EDWARDS AQUIFER
AUTHORITY

Groundwater Management Plan

1998 - 2008

August 1998

Acknowledgements

The initial *Groundwater Management Plan* of the Edwards Aquifer Authority was prepared under the guidance and direction of a special working group of the Authority's Board of Directors chaired by Ms. Luana Buckner, Medina County Director. The *Groundwater Management Plan* was developed with input from an advisory committee composed of representatives of surface water management entities, other groundwater conservation districts operating within the Authority's boundaries, and other interested parties. Staff input to the development of the plan was provided under the direction of Mr. Greg Ellis, General Manager, and Mr. Rick Illgner, Special Projects Coordinator. Assistance with the development of the *Groundwater Management Plan* was provided by Mr. Michael L. Personett and Mr. James P. Rizk of Turner Collie & Braden Inc. (TC&B Project No. 37-07659-001).

Table of Contents

List of Exhibits

1.0 Introduction

1.1 Purpose of the Edwards Aquifer Authority Groundwater Management Plan

In 1997, the 75th Texas Legislature enacted Senate Bill 1 (herein referred to as the Brown-Lewis Water Plan), which provides a major overhaul of many long-standing state water laws and policies. Among its many provisions, the Brown-Lewis Water Plan amends Chapter 36 of the Texas Water Code to require all underground water conservation districts to develop a management plan for groundwater within each district's jurisdiction. These Groundwater Management Plans are to be submitted to the Texas Water Development Board (TWDB) for review and certification by September 1, 1998.

The Edwards Aquifer Authority has prepared this Groundwater Management Plan to fulfill the requirements of the Brown-Lewis Water Plan and associated TWDB rules (Texas Administrative Code, Chapter 356). In addition, this plan is the first step towards fulfilling the requirements of the Edwards Aquifer Authority's enabling statute (73rd Texas Legislature, S.B. 1477 as amended, herein referred to as the EAA Act), which also requires the Edwards Aquifer Authority to develop and implement a comprehensive management plan.

As required by TWDB rules, the Edwards Aquifer Authority's groundwater management plan was developed with a 10-year planning period. However, it is likely this plan will be revisited and substantially revised much sooner to incorporate new information, as well as new policy and program initiatives. Specifically, it is expected that the Edwards Aquifer Authority's groundwater management plan will be amended to include relevant portions of, and ensure consistency with, the regional water management plan also mandated by the Brown-Lewis Water Plan.

1.2 Historical Overview of Edwards Aquifer Management Issues

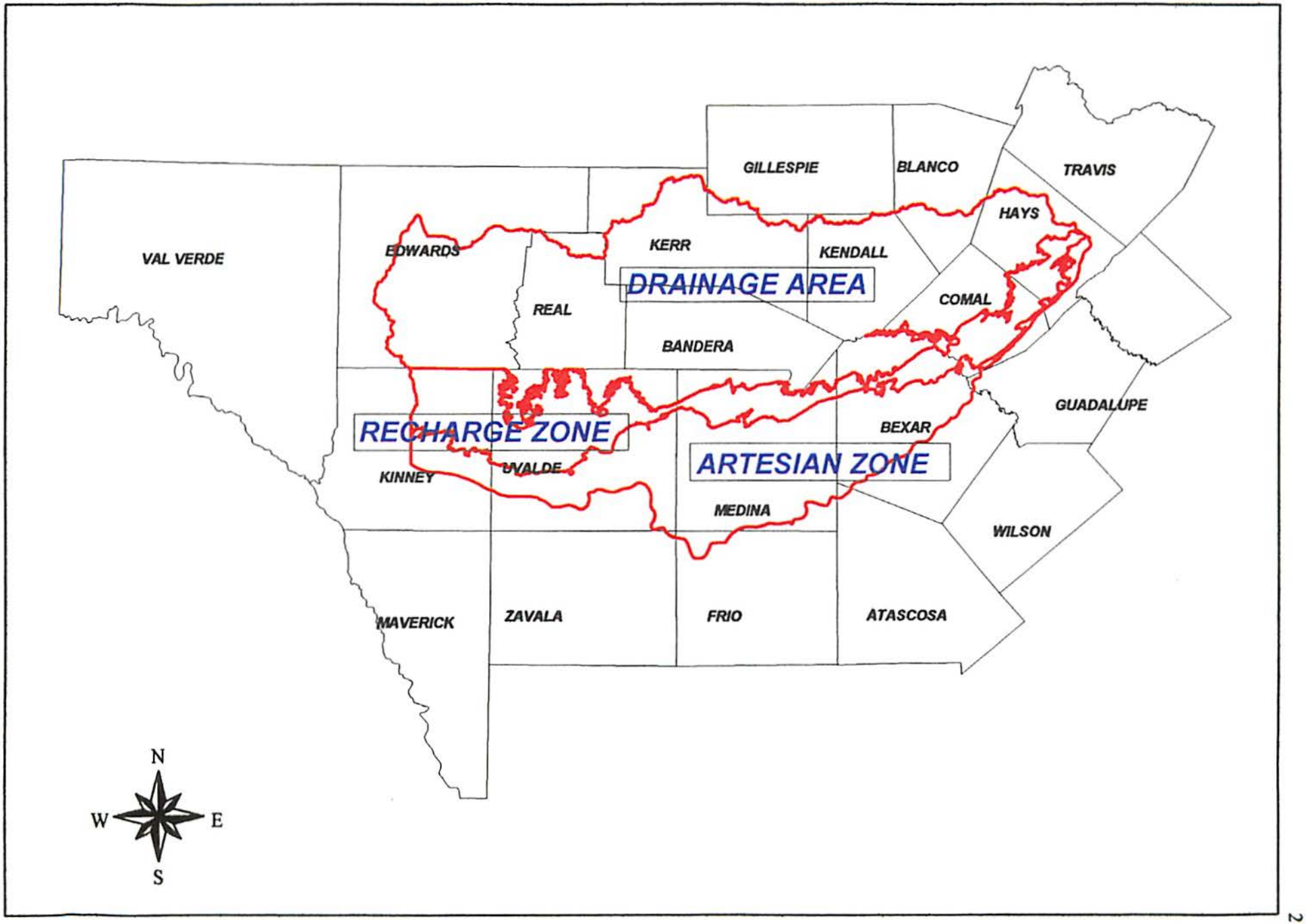
The southern portion of the Edwards Aquifer (see **Exhibit 1.1**) is a geologically complex subterranean water source that has been, and remains, the sole source of water for more than 1.5 million Texans. Because of its complexity and the history of its development and use, management of the Edwards Aquifer has been the subject of a long history of controversy and public debate. The following chronology highlights some of the major milestones that led to the creation of the Edwards Aquifer Authority:

1904 - By judgment in the case of Houston & T.C. Railroad Co. vs. East, the rule of capture becomes the legal doctrine for groundwater development in Texas. This doctrine provides that groundwater is private property and that a landowner may withdraw groundwater from beneath his or her property for beneficial use without limitation or liability for impact on neighboring landowners.

1949 - The Texas Legislature authorizes the voluntary creation of groundwater conservation districts. These districts have limited powers to regulate and manage groundwater withdrawals and use within their boundaries.

1959 - The Texas Legislature creates the Edwards Underground Water District (EUWD) to "conserve, protect, and increase the recharge of" the Edwards Aquifer. The EUWD's original jurisdiction included five counties overlying the southern portion of the Edwards Aquifer: Bexar, Comal, Hays, Medina and Uvalde counties. While similar to other groundwater

Exhibit 1.1 Extent of the Edwards Aquifer



districts, the EUWD differed in that it was not granted the rule-making authority to regulate withdrawals from the aquifer.

1987 - The Texas Legislature provides the EUWD with specific authority to develop, implement and enforce a regional drought management plan.

1989 - Uvalde and Medina counties, which rely heavily on the Edwards Aquifer for agricultural irrigation, withdraw from the EUWD. In withdrawing from the EUWD, Medina and Uvalde county residents cite concerns about proposed plans to limit and assess fees on withdrawals from the Edwards Aquifer.

1989 - The Guadalupe-Blanco River Authority (GBRA) files suit in state district court seeking a declaration that the Edwards Aquifer is an underground stream subject to state regulation.

1992 - Seeking to avoid federal intervention, the Texas Water Commission (TWC) attempts to mediate among regional interests to achieve support for an Edwards Aquifer management plan. After failing to reach an agreement, the TWC declares the Edwards Aquifer to be an underground stream and adopts rules for the management and regulation of withdrawals from the aquifer. Subsequently, TWC's actions were invalidated by a state district court.

1993 - Sierra Club v. Lujan. The Sierra Club sued the U.S. Fish and Wildlife Service (USFWS), among others, for failing to protect the endangered species that live in Comal and San Marcos Springs. The Club claimed that by not providing information as to necessary spring flows, the USFWS was not carrying out its responsibilities under the Endangered Species Act (ESA). The trial court held for the Sierra Club and ordered USFWS to designate minimum spring flows required at San Marcos and Comal Spring to ensure protection of endangered species. The court also ordered the TWC to prepare a plan to ensure the springs will not drop below the minimum levels defined by USFWS during times of drought.

1993 - Senate Bill 1477 is enacted by the 73rd Texas Legislature providing for the creation of a "conservation and reclamation district" named the Edwards Aquifer Authority. The Edwards Aquifer Authority is to replace the EUWD and is given broad powers to regulate withdrawals from the Edwards Aquifer. However, establishment of the Edwards Aquifer Authority is delayed because of a Justice Department ruling in a suit brought under the federal Voting Rights Act. The suit contended that the Voting Rights Act had been violated since the EAA Act replaced an agency governed by an elected board of directors with an agency run by an appointed board.

1995 - The 74th Texas Legislature enacts House Bill 3189, which amends the EAA Act to provide for an elected board of directors for the Edwards Aquifer Authority. However, once again establishment of the Edwards Aquifer Authority is delayed as a result of a state district court ruling that the EAA Act, on its face constituted an unconstitutional "takings" of private property.

1996 - Sierra Club v. Glickman. The Sierra Club claimed that the United States Department of Agriculture's (USDA) subsidization of farming, while failing to establish agricultural water conservation programs, leads to over-pumping of the aquifer, thereby threatening endangered species and causing water pollution. The trial court rendered judgment in favor of the Sierra Club, ordering USDA to: (1) develop and carry out a program to assist in preserving natural resources and protecting fish and wildlife through land conservation and utilization; (2) develop and implement an intra-agency program to protect waters from contamination; (3) evaluate and consult with USFWS in implementing a program to conserve endangered species

in the aquifer. Enforcement of this judgment has been stayed pending the outcome of the appeals process initiated by the defendants. The case is still on appeal to the U.S. Fifth Circuit Court of Appeals.

1996 – Sierra Club v. City of San Antonio. Sierra Club sought certification of a defendant class of Aquifer pumpers, and alleged that, by their pumping from the Aquifer, the defendants were "taking" endangered species in violation of the ESA. Although it refused to grant the class certification sought by the Club, the trial court entered a preliminary injunction, ordered pumping restrictions based upon springflows, and ordered the injunction to remain in effect until the defendants "can demonstrate that a critical management plan developed by the Edwards Aquifer Authority will be operative." On appeal to the U.S. Fifth Circuit Court of Appeals, the 5th court vacated the lower Court's preliminary injunction, reasoning that, under the **Burford** doctrine, abstentation was proper where, by proceeding, the Court could risk reaching a different answer than the state institution with a greater interest in and familiarity with the matters at issue (the EAA). Sierra Club v. City of San Antonio, et al., 112 F.3d 789. The Fifth Circuit reasoned that the federal courts should abstain from becoming involved in regulating the aquifer in order to give the EAA the opportunity to do its job. On January 26, 1998, the Supreme Court denied, without comment, the Sierra Club's writ of appeal, thereby letting stand the Fifth Circuit's ruling.

1996 - On June 28, 1996, the Texas Supreme Court rules unanimously in overturning the district court ruling finding the EAA Act unconstitutional. The EUWD ceases to exist and the Edwards Aquifer Authority commences operations.

1.3 Edwards Aquifer Authority Perspective on the Management of the Edwards Aquifer

As evidenced by timeline and events leading to its creation, the Edwards Aquifer Authority was born of controversy and continues to be subject to close public scrutiny in its efforts to fulfill its statutory responsibilities. The Edwards Aquifer Authority's overall perspective on Edwards Aquifer management is that it must strive to balance the needs and interests of all water users and affected stakeholders in the region. For example, while a goal of the Edwards Aquifer Authority is to manage the Edwards Aquifer and to maintain flows at Comal and San Marcos Springs, the Edwards Aquifer Authority also recognizes that a balance must be struck between the protection of important environmental resources and the continued provision of an adequate water supply to support the region's population and economy.

Effective management of the Edwards Aquifer must consider and balance impacts on:

- *Irrigators*
- *Municipal/Industrial users*
- *Environmental/recreation interests associated with Comal and San Marcos springs*
- *Downstream water users in the Guadalupe River Basin*

Given the very real challenges associated with implementing regulatory management of Edwards Aquifer withdrawals, the Edwards Aquifer Authority believes that a policy of "transitional management" of the Edwards Aquifer is both realistic and necessary in order to accomplish long-term regional water management goals. The immediate goal and

priority of the Edwards Aquifer Authority is to put in place an efficient, effective and equitable regulatory program to manage withdrawals of water from the Edwards Aquifer. Once in place, it is expected that a regional water market will develop as an integral component of aquifer management. The process of establishing a new management paradigm for the Edwards Aquifer is expected to require several years.

2.0 About the Edwards Aquifer Authority

2.1 Edwards Aquifer Authority Mission and Function

Edwards Aquifer Authority Mission Statement:

The Edwards Aquifer Authority is committed to manage and protect the Edwards Aquifer system to ensure the entire region of a sustainable, adequate, high quality and cost effective supply of water, now and in the future.

The Edwards Aquifer Authority began operations on June 28, 1996 as a "conservation and reclamation district" to manage the southern portion of the Edwards Aquifer as specified in its enabling statute, the EAA Act. The EAA Act establishes the purposes and responsibilities of the Edwards Aquifer Authority, specifies management functions and goals, and provides guidelines for the operation of the Edwards Aquifer Authority. The Texas Legislature, in enacting the EAA Act, directed the Edwards Aquifer Authority to:

- protect the water quality of the aquifer;
- protect the water quality of the surface streams to which the aquifer provides streamflow;
- achieve water conservation;
- maximize the beneficial use of water available for withdrawal from the aquifer;
- protect aquatic and wildlife habitat;
- protect species that are designated as threatened or endangered under state or federal law;
- provide for instream uses, bays and estuaries;
- protect domestic and municipal water supplies;
- protect the operation of existing industries;
- protect the economic development of the State;
- prevent the waste of water from the aquifer; and
- increase recharge of water to the aquifer.

In order to meet these objectives, the EAA Act directs that, unless increased by the board of directors based on the results of research, permitted withdrawals from the Edwards Aquifer are to be limited to no more than 450,000 acre-feet per calendar year through the year 2007. Afterwards, permitted withdrawals are to be reduced to 400,000 acre-feet per year unless increased by the board of directors. In addition to these requirements, the EAA Act requires the Edwards Aquifer Authority to develop and implement a "Critical Period Management Plan" to address aquifer usage during times of drought. In addition to its specific powers, the Edwards Aquifer Authority is also granted, among other powers, the rule making and enforcement powers of other Texas groundwater districts created under Chapter 36 of the Texas Water Code. It should be noted that the Edwards Aquifer Authority's responsibilities only apply to the use and management of the Edwards Aquifer within the Edwards Aquifer Authority's boundaries. The Edwards Aquifer Authority has no regulatory powers over portions of the Edwards Aquifer outside of its boundaries, other groundwater or any surface water resources.

The EAA Act also gives the Edwards Aquifer Authority responsibilities to conduct research on topics relevant to regional water resources management. This includes the ability to conduct or contract for research on topics such as the development of additional water supplies, water quality, water resources management and augmentation of aquifer springflow.

2.1.1 Water Resource Planning Responsibilities of the EAA Act

In addition to its other requirements, the EAA Act directs the Edwards Aquifer Authority to engage in long-range regional water resource planning. Specifically, the statute requires the Edwards Aquifer Authority to develop and implement a "comprehensive management plan". The guidelines for the Edwards Aquifer Authority's water resource planning activities are shown in the highlighted box below.

The EAA Act directs the Edwards Aquifer Authority to:

- *develop and implement a comprehensive management plan that includes conservation, future supply and demand management plans;*
- *develop a 20-year plan for providing alternative supplies of water to the region, with five-year goals and objectives; and*
- *perform the following in plan development:*
  - *(1) an investigation of all alternative technologies*
  - *(2) a cost-benefit and environmental analysis*
  - *(3) an investigation of mechanisms for providing financial assistance for alternative supplies.*

2.1.2 Groundwater Management Planning under the Brown-Lewis Water Plan

In 1997 the 75th Texas Legislature enacted S.B. 1 (the Brown-Lewis Water Plan). Among its many far-reaching provisions is a new requirement that groundwater districts develop and submit Groundwater Management Plans to the TWDB for review and certification. This requirement applies to the Edwards Aquifer Authority and adds procedural requirements and new deadlines for the agency's planning activities. Specifically, the Edwards Aquifer Authority's Groundwater Management Plan must be consistent, as appropriate, with any approved regional water management plan prepared pursuant to the Brown-Lewis Water Plan (see **Section 5.1**). This GMP will be an important source of input to the Brown-Lewis Water Plan regional planning process. The following highlighted box details the requirements for Groundwater Management Plan approval.

Brown-Lewis Water Plan mandated Groundwater Management Plans are to include:

- *A planning period of at least ten years;*
- *The Edwards Aquifer Authority's estimates of:*
  (1) Amount of available groundwater,
  (2) Annual amount of groundwater used,
  (3) Annual groundwater recharge (including amount of feasible recharge augmentation); and
  (4) Projected water supply and demand.
- *Applicable management goals of the Edwards Aquifer Authority;*
- *The Edwards Aquifer Authority's management objectives and performance standards for achieving its goals; and*
- *The actions, procedures, performance and avoidance necessary to implement the Groundwater Management Plan.*

2.2 Edwards Aquifer Authority Organization

The Edwards Aquifer Authority operates through the coordinated efforts of its board of directors, the South Central Texas Water Advisory Committee and the Edwards Aquifer Authority's staff.

