.

II.A.3. Contact: Pamela A. Hurt, EPA Headquarters, (202) 260-2441, phurt@epamail.epa.gov or Karen Alvarez, EPA Region 6, (214) 665-7273

Homepage: www.epa.gov/ecocommunity

Description: EPA is soliciting applications through an RFP published in the May 15, 1997 *Federal Register* for the Sustainable Development Challenge Grant Program (SDCG). EPA has $5 million in FY1997. Approximately 80 percent of the funds will go to support city/metropolitan-related projects with the remaining for rural projects. The SDCG program focuses on "place-based approaches" to solving problems related to urban growth, loss of open spaces and wetlands, and public investment/disinvestment patterns.

There are two funding categories: 1) $50,000 or less, and 2) $50,001 and $250,000. Projects can be for a duration of up to 3 years and will require a minimum of 20 percent match.

The program is encouraging city/metropolitan applications as well as those demonstrating partnering among community, business, and government entities to develop environmental management that pairs quality of life activities with sustainable development and revitalization. EPA is looking for projects that comprehensively address environmental and economic issues in urban areas.

These grant funds could be used to enhance a portion of the City of Brownsville Resaca project.

Constraints: Application deadline for this year's grant funds is **August 15, 1997.**

II.B. Bureau of Reclamation, U.S. Department of the Interior

Address: U.S. Department of the Interior
Bureau of Reclamation
300 East 8th Street, Suite 800
Austin, Texas 78701

Contact: Shirley Shadix, Program Coordinator, (512) 916-5646, 6ATFO.SSHADIX@IBR6GW81.GP.USBR.GOV

Description: The Bureau of Reclamation (the Bureau) is appropriated funding from Congress for technical assistance which it allocates to projects via an existing memorandum of understanding (MOU) with the Texas Water Development Board (TWDB) and a pending MOU with the Texas Natural Resource Conservation Commission (TNRCC). The TNRCC MOU is anticipated for FY1998. The Bureau anticipates receiving their FY1998 funding within the next month or two.

This funding is for in-kind technical assistance such as facility design and hydrology studies. The average level of assistance is approximately $50,000.

Application for this funding would require a letter from the sponsor (i.e., the STDC or the City of Brownsville) describing the project and requesting assistance. The Bureau cannot act without a specific request for assistance. They already are considering projects, so this would need to happen fairly quickly to be considered for FY1998.

The Bureau's other funding is appropriated directly from Congress to specific Bureau projects. They now are considering their FY2000 budget and would be interested in meeting with the City of Brownsville to discuss the possibility of requesting funding from Congress for FY2000.

Their region contains Texas, Oklahoma, and Southern Kansas.

Constraints: To get a direct congressional appropriation for the City of Brownsville Resaca Project is not impossible, but would require a concerted effort on the part of South Texas' congressional delegation and other politicians. Since they already are considering FY1998 projects, action would need to happen immediately for Technical Assistance funding.

II.C. U.S. Fish and Wildlife Service, U.S. Department of the Interior

Address: USFWS
Lower Rio Grande Valley National Wildlife Refuge
320 North Main, Room A-103
McAllen, Texas 78501

Contact: Larry Ditto, Refuge Manager, (956) 787-3079 ext. 114, or David Blankinship, Ascertainment Biologist, (956) 787-3079 ext. 110

Constraints: USFWS does not have any funding at the current time for land acquisition, but can provide technical assistance and other in-kind forms of assistance.

II.D. Economic Development Administration, U.S. Department of Commerce

Address: U.S. Department of Commerce
Economic Development Administration
Austin Regional Office
Thornberry Building, Suite 121
903 San Jacinto Boulevard
Austin, Texas 78701-2450

Contact: Jonathan Markely, (512) 916-5407

Contact: Ava Lee, (512) 916-5824, alee@doc.gov (She covers South Texas, Louisiana, and Arkansas)

Fax: (512) 916-5613

Description: Economic Development Administration (EDA) programs are to support projects designed to alleviate conditions of substantial and persistent unemployment and underemployment in economically-distressed areas and regions of the Nation, including creation of long-term jobs and industry location. Funding also is meant to address economic dislocation from job losses. EDA funding is intended for industrial and commercial development rather than residential use.

