2006

RIO GRANDE
REGIONAL WATER PLANNING GROUP

Rio Grande Regional Water Plan

Final Plan

January 5, 2005

Final Plan for Review
Rio Grande Regional Water Plan

Technical Development of this report (Final Plan) was accomplished with the cooperation of the following consultants:

NRS Consulting Engineers
R.J. Brandes Company
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Texas Agricultural Experiment Station
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EXECUTIVE SUMMARY

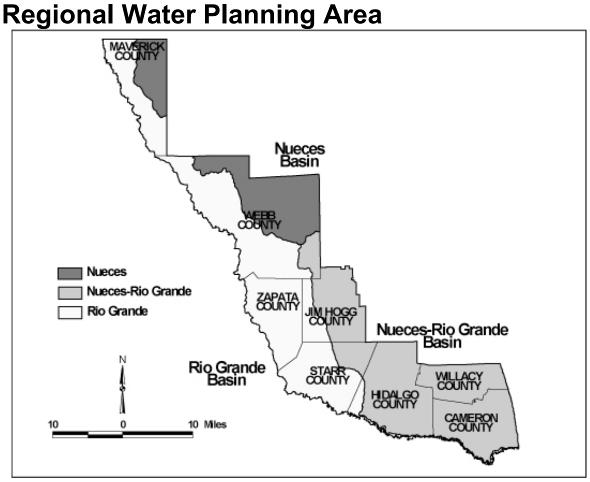
Introduction: Overview of the Regional Water Planning Process

In 1997, the 75th Texas Legislature enacted Senate Bill 1 (SB 1), often referred to as the Brown-Lewis Water Management Plan after its Senate and House sponsors. The legislation grew out of the drought of the early to mid 1990s and the increasing public awareness of rapidly growing water demands in the state. The issues and concerns addressed in SB 1 included state, regional, and local planning for water conservation, water supply and drought management, administration of state water rights programs, interbasin transfer policy, groundwater management, water marketing, state financial assistance for water-related projects, and state programs for water data collection and dissemination.

SB 1 radically altered the manner in which state water plans are prepared, establishing a "bottom up" approach based on regional water plans that are prepared and adopted by appointed regional water planning groups (RWPGs) representing 11 different stakeholder interests. There are 16 RWPGs; the members serve without compensation. The planning process is coordinated by the Texas Water Development Board (TWDB), which assembles the 16 regional water plans into one comprehensive State Water Plan.

Initially designated by TWDB as "Region M", the Rio Grande Regional Water Planning Area (or the Rio Grande Region) consists of the eight counties adjacent to or in proximity to the middle and lower Rio Grande. They are: Cameron, Hidalgo, Jim Hogg, Maverick, Starr, Webb, Willacy, and Zapata (see Exhibit 1).

Exhibit 1: Rio Grande Regional Water Planning Area



The Rio Grande RWPG now consists of 19 members representing all 11 interest group categories specified in SB 1 (see Exhibit 2). In addition to its voting membership, the Rio Grande RWPG includes non-voting members representing state agencies and the Mexican federal government.

Exhibit 2: Rio Grande Regional Water Planning Group

INTEREST	NAME	RESIDENT COUNTY
PUBLIC	Mary Lou Campbell, Secretary* Mercedes	Hidalgo
COUNTIES	Jose Aranda County Judge	Maverick
	John Wood County Commissioner, Brownsville	Cameron
MUNICIPALITIES	Roberto Gonzalez* Water Works, Eagle Pass	Maverick
	John Bruciak, General Manager Brownsville Pub	Cameron
	Adrian Montemayor Water Utilities, Laredo	Webb
INDUSTRIES	Gary Whittington Unifirst Linen Service, Harlingen	Cameron
AGRICULTURE	Robert E. Fulbright* Hinnant & Fulbright, Hebbronville	Jim Hogg
	Ray Prewett Texas Citrus Mutual, Mission	Hidalgo
ENVIRONMENTAL	Karen Chapman Environmental Defense, Brownsville	Cameron
SMALL BUSINESS	Donald K. Mcghee Hydro Systems, Inc., Harlingen	Cameron
	Xavier Villareal T&J Office Supply, Zapata	Zapata
ELECTRIC GENERATING UTILITIES	Kathleen Garrett Sempra Texas Services, LP/Topaz Power Group	Cameron, Hidalgo, Webb
RIVER AUTHORITIES	James Darling Rio Grande Regional Water Authority	Hidalgo
WATER DISTRICTS	Sonny Hinojosa HCID No. 2, San Juan	Hidalgo
	Sonia Kaniger CCID No. 2, San Benito	Cameron
WATER UTILITIES	Charles Browning, Vice-Chair* North Alamo WSC, Edinburg	Hidalgo
OTHER	Glenn Jarvis, Chair* Attorney, McAllen	Hidalgo
	James Matz Mayor, Palm Valley	Cameron

The first round of regional water planning culminated in 2002. The second round of planning began later that year. This plan represents the culmination of the second effort of regional planning. In this round of planning, the RWPG amended the original plan to include desalination of brackish groundwater as a recommended water management strategy; updated population and water demand projections; incorporated new data from the Rio Grande Water Availability Model into water supply projects; and analyzed additional water management strategies.

Highlights of the 2006 Rio Grande Regional Water Plan

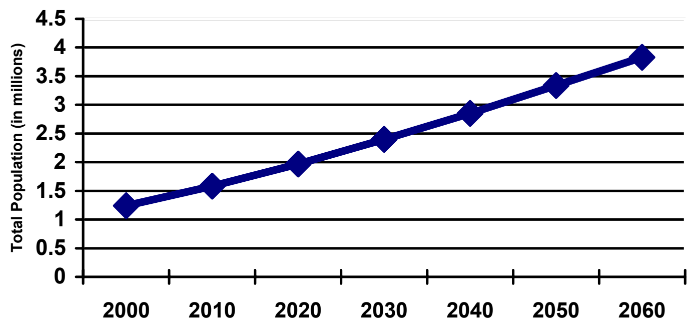
The Rio Grande region faces significant water needs over the next 50 years. Population growth and an aging irrigation infrastructure will combine to produce a deficit of nearly 600,000 acre-feet of water by the year 2060 unless specific water supply and management strategies are implemented. Local buy-in and action are needed to implement several of the water supply strategies; for many, funding sources must be identified. Others require additional in-depth evaluation.

What is clear, though, is that improving irrigation district systems that convey water from the Rio Grande to both farms and cities is the most economical means of stretching limited water supplies to meet all needs.

Population Growth & Water Demand

Population in the Rio Grande region more than tripled over the period 1950-2000, increasing from almost 399,000 to more than 1.2 million. By 2060, population in the eight-county area is projected to increase more than three-fold, to over 3.8 million.

Exhibit 3: Projected Population Growth of Rio Grande Regional Water Planning Area



That growth in population will fuel increased demand for water for municipal purposes: drinking, hygiene, lawns and gardens, recreational use, etc. Municipal water demand, now about 230,000 acre-feet per year (AF/yr), is projected to swell to almost 626,000 AF/yr. (An acre-foot of water equals 325,581 gallons.)

Simultaneously, irrigation demand is projected to decrease, as land is converted from agricultural uses to urban uses.

Exhibit 4: Year 2000 Water Demands by Type of Use

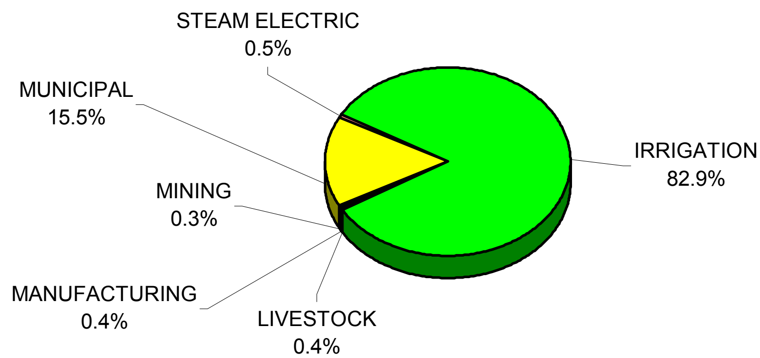
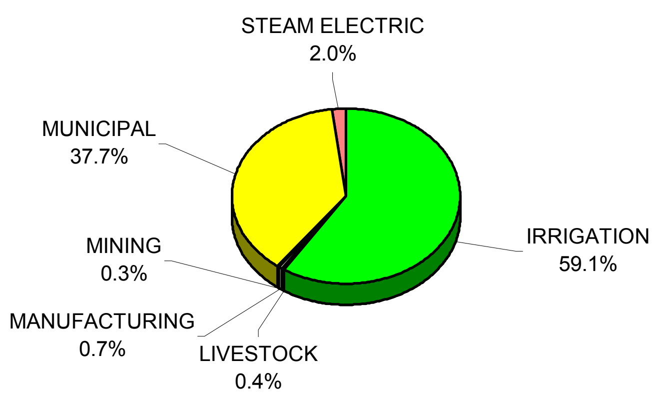


Exhibit 5: Year 2060 Water Demands by Type of Use



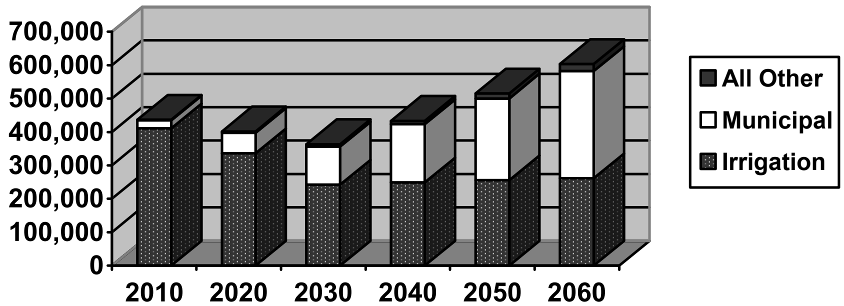
Water Supply Needs

The vast majority of the water available to the region – more than 94 percent – comes from supplies stored in the Amistad and Falcon Reservoir System. Because of sedimentation in the reservoirs, the amount of water available from the system is projected to decline from 1.12 million AF/yr in 2010 to 1.08 million AF/yr in 2060. In addition, the dependable firm water supply from the system during drought-of-record conditions is about 1 million AF/yr.

Analyses conducted by the Rio Grande RWPG show that the region in general faces significant water supply needs even though some users in some areas actually may have surplus supplies.

Shortages in municipal supplies are projected to increase more than 13-fold from 2010 to 2060.

Exhibit 6: Water Supply Deficits for the Rio Grande Region (in acre-feet/year)



The regional planning process identified 48 Water User Groups (WUGs) that will need additional supplies over the 50-year planning horizon. The large majority with needs (29) are urban municipal WUGS. The list also includes 10 rural municipal WUGs, 6 irrigation WUGs, 2 power generation WUGs, and 1 manufacturing WUG.

The TWDB has estimated that unmet water needs could have considerable socioeconomic impacts on the region: more than $2 billion lost to decreased sales, $2 billion in lost income, more than 26,000 lost jobs, and more than $75 million in lost taxes by 2060.

Strategies to Meet Water Needs

Analyses conducted for the Rio Grande RWPG found that improvements to irrigation district conveyance systems and on-farm conservation measures can produce significant water savings at economical costs.

Conveyance system improvements could produce water savings of more than 243,000 AF/yr – about 40 percent of the total water shortage projected for the 8-county area in 2060 – at an annual cost of less than $121/AF. On-farm conservation measures could produce annual savings of more than 274,000 AF/yr at an annual cost of about $253/AF.

Recommendations for improvements to conveyance systems include:

- installing no-leak gates;
- installing additional water measurement devices;
- converting smaller concrete canals in poor condition to pipeline;
- lining smaller earthen canals previously constructed of more porous soils; and
- implementing a verification program to monitor and measure the effectiveness of the efficiency improvements.

Technologies and methods available for on-farm conservation include plastic pipe (poly pipe), low energy precision application systems, irrigation scheduling using an evapotranspiration network, drip irrigation, metering, unit pricing of water, and switching to water efficient crops.

Water saved through these means also could help offset municipal shortages. The Rio Grande RWPG identified three primary strategies for meeting increasing domestic, municipal and industrial (DMI) needs:

- optimize the supply of water available from the Rio Grande;
- expand water conservation programs; and
- diversify water supplies for DMI use by developing alternative sources, including reused or reclaimed water, groundwater, and desalination.

The Rio Grande RWPG identified 10 municipal strategies for meeting water demand (see Exhibit 7). The most economical is implementing advanced water conservation measures, such as retrofitting plumbing fixtures and installing water-wise landscaping.

Total cost of all water management strategies identified approaches $235 million.

Exhibit 7: Water Management Strategy Summary

Strategy	Yield, ac-ft (Additional)	Acre-foot Cost (Annual)	Total Annual Cost
Advanced Water Conservation	19,009	$ 112.47	$ 2,137,995
Groundwater development	29,824	$ 304.46	$ 9,080,215
Urbanization	15,245	$ 368.37	$ 5,615,801
Non-Potable Reuse of reclaimed water	30,841	$ 415.22	$ 12,805,800
Contract Water Rights	4,577	$ 455.56	$ 2,085,053
Desalination of Brackish groundwater	69,832	$ 505.51	$ 35,300,774
Brownsville Weir and Reservoir	20,643	$ 537.27	$ 11,090,865
Acquisition of Rio Grande water rights	143,944	$ 542.74	$ 78,123,949
Potable Reuse of reclaimed water	1,120	$ 705.89	$ 790,597
Desalination of Seawater	7,902	$ 767.63	$ 6,065,812
Total	342,937		$ 163,096,861
Irrigation Demands			
Conveyance System Improvements	218,783	$ 120.68	$ 26,402,732.4
On-Farm Conservation	219,226	$ 253.38	$ 55,547,483.9

State rules require the water planning groups to report on how affected entities propose to pay for water management strategies. The total annual cost for all municipalities to implement necessary Water Management Strategies to offset potential water supply deficits is $152 million. Based on information gathered from the aforementioned surveys, 40% of total annual costs will be provided by bonds, 33% with federal government programs, 16% with state government programs, 8% with cash reserves, and 3% with other methods.

The total annual cost for all irrigation Water Management Strategies is $82 million. On-farm conservation measures will cost $56 million and irrigation conveyance system improvements will cost $26 million. Some 40% of on-farm costs will be locally funded, and the remainder will be from outside sources. About 10% of irrigation conveyance system improvements will be locally funded, and 90% will be from outside sources.

Additional Issues & Recommendations

Many of the issues and needs of the region arise from the fact that the Rio Grande is an international river whose waters are shared by the U.S. and Mexico. No other regional water planning area faces this reality. Consequently, the recommendations made by the Rio Grande RWPG for action to address regional water needs are divided into two categories: some recommendations fall within the authority of the State of Texas; others must be addressed through the auspices of the International Boundary and Water Commission and/or other international and federal agencies. Summaries of recommendations are presented below; full recommendations are contained in Chapter 8.

Recommendations on State Issues

- The State of Texas should consider factors other than merely population in funding the planning process in Region M because of the unique circumstances affecting water supply in the area.

- The State should continue financing brackish groundwater projects and the demonstration seawater desalination project as means to increase water supply alternatives in the region.

- The State should authorize the Rio Grande Watermaster to manage the Rio Grande WAM and should fully appropriate to the Texas Commission on Environmental Quality fees paid by Rio Grande water right holders.

- The State should assist in finding new technical and financial resources to help the region combat aquatic weeds and salt cedar and thus protect its water supplies.

- The State should continue providing technical and financial resources to fully develop the regional GAM.

- The State should amend the planning process to allow for treating each irrigation district with the region as a WUG, rather than as part of "County-Other," in order to allow for development of individual water management strategies for the districts.

- The Texas Commission on Environmental Quality should provide assistance to the Rio Grande RWPG as it reviews rules on converting water rights from one use to another and considers appropriate rule amendments, if necessary.

- Entities within the region are encouraged to cooperate to resolve water issues through such means as regional water and wastewater utilities.

- The formation of groundwater conservation districts is encouraged as a means to protect groundwater supplies.
- The State should appropriate sufficient funds to the Texas Railroad Commission to allow for capping abandoned oil and gas wells that threaten groundwater supplies.
- The Texas Legislature should provide technical and financial assistance to implement water management strategies identified in the regional water plans.
- The Texas Legislature should appropriate funds to continue the regional water planning process.
- The Texas Legislature should appropriate funds to the Texas Water Development Board to implement and provide assistance to water user groups in developing and implementing appropriate Advanced Water Conservation measure, including a statewide public outreach and education program.

Recommendations on National and International Issues

- The International Boundary and Water Commission (IBWC) should renew efforts to ensure that Mexico complies with Minute 309 and set in place means to achieve full compliance with the 1944 Treaty.
- The United States and Mexico should reinforce the powers and duties of both Sections of the IBWC.
- The Minute 309 conservation projects funded by the North American Development Bank and other projects funded by national and international agencies to modernize and improve the facilities of irrigation districts in the Rio Grande Basin should be supported and given priority.
- The conservation irrigation projects currently underway through the Bureau of Reclamation for improvement to the irrigation systems of irrigation districts in the Rio Grande Basin in the United States should be supported and implemented.
- For purposes of clarity, the IBWC should approve a Minute setting out the definition of “extraordinary drought.”
- Accounting of water between the United States and Mexico pursuant to the 1944 Treaty should be consistent with the 1906 Convention.
- For better water management in the Lower Reach of the Rio Grande, downstream of Anzalduas Dam, both countries should reaffirm operational policies that Mexico continue to take its share of waters through the Anzalduas canal diversion.

- IBWC should convene a binational meeting of water planners and water use stakeholders in both countries within six months following completion of the annual water accounting in which an annual deficit in flows from the named Mexican tributaries in the 1944 Treaty occurs.

- IBWC should restore the Rio Grande below Fort Quitman, Texas.

- The IBWC should assume all local and regional financial responsibility for upkeep and maintenance of El Morillo Drain.

- IBWC should coordinate bilateral efforts to review and evaluate existing sources of data regarding groundwater development in both countries in the Rio Grande Basin below Fort Quitman to the Gulf of Mexico.

- Regional watershed planning should be encouraged on both sides of the Rio Grande throughout the basin.

- Interstate compacts between affected states in Mexico should be encouraged.

Chapter Summaries

The remainder of this Executive Summary provides a synopsis of each chapter.

- Chapter 1 presents a description of the regional water planning area. This includes information regarding current water uses and major water demand centers, sources of surface and groundwater supply, agricultural and natural resources, and the demographic and socioeconomic characteristics of the region. Also included are summaries of existing regional water plans, recommendations in the current state water plan, and local water plans, as well as an assessment of threats to agricultural and natural resources.

- Chapter 2 presents current and projected population and water demands. This information is reported by city and county and for the portion of each river basin within the Rio Grande Region. Water demand projections are presented for six water use categories: municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock.

- Chapter 3 provides a total analysis of the region's water supply.

- Chapter 4 identifies and evaluates selected water management strategies based on needs.

- Chapter 5 analyzes the impacts of water management strategies on key parameters of water quality and the impacts of moving water from rural and agricultural areas.

- Chapter 6 describes consolidated water conservation and drought management recommendations of the regional water plan.

- Chapter 7 describes how the regional plan is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources.

- Chapter 8 presents recommendations for unique stream segments, reservoir site, and legislative options.

- Chapter 9 provides recommendations to the Legislature on funding for water infrastructure.

- Chapter 10 describes public participation, facilitation, and plan implementation issues.

Physical Description of the Rio Grande Region

The climate of the Rio Grande Region ranges from a humid subtropical regime in the eastern portion of the region to a tropical and subtropical regime in the remaining portion of the region. Prevailing winds are southeasterly throughout the year and the warm tropical air from the Gulf of Mexico produces hot and humid summers and relatively mild and dry winters.

Average annual net lake evaporation in the Rio Grande Region varies from 40 to 44 inches at the coast to approximately 60 to 64 inches at the central portion of the region near southern Webb County. The amount of rainfall varies across the Lower Rio Grande Region from an average of 28 inches at the coast to 18 inches in the northwestern portion of the region. Most precipitation occurs during the spring from April through June, and during the late summer and early fall, from August through October.

The Rio Grande Region is located entirely within the Western Gulf Coastal Plains of the United States, an elevated sea bottom with low topographic relief. Topography in the region ranges from a rolling, undulating relief in the northwestern portion becoming progressively flatter near the Gulf Coast. The Rio Grande flows southeasterly through the region before turning east to its confluence with the Gulf of Mexico.

In general, soils in the Rio Grande Region generally consist of calcareous to neutral clays, clay loams and sandy loams.

The Lower Rio Grande Valley is the northern boundary of much of the semitropical biota of Mexico. A number of plant and animal species from the more xeric and mesic areas to the west and northeast, respectively, converge in the area.

The lower Laguna Madre is a hypersaline bay most of which lies in the eastern portions of Cameron and Willacy counties. Shallow depth, extensive seagrass meadows, and tidal flats characterize it. The lower Laguna Madre supports a wide variety of marine aquatic organisms and wildlife.

Public and private interests have created several refuges and preserves in the Lower Rio Grande Valley to protect remaining vegetation and the habitats of endangered and threatened species. These include the Lower Rio Grande Valley National Wildlife Corridor/Refuge, Laguna Atascosa National Wildlife Refuge (NWR), Santa Ana NWR, Anzalduas County Park, Falcon State Park (SP), Bentsen-Rio Grande Valley SP, Boca Chica SP, Las Palomas Wildlife Management Area (WMA), Arroyo Colorado WMA, Sabal Palm Audubon Center and Sanctuary, the Nature Conservancy's Chihuahua Woods Preserve, and the SouthBay Coastal Preserve.

Demographic and Socioeconomic Characteristics of the Rio Grande Region

The South Texas border region has seen significant growth over the past 30 years. Gross regional product in this region quadrupled from $5.3 billion in 1970 to $20.3 billion in 2000, for an annual growth rate of 4.6 percent. During the same period, employment in the region grew at an average annual rate of 3.2 percent, as compared to a statewide rate of 2 percent. In 2000, the region accounted for 6.7 percent of the population and 4.4 percent of the state’s employment base.

Exhibit 8: Rio Grande Region Counties Eligible for EDAP Assistance

Counties	Average Unemployment Rate 2001-2003 (%)	Percent Above State Rate	Average Per Capita Income 2000-2002 ($)	Percent Below State Rate
Texas Average	6.0	n/a	28,765	n/a
Cameron	10.1	69.2	15,519	-46.0
Hidalgo	13.3	122.1	14,208	-50.6
Maverick	23.6	293.7	12,002	-58.3
Starr	19.3	221.6	10,013	-65.2
Webb	7.2	20.6	15,890	-44.8
Willacy	17.0	183.5	14,423	-49.9
Zapata	7.9	31.3	12,988	-54.8

The TWDB has classified seven out of the eight counties in the Rio Grande Region as eligible for assistance through the Economically Distressed Assistance Program (EDAP). EDAP eligibility is limited to counties with an unemployment rate higher than 25 percent of the state average over the latest three-year period and an average per capita income rate 25 percent below the state average. The qualifying level of per capita income is $21,573.75; the qualifying level unemployment is 7.5 percent.

Current and Projected Population & Water Demand for the Rio Grande Region

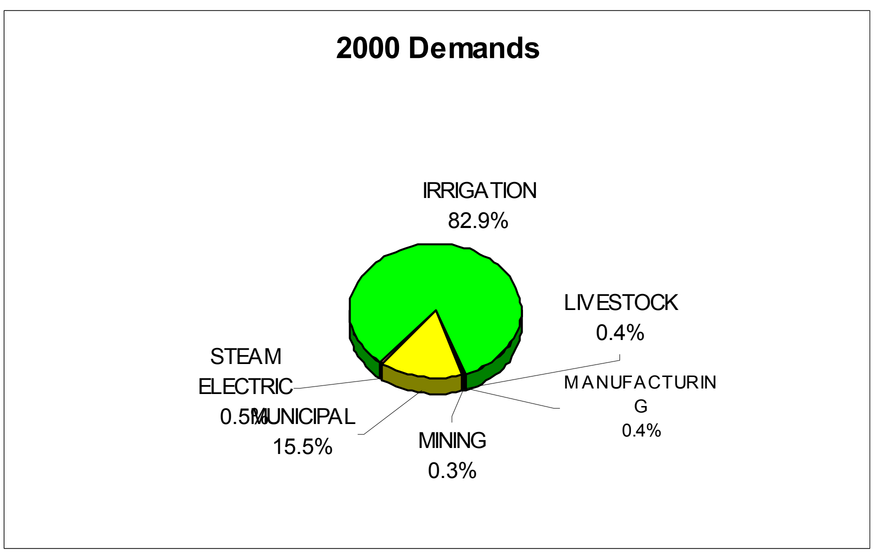
The TWDB projects population in the eight counties comprising the Rio Grande Regional Water Planning Area will more than triple from 2000 to 2060.

Exhibit 9: County Population Projections

COUNTY	2000	2010	2020	2030	2040	2050	2060
Cameron	335,227	415,136	499,618	586,944	673,996	761,073	843,894
Hidalgo	569,463	744,258	948,488	1,177,243	1,424,767	1,695,114	1,972,453
Jim Hogg	5,281	5,593	5,985	6,286	6,538	6,468	6,225
Maverick	47,297	55,892	64,984	73,581	81,032	87,850	93,381
Starr	53,597	66,137	79,538	93,338	107,249	120,959	134,115
Webb	193,117	257,647	333,451	418,332	511,710	613,774	721,586
Willacy	20,082	22,519	24,907	27,084	28,835	30,026	30,614
Zapata	12,182	14,025	16,217	18,415	20,486	22,354	23,733
TOTALS	**1,236,246**	**1,581,207**	**1,973,188**	**2,401,223**	**2,854,613**	**3,337,618**	**3,826,001**

Total annual water demand for the region is projected to *increase* until 2010, then *decrease* until 2030, and then steadily *increase* until 2060. This trend is attributable to diminishing irrigated acreage and rising urban populations, especially in the Rio Grande Valley, as land use changes from agriculture to urbanization. Water demand for irrigation in the region is projected to fall from the current 82.9% of total water use to 59.1% by 2060. During the same period, municipal water demands are projected to increase from almost 16% to almost 38%.

Exhibit 10: Total Water Demands by Type of Use, 2000 and 2060



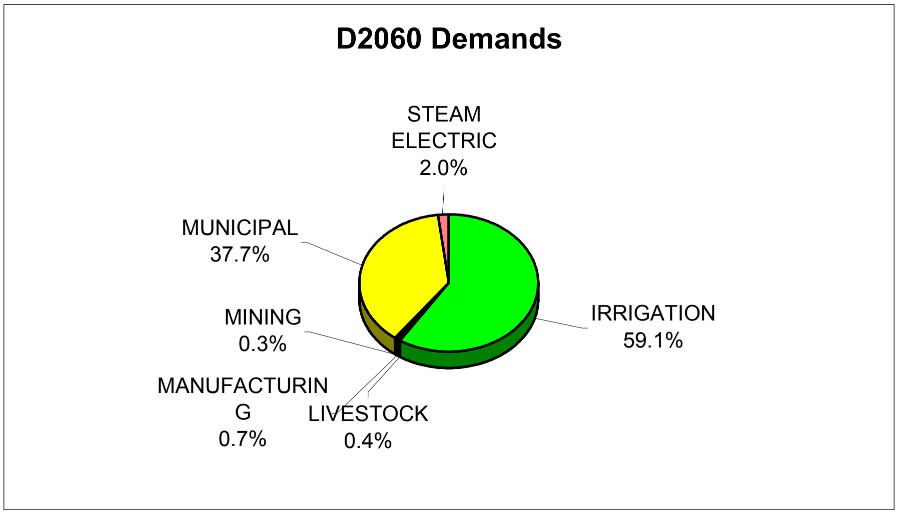


Exhibit 11: Water Demand Projections (acre-feet/year)

Water Demand Projections	2000	2010	2020	2030	2040	2050	2060
Irrigation (AF/YR)	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749
Livestock (AF/YR)	5,817	5,817	5,817	5,817	5,817	5,817	5,817
Manufacturing (AF/YR)	6,208	7,509	8,274	8,966	9,654	10,256	11,059
Mining (AF/YR)	3,869	4,186	4,341	4,433	4,523	4,612	4,692
Municipal (AF/YR)	226,536	279,633	338,716	403,511	472,632	547,747	625,743
Steam Eelctric (AF/YR)	6,780	13,463	16,864	19,716	23,192	27,430	32,598
Total Water Demand (AF/YR)	1,458,857	1,474,241	1,456,243	1,424,192	1,497,567	1,577,611	1,661,658

Evaluation of the Adequacy of Current Water Supplies

Current Rio Grande Supplies

The Rio Grande Region in Texas encompasses portions of three river basins: the Rio Grande, Nueces, and Nueces-Rio Grande Coastal. However, practically all of the surface water available to and used within the region is from the Rio Grande. Nearly all of the dependable surface water supply is from the combined yield of the Amistad and Falcon International Reservoirs, the two major reservoirs on the Rio Grande. Most of the inflow to this reservoir system comes from the Rio Conchos in the State of Chihuahua, Mexico, and the Pecos River in Texas. The estimated firm yield of the reservoir system (i.e., the amount of water available in the drought of record) for the U.S in 2005 was approximately 1.01 million acre-feet per year.

This represents more than 94 percent of the total amount of water presently available to the region from all sources (e.g., groundwater, reuse, Rio Grande tributaries, and other local sources). Over time, however, the total dependable water supply from the Rio Grande is projected to decrease significantly, largely as a consequence of reduced conservation storage capacity due to sedimentation of the Amistad/Falcon Reservoir System. Between the years 2010-2060, the firm yield of the reservoir system is projected to decrease by nearly 32,500 acre-feet (approximately 3 percent).

Because of the manner in which available supplies from the Amistad/Falcon Reservoir System are managed and allocated, the impact of declining supplies will be borne directly by irrigation and mining water users. Under the water rights system for the middle and lower Rio Grande, domestic-municipal-industrial (DMI) water rights have a very high degree of reliability. A DMI reserve of 225,000 acre-feet is continually maintained in the reservoir system. By comparison, irrigation and mining water rights are residual users of stored water from the reservoirs.

An additional concern involves the operation of reservoirs in Mexico's portion of the watershed that contributes flows to the Amistad/Falcon Reservoir System. Mexico has constructed an extensive system of reservoirs on the tributaries, especially in the Conchos River Basin. The combined storage capacity of all of Mexico's major reservoirs on Rio Grande tributaries is approximately 2.5 times the country's available conservation storage in Amistad and Falcon Reservoirs. This has serious implications in light of Mexico's statement that it operates its tributary reservoirs not for the purpose of meeting its obligations under the 1944 Treaty but rather solely to capture water for meeting and expanding its own internal water demands.

Mexico has only recently repaid a long-term deficit in excess of 1 million acre-feet with respect to the minimum tributary inflows to the Rio Grande required by the Treaty. This situation calls into question the certainty the amount of Rio Grande water that will be available in the future to the Texas water right holders.

Other water supply sources for the region include:

- The Arroyo Colorado, which traverses Cameron, Hidalgo, and a small portion of Willacy counties, represents a second potential water supply. Use of the water in the Arroyo Colorado for municipal, industrial or irrigation purposes is severely limited because of poor quality conditions; its daily flows are comprised primarily of return flows from agriculture and municipalities and locally generated runoff. Nonetheless, the Arroyo Colorado is an important source of freshwater inflows to the lower Laguna Madre, which is both economically and ecologically important to the region.

- Groundwater, primarily from the Gulf Coast Aquifer. Most groundwater in the region is of poor quality and cannot be used for agriculture or municipal use without treatment. Technological advances are driving down the costs of desalinating brackish groundwater, and this supply has become an option for municipal use, particularly to meet peak demands
- Reuse or "reclaimed water," which provides about 13,000 acre-feet per year (one percent) for irrigation, manufacturing, and steam electric uses.

Exhibit 12 provides a summary of the total amounts of available current water supplies for the Rio Grande Region by water use category for each decade through 2050.

Exhibit 12: Current and projected water supplies for the Rio Grande Region (AF/yr)

Water Use Category	2010	2020	2030	2040	2050	2060
Irrigation	752,995	746,006	739,518	733,030	726,541	720,552
Municipal	321,969	321,495	321,559	321,470	320,653	320,551
Steam Electric	16,216	16,216	16,216	16,216	16,216	16,216
Livestock	5,816	5,816	5,816	5,816	5,816	5,816
Manufacturing	6,549	6,552	6,555	6,558	6,560	6,563
Mining	4,941	5,087	5,168	5,248	5,329	5,398
Region Total	**1,108,486**	**1,101,172**	**1,094,832**	**1,088,338**	**1,081,115**	**1,075,096**

Identification, Evaluation, & Selection of Water Management Strategies Based on Needs

The Rio Grande Region faces significant water supply needs even though surpluses of water exist for some categories of use in some counties in some years. In general, deficits in municipal, manufacturing, and steam electric increase over the life of the planning study while irrigation deficits decline due to urbanization. A water supply "need" means that current or projected demands are greater than supply, producing a water supply "deficit" or shortage. Supply in "excess" of demand, on the other hand, results in a water supply "surplus" for the particular user.

Exhibit 13: Water Supply Needs for the Rio Grande Region by Category of Use (AF/yr)

Category of Use	2010	2020	2030	2040	2050	2060
Municipal	23,936	61,064	113,978	174,120	245,148	321,248
Manufacturing	1,921	2,355	2,748	3,137	3,729	4,524
Irrigation	410,637	336,224	242,442	248,903	255,366	261,330
Steam Electric	0	1,980	4,374	7,291	11,214	16,382
Mining	0	0	0	0	0	0
Livestock	1	1	1	1	1	1
TOTAL WATER NEEDS (AF/yr)	**436,494**	**401,623**	**363,542**	**433,451**	**515,457**	**603,484**

Exhibit 14: Water Supply Surpluses for the Rio Grande Region by Category of Use (AF/yr)

Category of Use	2010	2020	2030	2040	2050	2060
Municipal	66,272	43,847	32,027	22,960	18,355	16,059
Manufacturing	962	634	338	42	34	29
Irrigation	0	0	212	185	158	133
Steam Electric	2,753	1,332	874	315	0	0
Mining	755	747	736	726	717	704
Livestock	0	0	0	0	0	0
TOTAL WATER SURPLUS (AF/yr)	**70,742**	**46,560**	**34,187**	**24,228**	**19,264**	**16,925**

Opportunities for developing additional water supplies for municipal use are limited in the Rio Grande Region because of hydrologic characteristics, economics, and legal constraints associated with the 1944 Mexico/U.S. Water Treaty. Few opportunities exist to increase the water supply yield of the Rio Grande. However, a number of strategies for augmenting municipal water supplies have been examined as part of this planning effort. These include advanced municipal water conservation, Brownsville weir and reservoir, reuse of reclaimed water strategies for optimizing surface water supply from the Rio Grande, groundwater development, brackish and sea water desalination, and acquisition of additional Rio Grande supplies for domestic-municipal-industrial (DMI) uses.

Advanced water conservation is aimed at reducing the amount of water used per capita, thereby reducing overall municipal demand. Water rights purchase, water rights acquisition by long-term contract, and water rights acquisition through urbanization all involve transferring rights of Rio Grande water from irrigation usage to DMI usage. Since municipal water has the highest priority in the Amistad/Falcon system, irrigation water is in a constant state of shortage. Accordingly, conveyance and on-farm improvements are needed to reduce the impact of irrigation shortages. Municipal water management strategies are not cost-effective when applied to irrigation use.

Two water management strategies were evaluated to conserve water and provide additional supply for irrigation use: on-farm improvements and conveyance system efficiency improvements. Technologies and methods currently available for on-farm water conservation include: plastic pipe (poly pipe), low energy precision application, irrigation scheduling using an evapotranspiration network, drip, metering, unit pricing of water, and growing water efficient crops. The proposed conveyance efficiency program consists of six principal components: no-leak gates, additional water measurement devices, converting smaller concrete canals in poor condition to pipeline, lining smaller earthen canals, and implementing a verification program to monitor and measure the effectiveness of the efficiency improvements. However, there are few programs that provide financial assistance to irrigation districts for infrastructure improvements. Because agricultural water conservation is a central element of this regional water plan – and is essential to maintaining the viability of this sector of the regional economy – the

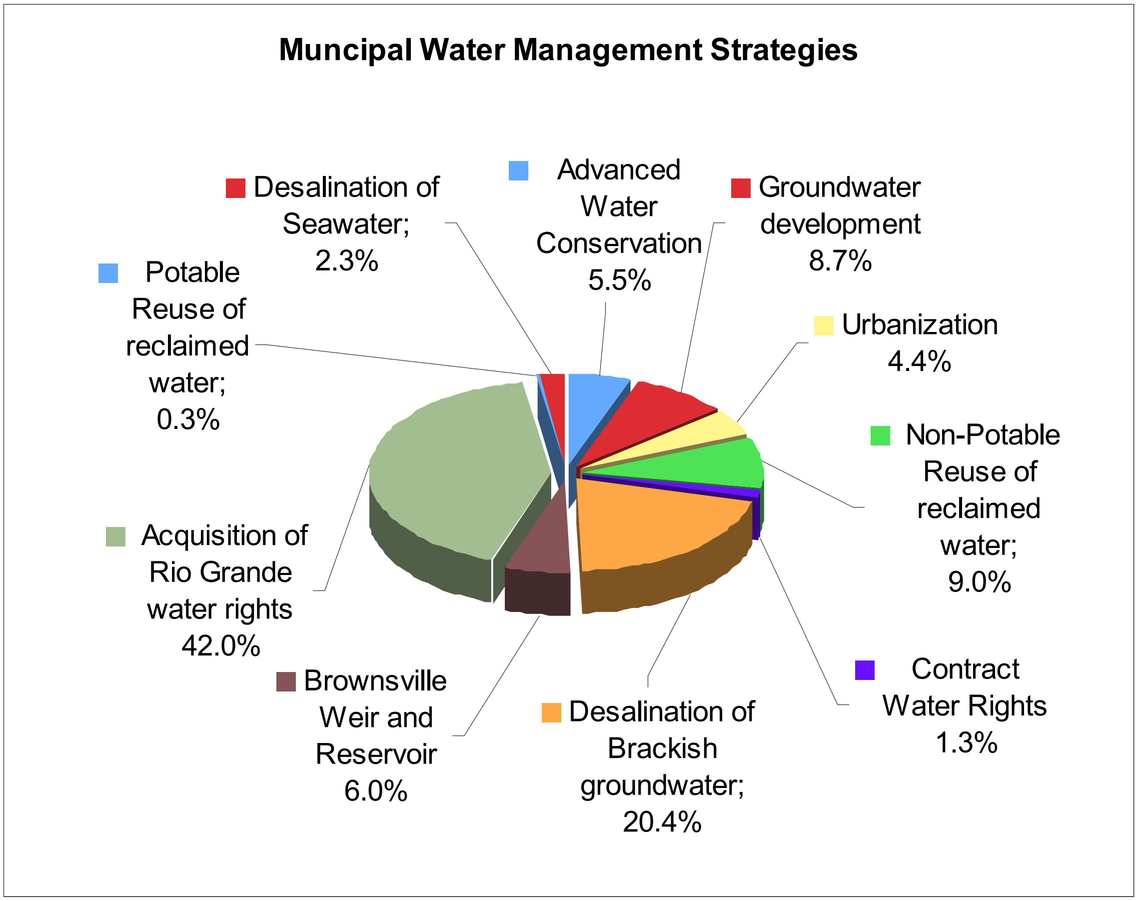
Rio Grande RWPG recommends that new public funding sources be developed to assist irrigation districts with implementing conservation programs.

The proposed water supply yield and cost per acre-foot associated with each water management strategy (WMS) are shown below.

Exhibit 15: Water Management Strategy Summary

Strategy	Yield, ac-ft (Additional)	Acre-foot Cost (Annual)	Total Annual Cost
Advanced Water Conservation	19,009	$ 112.47	$ 2,137,995
Groundwater Development	29,824	$ 304.46	$ 9,080,215
Urbanization	15,245	$ 368.37	$ 5,615,801
Non-Potable Reuse of reclaimed water	30,841	$ 415.22	$ 12,805,800
Contract Water Rights	4,577	$ 455.56	$ 2,085,053
Desalination of Brackish Groundwater	69,832	$ 505.51	$ 35,300,774
Brownsville Weir and Reservoir	20,643	$ 537.27	$ 11,090,865
Acquisition of Rio Grande Water Rights	143,944	$ 542.74	$ 78,123,949
Potable Reuse of Reclaimed Water	1,120	$ 705.89	$ 790,597
Desalination of Seawater;	7,902	$ 767.63	$ 6,065,812
Total	342,937		$ 163,096,861
Irrigation Demands			
Conveyance System Improvements	218,783	$ 120.68	$ 26,402,732.4
On-Farm Conservation	219,226	$ 253.38	$ 55,547,483.9

Exhibit 16: Water Management Strategy Yield Percentage



Impacts of WMS on Key Parameters of Water Quality and Impacts of Moving Water from Rural and Agricultural Areas

The following table summarizes the impacts of WMS on water quality.

Exhibit 17: Water Quality Impacts by Water Management Strategy

WMS	Positive Impacts	Negative Impacts
Additional Groundwater	Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased wastewater flows to receiving streams, i.e. higher organic levels Increased urban runoff during storm event
Advanced Water Conservation	Decreased wastewater flows	Increases concentration of organic matter in wastewater
Non-potable Reuse	Reduced wastewater flows Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation Decreased wastewater flows, resulting in lower organic levels in receiving streams	Increased urban runoff during storm event

Potable Reuse	Reduced wastewater flows Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation Decreased wastewater flows result in lower organic levels in receiving streams	Increased urban runoff during storm event
Brownsville Weir and Storage	Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows resulting in higher organic levels in receiving stream
Purchase of Water Rights	Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows to receiving streams, i.e. higher organic levels
Acquisition of Water Rights by Urbanization	Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows to receiving streams, i.e. higher organic levels
Acquisition of Water Rights by Long-Term Contracts	Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows to receiving streams, i.e. higher organic levels
Brackish Desalination	Improved water quality in wastewater effluent Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows to receiving streams, i.e. higher organic levels Increased levels of TDS in receiving streams due to concentrate discharge
Seawater Desalination	Improve water quality in wastewater effluent Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	Increased urban runoff during storm event Increased wastewater flows to receiving streams, i.e. higher organic levels Increased levels of TDS in receiving streams due to concentrate discharge
Conveyance Improvements	None	None
On-Farm Improvements	Decreased sediment and/or agricultural chemical runoff due to increased management and metering	None

Consolidated Water Conservation & Drought Management Recommendations

The Regional Water Plan provides guidance for selecting municipal water conservation strategies specific to the region, agricultural conservation plan for irrigation districts, and a model water conservation plan for a water user group.

The Rio Grande Regional Water Planning Group has incorporated into the 2006 Regional Water Plan strategies presented by the statewide Water Conservation Implementation Task Force in the *Water Conservation Best Management Practices Guide* (TWDB Report 362, Nov. 2004). Recommended strategies include:

- golf course conservation
- metering all new connections & retrofit on existing connections
- showerhead, aerator, and toilet flapper retrofit

- school education
- landscape irrigation conservation
- water wise landscape design
- athletic field conservation
- public information
- rainwater harvesting
- park conservation
- residential clothes washer incentive program

The Regional Water Plan also incorporates drought relief options offered by the U.S. Department of Agriculture through the Farm Service Agency: Conservation Reserve Program, Emergency Haying and Grazing Program, Farm Operating Loans, Farm Ownership Loans, Environmental Quality Incentive Program, Non-insured Crop Disaster Assistance Program, Farm Labor Housing Loans and Grants Program, and the Natural Resources Conservation Service.

The Regional Water Plan provides a template for agricultural conservation that follows TCEQ rules governing development of water conservation plans for public water suppliers. These rules define a water conservation plan as "a strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water."

The Regional Water Plan also provides a conservation plan for a water user group. According to TCEQ rules, water conservation plans for public water suppliers must have a utility profile, accurate metering, specification of goals, universal metering, and public education. Most have additional content for public water suppliers that are projected to supply 5,000 or more people in the next ten years and may have additional optional content.

Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources

Because the Rio Grande is the main source for both DMI use and irrigation use, optimizing the supply of water available from the river is an important aspect of protecting the state's water, agricultural, and natural resources. A key strategy here is implementing on-farm practices and rehabilitating irrigation systems to conserve water.

There is tremendous potential for water savings in both areas: 274,000 AF through on-farm improvements and 243,000 AF through conveyance system improvements. In the long run, total water savings associated with both strategies would allow irrigators to offset water supply deficits. However, the implementation timeframe will not offer immediate relief.

Another factor impacting the area of resource protection is Mexico's compliance with the 1944 Treaty. Even though Mexico has repaid its water debt, there is little assurance of future compliance should the region be gripped by another severe drought. Texas A&M studies have shown that the Lower Rio Grande Valley lost nearly $1 billion in decreased economic activity and 30,000 jobs as a direct result of Mexico's failure to comply with of its treaty obligations over the period 1992 to 2002.

Environmental flow needs are in the forefront of all issues dealing with long-term protection of the Texas' natural resources. One possibility for maintaining and increasing environmental flows is the acquisition of Rio Grande water rights for environmental usage through the Texas Water Trust. These water rights could be managed to produce sufficient flows throughout the region. However, this option may not be viable because of the current water rights purchase and transfer structure.

Given the WUG format currently being implemented by the TWDB, no option exists to formally allocate projected water supplies for environmental use. Alternatively, environmental flows in the Rio Grande could be included as a separate WUG in the next round of regional planning to ensure minimums would be met in a manner consistent with all other WUGs.

International cooperation from Mexico is critically needed to maintain flow levels. The U.S. Fish and Wildlife Service is currently in talks with Mexico regarding the introduction of triploid grass carp to the Rio Grande. If the United States were to implement an environmental flow program without Mexico's participation, the desired effect would be significantly reduced.

Another of the region's critical environmental issues is the growth of invasive plants such as water hyacinth and hydrilla and the spread of salt cedar and other aquatic plants. Unfortunately, eradication methods are both costly and physically strenuous. The natural rise and fall of water elevation in rivers and streams somewhat curtails these plants by drowning out new seedlings. However, in areas of minimal water flow, a perfect scenario exists for invasive plant growth.

Texas coastal estuaries, where freshwater from inland runoff mixes with the salty waters of the Gulf of Mexico, support an amazing abundance of wildlife. Young fish, shrimp, and crabs feed and hide in brackish estuary waters until they are mature enough to survive in the Gulf of Mexico. Resident and migratory birds by the thousands rest and feed in estuarine marshes. In fact, 95 percent of the Gulf's recreationally and commercially important fish and other marine species rely on estuaries during some part of their life cycle.

Approximately 343,000 AF/yr in new municipal water supplies are proposed in the 2006 Region M water plan. All of this except approximately 19,000 AF/yr of advanced water conservation can affect either freshwater inflows to the Lower Laguna Madre or streamflows in the Rio Grande. Alterations in flows on the Rio Grande are beyond the scope of the present evaluation. For Nueces-Rio Grande coastal basin streams draining to the Lower Laguna Madre there are no major dams, diversions, or other water management strategies proposed that can cause changes in streamflows. However, many of the proposed water management strategies can influence freshwater inflow through alteration of wastewater discharges based upon supplies imported from the Rio Grande basin or groundwater. Many of region's growing municipalities lie in the Nueces-Rio Grande coastal basin and will have greatly altered wastewater discharge into the streams that drain to the Laguna Madre.

The results of National Wildlife Federation analyses indicate no problems for freshwater inflows to the Lower Laguna Madre. The key spring and early summer inflow pulses needed to support strong productivity would not be impacted significantly. Nor would the ability of the Nueces-Rio Grande coastal basin to provide low flows during drought be altered very much. It should be kept in mind that much of the increase in wastewater discharge shown here is based on imports of water into the Nueces-Rio Grande coastal basin. These obviously come at the expense of the neighboring Rio Grande basin. An analogous effort to evaluate flow needs and effects of the Region M plan could be undertaken there in the next cycle of regional water planning.

Unique Stream Segments/Reservoir Sites/Legislative Recommendations

TWDB rules allow the RWPG to include in the regional water plan recommendations concerning legislative designation of ecologically unique streams, sites for future reservoir development, and policy issues. The Rio Grande RWPG elected to consider recommendations in each of these areas.

Ecologically Unique Stream Segments

State law prohibits state agencies and local units of government from developing a water supply project that would destroy the ecological value of a river or stream segment that has been designated by the Texas Legislature as ecologically unique. Furthermore, the TWDB cannot finance water supply projects located on a stream segment that has been designated as ecologically unique.

TWDB rules specify the criteria that are to be applied in the evaluation of potential ecologically unique river or stream segments. These are: biological function, hydrologic function, riparian conservation areas, high water quality/exceptional aquatic life/high aesthetic value, and threatened or endangered species/unique communities.

To assist the Rio Grande RWPG, the Texas Parks and Wildlife Department (TPWD) developed a list of candidate stream segments in each region that appear to meet the criteria for designation as ecologically unique. The Rio Grande RWPG also received suggestions from the U.S. Fish & Wildlife Service, Zapata County, and the Texas Shrimp Association through two stakeholder "focus group" meetings during the previous plan.

The Rio Grande RWPG reviewed the nominations submitted by TPWD and others with regard to legislative designation of river or stream segments as ecologically unique. The group elected not to include any recommendations.

Reservoir Sites

TWDB rules also provide that RWPGs "may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and the expected beneficiaries of the water supply to be developed at the site."

Two reservoir sites have been considered by the Rio Grande RWPG: the proposed Brownsville Weir and Reservoir; and the proposed Webb County low water dam. Neither is recommended for designation as a unique reservoir site at this time.

Legislative Recommendations

Under TWDB rules, regional water plans may include "regulatory, administrative, or legislative recommendations that the regional water planning group believes are needed and desirable to facilitate the orderly development, management, and conservation of water resources and preparation for and response to drought conditions."

Many of the issues and needs of the region arise from the fact that the Rio Grande is an international river whose waters are shared by the U.S. and Mexico. No other regional water planning area faces this reality. Consequently, the recommendations made by the Rio Grande RWPG for action to address regional water needs are divided into two categories: some recommendations fall within the authority of the State of Texas; others must be addressed through the auspices of the International Boundary and Water Commission and/or other international and federal agencies.

Recommendations on State Issues

- The State of Texas should consider factors other than merely population in funding the planning process in Region M because of the unique circumstances affecting water supply in the area.

- The State should continue financing brackish groundwater projects and the demonstration seawater desalination project as means to increase water supply alternatives in the region.

- The State should authorize the Rio Grande Watermaster to manage the Rio Grande WAM and should fully appropriate to the Texas Commission on Environmental Quality fees paid by Rio Grande water right holders as specified in Section 11.329 of the Texas Water Code for the purpose of fully funding Rio Grande Watermaster operations.

- The State should assist in finding new technical and financial resources to help the region combat aquatic weeds and salt cedar and thus protect its water supplies. The Rio Grande RWPG joins with the Far West Texas and Plateau RWPGs to encourage funding for projects aimed at eradicating salt cedar and other invasive plant species in the Rio Grande watershed and for ongoing long-term brush management activities.

- The State should continue providing technical and financial resources to fully develop the regional GAM.

- The State should amend the planning process to allow for treating each irrigation district with the region as a WUG, rather than as part of "County-Other," in order to allow for development of individual water management strategies for the districts.

- The Texas Commission on Environmental Quality should provide assistance to the Rio Grande RWPG as it reviews rules on converting water rights from one use to another and considers appropriate rule amendments, if necessary.

- Entities within the region are encouraged to cooperate to resolve water issues through such means as regional water and wastewater utilities.

- The formation of groundwater conservation districts is encouraged as a means to protect groundwater supplies, which are increasingly being tapped as a new water supply for municipal and industrial use.

- The State should appropriate sufficient funds to the Texas Railroad Commission to allow for capping abandoned oil and gas wells that threaten groundwater supplies.

- The Texas Legislature should provide technical and financial assistance to implement water management strategies identified in the regional water plans.

- The Texas Legislature should appropriate funds to continue the regional water planning process.

- The Texas Legislature should appropriate funds to the Texas Water Development Board to implement and provide assistance to water user groups in developing and implementing appropriate Advanced Water Conservation measure, including a statewide public outreach and education program.

Recommendations on National and International Issues

- The International Boundary and Water Commission (IBWC) should renew efforts to ensure that Mexico complies with Minute 309 and set in place means to achieve full compliance with the 1944 Treaty, including enforcement of Minute 234, which addresses the actions required of Mexico to completely eliminate water delivery deficits within specified treaty cycles. Water saved in irrigation conservation projects in Mexico should be dedicated to ensure deliveries to the Rio Grande pursuant to the 1944 Treaty under Article 4B(c) and Minute No. 234.

- The United States and Mexico should reinforce the powers and duties of both Sections of the IBWC pursuant to Article 24(c) which provides, among other things, for the enforcement of the Treaty and other Agreement provisions that "… *each Commissioner shall invoke when necessary the jurisdiction of the Courts or other appropriate agencies of his Country to aid in the execution and enforcement of these powers and duties.*"

- The Minute 309 conservation projects funded by the North American Development Bank and other projects funded by national and international agencies to modernize and improve the facilities of irrigation districts in the Rio Grande Basin should be supported and given priority. In particular, both countries should support continued grant funding for conservation projects through the NADBank's Water Conservation Investment Fund.

- The conservation irrigation projects currently underway through the Bureau of Reclamation for improvement to the irrigation systems of irrigation districts in the Rio Grande Basin in the United States should be supported and implemented.

- For purposes of clarity, the IBWC should approve a Minute setting out the definition of "extraordinary drought" as that term is implicitly defined in the second subparagraph of Article 4B(d) as an event which makes it difficult for Mexico " … to make available the *run-off* of 350,000 acre feet (431,721,000 cubic meters) annually." A drought condition occurs when there is less than 1,050,000 acre feet annually of *run-off waters* in the water sheds of the named Mexican tributaries in the 1944 Treaty, measured as water enters the Rio Grande from the named tributaries.

- Accounting of water between the United States and Mexico pursuant to the 1944 Treaty should be consistent with the 1906 Convention, which provides that all waters measured at Fort Quitman, Texas, are 100 percent allocated to the United States.

- For better water management in the Lower Reach of the Rio Grande, downstream of Anzalduas Dam, both countries should reaffirm operational policies that Mexico continue to take its share of waters through the Anzalduas canal diversion at the Anzalduas Dam or account for its water at that point, including any diversions by Mexico from the proposed Brownsville Weir Project storage, to the extent of its participation in the project.

- IBWC should convene a binational meeting of water planners and water use stakeholders in both countries within six months following completion of the annual water accounting in which an annual deficit in flows from the named Mexican tributaries in the 1944 Treaty occurs. This meeting would be designed to share data and information useful in planning for water needs and contingencies in the intermediate future.

- IBWC should restore the Rio Grande below Fort Quitman, Texas.

- The IBWC should assume all local and regional financial responsibility for upkeep and maintenance of El Morillo Drain.

- IBWC should coordinate bilateral efforts to review and evaluate existing sources of data regarding groundwater development in both countries in the Rio Grande Basin below Fort Quitman to the Gulf of Mexico. This effort should be focused on the potential impact on surface water supply in the Rio Grande watershed, with the goal of pursing such actions as may be necessary to evaluate present conditions and promote programs protecting the historical surface water supply in affected regions.

- Regional watershed planning should be encouraged on both sides of the Rio Grande throughout the basin, including efforts to promote binational coordination of long-range water plans.

- Interstate compacts between affected states in Mexico, similar to the Rio Grande Compact and Pecos River Compact between affected states in the United States, which deal with apportionment of available water supply from the Rio Grande and its tributaries to each state consistent with existing domestic and international law should be encouraged.

Water Infrastructure Funding Recommendations

The Infrastructure Financing Report (IFR) requirement was incorporated into the regional water planning process in response to Senate Bill 2 (77^{th} Texas Legislature). For purposes of the IFR, each RWPG is required to determine proposed financing for all of the water management strategies that were proposed in this second round of regional planning. For each of these strategies, the RWPG must determine the funding needed to implement the strategy and the types of funding that are likely to be accessed.

According to TWDB guidelines, the primary objectives of the IFR are to determine:

- the number of political subdivisions with identified needs for additional water supplies that will be unable to pay for their water infrastructure needs without some form of outside financial assistance;
- how much of the infrastructure costs in the regional water plans cannot be paid for solely using local utility revenue sources;
- the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any state funding sources considered); and,
- what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

In the majority of cases, municipal WUG strategies include urbanization, advanced water conservation measures and purchase of Rio Grande supplies. There are total of eight counties, 52 cities, and 15 water supply corporations in this regional planning area. Surveys were sent to only those that had been listed in the plan with a need during the50-year plan. Of these municipal WUGs, over 90% received a personal visit by the consultant team during the months June through November 2004. As part of the visit, the survey purpose was explained and the Regional Planning Group's role in the planning process.

The RWPG also sent out two surveys in this second round of planning: the first t in the summer 2004 and the second in October 2005. Samples of the surveys are attached to this report. The surveys were used to obtain additional information on water planning being conducted by the WUGs and their involvement with the RWPG.

The total annual cost for all municipalities to implement necessary Water Management Strategies to offset potential water supply deficits is $ 163 million. Based on information gathered from the aforementioned surveys, 40% of total annual costs will be provided by bonds, 33% with federal government programs, 16% with state government programs, 8% with cash reserves, and 3% with other methods.

The total annual cost for all irrigation Water Management Strategies is $82 million. On-farm conservation measures will cost $56 million and irrigation conveyance system improvements will cost $26 million. Some 40% of on-farm costs will be locally funded, and the remainder will be from outside sources. About 10% of irrigation conveyance system improvements will be locally funded, and 90% will be from outside sources.

Public Participation, Facilitation, and Plan Implementation Issues

Public Participation

Public participation is the basis of the regional water planning process initiated by SB 1 in 1997. TWDB rules require RWPGs to have at least one meeting prior to preparation of the regional water plan, provide ongoing opportunities for public participation during the planning process, and hold at least one public hearing prior to adoption of the "initially prepared" regional water plan. RWPGs are also required to comply with TWDB rules specifying how and to whom notice of public meetings and public hearings is to be provided.

As in the first cycle of regional water planning, the Rio Grande RWPG has gone well beyond minimum requirements set by the state for public participation, providing multiple opportunities for public input and for direct participation in the planning process and development of the draft plan. The group also intensified efforts in the second round of planning to ensure public involvement and participation in the process.

The Rio Grande RWPG has held regular meetings throughout the planning process, generally on a monthly basis. Each meeting has provided opportunity for public comment. As planning progressed, the opportunity for comment was moved from the end of the agenda to the beginning in order to better accommodate the needs of the public.

A variety of mechanisms have been used to publicize Rio Grande RWPG meetings, including notices to the media and postings to the Rio Grande RWPG's new website: *www.RioGrandeWaterPlan.org*. The website was developed in late 2003 as a resource for the public on issues of concern to regional water planning and information on the planning process.

A simple, easy-to-read trifold brochure about the region and the regional planning process was developed in August 2004 and has been distributed at a variety of forums and through direct mail. The brochure also directs readers to the website for additional, in-depth information.

Four newsletters have been published and distributed in the second round of regional water planning. A fifth newsletter will be produced after the plan is finalized and submitted to the TWDB.

Electronic versions of the summary newsletters were made available to all regional media as a way of promoting interest in the plan. Names on the mailing list for the newsletters were compiled from previous regional water planning efforts.

The Executive Summary of the plan is being translated into Spanish, and will be posted on the website.

The Rio Grande RWPG and its consultant team also actively solicited comment from local entities on the basic data used to develop the plan, including water infrastructure financing and draft population and water demand projections. In addition, presentations were made to a variety of groups with an interest in water planning, including water utility associations, citrus growers, and irrigation district boards of directors.

The Rio Grande RWPG provided extensive notice of and opportunity for public comment on the *Initially Prepared Plan*. A public hearing on the plan was held in Zapata, TX, on July 20, 2005. Additional presentations on the plan were made at public meetings throughout the region.

Facilitation

Facilitation of the regional water planning process for the Rio Grande Region has been provided by the staff of the Lower Rio Grande Valley Development Council (LRGVDC), with assistance from the consultant team. In addition to performing administrative duties relating to the management of State funds, the LRGVDC also made all arrangements for meetings of the Rio Grande RWPG, which included posting required meeting notices, preparing meeting agendas, and distributing agenda back-up materials to members of the RWPG. The LRGVDC tape-recorded all Rio Grande RWPG meetings and prepared the official meeting minutes. For non-voting Spanish-speaking members of the Rio Grande RWPG, an interpreter was provided at all RWPG meetings.

The consultant team also assisted in facilitating the planning process by providing presentations of technical information at RWPG meetings and assisting in identifying key water planning and policy issues.

Plan Implementation Issues

A number of key issues will affect whether this plan is successful in achieving its primary purpose of developing strategies for meeting the near and long-term water needs of the Rio Grande Region. Generally, the key issues relating to the implementation of this plan can be grouped into three categories:

- Issues and water management strategies that require additional in-depth evaluation. The recommendations presented in this regional water plan are based on a reconnaissance-level evaluation of projected water demands, water supply, needs, and various strategies for meeting future needs. Additional, more detailed feasibility-level planning will be necessary prior to implementing many of the recommended strategies. Also, in many cases, feasibility-level planning will need to be followed by engineering design and permitting activities. For the most part, the additional planning and project development activities required for strategy implementation will be the responsibility of local water suppliers (e.g., cities, water supply corporations, and irrigation districts). However, state and/or federal technical and financial assistance would greatly facilitate timely project development and implementation.

- Local buy-in and action to implement local water supply strategies. This regional water plan is best viewed as providing a framework for local action to implement strategies for meeting future water needs. The role of the Rio Grande RWPG is purely advisory. The RWPG has no authority to compel other entities to implement the actions recommended in this plan, nor does it have the authority or resources to undertake implementation activities on its own initiative. Rather, implementing strategies recommended for meeting future water needs is a primary responsibility of local water suppliers, which include cities, water supply corporations, other public water supply entities, and irrigation districts. With or without outside assistance, more detailed feasibility-level planning studies and engineering design is largely the responsibility of local water suppliers. Similarly, the costs of implementing water conservation and water supply strategies will be borne largely by the ratepayers served by local water suppliers. It is therefore essential that there be a strong commitment on the part of the governing bodies and management of local water suppliers to implement the strategies recommended in this plan.

- Funding for the implementation of plan recommendations. The availability of and access to funding for the implementation of recommended water management strategies is crucial. Most local water suppliers in the Rio Grande Region are governmental or quasi-governmental entities (e.g., water supply corporations) that have the authority to charge and collect taxes and/or fees for the services they provide. These entities also have the ability to borrow money to acquire additional water supplies and to develop and rehabilitate water-related infrastructure. For the most part, the direct costs for the services provided by these entities should be borne by the individual water users through taxes and/or fees for services. However, it should be recognized that there is also an appropriate role for the state and federal governments in financing water conservation, water supply development, and infrastructure projects. At present, there are a number of state and federal financial assistance programs for water-related infrastructure projects that are available to municipal water suppliers. However, there are few programs that provide financial assistance to irrigation districts for infrastructure improvements. Because agricultural water conservation is a central element of this regional water plan – and is essential to maintaining the viability of this sector of the regional economy – the Rio Grande RWPG recommends that new public funding sources be developed to assist irrigation districts with implementing conservation programs.

No interregional conflicts have been identified in the planning process or are contained in the plan.

RESUMEN EJECUTIVO

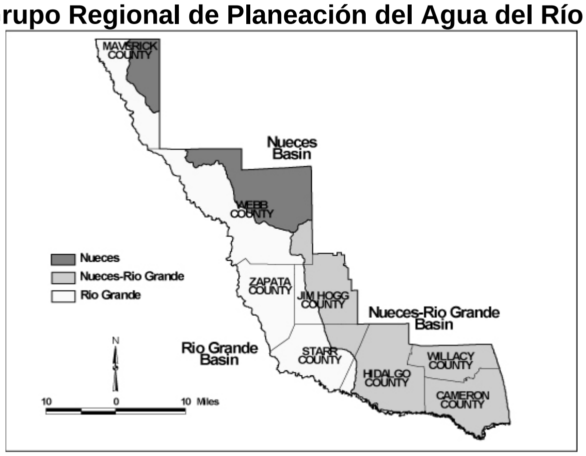
Introducción: Panorámica del Proceso de Planeación Regional para el agua

En 1997, la sesión número 75 de la Legislatura de Texas emanó el Acta número 1 del Senado o SB 1 (por sus siglas en inglés) normalmente referido como el Plan para el Manejo del Agua Brown-Lewis, ya que fueron estos últimos los que propusieron el acta en el Senado y en la Cámara de Diputados. La necesidad para esta legislación surgió a partir de la sequía que se acentuó desde principios y hasta la mitad de la década de 1990s; esto, aunado al gran interés del público sobre el incremento de la demanda del agua en el estado propiciaron la necesidad para emanar el acta. El Acta número 1 del Senado, cubre un gran número de asuntos que incluyen, entre otros, la participación del estado con los grupos de planeación regional y local sobre las medidas de conservación del agua, abastecimiento del agua, manejo del agua durante las sequías, programas de administración de los derechos sobre uso de agua, políticas de transferencia de agua entre cuencas, manejo del agua del subsuelo, comercialización del agua, búsqueda de asistencia estatal financiera para los proyectos relacionados con el agua y de programas estatales para la compilación de datos sobre el agua así como la diseminación de los mismos.

El SB 1 alteró radicalmente la manera en la cual los planes estatales sobre el agua eran preparados; la nueva iniciativa estableció un enfoque "de abajo hacia arriba" iniciándose en los grupos de planeación regional del Agua (RWPG por sus siglas en inglés) los cuales están conformados por 11 personas que representan a diferentes intereses y segmentos del área. Existen 16 grupos de planeación en el estado los cuales sirven sin fines de lucro. El proceso de planeación es coordinado por la Junta para el Desarrollo del Agua de Texas o TWDB el cual conjunta de los 16 planes regionales un solo plan general estatal para el agua.

La Región de Planeación para el Agua del Área del Río Grande (o Región del Río Grande) fue designada como la "Región M" por parte del TWDB. Esta región comprende de 8 condados adjuntos o cercanos a la parte media y baja del Río Grande. Estos condados son: Cameron, Hidalgo, Jim Hogg, Maverick, Starr, Webb, Willacy y Zapata.

Gráfica # 1: Área del Grupo Regional de Planeación del Agua del Río Grande



De acuerdo a lo especificado por el Acta SB 1 (véase gráfica # 2;) el Grupo de Planeación para el Agua del Río Grande (RWPG por sus siglas en inglés) ahora consiste de 19 miembros representando 11 categorías de grupos de intereses. Además de sus 11 miembros con derecho a voto, el RWPG del Río Grande también incluye a miembros con voz pero sin derecho a voto, y estos representan agencias estatales y al Gobierno Federal Mexicano.

Gráfica #2: Grupo Regional de Planeación del Agua del Río Grande

INTERÉS	NOMBRE	CONDADO REPRESENTADO
PÚBLICO	Mary Lou Campbell, Secretaria* Mercedes	Hidalgo
CONDADOS	Jose Aranda Juez de Condado	Maverick
	John Wood Regidor del Condado, Brownsville	Cameron
MUNICIPALIDADES	Roberto Gonzalez* Water Works, Eagle Pass	Maverick
	John Bruciak, Gerente General Brownsville PUB	Cameron
	Adrian Montemayor Water Utilities, Laredo	Webb
MANUFACTURAS	Gary Whittington Unifirst Linen Service, Harlingen	Cameron
AGRICULTURA	Robert E. Fulbright* Hinnant & Fulbright, Hebbronville	Jim Hogg
	Ray Prewett Texas Citrus Mutual, Mission	Hidalgo
MEDIO AMBIENTE	Karen Chapman Environmental Defense, Brownsville	Cameron
PEQUEÑOS NEGOCIOS	Donald K. Mcghee Hydro Systems, Inc., Harlingen	Cameron
	Xavier Villarreal T&J Office Supply, Zapata	Zapata
INDUSTRIA ELECTRICA	Kathleen Garrett Sempra Texas Services, LP/Topaz Power Group	Cameron, Hidalgo, Webb
AUTORIDAES DEL RÍO	James Darling Rio Grande Regional Water Authority	Hidalgo
DISTRITOS DE RIEGO	Sonny Hinojosa HCID No. 2, San Juan	Hidalgo
	Sonia Kaniger CCID No. 2, San Benito	Cameron
DISTRIBUIDORAS *(JUNTAS)* DE AGUA	Charles Browning, Vice-Chair* North Alamo WSC, Edinburg	Hidalgo
OTROS	Glenn Jarvis, Chair* Abogado, McAllen	Hidalgo
	James Matz Alcalde, Palm Valley	Cameron

La primera etapa de la planeación regional sobre el agua culminó en el 2002. La segunda etapa de planeación empezó al final de ese mismo año. Este plan representa los resultados de la culminación de la segunda etapa de planeación. En esta segunda etapa, el RWPG enmendó el plan original al incluir la desalinización del agua salobre como una recomendación dentro de la estrategia sobre el manejo del agua así como se incluyeron también una actualización sobre las proyecciones del crecimiento poblacional y la demanda del agua; incorporó nuevos datos proporcionados por el modelo (computarizado) de disponibilidad del agua del Río Grande dentro de la estrategia del abastecimiento del agua y analizó estrategias adicionales sobre el manejo del agua.

Puntos Importantes del Plan Regional 2006 para el Río Grande

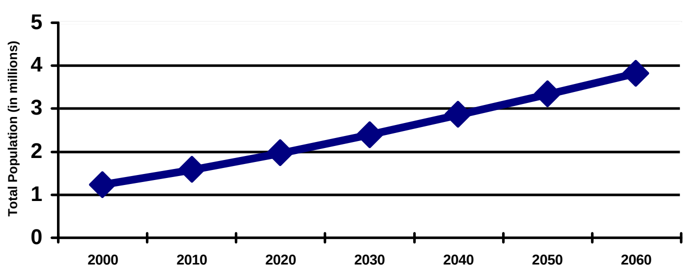
La región del Río Grande encara necesidades significantes para los próximos 50 años. El crecimiento poblacional junto con una infraestructura decadente del sistema de riego se combinarán para producir un déficit de cerca de 600,000 acres-pié de agua para el año 2060 a menos que se implementen estrategias específicas sobre el abastecimiento y manejo del agua. Se necesitará una conciencia total y acciones concretas por los grupos locales para implementar ciertas estrategias sobre el abastecimiento del agua; para muchas otras, las fuentes de financiamiento tendrán que ser identificadas mientras que algunas otras requieren evaluaciones adicionales aún más profundas.

Lo que es claro, sin embargo, es que la mejora de los sistemas de los distritos de riego que transportan agua del Río Grande hacia los cultivos y hacia las municipalidades es la forma más económica para extender las reservas limitadas de agua de una manera suficiente para cumplir con las necesidades identificadas.

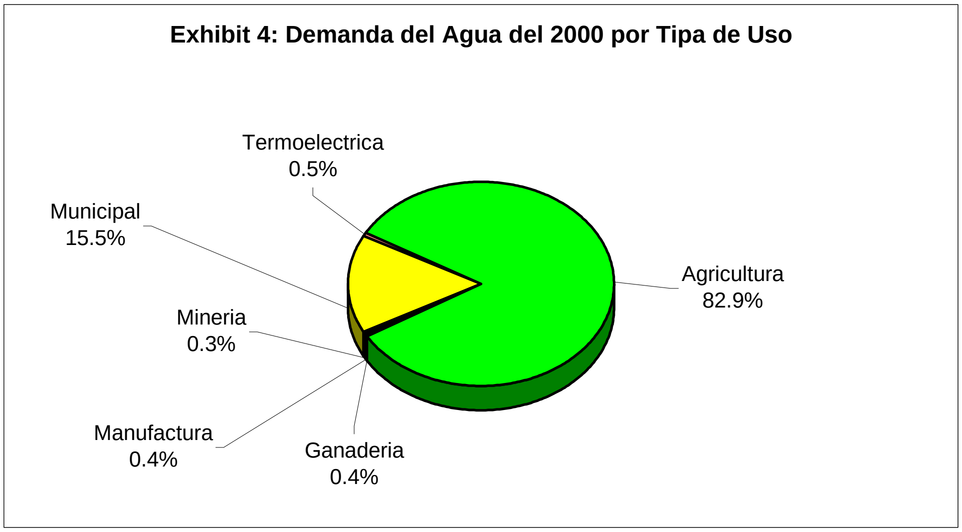
Crecimiento poblacional y demanda del agua

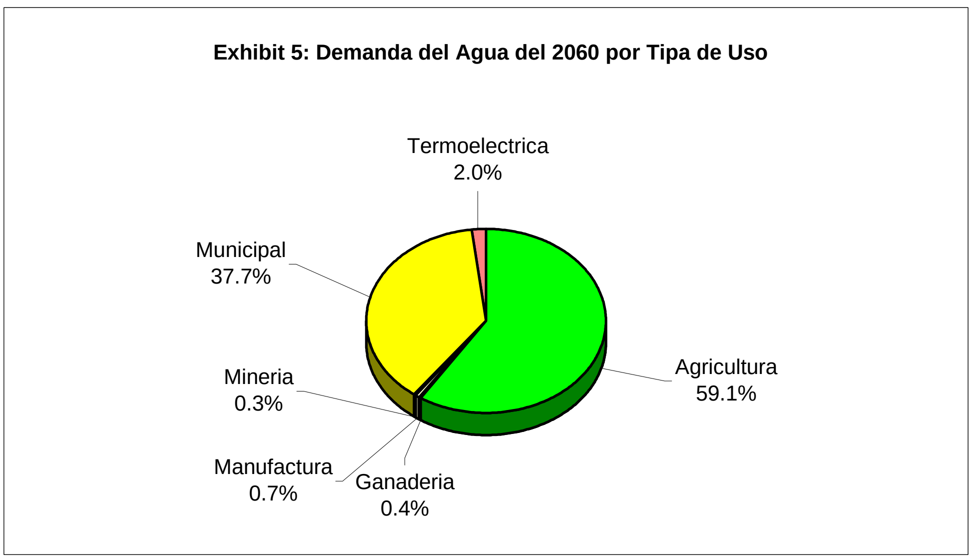
La población de la región del Río Grande de duplicó más del doble en el período de 1950 al 2000, incrementándose de casi 399,000 a más de 1.2 millones de pobladores. Para el año 2060, la población de los ocho condados se proyecta que crecerá a más del triple sobrepasando los 3.8 millones de personas.

Gráfica #3: Crecimiento poblacional proyectado para el Área del Grupo Regional de Planeación del Agua del Río Grande



Ese crecimiento poblacional agravará el aumento de la demanda de agua para propósitos municipales: agua potable, higiene, riego de jardines y patios, uso recreacional, etc. La demanda del agua municipal, hoy en cerca de los 230,000 acres pies por año (AF/yr por sus siglas en inglés) aumentará a casi 626,000 acres pies por año. (Un acre pie de agua equivale a 325,581 galones, es decir cerca de 1,232,324.09 litros.) Simultáneamente, se proyecta que la demanda de agua para el riego disminuirá de acuerdo al cambio del uso de la tierra de agricultura a urbana (véase Gráfica #4)





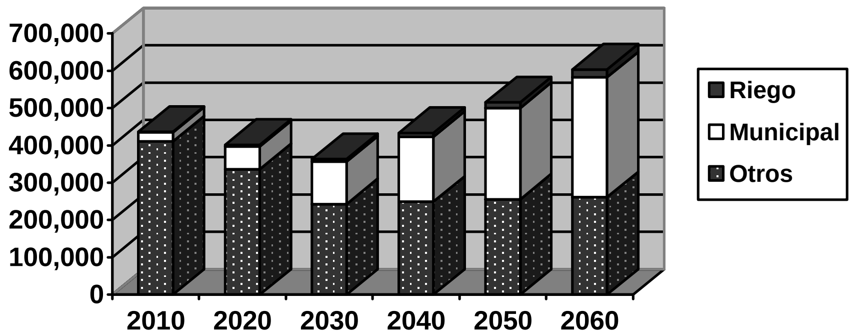
Necesidades del abastecimiento del Agua

La gran mayoría del agua disponible para la región – más del 94 por ciento- proviene de las reservas almacenadas en las Presas Falcón y en la Amistad. Pero debido a la sedimentación en las presas, la cantidad de agua disponible de estos sistemas se proyecta que se reducirá de 1.12 millones de AF/yr en el 2010 a cerca de 1.08 millones de AF/yr para el 2060. Además, el abastecimiento del agua de estos sistemas en temporada de sequía severa se reduce a cerca de 1 millón de AF/yr.

Los análisis conducidos por el RWPG del Río Grande demuestran que la región en general encara necesidades significantes del abastecimiento del agua aunque algunos de los grupos de usuarios tuviesen cantidades de agua excedentes.

El faltante de abasto para las municipalidades se proyecta que aumentará a más de trece veces del 2010 al 2060 (véase Gráfica #6).

Gráfica #6: Déficit de abastecimiento del agua para la Región del Río Grande (acres-pies de agua por año)



El proceso de planeación regional identificó 48 grupos de usuarios o WUGs (por sus siglas en inglés) que necesitarán abastecimientos adicionales de agua dentro del panorama de los 50 años. La gran mayoría de esos grupos con necesidades adicionales, 29 de esos 50 grupos de usuarios, son municipalidades urbanas. La lista también incluye a 10 grupos rurales municipales, 6 grupos de riego, 2 termoeléctricas y 1 grupo manufacturero.

La TWDB ha estimado que el gran número de necesidades del agua pudiese tener impactos socioeconómicos de consideración en la región para el año 2060. Se estima en más de 2 mil millones de pérdidas por concepto de ventas, 2 mil millones de pérdidas en ingreso, más de 26,000 desempleados y más de $75 millones de pérdidas por concepto de impuestos.

Estrategias para cumplir con las necesidades del agua.

Los análisis efectuados por el RWPG del Río Grande encontraron que las mejoras en los sistemas para el transporte (o acarreo)del agua por los distritos de riego así como medidas de conservación del agua en los campos de cultivo pueden producir significativos ahorros de agua a un costo relativamente económico.

Las mejoras en los sistemas para el transporte del agua pueden producir ahorros de más de 243,000 AF/yr – cerca de un 40% del déficit total del agua proyectada para el 2060 en el área de los 8 Condados y esto a un costo de anual de menos de $121/AF. Las medidas de conservación para el campo pueden producir ahorros anuales de más de 274,000 AF/yr a un costo anual de cerca de $253/AF.

Recomendaciones para las mejoras en los sistemas de transporte incluyen:

• instalación de compuertas a prueba de fugas;
• instalación adicional de aparatos medidores de agua ;
• la conversión de pequeños canales de concreto en mal estado al sistema de tubería;
• el revestimiento de canales chicos de tierra previamente excavados en terrenos porosos; y
• la implementación de los programas de verificación para monitorear y medir la eficiencia y efectividad de las mejoras.

Las tecnologías y métodos disponibles para la conservación del agua en el campo incluyen la tubería en plástico, sistemas de aplicación de baja energía; programación de riego usando la red de evapotranspiración, riego por goteo, medidores, precio unitario del agua así como la siembra de cultivos que requieran menos agua.

El ahorro del agua a través de estas medidas también puede ayudar a reducir el déficit de agua de las municipalidades. El RWPG del Río Grande identificó tres estrategias principales para cumplir con las necesidades proyectadas en las áreas doméstica, municipal e industrial o DMI (por sus siglas en inglés):

• optimizar el abasto del agua disponible del Río Grande;
• extender los programas de conservación del agua; y
• diversificar los abastos del agua para el uso de los DMI al desarrollar fuentes alternativas incluyendo reuso del agua o del reclamo del agua, extracción del agua del subsuelo y la desalinización.

El grupo de planeación o RWPG del Río Grande identificó 10 estrategias municipales para cumplir con la demanda del agua (vea la gráfica #7). La más económica es el implementar medidas avanzadas de conservación del agua, tales como artefactos de plomería de sellado instantáneo y promover jardines con plantas de bajo consumo de agua o xeriscapes. Los costos totales de todas las estrategias identificadas para el manejo del agua llegan cerca de los $235 millones.

Gráfica #7: Resumen de Estrategias sobre el Manejo del Agua

Demandas Municipales

Estrategia	Rendimiento, Acre-Pié (Adicional)	Costo por Acre-Pié (Anual)	Costo Total Anual
Conservación del agua (avanzada)	19,009	$ 112.47	$ 2,137,995
Extracción Agua del Subsuelo	29,824	$ 304.46	$ 9,080,215
Urbanización	15,245	$ 368.37	$ 5,615,801
Reuso del Agua no-Potable	30,841	$ 415.22	$ 12,805,800
Contrato de Derechos del Agua	4,577	$ 455.56	$ 2,085,053
Desalinización del Agua Salobre	69,832	$ 505.51	$ 35,300,774
Represa y reserva en Brownsville	20,643	$ 537.27	$ 11,090,865
Adquisición de Derechos de Agua del Río Grande	143,944	$ 542.74	$ 78,123,949
Re-uso del agua fines Potables	1,120	$ 705.89	$ 790,597
Desalinización del Agua del Mar	7,902	$ 767.63	$ 6,065,812
Total	342,937		$ 163,096,861

Demandas en el Riego

Mejoras a los sistemas de transporte del agua	218783	$ 120.68	$ 26,402,732.4
Conservación en el Campo	219226	$ 253.38	$ 55,547,483.9

La regla del estado requiere de los grupos de planeación a que reporten como las entidades afectadas se proponen pagar por las estrategias del manejo del agua El costo total de todas las municipalidades para implementar las Estrategias sobre el Manejo del Agua para compensar el déficit en el abastecimiento del agua es de $152 millones. Apoyándose en la información obtenida de las encuestas mencionadas, el 40% de los costos anuales serán proveídos por emisión de bonos, el 33% con programas federales, el 16% con programas estatales, el 8% con reservas en activos y el 3% con otros medios. El costo total anual para las Estrategias del Manejo del Agua para el riego es de $82 millones. Las medidas de conservación en el campo costarán $56 millones mientras que las mejoras en los sistemas de transporte y transferencia costarán $26 millones. Cerca del 40% de los costos en el campo serían financiados en el ámbito local, mientras que el resto tendría que provenir de fuentes externas. Cerca del 10% de las mejoras al sistema de transporte y transferencia del agua podría ser financiado localmente pero el 90% tendría que provenir de fuentes externas.

Asuntos adicionales y recomendaciones

Muchos de los asuntos y necesidades de la región surgen del hecho que el Río Grande es un río internacional cuyas aguas están compartidas por los Estados Unidos y por México. Ninguna otra región de planeación del estado tiene esta realidad Consecuentemente, las recomendaciones de acciones interpuestas por el RWPG del Río Grande y concernientes a resolver las necesidades regionales se dividen en dos categorías: algunas recomendaciones recaen en la autoridad del estado de Texas; mientras que otras recaen bajo el auspicio de la Comisión Internacional de Límites y Aguas o IBWC (por sus siglas en inglés) y/o en otras agencies federales e internacionales. Un resumen de las recomendaciones se presenta a continuación; las recomendaciones por entero se encuentran en el Capítulo 8.

Recomendaciones de materia Estatal:

- El estado de Texas debe de considerar otros factores y no solo el aspecto de la población, para el financiamiento del proceso de planeación en la Región M debido a las circunstancias únicas que afectan al abastecimiento del agua en esta área.

- El estado deberá de continuar financiando los proyectos de desalinización de agua salobre del subsuelo y de la demostración del proyecto de desalinización del agua del mar como una forma de proveer alternativas para el abastecimiento del agua para esta región.

- El estado deberá autorizar al Maestro Controlador del Agua para que maneje el agua por parte del WAM del Río Grande y debería otorgar el poder a la Comisión de Calidad Ambiental de Texas para recolectar cuotas de los derechohabientes al agua del Río Grande.

- El estado deberá de asistir en la búsqueda de nuevos recursos y técnicas para ayudar a combatir las malezas acuáticas incluyendo al pino salado para así ayudar a la región a proteger sus abastos de agua.

- El estado deberá de continuar proveyendo recursos financieros y técnicos para desarrollar el GAM regional.

- El Estado deberá enmendar el proceso de planeación para permitir tratar a cada distrito de riego ubicado dentro de la región como un grupo de usuarios del agua o WUG en lugar de ocupar la silla dentro de la categoría “Condado-Otros” para poder así desarrollar estrategias individuales sobre el manejo del agua para los distritos.

- La Comisión de Calidad Ambiental de Texas deberá de proveer asistencia al RWPG del Río Grande durante la revisión de sus reglas concerniente a la conversión de los derechos sobre el agua de un uso especificado a otro y, si es necesario, considerar enmendar los reglamentos apropiados a la material.

- A las entidades y agencias de la región se les solicita a cooperar para resolver los asuntos del agua en forma parecida a la seguida por las compañías de agua y aguas residuales.

- Se recomienda la formación de distritos de conservación del agua del subsuelo como una forma de protección de dichos abastos de agua.

- El Estado deberá de apropiar fondos suficientes para la Comisión de Ferrocarriles de Texas que permitan cubrir las norias de gas y petróleo abandonadas ya que estas están amenazando a los abastos de agua del subsuelo

- La Legislatura de Texas deberá de proveer asistencia técnica y financiera para implementar estrategias sobre el manejo del agua identificadas en los planes regionales.

- La Legislatura de Texas deberá apropiar fondos presupuestarios para continuar el proceso de la planeación regional del agua.

- La Legislatura de Texas deberá de apropiar fondos presupuestarios para la Junta para el Desarrollo del Agua de Texas o TWDB para implementar y proveer de asistencia a los grupos de usuarios del agua en el desarrollo e implementación de las Medidas Avanzadas para la Conservación del Agua, incluyendo programas de educación y de diseminación al público.