2.2.1 Board of Directors

The EAA Act provides that the Edwards Aquifer Authority is to be governed by a 17-member board of directors, 15 of which are elected. Elected directors represent 15 districts within Uvalde, Medina, Bexar and portions of Atascosa, Comal, Hays, Caldwell and Guadalupe counties as shown in **Exhibit 2.1**. The Edwards Aquifer Authority's directors are elected for four-year terms, with district elections staggered so that approximately half of the terms expire every two years. **Exhibit 2.2** shows the current (1998) directors and the districts they represent.

In addition to the 15 elected board members, there are also two non-voting appointed directors; one to represent the interests of Medina and Uvalde counties and one to represent the interests of downstream water users. The Medina/Uvalde County director is appointed to serve a four-year term by the Commissioner's Court of either Medina or Uvalde county on an alternating basis. The South Central Texas Water Advisory Committee (SCTWAC), which was established by the EAA Act to advise the board of directors of downstream water rights and issues, is responsible for appointing the second non-voting director to serve a four-year term.

Exhibit 2.1 - EAA Districts

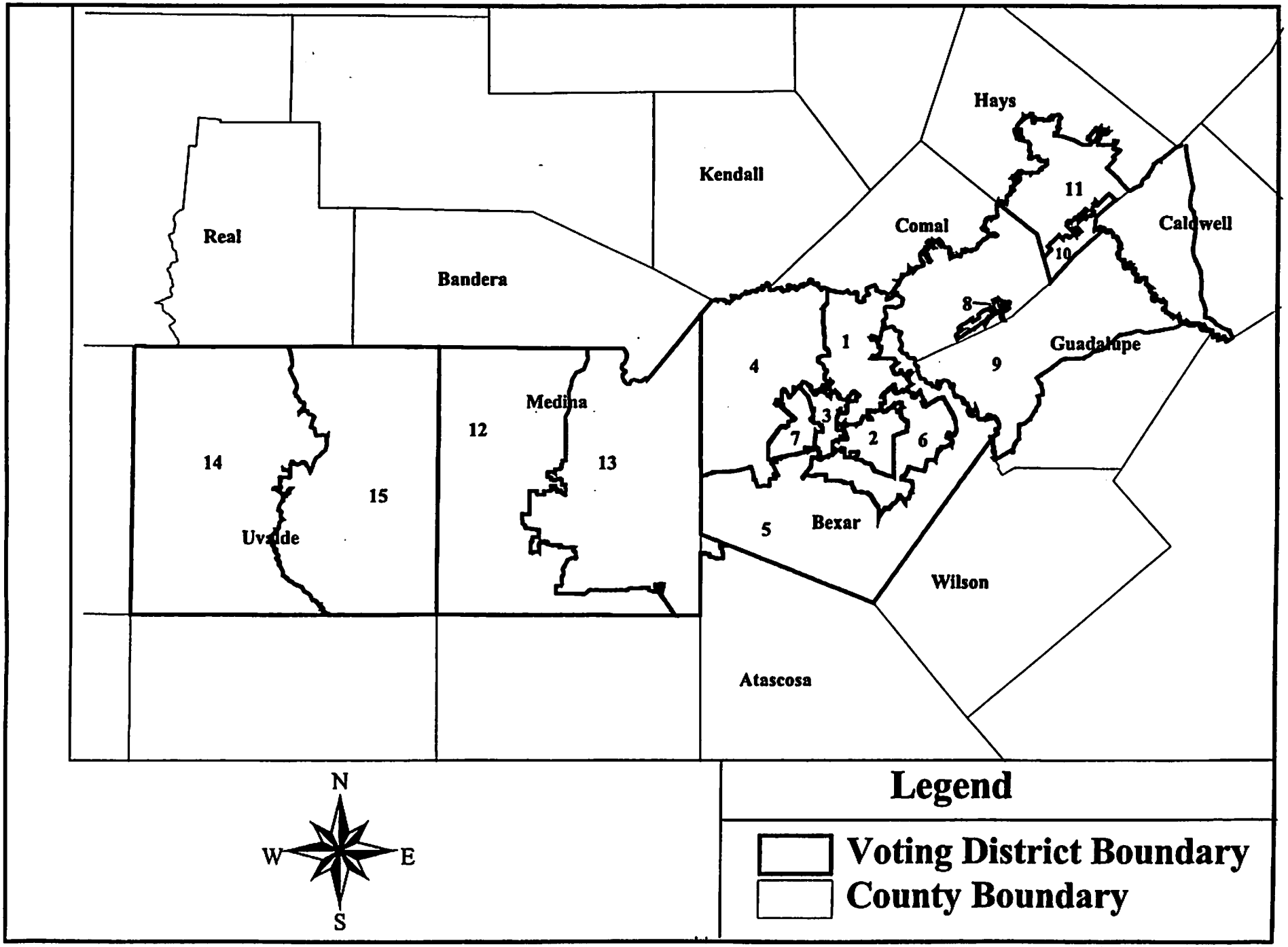


Exhibit 2.2 - Edward Aquifer Authority Board Members

Edwards Aquifer Aquifer Authority Board Members
(terms expire on December 1 of year in parentheses)

Bexar County
- District 1 - Carol Patterson, Secretary (1998)
- District 2 - John Sanders (2000)
- District 3 - Weir Labatt (1998)
- District 4 - Michael Beldon, Chairman (2000)
- District 5 - Sylvia Mendelsohn (1998)
- District 6 - Susan Hughes (2000)
- District 7 - Ramiro Cavazos (1998)

Comal County and a portion of Guadalupe County
- District 8 - Rita Ellis Banda (2000)
- District 9* - Doug Miller, Treasurer (1998)

* District 9 represents both Comal and Guadalupe County.

Hays County and a portion of Caldwell County
- District 10 - Ken Barnes (2000)
- District 11* - Mack Martinez (1998)

* District 11 represents both Hays and Caldwell County.

Medina County and a portion of Atascosa County
- District 12 - Hunter Schuehle* (1998)
- District 13** - Luana Buckner (1998)

* Appointed to fill unexpired term of District 12 and will have special election in 1998.
** District 13 represents both Medina and Atascosa County.

Uvalde County
- District 14 - Rogelio Muñoz, Vice Chairman (2000)
- District 15 - Bruce Gilleland (1998)

South Central Texas Water Advisory Committee Representative
- Bob Keith (2000)

Medina/Uvalde County Representative (appointed by Medina Co. Commissioner's Court)
- Milton Stolte (2000)

To facilitate its operation, the Edwards Aquifer Authority's Board of Directors has established eight functional committees as shown below. Each committee consists of five to eight directors, with staff support provided by an employee designated as the committee liaison. **Exhibit 2.3** shows the members of each committee as well as the committee liaison.

EDWARDS AQUIFER AUTHORITY COMMITTEE FUNCTIONAL RESPONSIBILITIES:

Executive Committee - *Assures the overall performance of the Edwards Aquifer Authority; responsibilities include conducting performance assessments for the general manager, monitoring and approval of director expenses, and interim board response between meetings.*

Administrative Committee - *Establishes operational procedures; responsibilities include management policies and oversight, internal organization and oversight, employee policies and benefits, public information, meeting procedures, and bylaw review.*

Legal Committee - *Monitors legal issues affecting the Edwards Aquifer Authority; responsibilities include oversight of the general counsel and other legal services.*

Finance Committee - *Oversees the fiscal operations of the Edwards Aquifer Authority; responsibilities include creating the budget, assessing user fees and managing audits.*

Permit Committee - *Oversees operation of the permit program; responsibilities include issuance, compliance, grievance, enforcement, monitoring, reporting and meter installation.*

Research & Technology Committee - *Ensures that the Edwards Aquifer Authority fulfills its goal to conduct research; responsibilities include the collection and development of scientific data, technological assessment of alternative management practices, and water quality.*

Aquifer Management Planning - *Manages water usage from the Edwards Aquifer; responsibilities include Critical Period Management Plan, Groundwater Management Plan, irrigation withdrawal suspension plan, transfer marketing rules, new supply sources, implementation of alternative management practices, strategies for achieving legislative mandates, economic impact studies and interaction with other regional water agencies.*

Legislative Committee - *Fulfills existing and monitors future legislation; responsibilities include state and federal initiatives, monitoring of bills that may affect the Edwards Aquifer Authority, coordination of activities by directors, staff or contract representatives and communication of legislative action to the board of directors.*

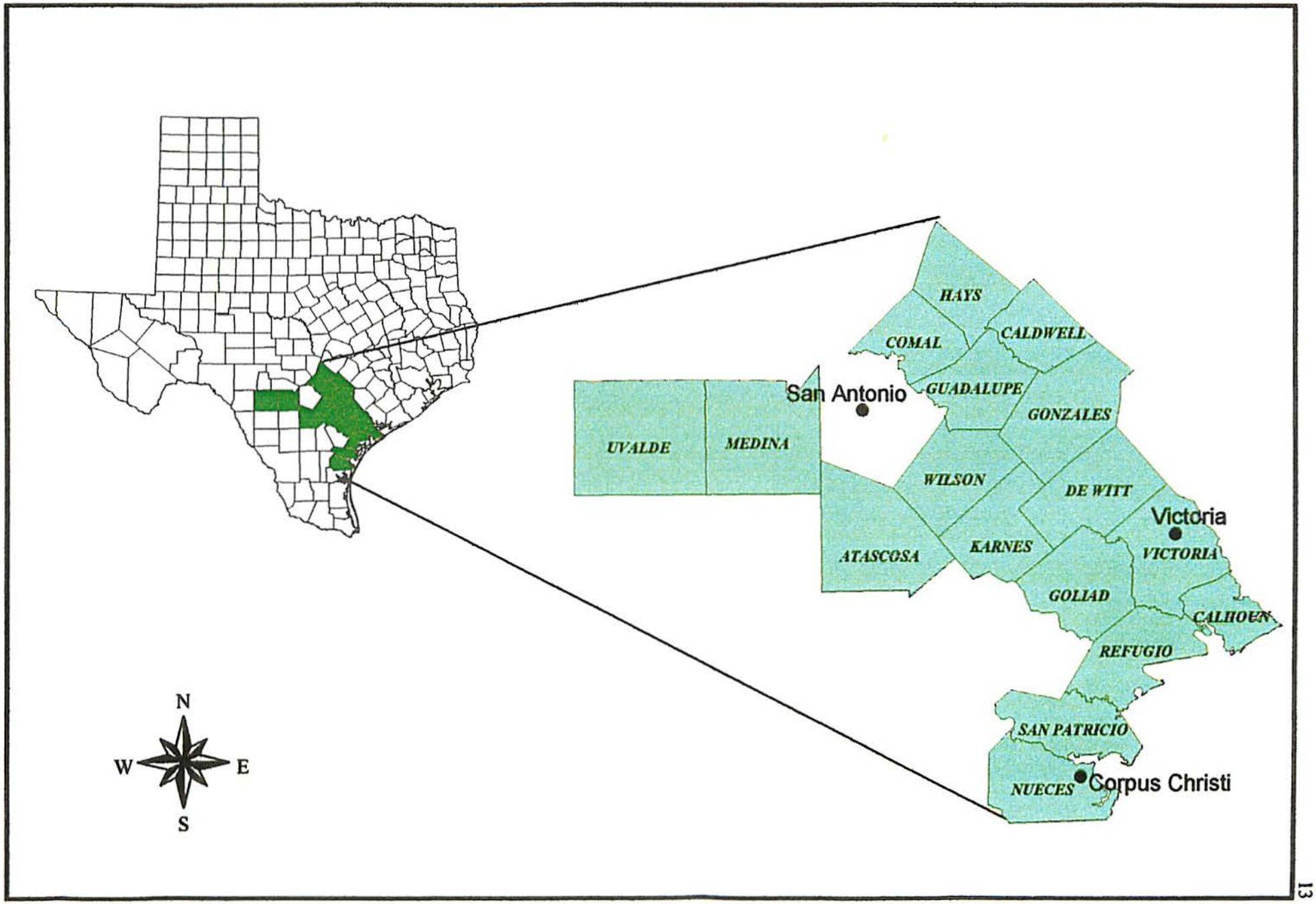
2.2.2 South Central Texas Water Advisory Committee

The EAA Act also establishes the South Central Texas Water Advisory Committee (SCTWAC) to advise the Edwards Aquifer Authority's board of directors on downstream water rights and issues. The SCTWAC consists of one representative from each of 17 counties plus the cities of San Antonio, Corpus Christi and Victoria (see **Exhibit 2.4**). However, when Atascosa County has a representative on the Edwards Aquifer Authority's board of directors, it may not have a representative on the SCTWAC. In addition to serving in an advisory role in matters relating to management of the

Exhibit 2.3 - Edwards Aquifer Authority Committee Members

Edwards Aquifer Authority 1998 Board Committees	
Administrative Committee • Ramiro Cavazos, Chair • Bob Keith • Carol Patterson • Milton Stolte • John Sanders Staff Liaison - Brock Curry	**Executive Committee** • Mike Beldon, Chair • Rogelio Muñoz • Doug Miller • Carol Patterson • Susan Hughes Staff Liaison - Greg Ellis
Aquifer Management Planning Committee • Ken Barnes, Chair • Rita Banda • Bob Keith • Milton Stolte • Weir Labatt • Sylvia Mendelsohn • Luana Buckner Staff Liaison - Rick Illgner	**Research & Technology Committee** • Susan Hughes, Chair • Rita Banda • Ramiro Cavazos • Carol Patterson • Bob Keith • Milton Stolte • Hunter Schuehl Staff Liaison - Gayle Kipp
Finance Committee • Doug Miller, Chair • Bruce Gilleland • Susan Hughes • Ramiro Cavazos • Hunter Scuehle Staff Liaison - Brock Curry	**Legislative Committee** • Weir Labatt, Chair • Ken Barnes • Luana Buckner • Rogelio Muñoz • Doug Miller Staff Liaison - Velma Danielson
Legal Committee • Mack Martinez, Chair • Rogelio Muñoz • John Sanders • Hunter Schuehle • Rita Banda Staff Liaison - Velma Danielson	**Permits Committee** • Luana Buckner, Chair • Ken Barnes • Bruce Gilleland • Weir Labatt • Sylvia Mendelsohn Staff Liaison - Steve Walthour

Exhibit 2.4 - Map of Areas Represented by the South Central Texas Water Advisory Committee



Edwards Aquifer, the presiding officer of the SCTWAC also is required to submit a report to the Edwards Aquifer Authority and the Texas Natural Resource Conservation Commission (TNRCC) by October 31 of each even-numbered year. This report must assess the effectiveness of the Edwards Aquifer Authority and the impacts on downstream water rights.

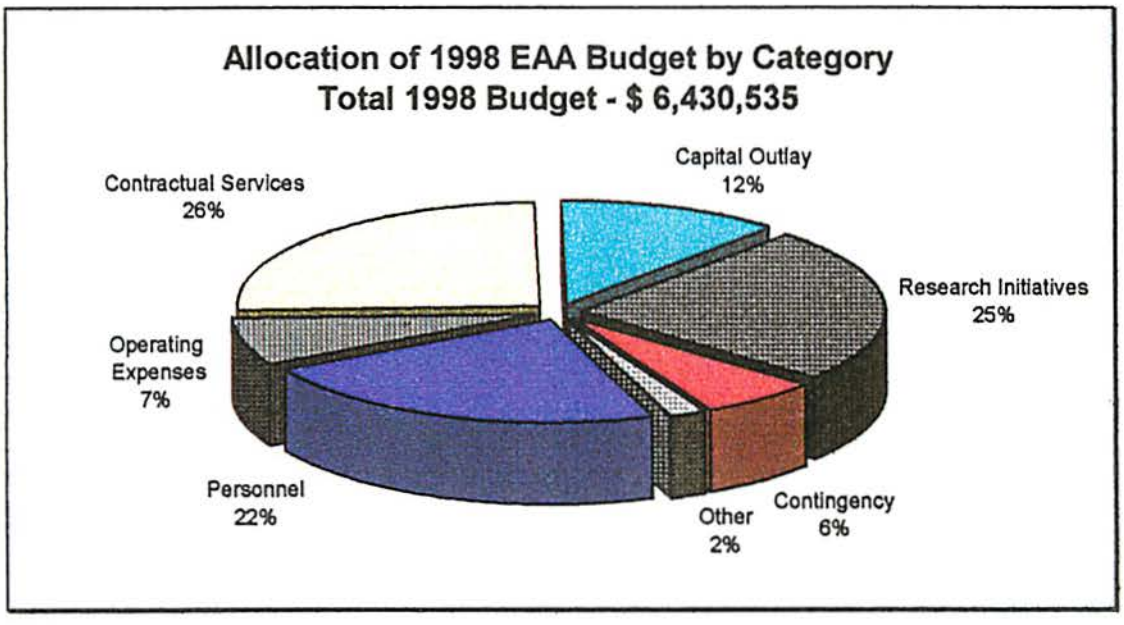
2.2.3 Edwards Aquifer Authority Staff

The Edwards Aquifer Authority has a full-time staff of 30 individuals to perform the administrative, professional and technical functions of the agency. The Edwards Aquifer Authority's general manager reports to and serves at the pleasure of the board of directors. The general manager is the liaison to the board of directors, and is responsible for executing board policy and for the day-to-day operations of the organization.

The organizational structure of the Edwards Aquifer Authority is based on four functional teams, as shown in **Exhibit 2.5**. The four teams are Executive, Administrative, Water Resources and Field Services. The general manager serves as the team leader for the Executive Team while, the other three teams are led by a program manager for that functional area.