Strategic funding priorities reflect those of the U.S. Department of Commerce and include the following:

1. Sustainable Development
2. Entrepreneurial Development
3. Economic Adjustment, especially base closures and downsizing
4. Infrastructure and development facilities in rural and urban Enterprise Communities and Empowerment Zones[1]
5. Projects that demonstrate innovative approaches to economic development; and/or
6. Projects supporting locally-created partnerships with regional economic development solutions.

[1] Rio Grande City is included in the Rio Grande Valley Empowerment Zone.

The following programs are authorized under the Public Works and Economic Development Act of 1965:

1. Public Works and Development Facilities Assistance: average funding level for a grant is $1,000,000;
2. Technical Assistance-Local Technical Assistance; National Technical Assistance; University Centers: average funding level is $176,000
3. Planning- Planning Assistance for Economic Development Districts, Indian Tribes, and Redevelopment Areas; Planning Assistance for States and Urban Areas; average funding levels for planning grants range from $43,000 to $107,000.

This EDA region covers Texas, Oklahoma, New Mexico, Louisiana, and Arkansas.

EDA has been in the position recently where they sought applicants to use up end-of-the-year funds. Given this, it may be worth examining this funding prospect if industrial or commercial components are possible.

Constraints: This information is for FY1997 only. Funding levels and application procedures could change for future years. EDA awards mostly grants, loans are more difficult to obtain. Grants require a 50/50 match with the match coming from non-federal sources. Some federal funds, such as the U.S. Department of Housing and Urban Development's (HUD) Community Development Block Grant (CDBG) funds lose their federal identity when channeled through the Texas Department of Housing and Community Affairs and can be considered a local match.

Projects which combine residential with industrial or commercial aspects would be competing for funding with solely economic development projects. In this case, economic development projects would be given priority. However, EDA is providing funding through the Empowerment Zone for a portion of a water/wastewater system in the Valley which would serve a new shopping mall.

II.E. U.S. Department of Housing and Urban Development

Address: Community Planning and Development
U.S. Department of Housing and Urban Development
Washington Square Building
800 Dolorosa, Room 306
San Antonio, Texas 78207

Contact: Richard Lopez, Program Manager, Community Planning and Urban Development, (210) 472-6821, main number (210) 472-6820, richard_l._lopez@hud.gov

Homepage: www.hud.gov

Description: As an entitlement city, Laredo directly receives U.S. Department of Housing and Urban Development (HUD) funding for the Community Development Block Grant (CDBG) program. Laredo received $4,372,000 for FY1997. The city should get approximately the same amount of funding each fiscal year. Eligible activities for this funding include water, wastewater, streets, drainage, and levy projects. Each city determines their priority list for projects and then works directly with HUD. To qualify, projects must serve a population with below 80 percent of the city median income or address an urgent public health or safety need such as substandard water and sewer systems. Project size is approximately $500,000. Hearings are taking place right now to determine funding for FY1998.

Constraints: Must work with city community development officials to be included on their list of projects.

II.F. U.S. Department of Agriculture

Address: U.S. Department of Agriculture
Rural Development
Rural Utilities Service
101 South Main
Suite 102, Federal Building
Temple, Texas 76501

II.F.1. Contact: Gary Lightsey, Rural Utilities Service, Rural Development (254) 298-1306

Homepage: www.rurdev.usda.gov or www.usda.gov/rus/water/wwregs.htm

Description: Rural Utilities Service (RUS) loans and grants help develop water and wastewater disposal systems, including storm drainage, in rural areas and towns with a population of 10,000 or less. There also are grants available for technical assistance. The technical assistance program helps in the cost-effective operation of rural water systems. The Water and Waste Disposal program is emphasizing the Clinton Administration's Water 2000 initiative to provide safe drinking water by the year 2000 in more than 400,000 households still lacking indoor water. RUS funds have been used to build systems in border colonias. In addition, a separate fund - 306C - provides individual grants of up to $5,000 to colonia households to connect to water/wastewater and to construct plumbing facilities and install fixtures in the home. RUS has significant funding for grants, loans, and loan guarantees.

Constraints: The population constraints eliminate larger cities such as Laredo or Brownsville. However, areas with population under 10,000 outside of the city limits are eligible if applying separately, including areas within a city's extra-territorial jurisdiction (ETJ).