Recomendaciones sobre los asuntos Nacionales e Internacionales

- La Comisión Internacional de Límites y Aguas (IBWC) deberá renovar sus esfuerzos para asegurar que México se adhiera a la Minuta o Acta 309 y establezca los mecanismos para el pleno cumplimiento del Tratado de 1944.

- Los Estados Unidos y México deberán de reforzar los poderes y tareas de ambas secciones del IBWC.

- Los proyectos de conservación del Acta o Minuta 309 financiados por el Banco de Desarrollo de Norteamérica (NADBank) y otros proyectos financiados por agencias nacionales y/o internacionales dedicados a modernizar y mejorar las instalaciones de los distritos de riego de la cuenca del Río Grande, se les deberá de dar prioridad y deberán ser apoyados.

- Los proyectos de conservación para el riego actualmente en proceso a través del Buró de Reclamación para la mejora de los distritos de riego de la cuenca del Río Grande en el lado estadounidense deberán ser apoyados e implementados.

- Para esclarecer el asunto, el IBWC deberá aprobar una Acta o Minuta esclareciendo la definición de “sequía extraordinaria.”

- La contabilidad del agua entre los Estados Unidos y México de acuerdo a lo estipulado en el Tratado de 1944 deberá ser consistente a lo acordado en la Convención de 1906.

- Para un mejor manejo en la parte baja del Río Grande, río abajo de la Presa Anzaldúas, ambos países deberán de reafirmar las políticas operacionales para que

México continúe tomando la parte de agua que le corresponde a través de su canal de desviación desde la Presa Anzaldúas.

- El IBWC deberá de convocar una reunión binacional con los grupos de planeación así como de los grupos de usuarios de ambos países dentro de seis meses a partir del término del conteo anual del agua cuando de detecte un déficit anual de aflujos desde las tributarias Mexicanas nombradas en el Tratado de 1944.

- El IBWC deberá restituir el Río Grande abajo del Fuerte Quitman en Texas.

- El IBWC deberá asumir toda la responsabilidad financiera local y regional retener y mantener el dren de El Morillo.

- El IBWC deberá de coordinar esfuerzos binacionales para revisar y evaluar las fuentes existentes de datos concerniente al desarrollo del agua del subsuelo en ambos países dentro de la cuenca del Río Grande desde corriente abajo del Fuerte Quitman hasta el Golfo de México.

- La planeación regional de las fuentes tributarias deberá ser promovida en ambos lados del Río Grande en el área que colinda con su cuenca.

- Se deberá de fomentar áreas interestatales consolidadas entre los estados afectados en México.

Resumen del capítulo

Lo siguiente provee una sinopsis de cada capítulo del Resumen Ejecutivo.

- El capítulo 1 presenta una descripción del área de planeación del agua regional. Esto incluye información concerniente a los usos actuales del agua y los centros más grandes que demandan el agua; fuentes del abastecimiento del agua de superficie y del subsuelo; recursos naturales y de agricultura y de las características demográficas y socioeconómicas de la región. Incluye también los resúmenes de los planes del agua regionales, recomendaciones del actual plan estatal del agua, y los planes locales elaborados, así como una evaluación de las amenazas a la agricultura y a los recursos naturales.

- El capítulo 2 denota las demandas del agua actuales y sus proyecciones. Esta información es reportada por ciudad y condado de acuerdo a su porción por cada segmento del río dentro de esta región del Río Grande. Las proyecciones para la demanda del agua son presentadas para cada una de las seis categorías de uso: municipal, manufacturera, de riego, generación de energía termoeléctrica, minería y ganadería.

- El capítulo 3 provee un análisis total del abastecimiento del agua en la región.

- El capítulo 4 identifica y evalúa estrategias seleccionadas para el manejo del agua basado en las necesidades.

- El capítulo 5 analiza los impactos de las estrategias para el manejo del agua en parámetros clave de calidad del agua y analiza los impactos del movimiento del agua desde áreas rurales y de agricultura.

- El capítulo 6 describe las recomendaciones consolidadas del plan regional acerca de la conservación del agua y las recomendaciones para su manejo durante las sequías.

- El capítulo 7 describe la consistencia del plan con la protección a largo plazo de los recursos del agua estatal, recursos agrícolas y recursos naturales.

- El capítulo 8 presenta las recomendaciones de los segmentos únicos del río, sitio de su reserva y opciones legislativas.

- El capítulo 9 provee recomendaciones a la legislatura concerniente a los fondos destinados para la infraestructura necesaria para el agua.

- El capítulo 10 describe la participación pública, facilitación y planes de implementación.

Descripción Física de la Región del Río Grande

El clima de la región del Río Grande varia de un régimen subtropical húmedo en su porción del Este a un régimen tropical a subtropical en la otra porción. El viento prevalece del Sureste durante el año y el aire cálido del Golfo de México produce unos veranos calientes y húmedos con una temporada de invierno relativamente leve y seca.

El promedio anual neto de evaporación de agua en la Región del Río Grande varía de 40 a 44 pulgadas en la costa hasta aproximadamente 60 a 64 pulgadas en la porción central de la región cerca del Sureste del Condado de Webb. La cantidad de precipitación pluvial varía en la parte baja de la Región del Río Grande de un promedio de 28 pulgadas en la costa a 18 pulgadas en la porción Noroeste de la región. La mayor precipitación ocurre durante la primavera de Abril a Junio, y al final del verano entre Agosto a Octubre.

La Región del Río Grande está ubicada dentro de la planicie del Golfo en la costa Oeste de los Estados Unidos, con una pequeña elevación sobre el nivel del mar y con una relieve topográfico muy pobre. La topografía de la región varia desde un relieve laminado cilíndrico a un ondulado en la parte Noroeste convirtiéndose en un relieve progresivamente plano cerca de la costa del Golfo. El Río Grande fluye hacia el sureste a través de la región virando hacia el Este con su desembocadura en el Golfo de México.

En general, el terreno calcáreo de la Región del Río Grande consiste generalmente de barro calizo, arcilla margosa y de arena arcillosa.

El bajo Valle del Río Grande es el limítrofe del Norte de mucha de la flora y fauna de México. Un número de especias de plantas y de animales de las áreas desérticas y semidesérticas del Oeste y del Noreste de la región convergen en el área.

La parte baja de la Laguna madre es una bahía hipersalina la cual yace en las porciones del Este de los Condados de Cameron y de Willacy. Se caracterizan por su poca profundidad, con grandes extensiones hierba marina, zargazo y bancos de arena. La parte baja de la Laguna Madre provee los nutrientes a una amplia variedad de organismos marinos y de vida silvestre.

Intereses públicos y privados han creado varios refugios y áreas de reserva en el Bajo Valle del Río Grande para proteger la vegetación y hábitat de especies en peligro y especies en peligro de extinción. Estos incluyen el Refugio-Corredor Nacional de Vida Silvestre del Bajo Valle del Río Grande, Refugio Nacional de Vida Silvestre de Laguna Atascosa (NWR) Santa Ana NWR, Parque del Condado en Anzaldúas, Parque Estatal Falcón (SP) Bentsen-Río Grande Valley SP, Boca Chica SP, Las Palomas Área de Manejo de Vida Silvestre (WMA), Arroyo Colorado WMA, Sabal Palm Audubon Centro y Santuario, La Conservación y Preserva Natural de Maderas de Chihuahua, y la Reserva Costera de SouthBay.

Características Demográficas y Socioeconómicas de la Región del Río Grande

La región fronteriza del Sur de Texas ha tenido un crecimiento significativo en los pasados 30 años. El producto regional en bruto en esta región se cuadruplicó de 5.3 mil millones en 1970 a $20.3 mil millones en el 2000, con un crecimiento anual del 4.6 porciento. Durante el mismo período, el empleo en la región creció a una tasa del 3.2 porciento comparado al 2.0 porciento del crecimiento estatal. En el 2000, la región representó el 6.7 por ciento de la población en el estado y un 4.4 porciento en empleos.

Gráfica # 8: Condados elegibles para asistencia por el EDAP en la Región del Río Grande

Condados	Promedio de tasa de desempleo 2001-2003 (%)	Porciento por arriba de la tasa estatal	Promedio de ingreso Per Capita 2000-2002 ($)	Porciento por debajo de la tasa estatal
Texas Average	6.0	n/a	28,765	n/a
Cameron	10.1	69.2	15,519	-46.0
Hidalgo	13.3	122.1	14,208	-50.6
Maverick	23.6	293.7	12,002	-58.3
Starr	19.3	221.6	10,013	-65.2
Webb	7.2	20.6	15,890	-44.8
Willacy	17.0	183.5	14,423	-49.9
Zapata	7.9	31.3	12,988	-54.8

El TWDB ha clasificado a siete de los ocho condados de la Región del Río Grande como elegibles para recibir asistencia dentro del Programa de Asistencia para los Económicamente en Desastre o EDAP (por sus siglas en inglés.) La elegibilidad para el EDAP está limitada para los condados con un desempleo mayor del 25 por ciento del promedio estatal sobre un período mayor de tres años y con un ingreso per cápita de un

25 porciento por debajo de los promedios estatales. El nivel de ingreso per cápita es de $21,573.75; y el nivel de desempleo es de un 7.5 porciento.

Población Actual y Proyectada y de Demanda del Agua para la Región del Río Grande

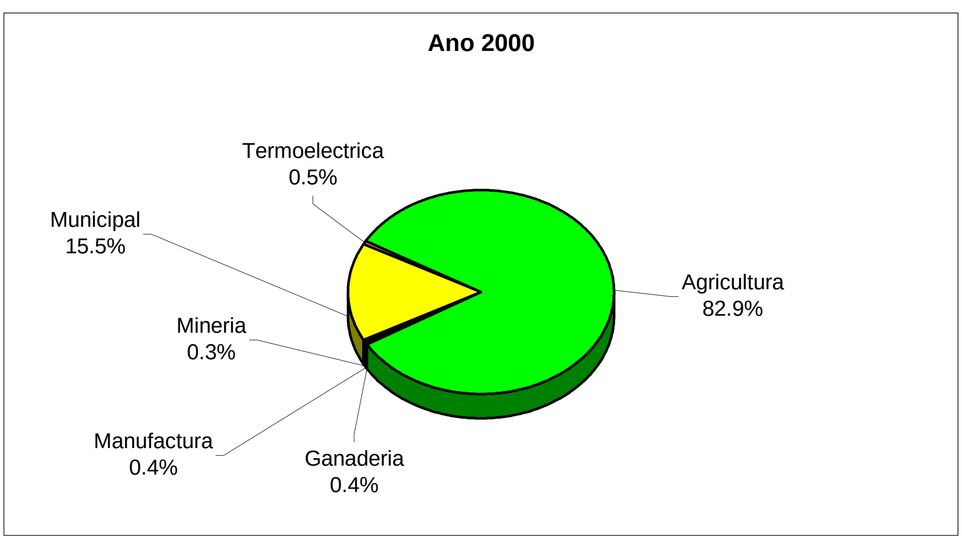
El TWDB proyecta que la población de los ocho Condados que suman el Área del Grupo de Planeación para el Agua del Río Grande será a más del triple del 2000 al 2060.

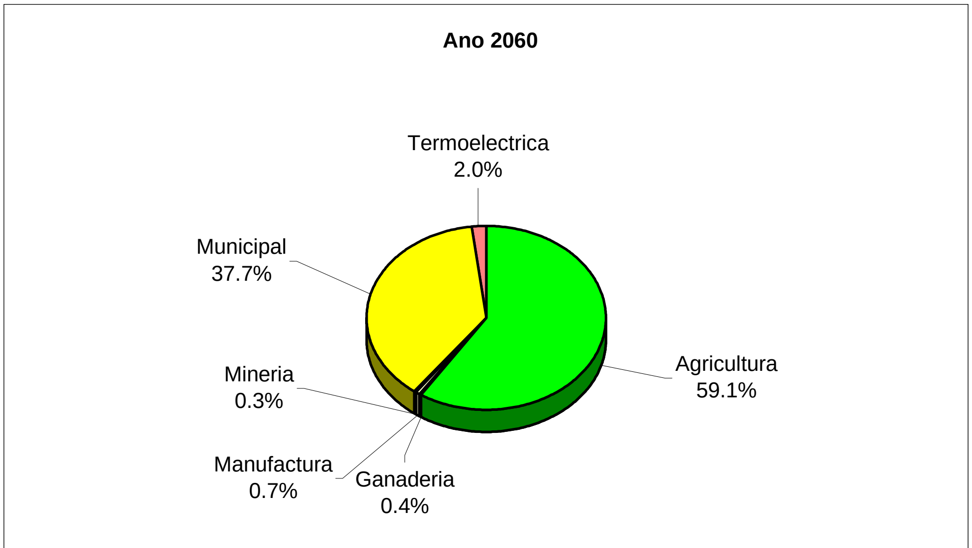
Gráfica #9: Proyecciones de Población por Condado

CONDADO	2000	2010	2020	2030	2040	2050	2060
Cameron	335,227	415,136	499,618	586,944	673,996	761,073	843,894
Hidalgo	569,463	744,258	948,488	1,177,243	1,424,767	1,695,114	1,972,453
Jim Hogg	5,281	5,593	5,985	6,286	6,538	6,468	6,225
Maverick	47,297	55,892	64,984	73,581	81,032	87,850	93,381
Starr	53,597	66,137	79,538	93,338	107,249	120,959	134,115
Webb	193,117	257,647	333,451	418,332	511,710	613,774	721,586
Willacy	20,082	22,519	24,907	27,084	28,835	30,026	30,614
Zapata	12,182	14,025	16,217	18,415	20,486	22,354	23,733
TOTALES	**1,236,246**	**1,581,207**	**1,973,188**	**2,401,223**	**2,854,613**	**3,337,618**	**3,826,001**

La demanda total anual de agua apara la región está proyectada *hacia el alza* hasta el 2010, después de observa un *descenso* hasta el 2030 para así continuar *una alza más* hasta el 2060. Esta tendencia se atribuye a una disminución de los campos de agricultura mientras que las ciudades crecen, especialmente en le Valle del Río Grande donde el uso de tierras está cambiando de agricultura a uso urbano. La demanda del agua para el riego en la región se proyecta una reducción de la cifra actual de 82.9% a un 59.1% para el 2060. Durante este mismo período, es proyectado que la demanda del agua para uso municipal aumentará de un 16% a un 38%.

Gráfica #10: Demanda Total del Agua por tipo de uso, 2000 y 2060





Gráfica #11: Proyecciones de la Demanda del Agua (AF/YR = *acres-pies por año*)

Proyecciones de la Demanda d	2000	2010	2020	2030	2040	2050	2060
Riego (AF/YR)	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749
Ganadería (AF/YR)	5,817	5,817	5,817	5,817	5,817	5,817	5,817
Manufactura (AF/YR)	6,208	7,509	8,274	8,966	9,654	10,256	11,059
Minería (AF/YR)	3,869	4,186	4,341	4,433	4,523	4,612	4,692
Municipal (AF/YR)	226,536	279,633	338,716	403,511	472,632	547,747	625,743
Termoeléctrica (AF/YR)	6,780	13,463	16,864	19,716	23,192	27,430	32,598
Demanda Total del Agua (AF/YR)	1,458,857	1,474,241	1,456,243	1,424,192	1,497,567	1,577,611	1,661,658

Evaluación Adecuada del Actual Abastecimiento de Agua

Abastecimiento Actual del Río Grande

La Región del Río Grande en Texas cubre tres porciones de cuencas: Río Grande, Nueces-Costa del Río Grande. Sin embargo, prácticamente toda el agua de superficie disponible para su uso se deriva del Río Grande. Casi todo el abasto de agua de superficie es una combinación de las Presas Internacionales de la Falcón y la Amistad, las cuales son las dos reservas mayores con la que cuenta. La mayoría de la afluencia de agua a estas presas proviene del Río Conchos en el Estado Mexicano de Chihuahua y del Río Pecos en Texas. Se calcula que el influjo firme al sistema de reservas (por ejemplo la cantidad de agua disponible en sequía severa) para los Estados Unidos fue de aproximadamente 1.01 millones de acre-pies por año.

Esto representa más del 94 porciento de la cantidad total de agua actualmente disponible para la región de todas sus Fuentes (subsuelo, por reuso, procedente de las tributarias del Río Grande, y otras Fuentes locales.) Sin embargo, a través del tiempo la cantidad total de agua disponible del Río Grande disminuirá considerablemente y esto por consecuencia de una baja en el almacenamiento de conservación debido al problema de la sedimentación en las Presas Falcón y Amistad. Entre los años 2010-2060, el influjo al sistema de Presas está proyectado a que se reduzca por casi 32,500 acres-pies (aproximadamente 3 porciento.)

Debido a la manera por la cual el abasto del agua de las Presas Falcón y Amistad es manejado y proporcionado, el impacto directo en la reducción del abasto será para los usuarios en las áreas del riego y de la minería. Bajo el sistema de los derechos para el agua para el centro y parte baja del Río Grande, los usuarios de las doméstica, municipal e industriales o DMI (por sus siglas en inglés) tienen prioridad. La reserva para los DMI de 225,000 acres-pies es mantenida continuamente en el sistema de Presas. En comparación, los derechos de la agricultura y de la minería se consideran secundarios para los sistemas de reserva del agua.

Una preocupación adicional involucra la porción de Presas / embalses en las tributarias Mexicanas que fluyen al Sistema de Presas Falcón/Amistad. México ha construido una serie de sistemas de reserva en esas afluentes tributarias, especialmente el de la cuenca del Río Conchos La capacidad del almacenamiento de agua combinado en las Presas Mexicanas construidas sobre las fuentes tributarias de las Presas Falcón y Amistad es 2.5 veces más grandes que la parte del agua que le corresponde a ese país. Esto trae serias implicaciones en las declaraciones de México en las que dice que opera estos sistemas de reserva para capturar el agua necesaria para sus propias demandas internas pero no para cumplir con sus obligaciones estipuladas en el Tratado de 1944.

Recientemente México ha pagado su muy atrasado déficit en exceso de 1 millón de acres pie con respecto a las cantidades mínimas de influjo de las tributarias al Río Grande especificados en el Tratado de 1944. Esta situación propicia la inseguridad para los usuarios de Texas de la disponibilidad futura del agua en el Río Grande.

Otras fuentes de agua para la región incluyen:

- El Arroyo Colorado, el cual atraviesa a los Condados de Willacy e Hidalgo y representa el Segundo potencial para el abasto de agua. El uso del agua del Arroyo Colorado para propósitos municipales, industriales o de riego esta severamente limitado por su poca calidad; su flujo diario esta conformado principalmente por los retornos de los flujos de la agricultura y municipalidades así como los escurrimientos locales. Sin embargo, el Arroyo Colorado es una importante fuente de agua dulce para la Laguna Madre, lo cual es igualmente importante tanto económicamente como ecológicamente para la región.

- El agua del subsuelo (freática) proviene principalmente del acuífero de la Costa del Golfo. La mayoría del agua freática en la región es de muy pobre calidad y no puede ser usada por la agricultura o las municipalidades sin un tratamiento efectivo. Los avances en la tecnología está permitiendo bajar los costos de desalinización del agua salobre del subsuelo, y esta fuente ha llegado a ser la opción por parte de las municipalidades para cumplir con la demanda en temporada pico.
- Reuso o “agua reclamada,” la cual provee de cerca de 13,000 acre-pie por año (uno porciento) para el riego, manufactura o para el uso de generar

La gráfica #12 provee un resumen de la cantidad total de agua actual disponible para la Región del Río Grande por categoría de uso hasta la década del 2050.

Gráfica #12: Abastos de agua actual y proyectada para la Región del Río Grande ***(en acres-pies por año)***

Categoria por Uso del Agua	2010	2020	2030	2040	2050	2060
Riego	752,995	746,006	739,518	733,030	726,541	720,552
Municipal	321,969	321,495	321,559	321,470	320,653	320,551
Termoelectrica	16,216	16,216	16,216	16,216	16,216	16,216
Ganaderia	5,816	5,816	5,816	5,816	5,816	5,816
Manufacturera	6,549	6,552	6,555	6,558	6,560	6,563
Mineria	4,941	5,087	5,168	5,248	5,329	5,398
Total para la Region	1,108,486	1,101,172	1,094,832	1,088,338	1,081,115	1,075,096

Identificación, Evaluación, y Selección de las Estrategias para el Manejo del Agua de Acuerdo a las Necesidades

La región del Río Grande encara significantes necesidades futuras para el abasto del agua aunque algunos excedentes de agua existan para algunas categorías de usuarios en algunos Condados. En general y de acuerdo a las proyecciones dentro de la planeación, aumentarán el déficit de agua en las áreas de las municipalidades, manufactura y en el área de generación de energía eléctrica; mientras que en el área de la agricultura los déficit actuales disminuirán debido a la urbanización. Una "necesidad" de abasto del agua surge cuando la demanda del agua es mayor que el abasto en las presas, produciendo así un déficit o faltante. Por la otra parte, el abasto en "exceso" de la demanda resulta en un excedente del abastecimiento de agua por un usuario.

Gráfica #13: Necesidades del abasto del agua para la Región del Río Grande por categoría de usuario (Acres-pies por año)

Categoría de uso	2010	2020	2030	2040	2050	2060
Municipal	23,936	61,064	113,978	174,120	245,148	321,248
Manufactura	1,921	2,355	2,748	3,137	3,729	4,524
Riego	410,637	336,224	242,442	248,903	255,366	261,330
Termoeléctrica	0	1,980	4,374	7,291	11,214	16,382
Minería	0	0	0	0	0	0
Ganadería	1	1	1	1	1	1
TOTAL de necesidades del agua	**436,494**	**401,623**	**363,542**	**433,451**	**515,457**	**603,484**

Gráfica #14: Excedentes de agua en la Región del Río Grande por categoría de uso (Acres-pie por año)

Categoría de uso	2010	2020	2030	2040	2050	2060
Municipal	66,272	43,847	32,027	22,960	18,355	16,059
Manufacturero	962	634	338	42	34	29
Riego	0	0	212	185	158	133
Termoeléctrica	2,753	1,332	874	315	0	0
Minería	755	747	736	726	717	704
Ganadería	0	0	0	0	0	0
Total de excedente de agua	**70,742**	**46,560**	**34,187**	**24,228**	**19,264**	**16,925**

Las oportunidades de la Región del Río Grande para desarrollar fuentes de agua adicionales para uso municipal son limitadas por razón de sus características hidrológicas, económicas y limitaciones legales derivadas del Tratado de 1944 entre los Estados Unidos y México. Existen pocas oportunidades para aumentar los influjos del agua en el Río Grande. Sin embargo, una serie de estrategias para aumentar la cantidad de agua para las municipalidades ha sido examinada como parte de esta planeación. Estas incluyen medidas de conservación de vanguardia por las municipalidades, la represa y su almacenamiento de agua en Brownsville; optimizar el reuso del agua reclamada de superficie del Río Grande; desarrollo de infraestructura para la extracción del agua del subsuelo, desalinización del agua salobre y del mar y la adquisición de abastos adicionales en el Río Grande para uso doméstico, municipal e industrial (DMI)

Las medidas de conservación avanzadas están enfocadas a reducir la cantidad de uso de agua por persona, para así reducir la cantidad de demanda agua municipal. La compra de derechos del agua, la adquisición de derechos a largo plazo por contrato y la adquisición de derechos por el proceso de urbanización involucraría transferir los derechos del agua del Río Grande por los usuarios de la agricultura. Debido a que el agua para uso municipal tiene prioridad dentro de los sistemas Amistad/Falcón, el agua para el riego constantemente sufre recortes. De la misma forma, la transferencia o transporte del agua y mejoras en los campos son necesarias para reducir el impacto de los faltantes de agua para el riego. Las estrategias para el manejo del agua por las municipalidades no son efectivas en cuanto a su costo en comparación al uso para el riego.

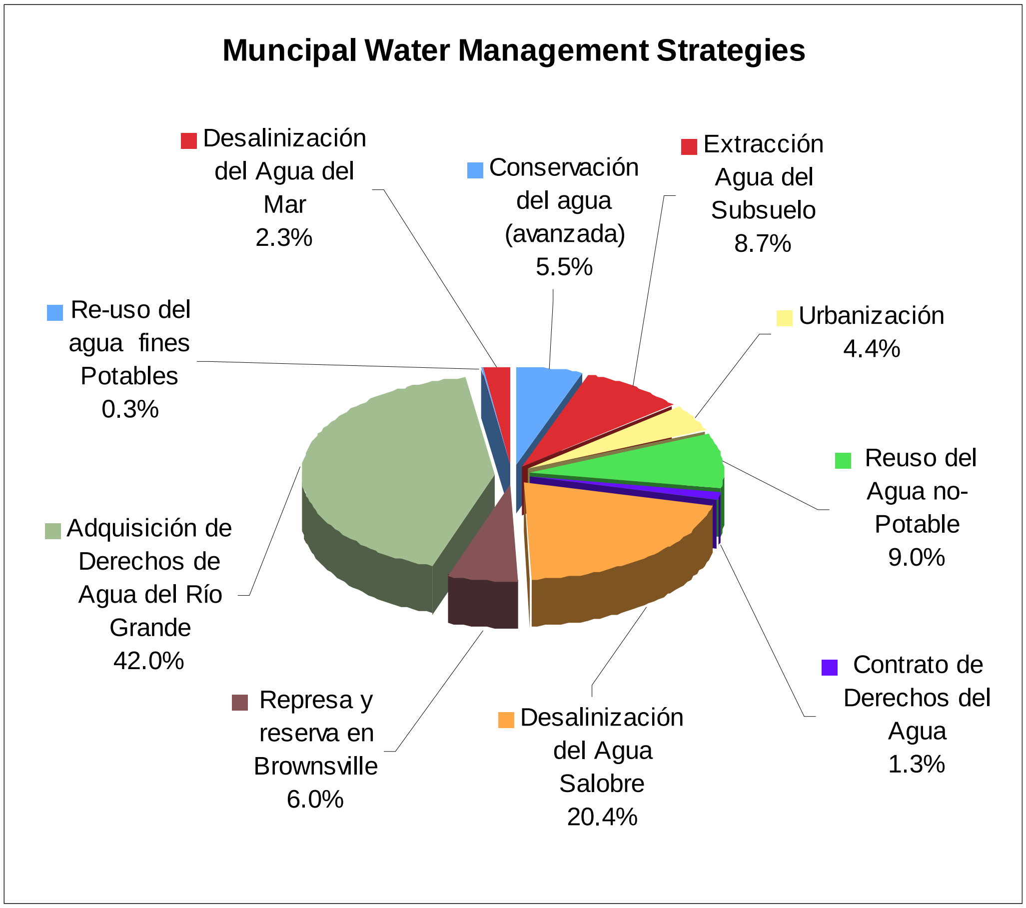
Dos estrategias para su manejo fueron evaluadas para conservar el agua y proveer de suplementos adicionales para su uso en el riego: mejoras en el campo y mejoras y eficiencia en los sistemas de transferencia, es decir el transporte del agua de un lugar al otro. Las tecnologías y métodos actualmente disponibles para la conservación del agua en el campo incluyen: tubería de plástico, aplicación del agua a precisión con baja energía, programación de riegos usando el sistema red de evapotranspiración, riego por goteo, precio unitario del agua y los cultivos de siembras hidro-eficientes. El propuesto programa eficiente de transferencia consiste de seis principales componentes: compuertas de sello instantáneo, represas con medidores adicionales, la conversión de pequeños canales de concreto en malas condiciones a canales entubados, el revestimiento de plástico de pequeños canales de tierra e implementar un programa de verificación para monitorear y medir la efectividad y eficiencia de las mejoras. Sin embargo, existen muy pocos programas que provean asistencia financiera a los distritos de riego para mejorar sus infraestructuras. Debido a que la conservación del agua para la agricultura es el elemento central de este plan regional para el agua – y es esencial para mantener la viabilidad de este sector dentro de la economía regional – el RWPG del Río Grande recomienda que sean implementadas y creadas fuentes de financiamiento dedicadas a ayudar a los Distritos de Riego con la implementación de estos programas de conservación. A continuación, se muestra el propuesto rendimiento del agua por costo por acre-pié con relación a cada una de las estrategias para el manejo del agua.

Gráfica #15: Resumen de Estrategias sobre el Manejo del Agua

Demandas Municipales

Estrategia	Rendimiento, Acre-Pié (Adicional)	Costo por Acre-Pié (Anual)	Costo Total Anual
Conservación del agua (avanzada)	19,009	$ 112.47	$ 2,137,995
Extracción Agua del Subsuelo	29,824	$ 304.46	$ 9,080,215
Urbanización	15,245	$ 368.37	$ 5,615,801
Reuso del Agua no-Potable	30,841	$ 415.22	$ 12,805,800
Contrato de Derechos del Agua	4,577	$ 455.56	$ 2,085,053
Desalinización del Agua Salobre	69,832	$ 505.51	$ 35,300,774
Represa y reserva en Brownsville	20,643	$ 537.27	$ 11,090,865
Adquisición de Derechos de Agua del Río Grande	143,944	$ 542.74	$ 78,123,949
Re-uso del agua fines Potables	1,120	$ 705.89	$ 790,597
Desalinización del Agua del Mar	7,902	$ 767.63	$ 6,065,812
Total	342,937		$ 163,096,861
Demandas en el Riego			
Mejoras a los sistemas de transporte del agua	218783	$ 120.68	$ 26,402,732.4
Conservación en el Campo	219226	$ 253.38	$ 55,547,483.9

Gráfica #16: Estrategia para el Manejo del Agua por Rendimiento Porcentual



Impactos Del WMS en Parámetros Clave de la Calidad del Agua y los Impactos para Mover el Agua de las Areas Rurales a la de Agrícultura

La siguiente tabla resume los impactos de los WMS (Estrategias para el Manejo del Agua) en la calidad del agua.

Gráfica #17: Impactos en la calidad del Agua por Estrategia de Manejo

WMS	Impactos Positivos	Impactos Negativos
Agua Freática adicional	**Disminución del sedimento/ escurrimientos de químicos agrícolas por las lluvias o riego excesivo**	**Aumento de flujos de aguas residuales a centros de captación (altos contenido de materia orgánica de municipalidades por evento pluvial**
Medidas de Conservación avanzadas	**Disminución de influjos de agua residual/aguas negras**	**Aumento de concentración de materia orgánica en las aguas negras**
Reuso no potable	**Reduce las afluentes de aguas residuales. Disminuye sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo;bajo impacto de niveles orgánico en centros de captación**	**Aumento de escurrimientos urbanos durante un evento pluvial**
Reuso Potable	**Reduce los influjos de aguas negras. Disminuye el sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo;bajo impacto de niveles orgánico en centros de captación.**	**Aumento de escurrimientos urbanos durante un evento pluvial**
Represa en Brownsville	**Disminuye el sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos en los flujos recibidores.**
Compra de Derechos para el Agua	**Disminuye el sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos en los flujos recibidores.**
Adquisición de Derechos para el Agua por Urbanización	**Disminuye el sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos en los flujos recibidores.**
Adquisición de Derechos para el Agua a largo Plazo-Contratos	**Disminuye el sedimento y/o escurrimiento de químicas agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos en los flujos recibidores.**
Desalinización del Agua Salobre del Subsuelo	**Mejora a la Calidad del Agua en el afluente de desagüe. Disminución de sedimento y/o escurrimientos de químicos agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos. Aumento en los niveles de TDS en los flujos recibidores por la concentración de descarga**
Desalinización del Agua del Mar	**Mejora a la Calidad del Agua en el afluente de desagüe. Disminución de sedimento y/o escurrimientos de químicos agrícolas por un evento pluvial o riego excesivo**	**Aumento de descargas urbanas durante un evento pluvial. Incremento de flujos residuales resultando en altos contenidos orgánicos. Aumento en los niveles de TDS en los flujos recibidores por la concentración de descarga**
Mejoras en la Transferencia	**Ninguna**	**Ninguna**
Mejoras en el campo	**Disminución de sedimento y/o escurrimiento de químicos agrícolas Debido a un aumento de manejo y de medida.**	**Ninguna**

Recomendaciones Sobre la Conservación Consolidada del Agua y su Manejo en Sequía

El Plan Regional para el Agua provee una guía para seleccionar las estrategias municipales para la conservación del agua, planes de conservación del agua en los Distritos de Riego y un plan modelo de conservación de la misma por grupo de usuarios.

El Grupo de Planeación de la Región del Río Grande ha incorporado dentro de su plan para el 2006 una serie de estrategias presentadas por el Grupo de Trabajo sobre la Implementación de Conservación del Agua en su publicación *Guía Práctica para el Mejor Manejo de Conservación del Agua* (Reporte 362 del TWDB de Nov 2004.) Las estrategias recomendadas incluyen:

- Conservación en campos de golf
- Medidores en todas las nuevas conexiones y el retroajuste en las conexiones existentes
- Sistemas anti-goteo en regaderas, aereadores y chapaletas para el sanitario
- Educación en la escuela
- Conservación durante la irrigación de jardines / parques
- Diseños de jardines de plantas de bajo consumo de agua
- Conservación en campos de atletismo
- Información pública
- Acopio del agua pluvial
- conservación en los parques
- programas de incentivos para las lavadoras caseras

El Plan Regional también incorpora opciones de alivio durante las sequías como lo ofrecido por el Departamento de Agricultura de los EEUU a través de la agencia del Servicio al Campo: Programa de Reserva, Programa de Pastura y Forraje, Prestamos al Campo, Prestamos a Agricultores, Programas de Incentivos de Calidad Ambiental, Programa de Asistencia para cosechas en desastre no aseguradas, Prestamos de Vivienda para Trabajadores del Campo, y por el Servicio de Conservación de Recursos Naturales.

El Plan regional para el Agua provee un modelo para la conservación del agua para la agricultura que sigue lo delineado por los reglamentos del TCEQ (Comisión de Calidad Ambiental de Texas) que gobiernan los planes de conservación de los sistemas públicos de abastecimiento. Estas reglas definen al plan de conservación como "una estrategia o combinación de estrategias para reducir la extracción de un volumen de agua de una fuente de abasto publica, para reducir la perdida del agua, para incrementar el reuso y reciclado de la misma y para prevenir la contaminación del agua."

El Plan Regional para el Agua también provee un plan de conservación del agua por grupo de usuario. De acuerdo a los reglamentos de TCEQ, los planes para la conservación del agua de los centros de abasto públicos deben de tener un perfil de utilidad, debe medirse de forma precisa, tener metas específicas, tener un sistema de medidor universal y ser de utilidad publica educativa. Debe tener un contenido adicional para los abastecedores de agua públicos que proyecte abastecer a 5,000 personas o más dentro de los próximos diez años, pudiendo tener un contenido adicional opcional.

Protección a Largo Plazo de los Recursos del Agua Estatal, Recursos Agrícolas y Recursos Naturales

Debido a que el Río Grande es la principal fuente para los usuarios del DMI y del riego, es un importante aspecto el de optimizar el abasto de agua disponible del río es un importante aspecto para proteger el agua estatal y los recursos de agricultura y naturales. Una estrategia clave es la de implementar prácticas de campo y el de rehabilitar los sistemas de riego para la conservación del agua.

Existe un gran potencial para el ahorro del agua en ambas áreas: 274,000 A\P (acres pié) en mejoras en el campo y 243,000 A\P a través de mejoras en el sistema de transportación o transferencia del agua. En un largo plazo, el total de ahorros en el agua con relación a ambas estrategias les permitirá a los irrigadores a nivelar el déficit en el abasto del agua. Sin embargo, las fechas para implementar estas estrategias no resuelven el problema inmediato.

Otro factor que impacta el área de la protección de este recurso es el cumplimiento de México con el Tratado de 1944. Aunque México ya pagó su deuda de agua, existe una duda razonable de su futuro cumplimiento en caso que la región encare otra sequía severa. Estudios hechos por la Universidad Texas A&M han demostrado que, durante el período de 1992 al 2002, el Bajo Valle del Río Bravo perdió cerca de mil millones de Dólares por la baja actividad económica y una pérdida de empleos de más de 30,000 como resultado directo de la falta de cumplimiento de México con sus obligaciones derivadas del Tratado.

Las necesidades ambientales de flujos son la parte frontal de todos los asuntos relacionados con la protección de los recursos naturales de Texas. Una posibilidad para mantener e incrementar los flujos ambientales es la adquisición de derechos del agua del Río Grande para uso ambiental a través del Fideicomiso del Agua de Texas. Estos derechos del agua podrían ser manejados para producir suficientes corrientes a través de la región. Sin embargo, esta opción no podría ser viable debido a la actual estructura de compra y transferencia de derechos del agua.

Debido a que la forma en que los WUGs (Grupos de Usuarios del Agua) están creados por la TWDB, no existe opción alguna para formalmente dedicar proyecciones de abastos de agua para uso ambiental. Alternativamente, flujos ambientales en el Río Grande pueden ser incluidos como un WUG separado en la próxima sesión regional de planeación para asegurar que se cumpla con lo necesario pero de manera consistente con los otros WUG's.

La cooperación internacional de México es críticamente necesaria para mantener los niveles de flujo. El Servicio de Peces y Vida Silvestre de los EEUU sostiene conversaciones con México concerniente a la introducción de peces Carpas Triploides al Río Grande. Y si los Estados Unidos quisieran implementar un programa de flujo ambiental sin la participación de México, el efecto deseado sería significantemente reducido.

Otro de los asuntos ambientales críticos de la región es el crecimiento de las plantas invasivas tales como el Jacinto acuático y la Hidrilla así como el crecimiento del pino salado y otras más. Desafortunadamente, los métodos de erradicación son física y económicamente estruendosos. El alta y bajo nivel de la elevación del agua en los ríos y corrientes de alguna manera parcialmente detiene a estas plantas al ahogar los nuevos brotes. Sin embargo, en las áreas de flujo mínimo, se crea el perfecto escenario para el crecimiento de estas plantas invasoras.

Los estuarios de Texas, donde las aguas dulces de tierra adentro se entremezclan con las aguas saladas del Golfo de México proveyendo una sorprendente abundancia de vida silvestre. Peces recién nacidos, camarón, jaibas se alimentan y refugian en las aguas salobres del estuario hasta que maduran lo suficiente para sobrevivir en el Golfo de México. Miles de aves residentes y migratorias descansan y se alimentan en sus ciénagas. De hecho, el 95 % de peces de importancia tanto para la pesca deportiva como la comercial se apoya en estos estuarios durante una parte de su ciclo de vida.

El Plan del 2006 de la Región M propone aproximadamente 343,000 acres-pies por año de nuevos abastos de agua de uso municipal. Toda esta cantidad, excepto 19,000 acre pies dedicados a la conservación avanzada del agua, puede tener algún efecto en los influjos hacia la parte baja de la Laguna madre o en la corriente del Río Grande. Cualquier alteración de los flujos del Río Grande está más allá del objetivo de la presente evaluación. No hay, presas o represas, canales de desvíos o estrategia alguna del Manejo del Agua que se hayan propuestos y que afecten el flujo del agua de la cuenca Nueces-Río Grande y sus escurrimientos del agua hacia la parte baja de la Laguna Madre. Sin embargo, muchas de las propuestas estrategias pueden afectar o influenciar el flujo del agua dulce por una posible descarga de aguas residuales resultado del abasto importado de la cuenca del RL Grande o del agua del subsuelo. Muchas de las municipalidades de la región yacen en las riberas de la cuenca del Río Grande y por consecuencia tendrán una alteración de las descargas de aguas residuales a las corrientes que se drenan a la Laguna madre.

Los resultados de los análisis efectuados por la federación Nacional de Vida Silvestre (National Wildlife Federation) no indican problema alguno para los influjos de agua dulce a la parte Baja de la Laguna Madre. No se afectarán las pulsaciones de caudal de flujo claves en la primavera y a principios del verano y que son necesarios para apoyar una productividad fuerte. Como tampoco se alterarán la habilidad de la cuenca Nueces-Río Grande de proveer flujos bajos durante una temporada de sequía. Obviamente, estos vienen a expensas de la cuenca adjunta del Río Grande. Un esfuerzo análogo para evaluar las necesidades de flujos y de los efectos en el plan de la Región M podrán ser considerados en el próximo ciclo de la planeación regional.

Segmentos Únicos de la Corriente/Sitios de Embalse/ Recomendaciones Legislativas

Las reglas del TWDB le permiten al RWPG a incluir en el plan regional del agua recomendaciones de la legislatura concerniente a las designaciones de aquellos segmentos ecológicamente únicos, sitios para el desarrollo de futuros depósitos para el agua y asuntos de políticas. El RWPG del Río Grande decidió considerar recomendaciones en cada una de estas áreas.

Segmentos Ecológicamente Únicos del Río

La ley estatal prohíbe a las agencias del estado y a los gobiernos locales de desarrollar proyectos para el abastecimiento del agua que pudiesen destruir el valor ecológico de un río o de un segmento de una corriente que halla sido designada por la Legislatura de Texas como un segmento único. Aún más, el TWDB no puede financiar proyecto alguno para el abastecimiento del agua que esté ubicado en un tramo designado como segmento único.

El TWDB específicamente menciona el criterio que tiene que ser aplicado en la evaluación de un río ecológicamente único o un segmento del mismo. Estos son: función biológica, función hidrológica, áreas de conservación ribereñas, alta calidad del agua, vida excepcional acuática de un alto valor estético y especies amenazadas o en peligro ido comunidades únicas.

Para ayudar al RWPG del Río Grande, el Departamento de Parques y Vida Silvestre de Texas (TPWD) desarrolló una lista de segmentos potencialmente candidatos en cada región que pueden reunir el criterio para la designación como ecológicamente única. El RWPG del Río Grande también recibió sugerencias de la Agencia de Peces y Vida Silvestre de los Estados Unidos, del Condado de Zapata y de la Asociación de Campos Camaroneros de Texas en dos sesiones de trabajo durante la elaboración del plan previo.

El RWPG revisó las nominaciones sometidas por el TPWD y otros concernientes a la designación del río o segmento como ecológicamente único. El grupo decidió no incluir recomendación alguna en este momento.

Sitios de Embalses o de Reserva para el agua

Las reglas del TWDB provee que los RWPG's "puedan recomendar sitios de valor único para la construcción de embalses o reservas para el abasto del agua al incluir las descripciones de los sitios, razones para la designación de únicos y de los beneficiados de ese abasto de agua que podría ser desarrollado en el sitio."

Dos sitios fueron considerados por el RWPG del Río Grande: La Represa y embalse en Brownsville; y la propuesta represa de agua baja en el Condado de Webb. Ninguna de estas dos es recomendada para la designación como sitio único en este momento.

Recomendaciones Legislativas

Bajo las reglas del TWDB, los planes regionales del agua pueden incluir "recomendaciones legislativas, reguladoras o administrativas que el grupo de planeación crea que sean necesarias y deseables para facilitar un desarrollo ordenado, un manejo y conservación de los recursos del agua y para la preparación y respuesta en condiciones de sequía."

Muchos de los asuntos y necesidades de la región surgen del hecho que el Río Grande es un río internacional cuyas aguas son compartidas por México y por los EEUU. Ninguna otra región encara esta realidad. Consecuentemente, las recomendaciones de acción efectuadas por el RWPG del Río Grande para satisfacer las necesidades detectadas son divididas en dos categorías: algunas recomendaciones recaen en la autoridad del Estado de Texas; mientras que otras recaen bajo el auspicio de la Comisión Internacional de Límites y Aguas (IBWC por sus siglas en inglés) y/o en otras agencies federales e internacionales.

Recomendaciones de materia estatal:

- El estado de Texas debe de considerar otros factores y no solo el aspecto de la población al financiar el proceso de planeación en la Región M debido a las circunstancias únicas que afectan al abastecimiento del agua de esta área.

- Como una forma de proveer alternativas para el abasto del agua para esta región, el estado deberá de continuar financiando los proyectos de desalinización de agua salobre del subsuelo y de la demostración del proyecto de desalinización del agua del mar.

- El estado deberá autorizar al Maestro Controlador del Agua para que maneje el agua por parte del WAM del Río Grande y debería otorgar el poder a la Comisión de Calidad Ambiental de Texas para recolectar cuotas de los derechohabientes del agua del Río Grande con total propósito de financiar las operaciones del control del agua tal y como lo especifica la sección 11.329 del Código del Agua.

- El estado deberá de asistir en la búsqueda de nuevos recursos y técnicas para ayudar a combatir las malezas acuáticas incluyendo al pino salado para así ayudar a la región a proteger sus abastos de agua. El RWPG del Río Grande se hermana con las regiones del Oeste y del centro para apoyar y buscar fondos para proyectos dedicados a erradicar el pino salado (salt cedar) de las Fuentes tributarias del Río Grande así como encontrar soluciones de largo tiempo para las actividades del control de malezas.

- El estado deberá de continuar proveyendo recursos financieros y técnicos para desarrollar el GAM regional. ("GAM" significa el Modelo de Disponibilidad del Agua del Subsuelo por sus siglas en Inglés.)

- El Estado deberá enmendar el proceso de planeación para permitir tratar a cada distrito de riego ubicado dentro de la región como un WUG (Grupo de Usuario del Agua), en lugar de ocupar la silla dentro de la categoría "Condado-Otros" para poder así desarrollar estrategias individuales sobre el manejo del agua para los distritos.

- La Comisión de Calidad Ambiental de Texas deberá de proveer asistencia al RWPG del Río Grande durante la revisión de sus reglas concerniente a la conversión de los derechos sobre el agua de un uso especificado a otro y, si es necesario, considerar enmendar los reglamentos apropiados a la materia.

- A las personas morales de la región se les solicita a cooperar para resolver los asuntos del agua en forma parecida a como lo resuelven las compañías de agua y aguas residuales.

- Se recomienda la formación de distritos de conservación del agua del subsuelo como una forma de protección de dichos abastos de agua; los cuales están siendo considerados como una nueva manera de abastecimiento de agua para usos municipales e industriales.

- El Estado deberá de apropiar fondos suficientes para la Comisión de Ferrocarriles de Texas que permitan tapar y cubrir las norias de gas y petróleo abandonadas ya que éstas están amenazando a los abastos de agua del subsuelo

- La Legislatura de Texas deberá de proveer asistencia técnica y financiera para implementar estrategias sobre el manejo del agua identificadas en los planes regionales.

- La Legislatura de Texas deberá de apropiar fondos presupuestarios para continuar el proceso de planeación regional del agua.

- La Legislatura de Texas deberá de apropiar fondos presupuestarios para la Junta para el Desarrollo del Agua de Texas o TWDB para implementar y proveer de asistencia a los grupos de usuarios del agua en el desarrollo e implementación de medidas avanzadas para la conservación del agua, incluyendo programas de educación y de diseminación al público.

Recomendaciones sobre los asuntos Nacionales e Internacionales

- La Comisión Internacional de Límites y Aguas (IBWC) deberá renovar sus esfuerzos para asegurar que México se adhiera a la Minuta o Acta 309 y establezca los mecanismos para el pleno cumplimiento del Tratado de 1944, incluyendo la aplicación de lo establecido por la Minuta o Acta 234 la cual explica las acciones requeridas por parte de México para eliminar completamente los déficit de entrega del agua dentro de los ciclos especificados en el Tratado. Los ahorros de agua por concepto de las medidas de conservación en México del agua para el riego deberán ser dedicados para asegurar las entregas requeridas en el Tratado de 1944 bajo el Artículo 4B(c) y el Acta 234.

- Los Estados Unidos y México deberán de reforzar los poderes y tareas de ambas secciones del IBWC de acuerdo a lo estipulado en el Articulo 24(c) el cual provee, entre otras cosas, la aplicación de la normatividad de lo estipulado en el Tratado y otras provisiones del Acuerdo a la siguiente cita: *"…. cada Comisionado podrá invocar cuando sea necesario la jurisdicción y competencia de las Cortes u otras agencias apropiadas de su país para que ayuden en la ejecución y aplicación de estos poderes y tareas."*

- Se les deberá de dar prioridad y deberán ser apoyados los proyectos de conservación delineados en el Acta o Minuta 309 y financiados por el Banco de Desarrollo de Norteamérica (NADBank) y a los otros proyectos financiados por agencias nacionales o internacionales que están dedicados a modernizar y mejorar las instalaciones de los distritos de riego ubicados en la cuenca del Río Grande.. En particular, ambos países deberán de continuar el apoyo a la continuación de fondos de subsidio para los proyectos de conservación aprobados y otorgados por el NADBank con los fondos de inversión para la conservación.

- De igual manera, deberán ser apoyados e implementados los proyectos de conservación para el riego actualmente en proceso a través del Buró de Reclamación para la mejora de los distritos de riego de la cuenca del Río Grande en el lado estadounidense.

- Para esclarecer el asunto, el IBWC deberá aprobar el Acta o Minuta esclareciendo la definición de "sequía Extraordinaria" cuyo dicho término está implícitamente definido en el Segundo subparrafo del Articulo 4B(d) como un suceso el cual dificulta a México "…. de hacer disponible su aporte o *afluencia de agua* de una cantidad de 350,000 acre-pies (431,721 metros cúbicos) anualmente." Una condición de sequía ocurre cuando exista menos de 1,050,000 acres-pies anualmente de *escurrimientos* de aguas en las cuencas tributarias Mexicanas nombradas en el Tratado de 1944; esta medida de agua se cuantifica cuando el agua entra al Río Grande desde las tributarias especificadas.

- La contabilidad del agua entre los Estados Unidos y México de acuerdo a lo estipulado en el Tratado de 1944 deberá ser consistente a lo acordado en la Convención de 1906, la cual provee que toda el agua medida en Fort Quitman Texas, será dedicada el 100% para los Estados Unidos.

- Para un mejor manejo en la parte Baja del Río Grande, río abajo de la Presa Anzaldúas, ambos países deberán de reafirmar las políticas operacionales para que México continúe tomando su parte de agua a través de su canal de desviación en la Presa Anzaldúas o contabilizar su agua en ese punto, incluyendo cualesquier desvío hecho por México de toda la parte que le pueda corresponder de la represa propuesta en Brownsville.

- El IBWC deberá de convocar una reunión binacional con los grupos de planeación así como los grupos de usuarios de ambos países dentro de seis meses a partir del término del conteo anual del agua y en el cual se detecte un déficit anual de flujo desde las tributarias Mexicanas nombradas en el Tratado de 1944. Esta reunión será diseñada para compartir datos e información útiles para la planeación de las necesidades y contingencias derivadas por el faltante de agua en el futuro medio-inmediato.

- El IBWC deberá restaurar el Río Grande abajo del Fuerte Quitman en Texas.

- El IBWC deberá asumir toda la responsabilidad financiera local y regional retener y mantener el dren de El Morillo.

- El IBWC deberá de coordinar esfuerzos binacionales para revisar y evaluar las fuentes existentes de datos concernientes al desarrollo del agua del subsuelo en ambos países dentro de la cuenca del Río Grande, desde abajo del Fuerte Quitman hasta el Golfo de México. Este esfuerzo deberá enfocarse en el impacto potencial del abasto de agua de superficie en los puntos de acopio del Río Grande, esto con la finalidad de tomar acciones que puedan ser necesarias para evaluar las condiciones presentes y promover programas de protección de la histórica fuente de abasto de agua de superficie en las regiones afectadas.

- Deberá ser promovida la planeación regional de las fuentes tributarias en ambos lados del Río Grande a través de su cuenca, incluyendo esfuerzos para promover una coordinación binacional de planeación a largo alcance.

- Se deberán de promover áreas interestatales consolidadas entre los estados afectados en México, de manera similar a las consolidaciones interestatales efectuadas entre (la región) del Río Grande y la del Río Pecos cuyas entidades estaban siendo afectadas en los Estados Unidos; dichas consolidaciones proporcionarán del agua disponible del Río Grande y sus tributarias para cada estado de una manera consistente y equitativa de acuerdo a las leyes existentes domésticas e internacionales.

Recomendaciones de Financiamiento para Infraestructura para el Agua

El requisito del Reporte Financiero para la Infraestructura o IFR (por sus siglas en inglés) fue incorporado dentro del proceso de planeación regional como una respuesta al Acta del Senado 2 (de la sesión número 77 de la Legislatura). Para los propósitos del IFR cada grupo regional de planeación debe de determinar el financiamiento propuesto para todas las estrategias para el manejo del agua que fueron introducidas en esta Segunda etapa del proceso. Por cada una de las estrategias, el RWPG debe de determinar los fondos necesitados para implementar la estrategia y el tipo de fondos que podrían ser accesados.

De acuerdo a las directivas del TWDB, los objetivos del IFR son el determinar:

- El número de subdivisiones políticas con necesidades identificadas de abasto adicional de agua el cual no podría pagar para su infraestructura necesaria sin asistencia externa.
- Que tanto del costo para la infraestructura incluido en el plan regional no podría ser pagado con las fuentes locales de ingreso.
- Las opciones financieras propuestas por las subdivisiones políticas para cumplir con sus necesidades de infraestructura (incluyendo la identificación de fondos estatales considerados,) y,
- El papel(es) que el RWPG propone al estado en el financiamiento de los proyectos propuestos para el abasto del agua.

En la mayoría de los casos, las estrategias de los WUG's (Grupos de Usuarios del Agua) municipales incluyen urbanización, medidas de conservación avanzadas y compra de abastos del Río Grande. Hay ocho Condados, 52 Ciudades y 15 corporaciones de abasto de agua dentro de ésta área de planeación regional. Se les enviaron encuestas solamente a aquellos que se identificaron en el plan con una necesidad durante el plan de 50 años. De estos WUG municipales, más del 90% recibieron una visita personal por el equipo consultivo durante los meses de Junio a Noviembre del 2004. Como parte de esa visita, el propósito de la encuesta fue explicado así como el papel del Grupo de Planeación Regional para el Agua o RWPG en el proceso de planeación.

El RWPG también envió dos encuestas en la segunda etapa de la planeación. La primera fue durante el verano del 2004 y la segunda en Octubre del 2005. Se adjuntan en este reporte una muestra de estas encuestas. Las encuestas fueron utilizadas para obtener información adicional para la planeación del agua efectuada por los WUG's dentro de su papel con el Grupo de Planeación regional para el Agua.

El costo total anual para todas las municipalidades para la implementación de las Estrategias del Manejo del Agua que sirven para balancear el déficit potencial del abasto del agua es de $163 Millones. De acuerdo a la información obtenida de las encuestas mencionadas, el 40% de los costos totales anuales serían proveídos a través de Bonos, 33% a través de programas federales, 16% de programas estatales, 8% con sus propias reservas de activos y el 3% de otra manera.

El costo total anual para las Estrategias del Manejo del Agua para el riego es de $82 millones. Las medidas de conservación en el campo costarán $56 millones mientras que las mejoras en los sistemas de transporte y transferencia costarán $26 millones. Cerca del 40% de los costos en el campo serían financiados en el ámbito local, mientras que el resto tendría que provenir de fuentes externas. Cerca del 10% de las mejoras al sistema de transporte y transferencia del agua podría ser financiado localmente pero el 90% tendría que provenir de fuentes externas.

Asuntos de Participación Pública, Facilitación e implementación del Plan

Participación Pública

La participación pública es la base del proceso de la planeación regional para el agua iniciada por el SB1 desde 1997. Las reglas del TWDB requieren a los grupos de planeación regionales (o RWPG's) a tener, como mínimo, una reunión previa a la preparación del plan regional. En esa reunión, se proveen las oportunidades de participación pública durante el proceso de planeación así también la de sostener por lo menos una audiencia pública antes de la adopción del "propuesto borrador" del plan. Los RWPG son requeridos a cumplir con las reglas del TWDB que especifican como y cuando se debe de proveer el aviso para las audiencias públicas.

Como desde el principio del ciclo, el grupo de planeación regional para el agua del Río Grande ha cumplido de más con el requisito mínimo establecido por el estado concerniente a la participación pública. Se ha proveído de múltiples oportunidades para recibir comentarios y testimonios públicos dentro del proceso de planeación y desarrollo del borrador del plan. El grupo ha intensificado sus esfuerzos en la segunda etapa de planeación para asegurar el involucramiento y participación del público en el proceso.

El RWPG del Río Grande ha sostenido reuniones regulares a través del proceso de planeación, generalmente en bases mensuales. Cada reunión se le ha proveído al público la oportunidad de otorgar sus opiniones. Al progresar la planeación, la oportunidad para comentarios públicos se cambió de la última parte del orden del día (agenda) a la primera parte, es decir al inicio de la misma, para favorecer al público.

Una gran variedad de mecanismos se han utilizado para publicar los trabajos de las reuniones del RWPG, incluyendo avisos a los medios de información, y avisos en el portal del RWPG del Río Grande website: *www.RioGrandeWaterPlan.org*. Este portal fue diseñado y establecido en el 2003 como una fuente alternativa para el público y para informar al mismo del proceso regional de planeación.

Un folleto tríptico de fácil lectura fue elaborado en Agosto del 2004 para diseminar la información de los trabajos de planeación regional. Este fue distribuido en una gran variedad de foros y por correo. El folleto también dirige a los lectores hacia el portal del Web para una mayor información.

Cuatro cartas informativas fueron elaboradas y distribuidas durante la segunda etapa de la planeación regional. Una quinta carta será producida al término del plan cuando sea sometido al TWDB.

Versiones electrónicas de resúmenes informativos fueron puestas a disposición de los medios de información de toda la región como una forma mas de promover interés en el plan. Los nombres en la lista para el envío de cartas informativas fueron compilados de los esfuerzos anteriores de la planeación.

El Resumen Ejecutivo del Plan fue traducido al español y será puesto en el portal del Web.

El RWPG del Río Grande y su equipo consultivo activamente han solicitado comentarios de las entidades locales acerca de la información básica usada para desarrollar el plan, incluyendo las proyecciones de financiamiento para la infraestructura para el agua y la demanda futura de la misma. Además, se efectuaron presentaciones a una variedad de grupos con interés en la planeación para el agua incluyendo a las asociaciones de servicios del agua, agrupaciones y productores de cítricos y en juntas de directores de los distritos de riego.

El RWPG del Río Grande también proveyó extensivamente avisos y oportunidades para los comentarios públicos para la *Preparación del Plan Inicial*. Se efectuó una audiencia pública en Zapata, Texas el 20 de Julio del 2005. Presentaciones adicionales fueron efectuadas en reuniones públicas en diferentes puntos de la región.

Facilitación

La facilitación para el proceso de planeación regional para el agua en la Región del Río Grande ha sido efectuada por el personal del Consejo para el Desarrollo del Bajo Río Grande o LRGVDC (por sus siglas en Inglés) con la ayuda del equipo consultivo. Además de elaborar en las tareas administrativas relacionadas con el manejo de los fondos estatales, el LRGVDC también a efectuado los arreglos para las reuniones del RWPG del Río Grande lo cual requiere además de proveer avisos de las reuniones programadas también de preparar las agendas de trabajo, distribuir los materiales de apoyo a cada uno de los miembros del grupo de planeación y de las logísticas. El LRGVDC también grabó todas las reuniones de este grupo y preparó las minutas oficiales de las reuniones. Para los miembros que no hablan Inglés, los cuales tiene voz pero no derecho a voto dentro del RWPG del Río Grande, se les proveyó de un interprete durante todas las reuniones de planeación.

El equipo consultivo también asistió en el proceso de facilitación durante la planeación al proveer presentaciones de información técnica durante las reuniones del RWPG y colaboró en la identificación de asuntos claves e importantes para el proceso de la planeación y asuntos de política.

Asuntos para la Implementación del Plan

Un número de asuntos claves podrán afectar el éxito de este plan relacionado con su principal propósito de desarrollar estrategias que cumplan con las necesidades del agua a corto y largo plazo en la región del Río Grande. Generalmente, los asuntos claves relacionados con la implementación de este plan pueden ser agrupados en tres categorías:

- Asuntos y estrategias sobre el manejo del agua que requieren evaluaciones adicionales más profundas. Las recomendaciones presentadas en este plan regional están apoyadas en la evaluación a un nivel de reconocimiento de las proyecciones de la demanda del agua, abasto de la misma, necesidades y varias estrategias percibidas para las necesidades futuras. Además será necesario elaborar una mayor y más detallada planeación antes de implementar muchas de las estrategias recomendadas para evaluar su factibilidad. También, en mucho de los casos, una planeación en el ámbito de factibilidad tendrá que ser efectuada por ingenieros durante el diseño y la tramitación de permisos. Por la mayor parte, las actividades adicionales de planeación y desarrollo de proyectos que requieran de una estrategia de implementación recaerán en la responsabilidad de las entidades o personas morales locales (por ejemplo las juntas de aguas, distritos de riego, etc.) Sin embargo, la asistencia técnica estatal y/o federal y la ayuda financiera grandemente facilitaría la prontitud del desarrollo e implementación de los proyectos.

- El apoyo y acción local para implementar las estrategias del abasto del agua son imperativos. Este plan del agua regional es mejor percibido como el marco de trabajo para la acción local para la implementación de estrategias para cumplir con las necesidades futuras del agua. El papel del RWPG del Río Grande es puramente de asesoría. El RWPG no tiene autoridad para obligar a otras entidades a implementar acciones recomendadas en este plan, ni tiene autoridad alguna o recursos propios disponible para efectuar la implementación de las actividades recomendadas por el grupo y contempladas dentro de este plan. En lugar de esto, la responsabilidad principal de implementar las estrategias recomendadas para cumplir con las necesidades futuras del agua recae en las agencias o corporaciones locales incluyendo a las municipalidades, juntas de aguas, corporaciones, distritos de riego, etc. Con o sin la ayuda de externa, es la responsabilidad de las agencias, entidades o personas morales locales el realizar estudios de planeación de factibilidad y de diseño de ingeniería. De manera similar, los usuarios o clientes locales asumirán y serán responsables de todos los costos para implementar las medidas y estrategias de conservación del agua y su abasto. Por ello, es esencial que exista un serio compromiso por parte de las entidades gubernamentales y las gerencias de las entidades locales para la implementación de las estrategias recomendadas dentro de este plan.

- Financiamiento para la implementación de las recomendaciones de este plan. La disponibilidad y acceso a los fondos para la implementación de las estrategias recomendadas para el manejo del agua es cruciales. La mayoría de las agencias locales de la Región del Río Grande son entidades gubernamentales o semi-gubernamentales (por ejemplo las corporaciones para el abastecimiento del agua) que tienen la autoridad para cargar y cobrar impuestos y/o cuotas por los servicios que ellos proveen. Estas entidades también tienen la habilidad para pedir fondos prestados para adquirir materiales, desarrollar y rehabilitar infraestructuras relacionadas con el agua. En su mayoría, los costos directos por los servicios que proveen esas entidades deben de ser pagados por los usuarios individuales a través de impuestos y/o cuotas por servicios. Sin embargo, debe de ser reconocido que también tiene un papel apropiado por los gobiernos estatal y federal en el financiamiento de las medidas de conservación del agua, desarrollo de abastecimientos de agua y de proyectos de infraestructura. En el presente, existe un número de programas de asistencia financiera para proyectos de infraestructura relacionada con el agua que están disponibles para las agencias municipales del agua. Sin embargo, existen muy pocos programas que proveen de asistencia financiera para mejorar la infraestructura de los distritos de riego. Debido a que la conservación del agua para la agricultura es un elemento central en este plan regional para el agua – y es esencial para mantener la viabilidad de este sector en la economía regional- el RWPG del Río Grande recomienda que nuevas fuentes de financiamiento público sean establecidas para ayudar a los distritos de riego a implementar los programas de conservación.

No se han identificado conflictos ínter-regionales durante el proceso de planeación o en el contenido de este plan.

REGION M REGIONAL WATER PLAN CONTENTS

Estimating the Required Investment to Attain Region M Water Savings Through Rehabilitation of Water Delivery Infrastructure-2005 Perspective

Water Management Strategies Cost Analysis (NRS Consulting Engineers)

Socioeconomic Impacts of Unmet Water Needs in the Rio Grande Water Planning Area

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CHAPTER 1.0 :INTRODUCTION – GENERAL OVERVIEW OF REGIONAL WATER PLANNING & SENATE BILL ONE

The Texas Water Development Board (TWDB) was established in 1957 through a state constitutional amendment. A six-member board was appointed by the governor to serve as a policy-making body. Membership consisted of overlapping six-year terms, and each board member had to be from a different section of the state. The agency's original function was to provide loan assistance to political subdivisions for the development of surface water supply projects that could not be financed through commercial channels. During the 1960s the board's responsibilities grew to include the authority to obtain and develop water conservation storage facilities, prepare a state water plan, and assume operations of the Texas Water Commission not related to the question of water rights.

In the 1990s the Texas Water Development Board had a number of broad responsibilities. One primary function was still the granting of loans to local governments in order to implement flood and pollution control, wastewater treatment, and municipal solid waste management. In addition, the board provided grants and loans to economically distressed areas of the state to implement water and sewage projects, including low-interest loans to colonia residents for plumbing improvements.

The agency was responsible for collecting data and conducting studies regarding agricultural water conservation, fresh water needs of Texas estuaries and bays, and surface and ground water resources. It also maintained the Texas Natural Resources Information System, a central database of information concerning the state's resources. The executive administrator's office implements the agency's policies. An administrative division provides support through services such as accounting, budget monitoring, and inventory record keeping. The board funds its assistance programs with state-backed bonds and federal grants to provide for a State Revolving Fund for borrowers, overseen by the office of the Development Fund manager.

Loan recipients also receive engineering and technical advice from the board's engineers and archeologists. As the agency responsible for developing a state water plan, the Texas Water Development Board employs a number of research sections to assess and project water availability, environmental impact, and water uses for both agricultural and municipal areas. The board continually collects surface and underground water information through hydrologic monitoring. It provides technical evaluation of water resource problems and promotes programs on conservation education. In 1991 the board had a budget of almost $11 million. By the early 1990s the agency had sold over $1 billion in bonds for the financing of water-related projects since its inception. It is the TWDB responsibility that there is an adopted State Water Plan established through Senate Bill 1.

During 1997 the 75th Texas Legislature enacted Senate Bill 1 (SB 1), often referred to as the Brown-Lewis Water Plan after its Senate and House sponsors. Due to the drought of 1996 and increasing public awareness of the state’s rapidly increasing water demands major legislation was provided for a major overhaul of the many longstanding state water laws and policies. SB 1 addressed a wide range of issues and concerns including state, regional, and local planning for water conservation, water supply and drought management; administration of state water rights programs; interbasin transfer policy; groundwater management; water marketing; state financial assistance for water-related projects; and state programs for water data collection and dissemination.

SB 1 radically altered the manner in which future state water plans are to be prepared. Historically, the state water plan has been prepared by the Texas Water Development Board (TWDB), with input from other state and local agencies and the public. With SB 1, the Legislature established a "bottom up" approach whereby future state water plans are to be based on regional water plans prepared and adopted by appointed regional water planning groups (RWPGs). The RWPGs serve without compensation and are responsible for overseeing the preparation of the regional water plans.

The regional water plans are to be based on an assessment of future water demands and currently available water supply and are to include specific recommendations for meeting identified water needs through 2040. The plans may also include recommendations regarding strategies for meeting long-term (2040-2060) needs, as well as recommendations regarding legislative designation of ecologically unique rivers and streams, reservoir sites, and policy issues. By law, the regional water plans are to be completed by January 5,2006, at which time the TWDB will have one year to compile a new state water plan. The rough draft of this regional water plan is due July 2005. The regional water plans and the state water plan are to be updated every five years. This is the second round of regional water planning.

In February 1998 the TWDB adopted administrative rules, which included the delineation of 16 regional water planning areas (see Figure 1.1) and the definition of the procedures and requirements for the development of the regional water plans. The TWDB also appointed the initial members of 16 RWPGs. Subsequently, the RWPGs adopted by-laws, selected a political subdivision to act as its administrative agent, and developed a scope of work and budget for preparation of the regional water plans. Funding for the preparation of the regional water plans was provided in the form of grants from the TWDB.

Initially designated by TWDB as "Region M", the Rio Grande Regional Water Planning Area (herein referred to as the Rio Grande Region) consists of the eight counties adjacent to or in proximity to the middle and lower Rio Grande (see Figure 1.2). These are:

Cameron	Starr	Maverick	Zapata
Hidalgo	Webb	Jim Hogg	Willacy

The Rio Grande Regional Water Planning Group, at the time of the adoption of this plan, consists of various members representing 10 of the 11 interest group categories specified in SB1. One category, river authorities, is not represented on the Rio Grande RWPG, as there are no river authorities in existence within the boundaries of the Rio Grande Region. In addition to its voting membership, the Rio Grande RWPG includes non-voting members representing state agencies and the Mexican federal government.

This is the second round of planning for the regional water plan. There are updates on the guidelines for the water planning itself, which are stated in Exhibit B. Exhibit B is used as a reference to the guidelines that will help in having accurate data for the population and water demand projections. The population projections were updated with the help of the guidelines set forth by Exhibit B. Cities were allowed to make corrections in their population count reported in 2000 by the United States Census. Several changes were made by the cities to have a better representation of the water demand needs. Exhibit B added several relevant chapters instead of seven now we have ten. All ten chapters will be described briefly in this chapter.

Figure 1.1: TWDB Designated Regional Water Planning Areas

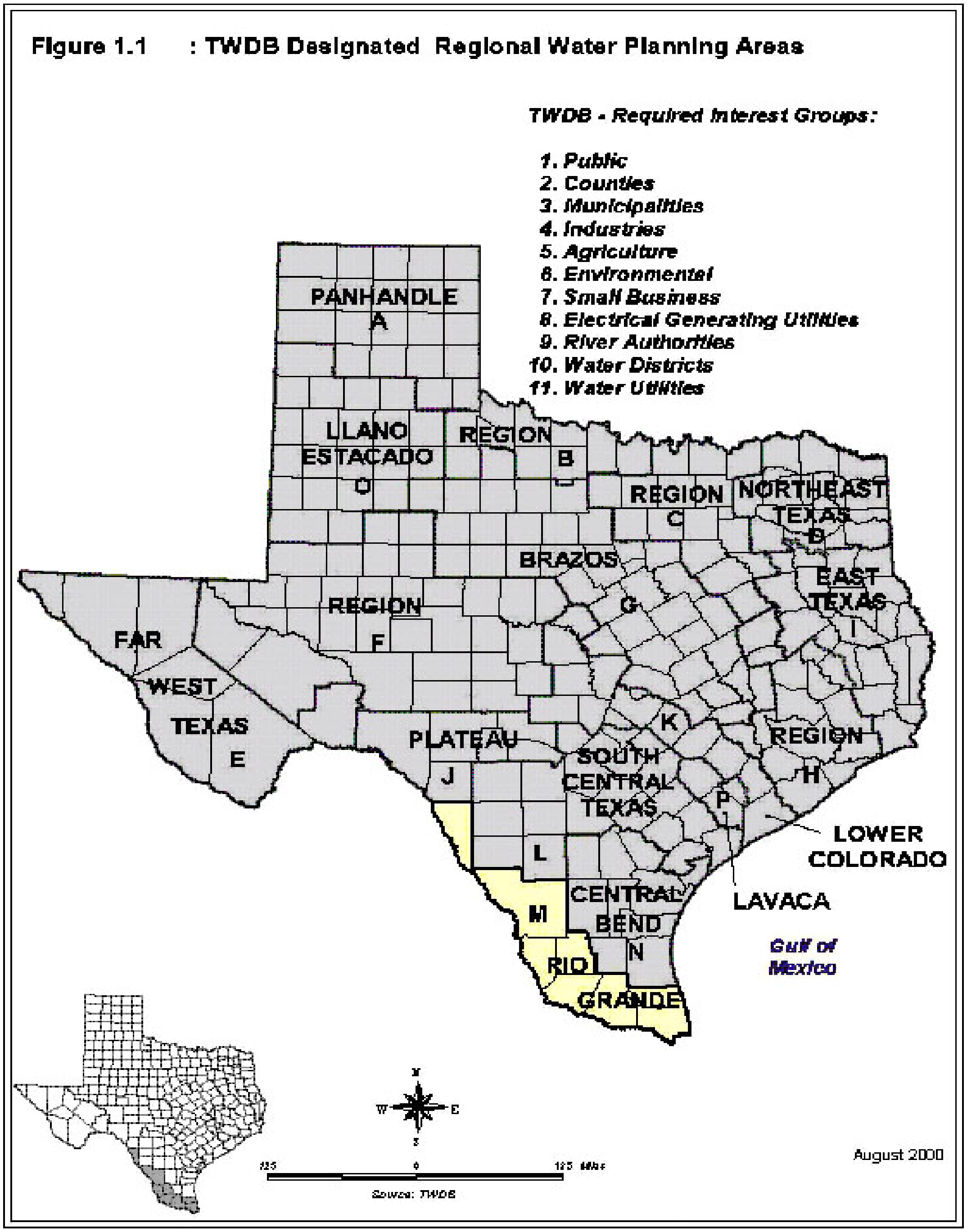
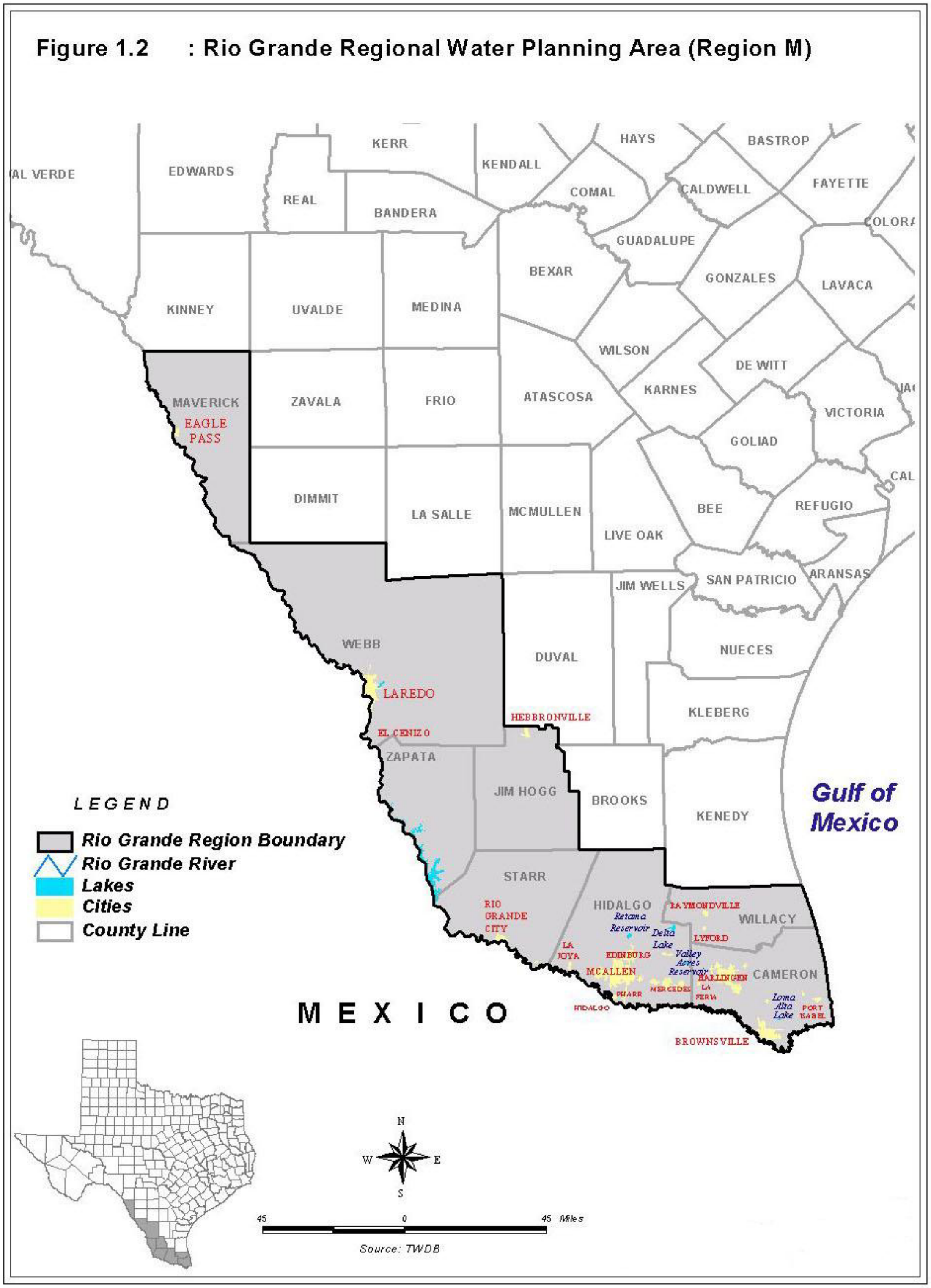


Figure 1.1 : TWDB Designated Regional Water Planning Areas

Figure 1.2: Rio Grande Water Planning Area (Region M)



Voting and non-voting members of the Rio Grande RWPG are shown in Table 1.1. The Lower Rio Grande Development Council (LRGVDC) serves as the administrative agency on behalf of the Rio Grande RWPG.

Table 1.1: Voting Members of the Rio Grande Regional Water Planning Group

INTEREST	NAME	RESIDENT COUNTY
PUBLIC	VACANT POSITION	
COUNTIES	JOSE ARANDA COUNTY JUDGE	MAVERICK
	JOHN WOOD COUNTY COMMISSIONER, BROWNSVILLE	CAMERON
MUNICIPALITIES	ROBERTO GONZALEZ* WATER WORKS, EAGLE PASS	MAVERICK
	JOHN BRUCIAK, GENERAL MANAGER BROWNSVILLE PUB	CAMERON
	ADRIAN MONTEMAYOR WATER UTILITIES, LAREDO	WEBB
INDUSTRIES	GARY WHITTINGTON UNIFIRST LINEN SERVICE, HARLINGEN	CAMERON
AGRICULTURE	ROBERT E. FULBRIGHT* HINNANT & FULBRIGHT, HEBBRONVILLE	JIM HOGG
	RAY PREWETT TEXAS CITRUS MUTUAL, MISSION	HIDALGO
ENVIRONMENTAL	MARY LOU CAMPBELL, SECRETARY* SIERRA CLUB, MERCEDES	HIDALGO
SMALL BUSINESS	DONALD K. MCGHEE HYDRO SYSTEMS, INC., HARLINGEN	CAMERON
	XAVIER VILLAREAL T&J OFFICE SUPPLY, ZAPATA	ZAPATA
ELECTRIC GENERATING UTILITIES	JAIME GOMEZ CENTRAL POWER & LIGHT, LAREDO	WEBB
RIVER AUTHORITIES	JAMES DARLING RIO GRANDE REGIONAL WATER AUTHORITY	HIDALGO
WATER DISTRICTS	SONNY HINOJOSA HCID NO. 2, SAN JUAN	HIDALGO
	SONIA KANIGER CCID NO. 2, SAN BENITO	CAMERON
WATER UTILITIES	Charles Browning, Vice-Chair* NORTH ALAMO WATER SUPPLY CORP., EDINBURG	HIDALGO
OTHER	Glenn Jarvis, Chair* Attorney, McAllen	HIDALGO
	JAMES MATZ MAYOR, PALM VALLEY	CAMERON

By rule, the TWDB has set forth specific requirements and guidelines for the preparation of the regional water plans (31 Texas Administrative Code, Chapter 357, Regional Water Planning Guidelines Rules). Accordingly, there are several key tasks that are common to the development of the water plans in all regions:

- Development of population and water demand projections by decade for the period 2010-2060;
- Evaluation of the adequacy of currently available water supplies under drought of record hydrologic conditions;
- Comparison of currently available water supplies with projected demands to identify where and when there is a surplus of supply or a need for additional supplies;
- Evaluation of the social and economic impacts of not meeting the identified water needs; and,
- Development of recommendations regarding strategies for meeting near-term water needs (2010 to 2040) and strategies or scenarios to meet long-term future needs (2040 to 2060).

In addition, each RWPG may, at their discretion, include recommendations in their regional water plans with regard to:

- Legislative designation of ecologically unique river and stream segments;
- Identification of sites uniquely suited for reservoir construction;
- Regulatory, administrative, or legislative actions to improve water resource management in the region or in the state; and,
- Coordinated planning with neighboring regions concerning mutual interests and shared resources.

This document presents the approved water supply plan for the Rio Grande Region. Pursuant to TWDB requirements, the plan is organized into ten chapters.

Chapter 1 presents a description of the regional water planning area. This includes information regarding current water uses and major water demand centers, sources of surface and groundwater supply, agricultural and natural resources, and the demographic and socioeconomic characteristics of the region. Also included is a summary of existing regional water plans, a summary of recommendations in the current state water plan, a summary of local water plans, and an assessment of threats to agricultural and natural resources.

Chapter 2 of this plan presents current and projected population and water demands. This information is reported by city and county and for the portion of each river basin within the Rio Grande Region. Water demand projections are presented for six water use categories: municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock.

Chapter 3 describes a total analysis of the region's water supply.

Chapter 4 presents how to identify, evaluate, and select Water Management Strategies based on needs.

Chapter 5 describes the impacts of water management strategies on key parameters of water quality and the impacts of moving water from rural and agricultural areas.

Chapter 6 describes consolidated water conservation and drought management recommendations of the regional water plan.

Chapter 7 presents a description of how the regional plan is consistent with Long-term Protection of the state's water resources, agricultural resources, and natural resources.

Chapter 8 describes unique stream segments/reservoir site/legislative recommendations.

Chapter 9 is a report to legislature on water infrastructure funding recommendations. The 77^{th} Texas Legislature required the Planning Groups to report to the TWDB how affected entities proposed to pay for Water Management Strategies in the approved Regional Water Plans.

Chapter 10 is to help in budgeting purposes for the actual adoption of the Regional Water Plan.

1.1 PHYSICAL DESCRIPTION OF THE RIO GRANDE REGION

The following sub-sections provide a general description of the region's physical characteristics including climate, topography, geology, soils, and natural resources.

1.1.1 Climate

The climate of the Rio Grande Region ranges from a humid subtropical regime in the eastern portion of the region to a tropical and subtropical regime in the remaining portion of the region. Prevailing winds are southeasterly throughout the year and the warm tropical air from the Gulf of Mexico produces hot and humid summers and relatively mild and dry winters. The July maximum temperature in the region ranges from about 96°F to 98°F. The January minimum temperature in the region ranges from about 40°F to 49°F (TWDB, 1977). The number of frost-free days (growing season) varies from 320 days at the coast to 230 days in the northwestern portion of the region near Maverick County. Average annual net lake evaporation in the Rio Grande Region varies from 40 to 44 inches at the coast to approximately 60 to 64 inches at the central portion of the region near southern Webb County (Figure 1.3). Lake-surface evaporation rates are highest in the summer months.

The amount of rainfall varies across the Lower Rio Grande Region from an average of 28 inches at the coast to 18 inches in the northwestern portion of the region (Figure 1.4). Most precipitation occurs during the spring from April through June, and during the late summer and early fall, from August through October. Spring precipitation is the result of seasonal transition as inflowing warm, moist air from the Gulf of Mexico and the Pacific Ocean generates thunderstorms. The period from late summer to early fall is the hurricane season, during which Atlantic and Gulf storms may move ashore along the Texas or Upper Mexican Gulf Coast. These storms can generate tremendous amounts of rainfall over a short period of time causing extensive flooding due to the relatively flat nature of the region's terrain. It is these fall storms, which provide a large portion of the surface water runoff captured in water supply reservoirs within the Rio Grande Basin.