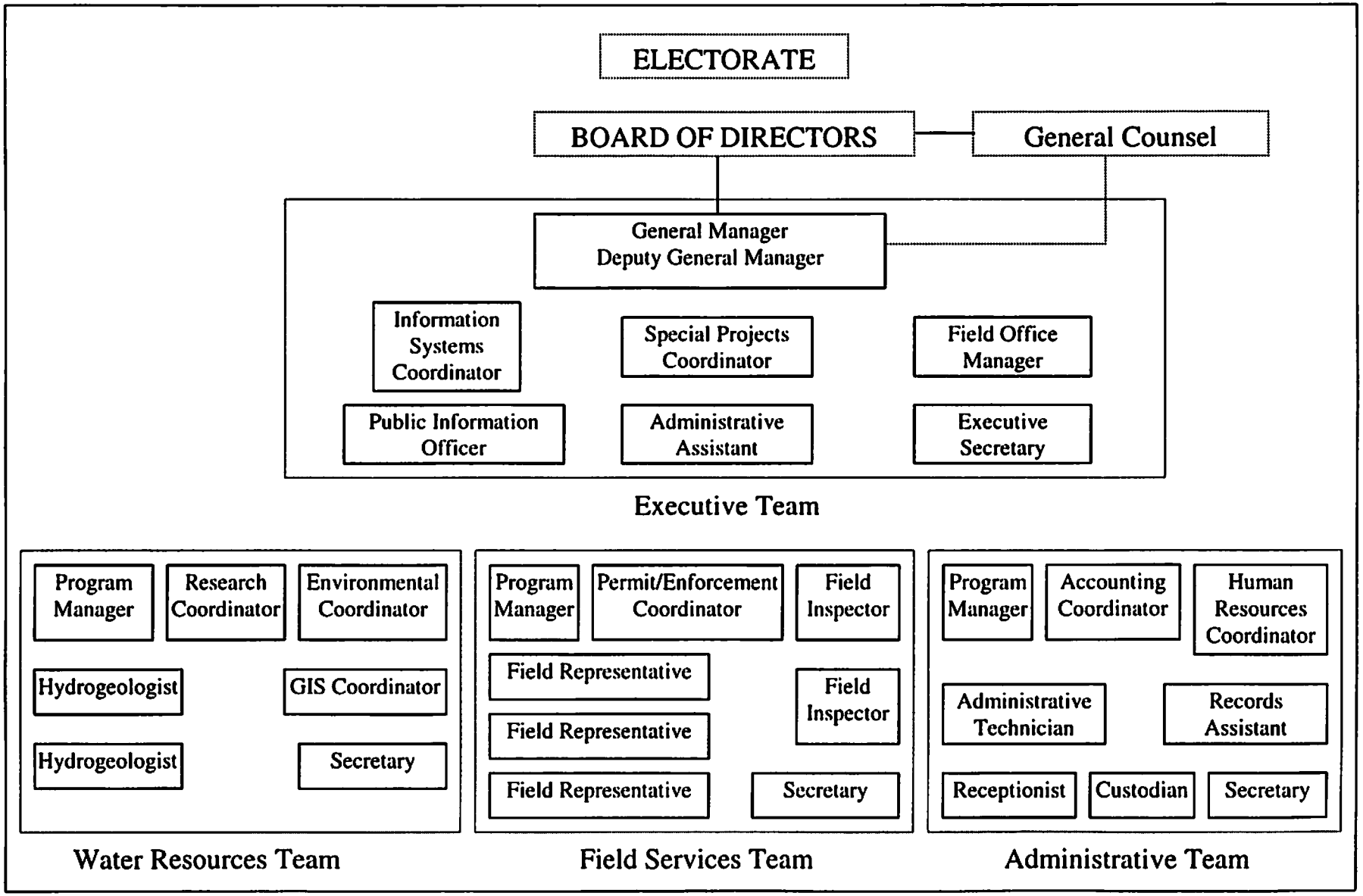
2.3 Edwards Aquifer Authority Annual Operating Budget

In 1998, the Edwards Aquifer Authority will operate with a budget of nearly $6.5 million. The following figure shows the major expense categories of the Edwards Aquifer Authority and their percentage of the total Edwards Aquifer Authority budget.



Total 1998 revenues are projected to be approximately $5.25 million, of which nearly 94 percent will be derived from aquifer management fees assessed on non-agricultural users. These fees are currently assessed at a rate of $17 per acre-foot, based on each non-agricultural users interim authorization to withdraw water from the Edwards Aquifer. Other sources of revenue include aquifer

Exhibit 2.5 - Edwards Aquifer Authority Organizational Chart



management fees from agricultural users[1], grants from other governmental agencies and interest earnings. The remaining $1.25 million of the 1998 budget will be drawn from revenues from the 1996-97 budget fund balance. Funds from the 1996-97 Edwards Aquifer Authority budget were derived from ad valorem (i.e., property) taxes collected by the former Edwards Underground Water District. These reserve funds will be exhausted in 1998. Consequently, in future years the Edwards Aquifer Authority's aquifer management fees will be set to generate revenues sufficient to fund all operating expenses.

[1] The aquifer management fee for agricultural withdrawals cannot be more than 20 percent of the fee rate assessed for non-agricultural use and is based on actual withdrawals from the Edwards Aquifer. Non-agricultural water users (i.e., municipal and industrial) are assessed annual fees based on the amount of water the permit holder is authorized to withdraw that year.

3.0 Description of the Planning Area

3.1 Planning Area

The Edwards Aquifer Authority's jurisdiction is limited to the Edwards Aquifer within an area that includes all of Bexar, Medina, Uvalde and parts of Atascosa, Comal, Caldwell, Hays and Guadalupe counties (see **Exhibit 2.1.**) Although the Edwards Aquifer Authority's regulatory jurisdiction is contained within these counties, the use and management of the Edwards Aquifer affect a much larger area. In addition to being the primary water source for users within the Edwards Aquifer Authority's boundaries, the Edwards Aquifer also supplies a significant portion of the flow in the Guadalupe River Basin downstream of Comal and San Marcos Springs. Consequently, the area of interest for water resources planning purposes includes the contributing zone of the Edwards Aquifer and downstream areas in the Nueces, San Antonio and Guadalupe River Basins. This planning area encompasses all of the counties and cities represented on the South Central Texas Water Advisory Committee. **Exhibit 3.1** shows the approximate extent of the Edwards Aquifer Authority's water resources planning area.

3.2 Planning Area Description

In 1990 the Edwards Aquifer was the primary water supply source for 1.36 million people living within the Edwards Aquifer Authority's boundaries. For discussion purposes, the region can be divided into three sub-regions, each of which relies directly on the aquifer to support somewhat differing economies and interests. The boundaries of these sub-regions are not exact. For example, even though most of metropolitan San Antonio is contained within Bexar County, the San Antonio metropolitan statistical area (MSA) as defined by the U.S. Census Bureau extends into portions of Comal, Guadalupe and Wilson Counties.

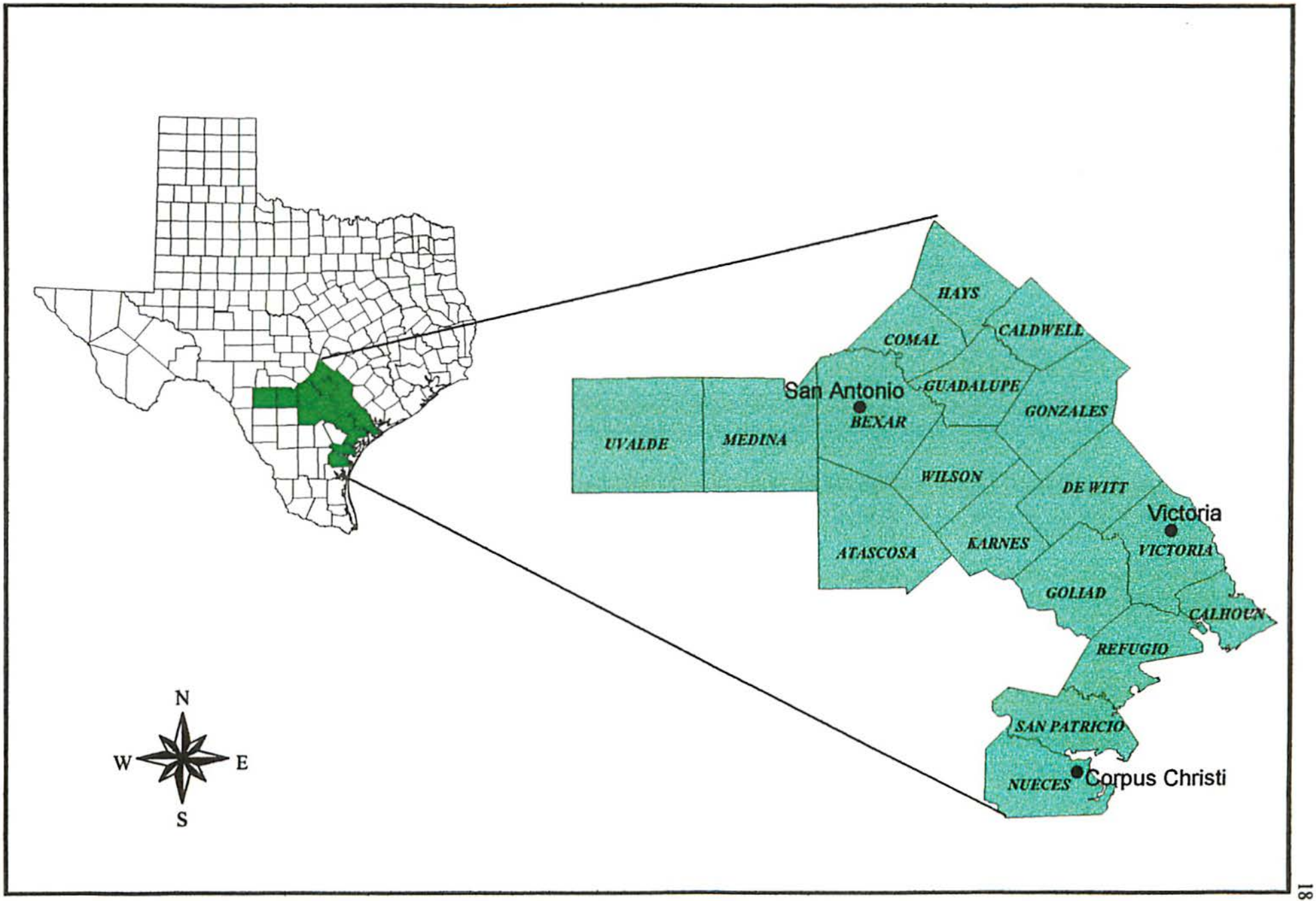
3.2.1 Western Region (Medina, Uvalde and a portion of Atascosa County)

In 1990 Medina and Uvalde counties together had approximately 51,000 residents, or about 4 percent of the population within the Edwards Aquifer Authority's jurisdiction. The economy of both of these western counties is driven largely by farming and ranching, of which irrigated farming is a significant component. From the years 1994 to 1997, these two counties generated an estimated annual average of $68.1 million from crops[1]. Of this value, roughly 90 percent was derived from crops that were grown in irrigated fields. Total irrigated acreage is estimated to be 41,600 and 49,800 acres (1994 statistics) for Medina and Uvalde counties respectively. Major crops include cotton, corn, milo, wheat and vegetables.

3.2.2 Central Region (Bexar County)

The central region, here defined as Bexar County, encompasses the majority of the San Antonio metropolitan area. In 1990, the population of Bexar County was 1.18 million people, which is

Exhibit 3.1 - EAA Water Resources Planning Area (SCTWAC and EAA Jurisdiction)



approximately 87 percent of the population within the Edwards Aquifer Authority's boundaries. The economy in the San Antonio region is diverse, and is supported by strong trade and service sectors, tourism and the presence of large military bases. Other significant components of the San Antonio economy include medical research, biotechnology and higher education. In 1994, total sales from San Antonio's major industries were estimated at over 29 billion dollars.[1] Total non-farm employment in the area was estimated at 644,100 in 1996, up nearly 15 percent from 1992. The presence of five local military bases serves as an anchor to the region and contributes roughly $4 billion to the local economy. Due to its high degree of development, water use in the San Antonio metropolitan area is predominantly municipal and industrial.

In addition to the urban economy of San Antonio, the western portion of Bexar County, to some extent, relies on agricultural activity. From 1994 to 1997, approximately $47.9 million was generated by revenue from crops. In 1994 the TWDB estimated approximately 15,700 acres of Bexar County was irrigated cropland.[2]

3.2.3 Eastern Region (portions of Comal, Hays, Guadalupe and Caldwell Counties)

The area to the north and east of Bexar County, here designated as the eastern region, consists of the portions of Comal, Hays, Guadalupe and Caldwell counties that fall within Edwards Aquifer Authority's jurisdiction. In 1990 the population of this sub-region was approximately 126,000 and contained the remaining 9 percent of the population within the Edwards Aquifer Authority's boundaries. Unique to the eastern region is the significance of Comal and San Marcos springs to the local economy. Specifically, the springs are important attractions in the area's water-oriented tourism industry. In addition to their economic value, Comal and San Marcos springs are also the exclusive home to several endangered and threatened plant and animal species and provide an important source of freshwater for downstream users in the Guadalupe River, bays and estuaries.

3.2.4 Downstream Areas

The downstream area designation refers to the cities and counties with representatives in the SCTWAC. Each of these communities shares the common interest that they are dependent on surface water flows that have some contribution to or from the Edwards Aquifer. Surface water uses by these communities vary widely and include municipal, industrial, irrigation and recreation.

3.3 Planning Area Population Projections[3]

Population within the Edwards Aquifer Authority's area of jurisdiction has grown and is expected to continue to grow significantly into the next century. While the area's 1990 population was estimated to be 1.36 million, projections estimate the 2050 population to be more than 3.6 million. The following table breaks down the population projections for the region.

---

[1] Source: Texas Comptroller of Public Accounts, San Antonio Metropolitan Area Economic Profile, 1997.
[2] Source: Texas Agricultural Extension Service.
[3] All population statistics within this report were derived from information within the Trans-Texas Water Program Report - West Central Study Area, Phase II entitled, *Population, Water Demand and Water Supply Projections*, January 1998. Figures have been rounded to the nearest hundred.

Table 3.3.1 - Edwards Aquifer Authority Population Projections

	Total in	Projections					
	1990	2000	2010	2020	2030	2040	2050
Atascosa*	1,600	2,300	2,700	3,100	3,500	3,800	4,100
Bexar	1,182,600	1,470,400	1,771,700	2,124,100	2,483,200	2,808,200	3,072,500
Caldwell*	19,800	23,700	27,600	31,200	33,700	33,700	33,700
Comal*	31,000	43,600	57,500	75,700	96,800	112,800	130,900
Guadalupe*	39,200	53,500	72,000	91,400	116,000	135,400	159,300
Hays*	36,100	44,400	54,500	65,200	78,900	95,200	111,900
Medina	27,300	33,300	38,100	42,300	44,900	47,000	49,600
Uvalde	23,300	26,500	29,800	32,800	35,600	38,100	40,600
TOTAL	**1,360,900**	**1,697,800**	**2,053,800**	**2,465,800**	**2,892,600**	**3,274,000**	**3,602,500**
*** Denotes portion of county population within Edwards Aquifer Authority jurisdiction**							

As the table above illustrates, all portions of the Edwards Aquifer Authority jurisdiction are expected to achieve significant population gains, with a total population increase of 287 percent over the 60-year period. Trends within this overall growth pattern show that the eastern region of the Edwards Aquifer Authority's area will experience the fastest growth; approximately 338 percent over the projection period. This is followed by the San Antonio area, which is projected to grow by 260 percent, and the western region, which is expected to grow by 178 percent.

3.4 Groundwater Resources

3.4.1 Hydrogeologic Characteristics of the Edwards Aquifer

The Edwards Aquifer is a permeable, carbonate aquifer that is capable of producing large quantities of high-quality water. The aquifer is composed of limestone and dolomite that lay within an area known as the Balcones Fault Zone. The aquifer's productivity is largely attributable to the occurrence and development of numerous faults, fractures, vugular porosity and caves that facilitate the transmission of water throughout the aquifer.

The Edwards Aquifer is approximately 180 miles long (east to west) and has a width varying from 5 to 40 miles wide (north to south). The total area covered by the aquifer is approximately 3,600 square miles. The Edwards Aquifer is bounded to the east by a groundwater divide in Kyle, Texas, and in the west by another groundwater divide in Brackettville, Texas. To the north, the Edwards Aquifer begins where formations outcrop into the recharge zone within the Edwards Plateau. The southern extent of the Edwards Aquifer is marked by the "bad water line." This line, which is also referred to as the saline-water line or fresh-water/saline-water interface, marks the interface where total dissolved-solids concentrations reach, 1,000 milligrams per liter.
The Edwards Aquifer consists of both an unconfined region and a confined region. The unconfined region of the aquifer, which covers approximately 1,500 square miles has a water surface that is at

normal atmospheric pressure. This area is also known as the recharge zone. The average thickness of this region is approximately 150 feet, and flow is generally toward the southeast. The confined portion of the Edwards Aquifer covers 2,100 square miles, has an average thickness of 500 feet and generally flows towards springs in the northeast. This portion of the aquifer is overlain by a low permeability, confining layer known as the Del Rio Clay Formation and lies on top of a confining layer known as the Glen Rose Formation. It is the presence of these confining layers that are responsible for the confined aquifer's artesian conditions and subsequent springflow.

While a portion of this recharge is direct recharge from outcroppings in the unconfined portion of the aquifer, the majority of the aquifer's recharge is from rain that falls in the areas to the north of the aquifer on the Edwards Plateau. This recharge occurs when watercourses cross the Balcones Fault Zone and lose flow to the unconfined portion of the aquifer. Major rivers and creeks that contribute to this recharge include the West Nueces, Nueces, Dry Frio, Frio, Sabinal, Medina and Blanco Rivers and the Seco, Hondo, Verde, Salado, Cibolo, Dry Comal and Purgatory Creeks.

Water in the Edwards Aquifer is discharged primarily through wells, seeps and springs, with a relatively small amount of discharge to the saline water zone. Major springs in the aquifer include the San Marcos and Comal Springs; smaller order springs are the San Pedro, Hueco, Leona and San Antonio Springs.