II.F.2. Natural Resources Conservation Service, U.S. Department of Agriculture (formerly the Soil Conservation Service)

Address: USDA NRCS
101 S. Main
Federal Building
Temple, Texas 78501-7682

Fax: (254) 298- 1388

Contact: Dale Mengers, (254) 298-1255

Description: The Watershed Protection and Flood Prevention Act authorizes the Secretary of Agriculture to provide technical and financial assistance to local organizations for planning and carrying out watershed projects. Eligible purposes include: 1) preventing damage from erosion, floodwater and sediment; 2) furthering conservation development, utilization and disposal of water; or (3) conserving and properly using land.

The programs under this act are limited to watershed areas of less than 250,000 acres in size and population under 50,000. Any projects over these limits would fall under the purview of the Army Corps of Engineers. The program emphasizes planning through interdisciplinary teams which include the project sponsors, other agencies and environmental groups in all stages of plan development.

This program is divided into eligible purposes based on agricultural and non-agricultural purposes. Relevant areas include flood prevention and nonagricultural water management. The latter includes improving fish and wildlife habitat, wetlands restoration, and public water-based recreational activities such as boating and fishing. These may include boat ramps, fishing piers, picnic tables, and sanitary facilities.

Eligible applicants include soil and water conservation districts, counties, state agencies, or flood control or irrigation districts. Usually, the project is sponsored by a number of different entities, however, the local soil and water conservation district must be the entity that requests assistance from NRCS.

To begin the application process, the soil and water conservation district writes a letter to NRCS requesting a feasibility study. To be eligible for NRCS funding, the project must meet a positive benefit/cost ratio.

If the project qualifies, then sponsors must a submit formal application. This first goes through the State Soil and Water Conservation Board. The sponsor must then set up a steering committee to establish a planning process. Once determined, the plan is reviewed through public hearings and agencies. The plan is then sent to Congress for funding.

NRCS establishes rankings of projects each year. Increased priority goes to the last job in a project which would complete the project. Also, projects with a local match or other funds gets priority. Flood prevention paired with municipal or industrial water also get priority. Very active sponsors who spend their own time and resources to prepare and advocate for projects usually get priority.

All funds are grant funds or in-kind assistance from NRCS.

NRCS already is working with Starr County on the Los Olmos Creek project. This project has received funding from Congress. They are waiting for land easements and already have the plan developed.

Constraints: Over 250,000 acres and 50,000 population is the responsibility of the Army Corps of Engineers NRCS is getting a backlog of projects which may have priority over Ambiotec's projects.

III. State Entities

III.A. Texas Natural Resource Conservation Commission

Address: Texas Natural Resource Conservation Commission
P.O. Box 13087
Austin, Texas 78711-3087

Homepage: http://www.tnrcc.state.tx.us/

III.A.1. Contact: Carol Limaye, Consumer and Utility Assistance Section, Water Utilities Division, (512) 239-6120

Description: The Consumer and Utility Assistance program offers technical and organizational/management assistance that it supports through circuit riders from the Texas Rural Water Association and the Community Resource Group. Assistance is available to rural utilities through the circuit riders.

Constraints: This program has no direct funding for projects.

III.A.2. Contact: Valerie Robinson, Non-Point Source Program, (512) 239-4551

Description: TNRCC is requesting permission from EPA to divert a portion of the funds from the 319 Grants Program to use for Total Maximum Daily Load (TMDL) studies which would enable stakeholders to determine load allocations. If their request is approved, they will do 3 watersheds, including the Arroyo Colorado. Even if their request is approved, a small portion of funding still will be available for the 319 Grants Program described below.

If the diversion of funds is not approved, the NPS Program will put out an RFP for 319 Grants. Eligible projects include projects to improve water quality in certain impacted areas such as wetland projects, integrated landscape uses, educational programs, and erosion restoration.

Award size depends on the projects selected, but generally ranges from $75,000-$600,000 for 3 year projects. The usual time frame is 4-6 months from the time the RFP closes to the announcement of grant awards.

III.B. Texas Water Development Board

Address: P.O. Box 13231
Austin, Texas 78711-2131

Homepage: http://www.twdb.state.tx.us

III.B.1. Contact: Ignacio Madera, Financial Applications Manager, (512) 463-7509. He is about to move back to EDAP but can remain a contact for the SWSRF, SRF, Water Loan Assistance Fund and the Flood Control Fund.