Figure 1.3: Rio Grande RWPA Average Annual Net Evaporation

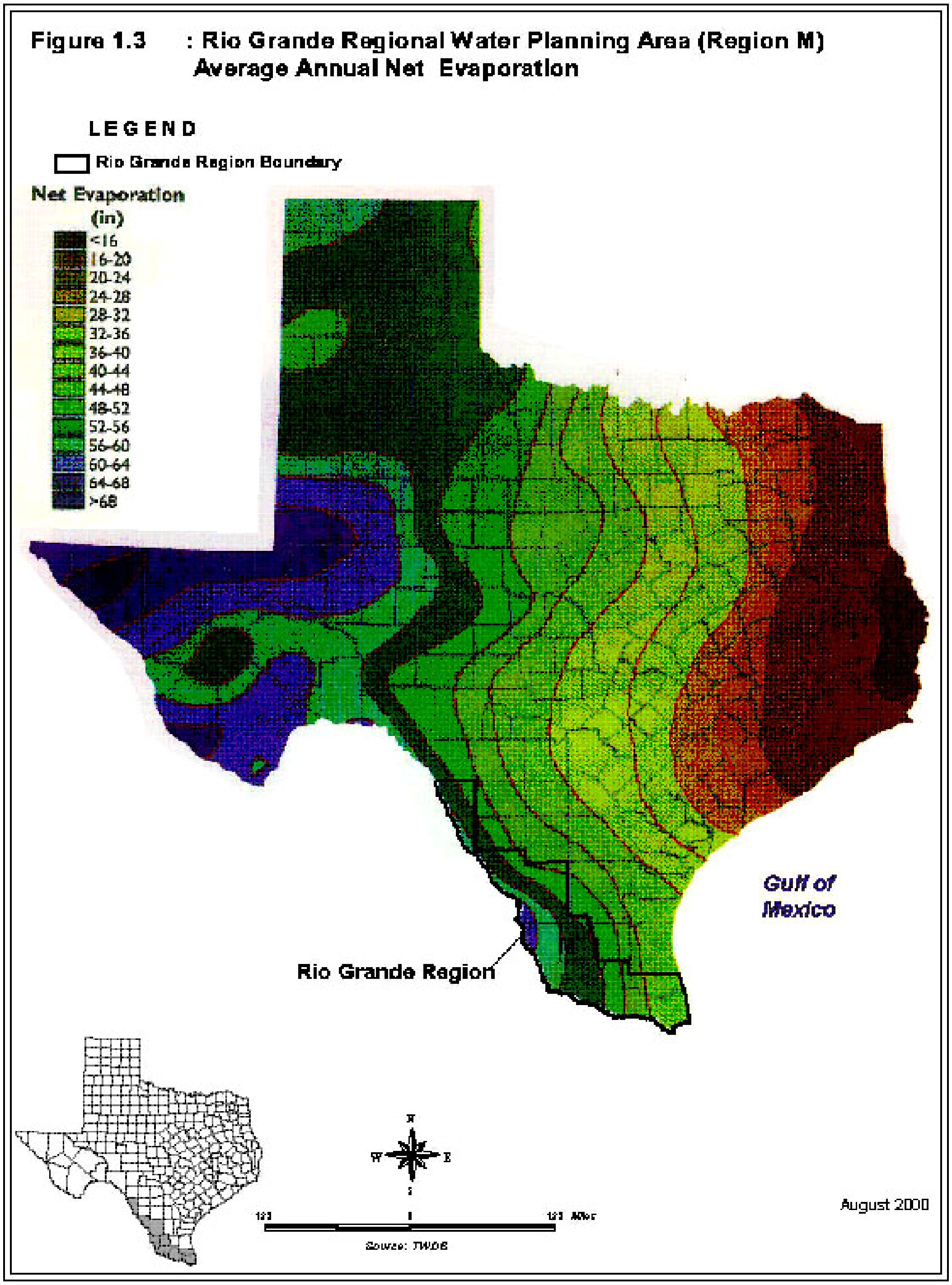
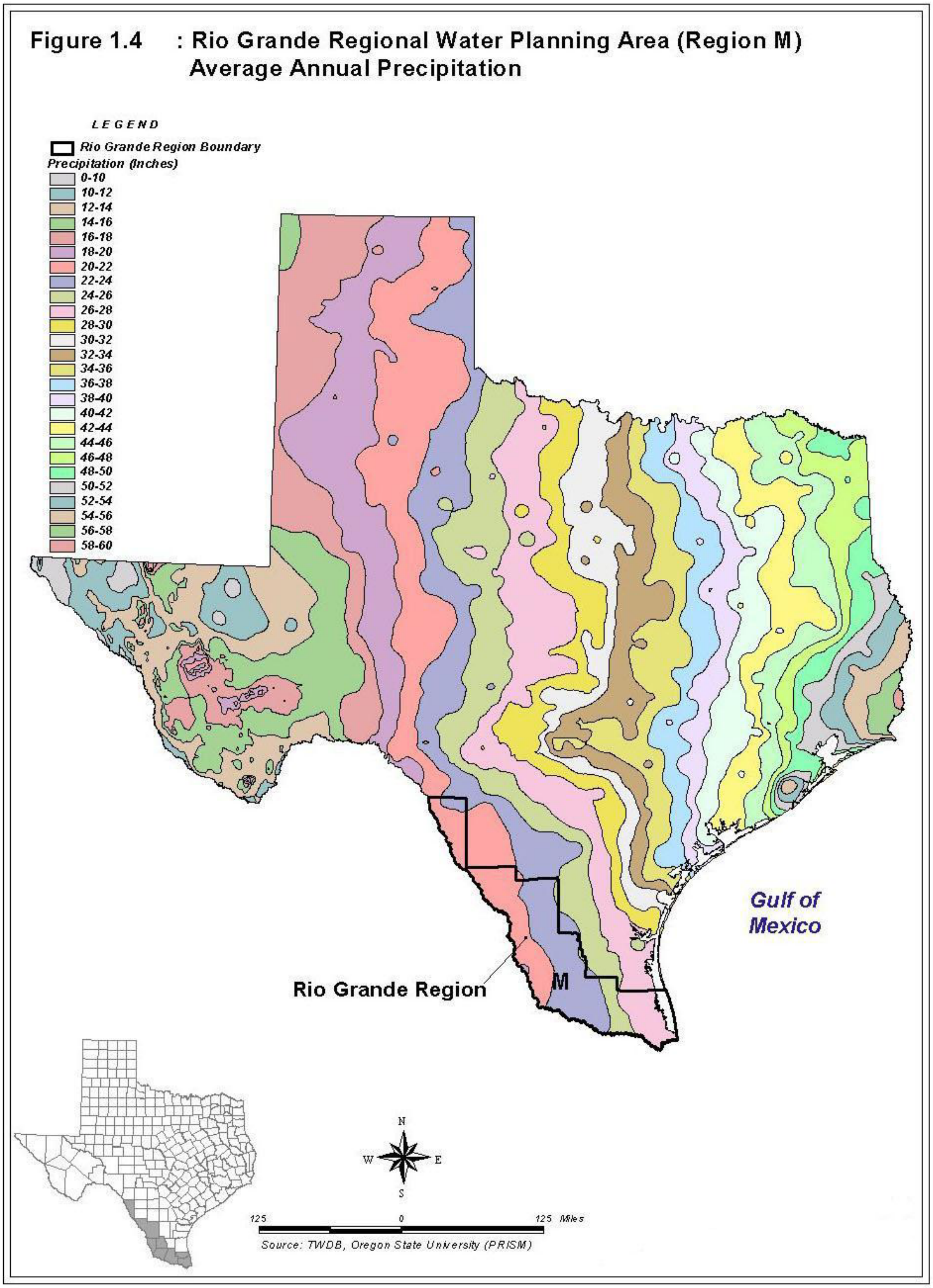


Figure 1.4: Rio Grande RWPA Average Annual Precipitation



1.1.2 Topography, Geology, and Soils

The Rio Grande Region is located entirely within the Western Gulf Coastal Plains of the United States, an elevated sea bottom with low topographic relief. Topography in the region ranges from a rolling, undulating relief in the northwestern portion becoming progressively flatter near the Gulf Coast. The lower portion of the region consists of a broad, flat plain which rises gently from sea level at the Gulf of Mexico in the east to an elevation of approximately 960 feet in the northern part of Maverick County at the upper end of the region. The western edge of this plain culminates in a westward-facing escarpment known as the Bordas Escarpment. Drainage in the region is by the aforementioned river basins and their tributaries. The Rio Grande River flows southeasterly through the region before turning east to its confluence with the Gulf of Mexico.

Geologic formations exposed in the region include Cretaceous, Tertiary, and Quaternary-aged deposits. In general, the geologic strata of the Rio Grande Region decreases in age from west to east across the area. The oldest strata, which are of Cretaceous age, outcrop in northwestern Maverick County and consist of chalky limestone and marl. The youngest or most recent sediments are located in Cameron County.

In general, soils in the Rio Grande Region generally consist of calcareous to neutral clays, clay loams and sandy loams. A general soils map is presented in Figure 1.5.

A general description of the topography, geology, and soils for each county in the region is presented in the following sections.

1.1.2.1 Cameron County

Cameron County is located at the extreme southern tip of Texas. The geologic formations in the county are not cemented (unlithified) and dip gently toward the Gulf of Mexico. They are of Pleistocene age or younger and only two geologic formations are exposed in the county; the Beaumont Formation and the overlying sediments of recent age (Holocene).

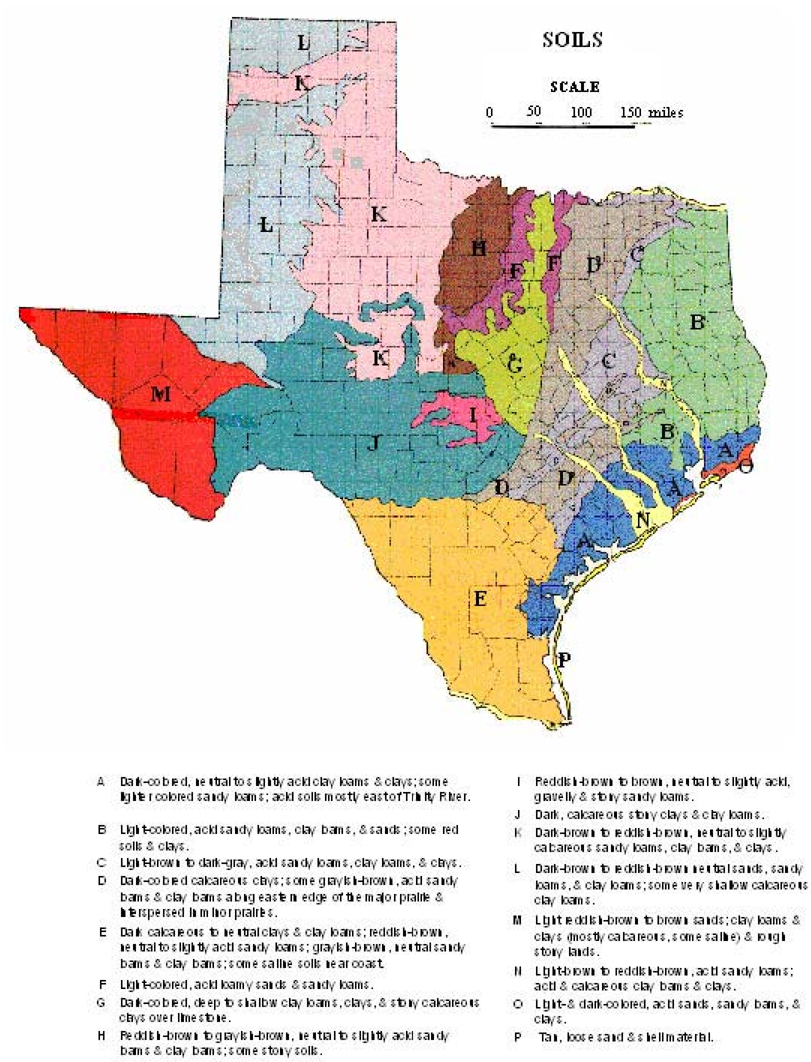
Cameron County consists of a flat plain that slopes gently to the northeast with an elevation that varies from sea level to 70 feet[1]. The county's average elevation is 45 feet. The greater part of the area is an alluvial plain or delta of the Rio Grande River.

The county is located in an area of highly intensified and specialized farming. A narrow band of saline coastal soils parallels the Gulf of Mexico and is used as range. Portions of the northern and eastern parts of the county are used for dryland farming. Soil associations mapped in Cameron County include: Sejita-Lomalta - Barrada, Laredo - Lomalta, Willamar, Laredo - Olmito, Rio Grande - Matamoras, Willacy - Racombes, Lyford - Raymondville - Lozano, Hidalgo - Raymondville, Willacy -

[1] Soil Survey of Cameron County, 1977

Raymondville, Raymondville, Harlingen-Benito, Harlingen, Mercedes, and Mustang-Coastal dunes associations (Soil Survey of Cameron County, 1977).

Figure 1.5: Soils of Texas



(Source: University of Texas Bureau of Economic Geology, 1977)

1.1.2.2 Hidalgo County

The land surface in Hildalgo County is nearly level to gently sloping. The elevation ranges from about 40 feet above mean seal level on the eastern side of the county to 375 feet above msl on the western side[2]. The surface sedimentary rocks, mostly unlithified, dip gently toward the gulf.

The major soils in Hidalgo County, used primarily for non-irrigated and irrigated crops, are generally deep, well drained, moderately permeable, and loamy throughout. They are on a nearly level to gently sloping upland plain. Soil associations in Hidalgo County include: Hidalgo, McAllen-Brennan, Brennan-Hidalgo, Willacy-Delfina-Hargill, Delmita-Randado, Willacy-Racombes, Nueces-Sarita, Delfina-Hebbronville-Comitas, Harlingen, Runn-Reynosa, Raymondville-Mercedes, Raymondville-Hidalgo, Rio Grande-Matamoras, and Pits-Jimenez-Quemado associations (Soil Survey for Hidalgo County, 1981).

1.1.2.3 Jim Hogg County

The topography in Jim Hogg County is mostly level to gently sloping and gently undulating. Wind-blown sand deposits are located across much of the south-central portion of the county. About 98 percent of the county is used for range[3]. Raising cattle is the main agricultural enterprise, but some cultivated crops are also produced. Seven soil associations are mapped for the county and consist of mostly sandy loams and fine sands. The soil associations in the county include: Delmita, Nueces-Sarita, Falfurrias-Sarita, Brennan-Hebbronville, Copita-Brennan, Cuevitas-Randado-Zapata, and Comitas associations (Soil Survey of Jim Hogg County, 1974).

1.1.2.4 Maverick County

The topography of Maverick County ranges from nearly level to rolling. Elevation in the county ranges from about 540 above msl in the southern part to 960 feet in the northern part[4]. The drainage pattern is distinctly expressed in most of the county, except in the north-central part, which is a nearly level and featureless plain. On the rolling hills, geological erosion occurs almost as fast as the soils form due to these soils being underlain at a shallow depth by strongly cemented caliche. Soil associations in Maverick County include: Copita-Pryor-Dant, Elindio-Montell, Jimenez-Olmos-Zapata, Catarina-Maverick, Brundage-Dant, Lagloria-Laredo, and Brustal associations (Soil Survey of Maverick County, 1977).

Approximately 92 percent of Maverick County is native rangeland used primarily for raising cattle. Significant irrigated cropland occurs in the county in an area generally paralleling the Rio Grande. The soils in the northern portion of the county consist of

[2] Soil Survey for Hidalgo County, 1981
[3] Soil Survey of Jim Hogg County, 1974
[4] Soil Survey of Maverick County, 1977

clays that produce mainly short grasses. Mesquite has invaded areas of these soils. Ridges and drainage-ways in these areas characterize the central and southern parts of the county. These soils are sandy loams and clay loams that produce a number of grasses and many shrubs. Shallow and gravelly soils on ridges, and hills along the Rio Grande produce good browse such as that provided by cuajillo, grasses, and forbs (Soil Survey of Maverick County, 1977).

1.1.2.5 Starr County

Starr County has a nearly level to undulating topography in most areas, but is rolling or hilly in a few locations. The most prominent landscape feature is the line of low hills that forms the boundary between the flood plain of the Rio Grande and the plain to the north. These gravelly, highly dissected ridges form an escarpment 50 to 100 feet above the flood plain[5]. At the southern extension of the west-facing Bordas Escarpment is a gently rolling plain with rounded hills and broad valleys. The hills are drained by a number of arroyos that flow into the Rio Grande. A minor but prominent landscape feature of Starr County is the sand sheet that covers the extreme northeastern part of the county. This area is the southwestern extension of an area of windblown sand that covers about 2,800 square miles of area in South Texas.

A majority of the county consists of deep, clayey and loamy soils on uplands. The parent material of most soils in the county consists of alkaline and calcareous, unconsolidated material deposited mainly in a fluvial (river) environment, as well as the windblown sand deposits discussed above. Eight different soil associations are mapped in Starr County and include the McAllen-Brennan, Catarina-Copita, McAllen-Zapata, Copita, Delmita, Rio Grande-Reynosa, Sarita, and Jimenez-Quemado associations (Soil Survey of Starr County, 1972).

1.1.2.6 Webb County

The land surface of Webb County is nearly level to rolling, with elevations ranging from 400 feet to about 900 feet above sea level[6]. The surface geology consists of consolidated and unconsolidated sedimentary and eolian (wind-blown) deposits that dip gently toward the Gulf of Mexico. Soils in Webb County consist of mostly deep, nearly level to gently sloping, clayey and loamy soils that vary widely in their potential for major land uses. Soil associations in Webb County include: Montell-Moglia-Viboras, Catarina-Maverick-Palafox, Catarina-Maverick-Moglia, Duval-Brystal, Aguilares-Montell, Hebbronville-Brundage-Copita, Copita-Verick, Delmita-Randado-Cuevitas, Maverick-Jimenez-Quemado, Laglori-rio Grande, and Nueces-Delfina (Soil Survey of Webb County, 1985).

1.1.2.7 Willacy County

[5] Soil Survey of Starr County, 1972
[6] Soil Survey of Webb County, 1985

Geologic formations in Willacy County crop out in bands that parallel the Gulf and dip gently gulfward[7]. The oldest surface geologic unit in the county is the Pleistocene-age Lissie Formation. Willacy County is on nearly level stream and coastal terraces where slopes are generally less than one percent; however, there is enough relief in the higher areas that well drained soils with well developed profiles have formed. Most of the soils in the county consist of loamy and clayey soils on nearly level flats and gently sloping ridges on stream and coastal terraces. Soil associations in Willacy County include: Raymondville-Mercedes, Lyford-Lozano, Hidalgo Racombes, Willacy-Racombes, Delfina-Hargill-Willacy, Willacy-Raymondville, Nueces-Sarita, Galveston-Mustang-Dune land, Sauz, Falfurrias, Satatton-Tatton, Willamar-Porfirio, Barrada-Lalinda-Arrada, and Saucel-Latina associations (Soil Survey of Willacy County, 1982).

1.1.2.8 Zapata County

Geologic units mapped in the county consist of mostly Eocene-aged deposits. The relief of the county is nearly level. Along the present stream channel of the Rio Grande, there are recent sediments derived from the wide variety of parent rocks within the vast watershed of the river. These sediments are mainly silty and alkaline or calcareous and they contain a high proportion of weatherable minerals.

A soil survey publication and map has not been prepared by the USDA Natural Resources Conservation Service (formerly the Soil Conservation Service) for Zapata County. Review of general soil map prepared by the Bureau of Economic Geology (Figure 1.5, above) indicates that the soils in the county consist of dark calcareous to neutral clays and clay loams and reddish-brown, neutral to slightly acid sandy loams.

1.1.3 Vegetation Areas (Biotic Communities)

Located within the Matamoran district of the Tamaulipan Biotic Province (Blair, 1950), the Lower Rio Grande Valley is the northern boundary of much of the semitropical biota of Mexico. A number of plant and animal species from the more xeric and mesic areas to the west and northeast respectively, converge in the Lower Rio Grande area.

1.1.3.1 Terrestrial Vegetative Types

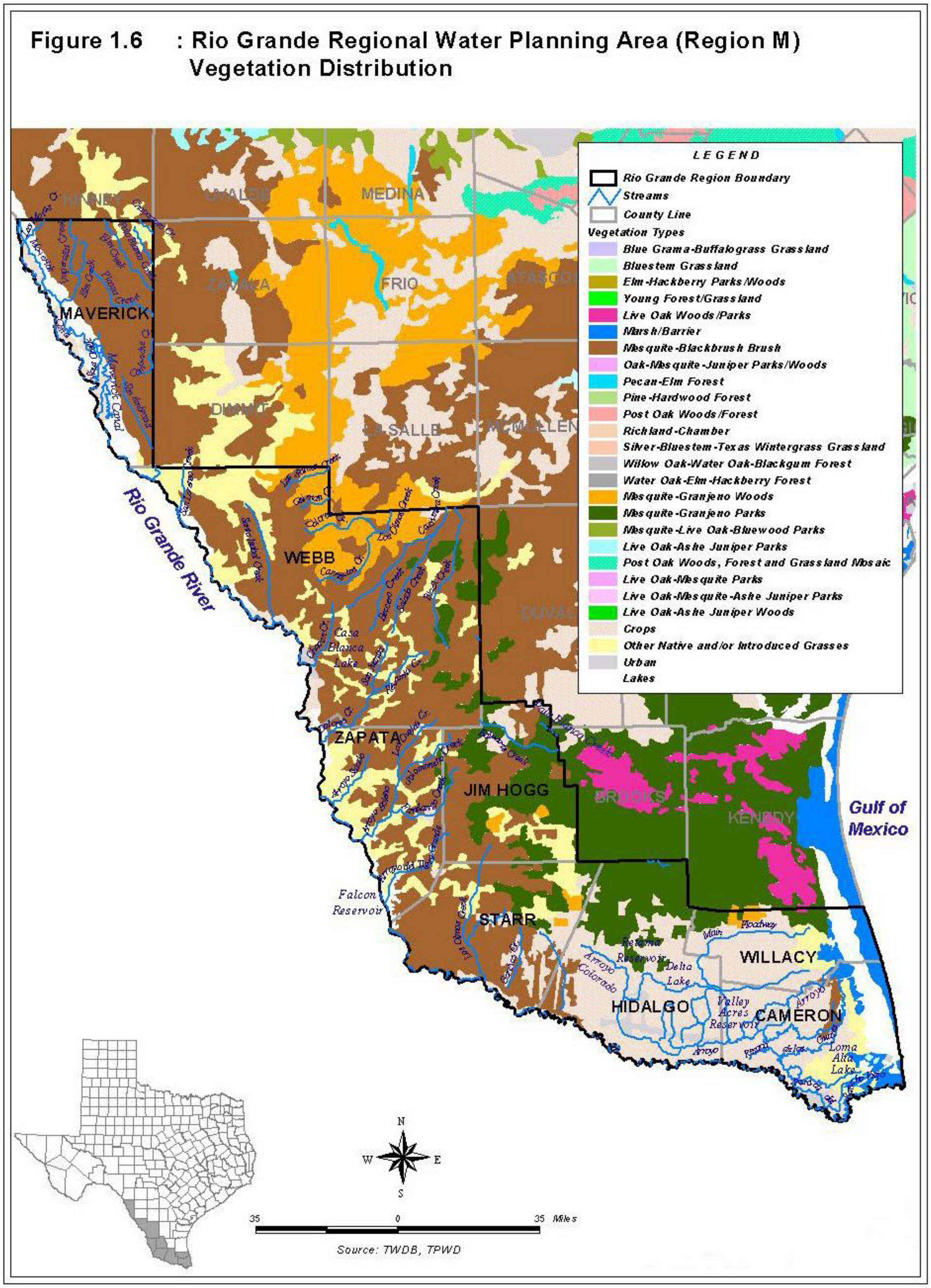
The predominant vegetation type in this area is thorny brush, but there is overlap with the vegetative communities of the Chihuahuan desert to the west, the Balconian province to the north (Texas Hill Country), and the tropical plant communities of Mexico to the south. The result is unique and varied flora and fauna. Xeric plants such as mesquite (Prosopis glandulosa), leatherstem (Jatropha dioica), lotebrush (Ziziphus obtusifolia), and brasil (Condalia hookeri) are found in this area. Sugar hackberry (Celtis laevigata) and Texas persimmon (Diospyra texana), more prevalent

[7] Soil Survey of Willacy County, 1982

to the north, are also located in the Lower Rio Grande Valley. Other common species such as lantana (Lantana horrida), Mexican olive (Cordia boisierri), and Texas ebony (Pithecellobium ebano) are typically more tropical in location. Montezuma bald cypress (Taxodium mucronatum), Gregg wild buckwheat (Eriogonum greggi), Texas ebony and anacahuita (Mexican olive) have their northernmost extension in the Lower Rio Grande Valley. More than 90 percent of total riparian vegetation and 95 percent of Tamaulipan Thornscrub have been cleared since the 1900s. Surface water remains only briefly in arroyos following substantial rainfall. Because of this scarcity of water the resulting vegetation types are closely correlated to topographic characteristics (LBJSPA, 1976).

Eleven distinct biotic communities compose the Lower Rio Grande Valley, stretching from Falcon Reservoir to the Gulf of Mexico (USFWS, 1997). The communities to the northwest are arid, semi-desert, thorny brush. Vegetation communities toward the coast are comprised of more wetlands, marshes and saline environments. (see Figure 1.6)

Figure 1.6: Rio Grande RWPA Vegetation Distribution



1.1.3.1.1 Ramaderos

This region, which occupies west-central Starr County, consists of arroyos that provide wildlife habitat.

1.1.3.1.2 Chihuahuan Thorn Forest

Located below Falcon Dam along the Rio Grande, the Chihuahuan Thorn Forest includes a narrow riparian zone and an upland desert shrub community. Rare plants such as the Montezuma bald cypress and the federally endangered Johnston's frankenia (Frankenia johnstonii) are found here, as well as such uncommon birds as the brown jay (Cyanocorax morio), ringed kingfisher (Ceryle torquata) and red-billed pigeon (Columba flavirostris).

1.1.3.1.3 Upper Valley Flood Forest

This community is located along the Rio Grande from south-central Starr County to the western border of Hidalgo County. The floodplain narrows in this region, with typical riverbank trees including Rio Grande ash (Fraxinus berlandieriana), sugar hackberry, black willow (Salix nigra), cedar elm (Ulmus crassifolia). Only a short distance from the river the dominant species shift to honey mesquite, granjeno (Celtis pallida), and prickly pear (Opuntia lindheimeri).

1.1.3.1.4 Barretal

The Barretal community occurs in southeastern Starr County, just north of the Upper Valley Flood Forest. Barreta (Helietta parvifolia), a small tree located on gravelly caliche hilltops, and paloverde (Parkinsonia texana), guajillo (Acacia berlandieri), blackbrush (Acacia rigidula), anacahuita, yucca (Yucca treculeana) and many species of cacti are typical of this community.

1.1.3.1.5 Upland Thorn Scrub

Upland Thorn Scrub, the most common community in the Tamaulipan Biotic Province, occurs in southwestern Hidalgo County. Typical woody plants include anacahuita, cenizo (Leucophyllum frutescens), and paloverde.

1.1.3.1.6 Mid-Valley Riparian Woodland

This community is located along the Rio Grande from western Hidalgo County eastward to the Sabal Palm Forest. This tall, dense, closed-canopy bottomland hardwood forest is favored by chachalacas (Ortalis vetula) and green jays (Cyanocorax yncas), birds more typical of Mexico. Trees of this community include Rio Grande ash, sugar hackberry, black willow, cedar elm, Texas ebony, and anaqua (Ehretia anacua).

1.1.3.1.7 Woodland Potholes and Basins

Central Hidalgo County and western Willacy County contain this community of seasonal wetlands and playa lakes. Additionally, three hypersaline lakes are present, attracting migrating shorebirds. The federally endangered ocelot (Leopardus pardalis) occupies dense thickets in this area. Wetlands are located in low woodlands of honey mesquite, granjeno, prickly pear, lotebush, elbow bush (Forestiera angustifolia) and brasil.

1.1.3.1.8 Mid-Delta Thorn Forest

The Mid-Delta Thorn Forest originally covered eastern Hidalgo County, the western two-thirds of Cameron County, and southwest Willacy County. Conversion of land for agricultural and urban uses has left only isolated pockets of native vegetation remaining. Typical plants include honey mesquite, Texas ebony, coma (Bumelia lanuginosa), anacua, granjeno, colima (Zanthoxylum fagara), and other thicket-forming species. This region provides excellent wildlife habitat and is a preferred area for white-winged dove (Zenaida asiatica).

1.1.3.1.9 Sabal Palms Forest

This area of riparian forest contains the last remaining acreage of original Sabal Palm Forest in south Texas. It is located on the Rio Grande at the southernmost tip of Texas. Vegetation in this region includes Texas sabal palm (Sabal texana), Texas ebony, tepeguaje (Leucaena pulverulenta), anacua, brasil, and granjeno. The National Audubon Society's Sabal Palm Grove Sanctuary is located in this area.

1.1.3.1.10 Loma Tidal Flats

Located at the mouth of the Rio Grande, this community consists of clay dunes, saline flats, marshes, and shallow bays along the Gulf of Mexico. Sea ox-eye (Borrichia frutescens), saltwort (Batis maritima), glasswort (Salicornia sp.), gulf cordgrass (Spartina spartinae), Berlandier's fiddlewood (Citharexylum berlandieri), Texas ebony and yucca are typical plants of this region.

1.1.3.1.11 Coastal Brushland Potholes

This community is comprised of dense brushy woodland around freshwater ponds, changing to low brush and grasslands around brackish ponds, and saline estuaries nearer the Gulf of Mexico. Typical plants include honey mesquite, granjeno, barbed-wire cactus (Acanthocereus pentagonus), and gulf cordgrass. Area wetlands provide important habitat for migratory wildlife.

1.1.3.2 Lower Laguna Madre

The lower Laguna Madre is a hypersaline bay most of which lies in the eastern portions of Cameron and Willacy counties. Shallow depth, extensive seagrass meadows, and tidal flats characterize it. Small portions of the lower Laguna Madre are estuarine in nature with more moderate to brackish salinities. The Arroyo Colorado provides most of the freshwater inflow to the bay with other drainage canals and floodways having smaller contributions. Freshwater from these sources aid in moderating salinities in the bay and are vital to the success of estuarine dependant aquatic species. The lower Laguna Madre supports a wide variety of marine aquatic organisms and wildlife. It also supports considerable water-related recreational activities (i.e. boating, sportfishing, bird watching, etc.) and commercial fisheries.

1.1.4 Protected Areas

Public and private interests have created several refuges and preserves in the Lower Rio Grande Valley to protect remaining vegetation and the habitats of endangered and threatened species. These include the Lower Rio Grande Valley National Wildlife Corridor/Refuge, Laguna Atascosa National Wildlife Refuge (NWR), Santa Ana NWR, Anzalduas County Park, Falcon State Park (SP), Bentsen-Rio Grande Valley SP, Boca Chica SP, Las Palomas Wildlife Management Area (WMA), Arroyo Colorado WMA, Sabal Palm Audubon Center and Sanctuary, the Nature Conservancy's Chihuahua Woods Preserve, and the SouthBay Coastal Preserve. Ten local communities and Texas Parks and Wildlife Department (TPWD) are currently in the final stages of planning for the World Birding Center committing $20-25 million to the project. These ten sites will be “world class” birding destinations attracting thousands of visitors to “bird” and learn about conservation of natural resources.

1.1.4.1 Lower Rio Grande Valley National Wildlife Refuge and Wildlife Corridor

The U.S. Fish and Wildlife Service (USFWS), with the support and assistance of the TPWD and several private organizations and individuals, is creating a wildlife corridor along the Rio Grande from Falcon Dam to the Gulf of Mexico. The wildlife refuge serves as the largest component of the Lower Rio Grande Wildlife Corridor. It currently includes 320 individual tracts totaling 88,044 acres. The completed refuge is projected to total 132,000 acres in fee and conservation easements. The wildlife refuges described below are part of this system. Additional acreage is purchased from willing sellers at fair market value or obtained through conservation easements.

1.1.4.2 Laguna Atascosa National Wildlife Refuge

Laguna Atascosa NWR contains more than 88,378 acres of land, providing essential habitat for a variety of south Texas wildlife. It is located north of the Rio Grande and south of the Arroyo Colorado along the Laguna Madre.

1.1.4.3 Santa Ana National Wildlife Refuge

This 2,088-acre refuge receives extensive bird watching attention because it is located at the convergence of two major migratory waterfowl flyways, the Central and the Mississippi. More than half of all butterfly species in the U.S. are found in this refuge.

1.1.4.4 Falcon State Park

This park, managed by the TPWD, contains over 500 acres above Falcon Dam. It is popular with bird watchers because of its diversity of bird species.

1.1.4.5 Sabal Palm Audubon Center and Sanctuary

This sanctuary, owned by the National Audubon Society, is located in the southernmost point of Texas on the Rio Grande. It is a 527-acre forested area that includes a substantial portion of the remaining sabal palm forest. The sanctuary is popular with bird watchers and other nature enthusiasts for its wildlife. The state threatened southern yellow bat (Lasiurus ega) is a year-round resident. The ocelot and jaguarundi (Herpailurus yagouaroundi) are believed to inhabit parts of the sanctuary.

1.1.4.6 Bentsen-Rio Grande Valley State Park

This park, managed by the TPWD, is located west of Mission in Hidalgo County. It consists of almost 600 acres of subtropical resaca woodlands and brushland, and is a popular bird-watching area. Boca Chica State Park, administered by Bentsen-Rio Grande Valley SP, is located in Southeastern Cameron County. Endangered and rare birds, such as Brown Pelicans, Reddish Egrets, Osprey, Peregrine Falcons, and several others, are commonly found in the park area.

1.1.5 Rare, Threatened, or Endangered Plant Species

The federal Endangered Species Act (ESA) of 1973, with amendments, provides a means to conserve endangered and threatened species and the ecosystems on which these species depend. The ESA provides for conservation programs for endangered and threatened species, and to take steps as may be appropriate for achieving the purposes of conserving species of fish and wildlife protected by international treaty. Federal agencies are required to ensure that no actions that an agency would undertake will jeopardize the continued existence of any endangered or threatened species, except as provided by the ESA. Any federal permits required to implement components of this water plan would be subject to the terms of the ESA. Specifically, Section 7 of the ESA requires that: "Each Federal agency shall, in consultation with and with the assistance of the Secretary (of the Interior), insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined…to be critical…. In fulfilling the requirements of this paragraph each agency shall use the best scientific and commercial data available."

Within the Rio Grande Region, twenty-six (26) plant species occur which have been designated by the USFWS and/or the TPWD as rare, threatened, or endangered. Seven out of the twenty-six species are federally listed species. Species designated as threatened or endangered receive full protection under the ESA. Species of Concern (SOC) are those species for which there is some information showing evidence of vulnerability, but lacking sufficient data to support listing at the present time.

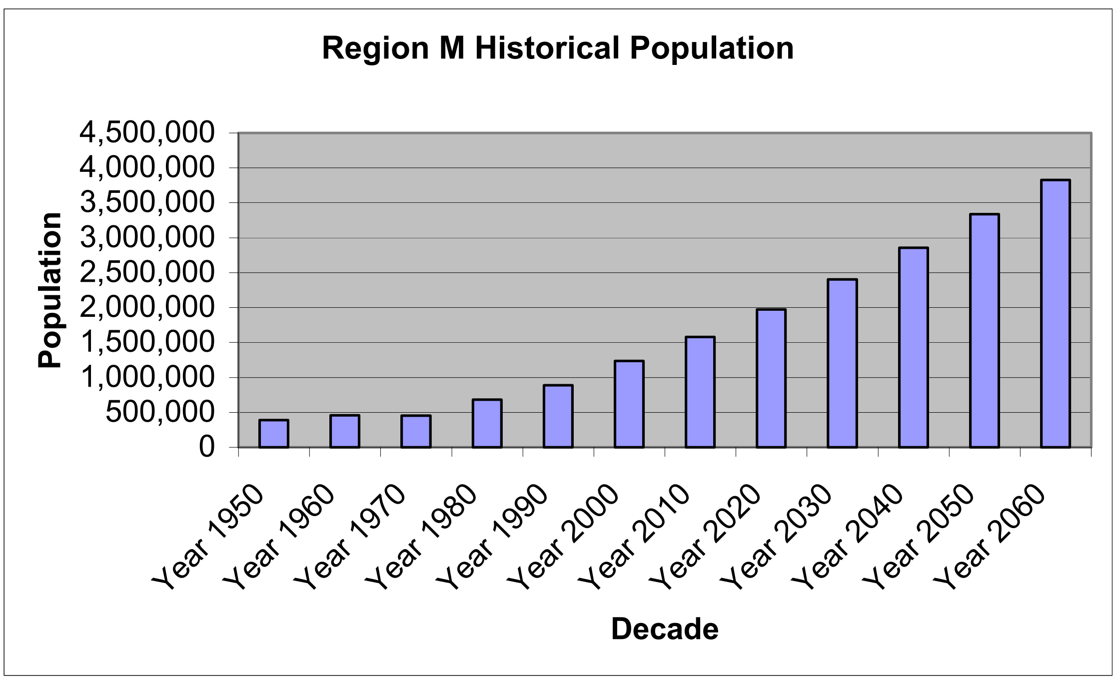
1.1.6 Rare, Threatened, or Endangered Animal Species

There are sixty-nine rare, threatened, or endangered animal species with habitat found within the Rio Grande Region that are listed by the USFWS and/or the TPWD. These include seven species of amphibians, 29 birds, nine fishes, eight mammals, 14 reptiles, and two insects. Thirteen out of the sixty-nine species are federally listed species.

1.2 DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF THE RIO GRANDE REGION

The following sub-sections provide an overview of the demographic and economic characteristics of the Rio Grande Region.

Figure 1.7: Historical Populations from US Census Bureau



Population in the Rio Grande Region increased from approximately 398,700 in 1950 to over 1.2 million in 2000. As shown in Figure 1.7, most of this increase has occurred since 1970. During the period from 1970 to 1990, six of the 31 fastest growing counties in Texas were within the Rio Grande Region. Hidalgo, Maverick, Starr, and Zapata counties more than doubled their populations during this 20-year period.
Population distribution in the Rio Grande Region is concentrated in Cameron, Hidalgo, and Webb counties. In 2000 the combined population of these three counties accounted for nearly 89 percent of the region's total population. Figures 1.8 and 1.9A show the population distribution for the region in 1950 and in 2000.

Figure 1.8: 1950 Region Population

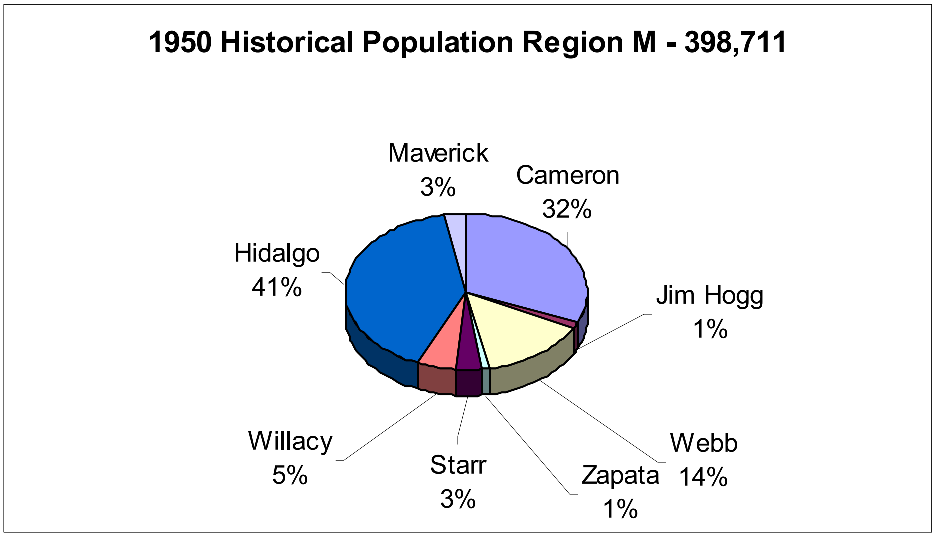


Figure 1.9: 2000 Region Population

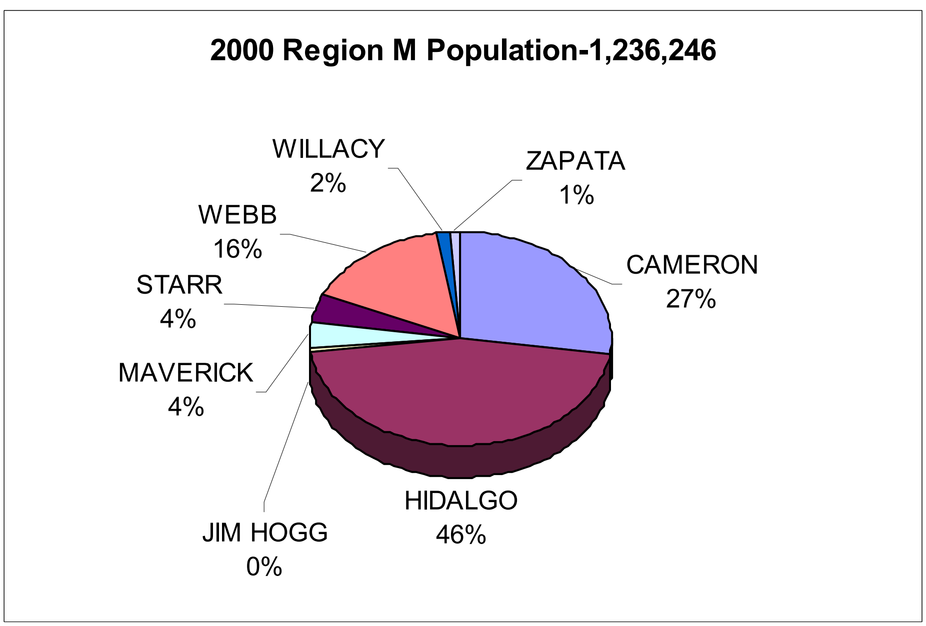
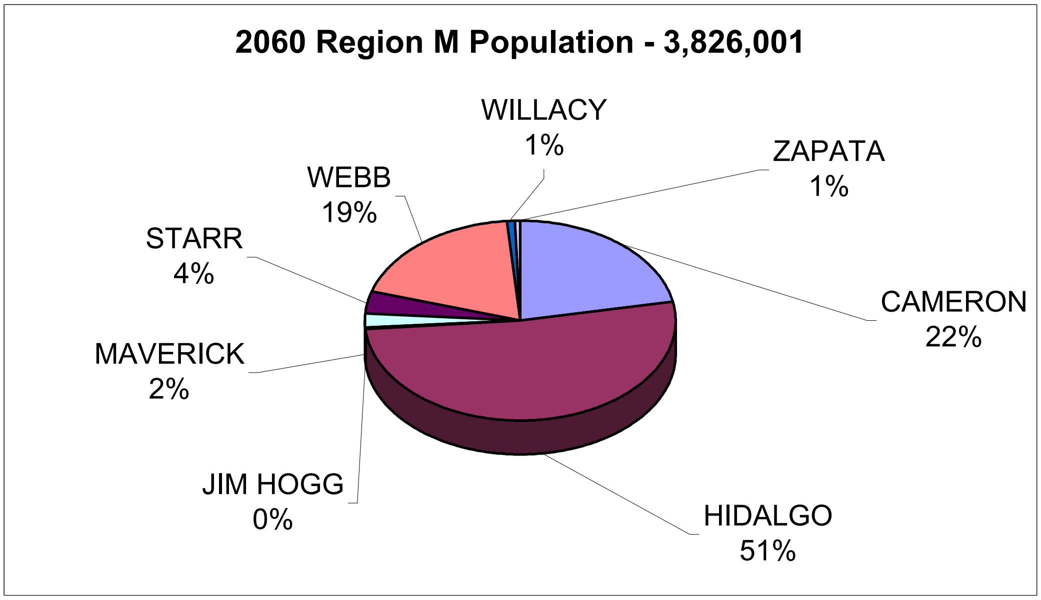


Figure 1.10: 2060 Region Population



1.2.1 Historical and Current Population

As indicated, the percentage of the region's population living in Cameron, Willacy and Jim Hogg counties has decreased slightly since 1950, while the portion of the population in the other five counties has either remained the same or increased. Chapter 2 of this report presents population growth projections for the Rio Grande Region for the 50-year planning period (2010 - 2060).

An important factor driving rapid population growth in the Rio Grande Region is its proximity to and its cultural, social, economic relationship with Mexico. Over the past 50 years, Mexico's population growth rate has been approximately three times greater than that of the United States. Much of that growth has occurred in the northern border states of Mexico. It is estimated that nearly seven million people currently live in the portion of the Rio Grande Basin that lies within Mexico. These population growth trends along both sides of the border are expected to continue for the foreseeable future.

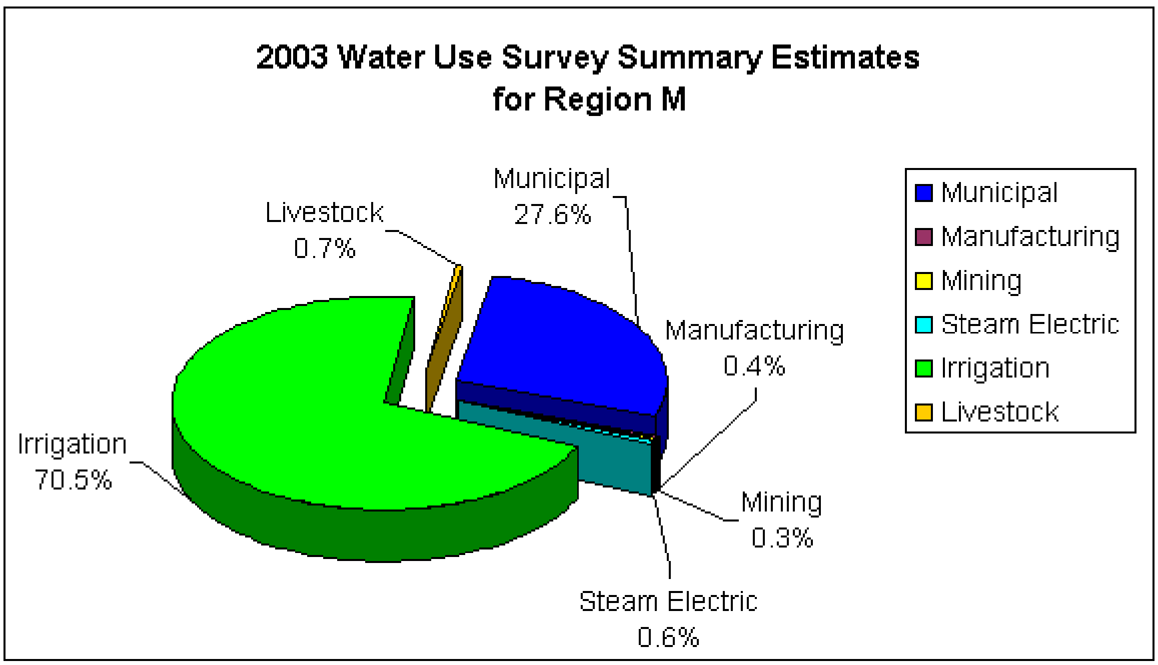
1.2.2 Current Water Use

According to the TWDB the water use for the year 2003 was based off of a population of 1,363,258. Hidalgo County came used a total of 383,387 acre-ft according the TWDB survey. Hidalgo used the most water compared to the other counties in the region. Cameron County came in second with a water use of 188,187 acr-ft. Jim Hogg County used the least amount of water at 1,520 acre-ft. Irrigation category used the most water for the region at 518,938 acre-ft. All this data can be found on the TWDB's website under their data section for water use.

Table 1.2: 2003 Water Use Estimates

2003 Water Use Estimates for Region M in acft								
Region	**County Name**	**Population Estimates**	**Municipal**	**Manufacturing**	**Mining**	**Steam Electric**	**Irrigation**	**Livestock**
M	CAMERON	365,095	56,587	1,085	8	2,090	128,066	351
M	HIDALGO	635,851	87,151	1,724	670	2,267	290,971	604
M	JIM HOGG	5,230	914	0	27	0	0	579
M	MAVERICK	50,006	7,624	65	140	0	50,164	402
M	STARR	57,541	6,516	9	0	0	7,686	1,140
M	WEBB	215,269	38,402	17	1,207	48	3,339	1,134
M	WILLACY	20,532	3,578	126	6	0	37,042	242
M	ZAPATA	13,734	2,240	0	0	0	1,670	481
Region M Total		**1,363,258**	**203,012**	**3,026**	**2,058**	**4,405**	**518,938**	**4,933**

Figure 1.11 2003 Water Use for Region M



1.2.3 Economic Activities

Historically, agriculture has been the predominant component of the economy of the Rio Grande Region. While the region is becoming more urbanized and its economy is becoming more diversified, agriculture still plays a major role in the regional economy. More than 75 percent of the region's total land area is used for agriculture and livestock (Figure 1.10). The Texas Comptroller of Public Accounts (CPA) website shows that agricultural income during the last five years have averaged over $500 million per year for Cameron, Hidalgo, Willacy, and Starr counties, of which, more than 80 percent was from crop production. The primary crops produced in the region are fruits, vegetables, cotton, and sorghum. Agriculture receipts in the other counties within the region come primarily from livestock, with some vegetable crop production.

Over the last five years, beef cattle have made up an average of 99 percent of total livestock cash receipts in the valley. That is an average value of more than $77 million a year. The majority of the receipts for beef cattle have come from Starr County, averaging about $57 million a year the past decade(CPA website).

Due in part to its proximity to Mexico, the trade, services, and manufacturing sectors are becoming increasingly important to the region's economy. The trade and service sectors of the economy have been responsible for much of the economic growth in the Rio Grande Region over the past decade in terms of both revenue and employment. Growth in these sectors of the economy is largely attributable to the significant expansion of trade between the U.S. and Mexico under the North American Free Trade Agreement (NAFTA). Under NAFTA, the region is becoming increasingly important as a transportation hub for trade with Mexico.

Manufacturing is an important sector of the economy, primarily in the region's three U.S. Census Bureau designated Metropolitan Statistical Areas of Brownsville-Harlingen-San Benito, McAllen-Edinburg-Mission, and Laredo. The most important factor in the expansion of the region's manufacturing sector has been the growth of the maquiladora industry in Mexico. At the end of the millennium, approximately 81 percent of the more than 2,000 maquila plants in Mexico were located in the six northern Border States. The maquila industry was originally designed to take advantage of certain U.S. tariff code provisions that allowed U.S. firms to export unassembled products to Mexico for assembly. The assembled products are then imported in the U.S. Duties were only paid on the value added during the assembly process rather than on the full value of the product. Even more favorable tariff conditions are now in place under NAFTA and the maquiladora industry has been shifting toward full transformation of raw materials for finished products.

In Jim Hogg, Webb, Starr, and Zapata counties, oil and gas production and trade are also important sources of income, averaging over $1 billion per year in taxable value in the past decade.

The Texas Department of Economic Development (TDED) website illustrates that in 1997 the total destination spending for tourism for Cameron, Hidalgo, Willacy, and Starr counties was over $1,000 million. Tourism in Falcon State Park has significant economic impact in Zapata and Starr Counties. In addition, water-related recreational activities (boating, sportfishing, bird watching, etc…) and commercial fishing in the lower Laguna Madre and adjacent waters also influence the regional economy. In 1995, the direct impact of water-related recreational activities in the

Laguna Madre to South Texas and the state was $221 million. The direct impact of commercial fishing in South Texas was $63.1 million.

Wildlife viewing in and around areas with aquatic habitats contributes considerably to the Rio Grande Valley Economy. The economic impact of bird watchers at surveyed refuges in the Rio Grande Valley is estimated to be approximately $90 million dollars per year (Source: TPWD, USFWS, and World Birding Center Community Council comments, 2000). Santa Ana NWR attracts an estimated 99,000 bird watchers per year, most of whom have traveled from outside of the four county area, and most from other states. These visitors inject $36 million dollars into the local economy, with a total gross input of almost $89 million dollars. Also, within the last two years, two new businesses have been added, which have begun taking tourists on canoeing and river exploration trips on the Rio Grande new birding lodging facilities. Additionally, existing outfitters on the Arroyo Colorado continue to do business. The four Valley nature festivals generate significant income to the local economics. The quality of the river and its adjacent wildlife habitat will affect the number of ecotourists visiting the Valley in the future.

Although the Rio Grande Region has seen a large increase in the number of jobs during the decade of the 1990s, unemployment remains significantly above the state and national averages, and median household income are significantly lower. High unemployment is attributed largely to the constant influx of immigrants from Mexico and the area's abundance of migrant workers. Table 1.3 presents median household income and unemployment rate by county.

Table 1.3: Median Household Income and Unemployment Rate, by County

County	Median Household Income ($)	Percent of Labor Force that is Unemployed (%)
Cameron	26,155	6
Hidalgo	24,863	6.3
Jim Hogg	25,833	4.3
Maverick	21,232	8.9
Starr	16,504	9.9
Webb	28,100	4.9
Willacy	22,114	6.6
Zapata	24,635	4.9

Source: Bureau of the Census

According to the Texas Comptroller of Public Accounts (CPA), Region M is part of the CPA's thirteen-region economic model for Texas. Region M is included in the South Texas Region of their model. This region according to the state comptroller is predicted to be the fastest growing region of the state from 2000 to 2005. During this first part of the millennium, employment growth in this region should reach 2.8 percent annually. This is a full percentage point above the expected average of 1.9 percent for the state of Texas as a whole. This trend is shows that this region will prosper despite the economic slowdown being set by the state of Texas as a whole.

The South Texas Border region saw a significant growth in the past 30 years. Gross regional product in this region has quadrupled from $5.3 billion in 1970 to $20.3 billion in 2000. This is an annual growth rate of 4.6 percent. In 1970, employment in South Texas Border region was 177,000 but by 2000 had grown to 535,000. This is an average annual growth of 3.2 percent. The statewide rate was 2 percent. The per capita spendable income rose from $7,400 in 1970 to $13,000 in 2000. This is a gain of 76 percent. In the year 2000 this region accounted for 6.7 percent of the population and 4.4 percent of the state's employment base.

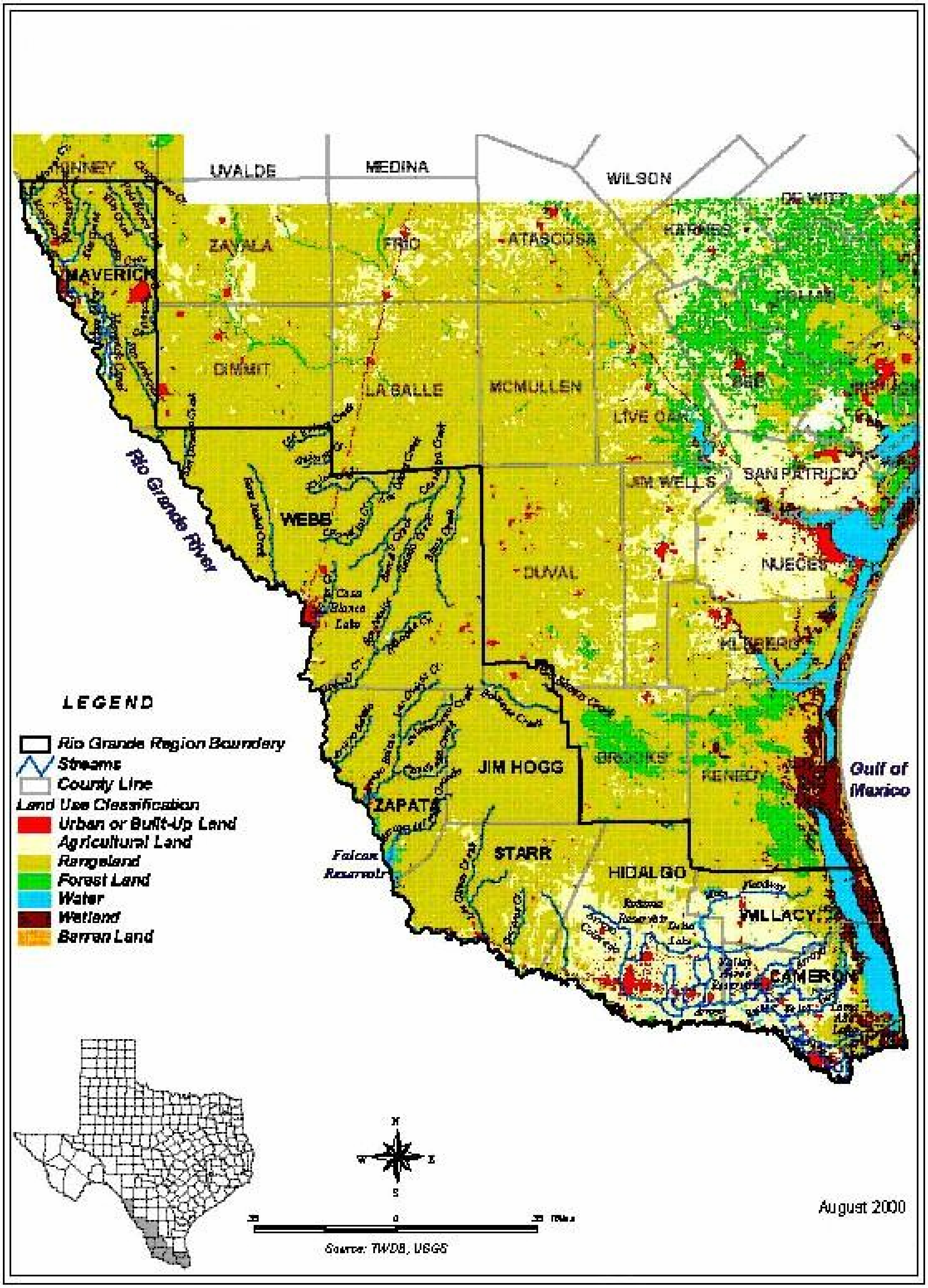
Table 1.4: EDAP Counties

Region M Counties Eligible for EDAP Legislation
Under Section 17.923 of the Water Code
Texas Water Development Board

Counties	Average Unemployment Rate 2001-2003 (%)	Percent Above State Rate	Average Per Capita Income 2000-2002 ($)	Percent Below State Rate
Texas Average	6.0	n/a	28,765	n/a
Cameron	10.1	69.2	15,519	-46.0
Hidalgo	13.3	122.1	14,208	-50.6
Maverick	23.6	293.7	12,002	-58.3
Starr	19.3	221.6	10,013	-65.2
Webb	7.2	20.6	15,890	-44.8
Willacy	17.0	183.5	14,423	-49.9
Zapata	7.9	31.3	12,988	-54.8

According TWDB seven out of the eight counties in Region M are labeled as EDAP Counties. This means even though this region is the fastest growing region it still needs a long way to hit economic prosperity. To be labeled eligible for EDAP legislation under Section 17.923 of the Water Code TWDB you need to meet certain criteria. The first one is that the county's unemployment rate has to be higher than 25% of the states average over the latest three-year data period. The second criteria is that the county's average per capita income rate has to be 25% below the state average over the latest three-year data period. The qualifying level of per capita income is $21573.75. The qualifying level unemployment is 7.5%. The highest unemployment rate is 23.4% by Maverick County. The lowest unemployment rate is 7.2% by Webb County. Table 1.3B shows the counties that qualify as EDAP counties. Overall Region M's economic profile is presented in this section through its positive and negative characteristics.

Figure 1.102: Rio Grande RWPA Surface Water Hydrology



1.3 SURFACE WATER RESOURCES

The Rio Grande Region encompasses portions of three river basins: the Rio Grande, the Nueces and the Nueces-Rio Grande (see Figure 1.11). An overview of the characteristics and surface water resources of each of basin is provided in the sections that follow and more detailed descriptions are provided in Chapter 3. The adoption of this plan has no major impacts to navigation regarding the water resources of the region.

1.3.1 Rio Grande Basin

As depicted in Figure 1.12, the Rio Grande Basin extends southward from the Continental Divide in southern Colorado through New Mexico, and Texas to the Gulf of Mexico. From El Paso, Texas to the Gulf, the Rio Grande forms the international boundary between the United States and Mexico, a straight-line distance of 700 miles and a river mile distance of nearly 1,250 miles. Approximately 176,000 square miles of the 355,500 square miles in the entire Rio Grande Basin contributes to the Rio Grande. The remainder of the Basin consists of internal closed sub-basins. The Texas portion of the contributing watershed encompasses approximately 54,000 square miles. Approximately 8,100 square miles within the Texas portion of the basin are in closed sub-basins that do not contribute flows to the Rio Grande. The Pecos and Devils Rivers are the principal tributaries of the Rio Grande in Texas. Both of these rivers flow into Amistad Reservoir on the Rio Grande, which is located upstream of the City of Del Rio, Texas, about 600 river miles from the mouth of the Rio Grande. There are no major springs in this region which could be used as source of water supply.

In Mexico, the Rio Conchos, Rio Salado, and the Rio San Juan are the largest tributaries of the Rio Grande. The Rio Conchos drains over 26,000 square miles and flows into the Rio Grande near the town of Presidio, Texas, about 350 river miles upstream of Amistad Reservoir. The Rio Salado has a drainage area of about 23,000 square miles and discharges directly into Falcon Reservoir on the Rio Grande. Falcon Reservoir is located between the cities of Laredo, Texas and Rio Grande City, Texas, about 275 river miles upstream from the Gulf of Mexico. The Rio San Juan has a drainage area of approximately 13,000 square miles and enters the Rio Grande about 36 river miles below Falcon Dam near Rio Grande City, Texas. Amistad-Falcon Reservoir system is designated as a special water resource by the TWDB (31 TAC 357.5(g)).

In addition to the two international reservoirs on the Rio Grande (i.e., Amistad and Falcon), Mexico has constructed an extensive system of reservoirs on tributaries of the Rio Grande. Figure 1.13 shows the location of these reservoirs. The impacts of the development of the tributary reservoirs in Mexico on the supply of water available to the Rio Grande Region has been evaluated as part of the regional planning effort and is discussed in Chapter 3.

The vast majority of the Rio Grande Basin is comprised of rural, undeveloped land that is used principally for farming and ranching operations. In Texas, the major urban centers include El Paso in the far western portion of the state; the cities of Del Rio, Eagle Pass, and Laredo on the river in the central portion of the basin; and Mission, McAllen, Harlingen, and Brownsville in the Lower Rio Grande Valley. In Mexico, there are several major urban areas along the Rio Grande including Juarez, Nuevo Laredo, Reynosa, Monterrey, and Matamoras.

Practically all of the surface water available to and used in the Rio Grande Region is from the Rio Grande. Nearly all of the dependable surface water supply that is available to the Rio Grande Region is from the yield of the Amistad and Falcon International Reservoirs. These reservoirs are operated as a system by the International Boundary and Water Commission (IBWC) for flood control and water supply purposes. These impoundments provide controlled storage for over eight million acre-feet of water owned by the United States and Mexico, of which 2.25 million acre-feet are allocated for flood control purposes and 6.05 million acre-feet are reserved for sedimentation and conservation storage (water supply).

Some very limited supplies are available from tributaries of the Rio Grande in Maverick, Webb, Zapata, and Starr counties; from the Arroyo Colorado which flows through southern Hidalgo County and northern Cameron County to the Laguna Madre; from the pilot channels within the floodways that convey local runoff and floodwaters from the Rio Grande throughout the Lower Rio Grande Valley to the Laguna Madre; and from isolated lakes and resacas in Hidalgo and Cameron counties. Under drought of record conditions, surface water supplies from sources other than the Rio Grande are of little significance.

According to available publications and literature, existing springs within the Rio Grande Basin of the Region M planning area (primarily Maverick, Webb, Zapata, Jim Hogg, and Starr Counties) are not numerous and small in terms of their discharge quantities. There are no major springs that are extensively relied upon for water supply purposes. Many of the small springs do provide water for livestock and wildlife when they are flowing. Typically the flow rate of the existing springs isles than 20 gallons per minute, with most springs in the region flowing at a rate of only a few gallons per minute. Therefore there are no major springs that are extensively relied upon for water supply purposes. Much of the area is underlain by shales and marls, which cannot store or transmit much water.

Figure 1.113: Rio Grande RWPA Surface Water Hydrology

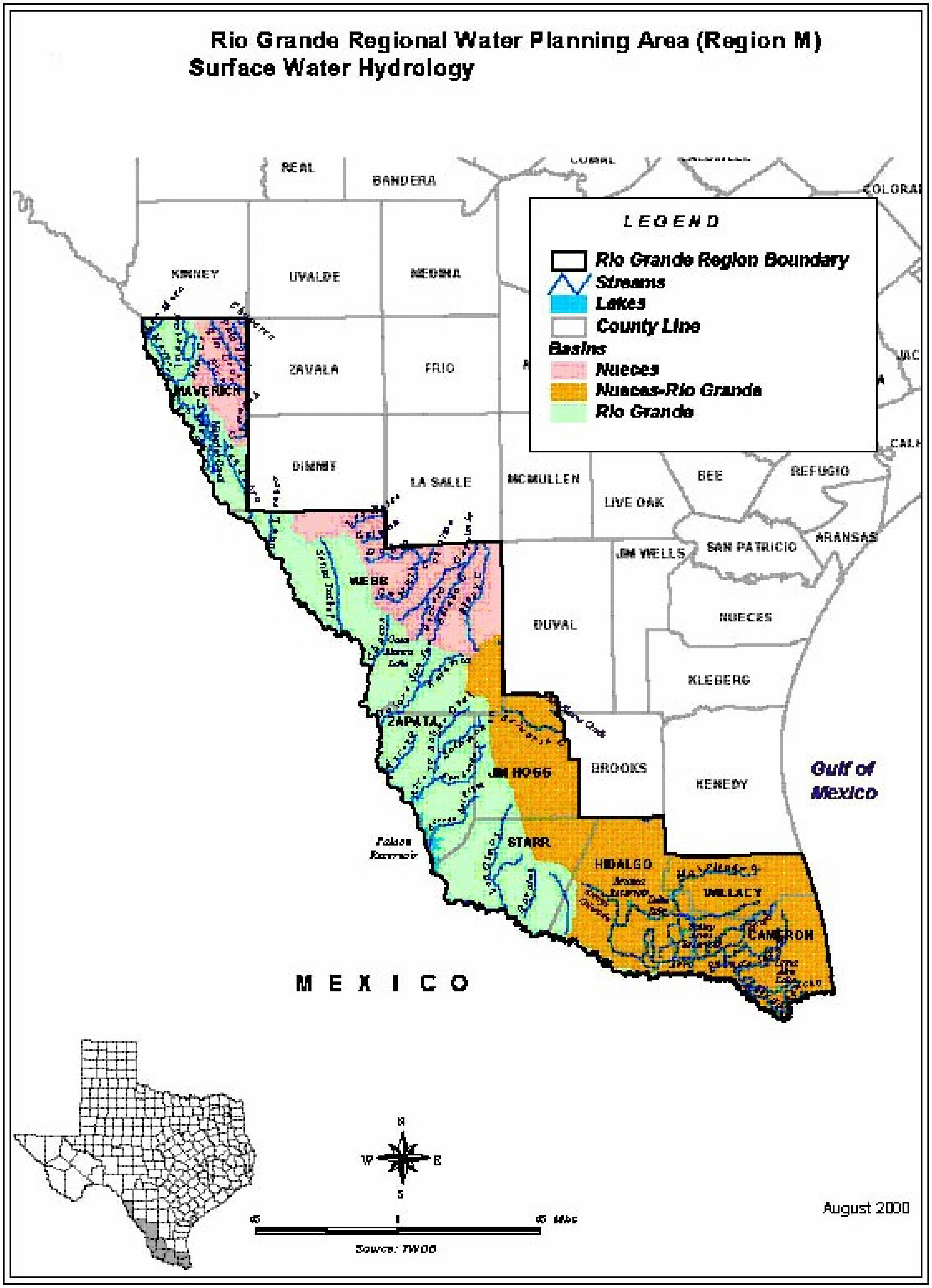


Figure 1.124: Rio Grande RWPA Watershed

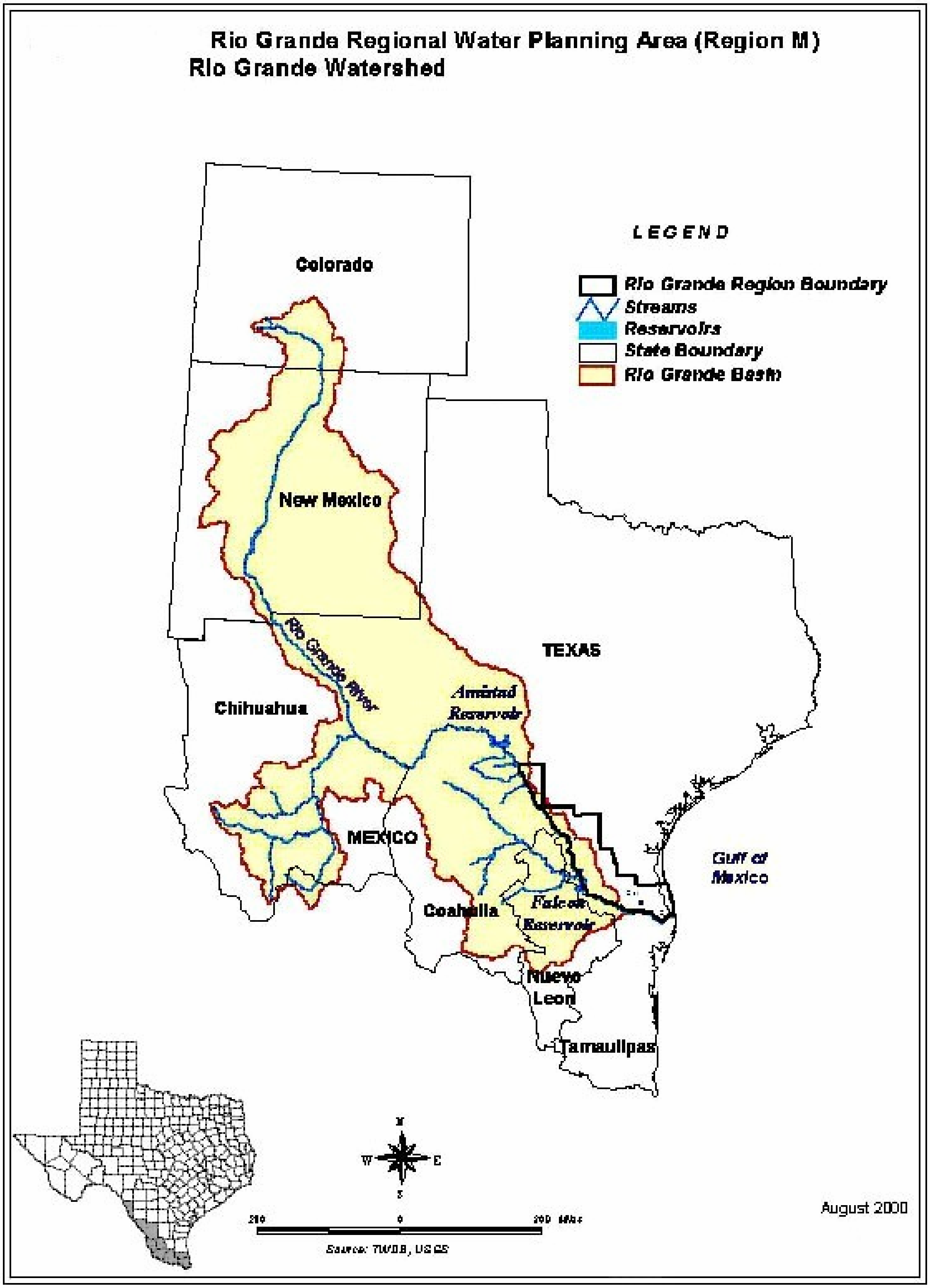
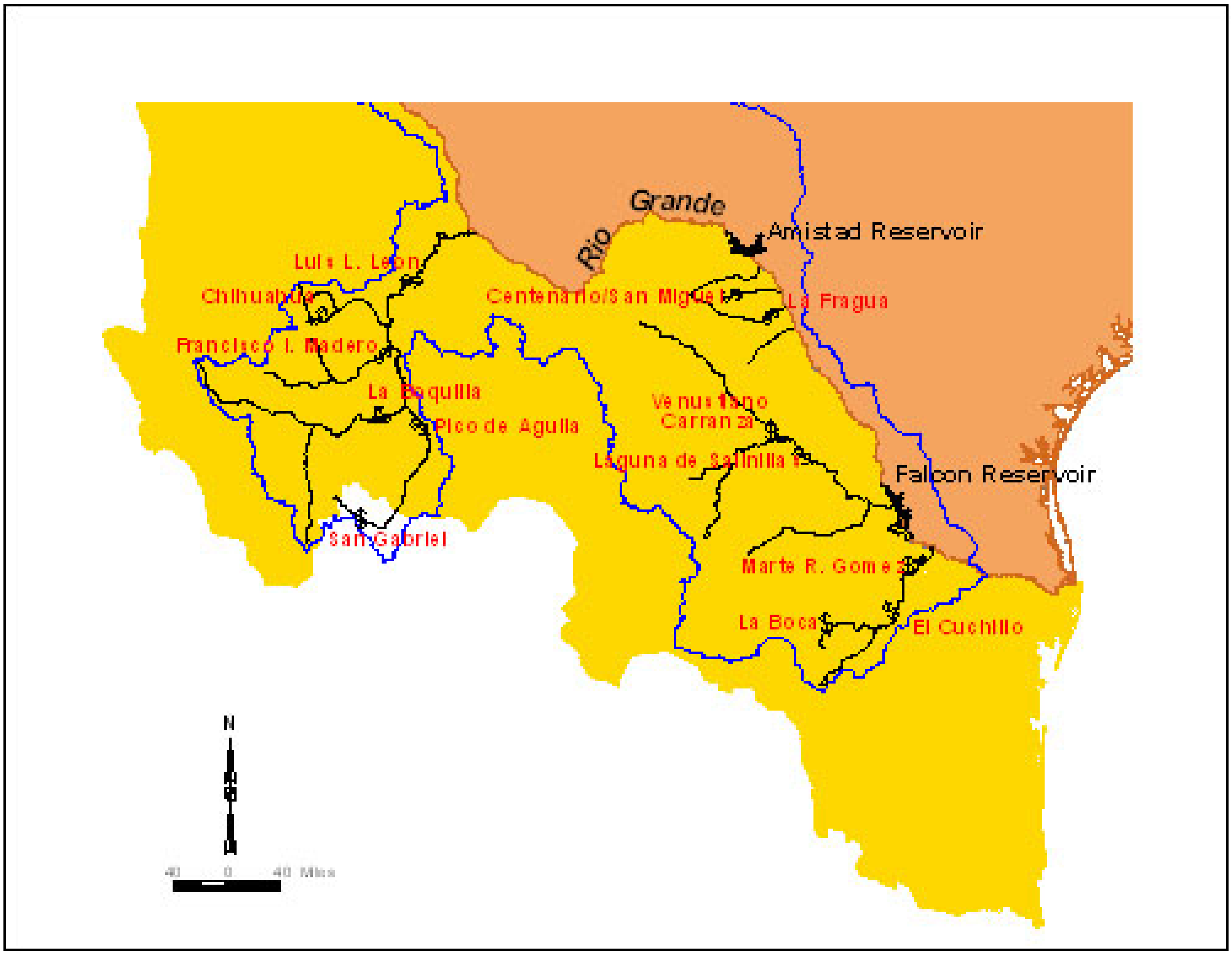


Figure 1.135: Major Reservoirs Located on Tributaries of the Rio Grande in Mexico



1.3.2 Nueces River Basin

The Nueces River Basin is bounded by the Rio Grande and Nueces-Rio Grande Basins on its southern boundary and by the Colorado, San Antonio, and San Antonio-Nueces Basins on its northern boundary. The basin extends from Edwards County in Texas to its discharge point in Nueces Bay, which flows into Corpus Christi Bay and ultimately to the Gulf of Mexico. As shown in Figure 1.11 (above), only a small portion of the Nueces Basin in Webb and Maverick counties is located within the Rio Grande Region. No part of the Nueces River passes through the Rio Grande Region and the Nueces Basin is of little consequence in terms of the surface water supply available to the region.

1.3.3 Nueces-Rio Grande Coastal Basin

The Nueces-Rio Grande Coastal Basin is bounded on the north by the Nueces River Basin, on the west and south by the Rio Grande Basin. The drainage area of the Nueces-Rio Grande Coastal Basin is 10,442 square miles. The area drains to the Laguna Madre Estuary. Within the Rio Grande Region the basin encompasses the southeastern portion of Webb County, nearly two-thirds of Jim Hogg County, the majority of Hidalgo and Cameron counties, and all of Willacy County (Figure 1.11, above). There are two major drainage courses in the basin: the main floodway and the Arroyo Colorado. The Arroyo Colorado is of special importance because it flows directly into the hyper-saline lower Laguna Madre. Freshwater inflows from the Arroyo Colorado are critical to the ecological health of the Laguna Madre estuary and the commercial and sport fishing industries that are dependent upon it. In addition to natural drainage, most of the surface water diverted from the lower Rio Grande, as well as water discharges and irrigation tailwater, flows to the Arroyo Colorado. However, there are no natural perennial streams within the drainage area and the basin is of little consequence in terms of water supply.

According to available publications and literature, existing springs within the Nueces-Rio Grande Coastal Basin of the Region M planning area (Cameron, Hidalgo and Willacy Counties) are not numerous and small in terms of their discharge quantities. There are no major springs that are extensively relied upon for water supply purposes. Many of the small springs do provide water for livestock and wildlife when they are flowing.

1.3.4 Surface Water Quality

Surface water quality is addressed in this section for portions of two basins - the Rio Grande, which flows directly into the Gulf of Mexico; and the Arroyo Colorado, which discharges into the Laguna Madre and then into the Gulf of Mexico. Surface and sub-surface discharges that arise from both natural processes and the activities of man affect the quality of these water resources. In general, the presence of minerals, which contribute to the total dissolved solids concentration in surface water, arise from natural sources, but can be concentrated as flows travel downstream. Return flows from both irrigation and municipal uses can concentrate dissolved solids, but can also add other elements such as nutrients, sediments, chemicals, and pathogenic organisms.

Water in the Rio Grande normally is of suitable quality for irrigation, treated municipal supplies, livestock, and industrial uses; however, salinity, nutrients, and fecal coliform bacteria are of concerns throughout the basin. Salinity concentrations in the Rio Grande are the result of both human activities and natural conditions: the naturally salty waters of the Pecos River are a major source of the salts that flow into Amistad Reservoir and continue downstream. Untreated or poorly treated discharges from inadequate wastewater treatment facilities primarily in Mexico, is the principal source for fecal coliform bacteria contamination. A secondary source is from nonpoint source pollution on both sides of the river, including poorly constructed or malfunctioning septic and sewage collection systems and improperly managed animal wastes. Nutrient levels are a concern in the Rio Grande, but current levels do not represent a severe threat to human health, nor have they supported excessive aquatic plant growth. In the Rio Grande, below Amistad Reservoir, contact recreation use is not supported due to the elevated levels of fecal coliform bacteria that have been observed.

The Arroyo Colorado traverses Willacy, Cameron, and Hidalgo counties and is the major drainageway for approximately two dozen cities in this area, with the notable exception of Brownsville. Almost 500,000 acres in these three counties are irrigated for cotton, citrus, vegetables, grain sorghum, corn, and sugar cane production, and much of the runoff and return flows from these areas are discharged into the Arroyo Colorado. The Arroyo Colorado and the Brownsville Ship Channel both discharge into the Laguna Madre near the northern border of Willacy County. The Arroyo Colorado includes the TCEQ Classified Stream Segment 2201 and 2202. Use of the water in the Arroyo Colorado for municipal, industrial, and/or irrigation purposes is severely limited because of the poor water quality conditions that exist there. A more detailed discussion of surface water quality is presented in Chapter 3.

1.4 GROUNDWATER RESOURCES

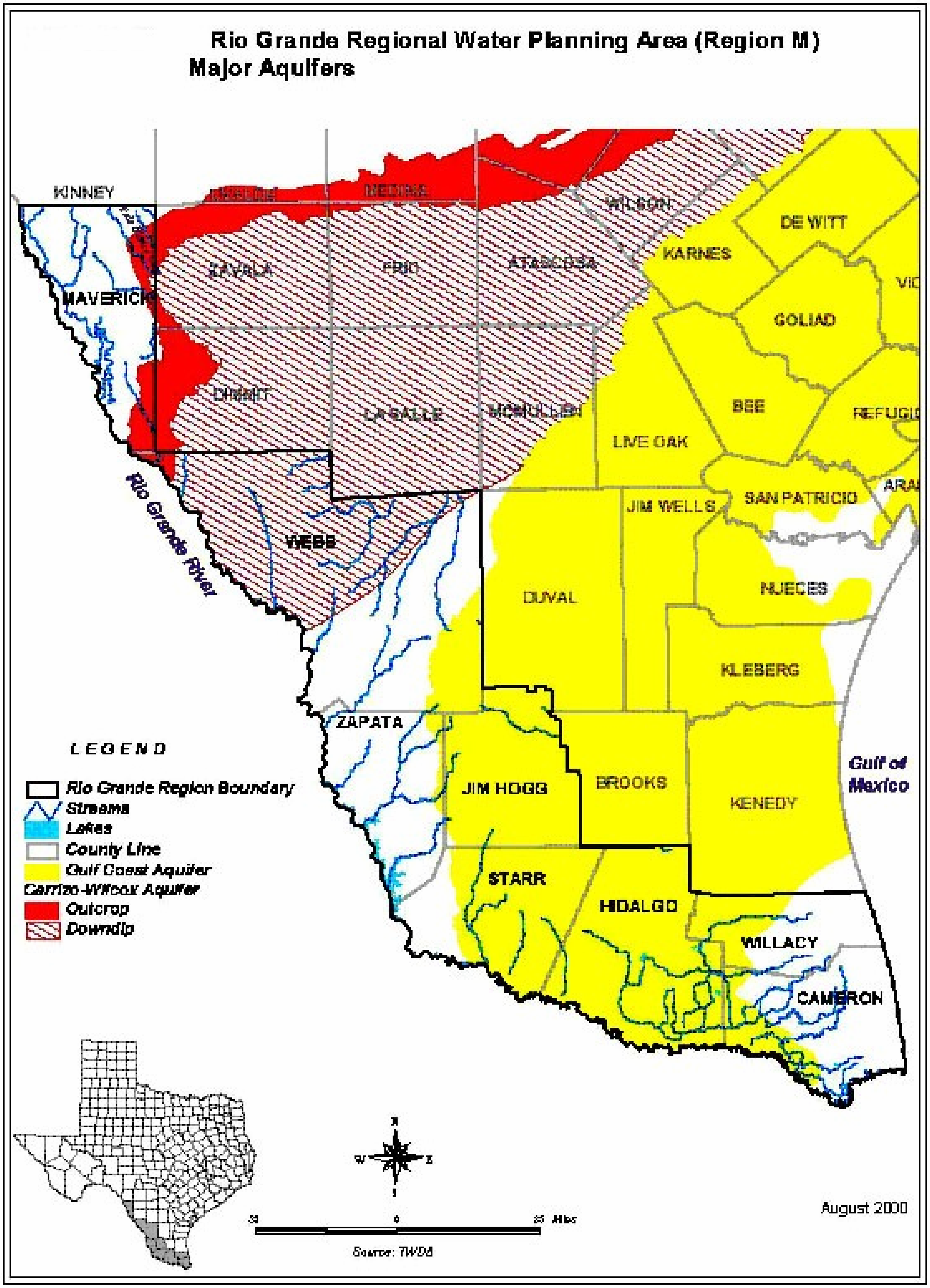
Throughout the Rio Grande Region groundwater provides water supply that ranges from sustainable municipal supplies to quantities of water suited for irrigation, livestock, and industrial supply. The major aquifers within the region include the Gulf Coast aquifer, which underlies the entire coastal region of Texas and the Carrizo aquifer that exists in a broad band that sweeps across the state beginning at the Rio Grande north of Laredo and continuing northeast to Louisiana. Figure 1.14 illustrates the location of these aquifers. The minor aquifers that exist within the region have not been identified in prior water plans developed by the TWDB as “minor aquifers,” but they may produce significant quantities of water that supply relatively small areas. These minor aquifers in the region include the Rio Grande Alluvium, which is also called the Rio Grande aquifer, the Laredo Formation, and the Yegua-Jackson aquifer. A more detailed discussion of each of these groundwater sources is presented in Chapter 3.

1.4.1 Groundwater Quality

In general, groundwater from the various aquifers in the region has total dissolved solids concentrations exceeding 1,000 mg/L (slightly saline) and often exceeds 3,000 mg/L (moderately saline). The salinity hazard for groundwater ranges from high to very high8. Localized areas of high boron content occur throughout the study area. Chapter 3 presents a detailed description of groundwater quality in the Gulf Coast aquifer, Carrizo Wilcox aquifer, Laredo Formation, Rio Grande Alluvium and in other aquifers in the Rio Grande Region.

[8] Salinity hazard is a measure of the potential for salts to be concentrated in the soil from high salinity groundwater. Accumulation or buildup of salts in the soil can affect the ability of plants to take in water and nutrients from the soil. Salinity hazard is usually expressed in terms of specific conductance in micromhos per centimeter at 25° C.

Figure 1.146: Region M Major Aquifers



1.5 EXISTING WATER PLANNING IN THE RIO GRANDE REGION

1.5.1 Local Water Planning

In addition to its impacts on state and regional water planning, Senate Bill 1 has also had a significant impact on local water planning in the Rio Grande Region and throughout the state. Under SB 1 and associated rules of the Texas Commission of Environmental Quality (TCEQ):

- Municipal, industrial and non-irrigation water right holders of 1,000 or more acre-feet and irrigation rights holders of 10,000 or more acre-feet are required to prepare and implement water conservation plans;

- All such water rights holders and all public water systems with more than 3,300 connections were required to prepare and submit a drought contingency plan by September 1, 1999; and,

- All public water systems with less than 3,300 connections were required to prepare a drought contingency plan by September 1, 2000.

Because of these requirements and recent drought conditions, many communities in the Rio Grande Region have addressed drought preparedness. A review of TCEQ records shows that many communities and irrigation districts in the region have water conservation and drought contingency plans. Specifically, as of February 2000:

Twenty-nine of the 39 municipal, industrial and non-irrigation water right holders of 1,000 or more acre-feet and irrigation rights holders of 10,000 or more acre-feet have prepared and filed water conservation plans with the TCEQ; and,

24 of the 26 public water systems in the region with more than 3,300 connections have prepared and filed drought contingency plans with the TCEQ.

Table 1.4 lists the entities that have prepared and filed water conservation and drought contingency plans. It should be noted that smaller public water systems (i.e., those with fewer than 3,300 connections) were required to prepare drought plans by September 2000. Furthermore, these small systems do not have to file their drought plans with the TCEQ.

In addition to drought preparedness at a local level, the on-going drought in the Rio Grande watershed has shown that the water rights system for the middle and lower Rio Grande functions effectively as a regional drought contingency plan. Under this system, domestic, municipal, and industrial (DMI) water rights have a very high degree of reliability and are provided with further assurance through a DMI reserve of 225,000 acre-feet that is maintained in the reservoir system. By comparison, irrigation and mining water rights are treated as residual users of stored water from the reservoirs and therefore bear the brunt of water supply shortages. In essence, irrigation and mining water demand must adjust to the available water supply. Furthermore, many irrigation districts allow transfers of water between individual irrigators. Such transfers have the effect of reallocating limited irrigation supplies from lower to higher value uses, thereby minimizing the economic impact of water shortages.