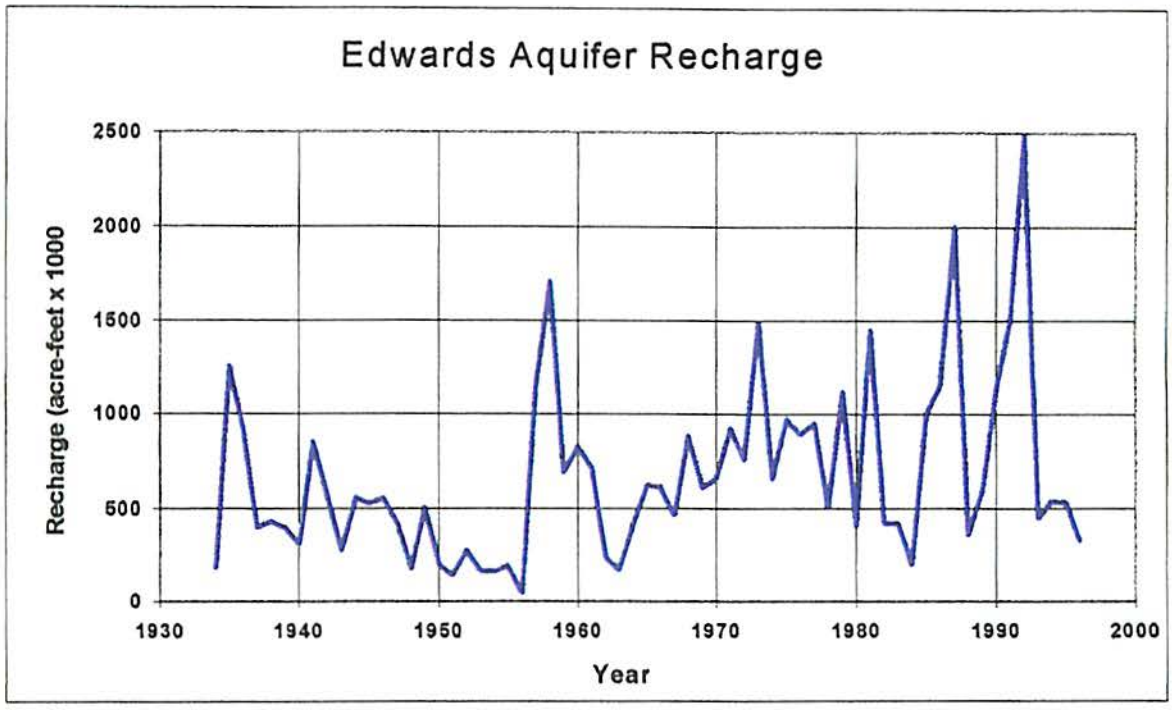
3.4.2 Water Supply in the Edwards Aquifer

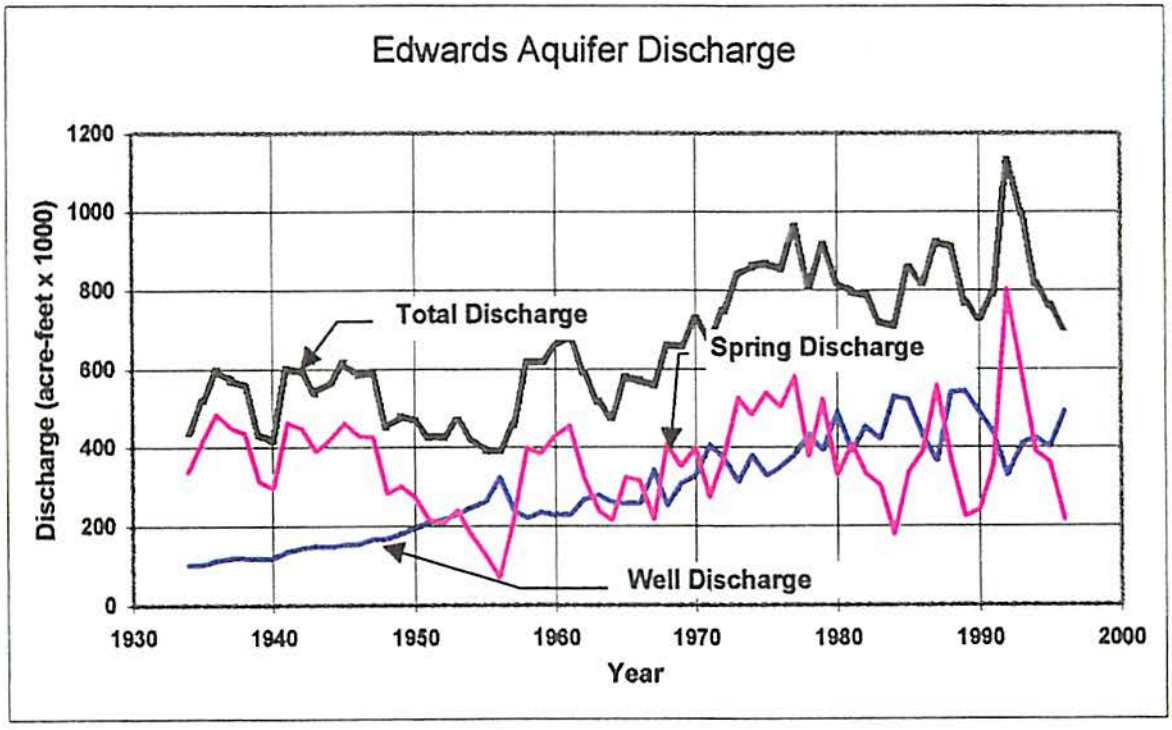
The Texas State Bureau of Economic Geology has estimated that the Edwards Aquifer contains 173 million acre-feet of fresh water.[1] However, the total amount of water that can be recovered from the aquifer is not known at this time. Although the aquifer stores, and is capable of, yielding large amounts of water, only a relatively small quantity on an annual basis can be withdrawn without reducing springflow. This amount of water can be estimated by conducting a water balance of aquifer recharge and discharge.

Summary of Aquifer Recharge and Discharge – Period of Record (1934-1996)

	Record High (ac-ft, year)	*Record Low (ac-ft, year)*	*Average (ac-ft, period of avg.)*
RECHARGE (source: stream losses)	2,486,000 (1992)	43,000 (1956)	668,700 (1934-96)
DISCHARGE			
Springflow	802,800 (1992)	69,800 (1956)	363,500 (1934-96)
Pumpage	542,400 (1989)	101,900 (1934)	410,300 (1987-96)
Source: Edwards Aquifer Hydrogeologic Report for 1996; Report 97-01.			

[1] Source: Bureau of Economic Geology, University of Texas at Austin, *Edwards Aquifer Storage Assessment, Kinney County to Hays County, Texas*, 1995.





As this water balance information reveals, the amount of Edwards Aquifer water available for use is subject to wide variation. While periods of greater than average rainfall yield large volumes of water for springflow and pumping, drought years yield relatively little water. It is these two extremes, along with the necessity to maintain springflow and consider downstream interests, that make effective management of the Edwards Aquifer crucial.

According to the EAA Act as amended, the Edwards Aquifer Authority may allow permitted withdrawal of up to 450,000 acre-feet per calendar year until 2008. Beginning January 1, 2008, allowable permitted pumpage is to be reduced to a maximum of 400,000 acre-feet per year. However, the EAA Act provides that the withdrawal limit may be revised:

> *"If, through studies and implementation of water management strategies, including conservation, springflow augmentation, diversions downstream of the springs, reuse, supplemental recharge, conjunctive management of surface and subsurface water, and drought management plans, the Authority determines that additional supplies are available from the aquifer, the authority, in consultation with appropriate state and federal agencies, may review and may increase the maximum amount of withdrawals provided by this section and set a different maximum amount of withdrawals."*

The Edwards Aquifer Authority has the mandate and responsibility to reduce withdrawals from the aquifer when the monitoring wells drop below levels prescribed in the Edwards Aquifer Authority's Critical Period Management Plan (CPMP). The CPMP establishes rules for the stages of water reductions, each of which is triggered by specified water levels in the index wells. Under the Critical Period Management Plan, aquifer withdrawals are allowed on an non-interruptible basis when the aquifer level is above 650 feet mean sea level (msl) at the J-17 index well in Bexar County and above 845 feet msl at the J-27 well in Uvalde County. Below these levels, the Critical Period Management Plan requires increasingly severe reductions in allowable withdrawals, based on the permitted user's base water use, and allowable water transfers for each successive stage of the plan.

3.4.4 Other Groundwater Resources

In addition to the Edwards Aquifer, groundwater resources for counties in the Edwards Aquifer Authority's planning region include the Carrizo-Wilcox, Trinity, Edwards-Trinity, Queen City and Sparta aquifers. Because statistics for groundwater resources are based on reported pumpage by county, it is difficult to determine the amount of groundwater use from other sources in the Edwards Aquifer Authority boundaries. However, available data for 1990 from Bexar, Medina and Uvalde counties shows an estimated use of 41,560 acre-feet[1] from non-Edwards Aquifer groundwater sources.

3.5 Surface Water Resources

In addition to groundwater from the Edwards Aquifer and other regional aquifers, surface water supplies are projected to be incorporated in the water management strategy within the Edwards Aquifer Authority area. However, while the Edwards Aquifer and other groundwater sources were described according to county and Edwards Aquifer Authority area designations, surface water resources will be considered in terms of river basins. This designation is necessary because the Edwards Aquifer Authority coincides with only a small portion of three river basins and because surface water is regulated by the state according to prior appropriation. The doctrine of prior appropriation states any person or entity granted a permit to use surface water has rights to water that are senior to those of subsequently issued permits and are junior to rights with previously issued permits.

3.5.1 Hydrologic Characteristics of the Nueces, San Antonio and Guadalupe River Basins

[1] Trans-Texas Water Program report entitled, *Population, Water Demand, and Water Supply Projections, West Central Study Area, Phase II, January 1998.*

The area of jurisdiction of the Edwards Aquifer Authority coincides with three major river basins. These basins from southwest to northeast are the Nueces, San Antonio and Guadalupe River Basins (refer to **Exhibit 3.2**).

Nueces River Basin

The Nueces River Basin drains 16,950 square miles and includes a total population (1990 statistics) of 165,500. The basin begins in Edwards County, outfalls into Nueces Bay, and crosses the Edwards Aquifer Authority area in Uvalde and part of Medina counties. Major waterways in this region include the West Nueces, Nueces, Sabinal, Frio, Leona and Atascosa Rivers, while Choke Canyon Reservoir and Lake Corpus Christi are the major reservoirs. In addition to directly supplying water through river rights, the rivers in the Nueces Basin are responsible for much of the Edwards Aquifer's recharge.

San Antonio River Basin

The San Antonio River Basin, which includes metropolitan San Antonio, drains 4,180 square miles and has a total population (1990 statistics) of 1.271 million. The northwestern extent of Bandera County marks the most upstream point in the basin's drainage area, which ultimately discharges into the Guadalupe River. The portion of Edwards Aquifer Authority area within the San Antonio River Basin includes the eastern portion of Medina, all of Bexar and the western parts of Comal and Guadalupe counties. The basin's major waterways include Cibolo Creek and the Medina and San Antonio rivers, of which the Medina (and Medina Lake) contributes to Edwards Aquifer recharge. The area's only major existing reservoir is Medina Lake, which is approximately 30 miles northwest of downtown San Antonio. Other water bodies in the basin, which are used for electric power plant cooling water, include Braunig and Calaveras lakes.

Guadalupe River Basin

The Guadalupe River Basin drains 6,700 square miles and has a total population (1990 statistics) of 302,400. The basin's most upstream extent is at the Kerr/Real County boundary and basin outfall is into San Antonio Bay. The Guadalupe River Basin crosses the Edwards Aquifer Authority area of jurisdiction in portions of Comal, Hays, Guadalupe and Caldwell counties. The Guadalupe, Comal, San Marcos, and Blanco rivers are the basin's main waterways, with the Blanco and possibly the Guadalupe rivers contributing to Edwards Aquifer recharge. In addition to river water rights, Canyon Lake and Coleto Creek Reservoir are major sources of water supply for the basin.

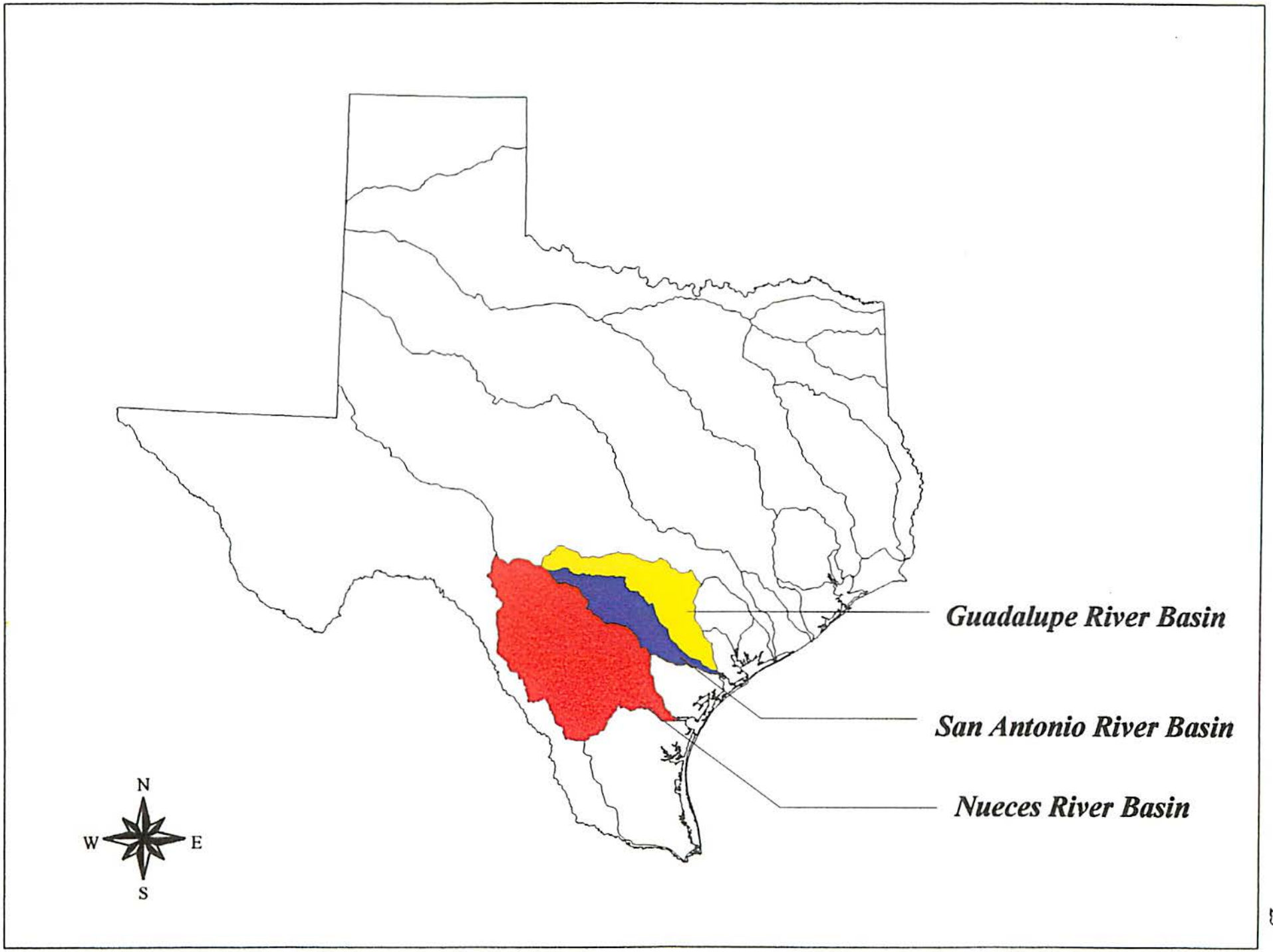
3.5.2 Available Surface Water Supplies[1]

In determining the existing available surface water supplies, four types of water sources were considered. These types of water sources include:

- reservoirs with a firm yield
- storage reservoirs for steam-electric power cooling
- storage reservoirs for water supply management and recreation
- run-of-river water rights.

[1] Except as noted, all water supply information within this report was taken from information developed for the Trans-Texas Water Program report titled, *Population, Water Demand, and Water Supply Projections, West Central Study Area, Phase II*, January 1998. (Figures are based originally on TWDB projections.)

Exhibit 3.2 - Nueces, San Antonio, and Guadalupe River Basins



Summary of Available Surface Water Supplies by River Basin*

Nueces Basin

	Firm Yield (ac-ft)	Permitted (ac-ft)
Reservoir		
Choke Canyon/Lake Corpus Christi	-	178,000
Run of River Rights	-	53,397
TOTAL	**-**	**231,397**

San Antonio Basin

	Firm Yield (ac-ft)	Permitted (ac-ft)
Reservoir		
Medina Lake	8,770[1]	66,750
Braunig Lake	-	12,000[2]
Calaveras Lake	-	37,000[2]
Run of River Rights	-	46,808
TOTAL	**8,770**	**162,558**

Guadalupe Basin

	Firm Yield (ac-ft)	Permitted (ac-ft)
Reservoir		
Canyon Lake	82,627[3]	50,000
Coleto Creek	-	12,500
Run of River Rights	-	272,327
TOTAL	**82,627**	**348,827**

* Source: Texas Water Development Board, *Water for Texas*, 1997 and Trans Texas Report, *Population, Water Demand, and Water Supply Projections*, West Central Study Area, 1998.

[1] Firm yield based on uniform monthly diversion directly from Medina Lake.

[2] Yield based on reuse of wastewater return flows from the City of San Antonio. In addition, the City of San Antonio recycling program will reuse an additional 35,000 acre-feet per year by 2020.

[3] Figure based on application for permit amendment filed with the TNRCC by the GBRA on 8/29/97. The current permitted yield for Canyon Lake is 50,000 acre-feet per year.

3.6 Current Water Use

To maintain consistency throughout the plan, current water use estimates for the Edwards Aquifer region are based on information presented in the Trans-Texas Water Program West-Central Study Area report titled *Population, Water Demand, and Water Supply Projections, West Central Study Area, Phase II.* This information was derived from projections prepared by the TWDB for the 1997-

State Water Plan. For estimates of current water use, 1990 is used as the base year. In addition to the TWDB water use information, data from the Edwards Aquifer Authority's publication, *Edwards Aquifer Hydrogeologic Report for 1996* were used to show 1996 reported water use and the 10-year average water use.

3.6.1 Categories of Water Use

Water use in the Edwards Aquifer Area can be categorized into six major types and with a special category for environmental use associated with springflow. The following is a description of these categories as defined in the Trans-Texas Water Program reports:

- **Municipal Water Use** - includes freshwater for drinking, food preparation, dishwashing, bathing, toilet flushing, laundry, lawn watering, private and public swimming pools, hot tubs, restaurants, car washes, commercial laundries, office, service hotel, motel, and retail building bathrooms and air conditioning, fire protection, fountains, public parks, sports centers, aquariums, zoos, and street washing. Municipal water must meet safe drinking standards as specified by federal and state laws and regulations.

- **Industrial Water Use** - includes freshwater used by industries for processing raw materials, including cooling of manufacturing processes, onsite electric power generation for use in manufacturing plants, cleaning and waste removal, grounds maintenance, sanitation, pollution control, internal transportation, and in some cases, such as food and beverage manufacturing, is included as part of the finished product.

- **Steam-Electric Power Water Use** - Steam-electric power generation plants use fresh water for condenser cooling, boiler feed makeup, sanitation, grounds maintenance and pollution control.