III.B.1.a. Description: The Drinking Water State Revolving Fund (DWSRF) will provide loans at lower than market interest rates to finance water supply projects in order to comply with drinking water regulations and to carry out the Safe Drinking Water Act. Applicants must be a political subdivision or a nonprofit water supply corporation.

Loans can be used for planning, design, and construction, including purchase of land integral to the project.

It is expected that the DWSRF will receive a federal capitalization grant of $70,153,800 plus state funds of $14,030,760. According to the State Intended Use Plan (IUP) for FY1997, Webb County is slated to receive an estimated loan of $37,860,000 to develop a well field, build transmission line and a booster station. Anticipated project start date is January 1, 1999. No other projects in the STDC region were listed in the IUP.

Must be in the IUP in order for the TWDB to fund.

Constraints: Since the DWSRF is a new program, it will take some time to work out the application process and receive funding. Also, any new projects would have to be taken into consideration and added to the IUP. It could be years before new projects will be considered or before projects on the current IUP receive Board commitment.

III.B.1.b. Description: The State Water Pollution Control Revolving Fund is the state revolving fund (SRF) for wastewater projects. It is capitalized primarily by EPA.

There are no projects listed in the FY1998 SRF IUP for projects in Webb, Starr, Zapata, or Jim Hogg counties.

Constraints: Projects not already listed on the IUP would need to demonstrate urgent need to receive priority over the already listed projects. Loan programs generally are too expensive for the STDC counties.

III.B.1.c. **Description:** The Water Loan Assistance Fund provides grants and loans for water supply projects.

Constraints: This is a TWDB fund with a higher interest rate than the SRF, therefore, it is a more expensive program.

III.B.1.d. **Description:** Flood Control projects may be funded by the TWDB in the form of loans to political subdivisions for structural and nonstructural flood control projects, and for development of floodplain management plans. TWDB has authorization for funding this program, but has not issued a loan for this program in at least the last 3 years. This fund has $2.5 million.

Ignacio Madera admitted that the Board does not market this program as much as other funds available at the TWDB. He attributes the lack of projects funded in recent years to the lack of marketing. Flood control projects receive the same interest rate as projects under the Water Loan Assistance Fund.

Projects take 6-9 months from the time the application is submitted to the time the loan is received. Projects begin with a pre-application meeting. The environmental assessment is a crucial component and can determine how long a project will take.

Constraints: Applicants must be located within an area where National Flood Insurance is available. Interest rates are comparable to the Water Loan Assistance Fund, therefore, more expensive than the SRF. The environmental assessment must be completed before Board funding commitment can take place. This can delay projects depending on the extent of the environmental assessment needed. In other TWDB programs, Board commitment can take place pending final assessment as long as the initial review shows no adverse social or environmental affects.

III.B.2. Contact: Fernando Escárcega, EDAP Director, (512) 475-2068

Description: The Economically Distressed Areas Program (EDAP) provides a combination of grants and loans for colonia water and wastewater projects meeting the geographic and economic criteria outlined by the program. Eligible applicants include political subdivisions in the Texas border counties, including the county, a city, or a water supply corporation. Colonia projects receive mostly grants and some loans. The overall ratio of all grants in this program cannot exceed 90 percent of the total program grants and loans.

EPA has considerable funds, mostly in grants. The interest rates on loans are very low.

Constraints: For colonia portion of projects only. However, can be used to fund increased capacity to a system for the portion of a system used by colonias. EDAP has been criticized for the delay in board commitment and construction completion. Many of these delays are local issues such as CCN (certificate of convenience or necessity) disputes.

Of the 26 projects which have received Board commitment since 1991, only 6 have been completed.

III.B.3. Contact: Carolyn Brittin, Chief, Regional Planning and Projects Planning Division, (512) 463-9893

Fax: (512) 475-2056

III.B.3.a. Description: The Regional Planning and Projects Planning Division funded STDC and Ambiotec for the Phase I portion of the Laredo water and wastewater study. This same division will be funding Phase II.

Constraints: STDC

III.B.3.b. Description: Regional Water Supply Planning under Senate Bill (SB) 1. SB1 requires regional planning which is similar to what STDC/Ambiotec now are completing. May take some time to work out requirements of SB1.