Table 1.5: Existing Local Water Plans filed with the TCEQ

Water Supplier		Water Conservation Plan	Drought Contingency Plan
1.	Brownsville PUB	X	X
2.	Laguna Madre Water District	X	X
3.	City of Edinburg	X	X
4.	City of Mercedes	X	X
5.	City of Mission	X	X
6.	City of Pharr	X	X
7.	Sharyland WSC	X	X
8.	City of Eagle Pass	X	X
9.	City of Laredo	X	X
10.	City of McAllen	X	X
11.	Los Fresnos	X	X
12.	La Joya WSC	X	X
13.	Military Highway WSC	X	X
14.	Olmito WSC	X	X
15.	North Alamo WSC	X	X
16.	City of San Benito	X	X
17.	City of San Juan	X	
18.	City of Alamo	X	X
19.	City of Weslaco	X	X
20.	City of Donna	X	X
21.	Maverick County WCID # 1	X	
22.	Rio Grande City	X	X
23.	City of Roma	X	
24.	East Rio Hondo WSC	X	
25.	San Ygnacio MUD	X	
26.	Zapata County Waterworks	X	X
27.	Brownsville IDD	X	X
28.	Harlingen ID CC # 1	X	X
29.	Bayview ID # 11	X	X
30.	Delta Lake ID	X	X
31.	Donna ID	X	X
32.	Hidalgo/Cameron Co. WCID # 9	X	X
33.	HCID # 2	X	X
34.	HCID # 1	X	X
35.	HCID # 16	X	X
36.	HCID # 5	X	X
37.	HCID # 6	X	X
38.	HCWID # 3	X	X
39.	La Feria ID CC # 3	X	X
40.	Santa Cruz ID # 15	X	X
41.	Cameron County ID # 2	X	X

Water Supplier		Water Conservation Plan	Drought Contingency Plan
42.	TxDOT	X	X
43.	United ID	X	X
44.	Valley Acres ID	X	X
45.	CP&L	X (Laredo, JL Bates, La Palma)	(TCEQ submittal not required)

1.5.2 Existing Regional Water Plans

Immediately prior to the initiation of the SB 1 regional water planning program, two regional water supply planning projects were conducted within the Rio Grande Region. In February 1998, Phase I of the South Texas Regional Water Supply Plan (STRWSP) was completed under the sponsorship of the South Texas Development Council, with funding assistance from the TWDB. This plan addressed water supply needs in Jim Hogg, Starr, Webb, and Zapata counties. The report for this initial planning phase provided background data and identified key issues that need to be addressed in future water planning. Specific recommendations regarding water supply strategies were not developed.

In February 1999, the Integrated Water Resources Plan (IWRP) for the Lower Rio Grande Valley was completed. This planning effort was sponsored by the Lower Rio Grande Valley Development Council with funding from the TWDB, the U.S. Economic Development Administration, the U.S. Bureau of Reclamation, and local sources. This plan addressed water planning issues in Cameron, Hidalgo, and Willacy counties. In addition to comparing projected water supplies and demand, the IWRP makes specific recommendations regarding water supply for the three counties it addressed. One of the key conclusions of the plan is that:

"The dramatic population growth will result in an increase in municipal water demands to supply domestic, manufacturing, and steam electric needs. However, these increasing municipal demands, and the remaining agricultural water requirements after the impacts of urbanization are considered, can be met through:

- improvements to the irrigation canal delivery system;
- aggressive water conservation efforts in all areas of consumption; and,
- implementation of wastewater reuse, desalination of brackish groundwater and desalination of seawater where cost effective."

Both the IWRP and the STRWSP were carefully reviewed as a part of this water planning process and serve as valuable references for this regional water plan.

1.5.3 Summary of Recommendations from the Current State Water Plan

The 1997 State Water Plan, Water for Texas, provides an overview of water-related problems and supply needs within the Rio Grande Region. The primary recommendation in this report by the Rio Grande Regional Water Planning Group is that the transfer of irrigation water rights to municipal use will be necessary to satisfy growing municipal demands. This recommendation represents a continuation of a trend that began when water rights for the Lower Rio Grande Valley were adjudicated in 1971. To illustrate, in 1971 there were approximately 155,000 acre-feet of Rio Grande water rights held for domestic-municipal-industrial (DMI) use. At present, there are approximately 240,000 acre-feet of water rights for DMI use in the area below Falcon Reservoir and approximately 58,000 acre-feet of water rights for DMI use in the middle Rio Grande. This increase in the amount of DMI water rights is a result of the gradual conversion of irrigation rights through voluntary, market-based transfers between willing buyers and willing sellers.

The 2002 State Water Plan also recommends that the City of Brownsville, acting through the Brownsville Public Utilities Board (PUB), meet its long-term projected water supply needs with the development of the Brownsville weir and reservoir. The project would consist of a weir in the Rio Grande that is located approximately eight miles downstream of the Gateway Bridge in Brownsville. This project would capture unregulated flows that normally discharge into the Gulf of Mexico and would provide an additional water supply for the City of Brownsville. Chapter 4 of this report presents a more detailed discussion of this project.

1.6 THREATS TO AGRICULTURAL AND NATURAL RESOURCES

1.6.1 Quantity

As described in section 1.3.3 and in detail in Chapter 3, under the existing water rights system irrigation water use is a "residual" claimant to available water supplies from the Rio Grande. During periods of low inflows to the reservoir system, when there are little or no allocations made to irrigation and mining storage accounts, these users deplete their storage accounts and may suffer shortages. Under "drought of record" conditions, hydrologic simulations of reservoir operations indicate that only 60-80 percent of the potential irrigation demand can be satisfied. In essence, the system for the administration of Rio Grande water rights functions as a regional drought management plan in that DMI uses are given a priority over irrigation and mining uses and, during drought conditions, irrigation and mining demands must be reduced to levels that match the available supply. Consequently, irrigated agriculture bears the brunt of drought in terms of supply shortages and the associated economic costs of such shortages. Chapter Seven discusses the effects of environmental provided by a study done by the National Wildlife Federation.

An additional threat to the availability of water from the Rio Grande for irrigation use is the development and operation of reservoirs on Mexican tributaries. An evaluation of the operation of existing reservoirs during the current drought indicates that significant quantities of water are owed to the United States by Mexico under the terms of the 1944 treaty. Because of the manner in which available supplies are managed by the State of

Texas, any decrease in water availability due to the operation of reservoirs in Mexico will result in further decreases in the available water supply for irrigation and mining use.

Another threat to the agricultural and natural resources of the region is the impact of ongoing and projected urbanization on currently undeveloped areas. Particularly in Cameron and Hidalgo counties, projected urbanization is expected to significantly reduce the area of irrigable farmland. Within the Lower Rio Grande Valley, urbanization is expected to be concentrated in corridors along State Highways 77 and 83, which run through agricultural areas. In addition to the direct reduction of irrigable farmland acreage due to change in land use, urbanization also impacts adjacent farmland by increasing property values and restricting some types of agricultural activities (e.g. use of pesticides).

Increased pumping of groundwater from the Gulf Coast Aquifer and the Rio Grande Alluvium may threaten riparian habitats fringing resacas and potholes. This would have a negative impact on ecotourism. The lowering of Falcon Lake level due to reduced inflow could negatively impact the diversity of bird species that currently exists. The increased pumping of groundwater and removal of water from storage will lower the flow rate of the existing springs across the region that livestock and wildlife may depend upon.

1.6.2 Water Quality

According to The State of Texas Water Quality Inventory, issued by the TCEQ in 1996, the size and wide range of geologic and climatic conditions in the Rio Grande Basin are responsible for a wide range of water quality in the river system. Most of the flow of the Rio Grande is diverted for irrigation and municipal uses at the American Canal in Texas and the Acequia-Madre Canal in Mexico before it reaches El Paso. Downstream of El Paso, most of the flow consists of treated municipal wastewater from El Paso and irrigation return flow. The Rio Grande flow is intermittent to Presidio, where inflow from Mexico's Rio Conchos enters the river. The presence of metals and pesticides has been identified sporadically throughout the Rio Grande Basin. Elevated fecal coliform levels occur in the river downstream of major U.S./Mexico border cities due to municipal wastewater discharges in Texas and untreated wastewater discharges in Mexico. Levels of chloride and total dissolved solids are increasing in the Rio Grande downstream of Falcon Reservoir due to repeated use of water for irrigation. Elevated nutrient levels are also common in the Rio Grande.

Major tributaries to the Rio Grande are the Devils River and Pecos River in Texas, and the Rio Conchos, Rio Salado, Rio San Juan, Rio Alamo, and Rio San Rodrigo in Mexico. The Devils River has no known water quality problems. The Pecos River drains a substantial part of New Mexico and far West Texas. The saline waters of the Pecos River entering Texas are stored in Red Bluff Reservoir. Downstream of the reservoir, the salinity in the Pecos River continues to increase.

The TCEQ's 1996 Clean Rivers Program also has summarized water quality concerns and possible water quality concerns on a river basin basis (TWDB, 1997).

The water quality of the Rio Grande Basin has been studied extensively in recent years to assess concentrations of salts, conventional pollutants, and toxics. Data indicate increasing levels of fecal coliform as an indicator of declining water quality. However, through the construction of new wastewater treatment facilities in Nuevo Laredo, as well as active programs for wastewater treatment improvements administered by the Border Environmental Cooperation Commission, these influences are not considered to be of long-term significance (STDC, 1998). Wastewater treatment plant expansions should be encouraged in the colonias to improve the quality of water that is discharged into the river.

The Texas Water Commission (now the TCEQ) in cooperation with IBWC and CAN completed intensive salt balance studies in 1988 and in 1993. These studies were incorporated into analyses by Miramoto, Fenn, and Swietlik (Flow, Salts, and Trace Elements in the Rio Grande, TR-169, July 1995). This report found that the salt load to the Amistad Reservoir was approximately 1.84 million tons per year. The contributing flow from Fort Quitman and the Pecos River was found to contribute 48 percent of the salt load while delivering only 21 percent of the flow. Salinity levels were observed to be increasing due to the specific influences of the Pecos River, Rio Salado, and tailwater from Fort Quitman. These three water sources were found to contribute 50 percent of the salt load and only 26 percent of the Texas/Mexico flow in the Rio Grande River.

The report observed that due to these salinity loads, concentrating effects of evaporation, and low flow contributions from non-point sources, the salinity levels of the Rio Grande were increasing. Furthermore, the salinity levels in Amistad Reservoir are projected to double from their 1969 levels by the year 2004 (increasing at a rate of 15 mg/L per year). Meanwhile, salinity concentration in Falcon Reservoir is projected to reach levels as high as 885 mg/L by the year 2000.

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

The TCEQ has participated in a Bi-national Toxic Substances Study of the Rio Grande River and is currently authoring a technical report addressing the study's results. This study, conducted with the IBWC and CAN, used regulatory screening levels for protection of aquatic life, human health, toxic concentrations considered for federal criteria and other criteria to screen water samples collected from the Rio Grande. Results suggest that the public water supply could be threatened if detected constituents were found in sufficiently high concentrations. The data may have more relevance to aquatic life than drinking water supply.

In The State of Texas Water Quality Inventory, the TCEQ noted that the Arroyo Colorado, the major drainage way in the Lower Rio Grande Valley, receives much of its flow from municipal, industrial, and agricultural wastewater generated in the area. In the above-tidal segment, which is wastewater effluent dominated, fecal coliform bacteria levels are elevated, preventing attainment of the standard for contact recreation use. In the tidal segment, the aquatic life use is not supported because of depressed dissolved oxygen concentrations. Nutrient and chlorophyll concentrations exceed screening levels in both segments (TWDB).

In the above-tidal portion of Petronila Creek, ortho-phosphorus concentrations are elevated. In addition, chloride, sulfate, and total dissolved solids concentrations exceed segment criteria, as a result of leaching from deposits left by past oil field activity (TWDB).

Elevated concentrations of various metals and/or pesticides occur in sediment in the Arroyo Colorado above tidal and Petronila Creek above Tidal. Pesticide residues derived from agricultural runoff have been a long-standing problem in the Arroyo Colorado (TWDB). The Texas Department of Health has issued a restricted-consumption advisory for the Arroyo Colorado in the above-tidal portion. The advisory recommends that fish consumption be limited to one meal per month due to elevated levels of chlordane, toxaphene, and DDT in fish tissue. The advisory covers portions of Willacy, Cameron, and Hidalgo counties. An aquatic life closure has been issued for Donna Reservoir due to elevated levels of PCBs in fish tissue (TWDB).

1.7 WATER PROVIDERS & DEMAND CENTERS

Table 1.6: Wholesale Water Providers

Wholesale Water Providers		
WWP	**County Name**	**Supply Basin**
Brownsville Irrigation & Drainage District	Cameron County	Nueces-Rio Grande
Cameron County WCID #2	Cameron County	Rio Grande
Delta Lake Municipal Authority	Willacy County Hidalgo County	Rio Grande
Donna Irrigation District Hidalgo County #1	Hidalgo County	Rio Grande
City of Eagle Pass	Maverick County	Rio Grande
Harlingen Irrigation District	Cameron County	Nueces-Rio Grande
Harlingen Waterworks System	Cameron County	Nueces-Rio Grande
Hidalgo County Irrigation District #6	Hidalgo County	Rio Grande
Hidalgo County WCID #1	Hidalgo County	Rio Grande
Hidalgo County WCID #16	Hidalgo County	Rio Grande
Hidalgo County WCID #2	Hidalgo County	Rio Grande
Hidalgo County WCID #3	Hidalgo County	Rio Grande
Hidalgo County WCID #9	Hidalgo County	Rio Grande
La Feria WCID #3	Cameron County Willacy County	Rio Grande
Laguna Madre WD	Cameron County	Rio Grande
City of McAllen	Hidalgo County	Rio Grande
Sharyland WSC	Hidalgo County	Rio Grande
Southmost Regional Water Authority	Cameron County	Nueces-Rio Grande
United Irrigation District	Hidalgo County	Rio Grande
Valley MUD #2	Cameron County	Nueces-Rio Grande Rio Grande
North Alamo Water Supply Corporation	Hidalgo County	Nueces-Rio Grande Rio Grande

Texas Water Development Board guidelines in Exhibit B state that a wholesale water provider is any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-ft of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. Table 1.6 above indicates the Water providers that follow the TWDB guidelines to designate them as Wholesale water Providers for this region.

Texas Water Development Board guidelines provide that that each regional water planning group may identify and designate "major water providers." These guidelines define major water provider as an entity "…which delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale and/or retail basis." The intent of TWDB requirements is to ensure that there is an adequate future supply of water for each entity that receives all or a significant portion of its current water supply from another entity.

Table 1.7: Major Water Demand Centers in the Rio Grande Region

Major Municipal Water Demand Centers	
County	***Demand Center***
Cameron	Brownsville-Harlingen-San Benito
Hidalgo	McAllen-Edinburg-Mission
Webb	Laredo

For this initial regional water plan, the Rio Grande RWPG elected to not designate any water suppliers in the region as "major water providers." This decision was made primarily based on the unique nature of water rights and water marketing in the Rio Grande Region. Although there are numerous entities, including irrigation districts and municipalities, that currently supply or deliver water to other entities, these relationships are not fixed and can change with the changing water needs of a water user group. Designation of major water providers will be re-considered in future updates of the regional water plan.

Table 1.8: Major Water Demand Centers in the Rio Grande Region

Irrigation Major Water Demand Centers						
Irrigation District	***Irrigable Acres***	***Authorized Water Right (ac-ft)***		***Irrigation District***	***Irrigable Acres***	***Authorized Water Right (ac-ft)***
Adams Gardens	7,400	18,737		HCWID#3 (McAllen)	3,200	9,752
Bayview	6,000	17,978		HCWID#5 (Progresso)	5,700	14,234
Brownsville	17,000	34,876		HCID#6 (Mission)	16,531	42,545
CCID#2 (San Benito)	75,000	151,941		HCCID#9 (Mercedes)	65,000	177,151
CCID#6(Los Fresnos)	15,000	52,142		HCID#13	1,200	4,856
CCWID#10	3,453	10,213		HCID#16 (Mission)	4,948	30,749
CCWID#16	1,753	3,913		HCWCID#18	2,100	5,505
CCWID#17	1,399	625		HCWCID#19	5,000	11,777
Delta Lake	70,000	174,776		La Feria ID CC#3	27,500	75,626
Donna	32,000	94,063		Santa Cruz ID #15	32,800	82,008
Engleman	7,761	20,031		Santa Maria ID CC#4	3,700	10,182
Harlingen	39,000	98,233		United ID	26,836	69,461
HCID#1 (Edinburg)	30,000	85,615		Maverick Co. ID	-	-
HCID#2 (San Juan)	46,709	147,675		Valley Acres	7,948	22,500
HCMUD	0	1,120				

* Valley Estates Utilities District was abolished on April 25, 2005.

ATTACHMENT 1-1

Texas Parks & Wildlife

Last Revision: 11 Feb 2005

Annotated County Lists of Rare Species

CAMERON COUNTY

	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Mexican Treefrog (*Smilisca baudinii*) – subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools		T
Sheep Frog (*Hypopachus variolosus*) – predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
White-lipped Frog (*Leptodactylus labialis*) - grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Brown Pelican (*Pelecanus occidentalis*) - largely coastal and near shore areas, where it roosts on islands and spoil banks	LE	E
Brownsville Common Yellowthroat (*Geothlypis trichas insperata*) - tall grasses and bushes near ponds, marshes, and swamps; breeding April to July		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) - cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Northern Aplomado Falcon (*Falco femoralis septentrionalis*) - open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird	LE	E

species		
Northern Beardless-tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July		T
Piping Plover (*Charadrius melodus*) – wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats	LT	T
Reddish Egret (*Egretta rufescens*) – resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear		T
Rose-throated Becard (*Pachyramphus aglaiae*) - riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July		T
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (Tillandsia unioides); feeds on invertebrates, fruit, and nectar; breeds March-August		
Snowy Plover (*Charadrius alexandrinus*) - wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats		
Sooty Tern (Sterna fuscata) – predominately "on the wing"; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July		T
Texas Botteri's Sparrow (*Aimophila botterii texana*) - grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses		T
Tropical Parula (*Parula pitiayuma*) – dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July		T
White-faced Ibis (*Plegadis chihi*) – prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats		T
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		T
Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T
Zone-tailed Hawk (*Buteo albonotatus*) - rough, deep, rocky canyons and streamsides in semiarid mesa, hill, and mountain terrain; breeding March to July		T

*** BIRDS-RELATED ***

Colonial waterbird nesting areas - many rookeries active annually
Migratory songbird fallout areas - oak mottes and other woods/thickets provide foraging/roosting sites for neotropical migratory songbirds

*** FISHES ***

American Eel (*Anguilla rostrata*) - most aquatic habitats with access to ocean; spawns January-February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries

Blackfin Goby (*Gobionellus atripinnis*) - brackish and freshwater coastal streams		T
Opossum Pipefish (*Microphis brachyurus*) - brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth		T
River Goby (*Awaous banana*) - clear water with slow to moderate current, sandy or hard bottom, and little or no vegetation; also enters brackish and ocean waters		T
Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt		
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves.	LE	E

*** INSECTS***

Smyth's Tiger Beetle (*Cicindela chlorocephala smythi*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches		

*** MAMMALS ***

Coues' Rice Rat (*Oryzomys couesi*) – cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August		T
Jaguar (*Panthera onca*) (extirpated) – dense chaparral; no reliable TX sightings since 1952	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Mexican Long-tongued Bat (*Choeronycteris mexicana*) - deep canyons where uses caves & mine tunnels as day roosts; also found in buildings & often associated with big-eared bats (*Plecotus* spp.); single TX record from Santa Ana NWR		
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Plains Spotted Skunk (*Spilogale putorius interrupta*) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
Southern Yellow Bat (*Lasiurus ega*) – associated with trees, such as palm trees (*Sabal mexicana*) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter		T
West Indian Manatee (*Trichechus manatus*) - Gulf and bay system; opportunistic, aquatic herbivore	LE	E
White-nosed Coati (*Nasua narica*) – woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground & in trees; omnivorous; may be susceptible to hunting, trapping, & pet trade		T
Yuma Myotis Bat (*Myotis yumanensis*) - desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; single offspring born May-early July		

MOLLUSKS

False Spike Mussel *(Quincuncina mitchelli*) - substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins		
Mexican Fawnsfoot *(Truncilla cognata*) - largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin		
Salina Mucket *(Potamilus metnecktayi*) - lotic waters; other habitat requirements are poorly understood; Rio Grande Basin		
Texas Hornshell *(Popenaias popeii*) - both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico	C1	

*** REPTILES ***

Atlantic Hawksbill Sea Turtle *(Eretmochelys imbricata*) - Gulf and bay system	LE	E
Black-striped Snake (*Coniophanes imperialis*) - extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June		T
Green Sea Turtle *(Chelonia mydas*) – Gulf and bay system	LT	T
Indigo Snake (*Drymarchon corais*) – thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T
Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Kemp's Ridley Sea Turtle *(Lepidochelys kempii*) - Gulf and bay system	LE	E
Leatherback Sea Turtle *(Dermochelys coriacea*) - Gulf and bay system	LE	E
Loggerhead Sea Turtle *(Caretta caretta*) - Gulf and bay system	LT	T
Northern Cat-eyed Snake (*Leptodeira septentrionalis septentrionalis*) - Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal		T
Speckled Racer (*Drymobius margaritiferus*) - extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August		T
Texas Horned Lizard (*Phrynosoma cornutum*) - open arid or semi-arid regions with sparse vegetation; grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover		T
Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T

*** VASCULAR PLANTS ***

Bailey's ballmoss (*Tillandsia baileyi*) – epiphytic on various trees and shrubs; flowering February-May

Green Island echeandia (*Echeandia texensis*) - associated with shrubs or in grassy openings in subtropical thornscrub plant communities on somewhat saline clay on lomas along the Gulf Coast near the mouth of the Rio Grande; known to flower in April, June, and November, and may also flower in other months		
Lila de los llanos (*Echeandia chandleri*) - grasslands and openings in subtropical woodlands and brush on clay soils; common in windblown saline clay on lomas near mouth of Rio Grande; flowering (May?) September-December; fruiting October-December		
Mexican mud-plantain (*Heteranthera mexicana*) - aquatic; ditches and ponds; flowering June-August		
Plains gumweed (*Grindelia oolepis*) – endemic; prairies and grasslands on black clay soils of the Gulf Coastal Bend; may occur along railroad rights-of-way and in urban areas; flowering May-December		
Runyon's cory cactus (*Coryphantha macromeris* var. *runyonii*) - endemic; low hills and flats on gravelly soils in Tamaulipan shrub communities along the Rio Grande		
Runyon's water willow (*Justicia runyonii*) - calcareous silt loam, silty clay, or clay in openings in subtropical woodlands on active or former floodplains; flowering (July-) September-November		
Shinner's rocket (*Thelypodiopsis shinnersii*) - mostly found along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouths of rivers; flowers mostly March and April		
South Texas ambrosia (*Ambrosia cheiranthifolia*) - open prairies and various shrublands on deep clay soils; flowering July-November	LE	E
St. Joseph's staff (*Manfreda longiflora*) - endemic; various soils (clays and loams with various concentrations of salt, caliche, sand, and gravel) in openings or amongst shrubs in thorny shrublands; on Catahoula and Frio formations, and also on Rio Grande floodplain alluvial deposits; flowering in September		
Star cactus (*Astrophytum asterias*) – gravelly saline clays or loams over the Catahoula and Frio formations, on gentle slopes and flats in grasslands or shrublands; flowering in May	LE	E
Texas ayenia (*Ayenia limitaris*) – woodlands on alluvial deposits on floodplains and terraces along the Rio Grande; flowering throughout the year with sufficient rainfall	LE	E
Vasey's adelia (*Adelia vaseyi*) – subtropical woodlands in Lower Rio Grande Valley; flowering January-June		

Status Key:	
LE, LT	- Federally Listed Endangered/Threatened
PE, PT	- Federally Proposed Endangered/Threatened
E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
C1	- Federal Candidate for Listing, Category 1; information supports proposing to list as endangered/threatened
DL, PDL	- Federally Delisted/Proposed for Delisting
NL	- Not Federally Listed
E, T	- State Listed Endangered/Threatened
"blank"	- Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

Texas Parks & Wildlife

Last Revision: 4 Apr. 2005

Annotated County Lists of Rare Special

HIDALGO COUNTY

Species	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Mexican Treefrog (*Smilisca baudinii*) - subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools		T
Sheep Frog (*Hypopachus variolosus*) - predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
White-lipped Frog (*Leptodactylus labialis*) – grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Brownsville Common Yellowthroat (*Geothlypis trichas insperata*) - tall grasses and bushes near ponds, marshes, and swamps; breeding April to July		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) – cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Gray Hawk (*Asturina nitidus*) **- mature woodlands of river valleys and nearby semiarid mesquite and scrub grasslands**		T
Hook-billed Kite (*Chondrohierax uncinatus*) – **dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas**		
Interior Least Tern (*Sterna antillarum athalassos*) – nests along sand and gravel bars within braided streams, rivers & some inland lakes	LE	E

Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Northern Beardless-tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July		T
Reddish Egret (*Egretta rufescens*) - resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear		T
Rose-throated Becard (*Pachyramphus aglaiae*) – riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July		T
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August		
Tropical Parula (*Parula pitiayuma*) - dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July		T
White-faced Ibis (*Plegadis chihi*) - prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats		T
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		T
Wood Stork (*Mycteria americana*) - forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T
Zone-tailed Hawk (*Buteo albonotatus*) - rough, deep, rocky canyons and streamsides in semiarid mesa, hill, and mountain terrain; breeding March to July		T

*** FISHES ***

American Eel (*Anguilla rostrata*) - most aquatic habitats with access to ocean; spawns January-February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries		
River Goby (*Awaous banana*) - clear water with slow to moderate current, sandy or hard bottom, and little or no vegetation; also enters brackish and ocean waters		T
Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt		
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves	LE	E

*** INSECTS***

Subtropical Blue-black Tiger Beetle (*Cicindela nigrocoerulea subtropica*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Manfreda Giant-skipper (*Stallingsia maculosus*) - most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk-

*** MAMMALS ***

Cave Myotis Bat (*Myotis velifer*) - roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore		
Coues' Rice Rat (*Oryzomys couesi*) - cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August		T
Jaguar (*Panthera onca*) (extirpated) - dense chaparral; no reliable TX sightings since 1952	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Mexican Long-tongued Bat (*Choeronycteris mexicana*) - deep canyons where uses caves & mine tunnels as day roosts; also found in buildings & often associated with big-eared bats (*Plecotus* spp.); single TX record from Santa Ana NWR		
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Southern Yellow Bat (*Lasiurus ega*) - associated with trees, such as palm trees (*Sabal mexicana*) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter		T
White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground & in trees; omnivorous; may be susceptible to hunting, trapping, & pet trade		T

MOLLUSKS

False Spike Mussel *(Quincuncina mitchelli*) - substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins		
Mexican Fawnsfoot *(Truncilla cognata*) - largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin		
Salina Mucket *(Potamilus metnecktayi*) - lotic waters; other habitat requirements are poorly understood; Rio Grande Basin		
Texas Hornshell *(Popenaias popeii*) - both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico	C1	

*** REPTILES ***

Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite T

Black Striped Snake (*Coniophanes imperialis*) – extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June T

Indigo Snake (*Drymarchon corais*) - thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter T

Keeled Earless Lizard (*Holbrookia propinqua*) – coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground

Northern Cat-eyed Snake (*Leptodeira septentrionalis septentrionalis*) - Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal T

Speckled Racer (*Drymobius margaritiferus*) - extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August T

Texas Horned Lizard (*Phrynosoma cornutum*) – open arid or semi-arid regions with sparse vegetation; grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover T

Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; shallow depressions at base of bush or cactus or underground burrow or hides under surface cover T

*** VASCULAR PLANTS ***

Bailey's ballmoss (*Tillandsia baileyi*) - epiphytic on various trees and shrubs; flowering February-May

Chihuahua balloon-vine (*Cardiospermum dissectum*) - shrublands on gravelly soils along Lower Rio Grande Valley; flowering July-September

Falfurrias milkvine (*Matelea radiata*) - endemic; known only from one collection from Falfurrias; habitat unknown; flowering (May?) June

Gregg's wild-buckwheat (*Eriogonum greggii*) – grasslands and brushlands on gypsum-capped hills; flowering in summer?

Mexican mud-plantain (*Heteranthera mexicana*) – aquatic; ditches and ponds; flowering June-August

Runyon's cory cactus (*Coryphantha macromeris* var. *runyonii*) - endemic; low hills and flats on gravelly soils in Tamaulipan shrub communities along the Rio Grande

Runyon's water-willow (*Justicia runyonii*) - calcareous silt loam, silty clay, or clay in openings in subtropical woodlands on active or former floodplains; flowering (July-) September-November

St. Joseph's staff (*Manfreda longiflora*) - endemic; various soils (clays and loams with various concentrations of salt, caliche, sand, and gravel) in openings or amongst shrubs in thorny shrublands; on Catahoula and Frio formations, and also on Rio Grande floodplain alluvial deposits; flowering in September		
Star cactus (*Astrophytum asterias*) - gravelly saline clays or loams over Catahoula & Frio formations, on gentle slopes & flats in grasslands or shrublands; flowering in May	LE	E
Texas ayenia (*Ayenia limitaris*) - woodlands on alluvial deposits on floodplains and terraces along the Rio Grande; flowering throughout the year with sufficient rainfall	LE	E
Vasey's adelia (*Adelia vaseyi*) - subtropical woodlands in Lower Rio Grande Valley; flowering January-June		
Walker's manioc (*Manihot walkerae*) - periphery of native brush in sandy loam; also on caliche cuestas?; flowering April-September (following rains?)	LE	E

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LE, LT	- Federally Listed Endangered/Threatened
PE, PT	- Federally Proposed Endangered/Threatened
E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
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Texas Parks & Wildlife

Last Revision: 25 Sep 2004

Annotated County Lists of Rare Species

STARR COUNTY

	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Mexican Burrowing Toad (*Rhinophrynus dorsalis*) - roadside ditches, temporary ponds, arroyos, or wherever loose friable soils are present in which to burrow; generally underground emerging only to breed or during rainy periods		T
Mexican Treefrog (*Smilisca baudinii*) – subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools		T
Sheep Frog (*Hypopachus variolosus*) – predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
White-lipped Frog (*Leptodactylus labialis*) - grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Brownsville Common Yellowthroat (*Geothlypis trichas insperata*) - tall grasses and bushes near ponds, marshes, and swamps; breeding April to July		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) – cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Gray Hawk (*Asturina nitidus*) **- mature woodlands of river valleys and nearby semiarid mesquite and scrub grasslands**		T
Hook-billed Kite (*Chondrohierax uncinatus*) - dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas		
Interior Least Tern (*Sterna antillarum athalassos*) – nests along sand and gravel bars	LE	E

within braided streams, rivers & some inland lakes
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous
Northern Beardless-tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July T
Reddish Egret (*Egretta rufescens*) – resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear T
Rose-throated Becard (*Pachyramphus aglaiae*) – riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July T
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August
Tropical Parula (*Parula pitiayuma*) – dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July T
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May T
Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960 T
Zone-tailed Hawk (*Buteo albonotatus*) - rough, deep, rocky canyons and streamsides in semiarid mesa, hill, and mountain terrain; breeding March to July T

*****FISHES*****
American Eel (*Anguilla rostrata*) - most aquatic habitats with access to ocean; spawns January-February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries
Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves. LE E

***** INSECTS*****
Cazier's Tiger Beetle (*Cicindela cazieri*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches
Manfreda Giant-skipper (*Stallingsia maculosus*) - most skippers are small and stout-

bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk

*** MAMMALS ***

Black Bear (*Ursus americanus*) - within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves, or under brush piles	T/SA; NL	T
Coues' Rice Rat (*Oryzomys couesi*) – cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August		T
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Plains Spotted Skunk (*Spilogale putorius interrupta*) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
White-nosed Coati (*Nasua narica*) – woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground & in trees; omnivorous; may be susceptible to hunting, trapping, & pet trade		T
Yuma Myotis Bat (*Myotis yumanensis*) - desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; single offspring born May-early July		

*** MOLLUSKS ***

Texas Hornshell (*Popenaias popeii*) – Rio Grande drainage from the Pecos River to the Falcon Breaks	C1	

*** REPTILES ***

Indigo Snake (*Drymarchon corais*) – thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T
Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite		T

Spot-tailed Earless Lizard (*Holbrookia lacerata*) - central & southern Texas and Adjacent Mexico; oak-juniper woodlands & mesquite-prickly pear associations; eggs laid underground; eats small invertebrates		
Texas Horned Lizard (*Phrynosoma cornutum*) - open arid or semi-arid regions with sparse vegetation; grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover		T
Texas Tortoise (*Gopherus berlandieri*) – open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T

*** VASCULAR PLANTS ***

Ashy dogweed (*Thymophylla tephroleuca*) - endemic; grassland or blackbrush or cenizo shrublands on fine sandy loam soils; flowering February-November	LE	E
Chihuahua balloon-vine (*Cardiospermum dissectum*) - shrublands on gravelly soils along Lower Rio Grande Valley; flowering July-September		
Gregg's wild-buckwheat (*Eriogonum greggii*) - grasslands and brushlands on gypsum-capped hills; flowering in summer?		
Johnston's frankenia (*Frankenia johnstonii*) - shrublands on flats on saline sandy to clayey soils and on rocky gypseous slopes; flowering throughout year depending on rainfall	LE-PDL	E
Kleberg saltbush (*Atriplex klebergorum*) - endemic; sandy to clayey loams, usually saline; often with other halophytes; maturation usually occurs in fall but may vary with rainfall		
Prostrate milkweed (*Asclepias prostrata*) - open bare ground on loose sandy loam, including disturbed areas; flowering March-October		
Runyon's cory cactus (*Coryphantha macromeris* var. *runyonii*) - endemic; low hills and flats on gravelly soils in Tamaulipan shrub communities along the Rio Grande		
Shinner's rocket (*Thelypodiopsis shinnersii*) - mostly found along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouths of rivers; flowers mostly March and April		
St. Joseph's staff (*Manfreda longiflora*) – endemic; various soils (clays and loams with various concentrations of salt, caliche, sand, and gravel) in openings or amongst shrubs in thorny shrublands; on Catahoula and Frio formations, and also on Rio Grande floodplain alluvial deposits; flowering in September		
Star cactus (*Astrophytum asterias*) – gravelly saline clays or loams over the Catahoula and Frio formations, on gentle slopes and flats in grasslands or shrublands; flowering in May	LE	E
Vasey's adelia (*Adelia vaseyi*) – subtropical woodlands in Lower Rio Grande Valley; flowering January-June		
Walker's manioc (*Manihot walkerae*) – periphery of native brush in sandy loam; also on caliche cuestas?; flowering April-September (following rains?)	LE	E
Zapata bladderpod (*Lesquerella thamnophila*) - endemic; blackbrush and/or cenizo shrublands on gravelly to sandy loams derived from Eocene formations; flowering March-April	LE	E

Status Key:

LE, LT	- Federally Listed Endangered/Threatened
PE, PT	- Federally Proposed Endangered/Threatened
E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
C1	- Federal Candidate for Listing, Category 1; information supports proposing to list as endangered/threatened
DL, PDL	- Federally Delisted/Proposed for Delisting
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E, T	- State Listed Endangered/Threatened
"blank"	- Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

Texas Parks & Wildlife — Last Revision: 7 Apr. 2005
Annotated County Lists of Rare Species

WEBB COUNTY

******* DRAFT ***** DRAFT ***** DRAFT***** DRAFT ***** DRAFT ***** DRAFT*******
UNDER CONSTRUCTION *** SPECIES MIGHT BE ADDED/DELETED DURING QUALITY CONTROL**

	Federal Status	State Status
***** AMPHIBIANS *****		
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) - cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Interior Least Tern (*Sterna antillarum athalassos*) – this subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish & crustaceans, when breeding forages within a few hundred feet of colony	LE	E
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August		
Western Burrowing Owl (*Athene cunicularia hypugaea*) - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culverts		
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		T
Wood Stork (*Mycteria americana*) - forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally		T

in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		
***** FISHES *****		
Blue Sucker (*Cycleptus elongatus*) - usually inhabits channels and flowing pools with a moderate current; bottom type usually consists of exposed bedrock, perhaps in combination with hard clay, sand, and gravel; adults winter in deep pools and move upstream in spring to spawn on riffles		T
Rio Grande Darter (*Etheostoma grahami*) – gravel and rubble riffles of creeks and small rivers		T
Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt		
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves.	LE	E
***** MAMMALS *****		
Black Bear (*Ursus americanus*) - within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves, or under brush piles	T/SA; NL	T
Big Free-tailed Bat (*Nyctinomops macrotis*) – habitat data sparse but records indicate that species prefers to roost in crevices and cracks in high canyon walls, but will use buildings, as well; reproduction data sparse, but gives birth to single offspring late June-early July; females gather in nursery colonies; winter habits undetermined, but may hibernate in the Trans-Pecos; opportunistic insectivore		
Cave Myotis Bat (*Myotis velifer*) - roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore		
Davis Pocket Gopher (*Geomys personatus davisi*) - burrows in sandy soils in southern Texas		
Ghost-faced Bat (*Mormoops megalophylla*) - colonially roosts in caves, crevices, abandoned mines, and buildings; insectivorous; breeds late winter-early spring; single offspring born per year		
Gray Wolf (*Canis lupus*) (extirpated) – formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E

White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade T

Yuma Myotis Bat (*Myotis yumanensis*) - desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; single offspring born May-early July

MOLLUSKS

False Spike Mussel *(Quincuncina mitchelli*) - substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins

Mexican Fawnsfoot *(Truncilla cognata*) - largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin

Salina Mucket *(Potamilus metnecktayi*) - lotic waters; other habitat requirements are poorly understood; Rio Grande Basin

Texas Hornshell *(Popenaias popeii*) - both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico C1

*** REPTILES ***

Indigo Snake (*Drymarchon corais*) - thornbrush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter T

Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground

Mexican Blackhead Snake (*Tantilla atriceps*) - southern Texas and northeastern Mexico; shrubland savanna; nocturnal; lays clutch of probably 1-3 eggs

Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite T

Spot-tailed Earless Lizard (*Holbrookia lacerata*) - central & southern Texas and Adjacent Mexico; oak-juniper woodlands & mesquite-prickly pear associations; eggs laid underground; eats small invertebrates

Texas Horned Lizard (*Phrynosoma cornutum*) - open arid or semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover T

Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover T

*** VASCULAR PLANTS ***

Ashy dogweed (*Thymophylla tephroleuca*) - endemic; grassland or blackbrush or cenizo shrublands on fine sandy loam soils; flowering February-November	LE	E
Johnston's frankenia (*Frankenia johnstonii*) - shrublands on flats on saline sandy to clayey soils and on rocky gypseous slopes; flowering throughout year depending on rainfall	LE-PDL	E
Kleberg saltbush (*Atriplex klebergorum*) - endemic; sandy to clayey loams, usually saline; often with other halophytes; maturation usually occurs in fall but may vary with rainfall		
McCart's whitlow-wort (*Paronychia maccartii*) – known only from one type specimen collected in Webb County, March 1962; type location is located three miles south of Mirando City, where substrate is hardpacked red sand, probably of the Cuevitas-Randado association derived from the Goliad formation; flowering in spring		
Nickel's cory cactus (*Coryphantha nickelsiae*) – alluvial gravels (?) or low hills along the Rio Grande; Webb County included in distribution based on 1906 specimen record with "Laredo" as location		

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Texas Parks & Wildlife

Last Revision: 4 Apr. 2005

Annotated County Lists of Rare Species

MAVERICK COUNTY

******* DRAFT ***** DRAFT ***** DRAFT***** DRAFT ***** DRAFT ***** DRAFT*******
UNDER CONSTRUCTION ** SPECIES MIGHT BE ADDED/DELETED DURING QUALITY CONTROL**

	Federal Status	State Status
***** AMPHIBIANS *****		
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) – potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Baird's Sparrow (*Ammodramus bairdii*) - shortgrass prairie with scattered low bushes and matted vegetation		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) – cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Gray Hawk (*Asturina nitida*) – locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas		T
Interior Least Tern (*Sterna antillarum athalassos*) – this subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish & crustaceans, when breeding forages within a few hundred feet of colony	LE	E
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
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Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T

*** FISHES ***

Blue Sucker (*Cycleptus elongatus*) - usually inhabits channels and flowing pools with a moderate current; bottom type usually consists of exposed bedrock, perhaps in combination with hard clay, sand, and gravel; adults winter in deep pools and move upstream in spring to spawn on riffles		T
Proserpine Shiner (*Cyprinella proserpina*) **– rocky runs and pools of creeks and small rivers**		T
Rio Grande Blue Catfish (*Ictalurus furcatus* ssp.) - spawns in late spring - early summer; deep areas of large rivers, swift chutes, pools with swift currents, reservoirs, fish-farm ponds; tolerates moderate salinities; eggs deposited in nests under logs, brush, or riverbank; bottom feeder; mostly crustaceans and aquatic insects when young, later fish and large invertebrates, also scavenges		
Rio Grande Darter (*Etheostoma grahami*) – gravel and rubble riffles of creeks and small rivers		T
Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt		
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves.	LE	E
West Mexican Redhorse (*Scartomyzon austrinus*) – known only from Alamito Creek, Big Bend region; restricted to rocky riffles of creeks and small to medium rivers, often near boulders in swift water		

*** MAMMALS ***

Big Free-tailed Bat (*Nyctinomops macrotis*) – habitat data sparse but records indicate that species prefers to roost in crevices and cracks in high canyon walls, but will use buildings, as well; reproduction data sparse, but gives birth to single offspring late June-early July; females gather in nursery colonies; winter habits undetermined, but may hibernate in the Trans-Pecos; opportunistic insectivore		

Black Bear (*Ursus americanus*) - within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves, or under brush piles	T/SA; NL	T
Cave Myotis Bat (*Myotis velifer*) - roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore		
Ghost-faced Bat (*Mormoops megalophylla*) - colonially roosts in caves, crevices, abandoned mines, and buildings; insectivorous; breeds late winter-early spring; single offspring born per year		
Gray Wolf (*Canis lupus*) (extirpated) – formerly known throughout the western two-thirds of the state in forests, brushlands, or grasslands	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Margay (*Leopardus weidii*) - neotropical forested areas; rests during the day in trees; forages both in trees and on the ground		T
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade		T
Yuma Myotis Bat (*Myotis yumanensis*) - desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; single offspring born May-early July		
*****MOLLUSKS*****		
False Spike Mussel *(Quincuncina mitchelli*) - substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins		
Mexican Fawnsfoot *(Truncilla cognata*) - largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin		
Salina Mucket *(Potamilus metnecktayi*) - lotic waters; other habitat requirements are poorly understood; Rio Grande Basin		
Texas Hornshell *(Popenaias popeii*) - both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico	C	
***** REPTILES *****		
Indigo Snake (*Drymarchon corais*) - thornbrush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T

Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground

Mexican Blackhead Snake (*Tantilla atriceps*) - southern Texas and northeastern Mexico; shrubland savanna; nocturnal; lays clutch of probably 1-3 eggs

Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite — T

Spot-tailed Earless Lizard (*Holbrookia lacerata*) - central & southern Texas and Adjacent Mexico; oak-juniper woodlands & mesquite-prickly pear associations; eggs laid underground; eats small invertebrates

Texas Horned Lizard (*Phrynosoma cornutum*) - open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September — T

Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover — T

*** VASCULAR PLANTS ***

Silvery wild-mercury (*Argythamnia argyraea*) – among shortgrass on whitish clay soils in shrub-invaded grasslands, particularly over the Yegua Formation; flowering April-June; fruiting until fall

Texas trumpets (*Acleisanthes crassifolia*) – shallow, well-drained, calcareous, gravelly loams over caliche on gentle to moderate slopes, often in sparsely vegetated openings in cenizo (*Leucophyllum frutescens*) shrublands

Status Key:	
LE, LT	- Federally Listed Endangered/Threatened
PE, PT	- Federally Proposed Endangered/Threatened
E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
C1	-Federal Candidate for Listing, Category 1; information supports proposing to list as endangered/threatened
DL, PDL	- Federally Delisted/Proposed for Delisting
NL	- Not Federally Listed
E, T	- State Listed Endangered/Threatened
“blank”	- Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated

Texas Parks & Wildlife

Last Revision: 19 Feb 2004

Annotated County Lists of Rare Species

JIM HOGG COUNTY

******* DRAFT ***** DRAFT ***** DRAFT***** DRAFT ***** DRAFT ***** DRAFT*******
UNDER CONSTRUCTION ** SPECIES MIGHT BE ADDED/DELETED DURING QUALITY CONTROL**

	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Sheep Frog (*Hypopachus variolosus*) – predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Interior Least Tern (*Sterna antillarum athalassos*) – this subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish & crustaceans, when breeding forages within a few hundred feet of colony	LE	E
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Northern Aplomado Falcon (*Falco femoralis septentrionalis*) - open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species	LE	E
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August		
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass		T

flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		
Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T
Zone-tailed Hawk (*Buteo albonotatus*) - rough, deep, rocky canyons and streamsides in semiarid mesa, hill, and mountain terrain; breeding March to July		T
***** INSECTS *****		
Los Olmos Tiger Beetle (*Cicindela nevadica olmosa*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches		
Manfreda Giant-skipper (*Stallingsia maculosus*) - most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk		
Superb Grasshopper (*Eximacris superbum*) - collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage		
***** MAMMALS *****		
Black Bear (*Ursus americanus*) - within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves, or under brush piles	T/SA; NL	T
Jaguar (*Panthera onca*) (extirpated) – dense chaparral; no reliable sightings in Texas since 1952	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Maritime Pocket Gopher (*Geomys personatus maritimus*) - fossorial, in deep sandy soils; feeds mostly from within burrow on roots & other plant parts, especially grasses; ecologically important as prey species & in influencing soils, microtopography, habitat heterogeneity, and plant diversity		
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Plains Spotted Skunk (*Spilogale putorius interrupta*) – catholic; in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade		T

Yuma Myotis Bat (*Myotis yumanensis*) - desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; single offspring born May-early July		
***** REPTILES *****		
Indigo Snake (*Drymarchon corais*) – thornbrush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T
Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Mexican Blackhead Snake (*Tantilla atriceps*) - southern Texas and northeastern Mexico; shrubland savanna; nocturnal; lays clutch of probably 1-3 eggs		
Northern Cat-eyed Snake (*Leptodeira septentrionalis septenrionalis*) - Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal; active, alert, rear-fanged, mildly venomous, but harmless to humans		T
Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite		T
Texas Scarlet Snake (*Cemophora coccinea lineri*) - mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September		T
Spot-tailed Earless Lizard (*Holbrookia lacerata*) - central & southern Texas and adjacent Mexico; oak-juniper woodlands & mesquite-prickly pear associations; eggs laid underground; eats small invertebrates		
Texas Horned Lizard (*Phrynosoma cornutum*) - open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September		T
Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association.; open brush w/grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T
***** VASCULAR PLANTS *****		
Bushy whitlow-wort (*Paronychia congesta*) - endemic; full sun in openings in blackbrush shrublands in shallow soils on xeric caliche or calcareous outcrops on the Bordas Escarpment; flowering April-June and probably sporadically after rains later in season	C1	
Star cactus (*Astrophytum asterias*) – gravelly saline clays or loams over the Catahoula and Frio formations, on gentle slopes and flats in grasslands or shrublands; flowering in May	LE	E

Status Key:

LE, LT	- Federally Listed Endangered/Threatened
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E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
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Texas Parks & Wildlife

Last Revision: 14 Apr. 2005

Annotated County Lists of Rare Species

ZAPATA COUNTY

	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Mexican Burrowing Toad (*Rhinophrynus dorsalis*) - roadside ditches, temporary ponds, arroyos, or wherever loose friable soils are present in which to burrow; generally underground emerging only to breed or during rainy periods		T
Mexican Treefrog (*Smilisca baudinii*) - subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools		T
Sheep Frog (*Hypopachus variolosus*) - predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
White-lipped Frog (*Leptodactylus labialis*) - grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) – scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) – cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Gray Hawk (*Asturina nitidus*) **- mature woodlands of river valleys and nearby semiarid mesquite and scrub grasslands**		T
Hook-billed Kite (*Chondrohierax uncinatus*) - dense tropical and subtropical forests, but does occur in open woodlands; uncommon to rare in most of range; accidental in south Texas		
Interior Least Tern (*Sterna antillarum athalassos*) – nests along sand and gravel bars within braided streams, rivers & some inland lakes	LE	E

Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Northern Beardless-tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July		T
Rose-throated Becard (*Pachyramphus aglaiae*) – riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July		T
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August		
Tropical Parula (*Parula pitiayuma*) - dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July		T
White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		T
Wood Stork (*Mycteria americana*) - forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T

*** FISHES ***

Rio Grande Shiner (*Notropis jemezanus*) – large, open, weedless rivers or large creeks with bottom of rubble, gravel and sand, often overlain with silt		
Rio Grande Silvery Minnow (*Hybognathus amarus*) (extirpated) - historically Rio Grande and Pecos River systems and canals; pools and backwaters of medium to large streams with low or moderate gradient in mud, sand, or gravel bottom; ingests mud and bottom ooze for algae and other organic matter; probably spawns on silt substrates of quiet coves.	LE	E

*** MAMMALS ***

Black Bear (*Ursus americanus*) - within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves, or under brush piles	T/SA; NL	T
Davis Pocket Gopher (*Geomys personatus davisi*) - burrows in sandy soils in southern Texas		
Jaguarundi (*Herpailurus yaguarondi*) – thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground & in trees; omnivorous; may be susceptible to hunting, trapping, & pet trade		T

MOLLUSKS

False Spike Mussel *(Quincuncina mitchelli*) - substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins		
Mexican Fawnsfoot *(Truncilla cognata*) - largely unknown; possibly intolerant of impoundment; possibly needs flowing streams and rivers with sand or gravel bottoms based on related species needs; Rio Grande basin		
Salina Mucket *(Potamilus metnecktayi*) - lotic waters; other habitat requirements are poorly understood; Rio Grande Basin		
Texas Hornshell *(Popenaias popeii*) - both ends of narrow shallow runs over bedrock, in areas where small-grained materials collect in crevices, along river banks, and at the base of boulders; not known from impoundments; Rio Grande Basin and several rivers in Mexico	C1	

*** REPTILES ***

Indigo Snake (*Drymarchon corais*) - thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T
Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Reticulate Collared Lizard (*Crotaphytus reticulatus*) - requires open brush-grasslands; thorn-scrub vegetation, usually on well-drained rolling terrain of shallow gravel, caliche, or sandy soils; often on scattered flat rocks below escarpments or isolated rock outcrops among scattered clumps of prickly pear and mesquite		T
Texas Horned Lizard (*Phrynosoma cornutum*) - open arid or semi-arid regions with sparse vegetation; grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover		T
Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T

*** VASCULAR PLANTS ***

Ashy dogweed (*Thymophylla tephroleuca*) - endemic; grassland or blackbrush or cenizo shrublands on fine sandy loam soils; flowering February-November	LE	E
Chihuahua balloon-vine (*Cardiospermum dissectum*) - shrublands on gravelly soils along Lower Rio Grande Valley; flowering July-September		
Correll's bluet (*Houstonia correllii*) - sandy soils in openings in mesquite woodlands or thorn shrublands		
Correll's false dragon-head (*Physostegia correllii*) - wet soils including roadside ditches and irrigation channels; flowering June-July		
Johnston's frankenia (*Frankenia johnstonii*) - shrublands on flats on saline sandy to clayey soils and on rocky gypseous slopes; flowering throughout year depending on rainfall	LE-PDL	E
Prostrate milkweed (*Asclepias prostrata*) - open bare ground on loose sandy loam, including disturbed areas; flowering March-October		
Star cactus (*Astrophytum asterias*) – gravelly saline clays or loams over the Catahoula	LE	E

and Frio formations, on gentle slopes and flats in grasslands or shrublands; flowering in May		
Zapata bladderpod (*Lesquerella thamnophila*) - endemic; blackbrush and/or cenizo shrublands on gravelly to sandy loams derived from Eocene formations; flowering March-April	LE	E

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Texas Parks & Wildlife
Annotated County Lists of Rare Species

Last Revision: 25 Sep 2004

WILLACY COUNTY

******* DRAFT ***** DRAFT ***** DRAFT***** DRAFT ***** DRAFT ***** DRAFT*******
UNDER CONSTRUCTION ** SPECIES MIGHT BE ADDED/DELETED DURING QUALITY CONTROL**

Species	Federal Status	State Status
***** AMPHIBIANS *****		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Sheep Frog (*Hypopachus variolosus*) – predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) - wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
***** BIRDS *****		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Brown Pelican (*Pelecanus occidentalis*) - largely coastal and near shore areas, where it roosts on islands and spoil banks	LE	E
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) - cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Gray Hawk (*Asturina nitida*) – locally and irregularly along U.S.-Mexico border; mature riparian woodlands and nearby semiarid mesquite and scrub grasslands; breeding range formerly extended north to southernmost Rio Grande floodplain of Texas		T
Interior Least Tern (*Sterna antillarum athalassos*) – this subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish & crustaceans, when breeding forages within a few hundred feet of colony	LE	E
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Northern Aplomado Falcon (*Falco femoralis septentrionalis*) - open country,	LE	E

especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species

Northern Beardless-Tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July — T

Piping Plover (*Charadrius melodus*) – wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats — LT — T

Reddish Egret (*Egretta rufescens*) – resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear — T

Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) - often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeds March-August

Snowy Plover (*Charadrius alexandrinus*) - wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats

Sooty Tern (*Sterna fuscata*) – **predominately "on the wing"; does not dive, but snatches small fish and squid with bill as it flies or hovers over water; breeding April-July** — T

Texas Botteri's Sparrow (*Aimophila botterii texana*) - coastal lowlands & prairies; brush or open grassy land; nests on or near ground, in tall grass or at base of tuft of grass — T

Tropical Parula (*Parula pitiayuma*) - dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July — T

White-faced Ibis (*Plegadis chihi*) – prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats — T

White-tailed Hawk (*Buteo albicaudatus*) - near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May — T

Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960 — T

***** BIRDS-RELATED *****

Colonial waterbird nesting areas - many rookeries active annually

***** FISHES *****

American Eel (*Anguilla rostrata*) - most aquatic habitats with access to ocean; spawns January-February in ocean, larva move to coastal waters, metamorphose, then females move into freshwater; muddy bottoms, still waters, large streams, lakes; can travel overland in wet areas; males in brackish estuaries

Opossum Pipefish (*Microphis brachyurus*) - brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth — T

***** INSECTS *****

Los Olmos Tiger Beetle (*Cicindela nevadica olmosa*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches

Manfreda Giant-skipper (*Stallingsia maculosus*) - most skippers are small and stout-bodied; name derives from fast, erratic flight; at rest most skippers hold front and hind wings at different angles; skipper larvae are smooth, with the head and neck constricted; skipper larvae usually feed inside a leaf shelter and pupate in a cocoon made of leaves fastened together with silk		
Superb Grasshopper (*Eximacris superbum*) - collected in south Texas, but repeated efforts to collect not successful; may over-winter in adult stage		
***** MAMMALS *****		
Coues' Rice Rat (*Oryzomys couesi*) - cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August		T
Jaguar (*Panthera onca*) (extirpated) – dense chaparral; no reliable sightings in Texas since 1952	LE	E
Jaguarundi (*Herpailurus yaguarondi*) - thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Maritime Pocket Gopher (*Geomys personatus maritimus*) - fossorial, in deep sandy soils; feeds mostly from within burrow on roots & other plant parts, especially grasses; ecologically important as prey species & in influencing soils, microtopography, habitat heterogeneity, and plant diversity		
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Plains Spotted Skunk (*Spilogale putorius interrupta*) - catholic; in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
Southern Yellow Bat (*Lasiurus ega*) – associated with trees, such as palm trees (*Sabal mexicana*) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter		T
West Indian Manatee (*Trichechus manatus*) – Gulf and bay system; opportunistic, aquatic herbivore	LE	E
White-nosed Coati (*Nasua narica*) - woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground and in trees; omnivorous; may be susceptible to hunting, trapping, and pet trade		T
***** REPTILES *****		
Atlantic Hawksbill Sea Turtle (*Eretmochelys imbricata*) - Gulf and bay system	LE	E
Black-striped Snake (*Coniophanes imperialis*) - extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June		T
Green Sea Turtle (*Chelonia mydas*) – Gulf and bay system	LT	T
Gulf Saltmarsh Snake (*Nerodia clarkii*) - saline flats, coastal bays, & brackish river mouths		
Indigo Snake (*Drymarchon corais*) – thornbrush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T

Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) - Gulf and bay system	LE	E
Leatherback Sea Turtle (*Dermochelys coriacea*) - Gulf and bay system	LE	E
Loggerhead Sea Turtle (*Caretta caretta*) - Gulf and bay system	LT	T
Mexican Blackhead Snake (*Tantilla atriceps*) - southern Texas and northeastern Mexico; shrubland savanna; nocturnal; lays clutch of probably 1-3 eggs		
Northern Cat-eyed Snake (*Leptodeira septentrionalis septentrionalis*) - Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal; active, alert, rear-fanged, mildly venomous, but harmless to humans		T
Spot-tailed Earless Lizard (*Holbrookia lacerata*) - central & southern Texas and Adjacent Mexico; oak-juniper woodlands & mesquite-prickly pear associations; eggs laid underground; eats small invertebrates		
Texas Horned Lizard (*Phrynosoma cornutum*) - open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September		T
Texas Tortoise (*Gopherus berlandieri*) - open scrub woods, arid brush, lomas, grass-cactus association.; open brush w/grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T
***** VASCULAR PLANTS *****		
Bailey's ballmoss (*Tillandsia baileyi*) - epiphytic on various trees and shrubs; flowering February-May		
Runyon's water willow (*Justicia runyonii*) - calcareous silt loam, silty clay, or clay in openings in subtropical woodlands on active or former floodplains; flowering (July-) September-November		
Short-fruited spikesedge (*Eleocharis brachycarpa*) – south coastal Texas (exact collection locality unknown); preferred habitat unknown, but presumably wet; collected (with mature achenes ?) in April		
Texas ayenia (*Ayenia limitaris*) - woodlands on alluvial deposits on floodplains and terraces along the Rio Grande; flowering throughout the year with sufficient rainfall	LE	E
Vasey's adelia (*Adelia vaseyi*) - subtropical woodlands in Lower Rio Grande Valley; flowering January-June		

Status Key:	
LE, LT	- Federally Listed Endangered/Threatened
PE, PT	- Federally Proposed Endangered/Threatened
E/SA, T/SA	- Federally Listed Endangered/Threatened by Similarity of Appearance
C1	-Federal Candidate for Listing, Category 1; information supports proposing to list as endangered/threatened
DL, PDL	- Federally Delisted/Proposed for Delisting
NL	- Not Federally Listed
E, T	- State Listed Endangered/Threatened
"blank"	- Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

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CHAPTER 2.0 :CURRENT AND PROJECTED POPULATION & WATER DEMAND FOR THE RIO GRANDE REGION

The primary goal in preparing the Rio Grande Regional Water Plan is to estimate current and future water demands within the region. In following chapters, water demand projections are compared with estimates of currently available water supplies to identify the location, extent, and timing of any future water shortages or surpluses. Texas Water Development Board (TWDB) rules (357.7) require that the results of the analyses of current and projected population and water demands be reported by city, by county, by river basin, and by categories such as irrigation, mining, manufacturing, municipal, livestock, and steam electric. Exhibit B (1.1.2) provides updated guidelines:

> "*The development of new population and water demand projections will be the most relevant feature of the first phase of this next round of planning. TWDB staff will prepare draft population and water demand projections for all the regions and their water user groups.*"

TWDB staff projections were approved by the board for use in regional water plans. These projections are the main reference tools for this chapter dealing specifically with population growth and associated water demands.

Table 2.1 summarizes the Rio Grande Regional Water Planning Area's projected population and expected water demand through the year 2060, delineated by category of use. All tables and graphs are based on data provided by TWDB.

Table 2.1: Population and Water Demand Projections Summary for the Rio Grande Regional Water Planning Area (RGRPA)

Regional Total Projection	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Population	1,236,246	1,581,207	1,973,188	2,401,223	2,854,613	3,337,618	3,826,001
Irrigation (AF/YR)	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749
Livestock (AF/YR)	5,817	5,817	5,817	5,817	5,817	5,817	5,817
Manufacturing (AF/YR)	6,208	7,509	8,274	8,966	9,654	10,256	11,059
Mining (AF/YR)	3,869	4,186	4,341	4,433	4,523	4,612	4,692
Municipal (AF/YR)	226,536	279,633	338,716	403,511	472,632	547,747	625,743
Steam Electric (AF/YR)	6,780	13,463	16,864	19,716	23,192	27,430	32,598
Total Water Demand (AF/YR)	1,458,857	1,474,241	1,456,243	1,424,192	1,497,567	1,577,611	1,661,658

As indicated, the previous regional water plan projected the Rio Grande Region's population to more than triple over the next 50 years, increasing from approximately 1.23 million people at present to 3.82 million by 2060. This dramatic growth is the principal factor underlying projected increases in municipal, manufacturing, and steam electric water demands. However, in terms of total demand within this region, projected increases in urban water demands are slightly offset by projected *decreases* in irrigation water demand. The result is a projected approximate *increase* of 14 percent in total water demand over the 50-year planning period.

The following sections of this chapter describe the methodology used to develop these projections. This chapter also presents projections of population and water demand for cities, for major providers of municipal and manufacturing water, and for categories of water use including municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock. Projected demands are also provided for each of the two river basins and the one coastal basin partially located within this region.

2.1 TWDB Guidelines For Revisions To Population And Water Demand Projections

To have a better standard of guidelines for calculating accurate population and water demand projections, a second round of planning was conducted, resulting in development of Exhibit B – a new set of guidelines adopted by the TWDB in accordance with all provisions of 31 Texas Administrative Code (TAC) Chapter 357. Provisions set forth in the TAC or TWDB agency rules take precedence over guidelines set forth in Exhibit B. Exhibit B Section 4.2 explains the process:

"Population and water demand projections for 2010 through 2060 for the state, counties, cities, and county-other (including utility sub-components) will be reviewed through a process coordinated by the Executive Administrator of the TWDB with the Planning Groups, TNRCC [now TCEQ], TDA, and the TPWD.

New population projections, using a standard cohort-component procedure, will be developed using the 2000 Census and other pertinent sources. Projections will be developed first at the county level; then the projections will be allocated to municipal and county-other water user groups."

TWDB met regularly with representatives of the various parties involved to achieve consensus. The projections were extensively evaluated before reaching final draft stage. Then, after lengthy analysis of population and water demand projections, TWDB approved these projections.

2.2 Population Projections

Population and water demand revisions incorporated up-to-date information. This section contains information on the planning group's methodology – a four-step process based on TWDB guidelines.

The first step was to project the living population at the beginning of the year who are expected to survive to the target year. The second step was to determine approximate net migration of this population; net migration rates were multiplied by adjusted population figures in the launch year. The third step was to project number of births and net impact of mortality and migration on the youngest age group. The fourth step was to combine results from the mortality, migration, and fertility modules. (This methodology is further explained in SB1 and Exhibit B. Race and gender were considered in calculating these projections.)

Population is the main factor in calculating total municipal water demand, including residential and commercial uses, and this data was then used to calculate each city's base per capita water use. Overall, municipal water demand projections are the product of three variables: current and projected population, per capita water use, and assumptions about the effects of certain water conservation measures. Therefore, future water savings resulting from installation of more water-efficient fixtures (according to the 1991 State Water-Efficient Plumbing Act) were also a consideration.

Population of the eight counties comprising the Rio Grande Regional Water Planning Area is projected to grow at an average rate of nearly 2 percent annually over the 50-year planning period. This suggests an increase from approximately 1.58 million residents in 2010 to over 3.82 million in 2060. Table 2.2 presents these projections, by county, for each decade of the planning period. Cameron and Hidalgo Counties lead with the highest total populations, while Webb County is forecast to experience the greatest proportionate annual increase for the region.

Figure 2.1: RGRWPA Population Projections (by decade)

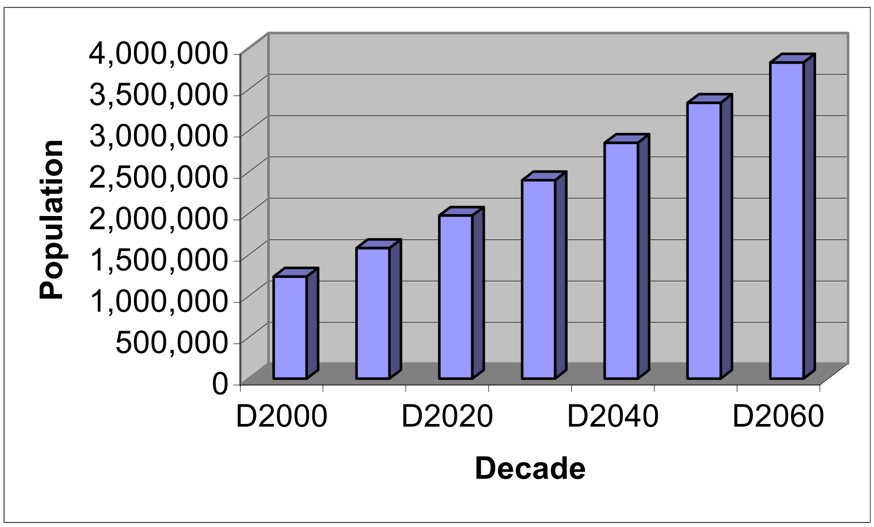
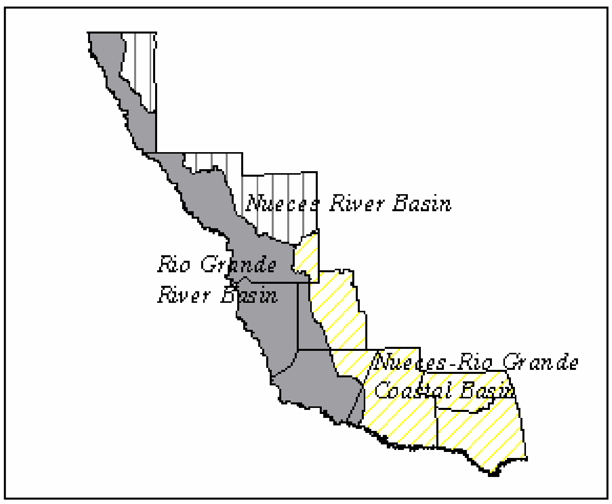


Table 2.2: RGRWPA Population - Projections by County

County Name	2000	2010	2020	2030	2040	2050	2060
CAMERON	335,227	415,136	499,618	586,944	673,996	761,073	843,894
HIDALGO	569,463	744,258	948,488	1,177,243	1,424,767	1,695,114	1,972,453
JIM HOGG	5,281	5,593	5,985	6,286	6,538	6,468	6,225
MAVERICK	47,297	55,892	64,984	73,581	81,032	87,850	93,381
STARR	53,597	66,137	79,538	93,338	107,249	120,959	134,115
WEBB	193,117	257,647	333,451	418,332	511,710	613,774	721,586
WILLACY	20,082	22,519	24,907	27,084	28,835	30,026	30,614
ZAPATA	12,182	14,025	16,217	18,415	20,486	22,354	23,733
Totals	**1,236,246**	**1,581,207**	**1,973,188**	**2,401,223**	**2,854,613**	**3,337,618**	**3,826,001**

Figure 2.2: River Basins in the RGRWPA



As discussed in Chapter 1, the Rio Grande Regional Water Planning Area covers a portion of the Nueces and Rio Grande River Basins as well as a portion of the Nueces-Rio Grande Coastal Basin. Figure 2.1 shows the approximate boundaries of these basins in relation to the region. Table 2.3 presents the population projections, by basin, for the region.

Table 2.3: Population Projection by River Basin and Decade

River Basin	1990	2000	2010	2020	2030	2040	2050	2060
NUECES-RIO GRANDE	661,367	922,204	1,176,504	1,464,313	1,778,744	2,110,863	2,464,534	2,820,050
RIO GRANDE	223,775	313,359	403,904	507,943	621,400	742,513	871,675	1,004,363
NUECES	751	683	799	932	1,079	1,237	1,409	1,588
Total	885,893	1,236,246	1,581,207	1,973,188	2,401,223	2,854,613	3,337,618	3,826,001

2.3 Water Demand Projections

Total annual water demand for the Rio Grande Regional Water Planning Area is projected to *increase* until 2010, then *decrease* until 2030, and then steadily *increase* until 2060. This trend is attributable to diminishing irrigated acreage and rising urban populations, especially in the Rio Grande Valley, as land use changes from agriculture to urbanization. (See Figure 2.3.)

Consequently, over time, total water demand for irrigation in the region is projected to fall from the current 82.9 percent to 59.1 percent by 2060. During the same period, municipal water demands are projected to increase from 15.5 percent at present to 37.7 percent in 2060. Figures 2.4 and 2.5 show the relative projected water demand, by type of use, for the years 2000 and 2060.

Figure 2.3: RGRWPA Total Water Demand Projections

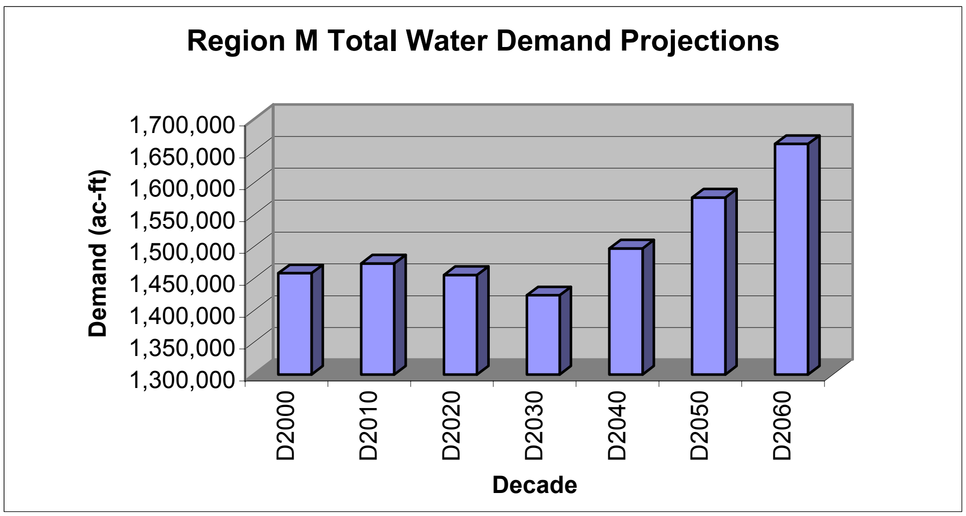


Figure 2.4: Year 2000 Total Water Demand by Type of Use

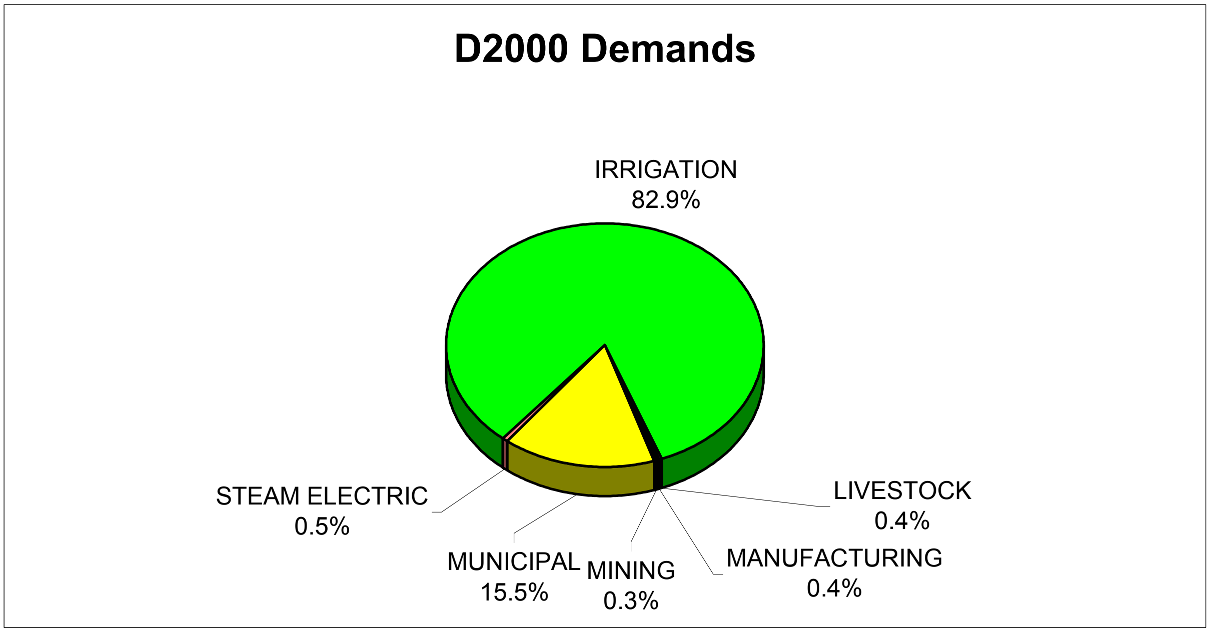
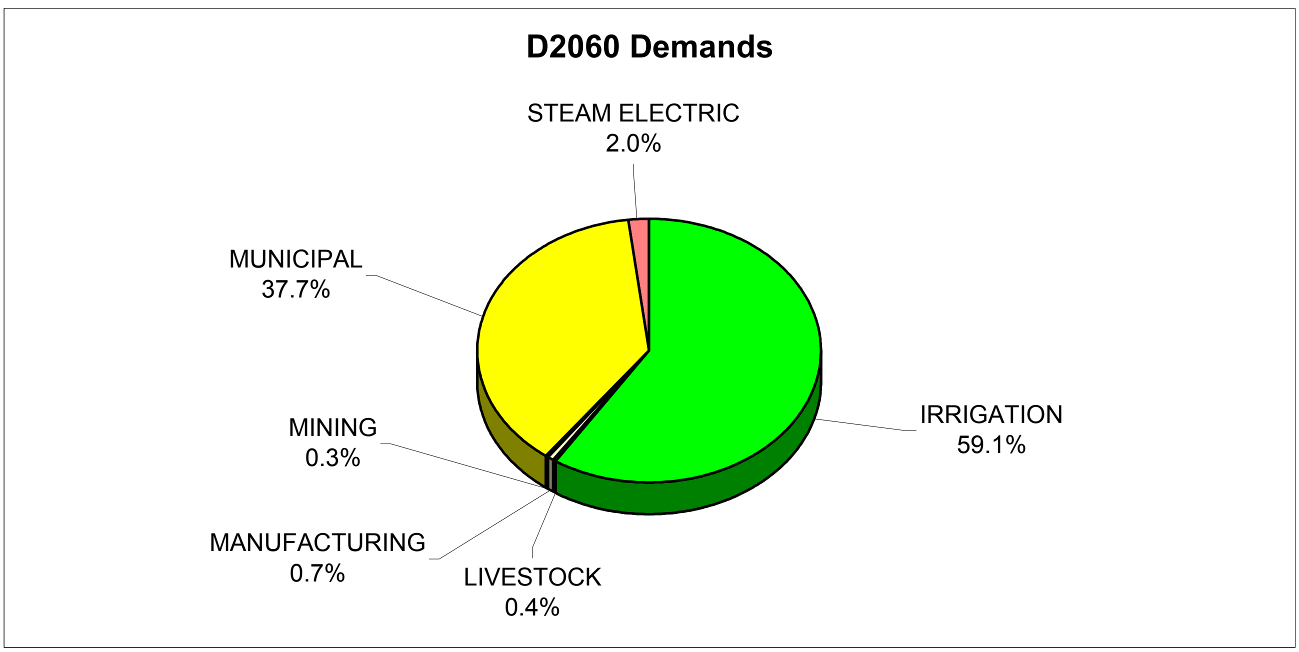


Figure 2.5: Year 2060 Total Water Demand by Type of Use

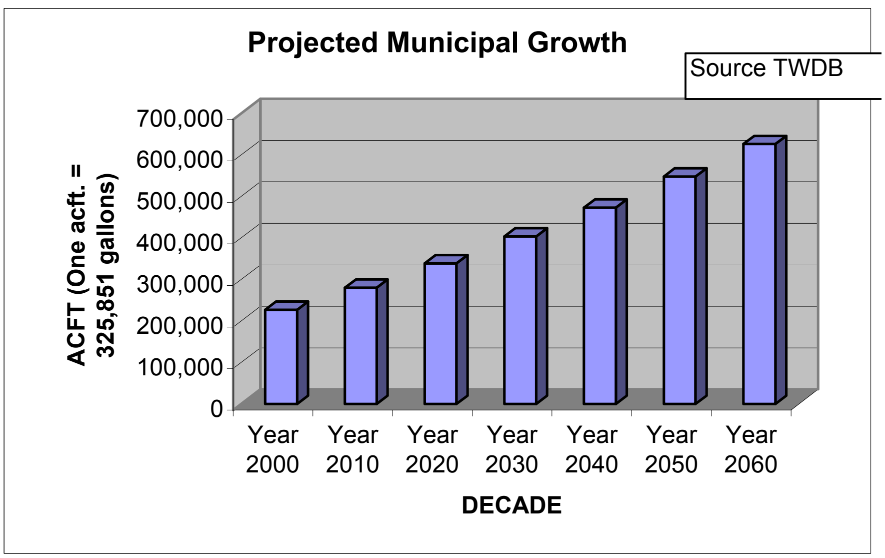


2.3.1 Projections for Municipal Water Demand

Municipal water consumption is calculated from data about residential, institutional, and commercial users. Factors affecting future municipal water use are population growth, climatic conditions, and water conservation practices. Because the region's population is projected to at least triple over the next 50 years, growth in municipal water use is inevitable.

Overall, annual municipal water demand within the region is projected to almost double from 2010 to 2060. (See Figure 2.6.) While this represents a major increase over the planning period, growth in water usage is significantly slower than rate of population growth. These projections are attributable to anticipated improvements in municipal water use efficiency and in water savings associated with the adoption of various conservation measures such as those proposed in the 1991 State Water Efficient Plumbing Act.

Figure 2.6: Projected RGRWPA Municipal Demand



PROJECTIONS

Table 2.4: Municipal Water Demand Projections by County (in acre-feet per year)

County Name	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050	Year 2060
CAMERON	71,792	86,496	102,264	118,321	134,693	151,275	167,665
HIDALGO	88,037	110,286	135,454	163,992	194,819	229,913	266,564
JIM HOGG	852	884	918	944	959	943	906
MAVERICK	7,911	8,912	9,939	10,911	11,751	12,552	13,274
STARR	10,677	12,648	14,726	16,898	19,095	21,293	23,513
WEBB	42,118	54,855	69,401	86,001	104,503	124,614	146,420
WILLACY	3,098	3,287	3,483	3,651	3,779	3,890	3,953
ZAPATA	2,051	2,265	2,531	2,793	3,033	3,267	3,448
TOTAL	**226,536**	**279,633**	**338,716**	**403,511**	**472,632**	**547,747**	**625,743**

The region's municipal water demand is projected to triple in the next 50 years, increasing from 279,633 acre-feet per year in 2010 to 625,743 acre-feet per year in 2060. Table 2.4 presents this projected growth, by county. As indicated, demand is concentrated in Cameron, Hidalgo, and Webb counties, which together account for nearly 89 percent of municipal water consumption in the region. Cameron County alone accounts for 38 percent, Hidalgo County accounts for 39 percent, and Webb County accounts for 19 percent of the region's municipal water use.

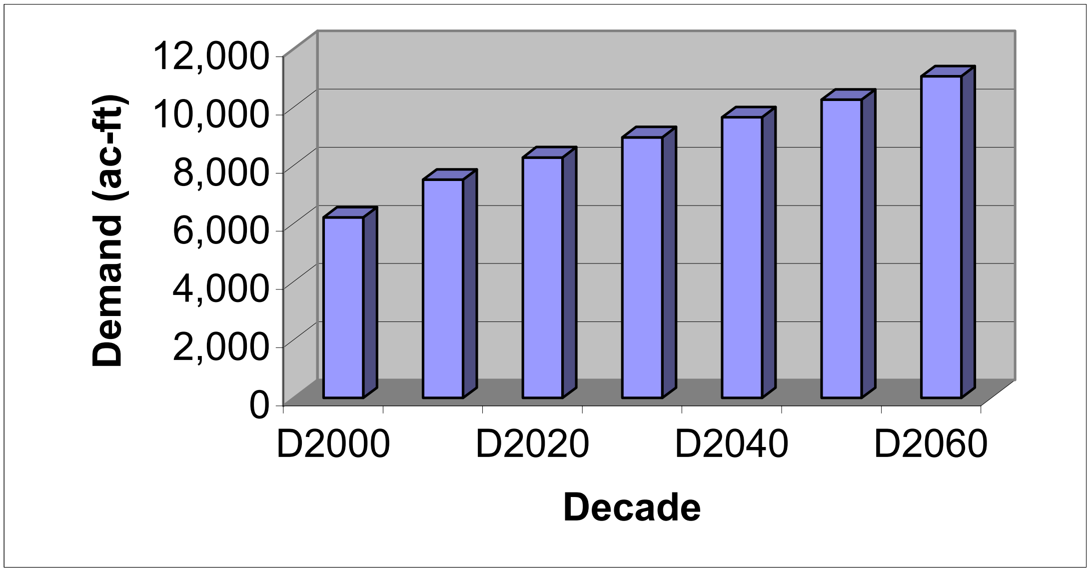
2.3.2 Projections for Manufacturing Water Demand

For SB 1 planning purposes, manufacturing water use is defined as the cumulative water demand on county and river basins for all industries within specified industrial classifications (SIC) determined by the TWDB. Projections of manufacturing water use developed by the TWDB and employed in the 1997 State Water Plan were used as default projections in this report except where better information warranted a revision. Exhibit B (4.2.4) states the following plan of research for calculating estimates of manufacturing water demand:

> *"Complete industry surveys to update water use efficiency estimates developed for the 2002 State Water Plan.*
> *Analyze the impact of technology adoption, and input substitution on the relationship of water used to output.*
> *Develop projections of industry output and associated water use by county."*

The region's demand for manufacturing water demand is projected to increase from approximately 7,509 acre-feet per year in 2010 to 11,059 acre-feet per year by 2060 (see Figure 2.7.), primarily due to projected population growth in Cameron and Hidalgo Counties. The TWDB has no data to enable similar projections for Jim Hogg, Starr, and Zapata Counties. Table 2.5 illustrates projected demand for manufacturing water in each of the counties and shows that Cameron and Hidalgo Counties will account for 98 percent of the total manufacturing need.

Figure 2.7: Projected RGRWPA Manufacturing Demand



PROJECTIONS

Table 2.5: Manufacturing Water Demand by County (in acre-feet per year)

COUNTY	2000	2010	2020	2030	2040	2050	2060
CAMERON	3,430	4,156	4,590	4,983	5,372	5,709	6,165
HIDALGO	2,674	3,236	3,559	3,851	4,143	4,403	4,742
JIM HOGG	0	0	0	0	0	0	0
MAVERICK	56	64	69	73	77	80	85
STARR	0	0	0	0	0	0	0
WEBB	23	28	31	34	37	39	42
WILLACY	25	25	25	25	25	25	25
ZAPATA	0	0	0	0	0	0	0
Total	6,208	7,509	8,274	8,966	9,654	10,256	11,059

2.3.3 Projections for Irrigation Water Demand

Irrigation water demand projections were determined by the Rio Grande RWPG with assistance from TCEQ. The numbers used differ from those recommended by the TWDB, which used a base year irrigation demand of 909,590 acre-feet. In researching the subject, the regional planning group realized that the base year value originally used by the TWDB is not accurate for actual irrigation demands. Data regarding annual rainfall, Amistad/Falcon reservoir levels, yearly allocations, and actual irrigation water usage was compiled from 1989 to 2004. (See the appendix.) The most accurate depiction of irrigation demand would take place in a year with normal rainfall and normal reservoir levels; based on these parameters, 1994 most accurately represented normal conditions. In 1994, rainfall totaled 20 inches, 2.5 inches below the average rainfall from 1989 to 2004. Also, the Amistad/Falcon reservoir system sat at 86.5% of total capacity. Total irrigation usage as reported by TCEQ was 1,180,278 acre-feet. This number is a combination of charged and no-charge water in the middle and lower Rio Grande River.

In addition to Amistad/Falcon source water, irrigation water also comes from Rio Grande tributaries, groundwater from various aquifers, local irrigation supplies, and reuse. These additional sources were treated as "supply equals demand" and totaled 29,377 acre-feet.

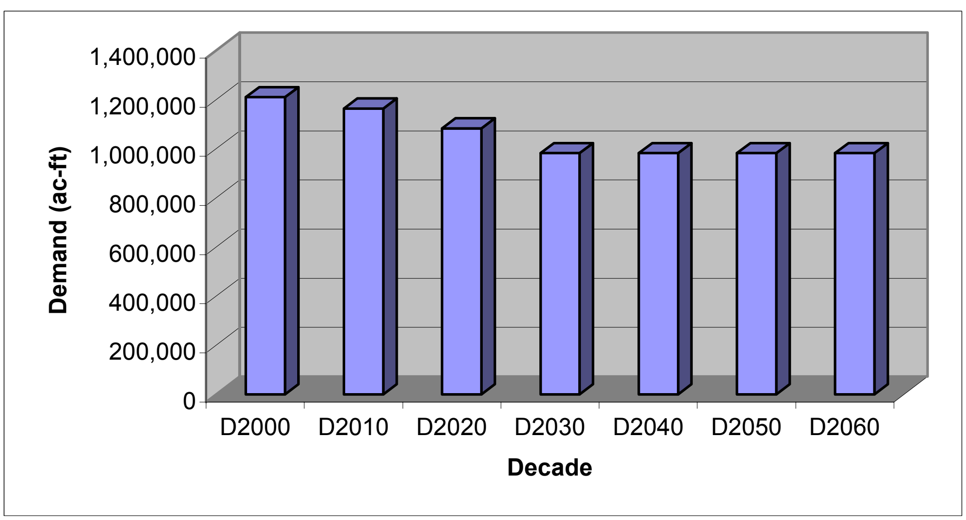
To summarize base year demand, 1994 was taken as a normal year with water usage from the Amistad/Falcon reservoir system totaling 1,180,278 acre-feet. Additionally, 29,377 acre-feet of irrigation supply/demand comes from other surface and groundwater sources. Summing these two figures gives a base year irrigation demand of 1,209,647 acre-feet.