- **Irrigation Water Use** - The application of fresh water to land to grow crops.

- **Mining Water Use** – Fresh water used in the recovery of petroleum, sand, gravel, clay and stone.

- **Livestock Water Use** - Includes drinking water and water used for the washing and sanitation of livestock housing and production facilities as needed for farm and ranch animals and poultry.

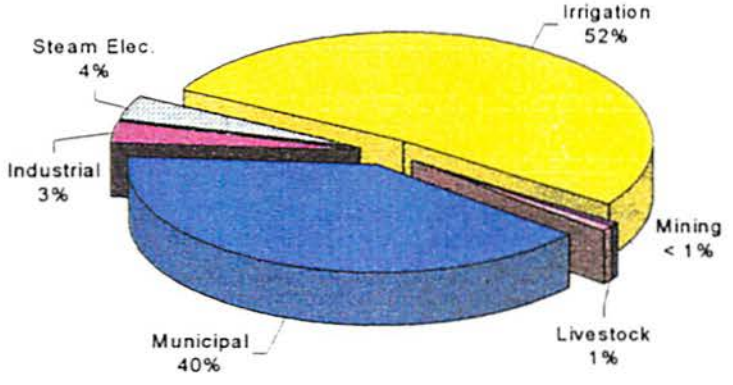
- **Environmental Use** - While not explicitly defined by the TWDB, the Edwards Aquifer has a unique, additional use of supplying springflow for environmental and recreational use. This usage consists of all springflow in San Marcos, Comal, Hueco, San Antonio, San Pedro and Leona springs.

3.6.2 Current Water Use within the Edwards Aquifer Authority Jurisdiction

Water use data for 1990 show that a total of 647,800 acre-feet of water was used within the Edwards Aquifer Authority's boundaries. Approximately 519,800 acre-feet or 80 percent of this demand was supplied by water from the Edwards Aquifer. The remaining 20 percent of 1990 water demand was met by other groundwater and surface water resources.

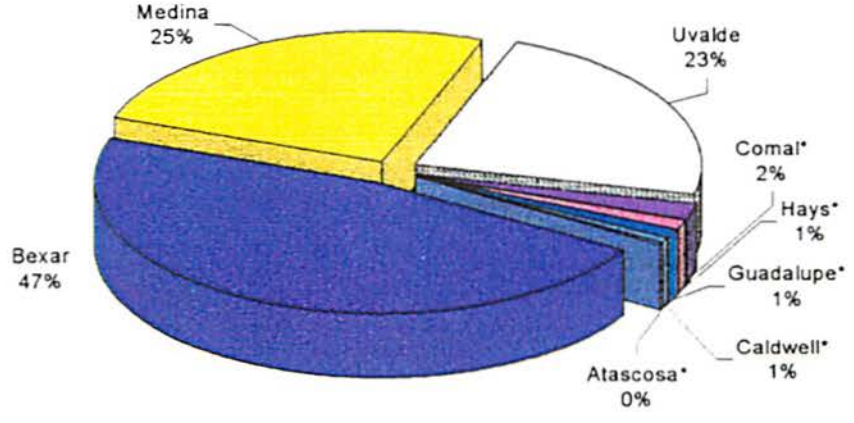
The following figures summarize area water use for 1990 by both county and type of use. In interpreting this data it is important to note that 1990 was a dryer than average year. During dry years, irrigation water demands typically increase significantly relative to demands during a year with "normal" rainfall. In particular, Medina and Uvalde counties, which rely heavily on irrigation to support their agricultural-based economies, show water use for 1990 in excess of that typical for a "normal" precipitation year.

EAA Area - Water Use Description
Total 1990 Use - 647,769 Acre-feet



Source Trans Texas Report, Population, Water Demand, and Water Supply Projections, West Central Study Area, 1998

1990 EAA Total Water Use - County Description
* Denotes portion of county within Edwards Aquifer Authority Jurisdiction



Source Trans Texas Report, Population, Water Demand, and Water Supply Projections, West Central Study Area, 1998

SUMMARY OF 1990 CURRENT WATER USE

Atascosa County *- In 1990 the portion of Atascosa County within Edwards Aquifer Authority jurisdiction used 1,800 acre-feet of water; about 0.3 percent of the total Edwards Aquifer Authority area usage. Total Atascosa County water usage was estimated to be more than 61,000 acre-feet. Water usage in Atascosa County is predominately for irrigation (81%) and municipal (19%) uses.*

Bexar County *- In 1990, Bexar County used 303,600 acre-feet of water; 47 percent of total usage in the Edwards Aquifer Authority area. Because the county includes much of metropolitan San Antonio, water usage is predominately municipal (74%), followed by irrigation (12%), steam electric power generation (8%) and industrial uses (5%).*

Caldwell County *- In 1990 the portion of Caldwell County within the Authority jurisdiction used 4,300 acre-feet of water, about 0.7 percent of the total Edwards Aquifer Authority area usage. Total Caldwell County water usage was estimated to be 7,200 acre-feet. Water usage in Caldwell County is predominately for municipal (91%) and livestock (9%) uses.*

Comal County *- Approximately 11,200 acre-feet of Comal County's current total water usage of 15,400 acre-feet is derived from the Edwards Aquifer Authority area. This amount, which represents about 2 percent of the Edwards Aquifer Authority area's total usage, is composed of: municipal (62%), industrial (29%), mining (8%) and livestock (1%) uses.*

Guadalupe County *- In 1990 the portion of Guadalupe County within Edwards Aquifer Authority jurisdiction used 6,500 acre-feet of water, about 1 percent of the total Edwards Aquifer Authority area usage. Total Guadalupe County water usage was estimated to be nearly 15,000 acre-feet. Water usage in Guadalupe County is predominately for municipal (79%), industrial (13%) and livestock (8%) uses.*

Hays County *- Hays County has a current total water usage of 13,000 acre-ft in 1990; however, only 7,900 acre-feet were used within the Edwards Aquifer Authority area. Water use is predominantly composed of municipal water use (94%), industrial (4%) and livestock (2%).*

Medina County *- Medina County's water usage in 1990 was 164,600 acre-feet; 25 percent of total usage in the Edwards Aquifer Authority area. Of this amount, 83,300 acre-feet was supplied by the Edwards Aquifer Authority while Medina Lake served as the primary source for the remainder of water usage. Water use was composed predominately of irrigation use (96%), with municipal water use (3%) representing the other significant use.*

Uvalde County *- Uvalde County consumed 147,900 acre-feet of water (144,100 acre-feet from the Edwards Aquifer), 23 percent of total usage in 1990, and has a usage pattern almost identical to that of Medina County - irrigation (95%),and municipal (4%).*

3.6.3 Current Water Use Supplied from the Edwards Aquifer

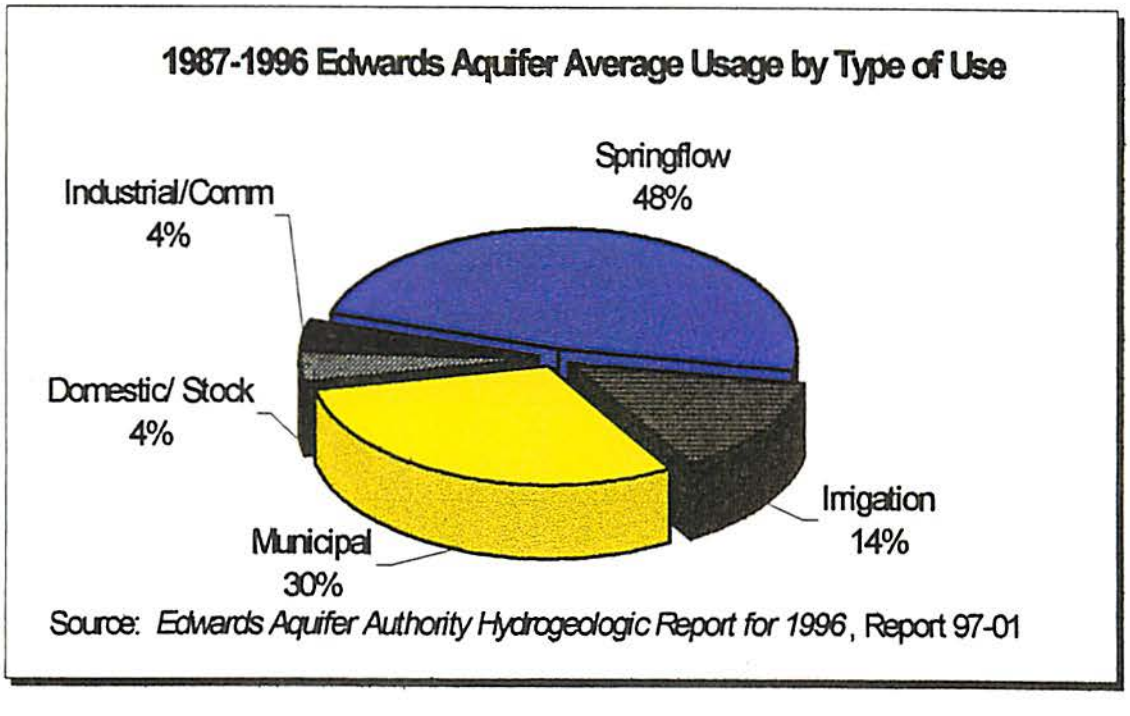
Of the 647,800 acre-feet of water used in the Edwards Aquifer Authority area in 1990, approximately 519,800 acre-feet was supplied from the Edwards Aquifer. The following table provides a summary of each county's use in 1990 as well as for 1996, which is the most current year for which records are available.

Table 3.6.1 Summary of Current Edwards Aquifer Usage (based on 1990 use)

County	1990[1] Edwards Aquifer Usage (acre-feet)	1996[2] Edwards Aquifer Usage (acre-feet)
Atascosa*	1,800	**
Bexar	268,100	286,600
Caldwell*	400	**
Comal*	11,200	20,400
Guadalupe*	3,000	**
Hays*	7,900	12,400
Medina	83,300	66,300
Uvalde	144,100	107,600
TOTAL	**519,800**	**493,300**

[1] Source: Trans Texas Report, 1998.
[2] Source: Edwards Aquifer Hydrogeologic Report for 1996.
* Denotes portion of usage within Edwards Aquifer Authority jurisdiction.
** Information presented by county in which pumping occurred instead of county of use.

In both 1990 and 1996 much of the state, including the Edwards Aquifer region, experienced lower than normal annual rainfall totals. Because of the fluctuation in annual and seasonal precipitation and its subsequent effect on irrigation water use, it is appropriate to look at average water use over a period of years as a somewhat more accurate representation of water use. The following shows the 10-year average for Edwards Aquifer water use by type of use.



As the above figure shows, on average, the amount of Edwards Aquifer water used for irrigation purposes is about 14 percent of total usage. However, during a dry year, such as occurred in 1990 and 1996, irrigation water usage represents a much larger fraction of total usage.

3.6.4 Current Water Use from other Groundwater and Surface Water Resources

Approximately 128,000 acre-feet water used in 1990 was supplied from water sources other than the Edwards Aquifer. These sources include other aquifers (described in **Section 3.4.4**) and surface water supplies (described in **Section 3.5**). While detailed breakdowns of water use from each source are not available, the county information does indicate that more than 60 percent of the non-Edwards Aquifer water use (81,300) acre-feet occurred within Medina County. The principal source of this water is Medina Lake.

3.7 Projected Water Demand

All information presented in this section is based on information from the Trans-Texas Water Program West-Central Study Area report titled *Population, Water Demand, and Water Supply Projections, West Central Study Area, West Central Study Area, Phase II.* These projections are based on water demand projections prepared by the TWDB for the 1997 "consensus-based" state water plan.

3.7.1 Projection Methodology

Projected water use is provided for each of the major categories of use. The TWDB water demand scenarios presented in this plan are as follows:

- Municipal - Most likely population
  - Most likely municipal water demand for below normal precipitation and advanced conservation
- Industrial - Base oil prices, with conservation for manufacturing
- Irrigation - Series 3 irrigation (aggressive adoption of irrigation technology and a reduction in federal farm programs by one-half)
- Steam - Electric power high series
- Mining - TWDB only series
- Livestock - TWDB only series.

Projections are presented over a 60-year horizon (from 1990), for the census decades 2000, 2010, 2020, 2030, 2040 and 2050.

3.7.2 Edwards Aquifer Authority Area Water Demand Projections

Water use in the Edwards Aquifer Authority area is projected to increase from 647,700 acre-feet (1990) to 1,009,500 acre-feet by the year 2050[1]. This increase is largely correlated to the anticipated

[1] Source: Trans Texas Water Program, *Population, Water Demand, and Water Supply Projections, West Central Study Area, Phase II*, January 1998. (Figures are based originally on TWDB projections and are under contention.)

population growth of the region as detailed in **Section 3.3**. The following table describes projected demands for each county over the 60-year period.

Table 3.7.1 – Projected Water Demand within the Edwards Aquifer Authority Area (excluding springflow)

	Total in	Projections (acre-ft)					
	1990	2000	2010	2020	2030	2040	2050
Atascosa*	1,800	2,000	1,900	1,900	1,900	1,900	2,000
Bexar	303,600	404,300	436,400	483,900	548,600	609,400	656,000
Caldwell*	4,300	4,900	5,100	5,300	5,600	5,500	5,400
Comal*	11,200	20,200	22,700	26,100	31,100	32,900	35,800
Guadalupe*	6,500	10,800	12,900	14,900	18,400	21,200	24,700
Hays*	7,900	10,700	12,000	13,400	15,900	18,900	22,100
Medina	164,600	176,100	164,600	158,100	152,100	146,300	140,800
Uvalde	147,900	144,300	139,300	134,500	130,400	126,300	122,600
TOTAL	**647,800**	**773,400**	**795,000**	**838,200**	**904,000**	**962,400**	**1,009,500**

* Denotes portion of county demand within Edwards Aquifer Authority jurisdiction

Within the projected figures above, several trends exist in the component water use categories comprising the total demand. The following summary describes these trends.

Summary of Trends in Projected Demand According to Type of Use

- ***Municipal*** *- Due to the area's relatively high projected population growth rate, it is expected that municipal water demand will increase from the 1990 usage of 259,600 to 626,500 acre-feet in 2050. While Bexar County will account for the majority of this increased demand, Comal, Hays and Guadalupe Counties will experience the greatest percentage increases.*

- ***Industrial*** *- Industrial water demand is projected to increase at a steady rate from its 1990 use of 19,300 acre-feet to 39,400 acre-feet in 2050.*

- ***Steam-Electric Power*** *- Steam-electric power generation water demand is correlated with population growth and is expected to increase a current usage of 24,300 acre-feet to 56,000 acre-feet in 2050.*

- ***Irrigation*** *- Irrigation water use in the Edwards Aquifer Authority area is expected to decline from 336,500 acre-feet in 1990 to 272,400 acre-feet in 2050. This decline is due to improved irrigation efficiency and anticipated future reduced farm acreage. Transfers are expected to create a further decline.*

- *Mining – An economic rebound is expected to create a sharp increase in water demand from 3,000 acre-feet in 1990 to 10,900 acre-feet in 2000. Beyond 2000 the demand is projected to remain nearly constant, with a projected use in 2050 of 9,100 acre-feet.*

- *Livestock - Estimated water use for livestock purposes within the area in 1990 was 5,200 acre-feet. This demand is projected to increase to its maximum level of 6,200 acre-feet annually in 2000 and is projected to remain constant until 2050.*

3.7.3 Projected Water Use in the Nueces, San Antonio and Guadalupe River Basins

The projected water use in Nueces, San Antonio and Guadalupe River basins follow a trend similar to that in the portion of the Edwards Aquifer Authority area that they intersect. The Nueces Basin, which intersects the Edwards Aquifer Authority area in agricultural Medina and Uvalde counties, is projected to see a decrease in water usage due to reduced and more efficient irrigation. However, the San Antonio and Guadalupe basins intersect the Edwards Aquifer Authority's jurisdiction in counties that are less dependent on agriculture and are projected to experience rapid population growth. It is this projected population growth and subsequent projected increase in municipal use that is largely responsible for overall projected increases in water demand. The following table provides the projected water demand for the Nueces, San Antonio and Guadalupe River basins.

Table 3.7.2 - River Basin Demands

	Total in	Projections (acre-ft/year)					
Basin	**1990**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Nueces*	558,200	580,000	557,600	539,100	521,500	507,600	498,100
San Antonio	358,700	465,200	496,000	544,400	611,900	675,900	727,500
Guadalupe	116,500	156,100	168,600	185,000	203,700	217,600	234,400
TOTAL	**1,033,400**	**1,201,300**	**1,222,200**	**1,268,500**	**1,337,100**	**1,401,100**	**1,460,000**

* These demands correspond only to the Nueces Basin area within the 32 county study area considered in the Trans-Texas report - West Central Study Area. The remaining area, the southwestern portion of the Nueces Basin, is considered in another Trans-Texas Report.

4.0 Goals, Management Objectives and Performance Standards

The Edwards Aquifer Authority's basic management goals are derived from its enabling statute, the EAA Act, as amended.

Edwards Aquifer Authority Management Goals:

- Develop, implement, and enforce comprehensive programs for managing withdrawals of water from the Edwards Aquifer in order to sustain domestic, municipal, agricultural and industrial water supplies. These programs will promote efficiency, control and prevent waste, and help protect natural resources.

- Facilitate the marketing and transfer of Edwards Aquifer water rights between buyers and sellers in order to promote efficiency and to control and prevent waste.

- Support and conduct research and, as appropriate, implement strategies to enhance the yield of the Edwards Aquifer and promote conjunctive management of groundwater and surface water supplies.

- Implement technical and financial assistance programs to encourage the use of cost-effective measures to improve water use efficiency, minimize waste, and increase beneficial reuse and recycling of water by municipal, industrial, commercial, institutional and agricultural water users so that water supplies are conserved or made available for alternative or future uses.

- Implement programs in cooperation with other local, state, and federal agencies to monitor and protect the quality of the Edwards Aquifer.

- Implement and enforce water management practices, procedures, and methods to ensure, by the end of 2012, the continuous minimum springflow of Comal Springs and San Marcos Springs in order to protect species, habitats, instream uses, and bays and estuaries that are dependent on discharge from the Edwards Aquifer.

- Continue to develop, operate, and maintain the data collection and retrieval network for the Edwards Aquifer region in order to improve basic data required to better understand the geology and hydrology of the Edwards Aquifer and to better understand the meteorological conditions that affect the Edwards Aquifer.