Constraints: Must be applied for by a regional planning group. However, these regional planning groups are yet to be determined.

III.B.3.c. Description: An RFP will be released in mid-July for Infrastructure and Near-Term Needs. A total of $600,000 will be available to split between regional wastewater planning and water supply. Grants generally range between $20,000 and $200,000.

Constraints: Planning only, cannot be used for construction.

III.B.3.d. **Description:** Flood Control Feasibility Grants also will be available with total funding in the amount $600,000. These individual grants generally are bigger than those for Infrastructure and Near-Term Needs.

Constraints: Planning only, cannot be used for construction.

III.C. Texas Department of Housing and Community Affairs

Address: TDHCA
P.O. Box 13941
Austin, Texas 78711-3941

Contact: Ruth Cedillo, Director, Community Development Program (512) 475-3882 or Cynthia Vallejo, (512) 475-3925

Homepage: tdhca.state.tx.us

Description: The South Texas Development Council, the Lower Rio Grande Development Council, and the Middle Rio Grande Development Council each has a *Gentlemen's Agreement* where the region receives a Community Development Block Grant (CDBG) allocation from the Texas Department of Housing and Community Affairs. The allocation is then divided up among the non-entitlement cities and counties in South Texas, including Webb county. There is a project cap of $500,000 for CDBG colonia projects and $350,000 ($700,000 for two years) for non-colonia CDBG projects. Grants can be used for water, wastewater, streets, drainage, levies, economic development, or recreational projects. Priority is given to urgently needed projects such as substandard water and wastewater systems. Funding from the CDBG Colonia Set-Aside can be applied for separately outside of the funds received by the region through the Gentlemen's Agreement. The Colonia Set-Aside is comprised of 10 percent of the state CDBG allocation and is available only to colonias within the 100 kilometer zone on the Texas-México border.

Constraints: Since Laredo is an entitlement city (see U.S. Department of Housing and Urban Development), only projects outside of the city limits in unincorporated areas of the county or small cities would be eligible for this funding.

III.D. Texas Parks and Wildlife Department

Address: Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

III.D.1. Contact: Elaine Dill or Lydia Barrientes, Recreational Grants Assistance Branch, (512) 912-7124

III.D.1.a. Description: The Recreation Grants Program is an option for the Resaca Project if the City of Brownsville wishes to enhance recreational aspects of the resacas. The Texas Recreation & Parks Account provides 50 percent matching funds to acquire property for and/or develop outdoor and indoor recreation areas and facilities. Local government sponsors must operate and maintain the facilities.

III.D.1.b. Description: The Boat Ramp Construction Program provides 75 percent matching grant assistance to local governments for the construction of public boat ramp facilities. Local sponsors must provide the land, legal access, a 25 percent local match, and operate and maintain for at least 25 years.

Constraints: These funds are for recreational programs only.

III.D.2. Contact: Jay Roberson, Dove Program Leader, (512) 389-8011, or Gary Waggerman, Las Palomas Wildlife Area Manager, (956) 383-8982

Description: The White-Winged Dove Stamp Fund receives revenue raised through the purchase of white-winged dove hunting stamps as well as federal pass-through funds from the Federal Aid in Wildlife Restoration Act and the Land and Water Conservation Act. Funds are used for land acquisition, research, and operation and maintenance of the Las Palomas Wildlife Refuge. They also provide technical guidance biologists to provide recommendations on projects. Emphasis is placed on restoration, reforestation, and leveraging other funding to maximize state and federal dollars. Land can be used for habitat restoration, trails, or interpretive centers. TPWD can purchase a zone around a resaca or provide seedlings/fencing, or provide labor. Open water is a high priority, and TPWD has targeted resacas in the past.

Funds are determined on a case-by-case basis. They seem to have more funds than they have projects right now. Total white-winged dove stamp funds are approximately $500,000 for FY1997.

Projects take generally between 1-3 years to receive necessary permits. If there are willing sellers and no conflicting interest, a project will take approximately 1 year.

Constraints: The greatest delay is in TPWD personnel time needed to develop the overall project agreement, including necessary permits.