In order to break down the irrigation demand from the Amistad/Falcon system (1,180,278 ac-ft) into by-county use, water rights associated with the Amistad/Falcon system were compiled and compared. For instance, irrigators in Cameron County hold 31.7 percent of all Region M irrigation water rights. This percentage was multiplied by the base year demand to arrive at the Cameron County base year demand for Amistad/Falcon water (374,585 ac-ft). The same methodology was used for each county in the region. As described earlier, additional water sources exist to provide irrigation water. They were treated as "supply equals demand" and were simply added to the Amistad/Falcon demands.

Projected irrigation demands for the extent of this planning study (2010-2060) were determined using the same percentage change in demand for each county as was used by the TWDB. (Reference Section 4.2.4.b of Exhibit B, provided as a supplement to this report.

The region's annual demand for irrigation water is projected to decrease from 1,209,647 acre-feet per year in 2000 to 981,749 acre-feet per year in 2060 (see Figure 2.8). This lower demand estimate arises from spreading urbanization which reduces irrigable acreage, primarily in Cameron and Hidalgo Counties.

Figure 2.8: Projected RGRWPA Irrigation Water Demand



PROJECTIONS

Table 2.6: Irrigation Water Demand Projections by County (in acre-feet per year)

COUNTY	2000	2010	2020	2030	2040	2050	2060
CAMERON	377,925	367,404	347,771	325,144	325,144	325,144	325,144
HIDALGO	611,399	583,030	525,971	453,772	453,772	453,772	453,772
JIM HOGG	6,413	817	817	817	817	817	817
MAVERICK	93,145	95,040	91,693	87,863	87,863	87,863	87,863
STARR	30,693	31,191	30,108	29,070	29,070	29,070	29,070
WEBB	23,723	20,507	19,548	18,654	18,654	18,654	18,654
WILLACY	58,586	59,191	60,203	60,623	60,623	60,623	60,623
ZAPATA	7,763	6,454	6,121	5,805	5,805	5,805	5,805
TOTAL	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749

Cameron County is projected to comprise 31.2 percent and 33.1 percent of the total demand for irrigation water in 2000 and 2060, respectively. Hidalgo currently accounts for 50.5 percent of the total irrigation demand, decreasing to 46.2 percent in 2060. Not coincidentally, these two counties have the highest percentage of water rights associated with the Amistad/Falcon system.

Important to note is that irrigation demands are highly variable from year to year. Overall agricultural economic conditions, weather conditions, and water availability are factors directly influencing the demand for irrigation water.

Market prices of agricultural commodities influence the amount of irrigated acreage planted each year and the types of crops planted. Also, above-normal or below-normal precipitation in irrigated areas can either suppress or increase irrigation demand, and because Amistad/Falcon irrigation rights are based on water availability, irrigation shortages can have the effect of suppressing water demand.

2.3.4 Projections for Steam Electric Water Demand

The TWDB [Exhibit B (4.2.4)] states a specific plan of research for estimating demand for steam electric water:

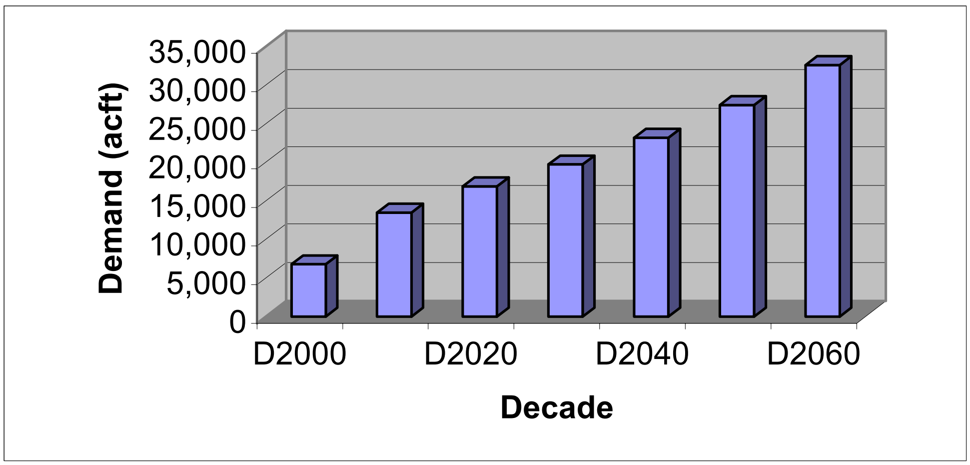
"The plan of research includes:

- *Description of water-consuming systems currently used in power generation facilities.*
- *Estimation of water consumption rates for each identified water-consuming system.*
- *Correlation of current state population with current electric use by region.*
- *Projection of electric power consumption requirements by county and for the state, based on population projections.*
- *Identification of current and potential water sources for demand by power generation.*
- *Estimation of future water use by power generation.*
- *Development and application of allocation methodology to derive demand projections by county."*

Annual demand for steam electric water is projected to increase from 13,463 acre-feet per year in 2010 to 32,598 acre-feet per year in 2060. (See Figure 2.9.) Most of this increase is expected to occur between 2000 and 2010 as a result of adding new capacity for generating steam electric power in Cameron and Webb counties.

Table 2.7 presents the projected demand for steam electric water, by county, for each of the region's eight counties. Cameron County makes up 12 percent of the demand. Hidalgo County accounts for 77 percent, and Webb County accounts for 11 percent. TWDB has no data about demand for steam electric water in Jim Hogg, Maverick, Starr, Willacy, and Zapata Counties.

Figure 2.9: Projected RGRWPA Steam Water Demand



PROJECTIONS

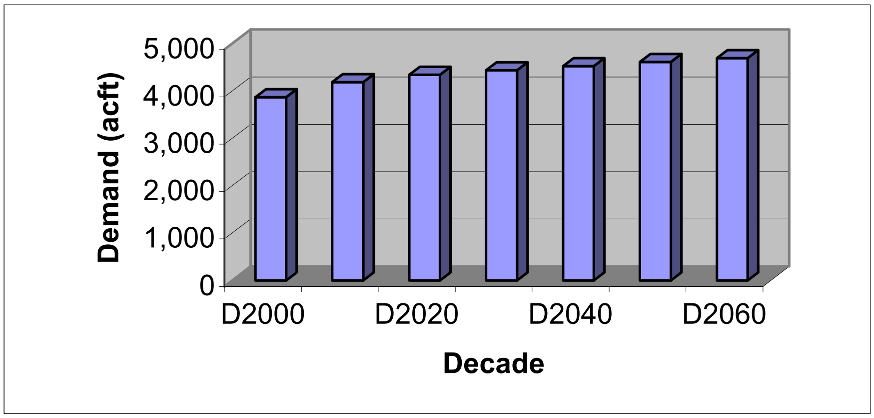
Table 2.7: Steam Electric Water Demand Projections by County (in acre-feet per year)

COUNTY	2000	2010	2020	2030	2040	2050	2060
CAMERON	1,498	1,616	1,523	1,780	2,094	2,477	2,944
HIDALGO	3,487	10,355	14,151	16,545	19,462	23,018	27,354
JIM HOGG	0	0	0	0	0	0	0
MAVERICK	0	0	0	0	0	0	0
STARR	0	0	0	0	0	0	0
WEBB	1,795	1,492	1,190	1,391	1,636	1,935	2,300
WILLACY	0	0	0	0	0	0	0
ZAPATA	0	0	0	0	0	0	0
TOTAL	6,780	13,463	16,864	19,716	23,192	27,430	32,598

2.3.5 Projections for Mining Water Demand

The state's default demand projections for mining water were based on forecasts of future production levels (sorted by mineral category) and their water use rates. These production projections are derived from state and national historic water use rates and are constrained by accessible mineral reserves in the region. Demand for mining water represents less than 1 percent of the region's total water needs and is expected to remain relatively constant over the 50-year planning period. (See Figure 2.10.) *Use* of mining water is greatest in Webb County (32.6 percent), Starr County (31 percent), and Hidalgo County (30.9 percent). In contrast, Willacy County has the lowest *demand* (less than 1 percent). Table 2.8 represents projected demand for mining water, by county, for the region.

Figure 2.10: Projected RGRWPA Mining Water Demand



PROJECTIONS

Table 2.8: Mining Water Demand Projections by COunty (in acre-feet per year)

COUNTY	2000	2010	2020	2030	2040	2050	2060
CAMERON	8	6	6	6	6	6	6
HIDALGO	1,196	1,442	1,561	1,633	1,704	1,774	1,836
JIM HOGG	27	33	36	37	38	39	40
MAVERICK	140	156	162	166	169	172	175
STARR	1,203	1,315	1,355	1,373	1,390	1,407	1,426
WEBB	1,262	1,204	1,192	1,189	1,187	1,185	1,180
WILLACY	6	6	6	6	6	6	6
ZAPATA	27	24	23	23	23	23	23
TOTAL	3,869	4,186	4,341	4,433	4,523	4,612	4,692

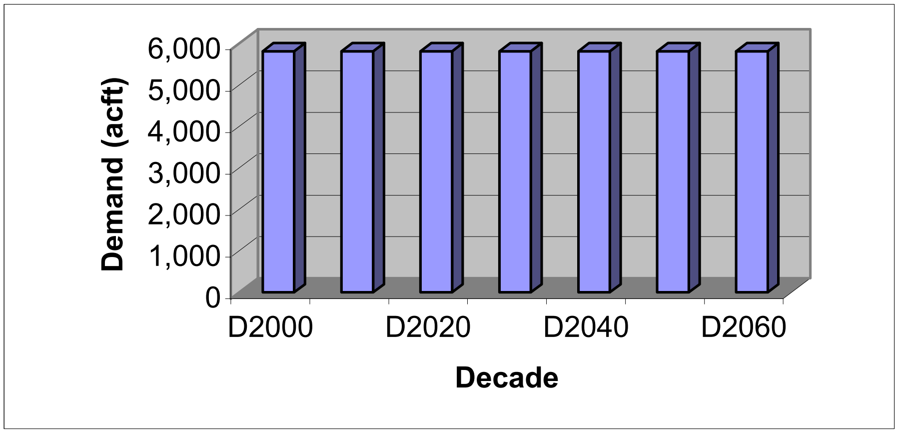
2.3.6 Projections for Livestock Water Demand

The TWDB's livestock water use projections were developed using Texas Agricultural Statistics Service's estimates of the numbers and types of livestock, and the Texas A&M Agricultural Extension Service's estimates of water usage rates for each type of livestock. Total livestock water is determined by multiplying consumption for a given livestock type by the number of that type of livestock in each of the eight counties. Exhibit B (Section 4.2.4) states:

> "*The 2006 Regional Water Plan will maintain the same rates of change in livestock water demand as included in the 2002 State Water Plan. Base water use for 2000 will be adjusted using the 2000 livestock inventory along with adjustments in water use per unit, based on research by the Texas Agricultural Experiment Station.*"

Livestock types are breeding cattle, dairy cattle, fed cattle, hogs, pigs, sheep, goats, hens, broilers, and horses. Surprisingly, demand for livestock water is low compared with other water demands, comprising only 1% of the region's total water usage. By year 2060, the figure is projected to drop to 0.4% of total water demand.

Figure 2.11: Projected RGRWPA Livestock Water Demand



Livestock water demand is relatively uniform over the eight-county area and is projected to remain fairly constant over the 50-year planning period. (See Figure 2.11.) Table 2.9 presents these projected demands, by county.

PROJECTIONS

Table 2.9: Projected Livestock Water Demand by County (in acre-feet per year)

COUNTY	2000	2010	2020	2030	2040	2050	2060
CAMERON	1,103	1,103	1,103	1,103	1,103	1,103	1,103
HIDALGO	681	681	681	681	681	681	681
JIM HOGG	518	518	518	518	518	518	518
MAVERICK	260	260	260	260	260	260	260
STARR	1,117	1,117	1,117	1,117	1,117	1,117	1,117
WEBB	1,513	1,513	1,513	1,513	1,513	1,513	1,513
WILLACY	151	151	151	151	151	151	151
ZAPATA	474	474	474	474	474	474	474
TOTAL	5,817	5,817	5,817	5,817	5,817	5,817	5,817

2.3.7 Needs for Wholesale Water Providers

Texas Water Development Board guidelines in Exhibit B state that a wholesale water provider is any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-ft of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. Table 2.10 below indicates the water providers that follow the TWDB guidelines to designate them as Wholesale Water Providers for this region. Demand projection figures were compiled through the TWDB's database for the region.

DEMAND PROJECTIONS

Table 2.10: Projected Wholesale Water Provider Demand (in acre-feet per year)

	2010	2020	2030	2040	2050	2060
Brownsville Irrigation & Drainage District	6071	6071	6071	6071	6071	6071
Cameron County WCID #2	15198	15198	15198	15198	15198	15198
Delta Lake Municipal Authority	8200	8200	8200	8200	8200	8200
Donna Irrigation District Hidalgo County #1	6880	6880	6880	6880	6880	6880
City of Eagle Pass	7707	7707	7707	7707	7707	7707
Harlingen Irrigation District	4692	4692	4692	4692	4692	4692
Harlingen Waterworks System	19238	19238	19238	19238	19238	19238
Hidalgo County Irrigation District #6	8291	8291	8291	8291	8291	8291
Hidalgo County WCID#1	1437	1437	1437	1437	1437	1437
Hidalgo County WCID#16	1437	1437	1437	1437	1437	1437
Hidalgo County WCID#2	24667	24667	24667	24667	24667	24667
Hidalgo County WCID#3	13980	13980	13980	13980	13980	13980
Hidalgo County WCID#9	11500	11500	11500	11500	11500	11500
La Feria WCID#3	4852	4852	4852	4852	4852	4852
Laguna Madre WD	7480	7480	7480	7480	7480	7480
City of McAllen	33548	33548	33548	33548	33548	33548
Sharyland WSC	12140	12139	12139	12140	12139	12140
Southmost Regional Water Authority	11844	11844	11844	11844	11844	11844
United Irrigation District	24009	24009	24009	24009	24009	24009
Valley MUD#2	1382	1382	1382	1382	1382	1382
North Alamo WSC	21954	21954	21954	21954	21954	21960

* North Alamo WSC's demands were compiled using the data provided by the WUG database. A water demand analysis of North Alamo WSC as a Wholesale Water Provider was not available at time of print.

ATTACHMENT 2-1

2006 Regional Water Plan
Population and Water Demand Projections Summary for Region M

Regional Total Projection

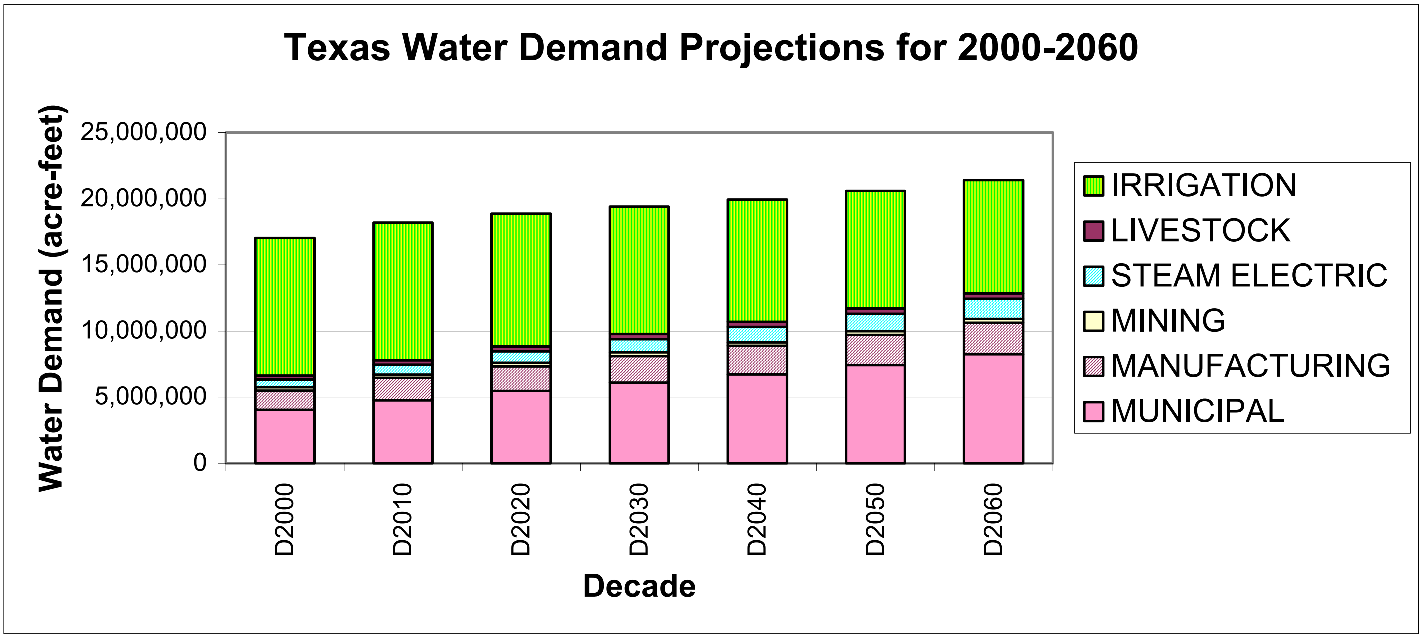
	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Population	1,236,246	1,581,207	1,973,188	2,401,223	2,854,613	337,618	3,826,001
Irrigation (AF/YR)	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749
Livestock (AF/YR)	5,817	5,817	5,817	5,817	5,817	5,817	5,817
Manufacturing (AF/YR)	6,208	7,509	8,274	8,966	9,654	10,256	11,059
Mining (AF/YR)	3,869	4,186	4,341	4,433	4,523	4,612	4,692
Municipal (AF/YR)	226,536	279,633	338,716	403,511	472,632	547,747	625,743
Steam Eelctric (AF/YR)	6,780	13,463	16,864	19,716	23,192	27,430	32,598
Total Water Demand (AF/YR)	1,458,857	1,474,241	1,456,243	1,424,192	1,497,567	1,577,611	1,661,658

Region M Population Projection by County

	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Cameron	335,227	415,136	499,618	586,944	673,996	761,073	843,894
Hidalgo	569,463	744,258	948,488	1,177,243	1,424,767	1,695,114	1,972,453
Jim Hogg	5,281	5,593	5,985	6,286	6,538	6,468	6,225
Maverick	47,297	55,892	64,984	73,581	81,032	87,850	93,381
Starr	53,597	66,137	79,538	93,338	107,249	120,959	134,115
Webb	193,117	257,647	333,451	418,332	511,710	613,774	721,586
Willacy	20,082	22,519	24,907	27,084	28,835	30,026	30,614
Zapata	12,182	14,025	16,217	18,415	20,486	22,354	23,733
REGION M TOTAL	**1,236,246**	**1,581,207**	**1,973,188**	**2,401,223**	**2,854,613**	**3,337,618**	**3,826,001**

2006 Regional Water Plan
Summary of Water Demand Projections for the state of Texas (ac-ft/

	D2000	D2010	D2020	D2030	D2040	D2050	D2060
MUNICIPAL	4,047,322	4,761,887	5,473,988	6,109,591	6,727,858	7,438,852	8,245,271
MANUFACTURING	1,449,508	1,696,145	1,861,979	2,009,101	2,153,850	2,275,681	2,389,593
MINING	271,215	255,455	265,423	271,308	272,619	275,446	284,088
STEAM ELECTRIC	561,394	737,170	868,580	1,012,212	1,156,170	1,321,733	1,515,556
LIVESTOCK	300,441	344,495	374,724	381,241	388,243	395,945	404,397
IRRIGATION	10,416,100	10,401,624	10,035,674	9,637,689	9,250,160	8,878,320	8,587,930
TEXAS TOTAL	17,045,980	18,196,776	18,880,368	19,421,142	19,948,900	20,585,977	21,426,835



2006 Regional Water Plan									
Municipal Water Demand Projections for 2000 - 2060 (in acft1)									
Region M									
Region	WUG Name	County Name	D2000	D2010	D2020	D2030	D2040	D2050	D2060
M	BROWNSVILLE	CAMERON	35,840	43,655	52,038	60,475	69,270	77,985	86,577
M	COMBES	CAMERON	186	208	229	256	281	309	341
M	COUNTY-OTHER	CAMERON	6,226	6,970	7,812	8,709	9,572	10,485	11,424
M	EAST RIO HONDO WSC	CAMERON	1,739	2,408	3,107	3,862	4,555	5,323	6,052
M	EL JARDIN	CAMERON	1,514	1,910	2,332	2,771	3,216	3,656	4,095
M	HARLINGEN	CAMERON	10,059	11,374	12,780	14,175	15,604	17,109	18,643
M	INDIAN LAKE	CAMERON	40	49	57	66	76	85	95
M	LA FERIA	CAMERON	699	855	1,031	1,214	1,403	1,587	1,777
M	LAGUNA MADRE WD	CAMERON	1,288	2,310	3,386	4,516	5,622	6,744	7,812
M	LAGUNA VISTA	CAMERON	214	268	323	382	444	503	564
M	LOS FRESNOS	CAMERON	541	767	1,008	1,247	1,490	1,745	1,988
M	LOS INDIOS	CAMERON	193	230	271	311	354	396	439
M	MILITARY HIGHWAY WSC	CAMERON	1,214	1,486	1,780	2,066	2,378	2,683	2,993
M	OLMITO WSC	CAMERON	612	952	1,314	1,691	2,060	2,444	2,809
M	PALM VALLEY	CAMERON	390	413	440	468	494	525	555
M	PALM VALLEY ESTATES UD	CAMERON	63	85	108	132	155	180	203
M	PORT ISABEL	CAMERON	2,458	2,645	2,846	3,052	3,254	3,470	3,681
M	PRIMERA	CAMERON	433	525	628	730	838	945	1,053
M	RANCHO VIEJO	CAMERON	253	373	496	627	755	888	1,015
M	RIO HONDO	CAMERON	385	404	428	453	475	503	533
M	SAN BENITO	CAMERON	4,386	4,916	5,484	6,050	6,630	7,241	7,863
M	SANTA ROSA	CAMERON	286	331	376	429	478	531	588

M	ALAMO	HIDALGO	1,703	2,319	3,022	3,808	4,675	5,667	6,684
M	ALTON	HIDALGO	1,208	3,346	4,153	5,061	6,056	7,135	8,268
M	COUNTY-OTHER	HIDALGO	7,833	9,886	13,072	16,626	20,536	24,981	29,542
M	DONNA	HIDALGO	2,101	2,309	2,565	2,842	3,156	3,521	3,924
M	EDCOUCH	HIDALGO	460	499	547	604	668	744	828
M	EDINBURG	HIDALGO	6,460	8,274	10,428	12,967	15,528	18,583	21,717
M	ELSA	HIDALGO	1,063	1,099	1,134	1,182	1,232	1,303	1,383
M	HIDALGO	HIDALGO	730	1,058	1,444	1,859	2,316	2,841	3,380
M	HIDALGO COUNTY MUD #1	HIDALGO	1,116	1,703	2,387	3,161	3,994	4,915	5,860
M	LA JOYA	HIDALGO	359	408	471	538	613	700	797
M	LA VILLA	HIDALGO	240	234	230	225	221	218	218
M	MCALLEN	HIDALGO	24,436	28,697	33,551	39,226	45,267	52,032	59,213
M	MERCEDES	HIDALGO	1,835	1,890	1,956	2,048	2,142	2,285	2,453
M	MILITARY HIGHWAY WSC	HIDALGO	1,195	1,346	1,540	1,748	2,000	2,271	2,568
M	MISSION	HIDALGO	7,579	9,864	12,564	15,594	18,792	22,529	26,363
M	NORTH ALAMO WSC	HIDALGO	8,706	11,675	15,158	19,046	23,352	28,297	33,369
M	PALMHURST	HIDALGO	622	1,157	1,789	2,497	3,263	4,099	4,957
M	PALMVIEW	HIDALGO	589	869	1,199	1,570	1,967	2,414	2,873
M	PENITAS	HIDALGO	149	149	150	150	151	155	161
M	PHARR	HIDALGO	6,899	8,474	10,370	12,511	14,887	17,448	20,202
M	PROGRESO	HIDALGO	456	576	717	867	1,037	1,234	1,436
M	SAN JUAN	HIDALGO	2,497	3,501	4,665	5,956	7,384	9,031	10,720
M	SHARYLAND WSC	HIDALGO	4,420	4,893	5,469	6,095	6,747	7,492	8,365
M	SULLIVAN CITY	HIDALGO	403	526	672	845	1,016	1,226	1,440
M	WESLACO	HIDALGO	4,978	5,534	6,201	6,966	7,819	8,792	9,843
		HIDALGO Total	**88,037**	**110,286**	**135,454**	**163,992**	**194,819**	**229,913**	**266,564**
M	COUNTY-OTHER	JIM HOGG	147	153	159	164	167	165	158
M	HEBBRONVILLE (CDP)	JIM HOGG	705	731	759	780	792	778	748
		JIM HOGG Total	**852**	**884**	**918**	**944**	**959**	**943**	**906**
M	COUNTY-OTHER	MAVERICK	2,223	2,727	3,249	3,742	4,183	4,573	4,926
M	EAGLE PASS	MAVERICK	4,720	4,932	5,123	5,314	5,460	5,644	5,818
M	EL INDIO WSC	MAVERICK	968	1,253	1,567	1,855	2,108	2,335	2,530
		MAVERICK Total	**7,911**	**8,912**	**9,939**	**10,911**	**11,751**	**12,552**	**13,274**

2006 Regional Water Plan								
Manufacturing Water Demand Projections for 2000 - 2060 (in acft1)								
Region M								
Region	**County Name[2)]**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**	**D2060**
M	CAMERON	3,430	4,156	4,590	4,983	5,372	5,709	6,165
M	HIDALGO	2,674	3,236	3,559	3,851	4,143	4,403	4,742
M	JIM HOGG	0	0	0	0	0	0	0
M	MAVERICK	56	64	69	73	77	80	85
M	STARR	0	0	0	0	0	0	0
M	WEBB	23	28	31	34	37	39	42
M	WILLACY	25	25	25	25	25	25	25
M	ZAPATA	0	0	0	0	0	0	0
	Region M Total	**6,208**	**7,509**	**8,274**	**8,966**	**9,654**	**10,256**	**11,059**

1) An acft is an amount of water to cover one acre with one foot of water and equals 325,851 gallons.
2) If the "(P)" is present for a county entry, then the county has been split by Regional boundaries and the data listed in the row represent only the county's water demands within the particular region, not the county's total.

2006 Regional Water Plan								
Mining Water Demand Projections for 2000 - 2060 (in acft[1])								
Region M								
Region	**County Name[2)]**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**	**D2060**
M	CAMERON	8	6	6	6	6	6	6
M	HIDALGO	1,196	1,442	1,561	1,633	1,704	1,774	1,836
M	JIM HOGG	27	33	36	37	38	39	40
M	MAVERICK	140	156	162	166	169	172	175
M	STARR	1,203	1,315	1,355	1,373	1,390	1,407	1,426
M	WEBB	1,262	1,204	1,192	1,189	1,187	1,185	1,180
M	WILLACY	6	6	6	6	6	6	6
M	ZAPATA	27	24	23	23	23	23	23
	Region M Total	**3,869**	**4,186**	**4,341**	**4,433**	**4,523**	**4,612**	**4,692**

1) An acft is an amount of water to cover one acre with one foot of water and equals 325,851 gallons.
2) If the "(P)" is present for a county entry, then the county has been split by Regional boundaries and the data listed in the row represent only the county's water demands within the particular region, not the county's total.

Projections last updated on 11/19/03

2006 Regional Water Plan

Steam Electric Water Demand Projections for 2000 - 2060 (in acft[1])

Region M

Region	County Name[2)]	D2000	D2010	D2020	D2030	D2040	D2050	D2060
M	CAMERON	1,498	1,616	1,523	1,780	2,094	2,477	2,944
M	HIDALGO	3,487	10,355	14,151	16,545	19,462	23,018	27,354
M	JIM HOGG	0	0	0	0	0	0	0
M	MAVERICK	0	0	0	0	0	0	0
M	STARR	0	0	0	0	0	0	0
M	WEBB	1,795	1,492	1,190	1,391	1,636	1,935	2,300
M	WILLACY	0	0	0	0	0	0	0
M	ZAPATA	0	0	0	0	0	0	0
	Region M Total	**6,780**	**13,463**	**16,864**	**19,716**	**23,192**	**27,430**	**32,598**

1) An acft is an amount of water to cover one acre with one foot of water and equals 325,851 gallons.

2) If the "(P)" is present for a county entry, then the county has been split by Regional boundaries and the data listed in the row represent only the county's water demands within the particular region, not the county's total.

2006 Regional Water Plan

Livestock Water Demand Projections for 2000 - 2060 (in acft[1])

Region M

Region	County Name[2)]	D2000	D2010	D2020	D2030	D2040	D2050	D2060
M	CAMERON	1,103	1,103	1,103	1,103	1,103	1,103	1,103
M	HIDALGO	681	681	681	681	681	681	681
M	JIM HOGG	518	518	518	518	518	518	518
M	MAVERICK	260	260	260	260	260	260	260
M	STARR	1,117	1,117	1,117	1,117	1,117	1,117	1,117
M	WEBB	1,513	1,513	1,513	1,513	1,513	1,513	1,513
M	WILLACY	151	151	151	151	151	151	151
M	ZAPATA	474	474	474	474	474	474	474
	Region M Total	**5,817**	**5,817**	**5,817**	**5,817**	**5,817**	**5,817**	**5,817**

1) An acft is an amount of water to cover one acre with one foot of water and equals 325,851 gallons.

2) If the "(P)" is present for a county entry, then the county has been split by Regional boundaries and the data listed in the row represent only the county's water demands within the particular region, not the county's total.

2006 Regional Water Plan
Irrigation Water Demand Projections by County (ac-ft/year)

	D2000	D2010	D2020	D2030	D2040	D2050	D2060
Cameron	377,925	367,404	347,771	325,144	325,144	325,144	325,144
Hidalgo	611,399	583,030	525,971	453,772	453,772	453,772	453,772
Jim Hogg	6,413	817	817	817	817	817	817
Maverick	93,145	95,040	91,693	87,863	87,863	87,863	87,863
Starr	30,693	31,191	30,108	29,070	29,070	29,070	29,070
Webb	23,723	20,507	19,548	18,654	18,654	18,654	18,654
Willacy	58,586	59,191	60,203	60,623	60,623	60,623	60,623
Zapata	7,763	6,454	6,121	5,805	5,805	5,805	5,805
Total	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749

Texas Water Development Board
2006 Regional Water Plan
Regional and State Total Population Projections for 2000 - 2060

REGION	P2000	P2010	P2020	P2030	P2040	P2050	P2060
A - Panhandle	355,832	388,104	423,380	453,354	484,954	516,729	541,035
B - Region B	201,970	210,642	218,918	223,251	224,165	223,215	221,734
C - Region C	5,254,722	6,625,282	7,966,389	9,093,847	10,246,795	11,559,990	13,087,849
D - North East Texas	704,171	772,163	843,027	908,748	978,298	1,073,570	1,213,095
E - Far West Texas	705,399	855,466	1,018,479	1,161,232	1,283,725	1,405,966	1,527,713
F - Region F	578,814	618,889	656,480	682,132	700,806	714,045	724,094
G - Brazos G	1,621,961	1,882,896	2,168,682	2,458,075	2,739,717	3,034,798	3,332,100
H - Region H	4,848,918	5,775,097	6,707,045	7,679,397	8,653,377	9,739,109	10,897,526
I - East Texas	1,011,317	1,090,382	1,166,057	1,232,138	1,294,976	1,377,760	1,482,448
J - Plateau	114,742	135,723	158,645	178,342	190,551	198,594	205,910
K - Lower Colorado	1,132,228	1,359,677	1,657,025	1,936,324	2,181,851	2,447,058	2,713,905
L - South Central Texas	2,042,221	2,460,599	2,892,933	3,292,970	3,644,661	3,984,258	4,297,786
M - Rio Grande	1,236,246	1,581,207	1,973,188	2,401,223	2,854,613	3,337,618	3,826,001
N - Costal Bend	541,184	617,143	693,940	758,427	810,650	853,964	885,665
O - Llano - Estacado	453,997	486,311	512,405	528,437	535,967	537,255	527,210
P - Lavaca	48,068	49,491	51,419	52,138	51,940	51,044	49,663
Texas State Total	**20,851,790**	**24,909,072**	**29,108,012**	**33,040,035**	**36,877,046**	**41,054,973**	**45,533,734**

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3.0 EVALUATION OF THE ADEQUACY OF CURRENT WATER SUPPLIES

3.1 INTRODUCTION

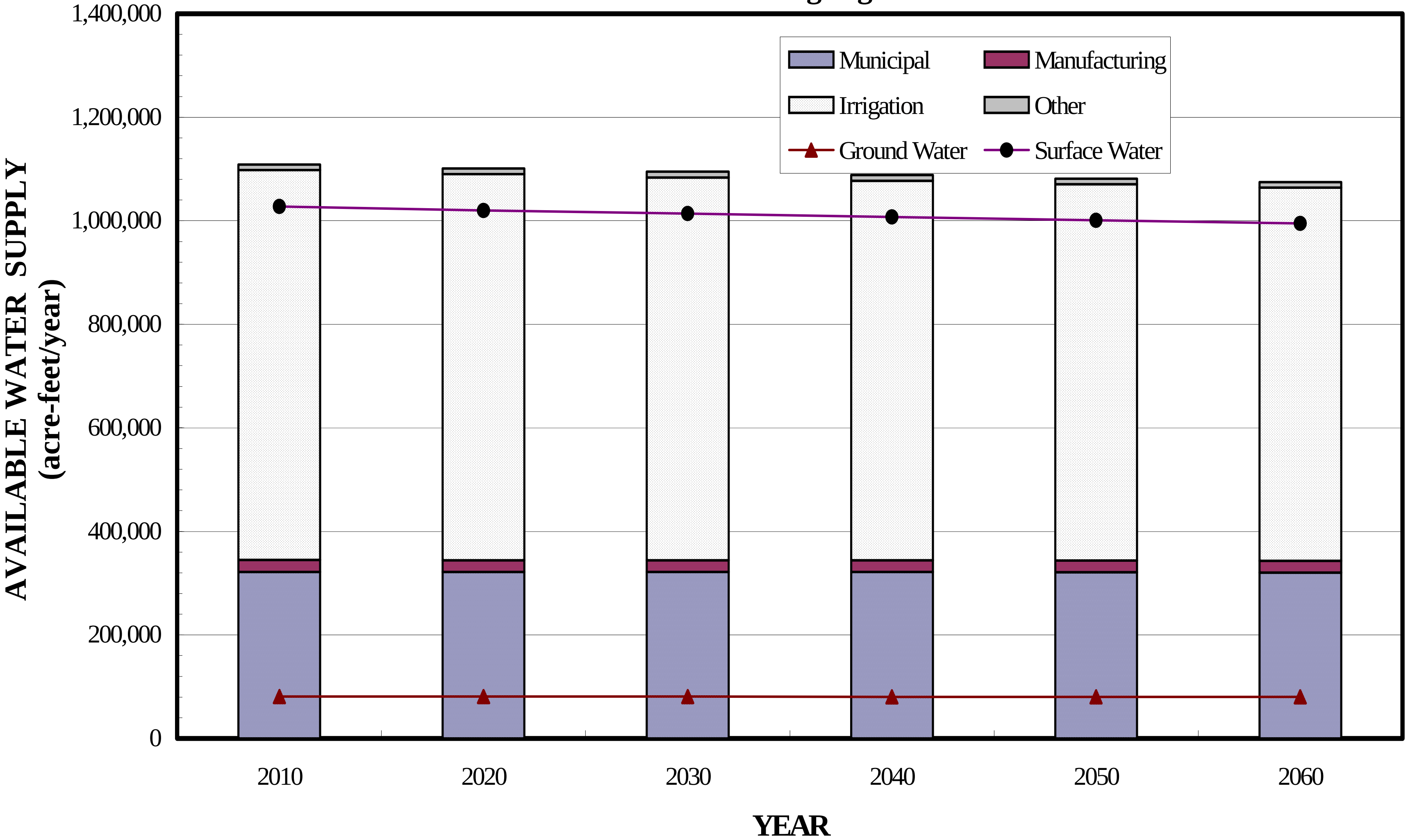
An understanding of the availability of current water supplies is critical to effectively planning for meeting the future water demands that are projected to occur in the Rio Grande Regional Water Planning Area (RGRWPA). Both surface water and groundwater are currently used within the region; however, surface water from the Rio Grande provides the vast majority of the supply for municipal, industrial, and irrigation purposes. The dependence upon surface water from the Rio Grande as the predominant source of supply for the RGRWPA is not expected to change over the next 50 years.

Guidelines from the Texas Water Development Board (TWDB) pursuant to the provisions of 31 TAC 357 regarding regional water supply planning require that data be developed regarding the current water supplies available to the RGRWPA for each decade through the year 2060. These data have been compiled and summarized using specific data entry forms provided by the TWDB. The first, referred to in the TWDB guidelines as "Form 1," summarizes the total quantities of water available to the region from individual and unique sources, including amounts of water available by river basin, by river or stream course, by reservoir, by aquifer, and by county. The second form, referred to by the TWDB as "Form 2," contains information similar to Form 1, but presents it for specific "water user groups" by county in the RGRWPA. Water user groups (WUGs) typically are cities or communities that provide water to their citizens and to other users in adjacent areas; however, they also can include utilities or groups of utilities that provide water for municipal use, rural or unincorporated areas relying on local water supply sources or served by small water supply entities. WUGs also are designated for certain water use categories aggregated on a county basis, such as manufacturing, steam electric power generation, mining, irrigation, and/or livestock. The last form developed by the TWDB, "Form 3," is intended to present a summary of the available current water supplies for entities designated as "wholesale water providers". For the RGRWPA, no wholesale water providers have been designated; therefore, Form 3 has not been used. The data and procedures used in developing the current water supply amounts for the region and a discussion of these results are presented in subsequent sections of this chapter.

A general indication of the quantities of water that are projected to be available by decade in the RGRWPA over the next 50 years based on current supplies is provided by the bar chart in Figure 3.1. The distribution of these available supplies among various water use categories is indicated on each of the bars in the chart. As is the case today, most of the available water supply is projected to be used for irrigation of crops over the next 50 years; however, as urbanization continues to encroach into agricultural areas and as the overall agricultural economy is potentially diminished, the indicated available supplies of irrigation water are likely to be reduced as demands for municipal and manufacturing water increase. The portions of the available supplies derived from surface water and from groundwater each decade also are plotted on the chart. As shown, surface water, almost entirely from Amistad and Falcon Reservoirs on the Rio Grande, will provide most of the available supply for the region.

It is important to recognize that the current water supply information for the RGRWPA as presented on the bar chart in Figure 3.1 reflects certain limiting criteria and assumptions set forth by the TWDB in its guidelines for conducting regional water supply planning studies. First of all, the available current water supply amounts reflect "drought of record" conditions. This means that they represent the annual amounts

Figure 3.1 - Currently Available Water Supplies by Use Category and by Source for the Rio Grande Water Planning Region



of water that would be available if the worst drought known to have previously occurred in the region as documented by existing hydrologic records should reoccur in the future. As will be discussed later, much of the Rio Grande Basin in Texas and Mexico currently is experiencing an extended drought, and this drought very likely could be the new drought of record for the river with respect to Amistad and Falcon Reservoirs and the water supplies these reservoirs provide to the United States and Mexico, exceeding the severity of the drought of the 1950s. Hence, the firm annual yield[1] of the Amistad-Falcon reservoir system with respect to United States water as determined by the hydrologic conditions corresponding to the drought of may be changing, and, of course, it is the firm annual yield of these reservoirs that limits, to a large extent, the available supply of water in the RGRWPA. Other factors that have been considered in establishing the amounts of water available for the RGRWPA based on current supplies include the current capacity of existing groundwater well fields; the hydrogeologic properties of aquifers in the region; the quality of existing water supplies with regard to usability; current water rights, permits, and other regulatory restrictions; the hydraulic capacity of existing conveyance infrastructure; current contracts and/or option agreements; and obligations that a WUG may have in terms of contracts or direct/indirect water sales to other WUGs. In some instances, one or more of these factors have determined the available water supply of individual water users.

This chapter presents information regarding the baseline data used to develop the future water supply estimates for the RGRWPA and describes the procedures and methodologies applied in analyzing current water supply sources for the region as a whole and for individual water users (WUGs). Also included are descriptions of and results from special studies that have been undertaken as part of the overall investigation of the available supplies of water for the RGRWPA, including an evaluation of the extent to which Rio Grande water could be delivered to municipalities in the Lower Rio Grande Valley during a severe drought without the benefit of irrigation carrying water in the river or in the irrigation district canal systems, an analysis of the potential impacts of Mexico's water use and tributary reservoir development on the yield of the international reservoirs on the Rio Grande and the supply of surface water available to the United States from the Rio Grande under the 1944 Treaty, and a review of the quality of the surface water and groundwater supplies that are projected to be available to the RGRWPA.

3.2 SURFACE WATER SOURCES

The RGRWPA includes eight counties that encompass portions of three river or coastal basins, the Rio Grande Basin, the Nueces River Basin, and the Nueces-Rio Grande Coastal Basin. The RGRWPA counties are identified on the map of the region in Figure 3.2 along with the boundaries of the three basins. Although water users are located in all three of these basins within the RGRWPA, practically all rely upon surface water from the Rio Grande or groundwater for their water supplies. Some very limited use is made of surface water supplies available from tributaries of the Rio Grande in Maverick, Webb, Zapata, and Starr counties; from the Arroyo Colorado, which flows through southern Hidalgo County and northern Cameron County to the Laguna Madre; from the pilot channels within the floodways that convey

[1] The firm annual yield of a reservoir or a system of reservoirs is defined as the maximum amount of water that can be withdrawn from the reservoir(s) each year during the occurrence of the drought of record without causing the reservoir(s) to go dry.

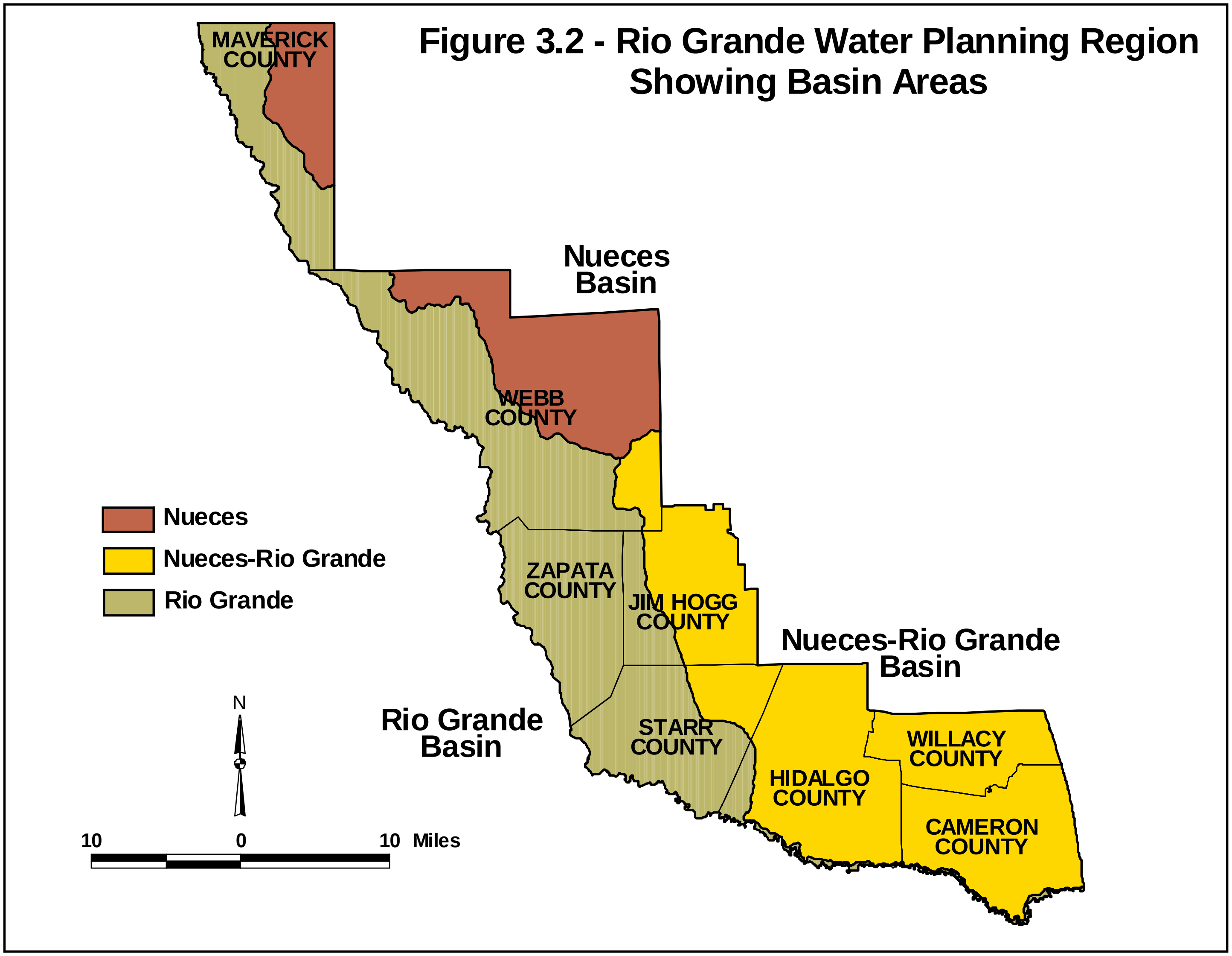


Figure 3.2 - Rio Grande Water Planning Region
Showing Basin Areas
MAVERICK COUNTY
Nueces Basin
WEBB COUNTY
Nueces
Nueces-Rio Grande
Rio Grande
ZAPATA COUNTY
JIM HOGG COUNTY
Nueces-Rio Grande Basin
N
Rio Grande Basin
STARR COUNTY
WILLACY COUNTY
HIDALGO COUNTY
CAMERON COUNTY
10
0
10 Miles

local runoff and floodwaters from the Rio Grande through the Lower Rio Grande Valley to the Laguna Madre; and from isolated lakes and resacas in Hidalgo and Cameron counties.

3.2.1 Rio Grande

The Rio Grande Basin extends southward from the Continental Divide in southern Colorado through New Mexico and Texas to the Gulf of Mexico. The Rio Grande forms the international boundary between the United States and Mexico from El Paso, Texas, to the Gulf, a straight-line distance of about 700 miles and a river-mile distance of almost 1,250 miles. The entire Basin (United States and Mexico) covers approximately 355,500 square miles; however, only about half of this area yields runoff to the Rio Grande. The non-contributing areas drain into internal closed sub-basins. The area of the contributing watershed is approximately 176,000 square miles, of which about 89,000 square miles, or 50.4 percent, are located within the United States. A map of the entire Rio Grande Basin is presented in Figure 3.3.

The Texas portion of the contributing watershed of the Rio Grande Basin encompasses about 54,000 square miles, or about one third of the total contributing watershed. In addition, there are about 8,100 square miles within the Texas portion of the basin that do not contribute runoff to the Rio Grande. These noncontributing areas extend generally southward from the New Mexico state line and include a large closed basin in portions of Hudspeth, Culberson, Jeff Davis, and Presidio counties in extreme western Texas.

The Pecos and Devils Rivers are the principal tributaries of the Rio Grande in Texas. Both of these rivers flow into Amistad Reservoir on the Rio Grande, which is located upstream of Del Rio, Texas, about 600 river miles from the mouth of the Rio Grande. On the Mexican side, the Rio Conchos, Rio Salado, and Rio San Juan are the largest tributaries. The Rio Conchos drains over 26,000 square miles and flows into the Rio Grande near Presidio, Texas, about 350 river miles upstream of Amistad Reservoir. The Rio Salado has a drainage area of about 23,000 square miles and discharges directly into Falcon Reservoir on the Rio Grande. Falcon Reservoir is located between Laredo, Texas and Rio Grande City, Texas, about 275 river miles upstream from the Gulf of Mexico. The Rio San Juan enters the Rio Grande about 36 river miles below Falcon Dam near Rio Grande City. The drainage area of the Rio San Juan covers about 13,000 square miles.

The Texas portion of the Rio Grande Basin is fairly broad upstream of the Devils River with a maximum width of about 200 miles. Downstream from the Devils River to below Falcon Dam, the Basin tapers down to a relatively narrow band bordering the Rio Grande and varying in width from 10 to 30 miles. In Hidalgo and Cameron counties, at the extreme lower end of the basin, the watershed is confined between levees and is generally less than a few miles in width. This system of levees and the associated drainage channels were constructed by the United States and Mexico to control flooding of the extensive agricultural and urbanized areas along the river in the Lower Rio Grande Valley.

The vast majority of the Rio Grande Basin is comprised of rural, undeveloped land that is used principally for farming and ranching operations. In Texas, the major urban centers include El Paso in the far western end of the state; Del Rio, Eagle Pass, and Laredo on the river in the central portion of the basin; and, Mission, McAllen, Harlingen, and Brownsville in the Lower Rio Grande Valley. Although these and most other cities in the Lower Valley actually are located outside of the contributing watershed of the Rio Grande, the river serves as the primary source for their water supplies. Substantial quantities of surface water are diverted from the Rio Grande in Texas to meet both municipal and agricultural demands. Much of this demand is in the Lower Rio Grande Valley where approximately three quarters of a million people reside and where irrigated farming is extensively practiced.

Figure 3.3 - Rio Grande Basin

For the most part, the water that is diverted from the Rio Grande in the Lower Valley is not returned to the river either as irrigation tailwater or treated wastewater effluent because of the natural slope of the land away form the river due to historical depositions of sediment along the floodplain of the river. Generally, these return flows are discharged into interior drainage channels and floodways that ultimately flow into the Laguna Madre and the Gulf of Mexico. An exception is the city of Brownsville, which has a wastewater discharge into the Rio Grande.

3.2.1.1 Rio Grande Reservoirs

Amistad and Falcon Reservoirs are the two major international reservoirs that are located on the Rio Grande. These impoundments provide controlled storage for over 8 million acre-feet of water owned by the United States and Mexico, of which 2.25 million acre-feet are allocated for flood control purposes and 6.05 million acre-feet are reserved for silt and conservation storage (water supply). Falcon Reservoir, completed in 1953 and located on the river about midway between Laredo and McAllen, was the first major reservoir constructed on the Rio Grande under the 1944 Treaty between the United States and Mexico. Today, it is considered to be the "lowest major international dam or reservoir" on the river in accordance with the provisions of the 1944 Treaty. The United States has 58.6 percent (or 1.56 million acre-feet) of the silt and conservation storage in Falcon Reservoir; Mexico owns the balance, 1.10 million acre-feet. In Amistad Reservoir, which was completed in 1968 just upstream of Del Rio, the United States utilizes and controls 56.2 percent of the total conservation storage capacity, or about 1.77 million acre-feet. The remainder of the conservation storage capacity, 1.38 million acre-feet, is owned and used by Mexico. Together, Amistad and Falcon Reservoirs make available a substantial supply of water for the United States and Mexico, and they provide significant flood control benefits for properties along the middle and lower reaches of the river.

Anzalduas Dam, completed in 1960 just south of Mission, Texas, provides for the diversion of the United States' share of the Rio Grande floodwaters into an interior floodway system, and it also enables the gravity diversion of water into Mexico's main water supply canal, referred to as the Anzalduas Canal. Anzalduas Reservoir has a total storage capacity of about 15,000 acre-feet at its normal maximum operating level of 104.5 feet above mean sea level. Of this amount, between 3,037 and 4,214 acre-feet are available as conservation storage for use by the United States. Anzalduas Reservoir serves as a storage and flow regulation facility for partially controlling and managing the United States' share of water in the lower reach of the Rio Grande.

3.2.1.2 Mexican Tributary Reservoirs

To develop its water resources, Mexico has constructed an extensive system of reservoirs on tributaries of the Rio Grande whose combined storage capacity substantially exceeds the total storage capacity available to Mexico in Amistad and Falcon Reservoirs on the mainstem of the Rio Grande. Water stored in these tributary reservoirs is used for municipal, industrial, and irrigation purposes in the vicinity of the reservoirs and downstream along the tributaries and the Rio Grande. Because the 1944 Treaty between the United States and Mexico stipulates that the United States is to receive certain minimum quantities of inflows to the Rio Grande from some of the Mexican tributaries on which reservoirs have been constructed (see Section 3.2.1.6.1 of this report), the potential impacts of these reservoirs on the delivery of the required minimum amounts of water to the United States are of particular concern with regard to water supply planning for the RGRWPA. This is especially critical since Mexico has stated that it does not operate its tributary reservoirs for the purpose of meeting its obligations under the 1944 Treaty, but rather, solely to capture water for meeting its own internal water demands. In light of the fact that Mexico currently has accrued a deficit with respect to the minimum tributary inflows to the Rio Grande required by the 1944 Treaty[2], the supply of water that will be available in the future to the United States and to the RGRWPA from Mexico remains somewhat uncertain.

The major reservoirs located in the Rio Grande Basin in Mexico are identified on the map in Figure 3.4. Pertinent features of these reservoirs are summarized in Table 3.1. As illustrated on the map, much of the reservoir development within Mexico has occurred in the Rio Conchos Basin in the State of Chihuahua. As noted previously, the Rio Conchos flows into the Rio Grande upstream of Amistad Reservoir, and it is one of the six Mexican tributaries of the Rio Grande that are named in the 1944 Treaty from which the United States is allocated a portion of the inflows to the Rio Grande.

As shown in Table 3.1, the combined conservation storage capacity of all of Mexico's major reservoirs on Rio Grande tributaries is approximately 6,358,000 acre-feet, which is about 2.5 times the available conservation storage capacity that Mexico has in Amistad and Falcon Reservoirs on the Rio Grande. The seven major tributary reservoirs located in the Rio Conchos Basin have a combined storage capacity of about 3,212,000 acre-feet, which includes the largest of the tributary reservoirs, La Boquilla, with a storage capacity of 2,353,500 acre-feet. Above Falcon Dam, including the Rio Conchos Basin, the combined storage capacity of the Mexican tributary reservoirs is approximately 4,424,000 acre-feet. Below Falcon Dam on the Rio Alamo and Rio San Juan, the combined storage capacity of the Mexican tributary reservoirs is about 1,934,000 acre-feet.

The year in which construction of each of the tributary reservoirs was completed also is indicated in Table 3.1. As shown, the oldest tributary reservoir is La Boquilla on the Rio Conchos, which was completed in 1916. The most recent reservoirs were constructed in 1993, El Cuchillo on the Rio San Juan and Pico de Aguila on the Rio Florido in the Rio Conchos Basin, and in 2000, Las Blancas on the Rio Alamo, which diverts water and conveys it by canal to the existing Marte R. Gomez Reservoir on the Rio San Juan.

3.2.1.3 Rio Grande Flood Flow Operations

All of the mainstem dams and reservoirs located on the Rio Grande within Texas are under the sole supervision and control of the International Boundary and Water Commission (IBWC). The International Boundary Commission was originally created as a joint commission by the United States and Mexico at the Convention of March 1, 1889, for the purpose of establishing the exact boundary between the two countries. Now, following a change in its name by the 1944 Treaty, the United States Section of the IBWC functions as an arm of the U. S. Department of State and is responsible for addressing all boundary and water issues along the United States-Mexico border. When the potential for flooding occurs, the reservoirs are operated by IBWC to minimize flood flows and flood damages along the middle and lower Rio Grande within the RGRWPA.

[2] On March 10, 2005, the United States and Mexico jointly announced that Mexico supposedly had agreed to fully repay its deficit under the 1944 Treaty by the end of September 2005 through transfers of water stored in Amistad/Falcon Reservoirs and deliveries made at Anzalduas Dam.

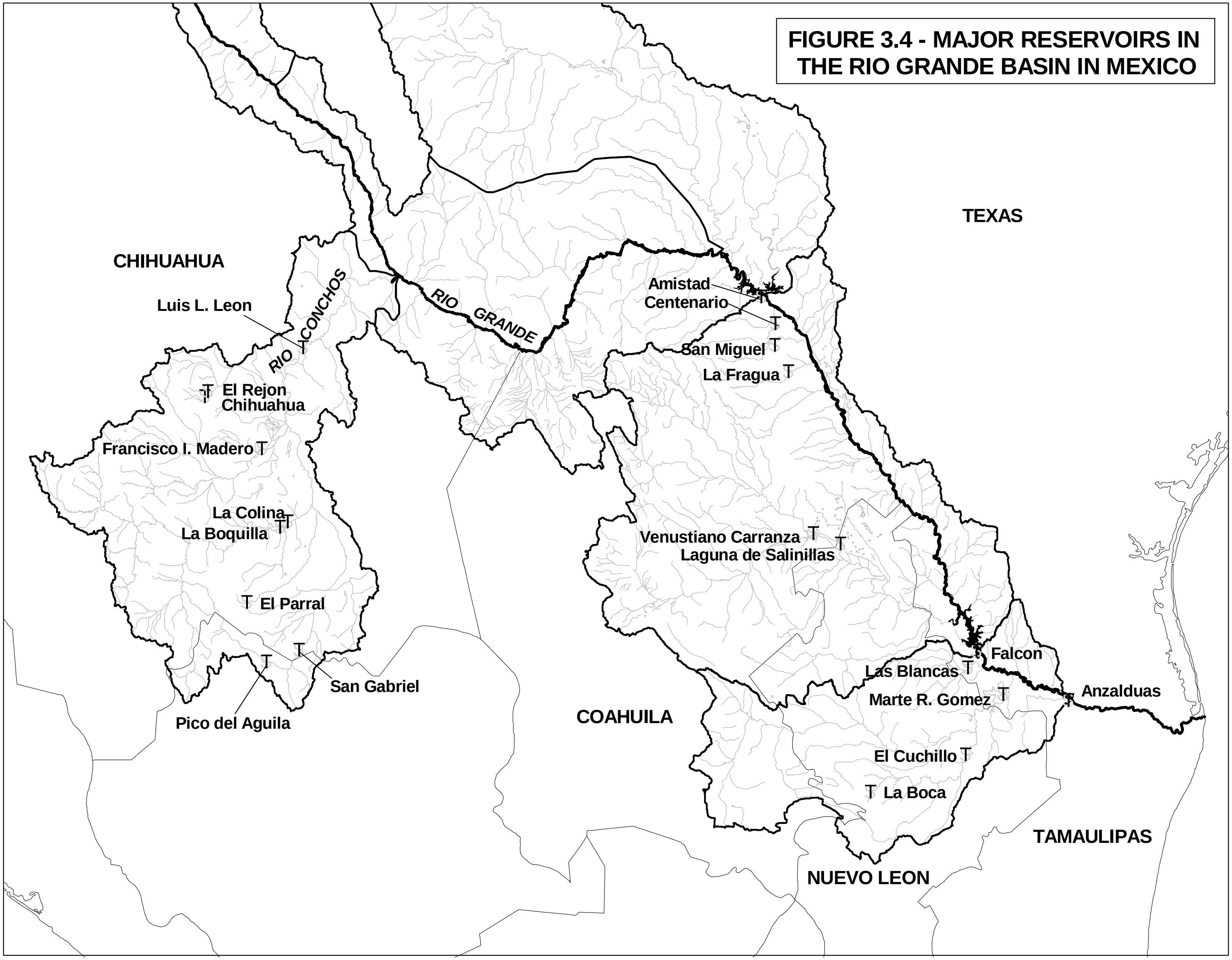


FIGURE 3.4 - MAJOR RESERVOIRS IN THE RIO GRANDE BASIN IN MEXICO
TEXAS
CHIHUAHUA
RIO CONCHOS
RIO GRANDE
Luis L. Leon
Amistad
Centenario
San Miguel
La Fragua
El Rejon
Chihuahua
Francisco I. Madero
La Colina
La Boquilla
Venustiano Carranza
Laguna de Salinillas
El Parral
Falcon
Las Blancas
Anzalduas
Marte R. Gomez
San Gabriel
Pico del Aguila
COAHUILA
El Cuchillo
La Boca
TAMAULIPAS
NUEVO LEON

Table 3.1 - Pertinent Features of Major Reservoirs Located on Rio Grande and Tributaries in Mexico

River Basin / Name	River	State	Year Closed	Storage Capacity Million M³	Storage Capacity Acre-Feet
Rio Conchos Basin					
La Boquilla	Rio Conchos	Chihuahua	1916	2,903	2,353,501
La Colina	Rio Conchos	Chihuahua	1927	24	19,538
Francisco I. Madero	Rio San Pedro	Chihuahua	1948	348	282,128
Chihuahua	Rio Chuviscar	Chihuahua	1960	26	21,079
Luis L. Leon	Rio Conchos	Chihuahua	1968	356	288,614
San Gabriel	Rio Florido	Durango	1979	255	206,732
Pico del Aguila	Rio Florido	Chihuahua	1993	50	40,536
Rio Conchos Basin Total Reservoir Storage Capacity:				3,962	3,212,127
Rio San Diego Basin					
San Miguel	Rio San Diego	Coahuila	1935	20	16,214
Centenario	Rio San Diego	Coahuila	1936	26	21,322
Rio San Diego Basin Total Reservoir Storage Capacity:				46	37,536
Rio San Rodrigo Basin					
La Fragua	Rio San Rodrigo	Coahuila	1991	45	36,482
Rio San Rodrigo Basin Total Reservoir Storage Capacity:				45	36,482
Rio Salado Basin					
Venustiano Carranza	Rio Salado	Coahuila	1930	1,385	1,122,838
Laguna de Salinillas	Rio Salado	Nuevo Leon	1931	19	15,404
Rio Salado Basin Total Reservoir Storage Capacity:				1,404	1,138,241
Rio Alamo Basin (1)					
Las Blancas	Rio Alamo	Tamaulipas	2000	124	100,514
Rio Alamo Basin Total Reservoir Storage Capacity:					100,514
Rio San Juan Basin (1)					
Rodrigo Gomez (La Boca)	Rio San Juan	Nuevo Leon	1957	41	33,239
El Cuchillo	Rio San Juan	Nuevo Leon	1993	1,123	910,512
Marte R. Gomez	Rio San Juan	Tamaulipas	1943	1,097	889,271
Rio San Juan Total Reservoir Storage Capacity:				2,261	1,833,023
Total Tributary Reservoir Storage Capacity:				7,718	6,357,923

1 Water in these reservoirs is dedicated to Mexico by treaty.

Mexico's Share of Conservation Storage in Major International Reservoirs on the Rio Grande

River Basin / Name	River	State	Year Closed	Storage Capacity Million M³	Storage Capacity Acre-Feet
Rio Grande Basin					
Falcon	Rio Grande	Tamaulipas	1953	1,355	1,098,674
Amistad	Rio Grande	Coahuila	1968	1,703	1,380,278
Total Rio Grande Reservoir Storage Capacity:				3,058	2,478,952

Both the United States and Mexico maintain interior floodway systems in the Lower Rio Grande Valley that receive flood flows diverted from the Rio Grande during high runoff periods. Each of these floodways is designed to carry up to 105,000 cfs (cubic feet per second). With the floodway diversions, the design discharge for the river can be reduced from 250,000 cfs at Rio Grande City (River Mile 235[3]) to 20,000 cfs below Retamal Dam (i.e., the lowest point where flood waters are diverted into the Mexican floodway system). A discharge level of 20,000 cfs is considered to be the safe capacity of the leveed reach of the lower Rio Grande through the Brownsville-Matamoros urban area; however, to the extent possible, IBWC attempts to limit flows through this reach to no greater than 15,000 cfs.

3.2.1.4 Rio Grande Normal Flow Operations

During non-flood periods, when low to average flows occur in the Rio Grande, requests for releases of water from the conservation storage pools in Amistad and Falcon Reservoirs are made to the IBWC by water users in both the United States and Mexico. In Texas, these requests are made through the Rio Grande Watermaster, an official employed by the Texas Commission on Environmental Quality (TCEQ).

Water users along the Rio Grande between Amistad and Falcon Reservoirs are delivered water released from Amistad Reservoir. Major municipal water users include the cities of Ciudad Acuna, Piedras Negras, and Nuevo Laredo in Mexico; and the cities of Eagle Pass and Laredo in Texas. Most of the water released from Amistad Reservoir is used for irrigation along the Rio Grande in both countries. The majority of the water diverted for irrigation along this reach in Texas is used in Maverick County.

Water released from Falcon Reservoir at the request of Mexico is diverted from the river primarily through the Anzalduas Canal, which has its headgates located in Anzalduas Reservoir near the city of Mission, Texas. The city of Matamoros, located downstream and across the river from Brownsville, also diverts water directly from the river for municipal and industrial use. In addition, there are several other small Mexican diverters that are unauthorized, but are known to pump water from the river for domestic and agricultural purposes. In Texas, water is diverted from the river at hundreds of locations extending along the entire length of the Rio Grande below Falcon Dam. The vast majority of the diversions are made by irrigation districts that supply water to agricultural users, as well as to municipalities and industries in the Lower Rio Grande Valley. The principal municipal water users include the cities of Raymondville, Harlingen, Brownsville, McAllen, Mission, Edinburg, Pharr, Weslaco, and Rio Grande City, and North Alamo Water Supply Corporation.

3.2.1.5 Rio Grande Watermaster

Requests for releases from the United States' conservation pools in Amistad and Falcon Reservoirs are administered and processed by the Rio Grande Watermaster under the purview of the TCEQ. The Rio Grande Watermaster makes daily requests to the IBWC for releases from the reservoirs to meet municipal, industrial, and agricultural demands in the Lower Rio Grande Valley below Falcon Dam, as well as, along the mainstem of the Rio Grande in the Middle Rio Grande Valley between Falcon and Amistad Reservoirs. For some users at the extreme lower end of the river, the requests are made five to seven days in advance of need to allow for the travel time required for the released water from Falcon

[3] The term "River Mile" refers to the distance in statute miles along the course of the Rio Grande upstream from its mouth at the Gulf of Mexico.

Reservoir to flow downstream along the more than 200 miles of river channel to the various points of diversion.

In determining the reservoir release amounts for downstream users, the Rio Grande Watermaster considers the quantity of water requested by all diverters and their respective locations along the river, potential channel losses and gains, watershed runoff and tributary inflows, channel and bank storage, waters impounded by instream weirs operated by individual diverters, and any available United States water that may be stored in Anzalduas Reservoir. To project the magnitude and timing of the releases needed to satisfy the requested individual diversions at their respective locations along the river, the Rio Grande Watermaster uses a series of seven river reaches below Falcon Dam and six river reaches between Amistad Dam and Falcon Reservoir, with each reach having a theoretical travel time equal to one day. These reaches are identified and described in Table 3.2. By knowing the number of days typically required for released water from either Amistad or Falcon Reservoirs to flow (travel) to the individual reaches under normal flow conditions, the Watermaster can schedule releases from the reservoirs in the proper amounts and on the proper days in response to the requested demands. To aid in the operation of the delivery system, the IBWC provides the Watermaster instantaneous data pertaining to streamflow rates at various locations along the river and preliminary estimates of the United States' share of these flows and of the water stored in Anzalduas Reservoir.

3.2.1.6 Rio Grande Water Allocations

3.2.1.6.1 United States - Mexico Treaties

Two treaties between the United States and Mexico contain basic provisions regarding the development and use of Rio Grande waters by the two countries. The 1906 Treaty[4] provides for delivery to Mexico by the United States of 60,000 acre-feet of water annually in the El Paso-Juarez Valley upstream from Fort Quitman, Texas. If shortages occur in the water supply for United States, then deliveries to Mexico are to be reduced in the same proportion as deliveries to the United States. The 1906 Treaty also includes a provision whereby Mexico "waives any and all claims to the waters of the Rio Grande for any purpose whatever between the head of the present Mexican Canal and Fort Quitman, Texas."

The 1944 Treaty between the United States and Mexico[5], which is administered by the IBWC, contains provisions relating to the allocation of Rio Grande waters along the reach of the river between Fort Quitman and the Gulf of Mexico, which includes the RGRWPA. This treaty provides for the allocation of all waters within this reach of the Rio Grande between the two countries and for the joint construction of as many as three major international reservoirs on the mainstem of the river for water supply and flood control purposes. Development of hydroelectric power at the reservoirs is also authorized under the treaty, with any hydropower generated divided equally between the two countries. Article 4 of the 1944 Treaty allocates the waters in the Rio Grande below Fort Quitman, Texas, between the United States and Mexico according to the following stipulations:

[4] Convention between the United States and Mexico, Equitable Distribution of the Waters of the Rio Grande; Proclaimed January 16, 1907; Washington, D. C.

[5] "Treaty Between the United States and Mexico, Utilization of the Waters of the Colorado and Tijuana Rivers and of the Rio Grande"; February 3, 1944; Washington, D. C.

Table 3.2 – River Reaches Used by Rio Grande Watermaster for Facilitating Water Deliveries From Amistad and Falcon Reservoirs to Downstream Users

Middle Rio Grande

Reach 1	Amistad Dam (RM 571.8)* to the IBWC streamflow gage at Del Rio, Texas (RM 561.2)
Reach 2	IBWC streamflow gage at Del Rio, Texas (RM 561.2) to IBWC streamflow gage at Eagle Pass, Texas (RM 497.0)
Reach 3	IBWC streamflow gage at Eagle Pass, Texas (RM 497.0) to IBWC streamflow gage near El Indio, Texas (RM 460.4)
Reach 4	IBWC streamflow gage at El Indio, Texas (RM 460.4) to IBWC streamflow gage at Laredo, Texas (RM 359.8)
Reach 5	IBWC streamflow gage at Laredo, Texas (RM 359.8) to San Ygnacio, Texas (at the headwaters of Falcon Reservoir)
Reach 6	San Ygnacio, Texas (at the headwaters of Falcon Reservoir) to Falcon Dam (RM 274.8)

Lower Rio Grande

Reach 1	Falcon Dam (RM 274.8) to the IBWC streamflow gage at Rio Grande City, Texas (RM 235.0)
Reach 2	IBWC streamflow gage at Rio Grande City, Texas (RM 235.0) to Anzalduas Dam (RM 170.3)
Reach 3	Anzalduas Dam (RM 170.3) to Retamal Dam (RM 132.5)
Reach 4	Retamal Dam (RM 132.5) to the IBWC streamflow gage at San Benito, Texas (RM 96.8)
Reach 5	IBWC streamflow gage at San Benito, Texas (RM 96.8) to Cameron County WCID No. 6 river diversion point (RM 68.4)
Reach 6	Cameron County WCID No. 6 river diversion point (RM 68.4) to IBWC streamflow gage near Brownsville, Texas (RM 48.7)
Reach 7	IBWC streamflow gage near Brownsville, Texas (RM 48.7) to the Gulf of Mexico (RM 0.0)

* "RM" refers to river miles upstream from the mouth of the Rio Grande at the Gulf of Mexico

A. To Mexico:

(a) All of the waters reaching the main channel of the Rio Grande (Rio Bravo) from the San Juan and Alamo Rivers, including the return flow from the lands irrigated from the latter two rivers.

(b) One-half of the flow in the main channel of the Rio Grande (Rio Bravo) below the lowest major international storage dam, so far as said flow is not specifically allotted under this Treaty to either of the two countries.

(c) Two-thirds of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, subject to the provisions of subparagraph (c) of Paragraph B of this Article.

(d) One-half of all other flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are those not named in this Article, between Fort Quitman and the lowest major international storage dam.

B. To the United States:

(a) All of the waters reaching the main channel of the Rio Grande (Rio Bravo) from the Pecos and Devils Rivers, Good-enough Spring, and Alamito, Terlingua, San Felipe and Pinto Creeks.

(b) One-half of the flow in the main channel of the Rio Grande (Rio Bravo) below the lowest major international storage dam, so far as said flow is not specifically allotted under this Treaty to either of the two countries.

(c) One-third of the flow reaching the main channel of the Rio Grande (Rio Bravo) from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo, provided that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet (431,721,000 cubic meters) annually. The United States shall not acquire any right by the use of the waters of the tributaries named in this subparagraph, in excess of the said 350,000 acre-feet (431,721,000 cubic meters) annually, except the right to use one-third of the flow reaching the Rio Grande (Rio Bravo) from said tributaries, although such one-third may be in excess of that amount.

(d) One-half of all other flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are those not named in this Article, between Fort Quitman and the lowest major international storage dam.

In the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries, making it difficult for Mexico to make available the run-off of 350,000 acre-feet (431,721,000 cubic meters) annually, allotted in subparagraph (c) of

> *paragraph B of this Article to the United States as the minimum contribution from the aforesaid Mexican tributaries, any deficiencies existing at the end of the aforesaid five-year cycle shall be made up in the following five-year cycle with water from the said measured tributaries.*
>
> *Whenever the conservation capacities assigned to the United States in at least two of the major international reservoirs, including the highest major reservoir, are filled with waters belonging to the United States, a cycle of five years shall be Considered as terminated and all debits fully paid, where upon a new five-year cycle shall commence.*

These treaty provisions are routinely applied by the IBWC to determine the ownership of waters between the United States and Mexico in the lower and middle Rio Grande. Historical data are available from the IBWC indicating the monthly quantities of each country's water that have flowed into the Rio Grande, that have been stored in Amistad and Falcon Reservoirs on the Rio Grande and in tributary reservoirs in each country, that have been released from the mainstem impoundments, that have been diverted from the Rio Grande, and that have passed the Brownsville streamflow gage and flowed to the Gulf of Mexico.

With regard to the repayment of deficits that may be incurred by Mexico under paragraph B(c) of Article 4 of the 1944 Treaty, the United States and Mexican Sections of the IBWC conducted investigations in 1969 that culminated in the joint issuance of Minute No. 234. This Minute established the starting date for water accounting pursuant to paragraph B(c) and outlined procedures and methods for making up deficiencies in the actual amounts of water delivered by Mexico to the United States under the terms of Article 4. Specifically, Mexico and the United States agreed to the following provisions as stated in Minute No. 234:

1. *That accounting of the waters of the Rio Grande allotted to the United States from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo shall begin October 1, 1953.*

2. *That in the event of a deficiency in a cycle of five consecutive years in the minimum amount of water allotted to the United States from the said tributaries, the deficiency shall be made up in the following five-year cycle, together with any quantity of water which is needed to avoid a deficiency in the aforesaid following cycle, by one or a combination of the following means:*

    a. *With water of that portion of the said tributary contributions to the Rio Grande allotted to the United States in excess of the minimum quantity guaranteed by the Water Treaty.*

    b. *With water of that portion of the said tributary contributions to the Rio Grande allotted to Mexico, when Mexico gives advance notice to the United States and the United States is able to conserve such water; and*

    c. *By transfer of Mexican waters in storage in the major international reservoirs, as determined by the Commission, provided that at the time of the transfer, United States storage capacity is available to conserve them.*

3. *That the provisions of Article 4 of the Water Treaty relating to the waters of the Rio Grande from the Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers and the Las Vacas Arroyo allotted to the United States be considered satisfied to September 30, 1968.*

It is important to note here that Mexico has been in a deficit condition with respect to the minimum inflow requirements stipulated in paragraph B(c) of the 1944 Treaty for the United States from the six Mexican tributaries since the end of the five-year accounting cycle that ended October 2, 1997 (see Section 3.8.3 of this report). The total official deficit as of September 30, 2004 was 716,668 acre-feet. Unofficially, as of April 2, 2005 the USIBWC estimated the remaining deficit at 268,111 acre-feet. The uncertainty related to the availability, or unavailability, of this water from Mexico in the future obviously has a direct bearing on water supply planning for the RGRWPA.

3.2.1.6.2 Rio Grande Valley Water Case

The United States' share of water stored in Amistad and Falcon Reservoirs and diverted from the lower and middle Rio Grande for domestic, municipal, industrial, and irrigation purposes is administered by the TCEQ in compliance with the decision of the Thirteenth Court of Civil Appeals in the landmark case styled *"State of Texas, et al. vs. Hidalgo County Water Control and Improvement District No. 18, et al."* and commonly referred to as the Rio Grande Valley Water Case. The original suit was filed by the State of Texas in 1956 to restrain the diversion of water from the Rio Grande for irrigation when the share of water due the United States from water impounded in Falcon Reservoir was 50,000 acre-feet or less. The storage amount of 50,000 acre-feet was the quantity of water that the Texas Board of Water Engineers (a predecessor agency to the TCEQ) had determined at that time to be necessary to meet municipal, domestic and livestock demands for a three-month period without additional inflows into Falcon Reservoir. Earlier efforts to apply voluntary restrictions on diversions of water had collapsed due to severe drought conditions and the consequent shortage of water supplies.

The original trial of the Valley Water Case lasted from January 1964 to August 1966, and the final judgment of the appellate court was entered in 1969. In 1971, the Texas Water Rights Commission (a predecessor agency to the TCEQ) adopted rules and regulations implementing the court decision. According to the judgment rendered in this case, a storage reserve in Falcon Reservoir equal to 60,000 acre-feet was established to meet municipal and industrial demands, and a total of approximately 155,000 acre-feet of water rights (annual usage) were allocated for domestic, municipal, and industrial uses. Irrigation water from the Rio Grande was allocated for 742,808.6 acres of agricultural land below Falcon Dam. Of this amount, 641,221 acres were assigned Class A irrigation rights, and the remaining acres were awarded Class B irrigation rights.

Whereas municipal uses, which include uses for domestic, industrial, manufacturing, and steam electric power generation purposes, were granted the highest water supply priority, the result of the Valley Water Case was to establish a weighted priority system along the lower Rio Grande for allocating the remaining surface water supply to irrigation (and mining) uses. The two classes of irrigation water rights that were established, (Class A and Class B) today provide a means for differentiating the rates at which water is credited to individual irrigation storage accounts in Amistad and Falcon Reservoirs. The Class A water right accrues water at a rate 1.7 times greater than the Class B water right. Although this weighted priority system for irrigation water users generally has little significance during years when water is abundant, its effect in water-short years is to distribute the shortage among all users, with the greater shortages occurring on lands with the Class B water rights.

In 1982, water rights in the Middle Rio Grande Basin; i.e., from Amistad Dam downstream to Falcon Reservoir, were adjudicated pursuant to Title 2, Subtitle B, Chapter 11, Subchapter G of the Texas Water Code. As a result of these proceedings, those water users located along the middle Rio Grande that were dependent upon water stored in Amistad or Falcon Reservoirs were assigned water rights based on the same allocation and accounting principles established in the Valley Water Case. Water users located on tributaries within the Middle Rio Grande Basin were assigned water rights based on the Prior Appropriation Doctrine.

Today, the Texas Rio Grande Watermaster is responsible for allocating the amount of water that can be diverted by each Class A and Class B irrigator and for supervising all use of water in the Lower and Middle Rio Grande Basins.

3.2.1.6.3 TCEQ Rio Grande Operating Rules

As a result of the Lower Rio Grande Valley Water Case, rules have been adopted by the State's water agencies, now the TCEQ, that regulate the operation of lower and middle Rio Grande system and the allocation of water among all users[6]. The rules applied by the TCEQ in administering mainstem water rights in the Lower and Middle Rio Grande Basins affect not only the amount of water that can be diverted from the Rio Grande and its tributaries, but also the operation of the storage pools in Amistad and Falcon Reservoirs. The current rules provide a reserve of 225,000 acre-feet of storage in Amistad and Falcon Reservoirs for domestic, municipal, and industrial uses, which is referred to as the "DMI pool," and an operating reserve that fluctuates between 380,000 acre-feet and 150,000 acre-feet, depending on the amount of water in conservation storage in the reservoirs. The stated purpose of the operating reserve in the TCEQ rules is to provide for: (1) loss of water by seepage, evaporation and conveyance; (2) emergency requirements; and, (3) adjustments of amounts in storage, as may be necessary by finalization of IBWC provisional United States-Mexico water ownership computations. The operating reserve is calculated monthly by multiplying the percentage of total United States conservation storage in the Amistad-Falcon system times the maximum operating reserve of 380,000 acre-feet. The calculated reserve cannot be less than 275,000 acre-feet, unless there is insufficient water stored in the reservoirs, in which case, the balance of the water in storage, after allocations for the DMI pool and irrigation account balances, is assigned to the operating reserve. Under no circumstances can the operating reserve be less than 150,000 acre-feet.

Today, consideration is being given to revising the TCEQ's Rio Grande operating rules by altering the storage amounts for the DMI reserve and the operating reserve. Investigations of the impacts of different reserve amounts on overall water availability and the yield of the Amistad-Falcon reservoir system are being undertaken as part of this Region M water supply planning study.

The TCEQ Rio Grande Watermaster administers the water allocations to municipal/domestic, industrial, agricultural and other user storage accounts. Such allocations are based on the available water in storage in Falcon and Amistad Reservoirs, as reported by the IBWC on the last Saturday of each month, less dead storage. To determine the amount of water to be allocated to various accounts, the Watermaster makes the following computations at the beginning of each month:

1. From the amount of water in usable storage, 225,000 acre-feet are deducted to re-establish the reserve; i.e., the DMI pool, for domestic, municipal, and industrial uses; hence, these uses are given the highest priority;

[6] "Chapter 303: Operation of the Rio Grande"; 31 Texas Administrative Code, §§ 303.1-303.73; Texas Water Commission Rules; August 26, 1987; Austin, Texas.

2. From the remaining storage, the total end-of-month account balances for all lower and middle Rio Grande irrigation and mining allottees are deducted; and,

3. From the remaining storage, the operating reserve is deducted.

After the above computations are made, the remaining storage, if any, is allocated to the irrigation and mining accounts. The allotment for irrigation and mining uses is divided into the Class A and Class B water rights categories. Class A rights (allottees) receive 1.7 times as much water as that allotted to Class B rights. An irrigation allottee cannot accumulate in storage more than 1.41 times its annual authorized diversion right, and, if an allottee does not use water for two consecutive years, its account is reduced to zero. If there is not sufficient water in storage to fully restore the operating reserve in Step 3 above, then the TCEQ rules authorize the Watermaster to make negative allocations of water from the irrigation and mining accounts in sufficient amounts to provide the minimum 150,000 acre-feet of operating reserve capacity.

Generally, under the current rules and regulations of the TCEQ, all United States water that is diverted from the lower and middle Rio Grande by authorized diverters is accounted for by the Rio Grande Watermaster with appropriate charges against annual authorized diversion accounts in accordance with existing individual water rights and against individual storage accounts in Falcon and Amistad Reservoirs. The rules specify that an allottee is charged for water requested and released as follows:

1. A diverter is charged with the actual amount diverted if the total diversion is within plus or minus 10 percent of the amount requested;

2. A diverter is charged with 90 percent of the certification (requested) amount, if the total diversion is less than 90 percent of the amount requested; and,

3. If the quantity of water diverted is more than 110 percent of the amount requested, the diverter is charged with the actual amount of water diverted.

The Rio Grande Watermaster maintains records of daily, weekly and monthly diversions made by all existing water rights along the lower and middle Rio Grande. Monthly and annual reports are provided to all users.

3.2.1.6.4 No Charge Pumping

There are some circumstances, however, when the water use and storage accounts of water rights holders along the lower and middle Rio Grande are not charged for water diverted from the river. These are referred to as "no charge pumping" periods, and diversions during such periods are authorized by an Order issued by the Texas Water Commission on August 4, 1981[7].

Generally the Rio Grande Watermaster allows no charge pumping when there are substantial flows in the river due to high runoff conditions or when there are flood spills or releases from Amistad and/or Falcon Reservoirs. When no-charge pumping is declared by the Rio Grande Watermaster, water from the Rio Grande can be diverted by authorized water rights holders in unlimited quantities, to the extent it is available, without their respective annual water use and storage accounts being charged. For the lower Rio Grande below Falcon Dam, the Rio Grande Watermaster makes a determination regarding no-charge

[7] Order issued pursuant to §11.0871 of the Texas Water Code.

pumping conditions taking into account the quantity of flow passing Anzalduas Dam, the amount of United States water stored in Anzalduas Reservoir, any anticipated storm water inflows from Mexico, and whether or not spills or flood releases are occurring at Falcon Dam.

3.2.1.7 Rio Grande Hydrology

Because of the international significance of the Rio Grande and the various treaties and agreements between the United States and Mexico regarding the ownership and use of the waters in the basin, extensive efforts have been undertaken by both countries, through their respective sections of the IBWC, to monitor and measure the flows in the Rio Grande, as well as, the inflows to and diversions from the river system. As such, a network of streamflow gages has been in operation for many years, with daily flow records available from most gages since the early 1950s. Some older records date back to the 1930s, and flow measurements for the gage on the Rio Grande at El Paso have been available since 1889. Most of these records are published in IBWC's annual Water Bulletins[8].

3.2.1.7.1 Historical Reservoir Inflows

Based on historical streamflow gage records and water balance calculations, the IBWC has determined the historical monthly inflows of United States water and Mexican water into Amistad Reservoir from the upper Rio Grande watershed and into Falcon Reservoir from the intervening watershed between Amistad Dam and Falcon Dam. A listing of these annual inflows is presented in Table 3.3 for the period 1945-2003[9]. Total annual inflows into both reservoirs for each country are listed by year and then by rank in descending order based on magnitude.