- Provide information to the public and interested parties on the mission, goals, and initiatives of the Authority and expand education programs on the geology, hydrology, use, conservation and management of the Edwards Aquifer.

- Ensure the efficient and cost-effective management and operation of the Edwards Aquifer Authority, as well as its overall fiscal integrity.

Texas Water Code Section 36.1071 and associated TWDB administrative rules require that the Edwards Aquifer Authority's Groundwater Management Plan address the following management goals, as applicable:

Water Plan Goals

- Providing the most efficient use of groundwater;
- Controlling and preventing waste of groundwater;
- Addressing conjunctive ground and surface water management issues; and
- Addressing natural resource issues that affect the use and availability of groundwater, and that are affected by the use of groundwater.

Goals Not Applicable

- Controlling and preventing subsidence

Each of the nine goals and functional program areas of the Edwards Aquifer Authority address one or more of the Brown-Lewis Water Plan groundwater management goals, ***except that the Edwards Aquifer region is not subject to land subsidence as a consequence of groundwater withdrawals***. In many instances, the Edwards Aquifer Authority's policies and programs in one program area address more than one Brown-Lewis Water Plan groundwater management goal. For example, the Edwards Aquifer Authority's policies regarding regulation of withdrawals from the Edwards Aquifer simultaneously serve to promote water use efficiency, discourage waste and maintain flows at Comal and San Marcos Springs, thereby protecting sensitive natural resources. Similarly, the Edwards Aquifer Authority's water conservation programs, while intended primarily to improve water use efficiency and minimize waste in order to extend available water supplies, will also contribute to the maintenance of springflows and protection of natural resources.

The Edwards Aquifer Authority's Groundwater Management Plan has been designed around the nine program areas. Below are the Edwards Aquifer Authority's management goals for each of these program areas, along with the management objectives and performance standards that will be used by the Edwards Aquifer Authority to achieve its goals. One or more management objectives and standards have been defined for each of the Edwards Aquifer Authority's programs or functions. To satisfy the requirements of the Brown-Lewis Water Plan, a matrix is provided for each of the nine program areas, which cross-references the Edwards Aquifer Authority's management objectives with the Brown-Lewis Water Plan management goals.

The General Manager will prepare and present an annual report to the Board of Directors on Authority performance in regards to achieving management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning January 1, 2000. The report will include the number of instances in which each of the activities specified in the Authority's management objectives was engaged in during the fiscal year. Each activity will be referenced to the estimated expenditure of staff time and budget in accomplishment of the activity. The notations of activity frequency, staff time and budget will be referenced to the appropriate performance standard for each management objective describing the activity, so that the effectiveness and efficiency of the Authority's operations may evaluated. The Board will maintain the report on

file, for public inspection at the Authority's offices upon adoption. This methodology will apply to all management goals contained within this plan.

4.1 Regulation of Edwards Aquifer Withdrawals

The EAA Act empowers the Edwards Aquifer Authority to manage all withdrawals and withdrawal points from the Edwards Aquifer through a comprehensive permitting, monitoring and enforcement program. This program is to include regular, additional regular, term and emergency withdrawal permits, and permits for new well construction or for major modification to existing wells. At specified aquifer levels, critical period management rules require well owners to reduce withdrawals to slow the rate of decline of springflow at Comal and San Marcos springs. In addition, the Edwards Aquifer Authority's rules require all Edwards Aquifer wells, including those exempt from permitting requirements, to be registered with the Edwards Aquifer Authority. The rules also provide that all permitted withdrawals from the aquifer are to be metered, and that the Edwards Aquifer Authority will pay the costs of purchasing, installing and maintaining metering devices for irrigation wells. However, exempt wells are not required to be metered. Finally, the Edwards Aquifer Authority has the power to ensure the proper closure of abandoned wells to prevent the waste of water or to protect water quality.

It should be noted there are a number of administrative implementation activities associated with the various types of withdrawal permits that represent a substantial commitment of the agency's resources. These include the development of databases for monitoring and tracking permitting activities, and preparation of regular monthly reports to the board of directors.

Goal 1.0 *Develop, implement, and enforce comprehensive programs for managing withdrawals of water from the Edwards Aquifer in order to sustain domestic, municipal, agricultural and industrial water supplies. These programs will promote efficiency, control and prevent waste, and help protect natural resources.*

Management Objective 1.1 – Initial Regular Permits

Begin issuing initial regular permits to withdraw water from the Edwards Aquifer by September 1998 and complete the issuance of all initial regular permits by the end of 2002.

Performance Standards:

1.1(a) Board adoption of the initial rules to allow permit applicants to file declarations of historical use by December 30, 1996.

1.1(b) Receive all permit applications by December 30, 1996.

1.1(c) Board adoption of all remaining Initial Regular Permit Rules by March 1998.

1.1(d) Propose all initial regular permits by May 1998.

1.1(e) Begin the contested case hearing process by April 1998.

1.1(f) Issue the first initial uncontested regular permits by September 1998.

1.1(g) Complete all administrative hearings for contested cases by the end of 2001.

1.1(h) Issue all initial regular permits upon completion of the contested case process by the end of 2002.

Management Objective 1.2 – Term Permit Program

Develop procedures, implement and maintain a program to review all applications for and to issue term permits for the withdrawal of water from the Edwards Aquifer by March 1998.

Performance Standards:

1.2(a) Board adoption of rules for term permits by March 1998.

1.2(b) Complete the initial review of each application for administrative completeness within 30 business days of receiving an application.

Management Objective 1.3 – Emergency Permit Program

Develop procedures and a plan by March 1998 to implement and maintain a program to review all applications and issue emergency permits to withdraw water from the Edwards Aquifer.

Performance Standards:

1.3(a) Board adoption of rules for emergency permits by March 1998.

1.3(b) Complete the initial review of each application within two (2) business days of receiving an application.

Management Objective 1.4 – Additional Regular Permits

Develop procedures and a plan by March 1999 to implement and maintain a program to review all applications and issue additional regular permits.

Performance Standards:

1.4(a) Board adoption of additional regular permit rules by December 2001.

1.4(b) Complete the initial review of each application for administrative completeness within 30 working days of receiving an application.

Management Objective 1.5 – Well Construction Permits

Develop procedures, implement and maintain a permitting program by March 1998 for drilling, equipping or completing new Edwards Aquifer wells or for substantial alteration of an existing well.

Performance Standards:

1.5(a) Board adoption of well construction permit rules by March 1998.

1.5(b) Complete the initial review of applications for administrative completeness within 30 business days of receiving an application.

Management Objective 1.6 – Critical Period Management Rules for Interim Authorization

Develop Critical Period Management Plan, by December 1998, for phased reductions in the amount of water that may be used or withdrawn from the Edwards Aquifer during critical drought periods under Interim Authorization.

Performance Standards:

1.6(a) Board adoption of the Critical Period Management Rules for Interim Authorization by October 1998.

1.6(b) Prepare a monthly compliance status report of pumpage for all authorized water users by the 10th business day of the month after the reporting month when any stage of the critical period is in effect.

Management Objective 1.7 – Critical Period Management Rules for Initial Regular Permits

Develop a program of rules, tracking mechanisms and compliance reports, by June 2003, for phased reductions in the amount of groundwater that may be used or withdrawn from the Edwards Aquifer during critical periods.

Performance Standards:

1.7(a) Board adoption of critical period management rules for regular permits within six months of issuing final initial regular permits.

1.7(b) Prepare a monthly compliance status report of pumpage for all authorized water users by the 10th business day of the month after the reporting month when any stage of the critical period is in effect.

Management Objective 1.8 – Permits Enforcement Program

Develop the rules and internal administrative procedures by September 1999 for a monitoring and enforcement program for all permits issued by the Edwards Aquifer Authority.

Performance Standards:

1.8(a) Begin a program of issuing of compliance orders by March 1998.

1.8(b) Board adoption of enforcement policies for all permits by September 1999.

Management Objective 1.9 – Well Registration Program

Develop procedures, implement and maintain a program by December 2000 to register all existing and new Edwards Aquifer wells.

Performance Standards:

1.9(a) Board adoption of well registration rules by March 1998.

1.9(b) For each registered well complete the initial review of all well registration information for administrative completeness within 30 business days of receiving an application.

1.9(c) Begin well registration by August 1998.

1.9(d) Require registration of all Edwards Aquifer wells by December 2000.

Management Objective 1.10 – Irrigation Well Metering Program

Implement a program by December 1998 to provide for the purchase, installation and maintenance of water flow and totalizing meters on irrigation wells withdrawing water from the Edwards Aquifer.

Performance Standards:

1.10(a) Contract with selected meter suppliers and installers by June 1997.

1.10(b) Board adoption of metering rules for all irrigation wells by September 1998.

1.10(c) All irrigation wells in service and pursuant to an initial regular permit will be equipped with a meter by December 1998.

1.10(d) Establish an irrigation meter maintenance program by December 1998.

Management Objective 1.11 - Municipal and Industrial Well Metering Program

Implement a program by September 2000 to provide for standards and maintenance of water flow meters for municipal and industrial wells withdrawing water from the Edwards Aquifer.

Performance Standards:

1.11(a) Board adoption of metering rules for all municipal and industrial wells by September 1998.

1.11(b) Ensure installation of all meters or other approved water measurement method by December 1998.

1.11(c) Complete field verification of all wells by September 2000.

Management Objective 1.12 – Recharge Rules

Develop and implement a program by March 1999 for issuing credits to increase recharge to the Edwards Aquifer.

Performance Standards:

1.12(a) Initiate development of a recharge permit program by October 1999.

1.12(b) Board adoption of all recharge rules by June 1999.

1.12(c) Complete the initial review of each application for recharge credits for administrative completeness within 30 business days of receiving an application.

Goal 1 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
1.1 Initial regular permits	•	•		•
1.2 Term permits	•	•	•	
1.3 Emergency permits	•	•	•	
1.4 Additional regular permits	•	•	•	•
1.5 Well construction	•	•		•
1.6 Critical period rules (interim)	•	•	•	•
1.7 Critical period rules (regular)	•	•	•	•
1.8 Permits enforcement	•	•		•
1.9 Well registration	•	•		•
1.10 Irrigation Well Metering	•	•		
1.11 Municipal and Industrial Well Metering	•	•		
1.12 Recharge Rules	•	•	•	•

4.2 Water Marketing and Transfers

The Edwards Aquifer Authority will provide regulatory oversight of proposed transfers between willing buyers and sellers. It is envisioned that a functioning market for Edwards Aquifer withdrawal rights will benefit the entire region by enabling users to obtain additional rights to satisfy increasing water demands. The Board of the Edwards Aquifer Authority is required to issue initial regular permits and additional regular permits. Once issued, these permits may be transferred between parties for use within the boundaries of the Edwards Aquifer Authority. This is one method that can be utilized to increase the permitted use of the aquifer by individual new and existing users, in addition to such methods as increasing aquifer withdrawal limits at the Board's discretion and recognizing additional withdrawal rights for those who cause artificial recharge to the aquifer. It should be noted that the Edwards Aquifer Authority is currently administering water rights transfers under interim authorization while the permanent program and permits are being established.

Goal 2.0 *Facilitate the marketing and transfer of Edwards Aquifer water rights between buyers and sellers in order to promote efficiency and to control and prevent waste.*

Management Objective 2.1 – Permit Transfer Program

Develop and implement a program by October 1998 for the review and approval of applications to transfer permits to withdraw water from the Edwards Aquifer.

Performance Standards:

2.1(a) Board adoption of rules for all permit transfers by October 1998.

2.1(b) Complete the initial review of each application for administrative completeness within 30 business days of receiving an application.

Management Objective 2.2 – Retirement of Withdrawal Permits

Develop and implement a program by the end of 1999 for the retirement of Edwards Aquifer groundwater withdrawal permits to achieve the 450,000 acre-foot per year limitation, unless otherwise modified by the Board of Directors.

Performance Standards:

2.2(a) Board adoption of a groundwater withdrawal permit retirement program by the end of 1999.

Management Objective 2.3 – Establishment of a Regional Water Bank

Establish a Regional Groundwater Management Bank by the end of 1999 to allow for the acquisition, deposit, transfer and withdrawal of permitted Edwards Aquifer withdrawal rights.

Performance Standards:

2.3(a) Board adoption of rules establishing the Regional Groundwater Management Bank by January 1999.

2.3(b) Board adoption of the groundwater withdrawal permit acquisition rules by June 1999.

2.3(c) Process all requests for deposit to or withdrawal from the Regional Groundwater Management Bank within five business days of receipt by the Edwards Aquifer Authority.

2.3(d) Begin a groundwater acquisition program by 2000.

Goal 2 -Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
2.1 Permit transfer program	•			•
2.2 Retirement of withdrawal permits	•			•
2.3 Regional water bank	•		•	•

4.3 Edwards Aquifer Yield Enhancement

The EAA Act declares the Edwards Aquifer to be a distinctive natural resource of the State; therefore, the Edwards Aquifer Authority is created to be a special management district. The Edwards Aquifer Authority regulates withdrawal of groundwater only from the Edwards Aquifer. However, the EAA Act directs the Edwards Aquifer Authority to maximize the beneficial use of groundwater available from the Edwards Aquifer. The regional dependence on the Edwards Aquifer and the dynamic nature of this special resource requires the Edwards Aquifer Authority to conduct research that will enhance regional water resources with the use of the Edwards Aquifer. Applied research includes, but is not limited to: springflow augmentation, springflow recirculation, recharge enhancement, range management, weather modification, saline water study, flow path studies, biological assessments and development of an Edwards Aquifer simulation model. To ensure maximum efficiency, overall management strategies must include conjunctive management, whereby the greater combined yields of ground and surface water resources replace the separate yields of each source.

Goal 3.0 *Support and conduct research and, as appropriate, implement strategies to enhance the yield of the Edwards Aquifer and promote conjunctive management of ground and surface water supplies.*

Management Objective 3.1 – Edwards Aquifer Optimization Strategies

Provide funding and management support for the successful initiation, by 1999, of a series of studies to provide information for the development of aquifer management strategies. With input from the Technical Advisory Group, a number of ongoing or proposed research studies have been identified for the Edwards Aquifer Optimization Program. These are grouped into three categories as follows:

Edwards Aquifer Studies:

- Recharge enhancement
- Springflow augmentation
- Springflow recirculation
- Range management
- Recharge calculation evaluation

Edwards Aquifer Flow Path and Modeling Studies:

- Saline water line study (in progress)
- Flow path study
- Model development and aquifer simulation

Biological Assessment Studies:

- Biology of vertebrates and invertebrates
- Control and management of exotic species
- Knowledge of Texas Wild Rice
- Cagles Map Turtle
- Thorough evaluation of minimum springflow requirements

Performance Standards:

3.1(a) Establish a technical advisory group (TAG) by November 1997.

3.1(b) Retain the services of a managing consultant for Edwards Aquifer optimization program by March 1999.

3.1(c) Complete the initial scope, schedule and budget for proposed optimization studies by March 1999.

3.1(d) Complete the overview of an aquifer optimization strategy by March 1999.

3.1(e) Develop a weather modification program to enhance rainfall and increase recharge by January 1999.

Management Objective 3.2 – Aquifer Yield Determination

Not later than the end of 2007, determine if the authorized amount of withdrawals from the Edwards Aquifer can be modified pursuant to Sections 1.14 (b),(c) of the EAA Act. It should be noted that any decision to increase withdrawals is different from the recharge credits discussed in **Section 5.1**.

Performance Standards:

3.2(a) Board adoption of a policy not later than the end of 2007 regarding the authorized amount of withdrawals from the Edwards Aquifer.

Management Objective 3.3 – Regional Water Supply Planning

Each year, participate in and support the South-Central Regional Water Planning Group's effort (TWDB designated Region L) with the development of a regional water plan that addresses the conjunctive management of all regional water resources.

Performance Standards:

3.3(a) Secure representation of the Edwards Aquifer Authority on the South-Central Regional Water Planning Group by February 1998.

3.3(b) Each year, provide input to the development of a regional water plan by the South-Central Regional Water Planning Group.

3.3(c) Review and revise the Edwards Aquifer Authority's groundwater management plan, as appropriate, to incorporate elements of the regional water plan into a Comprehensive Water Management Plan by the end of 2002.

Goal 3 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
3.1 Optimization strategies	•		•	•
3.2 Aquifer Yield Determination	•			•
3.3 Regional Water Supply Planning	•	•	•	•

4.4 Water Conservation

A key theme of the EAA Act is conservation. The Edwards Aquifer Authority is considered a conservation and reclamation district, and is directed to take all reasonable measures to ensure efficient water use. Permits are considered on the basis of beneficial use without waste. The Edwards Aquifer Authority is given wide latitude to provide financial assistance to promote water conservation and prevent waste, especially for irrigation users. Finally, the Edwards Aquifer Authority is to prepare and enforce a conservation plan for year-round improvement in water use efficiency and is required to deliver the plan to the Legislature by January 1 of each odd-numbered year.

Goal 4.0 *Implement technical and financial assistance programs to encourage the use of cost-effective measures to improve water use efficiency, minimize waste and increase beneficial reuse and recycling of water by municipal, industrial, commercial, institutional and agricultural water users so that water supplies are conserved or made available for alternative or future uses.*

Management Objective 4.1 – Agricultural Water Conservation

Develop and implement a program, by December 1998, to improve irrigation water use efficiency through the application of best management practices.

Performance Standards:

4.1(a) Annually award the A.O. "Odie" Gilliam Agricultural Water Conservation Award beginning in 1999.

4.1(b) Board adoption of the loan application and approval procedures for the agricultural water conservation loan program by October 1998.

4.1(c) Secure $3 million in funding from the TWDB Agricultural Water Conservation Loan Program by August 1998.

4.1(d) Process at least 20 loan requests by December 1999.

Management Objective 4.2 – Municipal Water Conservation

Develop a water conservation program by the end of 2000 to promote and, as appropriate, require conservation by municipal and other public water suppliers.

Performance Standards:

4.2(a) Board adoption of a municipal water conservation program and policies by the end of 2000

4.2(b) Require a conservation-oriented water rate structure in critical period management ordinances by January 1999.

Management Objective 4.3 – Institutional, Commercial, and Industrial Water Conservation

Develop a water conservation program by the end of 2000, to encourage and, as appropriate, require conservation by institutional, commercial and industrial water users.

Performance Standards:

4.3(a) Board adoption of an institutional, commercial and industrial water conservation program and policies by the end of 2000.