III.E. Texas Department of Transportation

Address: TxDoT
Design Division
125 E. 11th St.
Austin, Texas 78701

Contact: Mira Garcia, Design Division, (512) 416-2601

Description: The Intermodal Surface Transportation Enhancement Act (ISTEA) included $192 million in Enhancement Funds for various projects in Texas with strong ties to transportation. This was grant money used to fund projects ranging from hike & bike trails to remodeling county courthouses. All of the $192 million originally appropriated to Texas has been spent. Future funding for this program is in jeopardy. See description below.

Constraints: Currently, Congress is considering reauthorization of the transportation bill which includes ISTEA. It does not look good for a reauthorization of the ISTEA enhancement funds. Furthermore, many of the projects funded under this program have drawn great scrutiny for their apparently weak tie to transportation. Therefore, if monies should be appropriated in the future, they would require greater documentation of a strong link to facilitating transportation (vs. recreational transportation in the case of bike trails or storage of transportation records in the case of county courthouses).

Odessa received ISTEA enhancement funds to improve their *draws*, drainage canals similar to resacas. However, the project was reconsidered due to the high cost/benefit ratio with regard to the funding criteria was funded using local monies.

My understanding is the TxDoT was not a proponent of the ISTEA enhancement funds and is not anxious to do these projects in the future.

IV. Other Entities

IV.A. Rio Grande Valley Empowerment Zone Corporation

Address: RGVEZC
301 S. Texas
Mercedes, Texas 78570

Fax: (210) 514-4007

Homepage: ezec.gov/ezec/TX/riogrande.html

Contact: Don Medina, Economic Development Specialist; Vidal Balli, Community Planning Coordinator, (210) 514-4000

Description: The Rio Grande Valley Empowerment Zone (RGVEZ) is comprised of portions of Starr, Hidalgo, Cameron, and Willacy counties and received its Empowerment Zone (EZ) designation as part of a presidential initiative in 1994. The designation enables the RGVEZ to receive $40 million in federal funds through the U.S. Department of Agriculture and the ability to leverage other public and private funds with the goal of creating a sustainable and prosperous region.

With regard to the STDC, the RGVEZ includes Rio Grande City in Starr County. The designation was established for the period from 1994-2004. The RGVEZ is governed by a Board of Directors who develop overall regional and sub-zone priorities, oversee the budget, and review/update plans. The 2-3 year planning cycle allows for periodic review of the strategic plan to see if goals are being met and to make necessary revisions. Internal review is taking place now. Community comments will be solicited at the end of 1997 or the beginning of 1998.

The RGVEZ Strategic Plan Summary identifies water and wastewater infrastructure needs as one of seven priority needs. The short-term and future activities listed in the action plan for improving basic infrastructure include water and wastewater system improvements, with short-term projects intended for the first 2-3 years of EZ designation.

Water and wastewater infrastructure projects are being heavily emphasized in Hidalgo and Starr counties. In the sub-zone plan specific to Starr County, water and wastewater needs and flood control issues are identified as proposed strategies for key issues to be addressed in the initial two years after designation.

Those projects demonstrating public/private partnerships and the ability to leverage funds from a number of sources are given particular attention.

Don Medina, RGVEZC Economic Development Specialist, urged Ambiotec to arrange a meeting to discuss potential collaboration between Ambiotec and the RGVEZC for any water or wastewater planning or projects in Starr county.

Of the $40 million total funding, $29.7 million has been allocated to projects. This, in turn, has leveraged $54.3 million from other sources. At this point, projects are not ranked as they come in since there still is more funding available than there are projects.

They are still accepting new applications. The application procedure varies, depending on the development stage of the projects. Applications go first to the subzone board which considers applications twice monthly. If approved, the application then goes to the full board for consideration. Applications generally take 30-60 days for approval from the time they are received by the RGVEZC. Environmental assessment requirements depend on the area such as wetlands and archeological sensitivity.

IV.B. WaterWorks

Address: WaterWorks
1227 Paseo del Peralta
Santa Fe, New Mexico 87501

Contact: Charlie Clements, (505) 988-4270, waterwurks@aol.com

Fax: (505) 984-3089

Description: Charlie is on vacation. My understanding is that he has received approximately $100,000 from the Pew Charitable Trust to provide technical assistance to border colonia water and wastewater projects in Texas and New Mexico.