Over the 59-year period of available inflow data, the total amount of United States water that has flowed into Amistad and Falcon Reservoirs has averaged about 1,750,000 acre-feet per year, and the total amount of inflow to the reservoirs from Mexico has averaged about 1,280,000 acre-feet per year. In the wettest years, the reservoir inflows for each of the countries have approached four million acre-feet. As indicated, the lowest quantity of United States water that has flowed into the reservoirs is 708,265 acre-feet, which occurred in 1956. For Mexico, the lowest annual inflow is 297,488 acre-feet, which occurred in 2000. These inflow amounts reflect both the 1950s drought and the 1990s-2000s drought, which are generally considered to be the most severe droughts of record for the lower and middle Rio Grande. For comparison purposes, the annual inflows to the reservoirs during the drought period for the years 1993 through 2003 are highlighted. Certainly, as shown, the inflows that occurred during 1993-2003, particularly for Mexico, were some of the lowest experienced during the last sixty years, but for the United States, they still are not quite as low as those that occurred during the 1950s drought. However, as will be discussed later

8 International Boundary and Water Commission, United States Section and Mexico Section; "Flow of the Rio Grande and Related Data From Elephant Butte Dam, New Mexico to the Gulf of Mexico, 2001"; Water Bulletin No.71 and other previous Water Bulletins; El Paso, Texas.

9 The historical 1945-1997 reservoir inflow data base as used in this study includes the revised estimates of monthly historical inflows to Amistad and Falcon Reservoirs for the United States and Mexico as derived by Perez-Freese & Nichols during Phase II of the previous Lower Rio Grande Integrated Water Resource Planning Study that was undertaken by the Lower Rio Grande Valley Development Council in association with the Valley Water Policy and Management Council of the Lower Rio Grande Water Committee, Inc. in 1999. The historical inflows for 1998-2003 have been obtained from the IBWC during the current Region M water supply planning study.

relative to the firm annual yield of the Amistad-Falcon reservoir system, the 1990s-2000s drought appears to be the critical drought of record for both the United States and Mexico.

3.2.1.7.2 Historical Rio Grande Streamflows

Historical monthly and annual mean and median flow rates for several gaging stations on the Middle and lower Rio Grande are summarized in Table 3.4. These mean and median flow values have been derived using daily streamflow data compiled by the IBWC and presented in the annual Rio Grande Water Bulletins for the period 1960-2003 for stations on the lower Rio Grande and for the period 1968-2003 for the middle Rio Grande. These timeframes reflect the most recent periods for which published data are available since the currently existing reservoirs on the Rio Grande have been in place and operating. For the lower Rio Grande, 1960 is when Anzalduas Reservoir was constructed. Amistad Reservoir was constructed on the middle Rio Grande in 1968.

As expected, the average flows in the Rio Grande below Amistad Dam gradually increase from station to station in the downstream direction as influenced by tributary inflows from both the United States and Mexico. The effects of significant diversions into the Maverick Canal in Maverick County are evident by the reduction in flow at the Jimenez gage. The most prominent reductions in flow in the Rio Grande occur below Falcon Dam where significant diversions are made by water users in the United States at numerous locations and in Mexico through the Anzalduas Canal. The effects of inflows from the Rio San Juan are apparent in the Rio Grande flows measured at the gage at Rio Grande City.

3.2.1.7.3 Historical Lower and Middle Rio Grande Water Balances

To provide an overview of hydrologic conditions in the lower and middle Rio Grande in terms of the inflows to the system and the various diversions and outflows from the system, the available IBWC flow records have been reviewed and analyzed to establish general trends and average flow values. Using data from IBWC's published annual Water Bulletins, together with information obtained from IBWC regarding the historical monthly quantities of United States and Mexican water released from Amistad and Falcon Reservoirs and flowing to the Gulf of Mexico, average annual inflows to, and outflows from, the lower Rio Grande have been determined for the period 1960-2003. These results are displayed on the conceptual drawing presented in Figure 3.5. Similar inflow and outflow values also have been determined for the middle Rio Grande between Amistad and Falcon Reservoirs for the period 1968-2003, and these results are presented in Figure 3.6. The timeframes used to develop the average flow values for these water balances also reflect the most recent periods for which data are available since the currently existing reservoirs on the Rio Grande have been in place and operating.

As shown in Figure 3.5, an average of about 1.20 million acre-feet per year of United States water have been released (or spilled during flood periods) from Falcon Reservoir, while Mexico has released (or spilled) an average of approximately 1.00 million acre-feet per year during the period 1960 through 2003. Mexico also has received significant inflows of water from Rio Alamo and Rio San Juan, all of which is allocated to Mexico under the terms of the 1944 Treaty between Mexico and the United States. Inflows from the Rio Alamo and the Rio San Juan historically have averaged about 430,000 acre-feet per year; however, much of this water has occurred as flood flows and, without any means to capture and store the

Table 3.3 - Historical Annual United States and Mexican Inflows to the Rio Grande Above Amistad Reservoir and Between Amistad and Falcon Reservoirs

Year	United States Inflows, ac-ft			Mexican Inflows, ac-ft			Inflows Ranked In Descending Order				
	Above Amistad Reservoir	Below Amistad Reservoir	Total Annual Inflows	Above Amistad Reservoir	Below Amistad Reservoir	Total Annual Inflows	Year	Total U.S. Inflows ac-ft	RANK	Year	Total Mex. Inflows ac-ft
1945	1,163,203	285,000	1,448,203	883,389	278,000	1,161,389	1971	3,984,106	1	1971	3,794,270
1946	1,212,854	506,000	1,718,854	909,841	521,000	1,430,841	1954	3,970,792	2	1958	3,501,723
1947	973,130	426,000	1,399,130	669,063	371,000	1,040,063	1974	3,317,228	3	1981	2,668,850
1948	1,454,024	595,000	2,049,024	507,768	702,000	1,209,768	1958	3,257,139	4	1976	2,467,178
1949	1,666,097	783,000	2,449,097	1,042,898	442,000	1,484,898	1981	2,882,903	5	1978	2,318,497
1950	1,093,569	248,000	1,341,569	786,227	128,000	914,227	1976	2,669,234	6	1990	2,226,809
1951	743,512	371,000	1,114,512	404,486	326,000	730,486	1990	2,495,386	7	1991	2,215,339
1952	644,293	92,000	736,293	428,901	64,000	492,901	1949	2,449,097	8	1987	1,952,463
1953	505,469	380,000	885,469	222,231	1,003,000	1,225,231	1987	2,428,644	9	1992	1,906,695
1954	3,764,424	206,368	3,970,792	788,961	325,559	1,114,520	1991	2,336,391	10	1988	1,761,635
1955	1,161,083	262,728	1,423,811	677,209	344,411	1,021,620	1957	2,304,200	11	1986	1,748,591
1956	562,134	146,131	708,265	296,764	153,390	450,154	1978	2,299,662	12	1975	1,662,148
1957	1,670,650	633,550	2,304,200	564,144	727,886	1,292,030	1986	2,264,727	13	1979	1,566,850
1958	1,969,349	1,287,790	3,257,139	1,567,841	1,933,882	3,501,723	1992	2,220,265	14	1974	1,517,152
1959	1,400,966	413,263	1,814,229	667,730	489,555	1,157,285	1964	2,152,091	15	1949	1,484,898
1960	1,183,084	304,220	1,487,304	848,707	307,596	1,156,303	1948	2,049,024	16	1972	1,473,295
1961	1,173,210	438,643	1,611,853	624,584	583,960	1,208,544	1988	2,009,094	17	1967	1,467,261
1962	906,681	222,588	1,129,269	511,070	240,095	751,165	1975	1,974,648	18	1946	1,430,841
1963	770,142	259,995	1,030,137	481,290	307,161	788,451	1972	1,876,700	19	1973	1,420,827
1964	1,673,626	478,465	2,152,091	672,900	548,188	1,221,088	1979	1,839,699	20	1966	1,420,305
1965	1,039,969	334,430	1,374,399	489,720	350,059	839,779	1959	1,814,229	21	1980	1,361,638
1966	1,318,285	391,422	1,709,707	1,003,086	417,219	1,420,305	1980	1,738,551	22	1957	1,292,030
1967	954,207	713,220	1,667,427	523,436	943,825	1,467,261	1946	1,718,854	23	1953	1,225,231
1968	991,330	294,637	1,285,967	841,232	382,091	1,223,323	1966	1,709,707	24	1968	1,223,323
1969	843,864	346,676	1,190,540	705,083	382,759	1,087,842	1967	1,667,427	25	1964	1,221,088
1970	844,695	297,120	1,141,815	620,385	283,218	903,603	1977	1,627,565	26	1948	1,209,768
1971	1,783,089	2,201,017	3,984,106	692,998	3,101,272	3,794,270	1973	1,625,856	27	1961	1,208,544
1972	1,307,088	569,612	1,876,700	802,803	670,492	1,473,295	1961	1,611,853	28	1945	1,161,389
1973	918,028	707,828	1,625,856	679,907	740,920	1,420,827	2003	1,487,507	29	1959	1,157,285
1974	3,029,423	287,805	3,317,228	1,211,470	305,682	1,517,152	1960	1,487,304	30	1960	1,156,303
1975	1,284,972	689,676	1,974,648	748,604	913,544	1,662,148	1998	1,478,242	31	1985	1,146,181
1976	1,607,050	1,062,184	2,669,234	773,967	1,693,211	2,467,178	1985	1,467,746	32	1954	1,114,520
1977	1,163,283	464,282	1,627,565	550,896	554,875	1,105,771	1982	1,458,930	33	1977	1,105,771
1978	1,743,638	556,024	2,299,662	1,517,216	801,281	2,318,497	1945	1,448,203	34	1969	1,087,842
1979	1,275,063	564,636	1,839,699	878,202	688,648	1,566,850	1993	1,431,890	35	1947	1,040,063
1980	1,329,313	409,238	1,738,551	817,103	544,535	1,361,638	1955	1,423,811	36	2003	1,030,149
1981	1,888,274	994,629	2,882,903	1,238,430	1,430,420	2,668,850	2000	1,407,189	37	1955	1,021,620
1982	1,118,780	340,150	1,458,930	664,349	338,840	1,003,189	1947	1,399,130	38	1984	1,018,808
1983	910,765	342,907	1,253,672	497,472	291,291	788,763	1965	1,374,399	39	1993	1,018,709
1984	1,086,407	234,142	1,320,549	775,321	243,487	1,018,808	1950	1,341,569	40	1982	1,003,189
1985	1,043,484	424,262	1,467,746	682,379	463,802	1,146,181	1989	1,333,316	41	1950	914,227
1986	1,887,478	377,249	2,264,727	1,208,462	540,129	1,748,591	1984	1,320,549	42	1970	903,603
1987	1,797,750	630,894	2,428,644	1,203,973	748,490	1,952,463	1968	1,285,967	43	1989	874,095
1988	1,469,121	539,973	2,009,094	929,864	831,771	1,761,635	1983	1,253,672	44	1965	839,779
1989	1,055,062	278,254	1,333,316	589,071	285,024	874,095	1999	1,239,456	45	1999	790,198
1990	2,076,817	418,569	2,495,386	1,728,668	498,141	2,226,809	2001	1,227,186	46	1983	788,763
1991	2,027,658	308,733	2,336,391	1,892,590	322,749	2,215,339	1994	1,219,854	47	1963	788,451
1992	1,702,861	517,404	2,220,265	1,283,085	623,610	1,906,695	2002	1,198,871	48	1962	751,165
1993	1,181,767	250,123	1,431,890	788,586	230,123	1,018,709	1969	1,190,540	49	1994	744,394
1994	924,654	295,200	1,219,854	488,813	255,581	744,394	1996	1,184,139	50	1951	730,486
1995	895,126	218,838	1,113,964	387,891	240,841	628,732	1997	1,177,454	51	2002	705,751
1996	956,466	227,673	1,184,139	441,577	259,854	701,431	1970	1,141,815	52	1996	701,431
1997	951,291	226,163	1,177,454	398,567	242,833	641,400	1962	1,129,269	53	1997	641,400
1998	1,141,780	336,462	1,478,242	314,958	313,171	628,128	1951	1,114,512	54	1995	628,732
1999	899,246	340,210	1,239,456	379,527	410,671	790,198	1995	1,113,964	55	1998	628,128
2000	1,178,741	228,448	1,407,189	206,208	91,279	297,488	1963	1,030,137	56	1952	492,901
2001	935,554	291,632	1,227,186	183,849	133,833	317,682	1953	885,469	57	1956	450,154
2002	840,966	357,906	1,198,871	304,054	401,696	705,751	1952	736,293	58	2001	317,682
2003	954,473	533,034	1,487,507	360,704	669,445	1,030,149	1956	708,265	59	2000	297,488
AVG	1,288,971	456,651	1,745,622	734,924	549,786	1,284,710	- -	- -	- -	- -	- -

Table 3.4 - Historical Monthly and Annual Mean and Median Flows in the Middle and Lower Rio Grande

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MIDDLE RIO GRANDE													
Rio Grande below Amistad Dam - RM 571.8													
Mean, Acre-Feet	85,560	111,995	138,481	157,000	217,675	159,028	131,286	144,683	164,795	149,558	88,418	77,746	1,626,225
Mean, cfs	1,392	2,001	2,252	2,638	3,540	2,673	2,135	2,353	2,769	2,432	1,486	1,264	2,245
Median, cfs	1,238	1,506	2,224	2,167	3,130	2,459	1,608	1,821	1,583	1,384	1,207	1,184	2,289
Rio Grande at Del Rio – RM 561.2													
Mean, Acre-Feet	90,456	115,549	142,091	162,174	223,104	162,022	134,407	150,475	171,010	155,879	94,882	82,846	1,684,895
Mean, cfs	1,471	2,064	2,311	2,725	3,628	2,723	2,186	2,447	2,874	2,535	1,595	1,347	2,326
Median, cfs	1,358	1,614	2,313	2,320	3,196	2,364	1,654	2,054	1,542	1,474	1,261	1,227	2,327
Rio Grande near Jimenez – RM 530.3													
Mean, Acre-Feet	43,548	68,099	83,864	105,408	162,610	110,212	90,979	110,619	128,803	131,227	58,253	41,056	1,134,677
Mean, cfs	708	1,217	1,364	1,771	2,645	1,852	1,480	1,799	2,165	2,134	979	667.7038956	1,565
Median, cfs	433	524	1,132	1,235	2,139	1,425	858	1,276	963	867	524	377	1,566
Rio Grande at Piedras Negras - RM 497.0													
Mean, Acre-Feet	110,301	131,887	148,918	166,886	232,495	183,749	177,479	181,006	205,443	209,561	126,846	109,695	1,984,265
Mean, cfs	1,794	2,356	2,422	2,805	3,781	3,088	2,886	2,944	3,453	3,408	2,132	1,784	2,738
Median, cfs	1,458	1,939	2,430	2,190	3,320	2,795	1,855	2,472	2,045	2,089	1,664	1,604	2,550
Rio Grande near El Indio - RM 460.4													
Mean, Acre-Feet	117,623	136,373	154,713	174,668	245,449	195,694	185,855	190,393	216,449	219,562	136,266	115,091	2,088,135
Mean, cfs	1,913	2,435	2,516	2,935	3,992	3,289	3,023	3,096	3,638	3,571	2,290	1,872	2,881
Median, cfs	1,685	2,015	2,282	2,449	3,586	2,890	1,914	2,460	2,169	2,422	1,648	1,567	2,775
Rio Grande at Laredo – RM 359.8													
Mean, Acre-Feet	120,988	141,307	158,991	177,774	263,267	221,667	192,631	196,680	227,954	248,285	139,553	117,719	2,206,816
Mean, cfs	1,968	2,524	2,586	2,988	4,282	3,725	3,133	3,199	3,831	4,038	2,345	1,915	3,044
Median, cfs	1,645	2,099	2,442	2,289	3,862	3,104	2,051	2,729	2,648	3,230	1,746	1,577	2,883

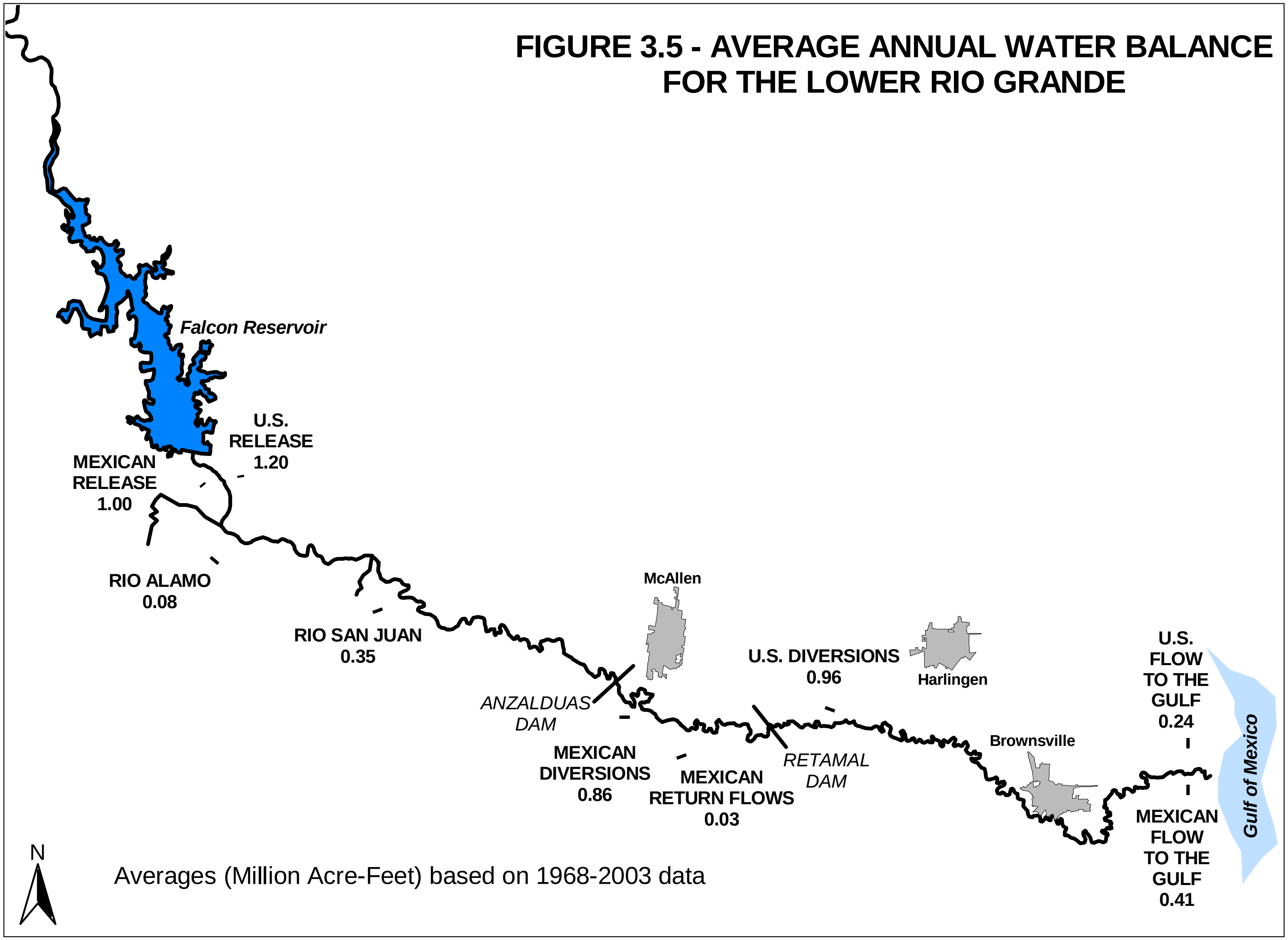
Source: 1968-2003 Historical data reported by IBWC for the Middle Rio Grande

Table 3.4 - Historical Monthly and Annual Mean and Median Flows in the Middle and Lower Rio Grande, cont'd

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LOWER RIO GRANDE													
Rio Grande below Falcon Dam - RM 274.8													
Mean, Acre-Feet	196,315	133,430	128,032	325,846	359,589	235,552	153,865	202,201	134,877	146,120	76,531	79,226	2,171,584
Mean, cfs	3,193	2,381	2,082	5,476	5,848	3,959	2,502	3,288	2,267	2,376	1,286	1,288	2,996
Median, cfs	2,842	1,956	1,780	4,993	6,310	3,352	2,258	2,219	1,160	1,494	989	922	2,926
Rio Grande at Rio Grande City - RM 235.0													
Mean, Acre-Feet	199,160	144,905	130,126	319,657	365,263	260,565	181,800	224,126	268,360	224,408	100,488	93,170	2,512,028
Mean, cfs	3,239	2,586	2,116	5,372	5,940	4,379	2,957	3,645	4,510	3,650	1,689	1,515	3,466
Median, cfs	2,947	2,142	1,770	4,872	6,461	3,664	2,383	2,540	1,854	2,213	1,200	986	3,242
Rio Grande Below Anzalduas Dam - RM 169.8													
Mean, Acre-Feet	88,441	68,472	77,622	124,926	157,335	179,689	136,588	133,615	196,939	177,256	81,116	71,587	1,493,585
Mean, cfs	1,438	1,221	1,262	2,099	2,559	3,020	2,221	2,173	3,310	2,883	1,363	1,164	2,059
Median, cfs	1,168	907	1,109	1,907	2,493	2,470	1,757	1,372	1,141	1,081	838	749	1,472
Rio Grande near San Benito - RM 96.8													
Mean, Acre-Feet	37,714	35,855	30,650	43,770	68,552	75,393	64,895	68,015	114,600	126,156	55,352	45,900	766,853
Mean, cfs	613	638	498	736	1,115	1,267	1,055	1,106	1,926	2,052	930	746	1,057
Median, cfs	384	339	293	425	675	735	430	374	487	385	304	294	531
Rio Grande near Brownsville - RM 48.7													
Mean, Acre-Feet	29,541	30,135	24,562	30,187	52,705	59,043	54,115	56,806	102,717	121,049	53,768	43,507	658,133
Mean, cfs	480	536	399	507	857	992	880	924	1,726	1,969	904	708	907
Median, cfs	191	245	170	178	402	375	208	189	367	285	315	227	375

Source: 1960-2003 Historical data reported by IBWC for the Lower Rio Grande

FIGURE 3.5 - AVERAGE ANNUAL WATER BALANCE FOR THE LOWER RIO GRANDE



Averages (Million Acre-Feet) based on 1968-2003 data

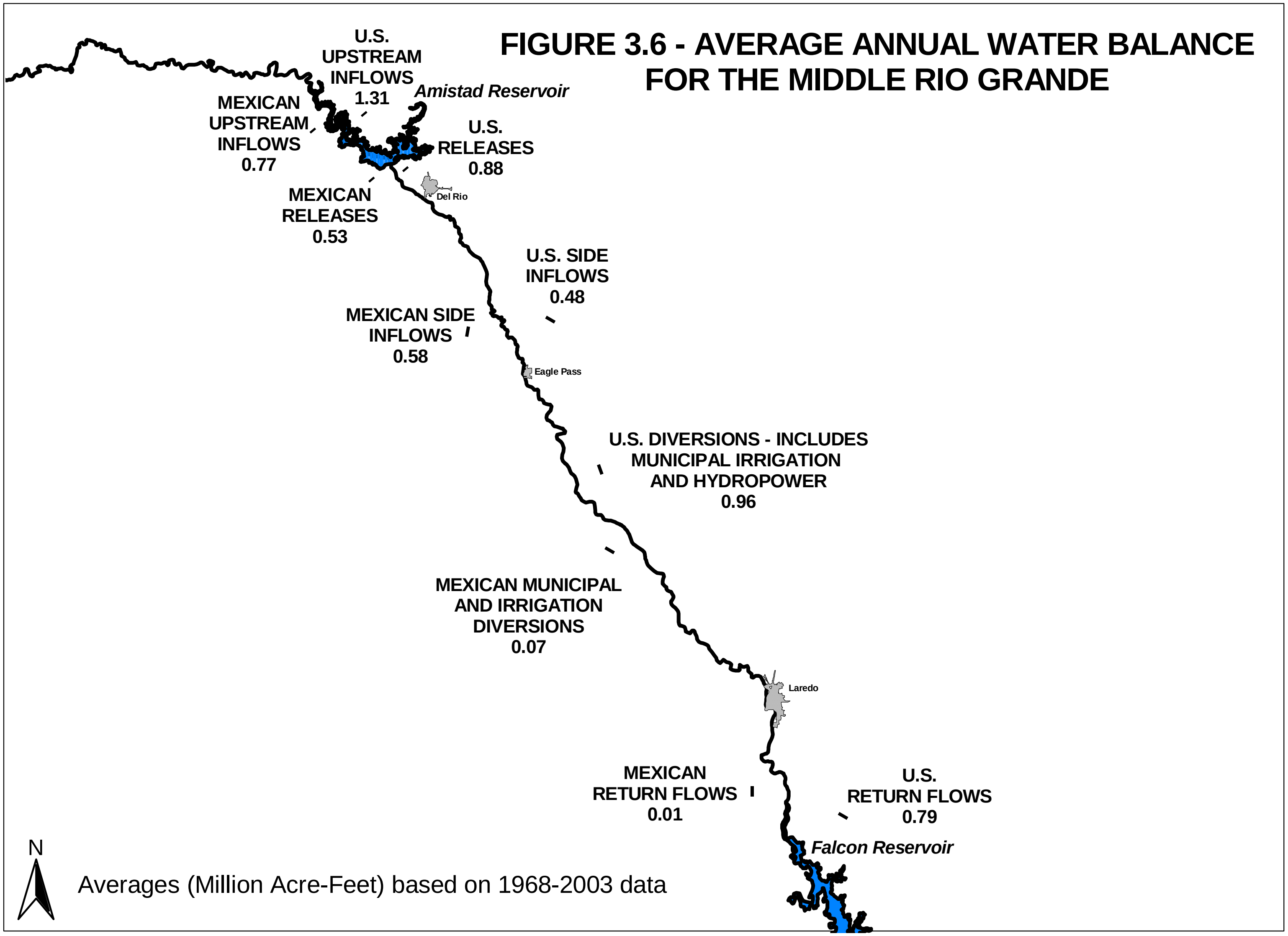


FIGURE 3.6 - AVERAGE ANNUAL WATER BALANCE
FOR THE MIDDLE RIO GRANDE
U.S. UPSTREAM INFLOWS 1.31
Amistad Reservoir
MEXICAN UPSTREAM INFLOWS 0.77
U.S. RELEASES 0.88
MEXICAN RELEASES 0.53
Del Rio
U.S. SIDE INFLOWS 0.48
MEXICAN SIDE INFLOWS 0.58
Eagle Pass
U.S. DIVERSIONS - INCLUDES MUNICIPAL IRRIGATION AND HYDROPOWER 0.96
MEXICAN MUNICIPAL AND IRRIGATION DIVERSIONS 0.07
Laredo
MEXICAN RETURN FLOWS 0.01
U.S. RETURN FLOWS 0.79
Falcon Reservoir
N
Averages (Million Acre-Feet) based on 1968-2003 data

water, it has flowed to the Gulf. As shown on the diagram, an average of 410,000 acre-feet per year of Mexican water has flowed to the Gulf of Mexico since 1960. On the United States side, of the average amount of water that has been released (or spilled) from Falcon Reservoir (1.20 million acre-feet per year) and that has flowed into the river as runoff from the ungaged watershed below Falcon Dam, an average of 0.96 million acre-feet per year has been diverted by United States users along the lower Rio Grande. During the period between 1960 and 2003, the United States share of water flowing to the Gulf of Mexico averaged about 240,000 acre-feet per year.

For the middle Rio Grande, as shown in Figure 3.6, the amounts of water that have been released from Amistad Reservoir have averaged about 0.88 million acre-feet per year for the United States and about 0.53 million acre-feet per year for Mexico. The corresponding inflows to Falcon Reservoir from the intervening watershed below Amistad Reservoir have been 0.48 million acre-feet per year for the United States and 0.58 million acre-feet per year for Mexico. As shown, most of the diversions from the river along this reach of the Rio Grande have been from the United States side.

<u>3.2.1.7.4 Historical Storage in Amistad and Falcon Reservoirs</u>

The monthly variations in the quantities of water stored in Amistad and Falcon Reservoirs since they were constructed are illustrated on the graphs in Figures 3.7 and 3.8, respectively. On each graph, the amounts of water in storage owned by the United States and by Mexico are indicated, along with the total storage values. The maximum conservation storage capacity of each of the reservoirs also is delineated. As shown, the level of storage in Amistad Reservoir typically has been higher relative to its maximum storage capacity than that in Falcon Reservoir. Similarly, Amistad Reservoir has spilled more often than Falcon Reservoir. This trend is consistent with the operating procedures for the two reservoirs whereby Amistad Reservoir is maintained as full as possible to more effectively conserve water with minimal evaporation losses, while releases from Falcon Reservoir are used primarily to meet the water demands of downstream users.

As illustrated, the lowest storage level to which Amistad Reservoir has ever fallen, since it was initially filled, was about 770,000 acre-feet in July 1998. Since the initial filling of Falcon Reservoir, the lowest level that it has dropped to was 160,000 acre-feet in January 1957; however, its storage did fall to near or just below 200,000 acre-feet on several occasions during the 2000-2002 period. Hence, the severity of the current drought on the lower and middle Rio Grande, which began in late 1992, is evident from the low storage levels experienced in Amistad and Falcon Reservoirs.

<u>3.2.1.7.5 Historical Storage in Mexican Tributary Reservoirs</u>

The historical monthly variations in the quantities of water stored in the reservoirs located on tributaries of the Rio Grande in Mexico since 1950 are illustrated on the graphs in Figures 3.9 and 3.10. Figure 3.9 shows the historical combined storage in the major reservoirs located on tributaries that flow into the Rio Grande upstream of Falcon Dam. This includes the twelve reservoirs located on streams in the Rio Conchos, Rio San Diego, Rio San Rodrigo, and Rio Salado Basins as listed in Table 3.1. The historical combined storage in the reservoirs located on tributaries that enter the Rio Grande downstream from Falcon Dam, i.e. in the three reservoirs on the Rio San Juan as listed in Table 3.1, is illustrated by the graph in Figure 3.10.

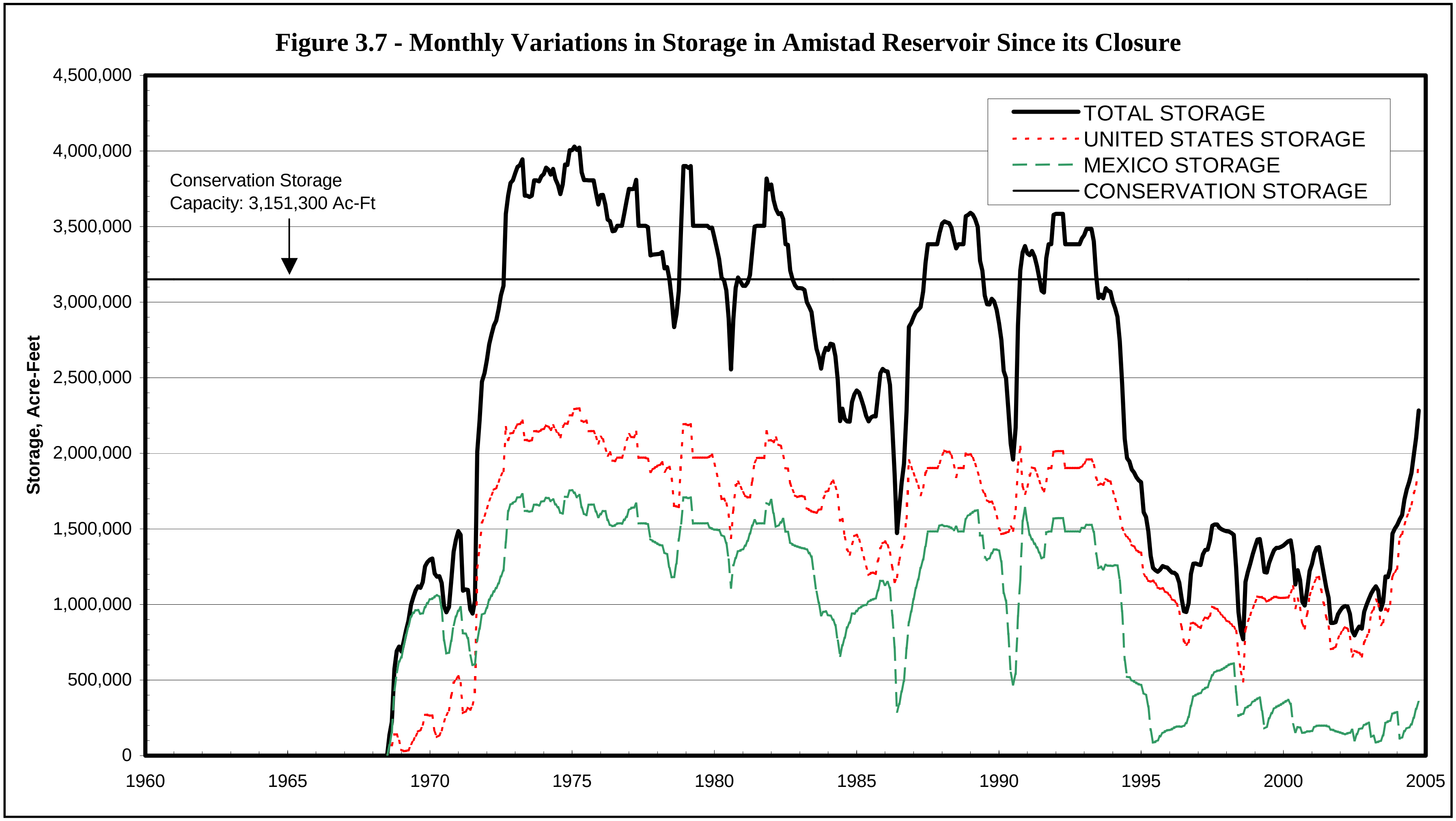


Figure 3.7 - Monthly Variations in Storage in Amistad Reservoir Since its Closure
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Storage, Acre-Feet
Conservation Storage
Capacity: 3,151,300 Ac-Ft
TOTAL STORAGE
UNITED STATES STORAGE
MEXICO STORAGE
CONSERVATION STORAGE
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

Figure 3.8 - Monthly Variations in Storage in Falcon Reservoir Since Its Closure

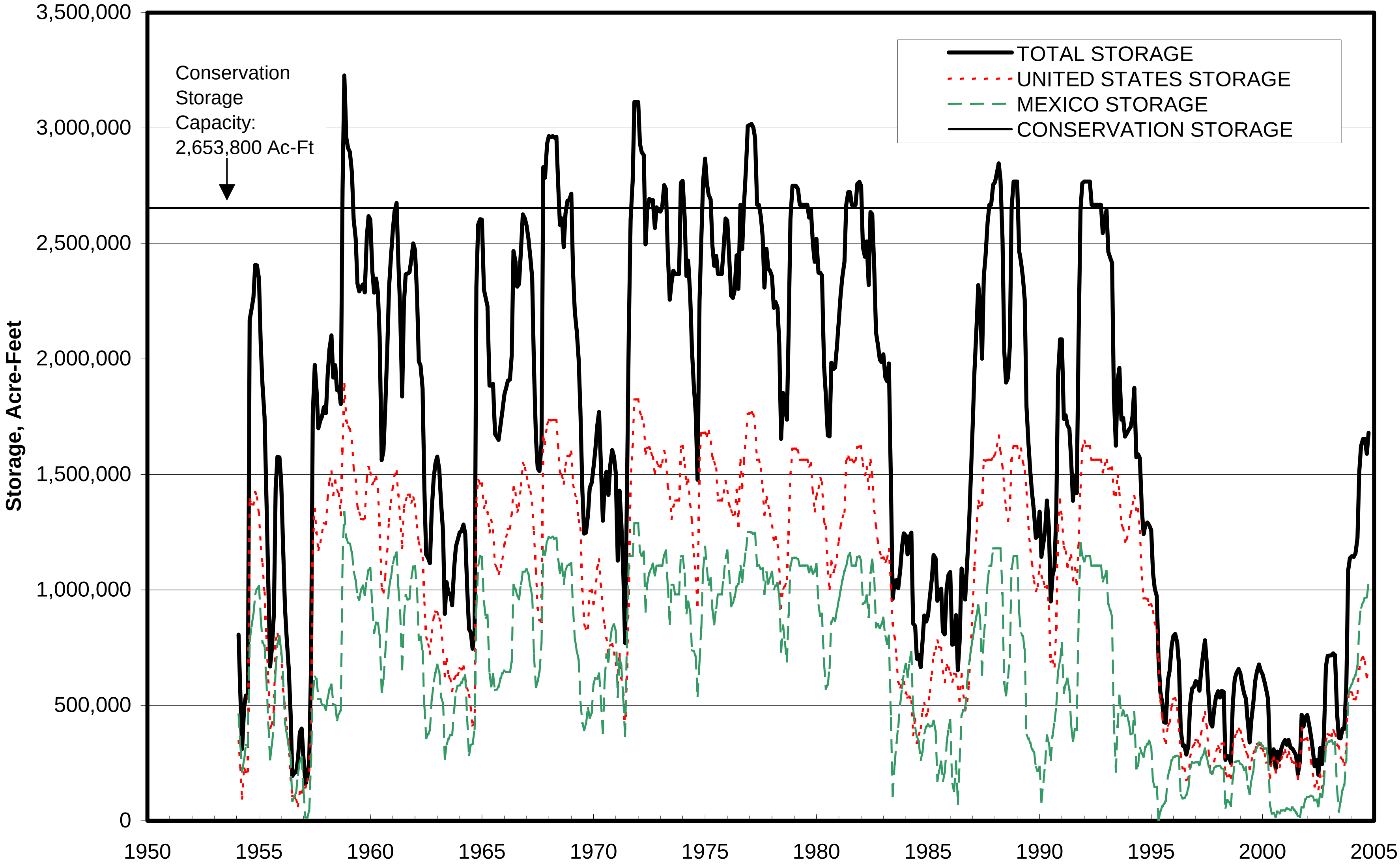


Figure 3.9 - Monthly Variations in Combined Storage in Mexican Reservoirs Located on Tributaries of the Rio Grande Upstream of Falcon Dam

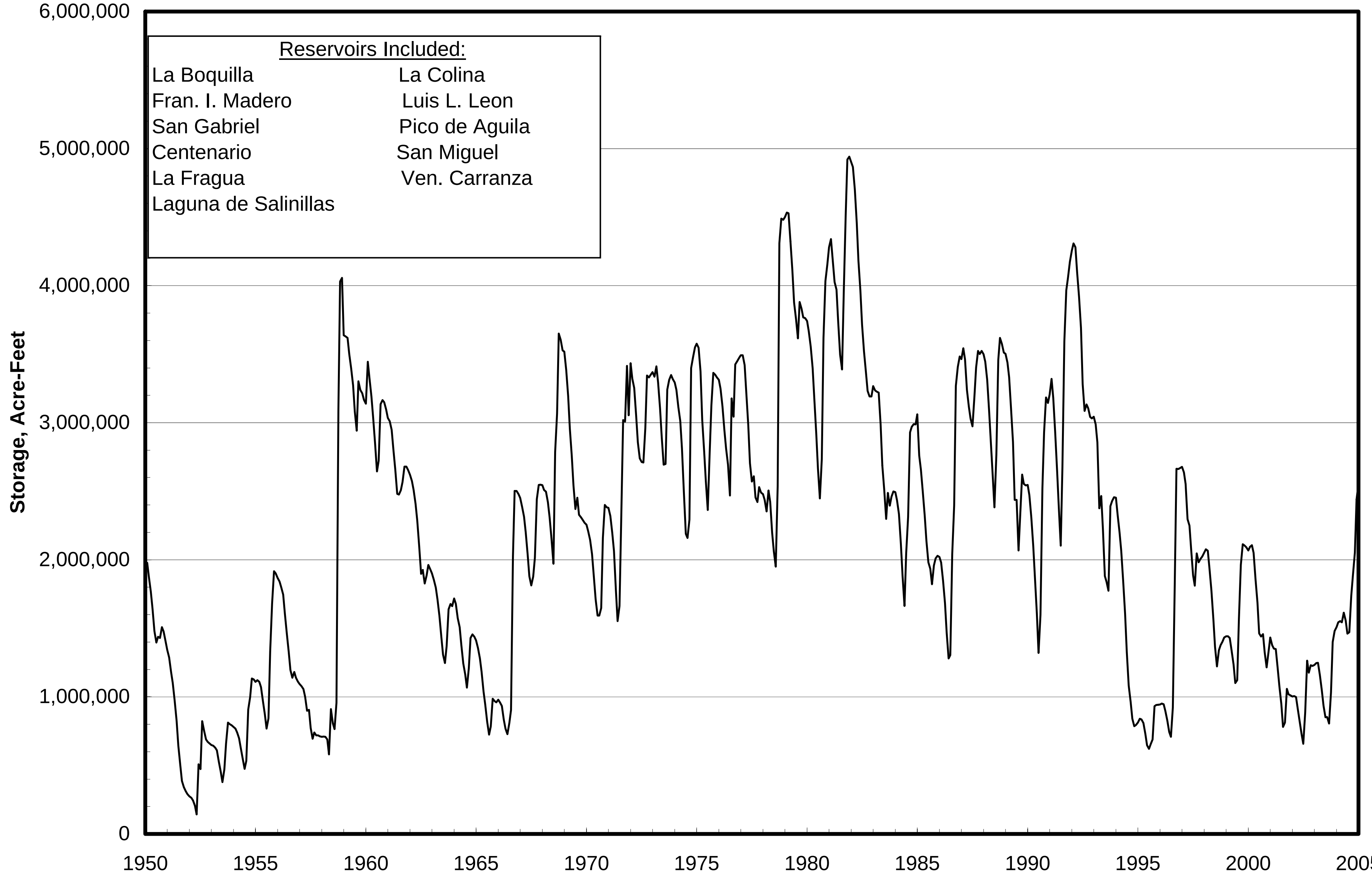
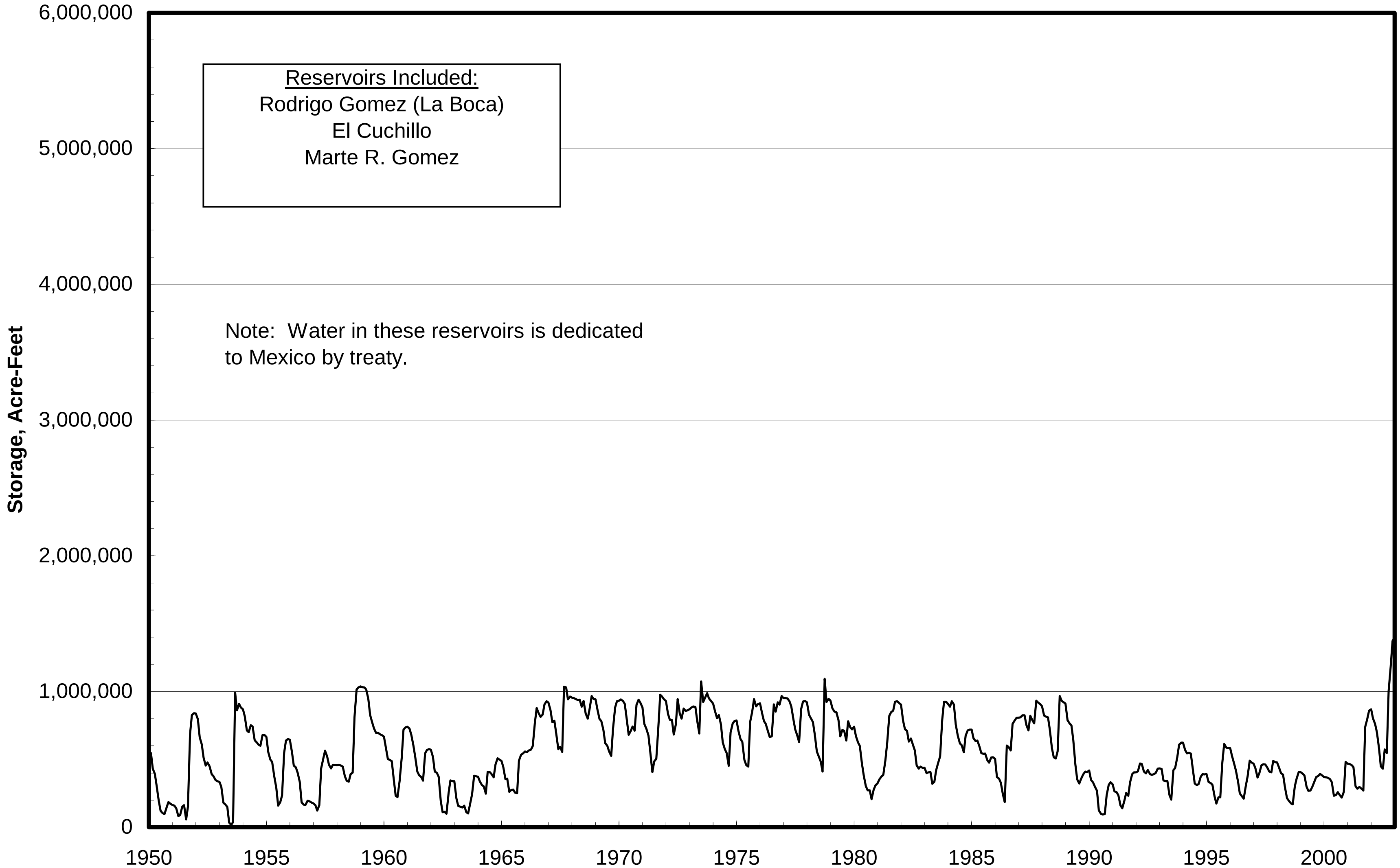


Figure 3.10 - Monthly Variations in Combined Storage in Mexican Reservoirs Located on Tributaries of the Rio Grande Downstream from Falcon Dam



As indicated by the plots, the amount of water Mexico has had stored in these tributary reservoirs has ranged from a few hundred thousand acre-feet to nearly five million acre-feet. Since the beginning of the current drought in the Rio Grande Basin, the minimum storage in these reservoirs was approximately 821,000 acre-feet in May 1995. Further discussion of storage in the Mexican tributary reservoirs and the current deficit accrued by Mexico with respect to its 1944 Treaty obligation to deliver minimum amounts of water to the United States from its tributaries is presented in Section 3.8 of this report.

3.2.1.8 Rio Grande Drought of Record

As illustrated by the historical annual inflows to Amistad and Falcon Reservoirs listed in Table 3.3 for the period 1945 through 2003, the flows in the Rio Grande during the 1950s and the 1990s-2000s appear to have been the lowest experienced during the last half century. Another analysis of long-term inflows of only United States water into Amistad and Falcon Reservoirs is presented by the graph in Figure 3.11. This plot shows the monthly variation of the 12-month and the 60-month running-average annual inflows for the period from 1900 through 1999. These historical reservoir inflows have been obtained from data originally developed by the IBWC for the period 1900 through 1944[10], and from inflows provided directly by the IBWC for the period from 1945 through October 1999, with some modifications to adjust for revised gage data[11].

As indicated by the curves in Figure 3.11, the drought of the 1950s appears to be the most severe when considering 12-month reservoir inflows, but the lowest 60-month average inflow for the drought of the 1990s-2000s appears to be more severe and longer in duration. The 60-month lowest average annual inflow value is indicative of the average amount of annual water usage that might be sustained over the duration of a multi-year critical drought, with adequate storage in Amistad and Falcon Reservoirs.

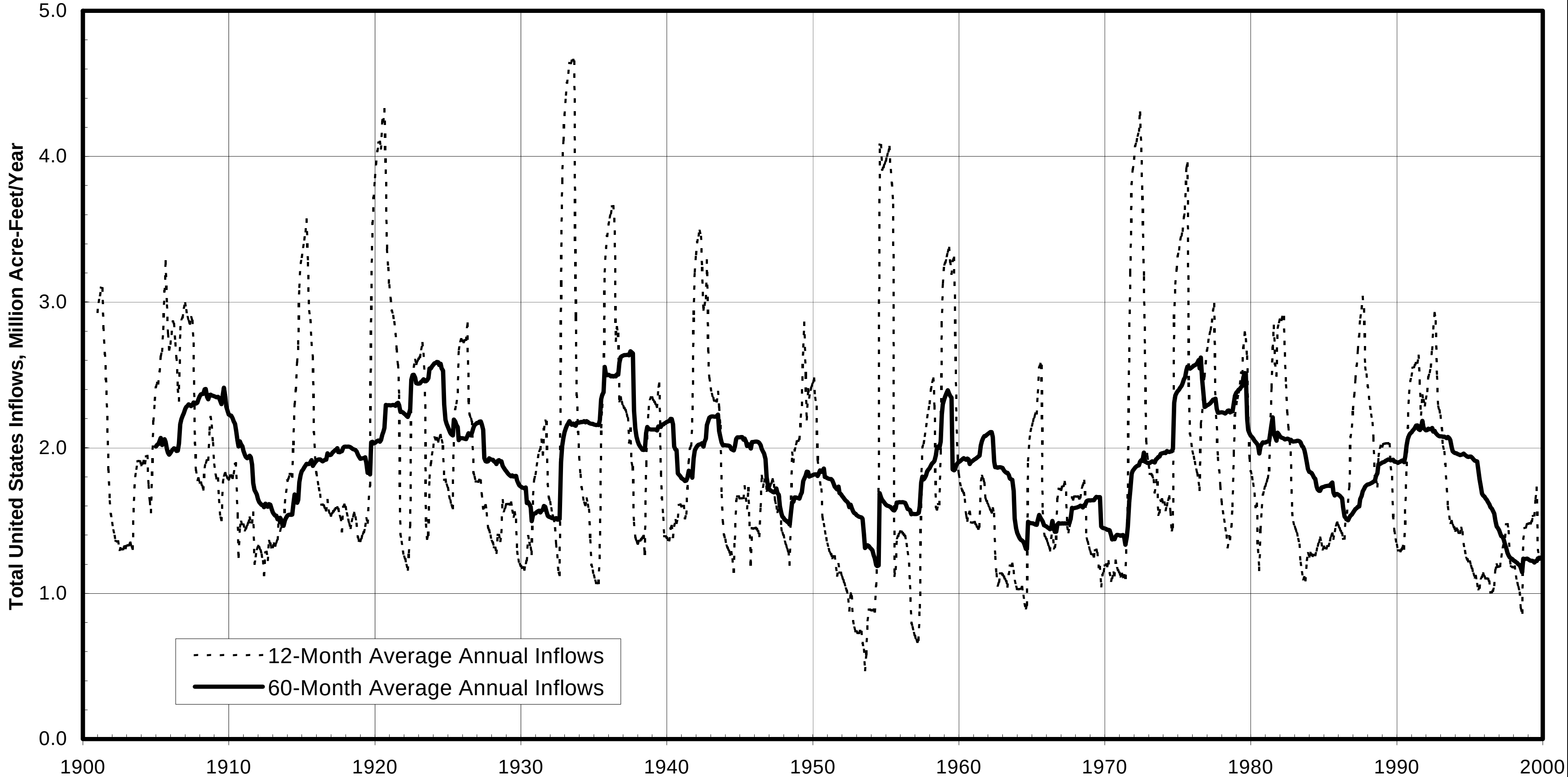
3.2.2 Other Rio Grande Tributaries

In the Middle Rio Grande Basin, there are some existing water rights that authorize diversions from tributaries of the Rio Grande, primarily for irrigation and mining uses. These tributaries include Javalin Creek in Zapata County; the North Branch of Manadas Creek, Chacon Creek, Becerro Creek and Salado Creek in Webb County; Los Olmos Creek in Starr County; and Rosita Creek in Maverick County. Streamflows in these tributaries typically are intermittent and occur only after rainfall periods. Hence, the water supplies provided by these tributaries generally are not dependable, and are available only during local runoff events. No future development of the water resources, such as with on-channel or off-channel reservoirs, of these tributaries, or any other tributaries of the Rio Grande, is likely to occur because of the over-appropriated nature of the Rio Grande itself, particularly with regard to Amistad and Falcon Reservoirs. Although the reliability and availability of the water supplies from these tributaries as authorized by the existing water rights are questionable, particularly during drought of record conditions,

[10] Unpublished computer simulations of the operation of Amistad and Falcon Reservoirs.

[11] Revised estimates of monthly inflows to Amistad and Falcon Reservoirs for the United States and Mexico were derived by Perez-Freese & Nichols during Phase II of the previous Lower Rio Grande Integrated Water Resource Planning Study in 1999.

Figure 3.11 - Variations in 12-Month and 60-Month Average Annual Total Inflows to the Rio Grande for the 1900-1999 Period



it is possible that some water supplies could be provided from these sources. As described later in this report, only limited portions of the authorized diversion amounts of these Rio Grande tributary water rights have been accounted for in estimating the available current water supplies for the affected counties.

3.2.3 Arroyo Colorado

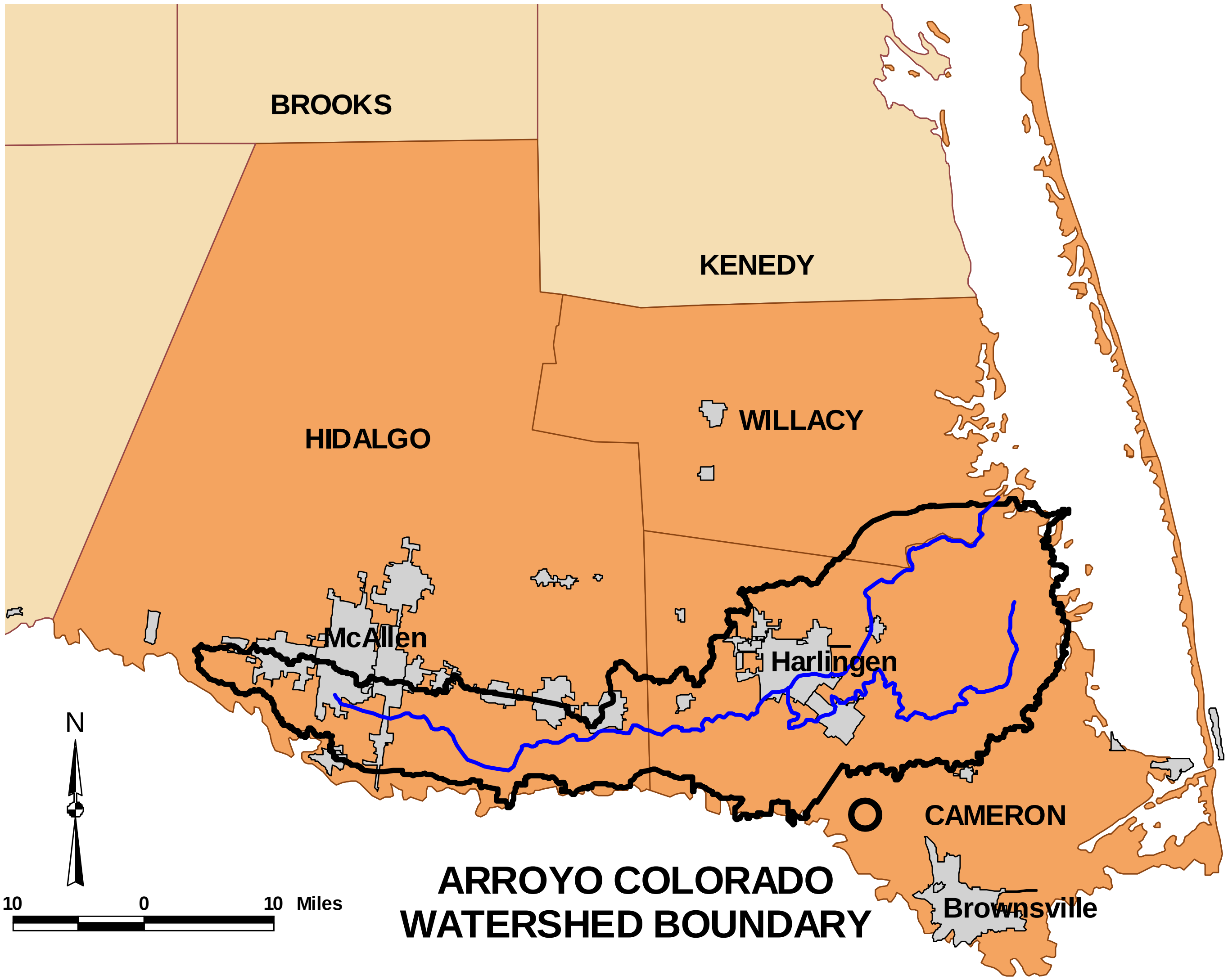
The Arroyo Colorado is an abandoned channel of the Rio Grande that extends eastward for about 90 miles from near Mission through southern Hidalgo County to Harlingen in Cameron County, eventually discharging into the Laguna Madre near the Cameron-Willacy county line. The watershed of the Arroyo Colorado drains approximately 700 square miles and generally consists of coastal plain that slopes gently toward the Gulf of Mexico. Figure 3.12 presents a map showing the Arroyo Colorado and its watershed. Flows in the Arroyo Colorado are sustained by treated wastewater discharges from cities in the region, irrigation return flows (tailwater), other agricultural runoff, storm water runoff, and base flows from groundwater. Flood flows from the Rio Grande also are occasionally diverted into portions of the Arroyo Colorado during major flood events on the river.

The Laguna Atascosa National Wildlife Refuge and several county and city parks are located along the banks of the Arroyo Colorado. The lower one-third of the watercourse is used for commercial shipping from the Gulf Intracoastal Waterway in the Laguna Madre upstream to the Port of Harlingen. Probably the most important use of the Arroyo Colorado, however, is as a source of freshwater inflows to the lower Laguna Madre. This portion of the Laguna Madre serves as an economically and ecologically important coastal water body in the region and the availability of freshwater inflows from the Arroyo Colorado is critical to maintaining its biological resources.

Use of the water in the Arroyo Colorado for municipal, industrial, or irrigation purposes is severely limited because of poor quality conditions. Salinity concentrations in the Arroyo typically exceed the limits considered desirable for human consumption, as well as those acceptable for irrigation of crops. Furthermore, water quality and fish tissue testing have found that: (1) low dissolved oxygen levels have impaired the fish community and other aquatic life downstream from the Port of Harlingen; (2) elevated levels of pesticides (chlordane, toxaphene, and DDE), and PCBs in the Donna Canal have resulted in a fish consumption advisory upstream from the Port of Harlingen; and, (3) bacteria levels are occasionally elevated indicating a potential health risk to people who swim or wade in the Arroyo upstream from the Port of Harlingen. In response to these use impairments, the TCEQ has performed a Total Maximum Daily Load (TMDL) study to assess the specific causes of the observed pesticide and PCB problems and to determine the pollution controls necessary to restore water quality in the Arroyo Colorado. A plan to reduce the pollutants is currently being implemented.

Because of the water quality problems that exist in the Arroyo Colorado, it has been assumed for purposes of this water planning study that there is no water currently available in the Arroyo Colorado for municipal, industrial, or irrigation uses within the RGRWPA. Some limited use of the water in the lower reach of the Arroyo Colorado occurs for aquaculture operations (shrimp farming), and this type of use may be expanded in the future. However, because of the importance of the freshwater inflows from the Arroyo Colorado to the biological resources of the Laguna Madre, future efforts to divert additional water from the Arroyo may be strongly resisted.

Figure 3.12 - Arroyo Colorado and its Watershed



3.2.4 Nueces-Rio Grande Resacas

In the Lower Rio Grande Valley, particularly in Cameron County, there are a number of existing water rights that authorize surface water diversions from small isolated lakes referred to as resacas. For the most part, these resacas are old abandoned channels of the Rio Grande that now receive inflows from local runoff, irrigation return flows, groundwater, and, in some cases, diversions from the Rio Grande, and they normally are relatively full. Because the topography along the Rio Grande in this area generally slopes away from the river, these resacas actually are located outside of the Rio Grande watershed and are in the Nueces-Rio Grande Coastal Basin. The resacas in Cameron County with authorized diversions include Resaca Quates, Resaca Fresnos, Resaca De Los, and Resaca Del Ran.

The water rights permits for diversions from these resacas authorized 225 acre-feet of water per year for municipal use and 13,684 acre-feet per year for irrigation use. It appears that these resacas are capable of serving as effective sources of water for meeting localized demands. As such, it has been assumed that the authorized diversion amounts of these resaca water rights will be available as part of the overall water supply for Cameron County.

3.2.5 Springs

According to available publications and literature[12,13], there are few existing springs within the Region M portions of the Rio Grande Basin and the Nueces-Rio Grande Coastal Basin and they are small in terms of their discharge rates. Much of the area is underlain by shales and marls, which cannot store or transmit much water. Typically, the flow rate of the existing springs is less than 20 gallons per minute, with most springs flowing at a rate of only a few gallons per minute. There are no major springs that are extensively relied upon for water supply purposes. Many of the small springs do provide water for livestock and wildlife when they are flowing.

3.3 SURFACE WATER RIGHTS

In general, all users that divert or store surface water in Texas are required to possess a water right that authorizes, as necessary, a specified amount of surface water that can be diverted from a particular stream or reservoir, the maximum rate of diversion, the maximum storage capacity for a reservoir, and, in the case of irrigation, the location of the fields that are to be irrigated. The TCEQ is the State agency responsible for issuing and administering water rights in Texas.

For the RGRWPA, the water rights master file of the TCEQ has been reviewed and analyzed, and all water rights authorizing surface water diversions and use within the planning region have been identified and summarized. A compilation of these individual water rights according to owner, grouped by basin, county and type of use, is contained in the Appendix, of this report. For each county in the region, the water rights are listed separately for the Rio Grande Basin and for the Nueces-Rio Grande Coastal Basin. The water rights are further categorized according to type of use; i.e., municipal, industrial (manufacturing), irrigation, and mining.

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[12] Gunnar Brune; “Springs of Texas: Vol. 1; Branch-Smith, Inc.; Fort Worth, Texas; 1981.

[13] Gunnar Brune; “Major and Historical Springs of Texas”; Texas Water Development Board; Report 189; Austin, Texas; 1975.

Table 3.5 presents a summary of the surface water rights in each of the eight counties in the RGRWPA. The values contained in Table 3.5 represent the maximum amounts of water that can be diverted annually under the authority of the existing water rights, expressed in acre-feet. Where water rights are registered in one county, but the water use is in a different county or multiple counties, they have been transferred into the county of actual use for the purposes of this table. Similarly, where a water right is listed for a certain use, such as domestic and livestock, but is actually authorized to be used for a different use, such as municipal, the actual use is reflected in this table. As shown, a total of 2,226,495 acre-feet per year of surface water diversion rights currently exist within the region. Of this amount, about 14% (305,997 acre-feet per year) is for municipal uses and about 3% (64,626 acre-feet per year) is for industrial uses. The vast majority of the surface water rights in the region (1,853,179 acre-feet per year or about 83%) are authorized for irrigation. Most of the surface water rights in the region are located in Hidalgo County (1,244,037 acre-feet of diversions per year or about 56%) and in Cameron County (681,043 acre-feet of diversions per year or about 31%). Approximately 96% of the total diversions authorized by the water rights in the RGRWPA are in the Rio Grande Basin, and practically all of these are associated with Amistad and Falcon Reservoirs.

3.4 AMISTAD-FALCON RESERVOIR SYSTEM

As noted previously, the vast majority of the water used in the RGRWPA is diverted from the Rio Grande. For the most part, this water originates as releases from Amistad and Falcon Reservoirs, both of which are located on the mainstem of the river. For this reason, it is important to understand the operation of the Amistad-Falcon reservoir system and to quantify the amount of water that potentially could be provided by these reservoirs during the drought of record.

3.4.1 Water Availability Model

The TCEQ is responsible for developing water availability models for all basins in Texas. R. J. Brandes Company (RJBCO) of Austin, Texas, under contract with the TCEQ, assisted the agency in the preparation, development, and application of a water availability model ("WAM") for the Rio Grande Basin (referred to as the "Rio Grande WAM"). The basic procedure applied in analyzing water availability in a particular river basin involves developing naturalized streamflows throughout the basin from historical hydrologic and other data, then simulating on a monthly basis the ability of individual water rights to meet their authorized diversions or storage quantities in accordance with the prior appropriation doctrine and, for the Rio Grande Basin, the TCEQ Rio Grande operating rules. The simulations are performed using the Water Rights Analysis Package computer program (referred to as "WRAP") that was developed by Dr. Ralph A. Wurbs of Texas A&M University[14]. An essential element of the Rio Grande WAM is the operation of the Amistad-Falcon reservoir system.

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[14] Wurbs, R.A., *Water Rights Analysis Package (WRAP) Modeling System Reference and Users Manuals*, Texas Water Resources Institute (TWRI), Technical Reports 255 and 256, August 2003, Revised December 2003; and Wurbs, R.A., *WRAP Revisions Since August 2003,* Texas Water Resources Institute (TWRI), February 2004.

Table 3.5 - Surface Water Rights by County (acre-ft/yr)

Basin/Use	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata	Region M
RIO GRANDE BASIN									
Municipal	132,743[a]	135,123	-	9,756	6,881	48,349	998	2,566	336,417
Industrial	2,420	8,881	-	114	-	1,645	-	-	13,059
Irrigation	573,586	928,927	-	138,538	40,651	27,113	88,287	10,205	1,807,307
Mining	10	530	-	90	53	1,668	-	344	2,694
County Total	**708,759**	**1,073,461**	**-**	**148,498**	**47,584**	**78,774**	**89,284**	**13,115**	**2,159,476**
NUECES-RIO GRANDE BASIN									
Municipal	225	-	-	-	-	-	-	-	225
Industrial	38,210[b]	300	-	-	-	-	3,250	-	41,760
Irrigation	27,606	7,549	-	-	-	-	10,717	-	45,872
Mining	-	-	-	-	-	-	-	-	-
County Total	**66,041**	**7,849**	**-**	**-**	**-**	**-**	**13,967**	**-**	**87,857**
REGION M TOTAL									
Municipal	132,968	135,123	-	9,756	6,881	48,349	998	2,566	336,642
Industrial	40,630	9,181	-	114	-	1,645	3,250	-	54,819
Irrigation	601,193	936,476	-	138,538	40,651	27,113	99,003	10,205	1,853,179
Mining	10	530	-	90	53	1,668	-	344	2,694
County Total	**774,801**	**1,081,310**	**-**	**148,498**	**47,584**	**78,774**	**103,251**	**13,115**	**2,247,333**

[a] Includes Brownsville Permit #1838 for 40,000 ac-ft of "excess flows" not supplied by Amistad-Falcon.
[b] Includes Harlingen Shrimp Farms Permit #4550 for 35,970 ac-ft of salt water from Laguna Madre.

Naturalized streamflows represent historical streamflow conditions, including typical wet, dry, and normal flow periods, without the influence of man's historical activities as they relate to water rights and water use. In essence, naturalized streamflows exclude the effects of historical diversions, return flows, and reservoir storage and evaporation. For the Rio Grande WAM, the naturalized streamflow database that has been developed covers the 61-year period from January 1940 through December 2000. The 1940-2000 historical period also includes the droughts of the 1950s and 1990s, both of which represent extreme drought conditions for most of the Rio Grande Basin. However, it is important to note that the 1990s drought has continued beyond the year 2000, and those streamflows are not included in the WAM.

The WRAP program simulates the allocation of prescribed amounts of water within a river basin to individual water rights, i.e. diversions and storage, subject to the prior appropriation doctrine ("first in time, first in right") as it is applied for water rights administration in Texas. The priority dates have been adjusted for the Rio Grande WAM to reflect the use-based priority system for water rights dependent on storage in Amistad and Falcon Reservoirs, international treaty obligations, and for water rights in Mexico, known as "concessions." The Mexico concessions used in the WAM are listed in Table 3.6.

WRAP utilizes a network of control points with interconnected links to describe flow paths and the locations of inflows, diversions, reservoirs, return flows, and other points of interest. Figure 3.13 presents a map showing the locations of all control points in the Rio Grande WAM. Computations within the model are performed on a monthly basis using monthly time series values of specified inflows, reservoir net evaporation rates, and water demands subject to prescribed water rights conditions and reservoir system operating rules. Results from the WRAP program include monthly diversion and storage amounts for each water right and the remaining unappropriated water at selected locations throughout the basin. The program also produces the regulated streamflow at every control point, reflecting the effects of flow depletions by upstream water rights and flow pass-throughs for downstream water rights.

Because all of the Rio Grande Basin below the New Mexico state line, including the Mexican portion of the basin, is included in the Rio Grande WAM, it has been necessary to incorporate into the WAM the essential provisions of existing international agreements between the United States and Mexico regarding the ownership of the water flowing in the Rio Grande. These agreements include the 1944 Treaty, which addresses the ownership of water downstream of Fort Quitman, and the 1906 Convention, which divides the water between the U.S. and Mexico above Fort Quitman.

One of the most important aspects of this process involves the transfer of Mexican water from certain Mexican tributaries of the Rio Grande to the U.S. segment of the WAM. This requirement stems from the 1944 Treaty as described earlier in Section 3.2.1.6.1, and it is accomplished in the WAM after all of Mexico's demands and reservoirs on these tributaries have been simulated, with no provisions in the model for Mexico to deliver the average of 350,000 acre-feet per year in accordance with paragraph B(c) of Article 4 of the 1944 Treaty. One-third of the remaining flow at the mouths of each of the six named Mexican tributaries then is diverted and subsequently discharged as a return flow to the U.S. segment of the river. Demands for water along the Rio Grande by both U.S. and Mexican water users downstream of these Mexican tributaries then are simulated in the model. The treaty provision requiring a minimum of 350,000 acre-feet per year to be delivered to the U.S. from the six named Mexican tributaries has not been incorporated into the WAM. The future enforcement of this treaty provision is uncertain.

Table 3.6 - Mexico Water Use Concessions Included In WAM

NAME OF CONCESSION	TYPE OF USE	DIVERSION AMOUNT acre-feet/year	STREAM NAME	ASSOCIATED RESERVOIR
103 Rio Florido Irrigation District 1	Irrigation	10,343	Rio Florido	San Gabriel
103 Rio Florido Irrigation District 2	Irrigation	74,849	Rio Florido	Pico del Aguila
005 Delicias Irrigation District 1	Irrigation	837,042	Rio Conchos	La Boquilla
005 Delicias Irrigation District 2	Irrigation	163,263	Rio Conchos	Francisco Madero
090 Lower Conchos Irrigation District	Irrigation	130,223	Rio Conchos	Luis Leon
006 Palestina Irrigation District 1	Irrigation	2,406	Rio Grande	Amistad
006 Palestina Irrigation District 2	Irrigation	1,968	Rio Grande	Amistad
006 Palestina Irrigation District 3	Irrigation	3,634	Arroyo de las Vacas	None
006 Palestina Irrigation District 4	Irrigation	14,376	Rio San Diego	San Miguel
006 Palestina Irrigation District 5	Irrigation	20,514	Rio San Diego	Centenario
Local Irrigation	Irrigation	21,006	Rio San Rodrigo	La Fragua
Local Irrigation	Irrigation	20,000	Rio Escondido	None
050 Acuna Falcon Irrigation District	Irrigation	23,361	Rio Grande	Amistad
004 Don Martin Irrigation District	Irrigation	285,337	Rio Salado	Venustiano Carranza
058 Alto Rio San Juan Irrigation District	Irrigation	6,090	Rio San Juan	None
031 Las Lajas Irrigation District	Irrigation	19,454	Rio San Juan	El Cuchillo
026 Bajo Rio San Juan Irrigation District 1	Irrigation	342,755	Rio San Juan	Marte R. Gomez

Table 3.6, cont'd.

NAME OF CONCESSION	TYPE OF USE	DIVERSION AMOUNT acre-feet/year	STREAM NAME	ASSOCIATED RESERVOIR
026 Bajo Rio San Juan Irrigation District 2	Irrigation	6,016	Rio Grande	Falcon
026 Bajo Rio San Juan Irrigation District 3	Irrigation	27,414	Rio Grande	Falcon
025 Bajo Rio Bravo Irrigation District - Anz.	Irrigation	697,555	Rio Grande	Falcon
TOTAL IRRIGATION:		2,707,606		
Acequia Madre-Juarez	Mun./Irr.	60,000	Rio Grande	Elephant Butte
La Colina - Downstream	Municipal	24,318	Rio Conchos	La Colina
Ciudad Acuna	Municipal	2,496	Rio Grande	Amistad
Piedras Negras	Municipal	10,425	Rio Grande	Amistad
Nuevo Laredo	Municipal	29,263	Rio Grande	Amistad
Ciudad Anahuac	Municipal	6,671	Salado	Venustiano Carranza
Ciudad Miguel Aleman	Municipal	7,636	Rio Grande	Falcon
Reynosa	Municipal	54,351	Rio Grande	Falcon
Matamoros, et al	Municipal	38,990	Rio Grande	Falcon
Monterrey - La Boca	Municipal	27,172	Rio San Juan	La Boca El Cuchillo
Monterrey - El Cuchillo	Municipal	59,788	Rio San Juan	El Cuchillo
Monterrey - Huasteca	Municipal	57,550	Rio San Juan	El Cuchillo La Boca
TOTAL MUNICIPAL:		378,480		

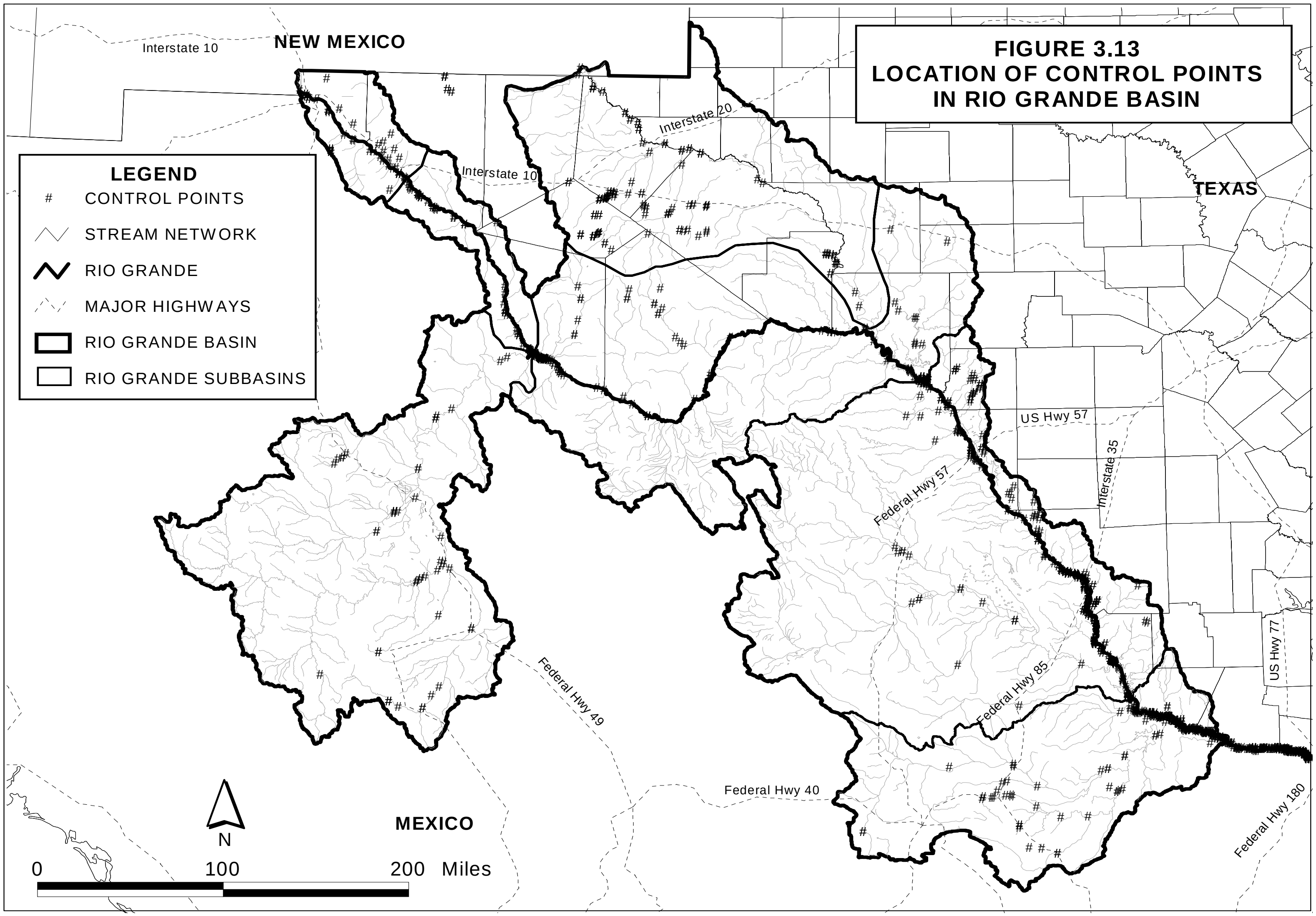


FIGURE 3.13
LOCATION OF CONTROL POINTS
IN RIO GRANDE BASIN
LEGEND
CONTROL POINTS
STREAM NETWORK
RIO GRANDE
MAJOR HIGHWAYS
RIO GRANDE BASIN
RIO GRANDE SUBBASINS
NEW MEXICO
TEXAS
MEXICO
Interstate 10
Interstate 20
Interstate 35
US Hwy 57
US Hwy 77
Federal Hwy 57
Federal Hwy 85
Federal Hwy 49
Federal Hwy 40
Federal Hwy 180
N
0
100
200 Miles

Another international aspect of the WAM relates to the equal split of the flows in the Rio Grande at Fort Quitman. It should be pointed out that the equal split of the Fort Quitman flows is the procedure currently used by the IBWC in its accounting of U.S. and Mexican ownership of water flowing in the Rio Grande. This procedure does not seem to be consistent, however, with language adopted by the 1906 Convention, which states that except for the delivery of Rio Grande Project water to Mexico at the Acequia Madre, all water flowing in the Rio Grande above Fort Quitman is owned by the United States. This would suggest that the U.S. owns all of the river water passing Fort Quitman, but this is not how the current accounting is performed by IBWC nor how the WAM is constructed.

Whereas the result of the Valley Water Case was to grant the highest water supply priority to municipal and industrial uses, the remaining Class A and B irrigation and mining water rights were subject to an allocation system dependent on the amount of storage remaining in Amistad and Falcon Reservoirs after water first was reserved for the municipal and industrial users and certain reservoir operating requirements. These procedures, which are discussed in Section 3.2.1.6.2 and are reflected in the TCEQ Rio Grande operating rules as described in Section 3.2.1.6.3, have been incorporated into the Rio Grande WAM and are used for each of the water rights dependent upon storage in the Amistad-Falcon reservoir system. As stipulated in the TCEQ rules, the prior appropriation doctrine is fully exercised for all water rights located on tributaries of the Rio Grande.

Generally, the maximum conservation storage capacity for each reservoir has been specified in the Rio Grande WAM in accordance with the maximum authorized storage amounts specified in the TCEQ water rights data base. As noted below, for purposes of this water supply planning study, these storage capacities have been reduced to reflect the effects of sedimentation over the next 50 or so years.

The United States pools in Amistad and Falcon Reservoirs are operated as a reservoir system. In the WAM, assumed operational rules are employed to store water primarily in Amistad Reservoir (the uppermost international impoundment) pursuant to the provisions of the 1944 Treaty between the U.S. and Mexico, while maintaining a lower operating pool in Falcon Reservoir to facilitate day-to-day releases to the water users in the Lower Rio Grande Valley.

3.4.2 Projected Reservoir Sedimentation Effects

Fundamental to properly simulating the storage behavior of Amistad and Falcon Reservoirs and to effectively account for evaporation losses is an accurate description of the relationships between the water surface elevation of each of the reservoirs and surface area and storage volume. These relationships, often referred to as “elevation-area-capacity” relationships, typically are derived from topographic maps of the reservoir sites before they were constructed or from bathymetric surveys of the reservoir bottoms after they have been impounded. As the reservoirs have aged over time, their elevation-area-capacity relationships have changed primarily due to sediment loadings that have been discharged into the reservoirs with inflows from their respective watersheds. Typically, the bottom contours of the reservoirs have been altered as sediment has been deposited, and the storage volume of the reservoirs has been reduced. The reduced storage volume of the reservoirs, in turn, can result in corresponding reductions in the firm annual yield of the reservoirs. Hence, for water supply planning purposes, it is important to project the degree to which future sediment loadings may further reduce the storage capacity of the reservoirs and how these storage reductions may impact the yield of the reservoirs.

The IBWC has developed elevation-area-capacity relationships for both Amistad and Falcon Reservoirs at different times since they were initially impounded. The most recent relationships were based on bathymetric surveys conducted in 1992 for both reservoirs. Prior to 1992, elevation-area-capacity relationships were determined in 1980 for Amistad Reservoir and in 1972 for Falcon Reservoir. Comparison of these sets of relationships for each of the reservoirs provides insight regarding the most recent sedimentation rates that have been effective in reducing the storage volumes of the reservoirs. Figure 3.14 presents a plot of the variation of storage volume in Amistad Reservoir with water surface elevation for the 1980 and the 1992 sedimentation conditions. A similar graph for Falcon Reservoir is presented in Figure 3.15 for the 1972 and the 1992 sedimentation conditions.

Examination of the storage-versus-elevation graphs indicates that Amistad Reservoir experienced moderate storage volume reductions due to sedimentation during the period between 1980-1992, whereas the reduction in the storage volume of Falcon Reservoir during the 1972-1992 period appears to have been minimal. One reason for these differences in sedimentation rates is that Amistad Reservoir is located upstream of Falcon Reservoir and, in effect, captures sediment loadings carried by the Rio Grande before they can enter Falcon Reservoir. Another possible cause is that the average inflows to Amistad Reservoir from its upstream watershed are about twice the average inflows into Falcon Reservoir from the intervening watershed between Amistad and Falcon Reservoirs. Hence, sediment loadings into Amistad Reservoir should be somewhat greater.

The average reservoir sedimentation rates exhibited by the changes in storage volume of Amistad and Falcon Reservoirs shown on the graphs in Figures 3.14 and 3.15 provide a means for projecting future sedimentation conditions in the reservoirs for water supply planning purposes. For Amistad Reservoir, the average sedimentation rate between 1980 and 1992 was on the order of 19,400 acre-feet per year, whereas for Falcon Reservoir between 1972 and 1992, the average sedimentation rate was only about 700 acre-feet per year. These rates of sedimentation in the reservoirs represent corresponding annual reductions in their conservation storage capacities equal to about 0.6 percent for Amistad and about 0.03 percent for Falcon.

During previous water planning efforts for the Lower Rio Grande Valley, the above observed sedimentation rates for Amistad and Falcon Reservoirs also were examined for purposes of projecting the effects of future sedimentation in the reservoirs on their respective elevation-area-capacity relationships and firm annual yields over the next 50 years. The results from these earlier investigations have been adopted for use in this water supply planning study for the RGRWPA. For Amistad Reservoir, the observed sedimentation rate during the 1980-1992 period was applied to develop adjusted elevation-area-capacity relationships for each decade through the year 2050. The resulting storage-versus-elevation curves for each decade between the year 2000 and 2050 are plotted in Figure 3.16. As expected, these curves gradually shift over time in the direction of lesser amounts of available conservation storage in the reservoir. The corresponding maximum amounts of conservation storage available to the United States and to Mexico in Amistad Reservoir by decade based on these curves are listed below in Table 3.7.

For Falcon Reservoir, the historical volume reduction due to sedimentation that occurred during the 1972-1992 period (0.03 % per year) was considered to be negligible; therefore, no adjustments in the elevation-area-capacity relationships were considered necessary to reflect future reservoir sedimentation effects. Consequently, the 1992 storage-versus-elevation curve presented in Figure 3.15 has been used in this study for all analyses of the future operation and yield of Falcon Reservoir.