Goal 4 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
4.1 Agricultural water conservation	•	•		•
4.2 Municipal water conservation	•	•	•	•
4.3 Institutional, Commercial, and Industrial conservation	•	•	•	•

4.5 Water Quality Protection

the EAA Act empowers the Edwards Aquifer Authority to prevent the pollution of the Edwards Aquifer. The Act also provides that the Edwards Aquifer Authority, with local governments having pollution control powers provided in the Texas Water Code, shall apply pollution control regulations throughout the counties included within the Edwards Aquifer Authority's boundaries and within a five-mile buffer zone. The Water Quality Protection Program is to ensure long-term protection of groundwater quality in the Edwards Aquifer and in receiving streams. The Edwards Aquifer Authority is participating in the U.S. Geological Survey's (USGS) National Water Quality Assessment Program, which establishes a 30-well monitoring network to assess water quality effects to recent urban development on the Edwards Aquifer Recharge Zone. The results of this study will provide valuable data the Edwards Aquifer Authority staff will use to develop strategies for monitoring and/or regulating land development activities over the recharge zone.

Goal 5.0 *Implement programs in cooperation with other local, state and federal agencies to monitor and protect the water quality of the Edwards Aquifer.*

Management Objective 5.1 – National Water Quality Assessment Program

Provide funding and staff support for the successful completion of a study by the end of 1999 to correlate the quality of recently recharged groundwater with different types of urban land use.

Performance Standards:

5.1(a) Provide the initial funding of $297,000 to the USGS by November 1997.

Management Objective 5.2 – Recharge Zone Protection

Develop an inter-jurisdictional strategy by May 1999 for the monitoring and/or regulating of land development activities over the Edwards Aquifer recharge zone.

Performance Standards:

5.2(a) Implement a program by May 1999, in cooperation with TNRCC and other agencies, to protect the recharge zone.

Management Objective 5.3 – Well Closure Program

Develop the rules and internal administrative procedures by January 1999 for a program to ensure the proper closure of abandoned Edwards Aquifer wells.

Performance Standards:

5.3(a) The Edwards Aquifer Authority will conduct a field investigation on each reported abandoned well within 30 days of receiving a report.

Goal 5 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
5.1 NAWQA		•		•
5.2 Recharge zone protection		•		•
5.3 Well closure program		•		•

4.6 Protection of Natural Resources

The Edwards Aquifer Authority is charged with managing the aquifer to sustain the diverse interests of the natural resource. Management of the aquifer is not solely for the benefit of those who withdraw water directly from the Aquifer from wells. Rather, management is intended to extend benefits to the surface streams to which the aquifer provides springflow, to protect aquatic and wildlife habitats, to protect species that are subject to federal or state protection, and to provide for instream uses, bays and estuaries. The broadest interpretation of natural resource protection is required. A Comprehensive Management Plan and a cooperative effort with state and federal natural resource agencies are important elements of a natural resource protection plan. However, pursuit of an Incidental Take Permit can not begin until a complete understanding of the legal ramifications occurs.

Goal 6.0 Implement and enforce water management practices, procedures and methods to ensure, by the end of 2012, the continuous minimum springflows of Comal Springs and San Marcos Springs to protect species, habitats, instream uses, and bays and estuaries that are dependent on discharge from the Edwards Aquifer.

Management Objective 6.1 – Comprehensive Management Plan

By the end of 2002, the Edwards Aquifer Authority will adopt a Comprehensive Water Management Plan for the Edwards Aquifer that includes aquifer management, water conservation, supply and critical period plans. The plan will have five-year goals and will recommend alternative water management technologies based on analyses of costs, benefits and environmental impacts. The plan will also consider the options for financing the recommended water management technologies that are available from the TWDB.

Performance Standards:

6.1(a) Achieve 450,000 acre-feet per year Edwards Aquifer withdrawal limitation for initial regular permits by January 2000 unless otherwise directed by the Authority's Board of Directors.

6.1(b) The Board will develop and adopt a Comprehensive Water Management Plan by the end of 2002 that will balance water supplies and demands for each five-year period during the planning period.

6.1(c) The plan will provide the means to achieve flow requirements at Comal and San Marcos Springs by the end of 2012.

Management Objective 6.2 – Compliance with the Federal Endangered Species Act

By the end of 1999, the Edwards Aquifer Authority will complete an evaluation of the benefits and liabilities of seeking an "incidental take" permit under Section 10a of the federal Endangered Species Act and establish the Edwards Aquifer Authority's policy with respect to seeking such a permit.

Performance Standards:

6.2(a) Board adoption of a policy with regard to obtaining an incidental take permit by the end of 1999.

Goal 6 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
6.1 CMP	•	•	•	•
6.2 Compliance with ESA	•	•	•	•

4.7 Data Acquisition and Analysis

The Edwards Aquifer Authority is committed to the collection and analysis of empirical data because effective management decisions are dependent on accurate information. The dynamic nature of the aquifer requires a variety of data collection that includes, but is not limited to: water levels, streamflows, springflows, rainfall, water quality and pumpage. Collection and analysis of large amounts of varied data has allowed the development of computer models that can be used as predictive tools to aid in the management of the Aquifer.

Goal 7.0 Continue to develop, operate and maintain the data collection and retrieval network for the Edwards Aquifer region to improve basic data required to better understand the geology and hydrology of the Edwards Aquifer and to better understand the meteorological conditions that affect the Edwards Aquifer.

Management Objective 7.1 – Water Level Data Collection and Analysis

Each year, maintain a program for the collection and analysis of Edwards Aquifer water level data.

Performance Standards:

7.1(a) Each year, maintain a water level data collection system.

7.1(b) Each year, collect water level data from 25 wells equipped with continuous digital recorders.

7.1(c) Each year, collect water level data from 17 wells that are measured manually.

Management Objective 7.2 – Water Quality Data Collection and Analysis

Each year, maintain an ongoing program for the collection and analysis of aquifer and surface water quality data.

Performance Standards:

7.2(a) Each year, maintain water quality data collection systems and make all repairs as needed.

7.2(b) Develop a water quality data dictionary by the end of 1999.

7.2(c) Each year, collect general water quality data such as temperature, pH, specific conductance and alkalinity from 76 wells and 3 springs.

7.2(d) Each year, collect water quality on metals data from 44 wells.

7.2(e) Each year, collect water quality data on pesticides from 16 wells.

7.2(f) Each year, collect water quality data from 7 stream sites that contribute water to the Edwards Aquifer recharge zone.

Management Objective 7.3 – Maintenance of Real-Time Hydromet Network

Each year, maintain the Edwards Aquifer Authority's network of 68 rain gauge and 30 stream gauge remote telemetry stations on the Edwards Aquifer recharge zone for the estimation of natural and artificial recharge.

Performance Standards:

7.3(a) Each year, maintain the real-time precipitation and stream flow data collection system and make all repairs as needed.

7.3(b) Develop a real-time precipitation and stream flow data dictionary by the end of 1999.

7.3(c) Establish an electronic linkage to the National Weather Service's NEXRAD system by the end of 2002.

7.3(d) Each year, collect data from 68 real-time data rain-gage stations.

Management Objective 7.4 – Geographic Information System (GIS)

Each year, maintain a fully functional GIS capability for storage, manipulation and graphical display of spatial data.

Performance Standards:

7.4(a) Begin entering locations and attribute data for all permitted wells by the end of 1997.

7.4(b) Begin entering locations and attribute data for all registered wells by the end of 1997.

Management Objective 7.5 – Hydrogeologic Report

Each year, prepare a report of hydrogeologic data for the Edwards Aquifer including data on aquifer water levels, recharge, withdrawals and spring discharge, and water quality.

Performance Standards:

7.5(a) Beginning in June 1998, prepare the annual report by June of each year for the previous water year.

Goal 7 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
7.1 Water level data	•		•	•
7.2 Water quality data		•		•
7.3 Real-time hydromet system	•		•	•
7.4 GIS	•	•	•	•
7.5 Hydrogeologic report	•	•	•	•

4.8 Public Information and Education

Staff continues to forge the Edwards Aquifer Authority's identity and to inform the region about its goals and initiatives by implementing a more proactive media-relations program, establishing better community relations, refocusing our educational support initiatives, developing a plan for emergency situations and continuing to improve internal communications.

Goal 8.0 *Provide information to the public and interested parties on the mission, goals, and initiatives of the Edwards Aquifer Authority and expand education programs on the geology, hydrology, use, conservation and management of the Edwards Aquifer.*

Management Objective 8.1 – Community Relations

Each year, implement a program to build better relations with communities throughout the eight-county region.

Performance Standards:

8.1(a) Edwards Aquifer Authority staff or directors conduct two community presentations per month.

8.1(b) Identify and participate in at least one appropriate public event in each of the eight counties within the Edwards Aquifer Authority's boundaries each year.

8.1(c) Staff will attend at least one stakeholder meeting per month.

Management Objective 8.2 – Media Relations

Each year, implement a program to inform and educate the public through the regional news media by issuing press releases, conducting periodic editorial board meetings, writing articles for various publications and training staff to better interact with the media.

Performance Standards:

8.2(a) Each year, conduct meetings with the editorial boards of 5 newspapers in the region.

8.2(b) Prepare at least three op-ed (i.e., editorial) pieces per year.

8.2(c) Each year, track all of the news stories about the Edwards Aquifer Authority.

8.2(d) Each year, conduct media training for all key staff.

8.2(e) Each year, revise and educate staff about the Edwards Aquifer Authority's media policy.

8.2(f) Issue at least one press release each month after the regular board meeting.

Management Objective 8.3 – Educational Program

Each year, continue to meet informational and educational needs in the region by focusing on basic information about the Edwards Aquifer Authority, its goals and initiatives, and the Edwards Aquifer.

Performance Standards:

8.3(a) Develop an educational program by January 1999.

8.3(b) Improve Internet access and increase website visits by 10 percent each year beginning in 1999.

8.3(c) Survey all permit holders to determine their information needs by August 1999.

8.3(d) Update website daily for the index well and springflow readings.

8.3(e) Update the Edwards Aquifer Authority website monthly with new information.

Goal 8 - Correlation of Edwards Aquifer Authority Management Objectives to Water Code, Section 36.1071 Management Goals

36.1071 Goals / EAA Goals	Efficient use of Groundwater	Control and Prevent Waste	Conjunctive Management	Natural Resource Issues
8.1 Community relations	•	•	•	•
8.2 Media relations	•	•	•	•
8.3 Education program	•	•	•	•

4.9 Management and Fiscal Responsibility

The Edwards Aquifer Authority relies entirely on aquifer management fees from groundwater users for its operating funds. These fees are assessed based on annual permitted withdrawals from the Edwards Aquifer. To maximize this revenue and maintain a fee rate as low as possible, the Edwards Aquifer Authority must operate efficiently and in a cost-effective manner. Accurate estimates of revenue and expenses help ensure a sound fiscal condition. Retaining experienced, knowledgeable staff maximizes efficiency and reduces the costs associated with hiring and training new employees.

Goal 9.0 *Ensure the efficient and cost-effective management and operation of, and the overall fiscal integrity of the Edwards Aquifer Authority.*

Management Objective 9.1 – Revenue Projections

Each year, project the annual revenues from aquifer management fees accurately.

Performance Standards:

9.1(a) For 1999 and each year thereafter, collect 100 percent of budgeted aquifer management fee revenue.

Management Objective 9.2 – Annual Operating Budget

Each year, project annual operating expenses accurately.

Performance Standards:

9.2(a) For 1999 and each year thereafter, maintain overall annual operating expenses within five percent of budgeted amounts.

Management Objective 9.3 – Staff Retention

Each year, retain experienced and knowledgeable staff to implement and administer the Edwards Aquifer Authority's policies and programs.

Performance Standards:

9.3(a) For 1999 and each year thereafter, maintain three-year average employee turnover rate of less than 10 percent.

Management Objective 9.4 – Historically Underutilized Business (HUB) Procurement

Each year, obtain goods and services from HUBs pursuant to statutory requirements and board policy.

Performance Standards:

9.4(a) Make a good faith effort each year, to award 30 percent of total annual contracted amount for goods and services to HUBs.

9.4(b) Prepare and file a status report with the Govenor's office and each house of the legislature on the implementation of the HUB procurement program by October 31 of even-numbered years.

Management Objective 9.5 – Sound Fiscal Operation

Each year follow internal policies and procedures for accounting, procurement, investments and the overall fiscal management of the Edwards Aquifer Authority.

Performance Standards:

9.5(a) Each year, maintain zero "material weaknesses" in the annual audit.

5.0 Meeting Future Water Supply Needs

The information presented in this section is provided to comply with the Brown-Lewis Water Plan requirement that groundwater management plans address any identified water supply deficits. The primary source of the information presented in this section is the Trans-Texas Water Program West-Central Study Area Phase I results, which were only recently finalized. This Edwards Aquifer Authority's Groundwater Management Plan will be an important source of input to the Brown-Lewis Water Plan regional planning process, which is to provide recommendations on strategies for meeting future water needs. Given that the Brown-Lewis Water Plan regional water planning process has only just commenced and will not be completed until September 1, 2000, the Edwards Aquifer Authority will not make specific water supply recommendations at this time.

5.1 Brown-Lewis Water Plan Regional Water Supply Planning

S.B.1 made significant changes in the approach to state water planning. Most notably, the Brown-Lewis Water Plan shifts the emphasis from a somewhat "top-down" planning approach directed by the TWDB to a more "bottom-up" approach. Specifically, the Brown-Lewis Water Plan requires the TWDB to establish regional water planning areas and to appoint members to an initial regional water planning group. With technical and financial assistance from the TWDB and in accordance with planning guidelines it set forth, the regional water planning groups are to prepare a consensus-based regional water plan by September 1, 2000. Once completed, the TWDB will assemble the regional water plans into a new state water plan by September 1, 2001.

In February 1998, the TWDB adopted rules establishing 16 water planning regions and designated the initial members of the regional water planning groups. The South-Central Regional Water Planning Area (designated by the TWDB as Region L) encompasses the entire jurisdiction of the Edwards Aquifer Authority, as well as much of the Guadalupe River Basin (see **Exhibit 5.1**).

Once organized, the regional water planning groups have proceeded with a two-phase planning process. The first phase, which was completed on August 1, 1998, was to develop a detailed scope-of-work and budget for the development of the regional water plans. The second phase, which is expected to begin during the fall of 1998, is to develop the regional water plans.

Exhibit 5.1 – South-Central Regional Water Planning Group Boundaries and Planning Board Members

February 19, 1998
Texas Water Development Board

Initial Planning Group Members:

Member	Interest
• Judge Charles Johnson	Counties
• John Kight	Counties
• Mike Thuss	Municipalities
• Jerry James	Municipalities
• Tim Gump	Municipalities
• Hugh Charlton	Industries
• Richard Eppright	Agricultural
• Bruce T. Foster	Agricultural
• Susan Hughes	Environmental
• Doug Miller	Small Business
• Evelyn Bonavita	Public
• Tom Moreno	Water Districts
• Ron Naumann	Water Utilities

Member	Interest
• Gloria Rivera	Small Business
• Vicente Gonzales	Small Business
• Mike Fields	Electric Utilities
• Bill West	River Authorities
• Fred Pfeiffer	River Authorities
• Con Mims	River Authorities
• Greg Ellis	Water Districts
• Mike Mahoney	Water Districts

There are 11 key tasks in the development of the regional water plan. These are:

- Identification of projected 50-year water demands within each region for municipal, manufacturing, irrigation, steam electric power generation, mining and livestock watering.
- Evaluation of the adequacy of existing water supplies.
- Identification of areas of projected water supply surplus and deficit within the region.
- Identification and evaluation of potentially feasible water management strategies to meet the identified water supply needs of the region.
- Selection of strategies to meet the near-term (0-30 years) and long-term (30-50 years) water supply needs of the region during drought-of-record hydrologic conditions and when flows are at 50 and 75 percent of normal.
- Evaluation of the social and economic impacts of not meeting specific water supply needs as a result of no feasible water management to meet that need.
- Evaluation and, if appropriate, development of recommendations regarding streams of "unique ecological value" and/or sites for future reservoir development.
- Evaluation of policy issues and, if appropriate, development of recommendations.
- Using the information and analyses derived from the preceding tasks, prepare a draft regional water plan.
- Conduct a public hearing on the draft regional water plan.
- Revise the draft plan, as appropriate, adopt the plan, and submit it to the TWDB for inclusion in the state water plan.

[Additional specific information about the scope-of-work for the South-Central Regional Water Planning Area will be incorporated into this Groundwater Management Plan when it becomes available]

The Brown-Lewis Water Plan regional water planning process provides a timely opportunity for the Edwards Aquifer Authority to further its mission and meet other requirements of the EAA Act. Specifically, it is anticipated that the regional water plan for the South-Central Regional Water Planning Area will provide valuable information and regional consensus on future water supply alternatives for the Edwards Aquifer region. This is information the Edwards Aquifer Authority needs to complete its Comprehensive Management Plan as required by the EAA Act. It is hoped that strategies for meeting future water supply needs will emerge from the regional planning process with broad public support, and that these strategies will form the basis of the water supply elements of the Edwards Aquifer Authority's Comprehensive Management Plan. Also, as indicated previously, the Edwards Aquifer Authority's Groundwater Management Plan must be consistent with the Brown-Lewis Water Plan-mandated regional water plan, once approved.

The Edwards Aquifer Authority will play a key role in the Brown-Lewis Water Plan regional water planning process both to facilitate the regional consensus on water management strategies and to ensure that the regional water plan and the Edwards Aquifer Authority's Groundwater Management

Plan are consistent. Coordination between the Authority and the South-Central Regional Water Planning Group will be made easier because the Edwards Aquifer Authority is directly represented on the South-Central Regional Water Planning Group by two of its directors and by its general manager.

5.2 Previous and Ongoing Regional Water Supply Efforts

Over the years a number of water resources planning efforts focused on the Edwards Aquifer region. In response to drought in the 1930s, the USGS initiated the collection of streamflow and related statistics for the Edwards Aquifer and performed a hydrogeologic assessment potential reservoir sites (e.g., the Cuero, Applewhite and Canyon reservoir sites). In 1952 another step was taken in regional water supply efforts when the City of San Antonio adopted a water supply master plan that included a recommendation that the city participate in the development of Canyon Reservoir. Since the 1950's, controversy has existed over the best means to ensure that all users in the Edwards Region have adequate water in drought and various water supply and water management strategies have been recommended to supplement and enhance Edwards Aquifer supplies.