IV.C. U.S.-Mexico Border Progress Foundation

Address: 1615 Murray Canyon Road, Suite 1000
San Diego, California 92108

Contact: Elsa Saxod, Executive Director, (619) 291-1574, borderprog@aol.com

Fax: (619) 291-3827

Homepage: http://www.borderprog.org.mx/

Description: The foundation was founded in 1991 as a binational organization to help find and utilize private resources to solve public problems and meet vital needs by focusing attention on the U.S.-Mexico border.

Constraints: Not a direct funding source. Ms. Saxod did not want to discourage seeking private sources of funding, but has found that in the past few years interest in funding border projects has waned considerably. Ms. Saxod has found that corporations and foundations are pulling back from funding these projects. In particular, as NAFTA is being reviewed this year, private corporations are notably staying out of the fight. Foundations that showed initial interest and investment are not coming to the table. Of the foundations that Ms. Saxod has identified, most are interested in funding reports, conferences, and directories, not direct infrastructure projects.

IV.D. Texas STEP (Small Towns Environment Program)

Address: Small Towns Environment Program
The Rensselaerville Institute
63 Huyck Road, P.O. Box 128
Rensselaerville, New York 12147

Fax: (800) 682-4203

Contact: Rob Hanna, (800) 682-4203, rawhanna@aol.com

Homepage: http://www.crisny.org/not-for-profit/thetute/STEPHOME.HTM

Description: Texas STEP is a collaborative partnership between public and private entities organized to solve water and wastewater needs in low-income communities and for systems not meeting compliance guidelines. It relies on the principal of self-help and is based on the premises that small towns require different and simpler public systems and that the small town "birthright of self-reliance" provides a tremendous resource for problem-solving and infrastructure development.

STEP has found that the self-help component can lower project costs up to 40 percent and can reduce the time considerably that it takes to complete a project.

The concept of a *Community Sparkplug* is heavily emphasized when determining the community readiness to carry out a self-help project. The *Sparkplug* is a member of the community who cares about his/her community and is willing to corral community energy to complete a project.

STEP requires a financial commitment to hook into a water/wastewater system from all community participants. It stresses a financial investment as opposed to grant programs which do not incorporate community commitment.

Texas STEP has partnered extensively with Loomis and Associates engineers who have found their relationship with Texas STEP to be very positive.

STEP also has a $2.5 million revolving loan fund underwritten by the Ford Foundation and the Pew Charitable Trusts. The fund offers low-interest financing for disadvantaged communities.

Constraints: STEP is not a funding source. They generally work with small communities to determine project viability. Self-help will not succeed if the community does not display "readiness" to undertake their own project. STEP has a number of criteria used to establish community readiness.

IV.E. The Community Resource Group, Inc.

Address: Community Resource Group, Inc.
7701 North Lamar, Suite 503
Austin, Texas 78752

Fax: (512) 371-1051

Contact: Harold Wells, State Director, (512) 454-1048

Description: The Community Resource Group (CRG) is a private, non-profit organization established in 1975 whose purpose is to seek long-term solutions to problems faced by rural residents and communities. CRG concentrates on rural water, wastewater, and housing issues. They are part of the Southern RCAP (Rural Community Assistance Program) whose headquarters is located in Fayetteville Arkansas. CRG receives public and private funding to support its programs which include the following:

Technical Assistance is provided to assess water and sewer problems and to develop appropriate solutions. This program addresses information on financing and developing water and wastewater systems and operation and management services.

Their Financing Assistance program helps communities locate, qualify, and apply for financing as well as evaluate alternative sources of financing.

The Community Loan Fund provides loans of up to $100,000 for community water and wastewater systems for capital projects. This program requires a 20 percent community match.

Constraints: CRG is out of loan funds at the current time and can make only small loans of approximately $10,000 for out-of-compliance systems.

CRG has a proposal in to the Texas Water Development Board (TWDB) to provide $2-3 million to CRG for them to re-lend for smaller loans (under $300,000) under the new Drinking Water State Revolving Fund (DWSRF). The proposal currently is being reviewed by the TWDB's attorneys. If approved, it would be the first program of its kind in the country.

However, CRG does not anticipate a decision being made by TWDB until at least October. Given the fact that the DWSRF is a new program, it could take even longer for these funds to be allocated.