Figure 3.14 - Elevation-Storage Relationships for Amistad Reservoir Based on 1980 and 1992 Bathymetric Surveys

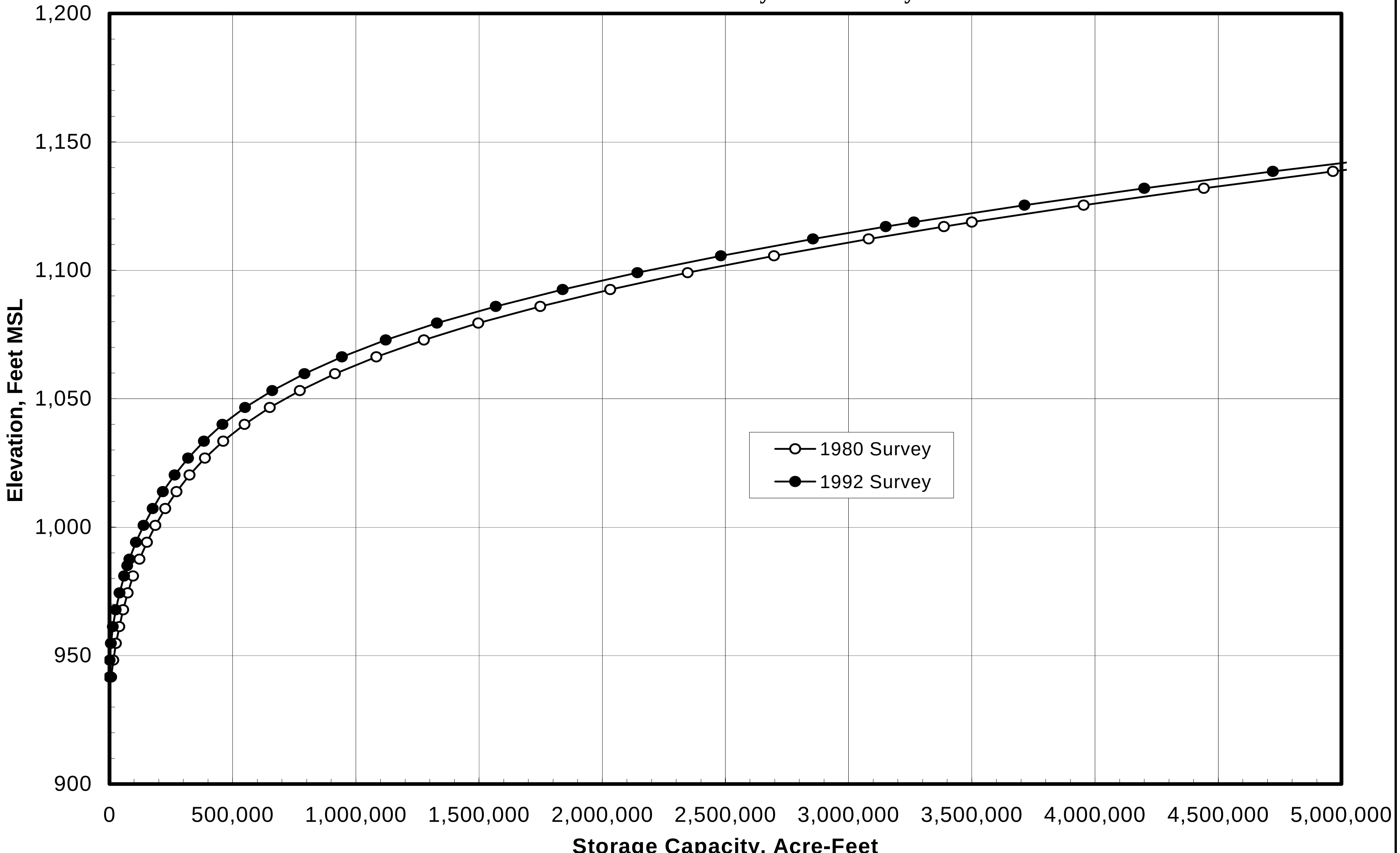


Figure 3.15 - Elevation-Storage Relationships For Falcon Reservoir
Based on 1972 and 1992 Bathymetric Surveys

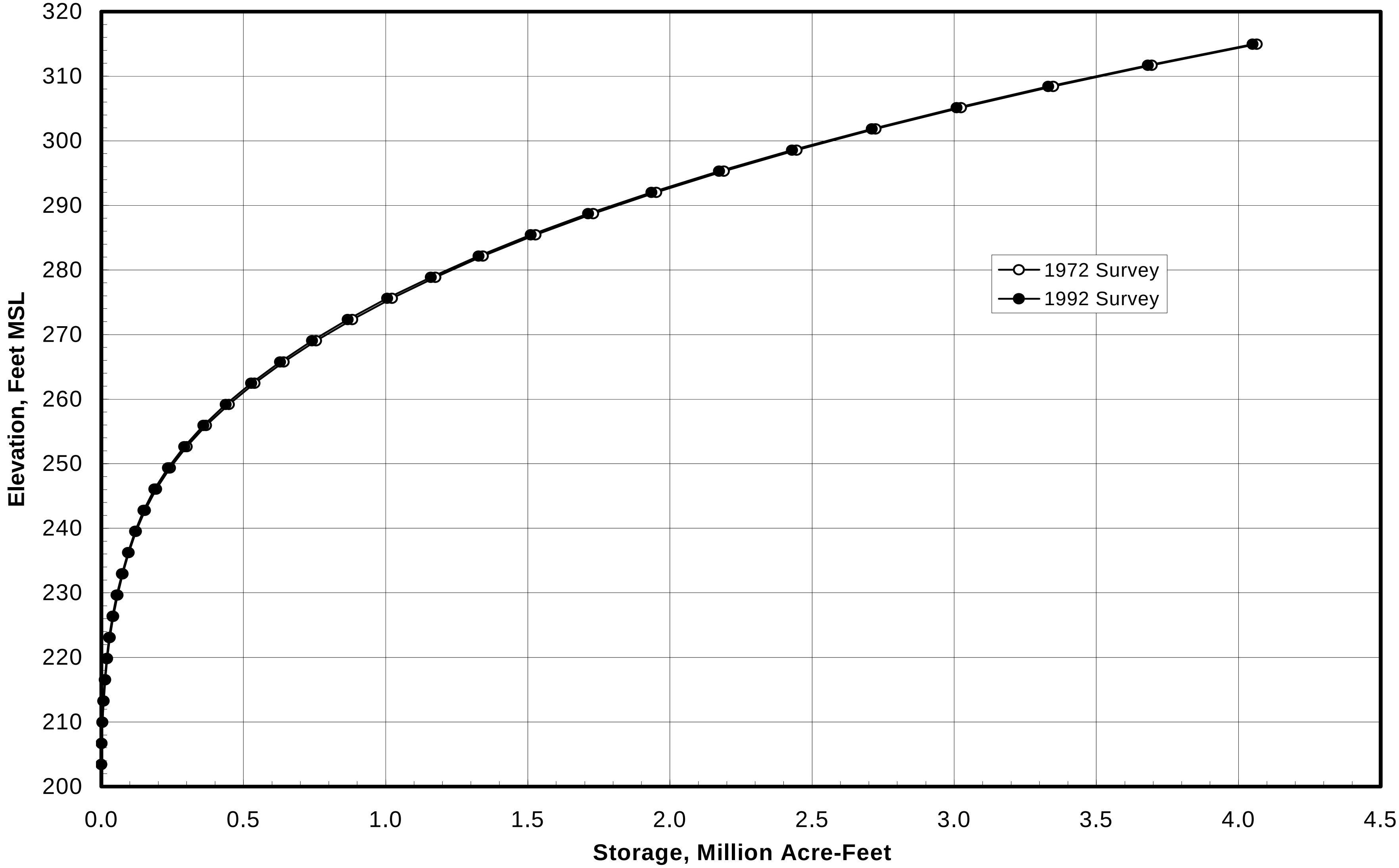


Figure 3.16 Elevation-Storage Relationships for Amistad Reservoir Projected to 2060 Based on 1980 and 1992 Bathymetric Surveys

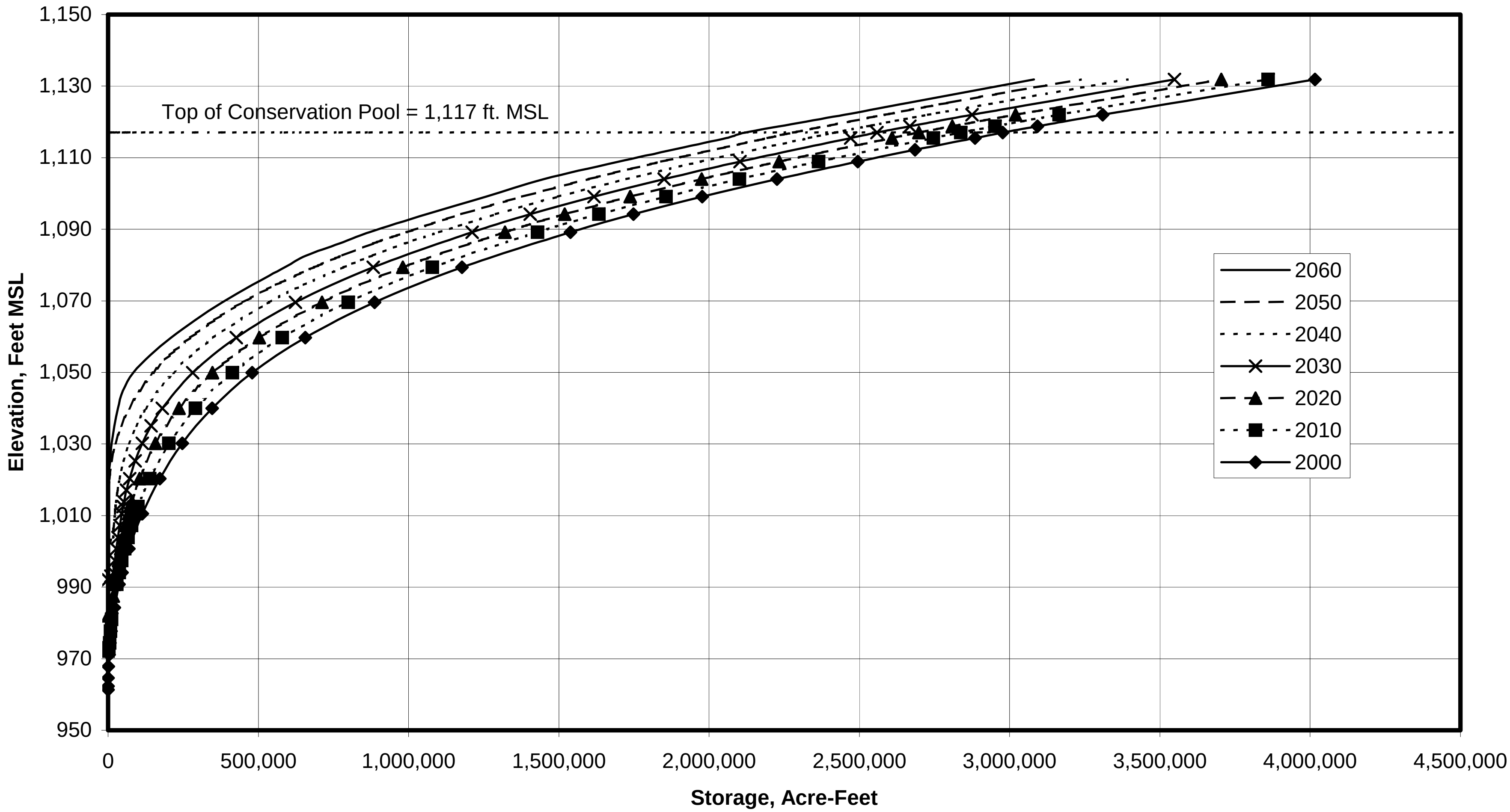


Table 3.7: Projected Maximum Conservation Storage Available in Amistad Reservoir

Year	United States Conservation Storage Acre-Feet	Mexico Conservation Storage Acre-Feet
2000	1,673,055	1,303,912
2010	1,594,648	1,242,804
2020	1,516,541	1,181,696
2030	1,437,833	1,120,588
2040	1,359,425	1,059,481
2050	1,281,018	998,373
2060	1,187,200	932,800

3.4.3 Reservoir System Firm Annual Yield

The firm annual yield of a reservoir or system of reservoirs is defined as the maximum amount of water that can be withdrawn from the reservoir(s) every year during the occurrence of the drought of record without causing the reservoir(s) to go dry. For water supply planning purposes, the TWDB requires that no more than this amount of surface water be considered as available from a reservoir, or reservoir system, for meeting future water demands. Hence, for purposes of the Rio Grande water supply planning effort, it is has been necessary to develop projections of the future firm annual yield of the Amistad-Falcon reservoir system since this system currently supplies and will continue to supply over the 50-year planning horizon the vast majority of the water used in the region.

Firm annual yield has been determined using the Rio Grande WAM with hydrologic conditions corresponding to the 1940-2000 period as described in Section 3.4.1. As described earlier with respect to the structure of the Rio Grande WAM, all Mexico demands and reservoirs are simulated during each monthly time step of the simulation process before the demands and reservoirs on the U.S. side of the river are simulated, including Amistad and Falcon Reservoirs. Furthermore, there are no provisions in the WAM to limit Mexico's use of its tributary flows, and the only water that reaches the Rio Grande from Mexico in the WAM is local runoff from adjacent watersheds, the unused runoff from below Mexico's lowest tributary reservoirs and any spills of floodwater from these reservoirs. This means that the minimum delivery of 350,000 acre-feet per year by Mexico as required by the 1944 Treaty, except "in the event of extraordinary drought or serious accident to the hydraulic systems on the measured Mexican tributaries", is not provided for. For determining the firm yield of the Amistad-Falcon reservoir system with the WAM, diversions from the reservoir system for the United States and for Mexico, stipulated in accordance with current demand distributions (geographically and by type of use) and use patterns (by month of the year), were reduced below the authorized amounts until no shortages were experienced, while maintaining all other water rights and Mexican concessions in the basin at their full authorized amounts. The minimum volume remaining in the reservoirs during the critical period was virtually zero for the firm yield demands, except for the required reserves as stipulated in the TCEQ Rio Grande operating rules. The resulting total demand for each country as specified in the WAM then was considered to be each country's share of the firm annual yield of the Amistad-Falcon reservoir system.

This procedure has been applied for each of the projected elevation-area-capacity relationships for the reservoirs as described above for the years 2000, 2010, 2020, 2030, 2040, 2050, and 2060. As the available conservation storage capacity in the reservoirs has been reduced over time due to sedimentation effects, the resulting firm annual yield of the system also has decreased.

Results from the firm annual yield analyses of the Amistad-Falcon reservoir system are presented in Table 3.8. Values of the firm annual yield are listed for both the United States and Mexico by decade for the period 2000 through 2060. As expected, the firm yield of the system for both countries gradually decreases in the future as sedimentation of the reservoirs is projected to occur over time and reduce the reservoirs' storage capacity. The United States' share of the firm annual yield of the reservoir system decreases from 1,087,449 acre-feet per year in the year 2000 to 1,024,987 acre-feet per year in the year 2060, a reduction of about six percent. Again, these yield values represent the maximum amount of water that can be withdrawn from the reservoirs on a continual basis by the United States should conditions similar to the drought of record recur.

Table 3.8 - Projected Firm Annual Yields of the Amistad-Falcon Reservoir System for the United States and Mexico by Decade (acre-feet/year)

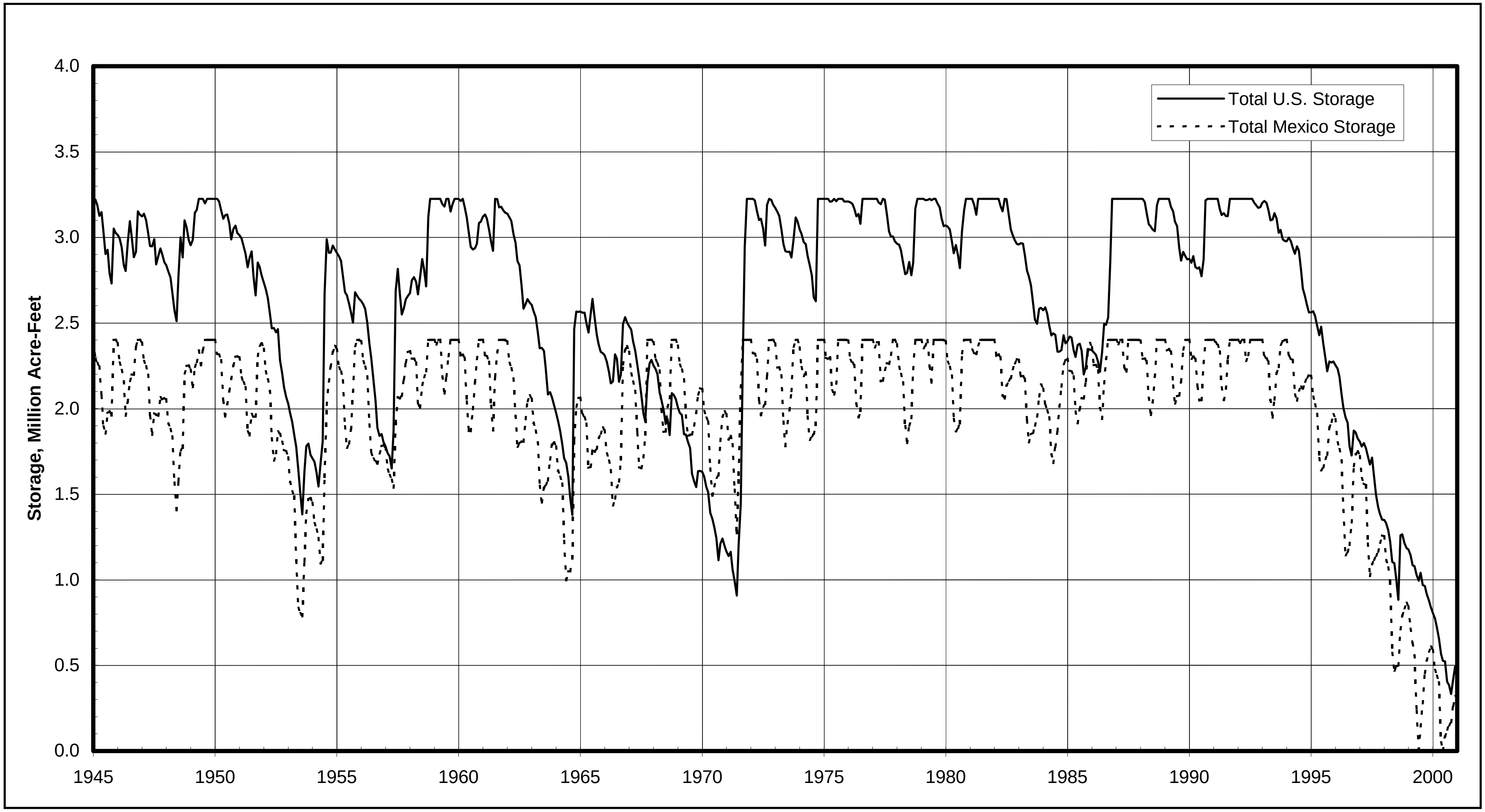
Year	United States	Mexico	Total
2000	1,087,449	901,700	1,989,149
2010	1,067,310	888,200	1,955,510
2020	1,056,719	879,700	1,936,419
2030	1,048,965	869,200	1,918,165
2040	1,041,627	858,700	1,900,327
2050	1,034,592	846,700	1,881,292
2060	1,024,987	835,700	1,860,687

For Mexico, the firm annual yield of the reservoir system is projected to decrease from about 901,700 acre-feet per year in the year 2000 down to about 835,700 acre-feet per year in 2060. Mexico's yield from the reservoirs is different from that of the United States because each country receives different amounts of inflows to the reservoirs in accordance with actual historical hydrologic conditions and the terms of the 1944 Treaty and because the amounts of conservation storage owned by each of the countries in the reservoirs are different.

The simulated monthly storage levels for the United States and for Mexico in Amistad and Falcon Reservoirs combined from the firm annual yield analysis for year-2000 reservoir sedimentation conditions are plotted on the graph in Figure 3.17 for the entire 1945-2000 simulation period. As illustrated, the minimum storage level in the reservoirs for United States and Mexico water occurs in 1999-2000. However, it is important to note that if the current drought continues, the yield could be reduced further.

Another point to note with regard to the storage plot in Figure 3.17 is that the minimum amount of water stored by the United States in the reservoirs during the critical drought period (2000) is not zero as typically is required for a firm annual yield analysis. This level of minimum storage occurs because of the provisions in the TCEQ's Rio Grande operating rules that require the domestic, municipal, and industrial (DMI) pool and the operating reserve to be fully restored and maintained each month and because at one month's irrigation supply must always be available in storage in the Amistad-Falcon reservoir system in the WAM to avoid an irrigation demand shortage. The minimum United States storage amount that is

Figure 3.17: Simulated Monthly Storage Levels for the US and Mexico in Amistad and Falcon Reservoirs Combined From the Firm Annual Yield Analysis for Year-2000 Sedimentation Conditions



simulated for the reservoirs during the critical drought period because of the minimum reserve requirements, in effect, provides an additional water supply beyond the firm annual yield of the reservoir system that serves as a factor of safety with regard to supplying DMI water demands.

3.5 GROUNDWATER SOURCES

Throughout the RGRWPA, groundwater has provided water supplies that range from sustainable municipal supplies to quantities of water suitable for irrigation, livestock, and industrial supplies. The major aquifers that exist within the region include the Gulf Coast aquifer, which underlies the entire coastal region of Texas, and the Carrizo-Wilcox aquifer that exists in a broad band that sweeps across the state beginning at the Rio Grande north of Laredo, then continuing northeasterly in an arc south and then east of San Antonio before continuing on to the northeastern corner of Texas and into Louisiana. These aquifers are delineated on the map in Figure 3.18 ("major and minor aquifers" in the Rio Grande Water Planning Region).

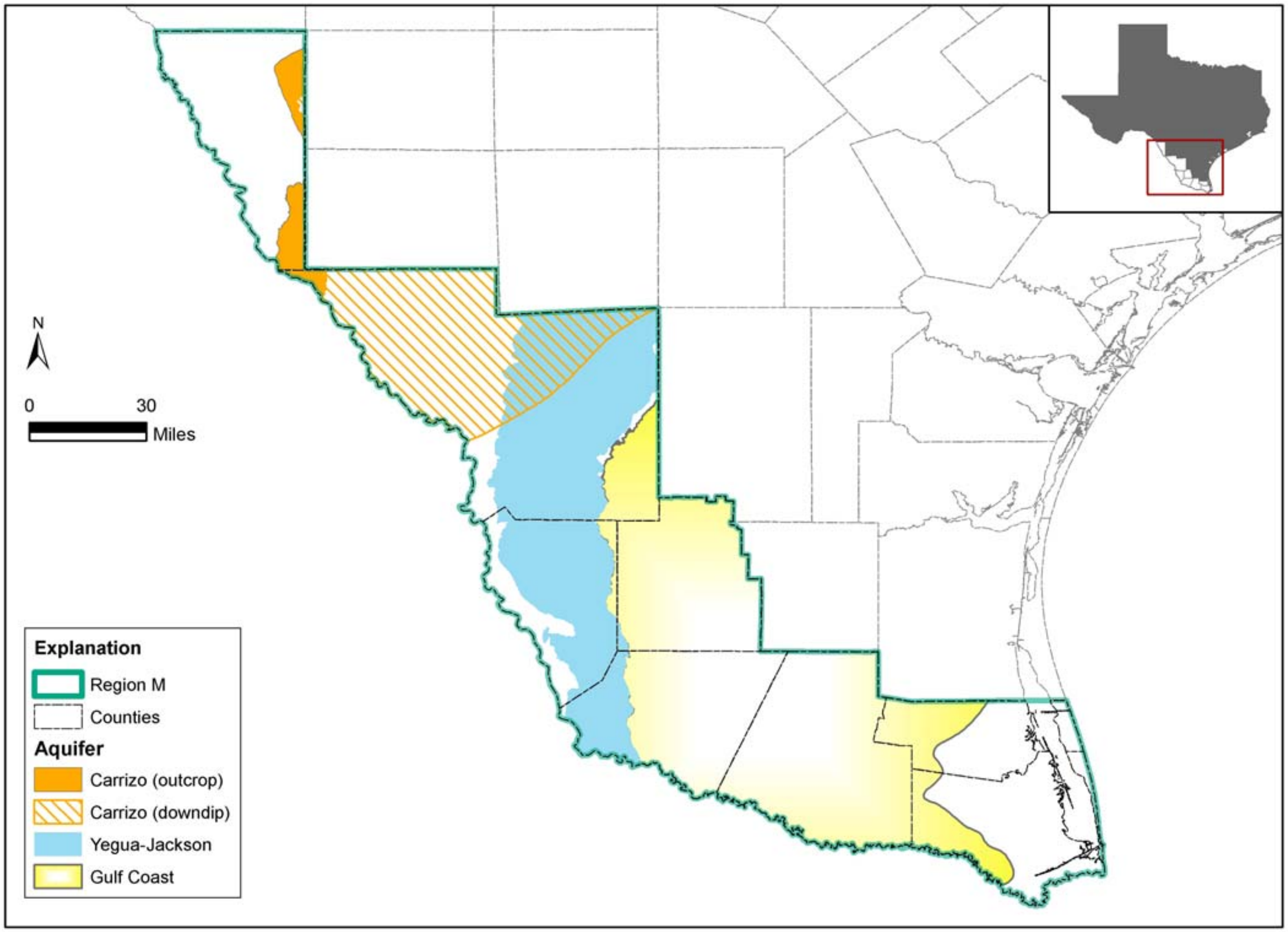
In 2002, the TWDB designated the Yegua-Jackson aquifer as a minor aquifer in the State of Texas. The primary rationale for this designation is that water use from the Yegua-Jackson aquifer ranks in the upper half of annual water use for the minor aquifers, with more than 11,000 acre-feet of water produced in 1997 across the State of Texas. In the RGRWPA, the Yegua-Jackson aquifer extends in a narrow band from the Rio Grande through Starr, Zapata, and Webb counties (Figure 3.18).

Less significant aquifers that exist within the region have not been designated by the TWDB as "minor aquifers," but they provide important water supplies for smaller areas. In the RGRWPA, other aquifers include the Rio Grande Alluvium, which is also called the Rio Grande aquifer, and the Laredo Formation.

The concepts of groundwater availability and aquifer sustainability have been debated significantly in recent years. For groundwater source availability, the TWDB planning guidelines (Exhibit B) require that regional planning groups *"Calculate the largest annual amount of water that can be pumped from a given aquifer without violating the most restrictive physical or regulatory or policy conditions limiting withdrawals, under drought-of-record conditions. Regulatory conditions refer specifically to any limitations on pumping withdrawals imposed by groundwater conservation districts through their rules and permitting programs."* This guideline requires that planning groups make a policy decision as to the interpretation of the term "most restrictive" as it relates to long-term groundwater availability.

TWDB Exhibit B further requires that "Once GAM (Groundwater Availability Model) information is accessible for an area within a region, the Planning Group shall incorporate this information in its next planning cycle unless better site-specific information is developed." The Rio Grande planning group concluded that the two available GAMs are the most appropriate tool for analyzing regional groundwater availability in the Region for the two major aquifers, the Carrizo-Wilcox and Gulf Coast aquifers. A GAM has not been completed for the Yegua-Jackson aquifer. Therefore, the ground-water availability assessment for the Yegua-Jackson and other small aquifers were based on published information,

Figure 3.18 – Major and Minor Aquifers in the Rio Grande Water Planning Region



historical water use data from these aquifers, available well and water level records, and the knowledge base of the consultant team. The planning group determined that it is in the best interest of the Region to maintain an acceptable level of aquifer sustainability during the 50-year planning window as well as for future generations beyond the 50-year planning period. Thus, for the two major aquifers for which GAMs exist, the groundwater availability for the planning period was defined as the amount of groundwater that could be withdrawn from aquifers over the next 50 years that would not cause more than 100 feet of water level decline in the aquifers as compared to water levels in 2000. These criteria were used to guide the development of the ground-water availability assessment and to determine groundwater supply for each aquifer in each county. As noted above, water supply for the Yegua-Jackson and other small aquifers was estimated from other information. The planning group acknowledges that additional water does occur in storage within the aquifers and that a portion of that water (above than the estimated supply) could be pumped if there is not a groundwater conservation district in place to prevent such withdrawals.

The steps involved in determining the water supply by county and aquifer using the Southern Gulf Coast GAM is summarized below. Because the GAM does not "output" a value for groundwater availability or supply, the model was used to determine the impact of different pumping scenarios so that those impacts could be compared to the criteria set by the planning group. Future pumping locations are not known with certainty. Therefore, the total "estimated" supply was distributed equally across each county and implemented into the predictive GAM model (2000-2050). The pumping was assumed to be constant starting in 2001, and was held at the projected level for 50 years. The drawdown across the model area was then assessed to determine if the drawdown criteria were met (i.e., if the average drawdown across the county was less about 100 feet). Depending on the drawdown results, projected supplies were adjusted and another simulation completed. This approach was used until the average drawdown in each county was about 100 feet at the end of the 50-year simulation period. The total county pumping that was necessary to produce the drawdown was then set equal to the supply for the county.

Much of the groundwater in the region is brackish (i.e., above 1000 mg/L of total dissolved solids). In order to be used for municipal supply, the brackish groundwater requires treatment. The portion of groundwater that is brackish has been estimated by looking at the overall water quality in each county on an aquifer-by-aquifer basis. The groundwater quality information is discussed in more detail in the following sections.

3.5.1 Gulf Coast Aquifer

3.5.1.1 Location and Use

The Gulf Coast aquifer exists in an irregular band along the Texas coast from the Texas-Louisiana border to Mexico. Historically the Gulf Coast aquifer has been used to supply varying quantities of water in Cameron, Hidalgo, Jim Hogg, eastern Starr, southeastern Webb, and southern Willacy counties as shown in Figure 3.19 (Approximate Productive Areas of Groundwater in the Lower Rio Grande Valley) as derived from McCoy, 1990[15] and Baker, 1979[16].

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[15] T. Wesley McCoy; Texas Water Development Board; "Evaluation of Ground-Water Resources In The Lower Rio Grande Valley, Texas"; Report 316; January, 1990; Austin Texas.

[16] E. T. Baker, Jr.;Texas Department of Water Resources; "Stratigraphic and Hydrogeologic Framework of Part of the Coastal Plain of Texas"; Report 236; July 1979;Austin, Texas.

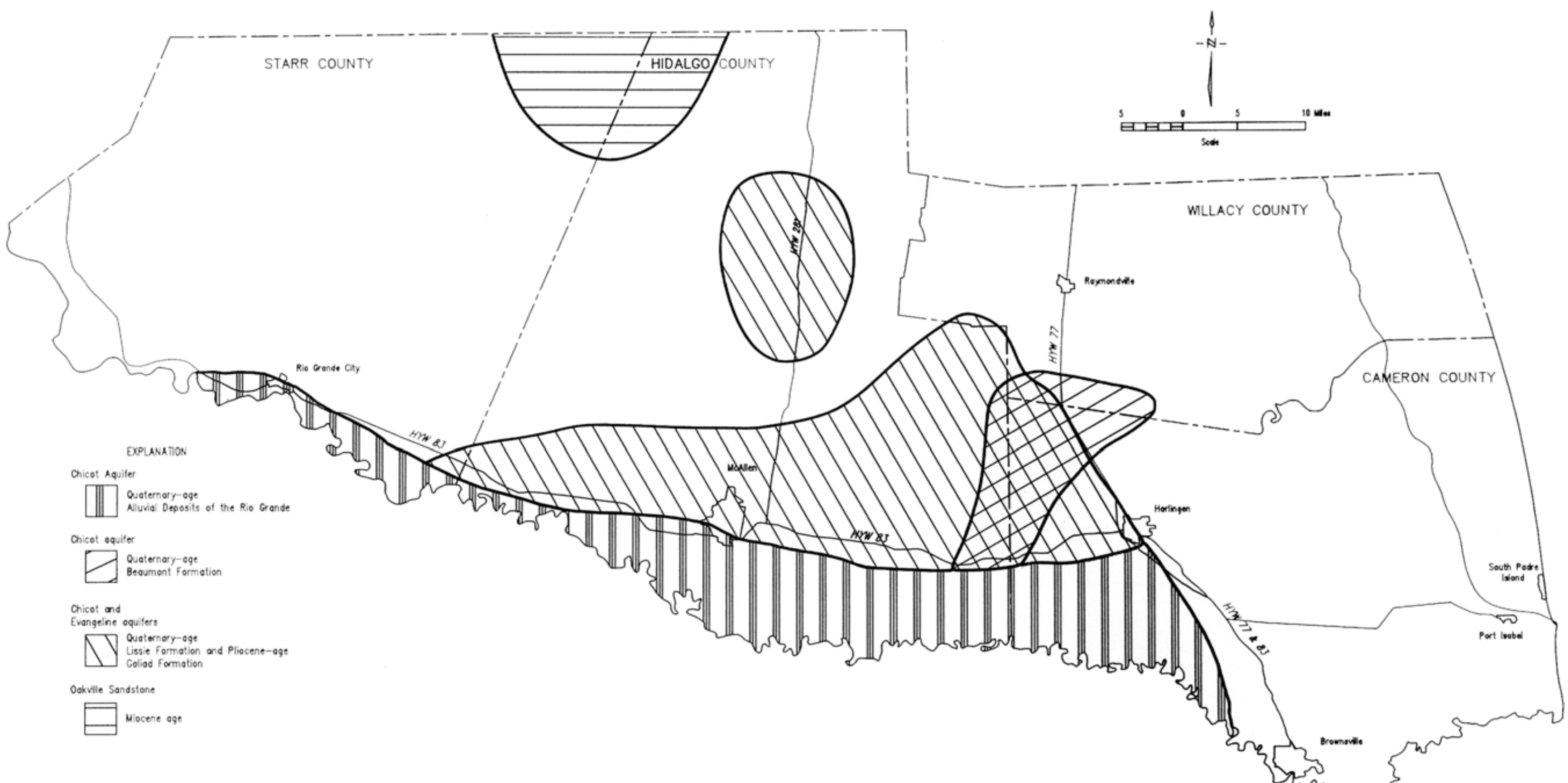


Figure 3.19 – Approximate Productive Areas of Groundwater in the Lower Rio Grande Valley

Total groundwater pumpage was approximately 22,770 acre-feet in 1997. In 1997, municipal pumpage accounted for 11,665 acre-feet, irrigation for 6,550 acre-feet, manufacturing use for 850 acre-feet, electric power generation for 720 acre-feet, mining for 2,410 acre-feet, and livestock use for 575 acre-feet. The greatest total groundwater use in recent years was estimated at 37,990 acre-feet in 1991, primarily driven by irrigation demands of 26,540 acre-feet. The largest volume of groundwater used to meet municipal demands was 11,685 acre-feet in 1996. Because groundwater is usually considered as a secondary source, the higher demand for groundwater has usually coincided with times when there was less surface water available.

3.5.1.2 Hydrogeology

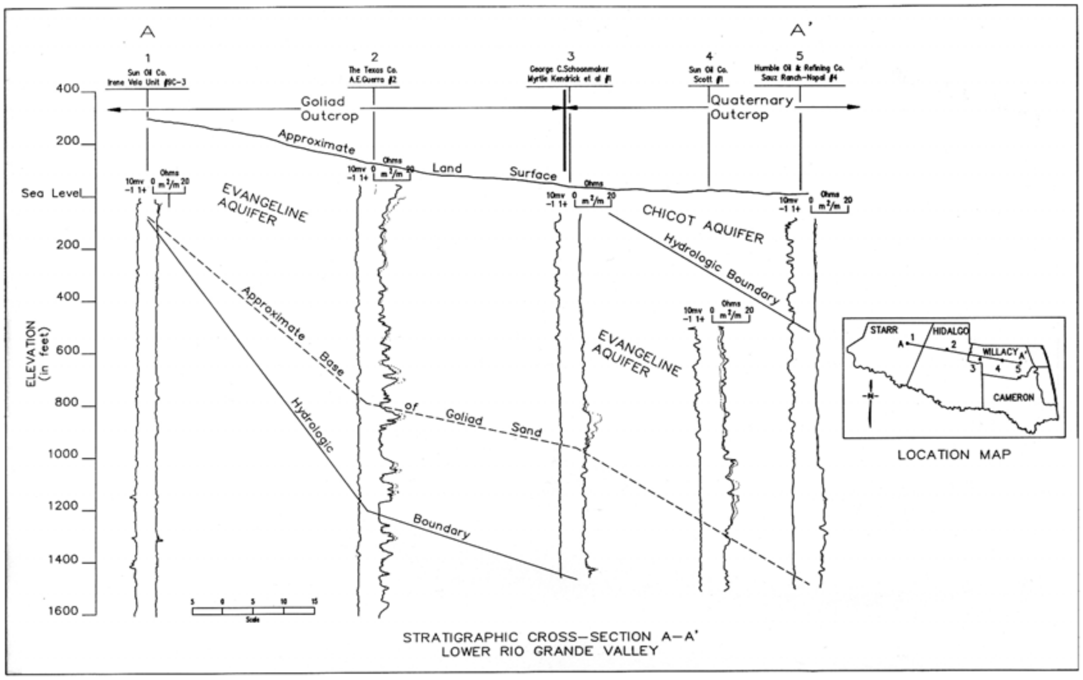
The Gulf Coast aquifer consists of interbedded clays, silts, sands, and gravels, which are hydrologically connected to form a leaky aquifer system. In general, there are four components of this system: the deepest zone is the Catahoulla; above the Catahoulla is the Jasper aquifer located within the Oakeville Sandstone; the Evangeline aquifer contained within the Fleming and Goliad sands is separated from the Jasper by the Burkeville confining layer; and the uppermost aquifer—the Chicot—consists of the Lissie, Willis, Bentley, Montgomery, Beaumont, and overlying alluvial deposits. In the RGRWPA, these overlying alluvial deposits include portions of the Rio Grande alluvium. These zones extend into Zapata and Webb counties, but produce smaller quantities of water in these areas. Figure 3.20 provides a stratigraphic cross-section of the Gulf Coast aquifer system in the Lower Rio Grande Valley.

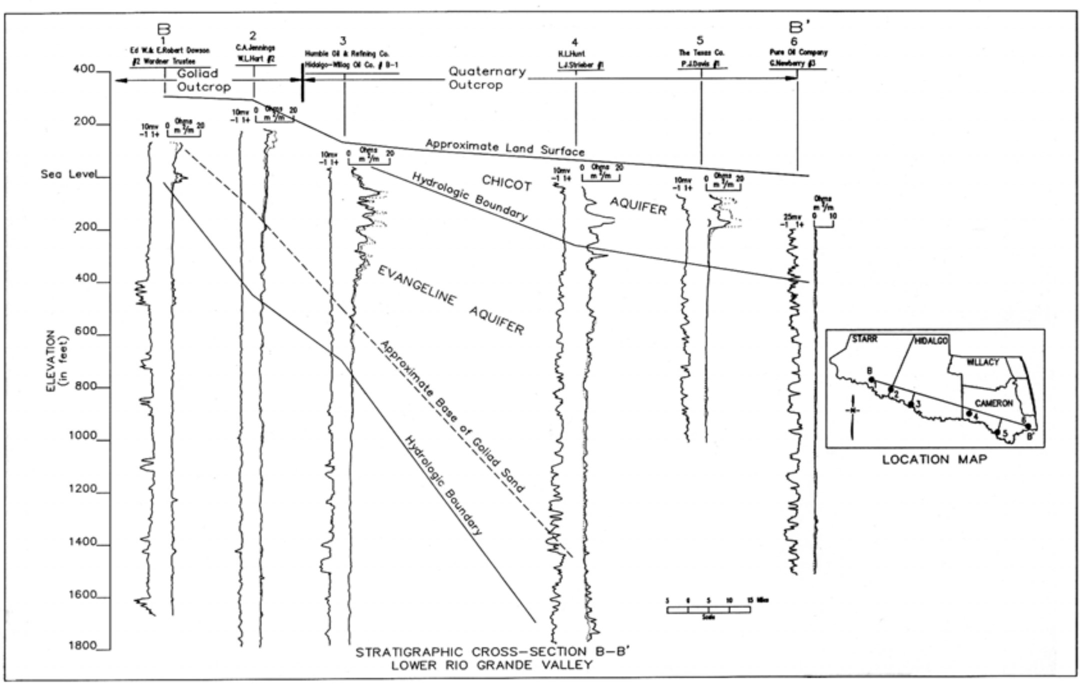
The primary water-producing zone varies from one area of the region to another. The Chicot aquifer is the primary water-producing zone in western Cameron and eastern Hidalgo counties. The Evangeline aquifer produces significant quantities of water in Cameron, Hidalgo, and Willacy counties. The Oakville Sandstone produces significant quantities of water in northeastern Starr County, northwestern Hidalgo County, and a portion of Jim Hogg County. The Catahoula formation produces small to moderate quantities of water in Webb County.

Recharge to the Gulf Coast aquifer occurs primarily through percolation of excess precipitation, which is precipitation that does not run off of the land surface or is not lost through evapotranspiration. This may be supplemented in some areas by the addition of irrigation water from the Rio Grande. In some areas recharge may be limited by shallow subsurface drainage systems designed to control the buildup of salts resulting from continued irrigation operations.

Although there are significant quantities of groundwater available, groundwater has not been heavily used and water levels have remained relatively stable over the years. The Gulf Coast aquifer is basically considered to be full. Well yields can vary significantly. In the Oakville Sandstone, average production is about 120 gallons per minute (gpm), while in the Chicot aquifer the average well yield is about 10 times this rate, or 1,200 gpm. In the Catahoula formation, yields range from 30 to 150 gpm.

Figure 3.20: A Stratigraphic Cross-Section of the Gulf Coast Aquifer System in the LRGV





3.5.1.3 Water Availability

The estimated volumes of groundwater available for development from the Gulf Coast aquifer are provided in Table 3.9. As discussed in Section 3.5.1, these groundwater availability estimates for the Gulf Coast aquifer were based on simulations with the Southern Gulf Coast GAM. It should be noted that boundary conditions representing the hydraulic connection between Gulf of Mexico and the Gulf Coast aquifer in the Southern Gulf Coast GAM might lead to an over-estimation of groundwater availability in Cameron County. Therefore, groundwater availability in Cameron County has been decreased by 30% to account for this limitation, but it is difficult to simulate the true long-term impact of pumping in this county under the current model architecture.

Table 3.9: Projected Groundwater Availability From the Gulf Coast Aquifer for Each County by Decade

	WATER AVAILABLE (acre-feet/year)					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Cameron	104,000	104,000	104,000	104,000	104,000	104,000
Hidalgo	52,500	52,500	52,500	52,500	52,500	52,500,
Jim Hogg	4,880	4,880	4,880	4,880	4,880	4,880
Starr	7,600	7,600	7,600	7,600	7,600	7,600
Webb	3,000	3,000	3,000	3,000	3,000	3,000
Willacy	90,100	90,100	90,100	90,100	90,100	90,100
Zapata	250	250	250	250	250	250

3.5.2 Carrizo-Wilcox Aquifer

3.5.2.1 Location and Use

The Carrizo Sand outcrops in a very small area in northwest Webb County, approximately 60 miles to the north-northwest of Laredo (see Figure 3.18, above). The formation continues north into Dimmit, Zavala, and Maverick counties, roughly parallel in orientation to those formations occurring to the east and south.

The reported total groundwater pumpage was only 806 acre-feet in 1997. In 1997, municipal pumpage accounted for 431 acre-feet, irrigation for 187 acre-feet, mining for 117 acre-feet, and livestock use for 71 acre-feet, while manufacturing and electric power generation did not use measurable quantities of groundwater. The greatest total groundwater use in recent years was estimated at 6,561 acre-feet in 1991, primarily driven by irrigation demands of 5,960 acre-feet, with 3,867 acre-feet applied for irrigation in Maverick County and 2,093 acre-feet applied for irrigation in Webb County. The largest volume of groundwater used to meet municipal demands was 512 acre-feet in 1995. Because groundwater is usually considered as a secondary source, the higher demand for groundwater has usually coincided with times when there was less surface water available.

3.5.2.2 Hydrogeology

The Carrizo Sand is the principal and most prolific aquifer within the northern portion of the RGRWPA. The Carrizo Sand is a coarse to fine grained, massive, loosely cemented, cross-bedded sandstone with some interbedded thinner sandstones and shales. It yields moderate to large quantities of groundwater, but the yield decreases with distance from the outcrop as the formation dips southeastward. Figure 3.21 provides a hydrogeologic section of the Carrizo Sand formation[17] across portions of Maverick, Zavala, Dimmit, LaSalle, and Webb counties. Recharge occurs primarily through exposure of the Carrizo Sand to precipitation at the outcrop and where the outcrop is incised by creeks or streams. A groundwater model has recently been developed for the Carrizo aquifer and further study is underway by the TWDB to fully assess the recharge and potential yield of this aquifer.

3.5.2.3 Water Availability

The projected quantities of water available from the Carrizo aquifer are presented in Table 3.10 below. These estimates are derived by assessing the Southern Carrizo-Wilcox GAM results based on the projected pumping that was incorporated into the predictive simulation covering the time period 2000-2050[18]. The estimated groundwater supply for each county is based on the criteria of not allowing more than 100 feet of additional drawdown from 2000 water levels.

Table 3.10: Projected Groundwater Availability From the Carrizo Aquifer for Each County by Decade

	WATER AVAILABLE (acre-feet/year)					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Maverick	2,050	2,050	2,050	2,050	2,050	2,050
Webb	17,100	17,100	17,100	17,100	17,100	17,100

[17] William Klempt, et. al.; Texas Water Development Board; "Groundwater Resources of the Carrizo Aquifer in the Winter Garden Area of Texas, Volume 1"; Report 210; September 1976; Austin, Texas.

[18] V.A. Kelley, et. al.; Texas Water Development Board; "Groundwater Availability Model for the Queen City and Sparta Aquifers", October 2004; Austin, Texas.

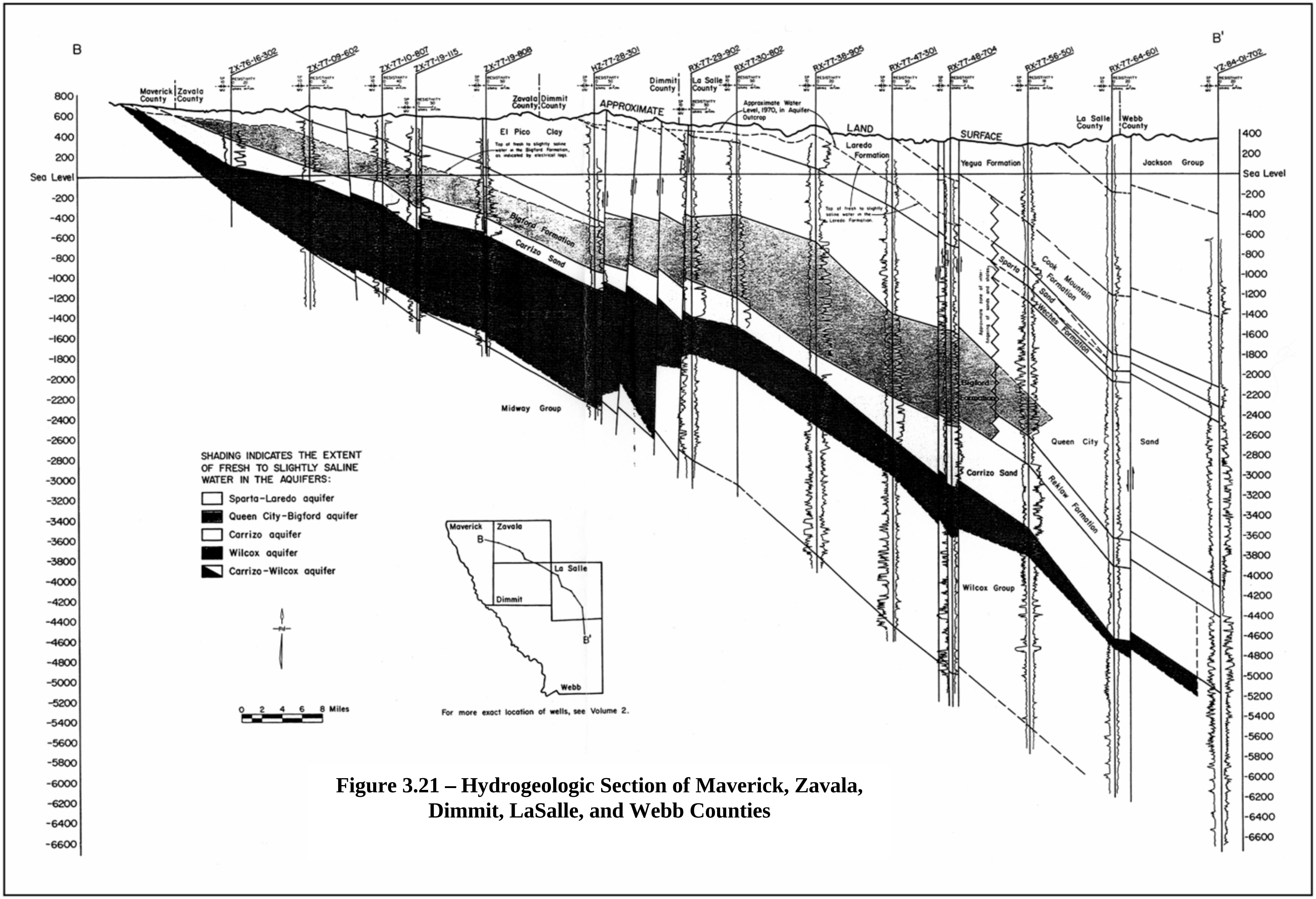


Figure 3.21 – Hydrogeologic Section of Maverick, Zavala, Dimmit, LaSalle, and Webb Counties

3.5.3 Minor and Other Aquifers

Other aquifers included in the RGRWPA that are known to supply groundwater include the Yegua-Jackson aquifer, Rio Grande Alluvium and the Laredo Formation. Although the Rio Grande Alluvium exists in the northern portion of the RGRWPA, most of the production from this formation occurs in the three most southern counties - Cameron, Hidalgo, and Starr. The Laredo Formation is primarily utilized in Webb County.

3.5.3.1 Location and Use

The Yegua-Jackson aquifer extends in a narrow band from the Rio Grande and Mexico across the State to the Sabine River and Louisiana. In the RGRWPA, the Yegua-Jackson aquifer extends in a narrow band from the Rio Grande through Starr, Zapata, and Webb counties (Figure 3-18). The amount and type of use from the Yegua-Jackson aquifer vary across the region.

The Rio Grande Alluvium primarily provides water in Hidalgo and Starr counties within about five miles of the Rio Grande. The quantities of water produced from this formation are probably included in the estimates of pumpage from the Gulf Coast aquifer by the TWDB because it is difficult to separate the surface deposits of the Rio Grande Alluvium from those of the Gulf Coast aquifer. The main differentiating characteristic is that the Rio Grande Alluvium is considered to be more permeable. The Laredo Formation is located in southeastern Webb County and northern Zapata County.

The estimates of past groundwater use from “other aquifers” in the RGRWPA includes four counties: Maverick, Webb, Zapata, and Starr. The aquifers that may be included in these estimates of use are the Rio Grande Alluvium, Laredo Formation, and the Catahoula Formation in Webb County. The total estimated groundwater use for 1997 was 1,172 acre-feet. The estimate of use from the “other aquifers” has been as high as 3,048 acre-feet in 1991, consisting of almost equal volumes of municipal and irrigation use.

3.5.3.2 Hydrogeology

The Yegua-Jackson aquifer consists of complex associations of sand, silt, and clay deposited during the Tertiary Period. Net sand thickness is generally less than 200 feet at any location within the aquifer. Water quality varies greatly within the aquifer, and shallow occurrences of poor-quality water are not uncommon, and this is especially true in the RGRWPA. In general, however, small to moderate amounts of usable quality water can be found within shallow sands (less than 300 feet deep) over much of the Yegua-Jackson aquifer. Although the occurrence, quality, and quantity of water from this aquifer are erratic, domestic and livestock supplies are available from shallow wells over most of its extent. Locally water for municipal, industrial, and irrigation purposes is available. Yields of most wells are small, less than 50 gallons per minute, but in some areas, yields of adequately constructed wells may be as high as 500 gallons per minute.

The Rio Grande Alluvium exists in Hidalgo County as a river alluvium, but transitions in Cameron County to a more deltaic type of deposit. The material composing the alluvium is highly variable from one location to another. The alluvium has generally been divided into three layers: shallow (less than 75 feet), middle (75 to 150 feet), and deep (150 to 225 feet). Yields are generally higher in the deeper zone and closer to the Rio Grande. Recharge is primarily through interaction with the river, with some surface recharge. Water levels have generally been stable. There is currently additional research being done by the TWDB to further identify the thickness and properties of this groundwater source.

The Laredo Formation is composed of a thick, fine- to very fine-grained sandstone and clay. It yields small to moderate quantities of water to wells in Webb County. The Cook Mountain Formation and Sparta Sand are generally equivalent to the Laredo Formation in the northeast portion of Webb County and have similar yields.

3.5.3.3 Water Availability

The TWDB has not tracked water usage in the Yegua-Jackson aquifer because it was designated a minor aquifer in 2002. In addition, there is not a GAM available for the Yegua-Jackson aquifer. Therefore, estimates of groundwater availability for the Yegua-Jackson aquifer (Table 3.11) were based in part on the historical TWDB estimate of groundwater from the "other" aquifers in the region. Historically, the TWDB has arbitrarily set a limit of 10,000 acre-feet per year for "other aquifers" in each county. This may exceed what can actually be produced in many cases, and in some cases may be much less than actual production. It is beneficial to note that the total historical use for all "other aquifers" in all counties has not exceeded 5,000 acre-feet per year. The existing TWDB estimates of water availability have been adopted.

Table 3.11: Projected Groundwater Availability From the Yegua-Jackson Aquifer for Each County by Decade

	WATER AVAILABLE (acre-feet/year)					
County	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Jim Hogg	100	100	100	100	100	100
Starr	2,000	2,000	2,000	2,000	2,000	2,000
Webb	5,000	5,000	5,000	5,000	5,000	5,000
Zapata	2,000	2,000	2,000	2,000	2,000	2,000

3.6 AVAILABLE CURRENT WATER SUPPLIES

The development of estimates of the current water supplies that are available for meeting projected future water demands in the RGRWPA has been accomplished through two separate, but interrelated activities; one for surface water and one for groundwater. Both of these activities have proceeded in generally the same fashion, i.e., they both have examined existing sources of water for the region with regard to the maximum supply available under drought of record conditions, taking into consideration other supply restrictions such as the current capacity of existing groundwater well fields; the hydrogeologic properties of aquifers in the region; the quality of existing water supplies with regard to usability; current water rights, permits and other regulatory restrictions; the hydraulic capacity of existing conveyance infrastructure; current contracts and/or option agreements; and obligations that a water user group (WUG) may have in terms of contracts or direct/indirect water sales to other WUGs. In some instances, one or more of these factors have determined the available water supply for individual water users.

Presented in the following sections are the specific steps and procedures that have been undertaken in arriving at the estimated quantities of surface and ground water that are considered to be available from currently existing sources for meeting future water demands in the RGRWPA.

3.6.1 Surface Water Supply Analysis

The analysis of available surface water supplies for the RGRWPA has focused, of course, on the Rio Grande, primarily on Amistad and Falcon Reservoirs. Other lesser sources of surface water such as tributaries of the Rio Grande in Maverick, Webb, Zapata, and Starr counties; the Arroyo Colorado, which flows through southern Hidalgo County and northern Cameron County to the Laguna Madre; the pilot channels within the floodways that convey local runoff and floodwaters from the Rio Grande through the Lower Rio Grande Valley to the Laguna Madre; and isolated lakes and resacas in Hidalgo and Cameron counties also have been considered in this investigation.

The existing priorities for allocating the United States' share of surface water stored in Amistad and Falcon Reservoirs as set forth in the TCEQ Rio Grande operating rules[19] have provided the primary means for determining how the firm annual yield supply of the reservoir system would be apportioned among the various water user groups in the RGRWPA. In essence, these rules stipulate that during drought periods when water shortages may occur, domestic, municipal, and industrial water uses must be supplied first, followed by irrigation and mining water uses. This is the general allocation procedure that has been used in this study.

Following is a description of the step-by-step procedures and analyses that have been undertaken in determining the quantities of surface water available for meeting future needs in the RGRWPA for specific categories of water use:

Step 1 <u>Municipal/Manufacturing Surface Water Supply – Amistad-Falcon Reservoir System:</u> All of the existing water rights[20] authorizing municipal and/or industrial (manufacturing) uses of water from Amistad and Falcon Reservoirs have been assumed to be fully supplied through the year 2060 by the firm annual yield of the reservoir system. These are the water rights with the highest priority for being allocated water stored in Amistad and Falcon Reservoirs under the TCEQ rules; therefore, they would be entitled first to the United States' share of the firm annual yield of the reservoir system. As indicated in Table 3.5, the total amount of annual diversions that are authorized by existing water rights within the Rio Grande Basin for municipal and/or industrial uses, including water from the Amistad-Falcon system, is approximately 391,000 acre-feet per year. Hence, with the United States' share of the firm annual yield of the Amistad-Falcon system projected to be on the order of 1,000,000 acre-feet per year over the next 50 years (Table 3.8), the supply of water represented by the municipal and industrial (manufacturing) water rights that are dependent upon the reservoir system has been assumed to be fully reliable and available all of the time.

[19] "Chapter 303: Operation of the Rio Grande"; 31 Texas Administrative Code, §§ 303.1-303.73; Texas Water Commission Rules; August 26, 1987; Austin, Texas.

[20] Based on the water rights master file of the TCEQ as of May 17, 2004.

Step 2 Municipal Surface Water Supply – Amistad-Falcon Reservoir System: The supply of water represented by the municipal water rights dependent upon the Amistad-Falcon reservoir system, which totals 336,642 acre-feet per year (Table 3.5), has been distributed to individual WUGs (cities, water districts, water supply corporations, irrigation districts, etc.) based on the actual water rights owned by these entities and/or on agreements between these entities and other water rights owners. In this manner, the entire authorized diversion amounts of all municipal water rights that use water from Amistad and Falcon Reservoirs have been fully allocated for planning purposes.

It is important to recognize that municipal water suppliers in Rio Grande Region that are dependent upon the Amistad-Falcon reservoir system for their water supplies operate under rules and regulations that originate from the 1969 final judgment of the Thirteenth Court of Civil Appeals in the water dispute commonly referred to as the "Rio Grande Valley Water Case." Among other things, this judgment allocated specific amounts of water in the Lower Rio Grande Valley to individual domestic, municipal and industrial (DMI) water users (typically cities) that were in existence at the time and had documented historical water usage, and it assigned these DMI water rights to specific irrigation districts, which had pumping facilities on the river, for the subsequent diversion and delivery of river water to the DMI users. In effect, the irrigation districts were assigned municipal water rights that were specifically designated for certain individual domestic, municipal, and industrial water users.

Today, most of the DMI water users in the Lower Rio Grande Valley continue to obtain their water supplies from the irrigation districts under the original water rights that are owned by the irrigation districts but that have specific assignments to the DMI users. In this regard, the irrigation districts request releases from Falcon Reservoir, pump this water from the Rio Grande into their own distribution systems, and ultimately deliver the water, less losses, to the DMI users. In some cases, there are written contracts between the DMI users and the irrigation districts for water delivery; however, often there are only general agreements between the DMI users and the irrigation districts that water will be delivered pursuant to the requirements of the original water rights that specifically assigned water to the DMI users. When these delivery contracts or agreements expire, they normally are simply extended with revised rates to cover pumping costs. Sometimes when the annual allotment for DMI water as stipulated in a water right is exceeded by an individual DMI water user, the irrigation district will continue to supply DMI water to the DMI user under the district's own water right and then charge the DMI user for this additional water. This one-time delivery of water is referred to as "contract water," but it really has nothing to do with a formal long-term contractual agreement. It simply means that water is being delivered to a DMI user on a short-term contractual basis.

What is most important from a water supply perspective with regard to these water supply arrangements between individual DMI users and irrigation districts in the Lower Rio Grande Valley is the total amount of DMI water that is available under the existing water rights, not whether or not there is a formal contract in place to guarantee the delivery of the water. The DMI water users are guaranteed the water because of the water rights themselves, and it is these water rights that determine the extent of the overall DMI supply. Since DMI water was assigned the highest priority relative to other types of uses; e.g., irrigation and mining, as a result of the Rio Grande Valley Water Case, the DMI water supply is guaranteed, as noted above, by the firm yield of the Amistad-Falcon reservoir system.

For these reasons, the currently available DMI water supplies for individual WUGs have been determined based primarily on allotments specified in existing water rights. It is these allotments that are of most importance to the WUGs with respect to their future water supplies, not the terms of any contract or other agreement. It is only when the projected municipal water usage by a WUG approaches the annual allotment for DMI water that is specified in the WUG's existing water rights that the WUG should be concerned with obtaining an additional water supply. Otherwise, its water supply will be provided in accordance with existing water rights. This is the procedure that has been applied herein, and it is considered to be the most appropriate for projecting currently available municipal water supplies.

It should be recognized, however, that there are some municipal water users that do have their own water rights, which they have acquired (usually purchased) from the irrigation districts. As with all municipal water rights, the projected water supplies associated with these municipal user-owned water rights have been set equal to their authorized annual diversion amounts since, because of their priority, they are fully protected by the firm yield of the Amistad-Falcon reservoir system. There also are some municipal water users that have specific contracts for DMI water from the irrigation districts under the districts' water rights (exclusive of the original allotments from the Rio Grande Valley Water Case). For these municipal water users with identifiable and known contracts, the projected water supplies that have been considered to be available for future use have been those specified in the contracts, with the term of the existing contracts taken into account.

The specific amounts of available current municipal water supplies that have been projected for the individual WUGs within the RGRWPA have been assigned to the respective WUGs. The balance of the available current municipal water supplies from Amistad and Falcon Reservoirs based on existing DMI water rights has been assigned to the municipal use category referred to by the TWDB as "County-Other."

Step 3 Municipal Surface Water Supply – Amistad-Falcon Reservoir System: To verify the accuracy of the available current water supplies as derived above, questionnaires were sent to specific municipal WUGs[21] summarizing their water supply sources and available amounts and requesting any additional information considered necessary to refine or update the water supply data. Follow-up meetings and telephone calls with each of the WUGs verified the water supply information. This revised information then was incorporated into the estimates of available current water supplies as appropriate.

Step 4 Municipal Surface Water Supply – Amistad-Falcon Reservoir System: To verify the accuracy of information regarding water supply agreements between specific water users and specific water suppliers as developed in Step 2 above, questionnaires also were sent to all irrigation districts believed to supply surface water from the Rio Grande to individual cities in the Lower Rio Grande Valley. Additionally, the irrigation districts were contacted directly to clarify water supply data and information. This revised information also was incorporated into the estimates of available current water supplies as appropriate.

[21] The same specifically named cities within the RGRWPA for which projected water demand information is available from the Texas Water Development Board.

Step 5 Municipal Surface Water Supply – Nueces-Rio Grande Resacas: As described in Section 3.6.4 above, the surface water supplies associated with water rights that authorize diversions from certain resacas in Cameron County have been assumed to be available for localized municipal use. Hence, a total of 225 acre-feet of water per year have been included in the "Municipal" water use category for Cameron County.

Step 6 Manufacturing Surface Water Supply – Amistad-Falcon Reservoir System: As with the available current supplies of water from the Amistad-Falcon system for municipal use, the available supplies for the "Manufacturing" (industrial) water use category also have been established based on the fully authorized diversion amounts of the existing Amistad-Falcon water rights that are designated for industrial purposes. As indicated in Table 3.5, the total amount of annual diversions within the Rio Grande Basin that are authorized by existing water rights for industrial uses is 18,849 acre-feet per year. Since industrial water rights include water that is used for steam electric power generation, a portion of the total authorized diversion amount for industrial use has been transferred to the "Steam Electric" water use category in accordance with existing water rights ownership and supply agreements. The water rights holders and the amounts of diversions transferred are summarized below by county:

Cameron County		
Central Power & Light	2,400	acre-feet/year
Hidalgo County		
AEP Electric	2,475	acre-feet/year
Webb County		
AEP Electric	1,645	acre-feet/year
Total Steam Electric Transfers	6,520	acre-feet/year

With these transfers, the total available supply for the "Manufacturing" water use category based on existing Amistad-Falcon water rights (industrial) is reduced to 6,539 acre-feet per year. These total amounts of available supply have been distributed by county.

Step 7 Manufacturing Surface Water Supply – Reuse: In addition to the firm supplies available for manufacturing uses from the Amistad-Falcon system as described in Step 6 above, there also is projected to be a certain amount of water available for manufacturing through reuse of treated wastewater effluent. The City of Harlingen previously provided Fruit of the Loom with up to 2,240 ac-ft/yr of reuse water. However, that plant has closed and the reuse program is no longer active. The City still has a valid water right for that amount, so for planning purposes, this amount has been assumed as the available current supply of reuse water for the "Manufacturing" water use category within the RGRWPA.

Step 8 Steam Electric Surface Water Supply – Amistad-Falcon Reservoir System: As noted in Step 6 above, 6,520 acre-feet of water per year from the Amistad-Falcon Reservoir system are available for use for steam electric generation purposes as a result of the supply transfers from the "Manufacturing" water use category. In addition, there are other sources of Amistad-Falcon water that are currently used for steam electric generation through agreements with individual water rights holders. In Hidalgo County, the Hidalgo County Irrigation District No. 6 supplies

3,466 acre-feet of "Municipal" water per year to Frontera Generation for steam electric generation purposes. Considering both water rights and agreements, the available current water supply for steam electric generation in the RGRWPA totals 9,986 acre-feet per year, and this amount is distributed among the individual counties in accordance with the locations where it is used.

Step 9 Steam Electric Surface Water Supply - Reuse: Reuse of treated municipal wastewater effluent also provides an additional source of water for steam electric generation. Currently, the City of McAllen has agreements to supply 4.5 million gallons of wastewater effluent per day (5,040 acre-feet/year) to the Calpine Power Plant. Hence, for planning purposes, the total water supply currently available through reuse of treated municipal wastewater effluent within the RGRWPA has been assumed to be 5,040 acre-feet per year, and this amount has been assigned to Hidalgo County.

Step 10 Irrigation and Mining Surface Water Supply – Amistad-Falcon Reservoir System: As noted in Table 3.5, the existing water rights in the Rio Grande Basin authorize the use of water from Amistad and Falcon Reservoirs for irrigation and mining purposes up to approximately 1.8 million acre-feet per year. This amount of usage far exceeds the projected firm annual yields of the reservoir system as indicated by the yield amounts presented in Table 3.8. Hence, the reservoir system is over-appropriated with regard to the total diversion amount authorized in existing water rights for irrigation and mining uses. In accordance with the water allocation priorities set forth in TCEQ's Rio Grande operating rules, water stored in Amistad and Falcon Reservoirs is available for irrigation and mining uses only after the demands for domestic, municipal, and industrial uses (including manufacturing and steam electric uses) have been supplied (to the extent authorized by existing water rights) and after the DMI pool and the operating reserve in the reservoirs have been fully restored. In effect, for purposes of water supply planning in accordance with TWDB guidelines, this means that the available water supply from Amistad and Falcon Reservoirs for irrigation and mining uses is represented by the balance of the firm annual yield of the reservoir system after the domestic, municipal, and industrial (including manufacturing and steam electric) water demands have been satisfied and after the DMI pool and the operating reserve in the reservoirs have been fully restored.

Therefore, in this study, the available water supply from Amistad and Falcon Reservoirs for irrigation and mining uses has been determined by operating the Rio Grande WAM in a manner that apportions the remaining firm annual yield of the reservoir system to irrigation and mining uses after first allowing for the expected municipal, manufacturing, and steam electric surface water supplies. For these analyses, which have been performed for each of the future decades through the year 2060, the municipal, manufacturing, and steam electric water supplies that are expected to be available from Amistad and Falcon Reservoirs have been specified in the WAM as the total authorized diversions for municipal, manufacturing and steam electric uses as stipulated in existing water rights. These supplies have been assigned the highest demand priority in accordance with the TCEQ rules included in the WAM. With these municipal, manufacturing, and steam electric demands specified in the WAM, and with the demands for all other non Amistad-Falcon water rights in the Rio Grande Basin set at their authorized amounts, the WAM has been operated to determine the remaining yield of the reservoirs that would be available for irrigation and mining uses under the projected reservoir sedimentation conditions for each decade. These remaining yield amounts for each decade represent the current water supplies available from Amistad and Falcon Reservoirs for irrigation and mining uses, and they have been apportioned among the counties of the RGRWPA based on the proportional authorized diversion amounts in each county as summarized in Table 3.5. The resulting available current water supplies for irrigation and mining uses in each county within the RGRWPA are listed in Table 3.12 for each decade through the year 2060. As shown, the available supplies of Amistad-Falcon firm yield for irrigation and mining uses vary from approximately 702,000 acre-feet in 2010 down to about 670,000 acre-feet in the year 2060.

It is generally accepted that a large part of the future demands for municipal, manufacturing, and steam electric uses in the RGRWPA will be supplied through the conversion of irrigation and mining water rights that utilize water from Amistad and Falcon Reservoirs. As urbanization continues to encroach into agricultural areas and as the overall agricultural economy is potentially diminished, the available supplies of irrigation and mining water indicated in Table 3.12 are likely to be reduced as demands for municipal, manufacturing, and steam electric water increase and begin to be satisfied with converted irrigation and mining water rights from the Amistad-Falcon reservoir system.

To provide some indication of how such conversions might affect the available supply of Amistad-Falcon water for irrigation and mining in the future, another set of firm yield analyses has been performed with the WAM. Keep in mind that water rights are converted from irrigation use to municipal use on a 2:1 ratio. For these simulations, the projected future demands for municipal, manufacturing, and steam electric uses were assumed to be entirely met through the conversion of irrigation and mining water rights, and the diversion amounts for these uses as specified in the WAM were set equal to their projected demands as set forth in Chapter 2 without any regard for the authorized diversion amounts for these uses specified in existing Amistad-Falcon water rights. The results from these WAM firm yield analyses are compared to the previous yield results on the graph in Figure 3.22 for each of the future decades through 2060. As expected, the available supplies of irrigation water from the Amistad-Falcon reservoir system are substantially reduced over the next 50 years because of the increased demands for municipal, manufacturing, and steam electric uses, which are assumed to be satisfied through the conversion of the existing irrigation and mining water rights. The 2060 available supply of irrigation water from the reservoirs is approximately 380,000 acre-feet, whereas without the

Table 3.12 Projected Firm Annual Yield Amounts for Irrigation and Mining Uses from the Amistad-Falcon Reservoir System After Satisfying Future Reservoir-Dependent Municipal, Manufacturing, and Steam Electric Demands Limited to Existing Authorized Diversions

AVAILABLE RESERVOIR YIELDS FOR IRRIGATION USES

County	2000	2010	2020	2030	2040	2050	2060
Cameron	224,303	222,560	220,342	218,283	216,223	214,165	212,263
Hidalgo	363,260	360,437	356,846	353,510	350,176	346,841	343,762
Jim Hogg	0	0	0	0	0	0	0
Maverick	54,173	53,755	53,219	52,722	52,224	51,727	51,268
Starr	15,896	15,772	15,616	15,470	15,324	15,178	15,043
Webb	10,603	10,520	10,415	10,318	10,221	10,123	10,034
Willacy	34,525	34,257	33,915	33,598	33,281	32,964	32,672
Zapata	3,991	3,960	3,920	3,884	3,847	3,810	3,776
TOTAL	706,751	701,261	694,273	687,785	681,296	674,808	668,818

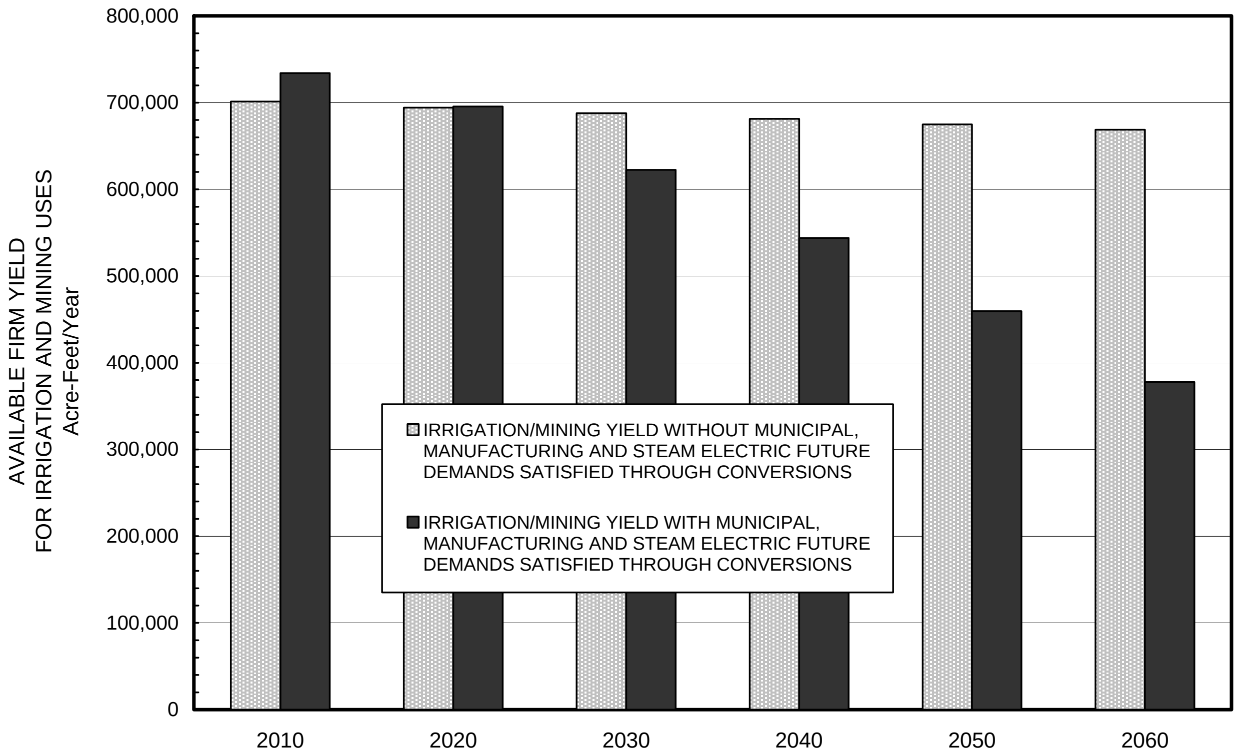
AVAILABLE RESERVOIR YIELDS FOR MINING USES

County	2000	2010	2020	2030	2040	2050	2060
Cameron	4	4	4	4	4	4	4
Hidalgo	207	205	204	202	200	197	196
Jim Hogg	0	0	0	0	0	0	0
Maverick	35	35	35	34	34	34	33
Starr	21	20	20	20	20	20	19
Webb	651	647	640	634	628	622	616
Willacy	0	0	0	0	0	0	0
Zapata	135	134	132	131	130	129	127
TOTAL	1,053	1,045	1,035	1,025	1,016	1,006	995

AVAILABLE RESERVOIR YIELDS FOR IRRIGATION AND MINING USES

County	2000	2010	2020	2030	2040	2050	2060
All Counties	707,805	702,306	695,308	688,810	682,312	675,814	669,815

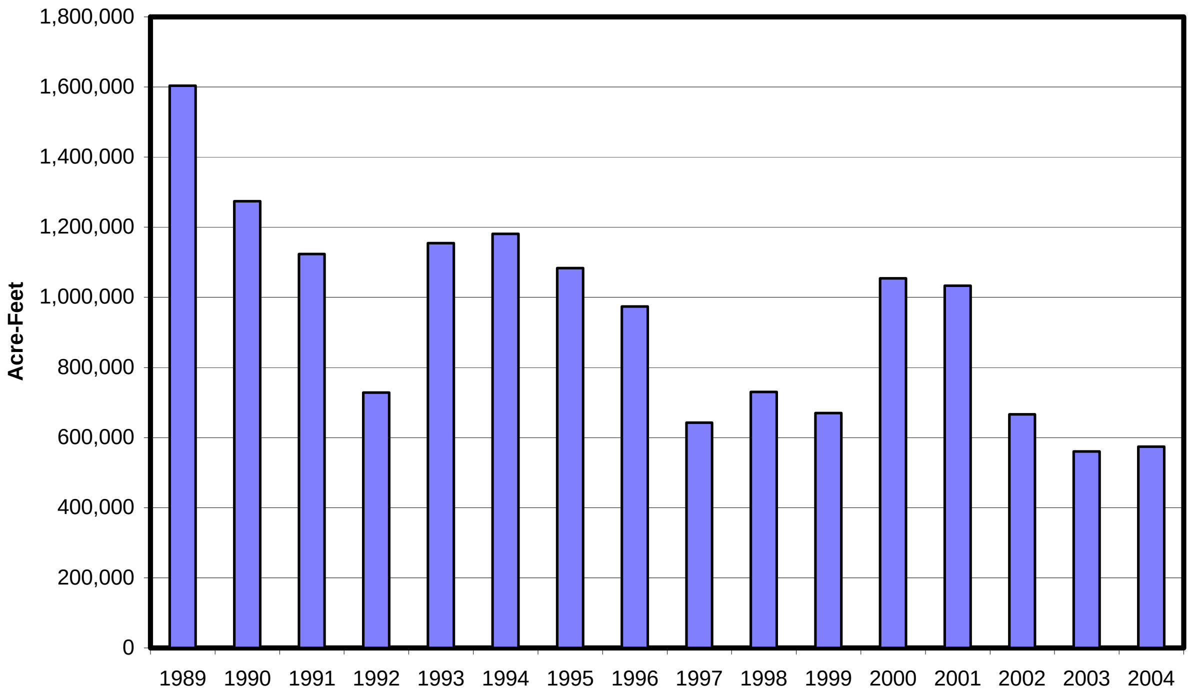
Figure 3.22 Amistad-Falcon Irrigation and Mining Yields Without and With Future Municipal, Manufacturing, and Steam Electric Water Demands Satisfied Through Conversions of Irrigation and Mining Water Rights



conversion of the existing irrigation and mining rights to satisfy the projected future municipal, manufacturing, and steam electric demands, the available supply of irrigation water from the reservoirs is estimated to be approximately 670,000 acre-feet.

It should be noted that both of the sets of results presented in Figure 3.22 reflect the amount of irrigation and mining water available during critical drought conditions. This is consistent with the conditions under which the projected demands have been developed for this plan. However, actual irrigation demands are highly variable and depend largely on meteorological and hydrologic conditions and the availability of irrigation water stored in the Amistad-Falcon reservoir system. If substantial water is available in storage at the beginning of a planting cycle, then more crops are grown that season or year with the prior knowledge that sufficient water will be available for irrigation should it be needed. Actual annual quantities of irrigation and mining water used from Amistad and Falcon Reservoirs in the lower and middle Rio Grande during the 1989-2004 period are shown in Figure 3.23. Irrigation water use represents more than 99.9% of the water used for these two purposes. As shown, the total water used varies substantially from year to year. The use generally is highest during years when adequate supplies were available. An exception is the year 1992, which was an extremely wet year with the Amistad-Falcon reservoir system completely full much of the time, but with very small demands for irrigation water because of more than adequate rainfall. In general, the lowest annual usage amounts correspond to years when the available storage in the Amistad-Falcon system and the irrigation

Figure 3.23 Total Historical Irrigation and Mining Water Use From Amistad and Falcon Reservoirs



Source: Rio Grande Watermaster

account balances were very low. This graph demonstrates that a single annual demand quantity for irrigation use in the middle and lower Rio Grande basins may not necessarily be representative of actual operations, even under drought conditions.

Step 11 Irrigation and Mining Surface Water Supply – Rio Grande Tributaries: As described in Section 3.2.2 above, the surface water supplies that are available for irrigation and mining uses under existing water rights on some of the tributaries of the Rio Grande are not continuous and are dependent upon local runoff conditions. These are prior appropriation water rights and are not dependent on Amistad-Falcon water. Supplies available for these water rights have been determined using the WAM during critical drought conditions in accordance with the water rights' established priority dates.

Step 12 Irrigation Surface Water Supply – Reuse: In addition to the supplies available for irrigation from the Amistad-Falcon system and from certain Rio Grande tributaries, there also is surface water available for irrigation through reuse of treated wastewater effluent. Most of this water is currently used for irrigating golf courses in the region. Based on information from the TWDB[22] and from direct contacts with individual entities, it is estimated that 5,557 acre-feet per year of treated wastewater are being supplied within the RGRWPA for irrigation purposes. Specific

[22] Texas Water Development Board Web Site; "Municipal Wastewater Reuse in Texas"; Austin, Texas.

users of this reuse water and the annual amounts used are listed below by county. For planning purposes, 5,557 acre-feet of reuse water per year have been assumed to be available for irrigation purposes within the RGRWPA, and this amount has been distributed to the individual counties in accordance with the indicated usage.

Cameron County		
Harlingen Treasure Hills Golf Course	246	acre-feet/year
Valley MUD#2 Rancho Viejo G. C.	239	acre-feet/year
Hidalgo County		
Mission Golf Course	2	acre-feet/year
N. Alamo San Carlos Grass Irrig.	80	acre-feet/year
Weslaco Golf Course	600	acre-feet/year
Pharr Golf Course	1,120	acre-feet/year
McAllen Palmview Golf Course	2,240	acre-feet/year
Webb County		
Laredo Golf Courses	1,120	acre-feet/year
Total Amount of Irrigation Reuse	5,647	acre-feet/year

Step 13 Livestock Surface Water Supply – Other Local Supply: Projected demands for livestock watering have been made for the RGRWPA, and these are described in Chapter 2. While water supplies for domestic and livestock demands sometimes are provided under existing water rights that are designated for municipal or irrigation uses, these types of demands typically are supplied using groundwater or surface water from local unpermitted sources such as small streams and stock ponds. In this study, it has been determined that the projected livestock water demands are met by existing groundwater supplies and no transfers of water from other sources has been made.

3.6.2 Groundwater Supply Analysis

The analysis of groundwater supplies available to users throughout the RGRWPA has been based on information from a variety of sources. The general steps used in developing the groundwater supply quantities are described below.

Step 1 A list of water user groups (WUGs) for the RGRWPA was compiled based on information listed in water supply allocation tables provided by the TWDB. The allocation tables indicate which water supplies are available to a user and how much of each supply is potentially to be allocated to that user. The amount of water that is available to each user is either listed as a limited quantity (acre-feet/year) or as a percentage value of the total supply.

Step 2 As indicated above, each WUG was assigned to a water supply. A groundwater supply has been defined as that portion of an aquifer within each basin of each county. Therefore, the total water available from an aquifer within the area of the RGRWPA has been divided among the counties of the region crossed by that aquifer and split between the basins within that portion of each county. Some water users, particularly municipalities, draw water from wells located in more than one basin of a county. These wells, however, may or may not tap separate aquifers. A separate entry has been included for each groundwater supply allocated to a user.

Step 3 Each WUG has been allocated a volume of water (acre-feet/year). This amount was calculated based on the water available and the allocation tables from the TWDB. Where the allocation tables indicated a limit value, that volume was entered. The allocation limit may be based on the user's pumping capacity during a drought, on an established legal limit, or on other information obtained from the individual user. Individual users were contacted by telephone to obtain additional information regarding system, pumping, and/or well limitations. Where the allocation tables indicated that a user was allocated a percentage of the available supply, that percent value was multiplied times the total available supply.

Step 4 After allocation values were established for each user listed, the total amount allocated from each groundwater supply was totaled and compared with actual groundwater availability. Cases of over allocations were resolved by reducing the allocation percentages (some supplies were distributed among several users with each allocated 100 percent of the available supply) and the allocation limits. The highest priority was given to municipalities and users listed as "County-Other." Other information such as a user's pumping capacity during drought (for municipalities) and whether a user also had surface water supplies available were taken into consideration. Where necessary to further resolve over-allocations, the tables of user demand information from the TWDB and from Chapter 2 of this report were also considered.

3.6.3 Summary of Water Supply Results

Table 3.13 provides a summary of the total amounts of available current water supplies for the entire RGRWPA by water use category and by source of supply for each decade through the year 2060. This table is a regional summary of the county data. A breakdown by county and basin is in Exhibit C.

As shown at the bottom of Table 3.13, the total available current water supply for the RGRWPA ranges from approximately 1,101,000 acre-feet in the year 2010 down to about 1,075,000 acre-feet in the year 2060. This reduction in the total water supply for the region is caused, of course, primarily by the decrease in the firm annual yield of the Amistad-Falcon reservoir system during this period as sedimentation in the reservoirs reduces their available conservation storage capacity. Some of the reduction also is due to gradually declining groundwater supplies. In accordance with the priorities for allocating water within the Rio Grande Basin as stipulated in the TCEQ's Rio Grande operating rules, the projected reduction in the water supply for the region is translated directly to irrigation and mining uses. Hence, the projected water supplies for these uses exhibit declines similar to those for the region. The projected water supplies for municipal, manufacturing and steam electric uses generally remain fairly level over the next 50 years as these supplies are provided for, to a large extent, from the firm annual yield of the Amistad-Falcon system.

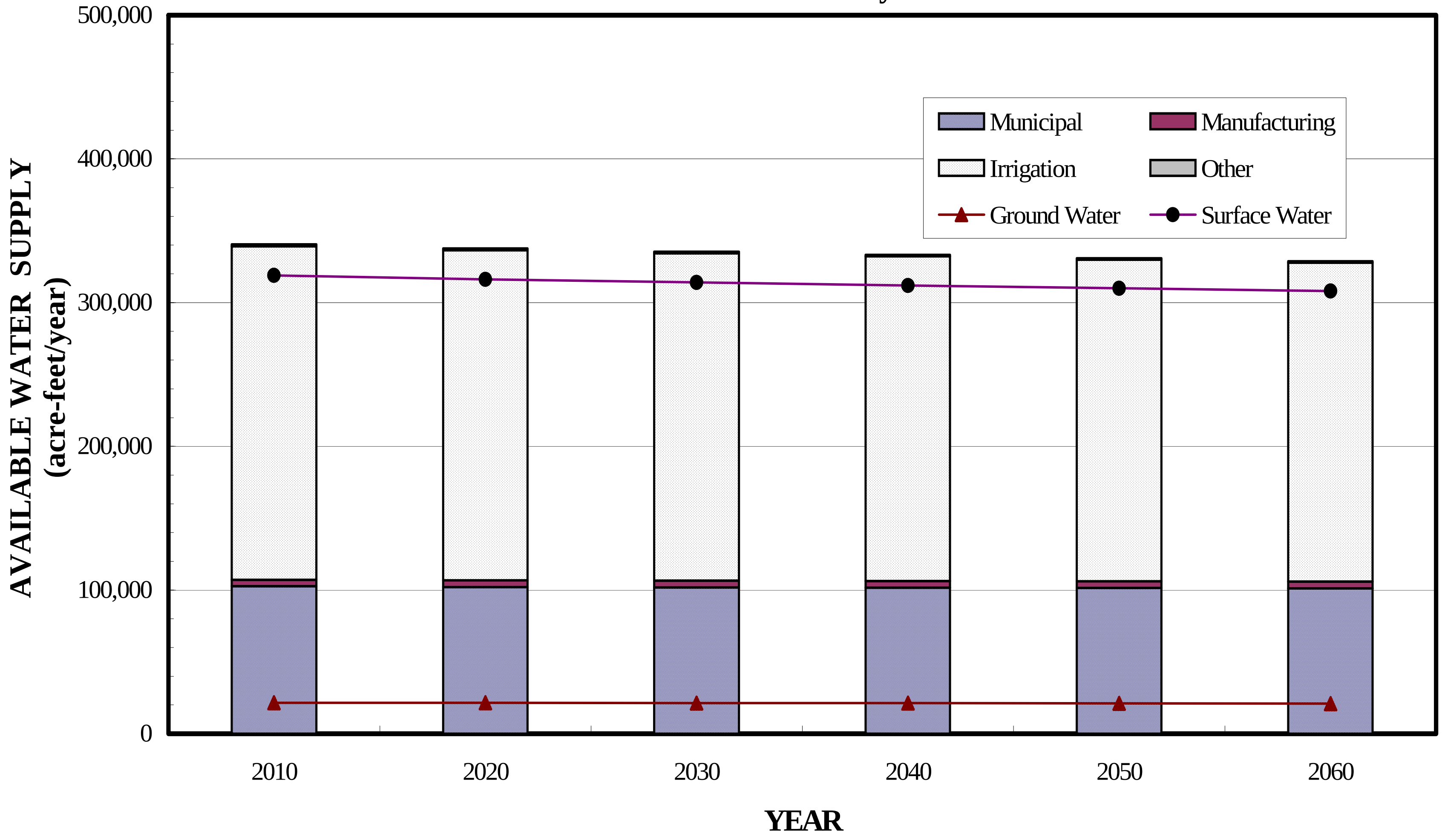
An indication of the water supplies available to each of the counties within the RGRWPA over the next 50 years by decade is provided by the bar charts in Figures 3.24 through 3.31. These charts have been developed from the water supply data developed through the stepped processes described above for surface water and groundwater. On each of these charts, the quantities of supplies available by type of use are shown. Also shown are the portions of the total supplies for each county that are projected to be from surface water and from groundwater.