While these past water planning efforts provided useful information on water supply and projected demands in the region, it was not until 1988 that a comprehensive regional water supply plan was developed. This effort, titled "Regional Water Resources Plan" was developed under the direction of joint committee of the San Antonio City Council and the Edwards Underground Water District Board of Directors. A key finding of this plan was that projected water demand would exceed available water supply in the region by the year 2010. Four strategies for increasing the available supply of water were evaluated in the plan: continued use of the aquifer; water conservation; wastewater reclamation and reuse; and surface water projects. Key recommendations from the 1988 plan included immediate development of the Applewhite Reservoir project and initiation of permitting for the Cibolo, Cuero I and Cuero II projects in order to meet long-range water supply needs.

As with previous state water plans, the 1990 plan identified immediate water supply needs in Edwards Aquifer region and recommended a combination of strategies for meeting future demands. Soon after the release of the 1990 state water plan, the TWDB, in cooperation with local and regional water agencies, initiated the Trans-Texas Water Program. The goal of the Trans-Texas Program was to "identify the most cost-effective and environmentally sensitive strategies for meeting the current and future water needs" for a large area of the state encompassing the Houston, San Antonio, Austin and Corpus Christi metropolitan areas. Four interrelated study areas were organized, of which the West-Central Study Area wholly encompassed the Edwards Aquifer region. Funding for the Trans-Texas Program was provided by the TWDB and local participating agencies.

The initial phase of the Trans-Texas Program was a reconnaissance-level investigation of a broad array of potential water management strategies, including water conservation and reuse, groundwater and surface water development, and the transfer of water from areas with identified surpluses to areas of projected need. In this phase, alternatives were evaluated in terms of technical feasibility (e.g., yield, reliability, etc.), cost and environmental acceptability. The second phase of the Trans-Texas Program was to provide a more detailed analysis of those water management strategies that appeared promising based on the results of Phase I.

The West-Central Study Area concluded Phase I of the Trans-Texas Program in April 1998. Estimates of yield, cost and environmental impact for 122 water supply and water management

options were developed. This information is considered to be the most current and comprehensive evaluation of water supply options for the Edwards Aquifer region. It is expected that this information will be a major source of input to the South-Central Regional Water Planning Group as it begins the process of developing a regional water plan.

5.3 Comparison of Edwards Aquifer Area Supply and Demand

The Edwards Aquifer region, particularly the San Antonio metropolitan area, has and continues to experience sustained population growth and economic development. As previously shown in Section 3.0 of this plan, the region's population is projected to increase by nearly 2 million between the year 2000 and 2050. Considering both the available water supply and projected water demands in the Edwards Aquifer region, the conclusion one draws from the data is that the region currently faces a water supply deficit and, absent additional yield from the Edwards Aquifer or other supplemental water sources, the deficit will grow steadily over time.

Table 5.3.1 provides a summary of the total estimated water supply available to the Edwards Aquifer region.

Table 5.3.1 Estimated Edwards Aquifer Region Water Supply*

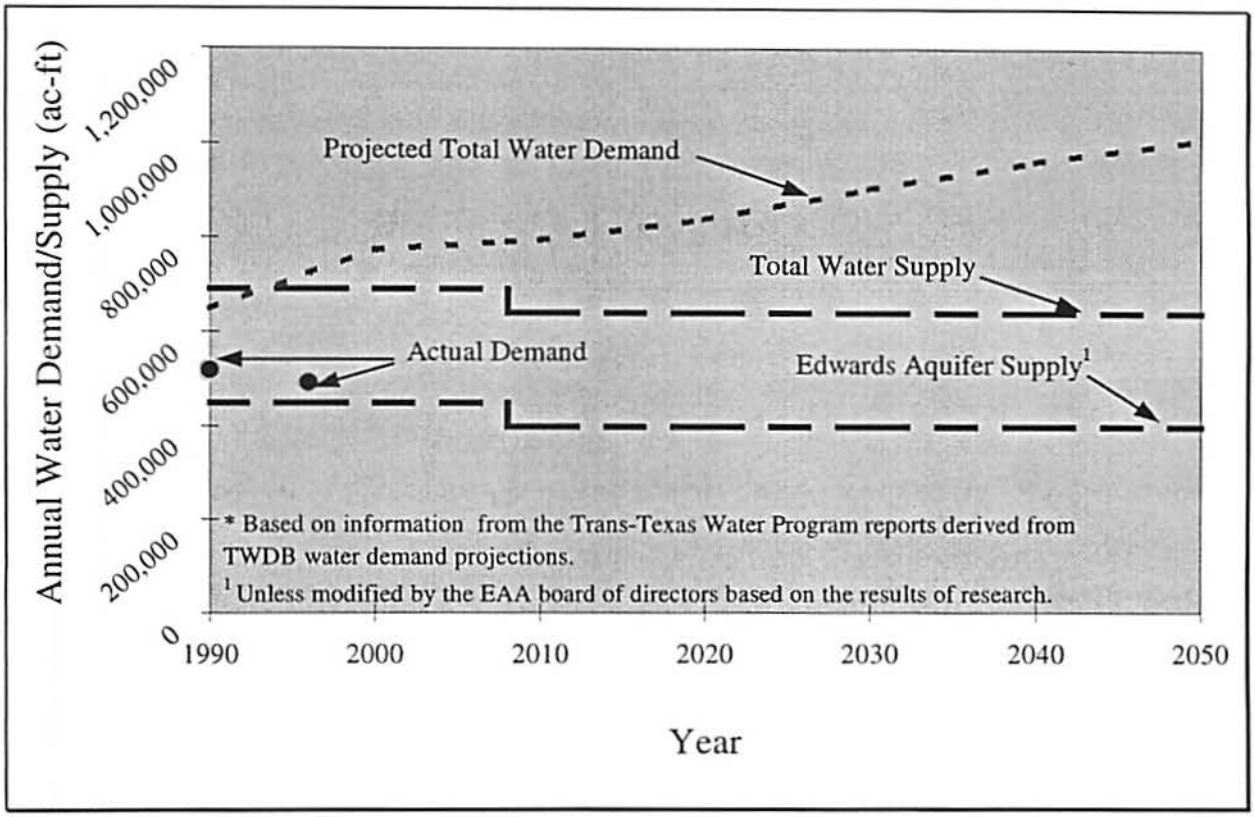
	Water Supply (acft/yr)			
Water Source	**1990**	**2000**	**2010**	**2020**
Edwards Aquifer[1]	450,000	450,000	400,000	400,000
Other Aquifers	39,750	39,750	39,750	39,750
Canyon Lake (Firm Yield)[2]	50,000	82,627	82,627	82,627
Medina Lake (Average Supply)[3]	57,970	57,970	57,970	57,970
Medina River Run of River Rights	11,580	11,580	11,580	11,580
Braunig Lake	12,000	12,000	12,000	12,000
Lake Calaveras	37,000	37,000	37,000	37,000
SAWS Recycling Program		35,000	35,000	35,000
TOTAL	658,300	725,927	675,927	675,927

* Source: Trans Texas Water Program, "West Central Study Area Phase I – Interim Report – Executive Summary".
[1] Unless Modified by the Edwards Aquifer Authority board of directors based on the results of research.
[2] Figure based on application for permit amendment filed with the TNRCC by the GBRA on 8/29/97.
[3] Medina Lake Average Supply is based on the 1934-89 historical period.

As indicated, the total water supply available to the region is expected to decrease as a consequence of the withdrawal limits on the Edwards Aquifer prescribed by the EAA Act. Per the EAA Act, total permitted withdrawals from the Edwards Aquifer are to be reduced by 50,000 acre-feet per year by 2008. By comparison, projected regional water demands are expected to increase by nearly 240,000 acre-feet per year between the year 2000 and 2050. The following figure presents the relationship between available supply and projected water demand. From this exhibit it can be seen that the Edwards Aquifer region currently faces a water supply deficit that will increase significantly over

time. Specifically, the regional water supply deficit is projected to exceed 80,000 acre-feet per year by 2000 and be nearly 369,000 acre-feet per year by 2050.

Figure 5.3.1 Total Water Demand and Supply Projections for the Edwards Aquifer Region



5.4 Water Management Strategies

As indicated, the feasibility of 122 water management strategies were investigated in the studies conducted for the Trans-Texas Program West Central Study Area. The sheer number of potentially feasible alternatives is indicative both of the region's historical dependence on the Edwards Aquifer and of the many existing opportunities to augment regional water supplies. Of the 122 alternatives studied, 106 were evaluated to determine potential yield, the unit cost of water, the number of acres of land affected (a surrogate measure for environmental impact), and other factors.

The water management strategies evaluated for the Trans-Texas Program West-Central Study Area can be grouped into two categories: those based on the geographic location of the alternative and those based on the type of water management strategy. By geographic location, the 122 alternatives are categorized as follows:

- Conservation/ Local Alternatives (14)
- Nueces River Basin (1)
- San Antonio River Basin (23)
- Guadalupe River Basin (59)

- Colorado River Basin (9)
- Brazos River Basin (4)
- Sabine River Basin (4)
- Brazos and Sabine River Basin (4)
- Carrizo Aquifer (4)

These water management strategies can also be classified according to the type of strategy or project. For the 106 alternatives for which more extensive evaluations were performed, the Trans-Texas program grouped the 106 water management strategies as follows:

Conservation and Leases (2) - This includes options that reduce demand through the implementation of conservation measures by municipal, commercial/industrial and agricultural uses, as well as options that consider transfers of Edwards Aquifer water rights through purchase or lease arrangements. The estimated cost of these options ranges from a low of $152 per acre-foot (1996 dollars) to a high of $276 per acre-foot.

Reuse (4) - This includes options that consider ways to beneficially use reclaimed water from wastewater treatment facilities within the study area. The estimated cost of reuse options ranges from a low of $138 per acre-foot to a high of $771 per acre-foot.

Natural Recharge (18) - Natural recharge is considered to be recharge to the aquifer with water originating from the Edwards Plateau catchment area, recharge zone or from springs originating from the Edwards Aquifer. This includes water that originated in region L and is delivered to the recharge zone. Natural recharge can be enhanced either through direct injection into the aquifer or through the delivery of water to the aquifer recharge zone. The estimated cost of aquifer yield enhancement options ranges from a low of $7 per acre-foot to a high of $5,870 per acre-foot.

Imported Recharge (25) - These options involve recharge to the aquifer with all or a portion of water originating from sources other than those categorized as natural recharge, regardless of the delivery system into the aquifer. The estimated cost of these options ranges from a low of $466 per acre-foot to a high of $1,305 per acre-foot.

Treatment and Distribution (57) - This category includes alternatives involving conventional treatment of surface water sources (disinfection in the case of the Carizzo water) and delivery to a municipal water distribution system. The estimated cost of these options ranges from a low of $266 per acre-foot to a high of $1,518 per acre-foot.

It is important to note that each of the water management strategies evaluated for the Trans-Texas Program West-Central Study Area were considered independently. However, many of the strategies are dependent on one another and are therefore not additive. For example, two options for obtaining water from the Carrizo Aquifer were investigated, both of which involve pumping 90,000 acre-feet per year. One option proposes pumped water be injected into the Edwards Aquifer while the other option, CZ-10B, proposes pumped water be delivered to the Edwards Aquifer recharge zone. One or the other, but not both, of these options could be implemented. Also, some alternatives have direct bearing upon other alternatives.

5.4.1 Natural and Imported Recharge Water Management Strategies[1]

As discussed above, there are two types of aquifer recharge water strategies that have been considered for their potential to augment available water supply from the Edwards Aquifer - natural and imported recharge. Two types of recharge enhancement structures have been studied. One type of structure, known as a Type I reservoir, is a "catch and release" impoundment located upstream of the recharge zone. Type I reservoirs are operated to detain flow from upstream storm events and release the impounded water at the maximum recharge rate of the aquifer through the downstream channel. The potential maximum yield from Type I natural recharge projects is 147,000 acre-feet per year under 1934-1989 "average conditions" and 71,000 acre-feet per year for the drought of record. This represents the combined yield from seven Type I structures. The estimated annual unit cost for each of these structures ranges from $193 to $418 per acre-foot for "average conditions" and $229 to $2,968 per acre-foot for drought of record conditions[2].

Type II recharge structures are located within the recharge zone, are normally dry, and impound water only for a few days or weeks following a storm event. A similar study of the potential yield available from Type II natural recharge projects estimated a maximum yield of 154,600 acre-feet per year during 1934-1989 average conditions and 70,600 acre-feet per year for the drought of record. This represents the combined yield of 16 recharge sites, including Indian Creek, with an estimated annual unit cost ranging from $193 to $221 per acre-foot for "average conditions" and $406 to $591 per acre-foot for drought of record conditions[1].

Recharge strategies using imported water supplies are the second type of recharge enhancement strategy. This includes water that originates in Region L and is delivered to the recharge zone. These alternatives consider all recharge to the Edwards Aquifer from sources other than the Edwards Aquifer catchment area and recharge zone. Imported recharge strategies can involve any of a number of methods for delivering water to the aquifer. These include Type I and Type II structures or wells to inject water directly into the aquifer. As mentioned in the previous section, 25 imported recharge alternatives were considered in the Trans-Texas Water Program. These alternatives ranged in cost from $466 to $1,305 per acre-foot with estimated individual yields ranging from 22,500 to 357,800 acre-feet per year.

---

[1] Sources: Trans-Texas Water Program report entitled, *West Central Study Area Phase I interim Report*, 1994 and Trans-Texas Water Program report entitled, *West Central Study Area Summary Report of Water Supply Alternatives, 1998.*

[2] Range of "average conditions" unit costs are based on the same total annual costs for the "drought conditions" scenario.

6.0 On-Going Water Planning Functions of the Edwards Aquifer Authority

It is important to recognize that water resources planning is a basic statutory responsibility of the Edwards Aquifer Authority. Also, water resources planning is an ongoing iterative process that must consider changing conditions and new information. As such, the Edwards Aquifer Authority's ***initial*** Groundwater Management Plan will require periodic review and revision. In particular, it is anticipated that this plan will be revised to incorporate appropriate elements of the regional water plan for the South Central Regional Water Planning Area.

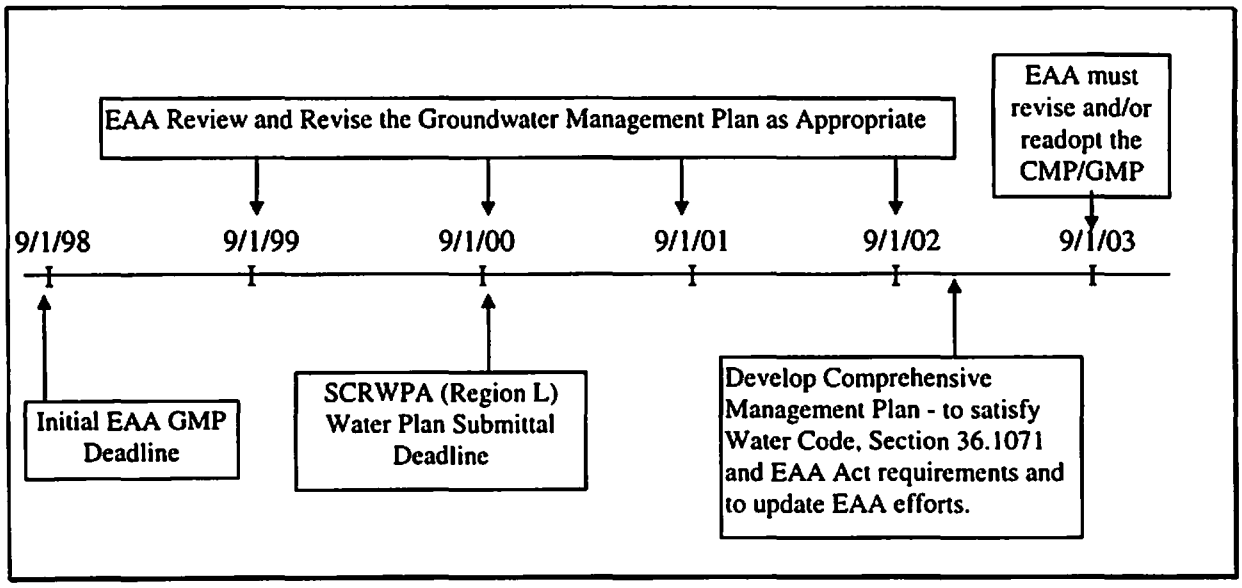
6.1 General Updates and Revisions to the Authority Groundwater Management Plan

As directed under the Brown-Lewis Water Plan, the Authority "**may review the plan annually, and shall readopt the plan with or without revisions at least once every five years.**" The Brown-Lewis Water Plan also states that the groundwater management plan, "**must be consistent with the approved regional water plan for each region in which any part of the district is located.**" Because the Edwards Aquifer Authority's area of jurisdiction is entirely within the South Central Regional Water Planning Area, it is this regional water plan, to be adopted by September 1, 2000, with which the Edwards Aquifer Authority's Groundwater Management Plan must conform.

As indicated in Section 5.0, this ***initial*** Groundwater Management Plan was developed without recommendations on specific water management strategies that could be implemented to meet future water needs in the Edwards Aquifer region. This approach was taken in order to minimize potential inconsistency with the soon to be prepared Brown-Lewis Water Plan regional plan. It is anticipated that subsequent versions of the Edwards Aquifer Authority's Groundwater Management Plan will incorporate relevant portions of the Brown-Lewis Water Plan regional water plan and will provide more definitive recommendations in regard to the implementation of regional water management strategies.

6.2 Comprehensive Groundwater Management Plan

Management Objective 6.1 in **Section 4.6** describes the Edwards Aquifer Authority's intention to revise its ***initial*** Groundwater Management Plan to incorporate elements of the Brown-Lewis Water Plan regional water plan, and in doings so, develop a "comprehensive" Groundwater Management Plan that fulfills the planning requirements of the EAA Act. The following timeline shows how this ***initial*** Groundwater Management Plan is expected to evolve into the required comprehensive management plan:


EAA Review and Revise the Groundwater Management Plan as Appropriate
EAA must revise and/or readopt the CMP/GMP
9/1/98
9/1/99
9/1/00
9/1/01
9/1/02
9/1/03
Initial EAA GMP Deadline
SCRWPA (Region L) Water Plan Submittal Deadline
Develop Comprehensive Management Plan - to satisfy Water Code, Section 36.1071 and EAA Act requirements and to update EAA efforts.