This new program will be mirrored after CRG's other loan programs and basically follow USDA's guidelines for their Rural Development programs.

V. Recommendations

V.A. South Texas Development Council Water Resource Project

Funding sources and possible partners for the South Texas Development Council Project can be delineated as the following: 1) overall funds; 2) technical assistance; 3) planning grants; 4) construction loans/grants; 5) colonia funds; and 6) self-help collaborators.

In general, planning grant funds can be obtained much more rapidly than construction funds. Non-traditional funding sources offer more rapid funding, but these tend to be very small loans/grants.

Federal programs and others are putting particular emphasis on sustainability, partnerships, and community participation in their selection criteria. These would all be important areas to consider when developing proposals. Partnerships among governmental and non-governmental entities also is being looked at by federal funding sources.

As with the Resaca Project, it would be worthwhile to pursue **EDA** funding for the STDC Project if there is an opportunity for an industrial or commercial component. EDA has been known to try to "dump" funding at the end of their fiscal year.

Sustainability is a key element given the regional nature of the STDC water and wastewater project. With its emphasis on sustainability, **BECC/NADBank** might be interested in supporting this project. The BECC's new **Technical Assistance Program** would offer a good source of funding for planning. Grant funds from the NADBank through the newly created **Border Environmental Infrastructure Fund** offer another likely avenue. Supplemental funding could come from the **Rio Grande Valley Empowerment Zone Corporation** for any portions of the project in the Rio Grande City segment of the Empowerment Zone. If BECC certification is obtained, the project may be eligible for NADBank's **Transition Fund** to make any loan portions more affordable.

All of the above-mentioned entities have funding and are under pressure to get projects underway.

This project could be enhanced greatly by incorporating self-help through **Texas STEP** which could minimize cost, length of project time, and increase sustainability. Utilizing STEP may very well be the necessary link to overcome political obstacles in the region as well as to enhance grass-roots participation in solving their **own** water problems.

Planning and construction funds will depend on the population, median income, and location of various communities included in this project. In general, the TWDB's **Regional Water Supply Planning Fund** and the **Infrastructure and Near-Term Needs Fund** appear to be likely candidates for planning funds. The Board's **Economically Distressed Areas Program (EDAP)** also offers planning grants for colonias. EPA's **Planning Grant** will be a good source when they receive FY1998 funds. Funding through EPA's **Border XXI** grants may be more difficult since all of the Border XXI workgroup categories are eligible to apply for this funding (i.e., air, water, hazardous waste, pollution prevention, environmental health). Given the number of other funding sources for border water and wastewater projects, this may be an unlikely source.

For colonia projects, the TWDB and the Texas Department of Housing and Community Affairs have an understanding to refer projects to one another to maximize funding. Projects are divided between TWDB's **EDAP** and TDHCA's **Colonia Set-Aside** based on which program can most effectively meet the needs of each community. TDHCA colonia set-aside funds tend to flow faster than EDAP's and are all grant funds. Since its inception in 1990, only seven EDAP projects have been completed. However, with its 90/10 grant/loan ratio, it is a cheap source of funding for communities with little ability to pay. In communities under 10,000, the RUS **Water and Wastewater Disposal** program now works effectively to get grant and loan funds out to impoverished communities, particularly colonias. RUS's **306C** grants for individual plumbing improvements and hook-ups also flow fairly quickly. Individual households would need assistance in selecting qualified contractors to complete the work -- or could utilize self-help to reduce cost and the possibility of consumer fraud.

Other construction grants could come from **Community Development Block Grants** directly from HUD for the City of Laredo or from TDHCA for other cities and counties included in the project. TWDB's traditional water and sewer loan funds generally are too expensive for the region. That is one of the reasons for the initial enactment of EDAP since border communities could not afford projects funded primarily through loans.

Again, foundations are unlikely to fund planning or construction of water and wastewater systems or water resource projects. There is potential for foundation funds for related projects. An example of this would be to conduct a broad-based community education campaign on water hygiene such as the highly successful public health education campaign *Agua Para Beber*. Another example would be to approach a foundation for funding to do a demonstration-type project using self-help on a regional project such as this one. Foundation funding also could be sought to develop community resources to address water resource planning. However, this would require a better idea for a specific request to make to a foundation and a separate search to match likely foundations with the given project.