Table 3.13 - Summary of Total Amounts of Currently Available Water Supplies for the RGWPR by Water Use Category and by Source of Supply

Water Use Category / Source of Supply	2000	2010	2020	2030	2040	2050	2060
MUNICIPAL							
Water User Groups							
Surface Water - Amistad/Falcon System	293,047	295,839	295,598	295,903	296,077	295,852	295,739
Surface Water - Other Local Supply	0	0	0	0	0	0	0
Surface Water - Rio Grande Tributaries	0	0	0	0	0	0	0
Surface Water - Reuse	0	0	0	0	0	0	0
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	12,956	22,783	22,549	22,306	22,043	21,751	21,461
Ground Water - Carrizo-Wilcox	1,190	1,190	1,191	1,192	1,192	1,193	1,194
Ground Water - Other Aquifer	2,157	2,157	2,157	2,157	2,157	2,157	2,157
MUNICIPAL - TOTAL	**309,350**	**321,969**	**321,495**	**321,559**	**321,470**	**320,953**	**320,551**
MANUFACTURING							
Surface Water - Amistad/Falcon System	3,373	3,373	3,373	3,373	3,373	3,373	3,373
Surface Water - Other Local Supply	0	0	0	0	0	0	0
Surface Water - Rio Grande Tributaries	0	0	0	0	0	0	0
Surface Water - Reuse	2,240	2,240	2,240	2,240	2,240	2,240	2,240
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	908	908	908	908	908	908	908
Ground Water - Carrizo-Wilcox	0	0	0	0	0	0	0
Ground Water - Other Aquifer	28	28	31	34	37	39	42
MANUFACTURING - TOTAL	**6,549**	**6,549**	**6,552**	**6,555**	**6,558**	**6,560**	**6,563**
STEAM ELECTRIC							
Surface Water - Amistad/Falcon System	9,986	9,986	9,986	9,986	9,986	9,986	9,986
Surface Water - Other Local Supply	0	0	0	0	0	0	0
Surface Water - Rio Grande Tributaries	0	0	0	0	0	0	0
Surface Water - Reuse	5,040	5,040	5,040	5,040	5,040	5,040	5,040
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	1,190	1,190	1,190	1,190	1,190	1,190	1,190
Ground Water - Other Aquifer	0	0	0	0	0	0	0
Ground Water - Carrizo-Wilcox	0	0	0	0	0	0	0
STEAM ELECTRIC - TOTAL	**16,216**	**16,216**	**16,216**	**16,216**	**16,216**	**16,216**	**16,216**

Table 3.13	**- Summary of Total Amounts of Currently Available Water Supplies for the RGWPR by Water Use Category and by Source of Supply, cont'd.**						
Water Use Category / Source of Supply	2000	2010	2020	2030	2040	2050	2050
MINING							
Surface Water - Amistad/Falcon System	1,054	1,046	1,036	1,026	1,017	1,008	996
Surface Water - Other Local Supply	0	0	0	0	0	0	0
Surface Water - Rio Grande Tributaries	0	0	0	0	0	0	0
Surface Water - Reuse	0	0	0	0	0	0	0
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	2,971	2,971	3,123	3,211	3,297	3,382	3,460
Ground Water - Carrizo-Wilcox	598	598	595	596	597	598	597
Ground Water - Other Aquifer	327	327	332	335	338	341	344
MINING - TOTAL	**4,949**	**4,941**	**5,087**	**5,168**	**5,248**	**5,329**	**5,398**
IRRIGATION							
Surface Water - Amistad/Falcon System	706,752	701,262	694,273	687,785	681,297	674,807	668,818
Surface Water - Irrigation Local Supply	3,588	3,588	3,588	3,588	3,588	3,588	3,588
Surface Water - Rio Grande Tributaries	510	510	510	510	510	510	510
Surface Water - Reuse	5,647	5,647	5,647	5,647	5,647	5,648	5,648
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	29,127	29,127	29,127	29,127	29,127	29,127	29,127
Ground Water - Carrizo-Wilcox	2,542	2,542	2,542	2,542	2,542	2,542	2,542
Ground Water - Other Aquifer	10,319	10,319	10,319	10,319	10,319	10,319	10,319
IRRIGATION - TOTAL	**758,485**	**752,995**	**746,006**	**739,518**	**733,030**	**726,541**	**720,552**
LIVESTOCK							
Surface Water - Amistad/Falcon System	0	0	0	0	0	0	0
Surface Water - Livestock Local Supply	0	0	0	0	0	0	0
Surface Water - Rio Grande Tributaries	0	0	0	0	0	0	0
Surface Water - Reuse	0	0	0	0	0	0	0
Surface Water - Nueces/Rio Grande Resacas	0	0	0	0	0	0	0
Ground Water - Gulf Coast	3,817	3,817	3,817	3,817	3,817	3,817	3,817
Ground Water - Carrizo-Wilcox	1,019	1,019	1,019	1,019	1,019	1,019	1,019
Ground Water - Other Aquifer	980	980	980	981	981	980	980
LIVESTOCK - TOTAL	**5,816**	**5,816**	**5,816**	**5,817**	**5,817**	**5,816**	**5,816**
REGION M - TOTAL	**1,101,365**	**1,108,486**	**1,101,172**	**1,094,832**	**1,088,338**	**1,081,415**	**1,075,096**

Figure 3.24 - Currently Available Water Supplies by Use Category and by Source for Cameron County



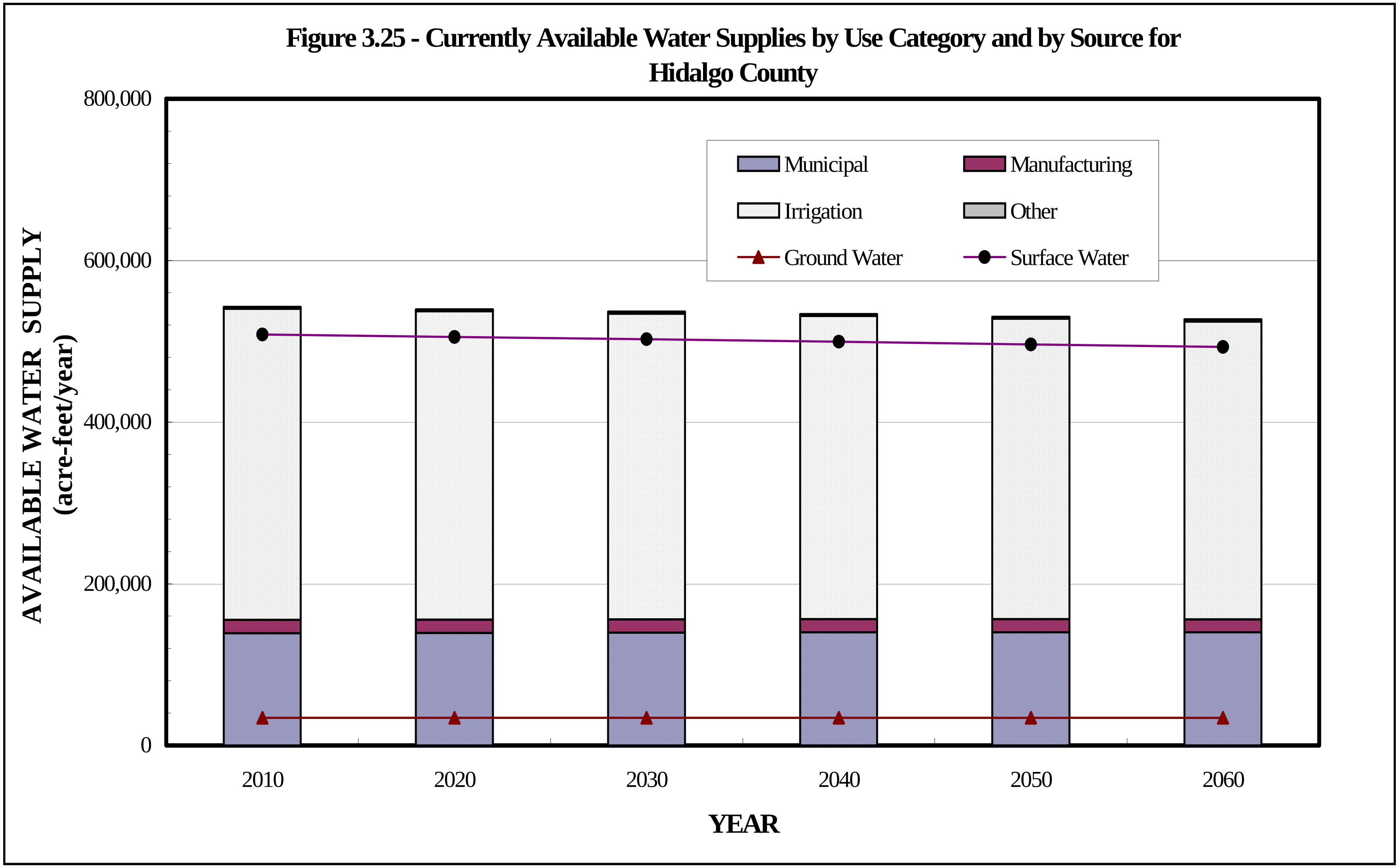


Figure 3.25 - Currently Available Water Supplies by Use Category and by Source for Hidalgo County
Municipal
Manufacturing
Irrigation
Other
Ground Water
Surface Water
AVAILABLE WATER SUPPLY (acre-feet/year)
800,000
600,000
400,000
200,000
0
2010
2020
2030
2040
2050
2060
YEAR

Figure 3.26 - Currently Available Water Supplies by Use Category and by Source for Jim Hogg County

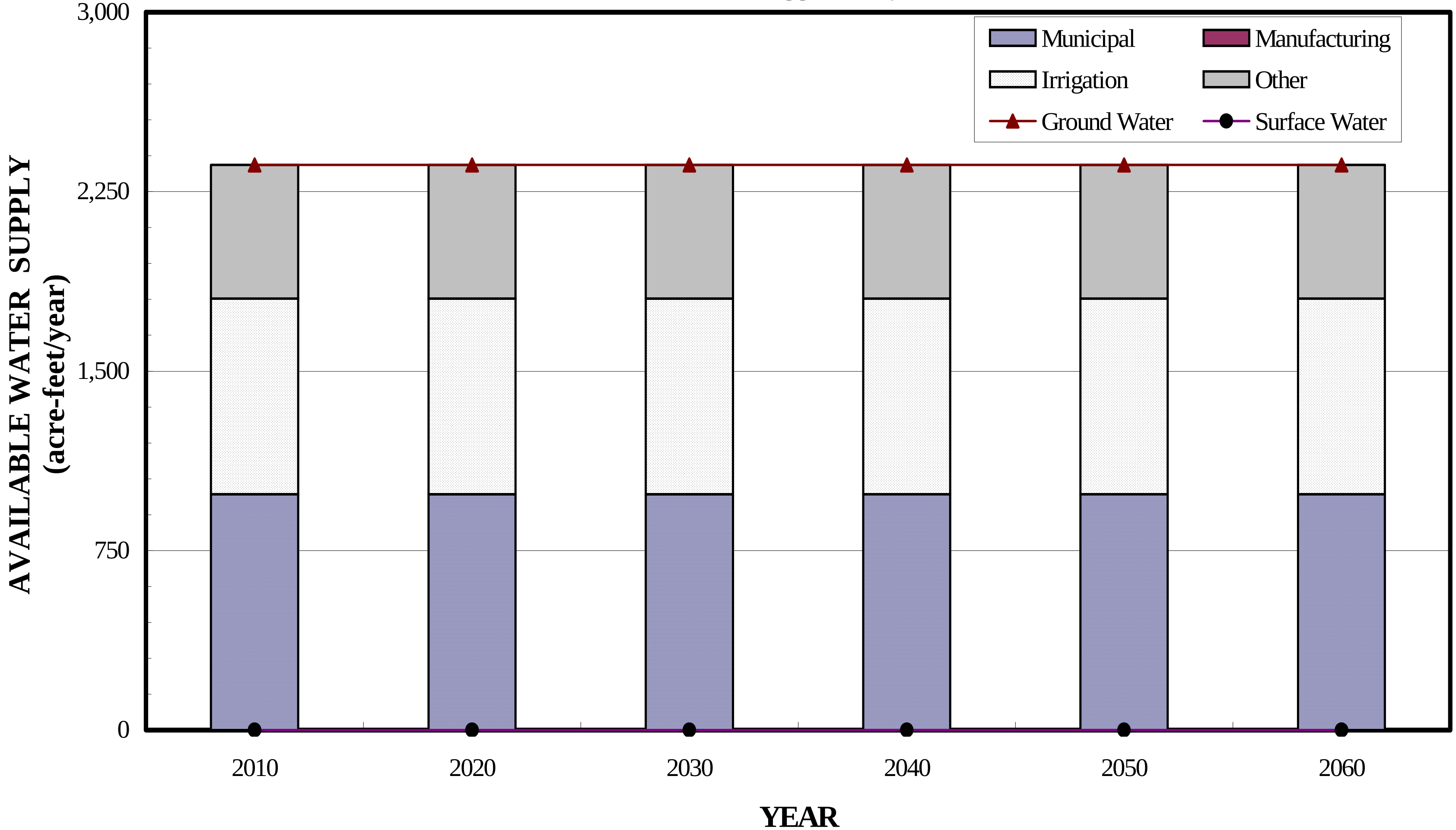


Figure 3.27 - Currently Available Water Supplies by Use Category and by Source for Maverick County

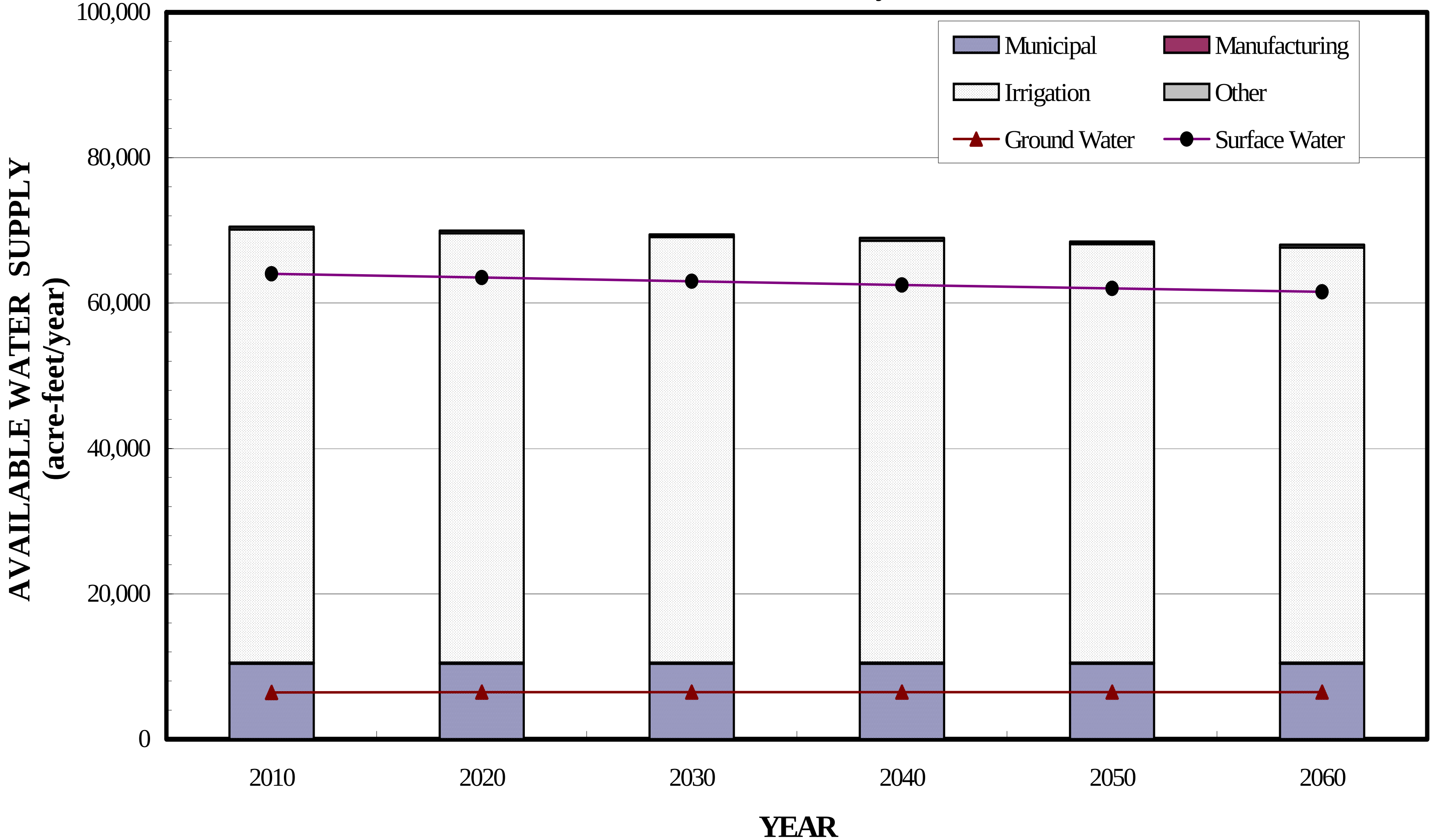
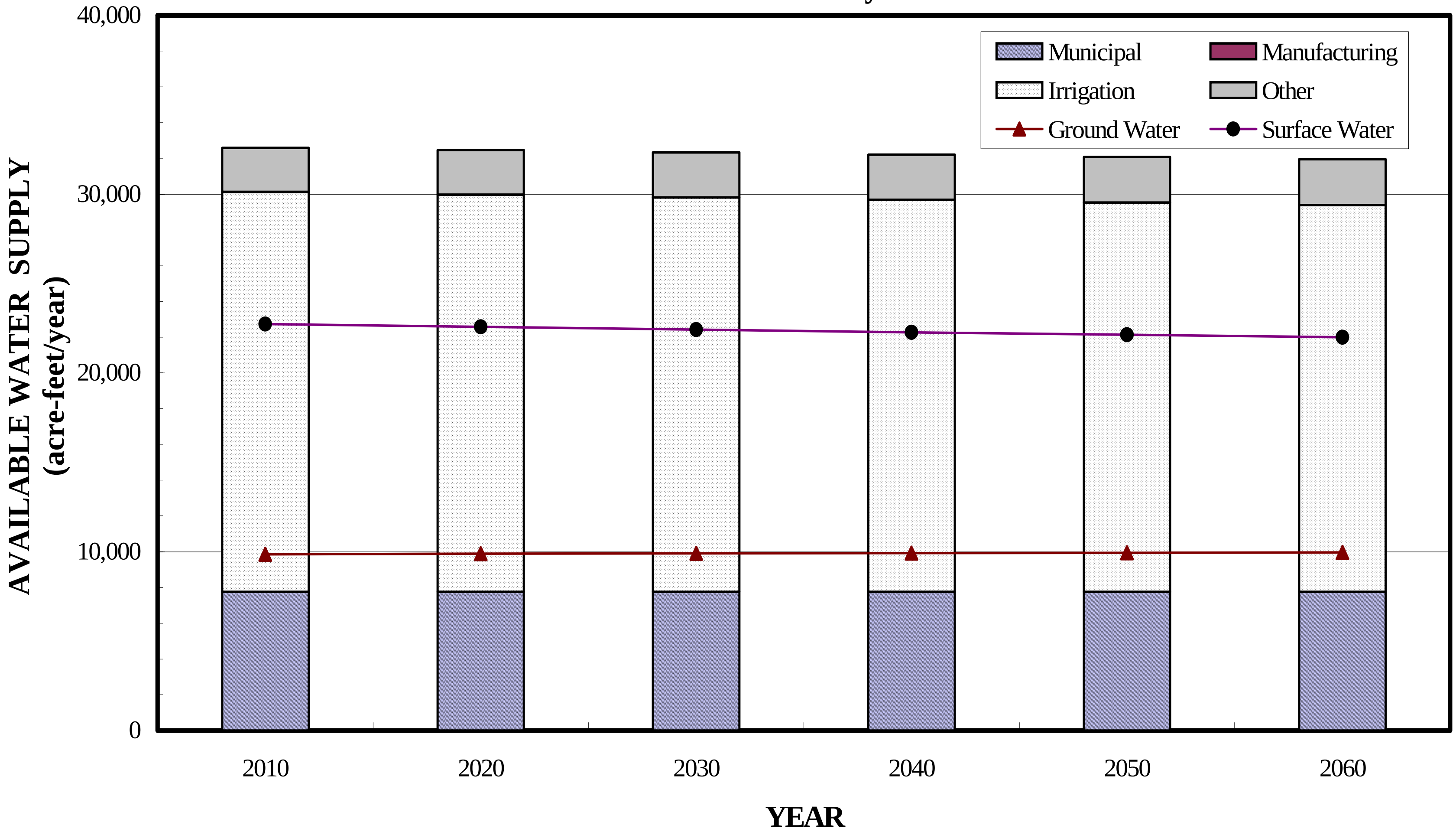


Figure 3.28 - Currently Available Water Supplies by Use Category and by Source for Starr County



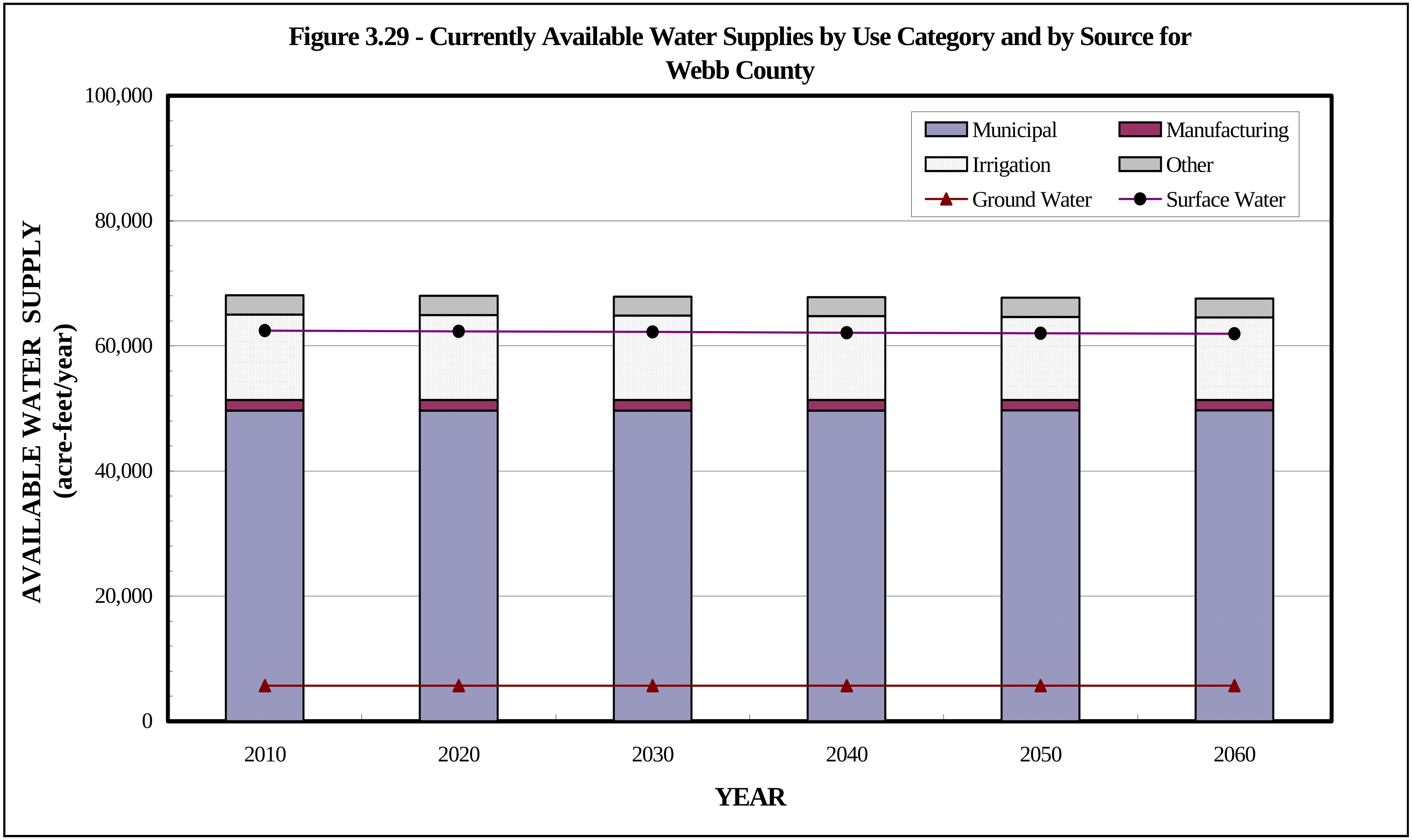


Figure 3.29 - Currently Available Water Supplies by Use Category and by Source for Webb County
100,000
80,000
60,000
40,000
20,000
0
AVAILABLE WATER SUPPLY (acre-feet/year)
Municipal
Manufacturing
Irrigation
Other
Ground Water
Surface Water
2010
2020
2030
2040
2050
2060
YEAR

Figure 3.30 - Currently Available Water Supplies by Use Category and by Source for Willacy County

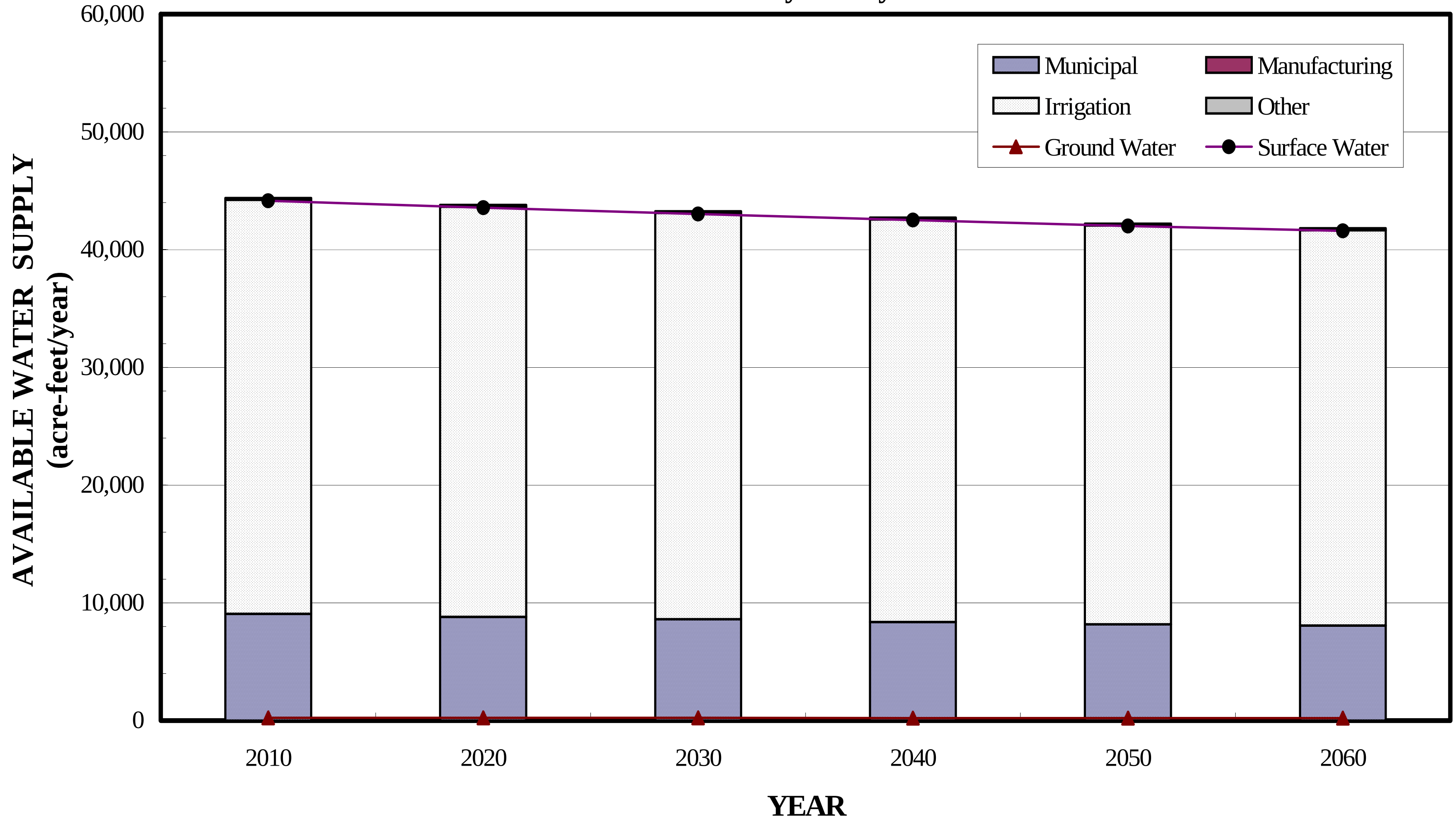
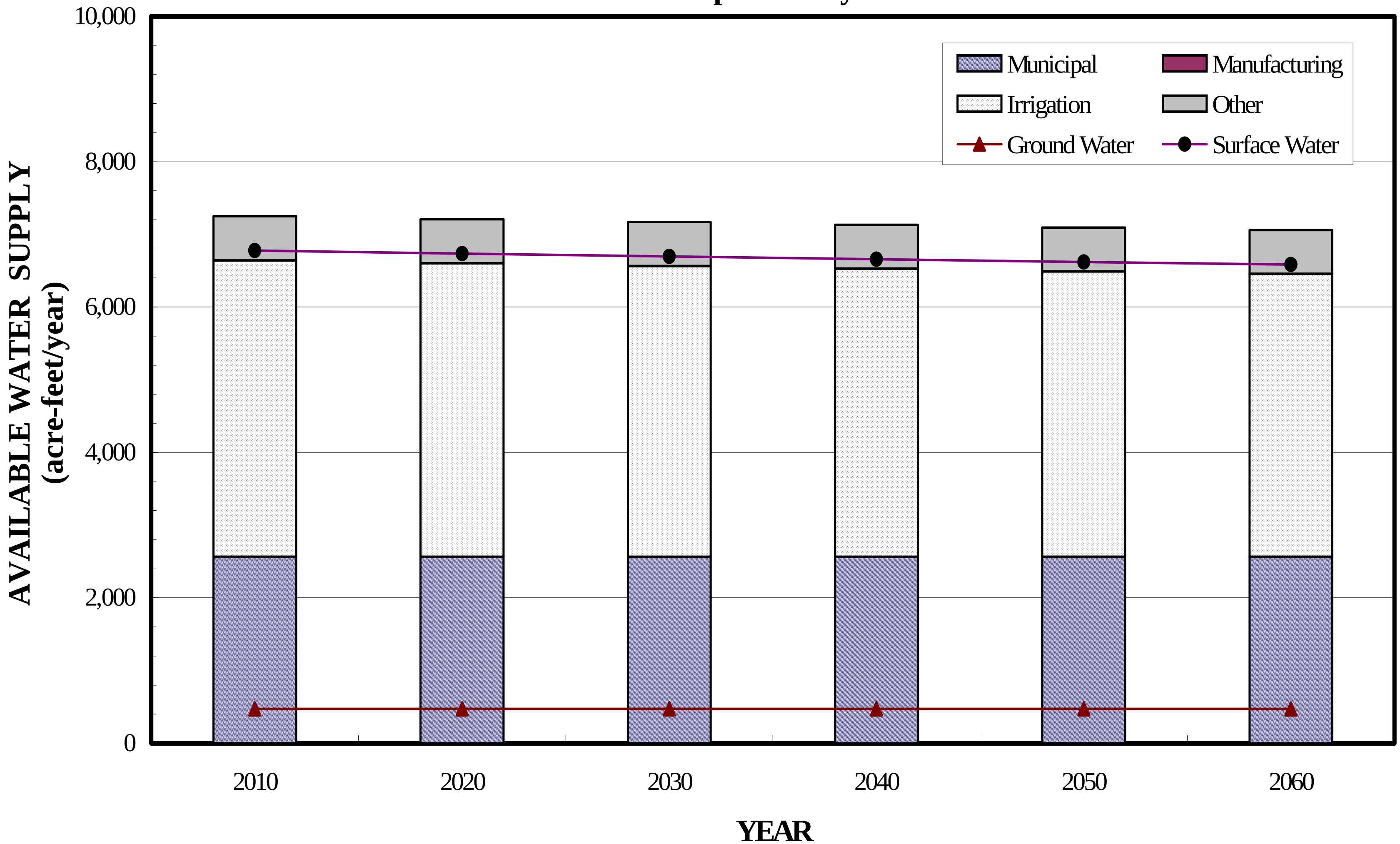


Figure 3.31 - Currently Available Water Supplies by Use Category and by Source for Zapata County



3.7 LOWER RIO GRANDE MUNICIPAL DELIVERIES DURING SEVERE DROUGHTS

One of the concerns regarding the availability of water in the Lower Rio Grande Valley pertains to the delivery of water to municipal users during severe drought periods when irrigation water use may be curtailed or ceased all together as the total supply of United States water stored in Amistad and Falcon Reservoirs falls to low levels. Under the current Rio Grande operating rules, the available supply of water in the reservoirs for irrigation use is gradually depleted as irrigation diversions are made during periods when the inflows to the reservoirs are low. During extended periods of continued irrigation use and low reservoir inflows, the available quantity of irrigation water stored in the reservoirs can be reduced to zero. Should such conditions occur, no releases of irrigation water would be made from Falcon Reservoir. This would mean that deliveries of municipal water from the reservoir to entities in the Lower Rio Grande Valley would have to be made without the normal carrying water provided by the irrigation water deliveries. Under these circumstances, the water losses, due to such factors as seepage and evaporation, that may be experienced either along the river channel or within the irrigation district delivery systems that are used to convey raw water from the river to the municipal water users could be substantial. Also of concern under these conditions is whether or not the existing diversion facilities on the lower Rio Grande would be able to physically withdraw water from the river because of the potentially lower river levels.

3.7.1 Irrigation District Municipal Water Supply Network

Studies recently have been made to identify the municipalities in the Lower Rio Grande Valley that are dependent on irrigation district canal systems for the delivery of their water supplies and to delineate the portions of those canal systems that are actually used for delivering water from the Rio Grande to the municipalities[23]. There are 39 municipal water treatment plants that take raw water from the water distribution networks of 14 irrigation districts in Hidalgo and Cameron Counties in the Lower Rio Grande Valley. For purposes of this report, those portions of the water distribution networks of irrigation districts that also are used to convey and deliver municipal water from the Rio Grande are referred to as the municipal supply network (MSN). As of November 2003, the MSN consisted of the various facilities and features summarized in Table 3.14.

Table 3.14 – Summary of Municipal Water Supply Network Characteristics

Component	Width/Diameter	Length (miles)	Surface Area (acres)	Static Volume (acre-feet)
Lined Canals	4 – 80 feet	~92	~229	~721 – ~866
Unlined Canals	10 – 150 feet	~168	~1,137	~4,382 – ~6,527
Pipelines	14 – 72 inches	~25	n/a	~27
Resacas	n/a	n/a	~377	~2,484
Reservoirs	n/a	n/a	~3,845	~8,216
TOTALS	n/a	~285	~5,588	~15,830 – ~18,120

[23] Fipps, Guy, P.E.; "The Municipal Water Supply Network of the Lower Rio Grande Valley"; Irrigation District Program, Irrigation Technology Center, Texas Cooperative Extension, Texas Agricultural Experimental Station; Texas A&M University, College Station, Texas; February, 2004.

Table 3.15 summarizes the various types, lengths and sizes of facilities used in each of the 14 irrigation districts to deliver municipal water. Figure 3.32 is a map of a portion of the Lower Rio Grande Valley showing the irrigation districts and conveyance facilities used for delivering municipal water.

Table 3.15 - Municipal Water Supply Network Characteristics by Irrigation District

District	Lined Canals		Unlined Canals		Pipelines		Resacas	Reservoirs
	Width (feet)	Length (miles)	Width (feet)	Length (miles)	Diameter (inches)	Length (miles)	Area (acres)	Area (acres)
Delta Lake	40 - 25	12.3	47 - 115	35.4	14 - 36	5.5	n/a	2,377.0
Donna	6 – 33	7.3	49 – 54	5.8	n/a	n/a	n/a	370.0
Edinburg	9 – 41	9.5	32 – 77	22.3	n/a	n/a	n/a	n/a
Harlingen	n/a	n/a	36 – 100	16.6	n/a	n/a	n/a	9.0
HCID 3	n/a	n/a	10 – 52	4.1	60 – 72	1.3	n/a	n/a
HCID 16	17	0.7	n/a	n/a	60	1.1	n/a	273.1
La Feria	14 – 16	3.8	35 – 52	12.7	n/a	n/a	n/a	292.8
Los Fresnos	n/a	n/a	25 – 52	12.1	n/a	n/a	n/a	n/a
Mercedes	13 – 24	19.2	36 – 141	13.9	30	1.2	81.1	n/a
Mission 6	16 – 25	5.7	35 – 60	0.8	n/a	n/a	n/a	61.3
San Benito	n/a	n/a	17 – 49	31.1	24	0.8	295.7	n/a
San Juan	14 – 80	12.7	50 – 150	5.0	15 – 54	15.5	n/a	334.9
Santa Cruz	10 – 24	9.11	40 – 60	1.9	n/a	n/a	n/a	127
United	15	11.4	n/a	6.6	n/a	n/a	n/a	n/a
TOTALS	- -	91.7	- -	168.3	- -	25.4	376.8	3,845.1

Table 3.15B: Irrigation Districts Holding Water Rights of Municipal Users

IRRIGATION DISTRICT	WR#	AF/yr
HARLINGEN IRR DIST	831	18320
CAMERON CO WID #16	838	189
CAMERON CO IRR DIST NO 2	841	5500
CAMERON CO IRR DIST NO 2	841	4767.5
CAMERON CO IRR DIST NO 2	841	890
CAMERON CO IRR DIST NO 2	841	750
BROWNSVILLE IRRIGATION DISTRICT	843	6071
BAYVIEW IRR DIST 11	4548	45
HIDALGO COUNTY IRR DIST 16	802	1500
LA FERIA ID CAMERON CO 3	803	1800
LA FERIA ID CAMERON CO 3	803	900
LA FERIA ID CAMERON CO 3	803	300
DONNA ID HIDALGO CO 1	805	4190
HIDALGO CO IRR DIST 2	808	11777.5
ENGLEMAN IRRIGATION DISTRICT	809	518.475

DELTA LAKE IRR DIST	811	610
DELTA LAKE IRR DIST	811	600
DELTA LAKE IRR DIST	811	5670
HIDALGO & CAMERON CO WCID NO 9	812	1500
HIDALGO & CAMERON CO WCID NO 9	812	2580
HIDALGO & CAMERON CO WCID NO 9	812	5240
HIDALGO & CAMERON CO WCID NO 9	812	1340
HIDALGO & CAMERON CO WCID NO 9	812	1840
HIDALGO & CAMERON CO WCID NO 9	812	500
HIDALGO CO IRR DIST 1	816	5390
HIDALGO CO IRR DIST 1	816	625
HIDALGO CO IRR DIST NO 6	828	5816
UNITED IRRIGATION DISTRICT	846	5000
UNITED IRRIGATION DISTRICT	846	8125
UNITED IRRIGATION DISTRICT	846	1190
UNITED IRRIGATION DISTRICT	849	5300

In Table 3.14, static volume is defined as the volume of water needed to fill the MSN to normal operating levels for agricultural water deliveries. Static means that the water is not flowing in the system. Usually, water in the MSN is not static, but moves or flows continuously. The *transient volume* is somewhat higher than the static volume presented in Table 3.14. The static volume of each of the components of the MSN has been determined by multiplying the cross-sectional area of each component (when filled to its normal operating volume) by its length. Most of the irrigation canals have a trapezoidal cross-sectional shape; however, because the cross-sectional shape of some of the canals was not known, the static volume calculations for these canals were based on two different assumed cross sections; parabolic (minimum) and rectangular (maximum).

The resulting static volumes for the various components of the MSN within each of the irrigation districts are summarized in Table 3.16. As shown, to fill the MSN entirely with municipal water, assuming no irrigation water is being conveyed through the irrigation district canal systems, would require on the order of 16,000 acre-feet to 18,000 acre-feet of water. This is water that would have to be released from Falcon Reservoir, and it likely would have to be charged against the municipal accounts.

Figure 3.32 – Municipal Water Supply Network

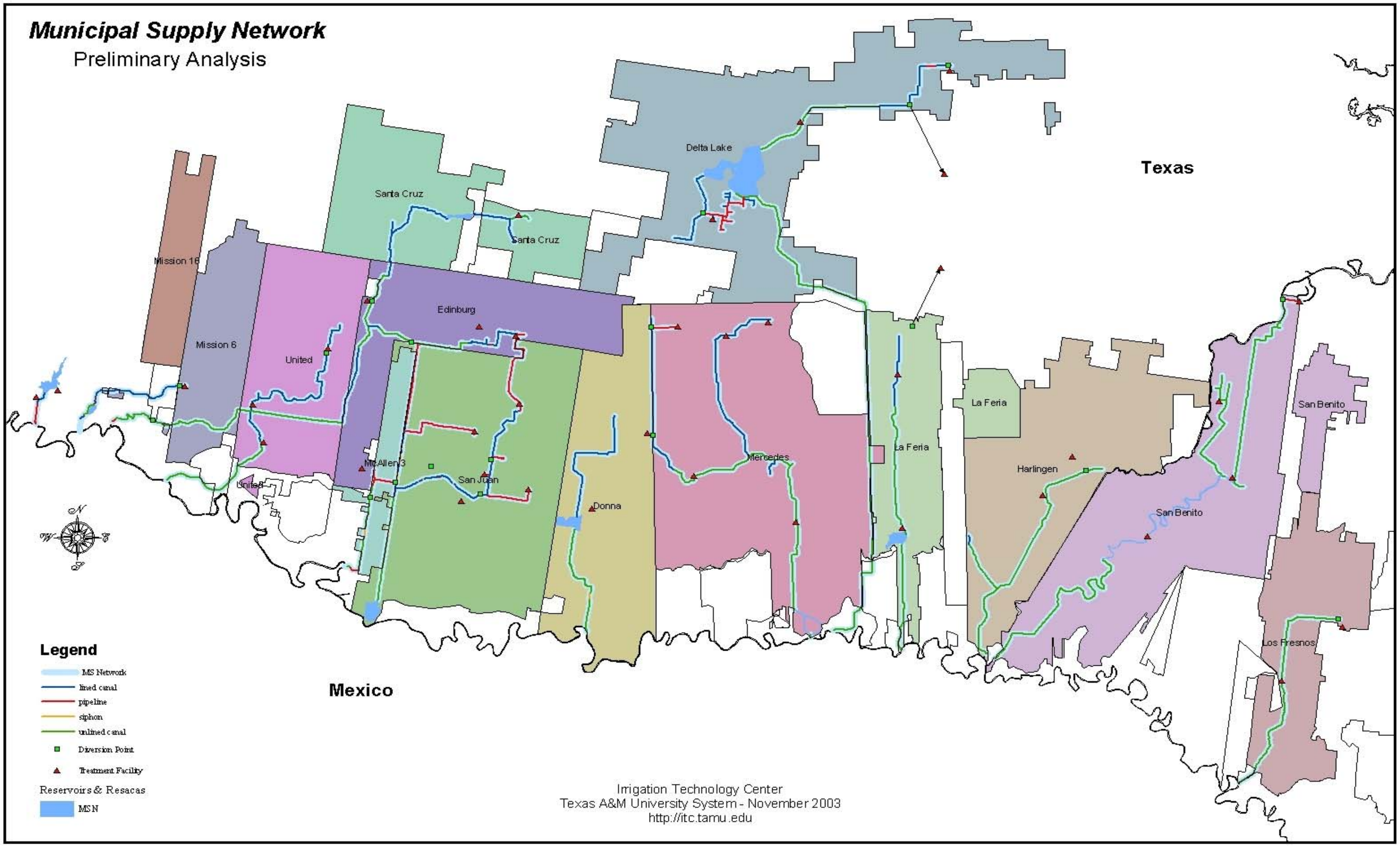


Table 3.16 – Static Volumes of Municipal Water Supply Network Components Within Each Irrigation District

District	Lined Canals			Unlined Canals			Pipelines	Resacas	Reservoirs	Total	
	Unknown Shape		Trap. Shape	Unknown Shape		Trap. Shape					
	Min	Max		Min	Max					Min	Max
Delta Lake	82.9	131.1	n/a	856.6	1,840.2	n/a	1.9	n/a	943.0	1,884.4	2,916.2
Donna	60.2	90.4	n/a	174.6	261.9	n/a	n/a	n/a	1,480.0	1,714.8	1,832.3
Edinburg	69.8	110.4	n/a	618.4	927.6	n/a	n/a	n/a	n/a	688.2	1,038.0
Harlingen	n/a	n/a	n/a	348.7	523.1	n/a	n/a	n/a	27.0	375.7	550.1
HCID 3	n/a	n/a	n/a	70.9	106.4	n/a	4.1	n/a	n/a	75.0	110.5
HCID 16	5.4	8.5	n/a	n/a	n/a	n/a	2.6	n/a	2,000.0	2,008.0	2,011.1
La Feria	n/a	n/a	21.7	n/a	n/a	332.4	n/a	n/a	1,171.2	1,525.3	1,525.3
Los Fresnos	n/a	n/a	n/a	186.6	279.9	n/a	n/a	n/a	n/a	186.6	279.9
Mercedes	n/a	n/a	111.0	514.1	771.1	n/a	0.7	827.8	n/a	1,453.8	1,710.6
Mission 6	35.9	53.8	n/a	18.6	27.8	n/a	n/a	n/a	350.0	404.5	431.6
San Benito	n/a	n/a	n/a	402.8	586.8	n/a	0.3	1,656.2	n/a	2,059.1	2,243.3
San Juan	n/a	n/a	138.9	n/a	n/a	514.6	17.0	n/a	1,674.4	2,344.9	2,344.9
Santa Cruz	68.2	70.06	n/a	23.7	35.6	n/a	n/a	n/a	570.0	661.9	676.2
United	4.5	6.7	123.3	n/a	n/a	319.9	n/a	n/a	n/a	447.7	449.9
TOTALS	326.9	471.5	394.9	3,215.0	5,360.4	1,166.9	26.6	2,484.0	8,215.6	15,829.9	18,119.9

3.7.2 River Channel and Irrigation District Delivery System Water Losses

Preliminary estimates of the potential water losses that could be experienced when only municipal water is released from Falcon Reservoir during critical drought periods have been made in previous investigations that were undertaken as part of Phase II of the Lower Rio Grande Valley Regional Integrated Water Resources Planning Study (LRGIWRP-II Study) conducted by the Lower Rio Grande Valley Development Council[24]. In these investigations, an Amistad-Falcon Reservoir Operations Model (ROM) was modified and operated to evaluate the extent of the water losses that could be experienced along the lower Rio Grande and within the irrigation district water delivery systems during drought periods with only municipal water being released for the United States from Falcon Reservoir. As the basis for developing and structuring the ROM for the Amistad-Falcon reservoir system, the existing SIMYLD-II reservoir system model, or computer program, was used[25]. The original version of this program was formulated and coded by the TWDB. The fundamental concept in applying the SIMYLD-II program is that the physical reservoir system can be transformed into a capacitated network flow problem. In making this transformation, the real system's physical elements are represented as a combination of two possible network components - nodes and links. The basic SIMYLD-II program, as applied to the Amistad-Falcon system, provides a multi-reservoir simulation model capable of describing the movement and storage of water through a system of river reaches, canals, reservoirs and non-storage river junctions over a specified period of time.

Simulations were made with the ROM for a hypothetical period between 1995-2000, which was based on actual historical hydrologic and demand conditions through March 1998, and on assumed 1995 critical drought hydrologic conditions and year-2000 municipal demands for the period from April 1998 through December 2000[26]. With routines incorporated into the ROM to describe the channel losses along the lower Rio Grande and the anticipated losses within the irrigation district water delivery systems, the results from the ROM simulations provide an indication of the total quantities of water losses that could be experienced with only municipal water deliveries made in the Lower Rio Grande Valley without the benefit of irrigation carrying water.

For these simulations, five reaches of the river were delineated for describing river channel losses between Falcon Dam and Brownsville. These reaches are identified on the map of the four-county Lower Rio Grande Valley in Figure 3.33, and they are the same as those used by the Rio Grande Watermaster for facilitating water deliveries to the Lower Rio Grande Valley as previously described in Table 3.2. The expanded SIMYLD II link-node network for the Amistad-Falcon ROM is shown in Figure 3.34.

The projected year-2000 municipal demands for the United States water users in the Lower Valley were distributed among the different nodes in the revised ROM based on geographical location and available information regarding which cities divert water directly from the river and which irrigation districts deliver river water to which cities. Table 3.17 summarizes the distribution of the year-2000 United States

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[24] R. J. Brandes Company; "Evaluation of Amistad-Falcon Water Supply Under Current and Extended Drought Conditions"; Phase II, Lower Rio Grande Valley Regional Integrated Water Resources Planning Study; Lower Rio Grande Valley Development Council and the Valley Water Policy and Management Council of the Lower Rio Grande Water Committee, Inc.; Austin, Texas; March, 1999.

[25] Texas Water Development Board; "Economic Optimization & Simulation Techniques for Management of Regional Water Resource Systems, River Basin Simulation Model, SIMYLD-II Program Description"; July, 1972; Austin, Texas.

[26] Actual hydrologic and demand conditions were used only for the period extending through March, 1998 because March, 1998 was the last month for which these data were available from the International Boundary and Water Commission at the time this investigation was undertaken. The year-2000 demands were obtained from the TWDB and were effective as of January 1999.

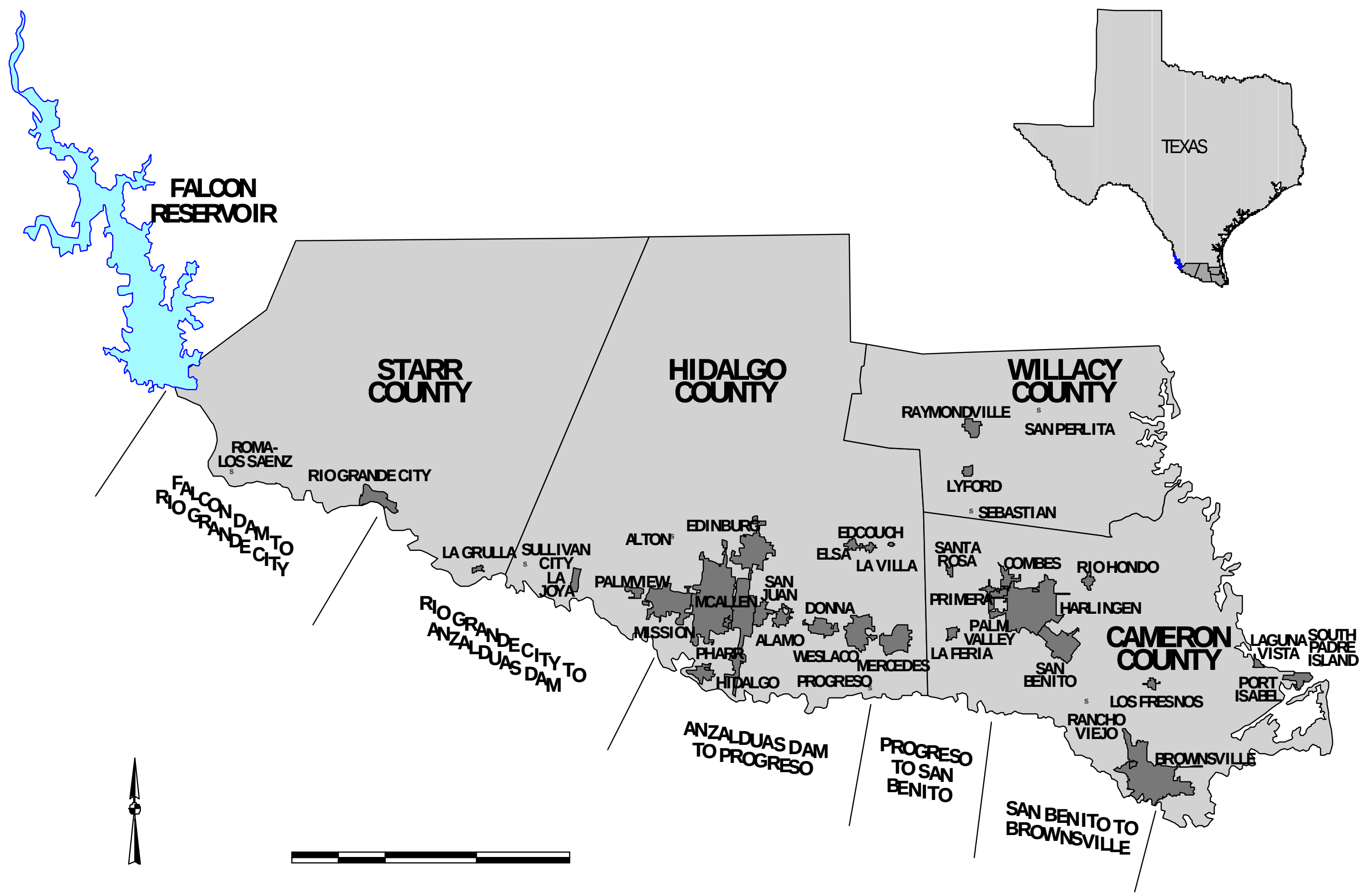
municipal water demands among the different river reaches and model nodes (Nodes 9, 11, 14, 16, 18, and 20). The various cities assigned to specific reaches and nodes in the ROM are listed in the table, and the corresponding sums of the year-2000 municipal water demands associated with each node are indicated. The locations of these cities within the four-county Lower Rio Grande Valley also are shown on the map in Figure 3.33.

Also included in Table 3.17 are the water demands for Mexico that were assigned to the nodes representing the Anzalduas Canal (Node 12) and the city of Matamoros and other Mexican water users in the Lower Rio Grande Valley below Anzalduas Dam (Node 19). The annual demand for the Anzalduas Canal node was based on the actual year 1995 canal diversions as reported by the IBWC during periods when irrigation usage by Mexico was minimal. For Matamoros and other lower Rio Grande Mexican water users that divert their water directly from the Rio Grande, the annual demand in Table 3.17 reflects the actual 1995 releases of Mexico's water from Anzalduas Reservoir during non-irrigation periods.

For purposes of estimating seepage, evaporation and other losses that are typically experienced when United States water is conveyed through the irrigation district water delivery systems in the Lower Rio Grande Valley, information compiled and analyzed by other investigators during the LRGIWRP-II Study were used. In those investigations, it was concluded that, as an overall average, about 20 percent of the total amount of water diverted from the river by all of the districts is typically lost and not actually delivered to water users. Hence, the 20-percent loss rate also was assumed to be an appropriate average value for estimating the quantities of municipal water that potentially could be lost through the irrigation district delivery systems without irrigation carrying water. However, in order to provide for some level of variation in the estimated loss quantities, values of 15 percent and 25 percent also were incorporated into the analyses.

It should be noted that these levels of percentage loss rates for the irrigation district delivery systems under conditions with only municipal water being conveyed through the systems are strictly estimates. Values for these loss rates were not verified with any field measurements or actual system data because such data and information were not known to exist for conditions similar to those that would occur with only municipal water being delivered. The historical average values of loss rates on the order of 20 percent for the irrigation district systems very likely were derived from actual data and observations that represented normal conditions when the systems were fully charged with water. Hence, the 20-percent loss rate reflects total seepage and evaporation losses from all components (canals, pipelines, and storage reservoirs) of the district delivery systems when full irrigation and municipal deliveries were being made. With only municipal water being delivered, it is reasonable to expect that only the essential canals and pipelines within each district system would be used to convey the municipal water; hence, the quantities of the associated losses should be less than those that normally would occur if all of the canals and pipelines were being used to convey water. The question that remains unanswered is whether the losses from the essential canals and pipelines that would be used to convey the municipal water would still be on the order of 20 percent of the quantity of municipal water being conveyed. In some cases, these losses certainly could be higher than 20 percent because the essential canals and pipelines would likely include the largest components; i.e., those with the largest surface area and wetted perimeter, that are located nearest the river within a given irrigation district system. However, it is also likely that these largest components of a given irrigation district system would be those that probably have been improved and possibly lined to minimize losses. These offsetting factors suggest that assuming average loss rates on the order of 20 percent for the irrigation district delivery systems may be appropriate even when only municipal water is being conveyed.

Figure 3.33 - Designated River Reaches Along the Rio Grande



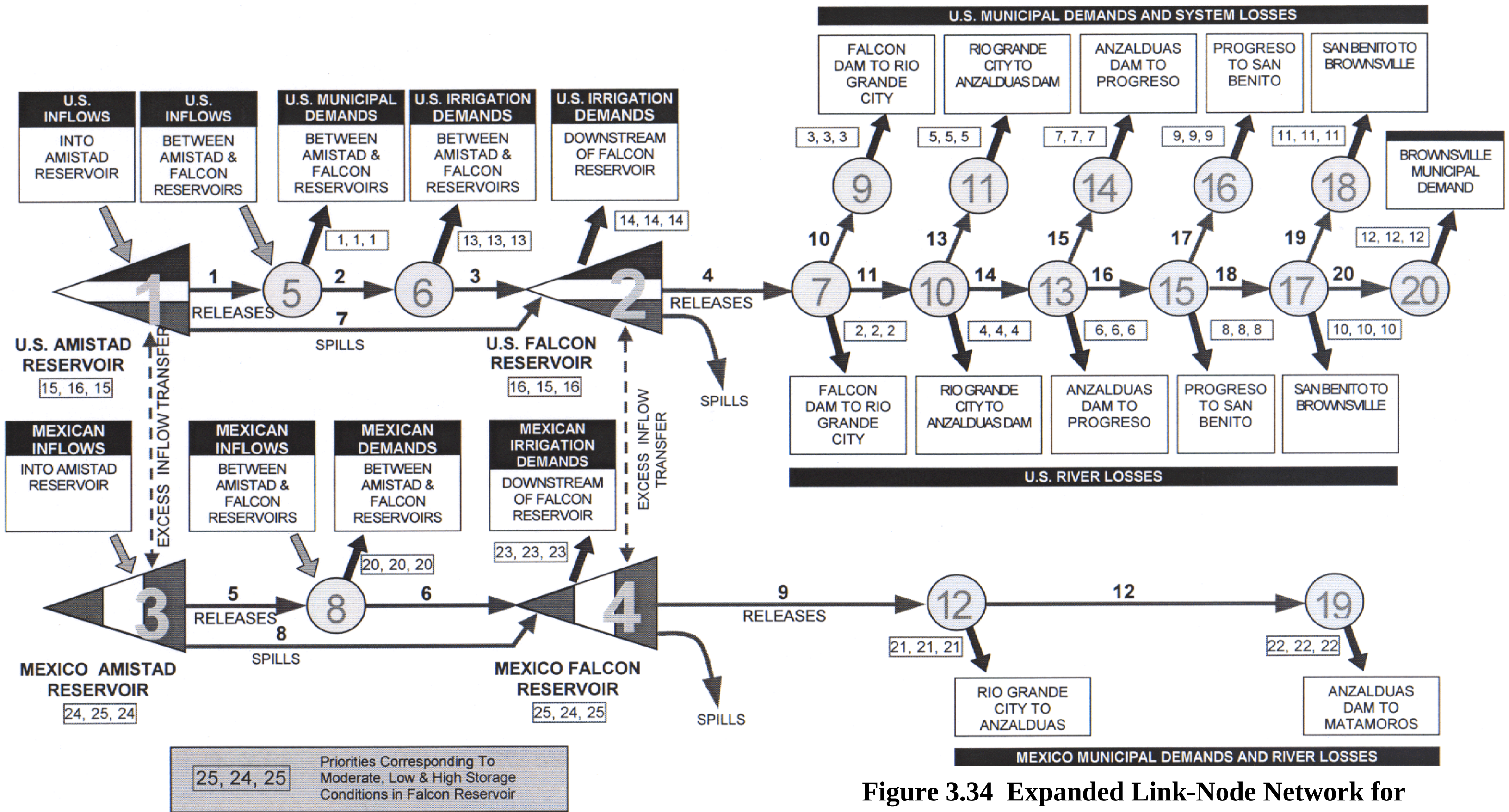


Figure 3.34 Expanded Link-Node Network for Amistad-Falcon Reservoir Operations Model

Table 3.17 - Distribution of Projected Water Demands and Associated Irrigation District Delivery System Losses Under Severe Drought Conditions

ROM NODE NO.	REACH / NODE DESCRIPTION	PROJECTED YEAR-2000 WATER DEMANDS Acre-Feet	IRRIGATION DISTRICT DELIVERY SYSTEM CONVEYANCE LOSSES 15% Acre-Feet	20% Acre-Feet	25% Acre-Feet
9	Falcon Dam to Rio Grande City	5,032	351	469	586
	Rio Grande City*				
	Roma/Los Saenz				
11	Rio Grande City to Anzalduas Dam	47,997	7,200	9,599	11,999
	La Grulla				
	Starr County - Other				
	Sullivan City				
	La Joya				
	Palmview				
	Alton				
	Mission				
	Hidalgo County - Other				
14	Anzalduas Dam to Progreso	55,698	8,355	11,140	13,925
	Hidalgo				
	McAllen				
	Edinburg				
	Pharr				
	San Juan				
	Alamo				
	Donna				
	Elsa				
	Edcouch				
	La Villa				
	Weslaco				
	Progreso				
16	Progreso to San Benito	31,225	4,684	6,245	7,806
	Mercedes				
	San Perlita				
	Raymondville				
	Lyford				
	Sebastion				
	Willacy County - Other				
	La Feria				
	Santa Rosa				
	Palm Valley				
	Primera				
	Combes				
	Harlingen				
	Rio Honda				
	San Benito				

* Since raw water deliveries to Rio Grande City are diverted directly from the Rio Grande, no conveyance losses have been assigned to its projected year-2000 water demand (2,689 ac-ft).

Table 3.17 - Distribution of Projected Water Demands and Associated Irrigation District Delivery System Losses Under Severe Drought Conditions, cont'd.

ROM NODE NO.	REACH / NODE DESCRIPTION	PROJECTED YEAR-2000 WATER DEMANDS Acre-Feet	IRRIGATION DISTRICT DELIVERY SYSTEM CONVEYANCE LOSSES 15% Acre-Feet	20% Acre-Feet	25% Acre-Feet
18	San Benito to Brownsville Rancho Viejo Los Fresnos Laguna Vista Port Isabel South Padre Island Cameron County - Other	19,245	2,887	3,849	4,811
20	Brownsville*	27,000	0	0	0
TOTAL	UNITED STATES DEMANDS AND SYSTEM LOSSES	186,198	23,476	31,302	39,127
12	Mexico Anzalduas Canal*	230,051	0	0	0
19	Matamoros and Other Users*	43,447	0	0	0
TOTAL	MEXICO DEMANDS AND SYSTEM LOSSES	273,498	0	0	0

* Since raw water deliveries to Brownsville, the Anzalduas Canal, and Matamoros are diverted directly from the Rio Grande, no conveyance losses have been assigned to their respective water demands.

The resulting amounts of water losses associated with the conveyance of United States municipal water through the irrigation district delivery systems also are listed in Table 3.17 for each of the nodes in the revised ROM network where the lower Rio Grande municipal water demands are assigned. Three columns of figures are presented corresponding to the three different assumed percentages for conveyance losses (15%, 20%, and 25 %). For those entities that divert water directly from the river (Rio Grande City, Brownsville, Anzalduas Canal, and Matamoros), no conveyance losses are indicated.

An analysis of historical monthly streamflow records for gages located along the lower Rio Grande also was made in an attempt to quantify historical channel losses from the river under flow conditions similar to those that might occur during extreme drought periods when only municipal water deliveries would be made from Falcon Reservoir. For this purpose, historical monthly streamflow and diversion data were examined for the period from 1960 through 2003[27] for each of the river reaches as previously identified on the map of the lower Rio Grande in Figure 3.33. Using these data, months during which the historical flows in the lower Rio Grande were of the same general magnitude as those that might be expected during future periods when only municipal water deliveries would be made from Falcon Reservoir were identified. The general ranges of these flow conditions by reach of the river were inferred based the projected demands and the estimated delivery system conveyance losses listed in Table 3.17. For the selected historical monthly data sets, water balance analyses were performed for each of the reaches to quantify monthly losses or gains. For the water balance analyses, the gaged monthly streamflows at the upstream and downstream ends of each reach and the corresponding gaged incremental tributary inflows and reported diversions were used.

The resulting monthly percentage losses and gains, calculated based on the flow at the upstream end of each reach, were plotted versus the flow at the downstream end of each reach. Plots were prepared for each of the five reaches of the lower Rio Grande. While the data shown on these plots does exhibit considerable variations with flow, the indicated loss percentages, nonetheless, do provide general estimates of the level of losses that might be expected, and these values were used to establish the following average and high percentage loss rates for each of the reaches:

River Reach	Average Loss Rate	High Loss Rate
Falcon Dam to Rio Grande City	4 %	7 %
Rio Grande City to Anzalduas Dam	5 %	7 %
Anzalduas Dam to Progreso	2 %	4 %
Progreso to San Benito	2 %	7 %
San Benito to Brownsville	8 %	10 %

Six different operations of the modified ROM were made corresponding to the three sets of irrigation district delivery system loss rates (15%, 20%, and 25%) and the two sets of river channel loss rates (average and high). Results from these simulations indicate that between 13 and 21 percent of the municipal water released from the reservoir for the United States during extreme drought periods without any irrigation carrying water potentially could be lost along the river, with Mexico's losses ranging between 11 and 17 percent. The differences between the river loss rates for the two countries are the result of allocating the total losses in a given reach based on the proportional amount of water that each country has flowing in the reach.

[27] At the time of the studies, this was the last year for which published and unpublished streamflow and diversion records were available from the IBWC.

The total amount of water that must be released at any one time from Falcon Reservoir in order to satisfy United States municipal demands in the Lower Rio Grande Valley without the benefit of irrigation carrying water is equal to the sum of the individual demands themselves plus the estimated losses associated with the irrigation district delivery systems plus the estimated losses along the river channel. The resulting total loss rates associated with each of the six combinations of assumed irrigation district delivery system loss rates (15%, 20%, and 25%) and river channel loss rates (average and high) are summarized in Table 3.18 for as percentages of the total municipal demands and as percentages of the corresponding releases from Falcon Reservoir required to meet these demands. These loss rates suggest that between 29 and 52 percent of the total United States municipal demands below Falcon Reservoir can be expected to be lost either along the river channel or through the irrigation district delivery systems, which means that an additional 29 to 52 percent of the municipal demands must be released from Falcon Reservoir in order for the full amount of the municipal demands to be satisfied; i.e., at the water treatment plant headgates. Or stated another way, for every acre-foot of United States water that is released from Falcon Reservoir to meet downstream municipal demands without the benefit of irrigation carrying water, between 22 and 34 percent can be expected to be lost either along the river channel or through the irrigation district delivery systems.

Corresponding results for Mexico based on the ROM simulations also are summarized in Table 3.18. The indicated total loss rates for Mexico (12% to 20% of total demands or 11% to 17% of Falcon releases) are considerably less than those for the United States because they do not reflect any conveyance losses within Mexico’s internal water delivery system, for example, along the Anzalduas Canal. These total loss rates reflect only river channel losses. The corresponding river channel loss rates for the United States based on Falcon Reservoir releases are comparable and range between 13 and 21 percent.

3.7.3 Withdrawal Capabilities of Existing Diversion Facilities

Municipal water users in the Lower Rio Grande Valley that rely on irrigation districts to pump and deliver their water from the Rio Grande also have expressed concerns regarding the ability of the districts' pumping facilities on the river to effectively function when flows in the river may become diminished because irrigation water is not being conveyed. As with the loss analysis described in the previous section, under these conditions, it is conceivable that if only municipal water is being released from Falcon Reservoir and conveyed in the river, then the river levels may be so low that the pump intakes could be physically above the level of the river and, therefore, unable to withdraw water from the river.

To investigate this potential problem, the Lower Rio Grande Development Council entered into a Research and Planning Fund Research Grant Contract with the TWDB to assemble data on each irrigation district diversion facility on the lower Rio Grande that delivers water for domestic, municipal, and industrial uses. The objective of the study was to assess the irrigation district diversion facilities on the river to develop an opinion as to whether municipal water supplies could be pumped from the river and delivered under conditions when little or no irrigation water is being used.

Table 3.18 - Summary of Total Losses Associated with Municipal Water Deliveries in the Lower Rio Grande Valley Under Severe Drought Conditions

UNITED STATES WATER DELIVERIES

Irrigation District System Loss and River Loss Condition	Based On Municipal Releases	Based On Falcon Demands
15% Irrigation System Loss, Average River Loss	29 %	22 %
20% Irrigation System Loss, Average River Loss	34 %	25 %
25% Irrigation System Loss, Average River Loss	38 %	28 %
15% Irrigation System Loss, High River Loss	42 %	29 %
20% Irrigation System Loss, High River Loss	47 %	32 %
25% Irrigation System Loss, High River Loss	52 %	34 %

MEXICAN WATER DELIVERIES

River Loss Condition	Based On Total Demands	Based On Falcon Releases
Average River Loss	12 %	11 %
High River Loss	20 %	17 %

To achieve the basic objective of the study, the following specific activities were undertaken:

- Available construction drawings showing the general plan and capacity of each diversion facility, including existing weirs, were assembled;
- A committee of three irrigation district representatives and three municipal representatives was established to review the assembled drawings;
- Each critical diversion facility was reviewed and discussed to evaluate its capabilities for delivering municipal water in the absence of irrigation water in the river; and,
- A written summary report was prepared.

Based on past history of operations, it was verified during the study that the irrigation districts can divert, and have diverted, water from the Rio Grande when there is no irrigation water being released from Falcon Reservoir; although, pumping efficiencies are negatively affected and the overall volumes capable of being pumped are limited. There are documented data from the Rio Grande Watermaster and the IBWC that indicate the historical periods of time when little or no irrigation water was being released from Falcon Reservoir. The water diverted from the river during these periods was only municipal water. Based on this historical data, the study concluded that irrigation districts would be able to physically pump water from the river even if the only water flowing in the Rio Grande is water that has been released from Falcon Reservoir for municipal uses.

The study also noted that the major water diverters (irrigation districts) along lower Rio Grande, below Anzalduas Dam, have weirs constructed across the river downstream of their respective diversion points. These weirs are effective in maintaining a minimum river elevation at the districts pumping facilities and creating a pool of water that facilitates the diversion of water during low flow conditions. Irrigation districts with their river pumping facilities located upstream of Anzalduas Dam utilize the reservoir created by the dam itself; therefore, their ability to divert water for municipal use generally is not affected when there is no irrigation water flowing in the river.

In conclusion, the study made the following recommendations:

> *All cities and/or water purveyors must be required to have control of, or contract to an irrigation district for, raw water storage for at least 20 to 30 days of supply. Raw water storage requirements should meet the maximum daily demand from the water treatment facility. The 20 to 30-day storage requirement should be a firm storage requirement and not be based on total volume of storage. If cities had a requirement to have 20 to 30 days of water storage, it would greatly increase the efficiency in how the irrigation districts divert water. This would be the responsibility of the city and not the district since it would only benefit the city.*
>
> *Several cities rely on the irrigation districts' canal system as their reservoir. This practice places an unnecessary burden on the irrigation districts. Cities should not take into account canals as storage facilities unless there are no taps to the canal prior to the cities' diversion points. In other words, they can use that portion of the canal that serves solely their water treatment facility, if and only if, the irrigation district agrees to the concept. The storage could be contained through weirs or gates to meet that storage requirement. If an irrigation district has a storage structure at the present time, the district might explore to determine if the structure can be reworked to provide more storage, or to determine if there is a way that the city can put their own storage facility into operation. If the district has a storage structure presently, the district could work with the city to fund the needed repairs of the facility.*

In addition, the study also made the following specific recommendations to insure the continued pumping ability of the districts under low flow conditions:

1. *A study should be made on all existing Rio Grande weirs (and future installations) that could determine their positive impact on pumping conditions during low flows. Also, to determine what could be done to increase the positive results of the weirs now in place.*

2. *Further study should be done on the aquatic weed infestation and its impact on low Rio Grande flows.*

3. *The water ordering mechanism now being used between the irrigation districts and the Rio Grande Watermaster needs to be investigated to determine what would best enhance the*

efficient delivery of water from the Falcon Lake if the situation ever arose where only municipal water was remaining in the reserves.

4. *Additional measuring or gaging stations along the river could better monitor the river flow and could provide a higher level of operation. Efforts should be made to coordinate the activities of all the agencies to assist in the funding of such a program.*

5. *Negative environmental effects resulting from the low flows, such as potential fish or wildlife damage, need to be addressed by those water right holders (Texas Parks & Wildlife, U.S. Fish and Wildlife, etc.) who have the water reserves that could possibly alleviate these conditions. No other water right allocation holders should use their reserves for this purpose.*

6. *The cities can help themselves by either studying their water supply system themselves or hiring someone to assess their needs and provide an answer for them. Many of the smaller towns have let their treatment and distribution systems and their water supply sources to their system deteriorate for so many years. These cities are in an almost impossible situation money-wise to be able to provide any type of fix to these facilities.*

3.8 MEXICAN WATER DEFICITS UNDER 1944 TREATY

As discussed earlier in this report (see Section 3.2.1.6.1**)**, the 1944 Treaty between the United States and Mexico contains a provision whereby Mexico is to provide the United States with a minimum of 350,000 acre-feet per year, averaged in five-year cycles, of inflows to the Rio Grande from six named tributaries located below Fort Quitman, Texas. The inflows from these tributaries contribute directly to the Amistad-Falcon water supply that is extensively relied upon by water users in the RGRWPA. Hence, when these tributary inflows are reduced, the available water supply for the RGRWPA also is reduced.

The IBWC is responsible for measuring the Mexican tributary inflows and performing the necessary water accounting in accordance with the provisions of the 1944 Treaty. Since October 1992, data reported by the IBWC indicate that Mexico has failed to deliver the required minimum inflows to the United States, and, therefore, Mexico accrued a deficit of 1,024,000 acre-feet for the five-year accounting cycle that ended on October 2, 1997. For the five-year accounting cycle that ended on October 2, 2002, the deficit owed by Mexico was 384,100 acre-feet. For the ten years from October 3, 1992 through October 2, 2002, the total amount of the inflow deficit incurred by Mexico on the six named tributaries identified in the 1944 Treaty was 1,408,100 acre-feet. As a result of the substantial inflows that have occurred in the last year or so, Mexico’s current deficit (as of March 5, 2005) now has been reduced to 737,403 acre-feet.

Because of the substantial amount of the current Mexican water deficits and because agricultural interests in the Lower Rio Grande Valley have been severely impacted during the drought of the 1990's as available water supplies from Amistad and Falcon Reservoirs have diminished, there has been increased concern by all Rio Grande water users regarding the reasons for the deficits and Mexico's ability to repay the deficits in accordance with the terms of the 1944 Treaty and Minute No. 234. To begin to address these issues, special studies were undertaken as part of the first round of this regional water planning effort for the RGRWPA, and preliminary results pertaining to the Mexican water deficits were presented in a separate report[28]. The United Section of the IBWC also issued a report in April, 2002 that discussed the deficit situation and included much of the data and information previously compiled and presented in the earlier Brandes report[29]. For specific details regarding these findings, these Mexican deficit reports should be consulted.

It should be noted that after February 2000, Mexico transferred approximately 138,000 acre-feet of its water stored in the Amistad-Falcon reservoir system to the United States in an effort to help offset the deficits under the 1944 Treaty. Mexico also agreed to provide to the United States through September 2000, a portion of the inflows to the Rio Grande that Mexico was entitled to under the provisions of the 1944 Treaty. This additional water that Mexico allocated to the United States totaled about 110,000 acre-feet. In June 2002, the IBWC issued Minute 308, which transferred 90,000 acre-feet of Mexican water stored in Amistad and Falcon Reservoirs to the United States. In July 2003, the IBWC issued Minute 309, which ultimately was to result in up to 321,043 acre-feet per year being released from the reservoirs in the Rio Conchos basin to the Rio Grande. To achieve this, Minute 309 required funding from the North American Development Bank (NADBank) for improvements to the irrigation systems of several large irrigation districts in the Rio Conchos basin. The water saved by these improvements was to be released to the Rio Grande, with the United States receiving its share as allocated under the 1944 Treaty. Efforts are still underway to implement Minute 309.

On March 10, 2005, Mexico finally agreed to settle its water deficit in full by October, 2005. The details of how and when these water payments or transfers to the United States would be made are unknown.

3.9 SURFACE WATER QUALITY

Surface water quality is addressed in this section for portions of two basins - the Rio Grande, which flows directly into the Gulf of Mexico, and the Arroyo Colorado, which discharges into the Laguna Madre and then into the Gulf of Mexico. Surface and sub-surface discharges that arise from both natural processes and the activities of man affect the quality of these water resources. In general, the presence of minerals, which contribute to the total dissolved solids concentration in surface water, arise from natural sources, but can be concentrated as flows travel downstream. Return flows from both irrigation and municipal uses can concentrate dissolved solids, but can also add other elements such as nutrients, sediments, chemicals, and pathogenic organisms.

3.9.1 Rio Grande

Water in the Rio Grande normally is of suitable quality for irrigation, treated municipal supplies, livestock, and industrial uses, but salinity, nutrients, and fecal coliform bacteria are concerns identified throughout the basin. Salinity concentrations in the Rio Grande are the result of both human activities and natural conditions: the naturally salty waters of the Pecos River are a major source of the salts that flow into Amistad Reservoir and continue downstream. Untreated or poorly treated discharges from inadequate wastewater treatment facilities, primarily in Mexico, are the principal source for fecal coliform bacteria

[28] R. J. Brandes Company; "Preliminary Analysis of Mexico's Rio Grande Water Deficit Under the 1944 Treaty"; Second Draft Report to the Rio Grande Regional Water Planning Group and the Lower Rio Grande Valley Development Council; Austin, Texas; April 3, 2000.

[29] United States Section, International Boundary and Water Commission; "Deliveries of Waters Allotted to the United States Under Article 4 of the United States – Mexico Water Treaty of 1944; El Paso, Texas; April, 2002.

contamination. A secondary source is from nonpoint source pollution on both sides of the river, including poorly constructed or malfunctioning septic and sewage collection systems and improperly managed animal wastes. Although frequently identified as a concern, nutrient levels do not represent a threat to human health nor have they supported excessive aquatic plant growth and caused widespread depressed dissolved oxygen levels.

Following is a discussion of water quality for each of the following individual river segments:

- Amistad to Falcon Reservoir;
- Falcon Reservoir;
- Below Falcon Reservoir;
- Arroyo Colorado; and,
- Laguna Madre.

Where available, the TCEQ water quality stream segment number corresponding to a particular reach of the river or other stream is noted. In addition, the current water quality standards for each of these stream segments are provided in Table 3.19.

3.9.1.1 Amistad to Falcon Reservoir

In the Rio Grande below Amistad Reservoir (TCEQ Stream Segment No. 2304), the major water quality concern is the occurrence of fecal coliform bacteria (at low-flow conditions) resulting from inadequately treated wastewater discharges. Historically, this has resulted from inadequate wastewater treatment facilities in Mexico, but is also resulting from “Colonia” developments on the United States side of the Rio Grande. Due to the elevated levels of fecal coliform bacteria that have been observed, contact recreation use is not supported. Possible other concerns are nitrogen and phosphorus. This segment of the river was included on prior 303d lists of water quality limited stream segments, and remains on the draft 303d list for 2004. The original basis for listing this segment was the occurrence of sediment toxicity downstream of Laredo and Eagle Pass.

3.9.1.2 Falcon Reservoir

In Falcon Reservoir (TCEQ Stream Segment No. 2303), the elevated total dissolved solids have been identified as a concern. Phosphorus is identified as a possible concern. The average concentrations of chlorides and total dissolved solids exceed the criteria established to safeguard general water quality uses.

3.9.1.3 Below Falcon Reservoir

The Rio Grande below Falcon Reservoir (TCEQ Stream Segment No. 2302) is regulated by releases from Falcon Reservoir. Concerns that have been identified include elevated total dissolved solids and fecal coliform bacteria (at low-flow conditions). Possible concerns are nitrogen and phosphorus. This segment is on the draft 303(d) list for 2004 because of bacteria. Because of elevated levels of fecal coliform bacteria, contact recreation use is not supported. In the lower 25 miles of this reach, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation. As water levels continue to decline in Amistad and Falcon Reservoirs, the dissolved solids concentrations of the stored water continues to increase. Total dissolved solids concentrations usually range from 400 to 750 mg/L

Table 3.19 – Summary of Water Quality Standards for Stream Segments in the Lower Rio Grande Region

		DESIGNATED WATER USES				CRITERIA						
Segment No.	**Segment Name**	**Recreation**	**Aquatic Life**	**Domestic Water Supply**	**Other**	**Cl^{-1} (mg/L)**	**SO_4^{-2} (mg/L)**	**TDS (mg/L)**	**Dissolved Oxygen (mg/L)**	**pH Range (SU)**	**Indicator Bacteria[1] [Fecal Coliform] #/100ml**	**Temperature (°F)**
NUECES-RIO GRANDE COASTAL BASIN												
2201	Arroyo Colorado Tidal	Contact Recreation	High						4.0	6.5-9.0	35/200	95
2202	Arroyo Colorado Above Tidal	Contact Recreation	Inter-mediate			1,200	1,000	4,000	4.0	6.5-9.0	126/200	95
RIO GRANDE BASIN												
2301	Rio Grande Tidal	Contact Recreation	Excep-tional						5.0	6.5-9.0	35/200	95
2302	Rio Grande Below Falcon Reservoir	Contact Recreation	High	Public Supply		270	350	880	5.0	6.5-9.0	126/200	90
2303	International Falcon Reservoir	Contact Recreation	High	Public Supply		200[140]	300	1,000 [700]	5.0	6.5-9.0	126/200	93
2304	Rio Grande Below Amistad Reservoir	Contact Recreation	High	Public Supply		200	300	1,000	5.0	6.5-9.0	126/200	95
2305	International Amistad Reservoir	Contact Recreation	High	Public Supply		150	270	800	5.0	6.5-9.0	126/200	88
BAYS AND ESTUARIES												
2491	Laguna Madre	Contact Recreation	Excep-tional/ Oyster						5.0	6.5-9.0	14	95
2493	South Bay	Contact Recreation	Excep-tional/ Oyster						5.0	5-9.0	14	95
2494	Brownsville Ship Channel	Non-Contact Recreation	Excep-tional						5.0	6.5-9.0	35/200	95

Table 3.19 – Summary of Water Quality Standards for Stream Segments in the Lower Rio Grande Region, cont'd.

		DESIGNATED WATER USES				CRITERIA						
Segment No.	Segment Name	Recreation	Aquatic Life	Domestic Water Supply	Other	Cl^{-1} (mg/L)	SO_4^{-2} (mg/L)	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	Indicator Bacteria[1] [Fecal Coliform] #/100ml	Temperature (°F)
GULF OF MEXICO												
2501	Gulf of Mexico	Contact Recreation	Exceptional/ Oyster						5.0	6.5-9.0	14	95

[1] The indicator bacteria for freshwater is *E. coli* and Enterococci for saltwater. Fecal coliform is an alternative indicator.

Stream Segment Descriptions

2201 Arroyo Colorado Tidal - from the confluence with Laguna Madre in Cameron/Willacy County to a point 100 meters (110 yards) downstream of Cemetery Road south of Port Harlingen in Cameron County
2202 Arroyo Colorado Above Tidal - from a point 100 meters (110 yards) downstream of Cemetery Road south of Port Harlingen in Cameron County to FM 2062 in Hidalgo County (includes La Cruz Resaca, Llano Grande Lake, and the Main Floodway)
2301 Rio Grande Tidal - from the confluence with the Gulf of Mexico in Cameron County to a point 10.8 kilometers (6.7 miles) downstream of the International Bridge in Cameron County
2302 Rio Grande Below Falcon Reservoir - from a point 10.8 kilometers (6.7 miles) downstream of the International Bridge in Cameron County to Falcon Dam in Starr County
2303 International Falcon Reservoir - from Falcon Dam in Starr County to the confluence of the Arroyo Salado (Mexico) in Zapata County, up to the normal pool elevation of 301.1 feet (impounds Rio Grande)
2304 Rio Grande Below Amistad Reservoir - from the confluence of the Arroyo Salado (Mexico) in Zapata County to Amistad Dam in Val Verde County
2305 International Amistad Reservoir - from Amistad Dam in Val Verde County to a point 1.8 kilometers (1.1 miles) downstream of the confluence of Ramsey Canyon on the Rio Grande Arm in Val Verde County and to a point 0.7 kilometer (0.4 mile) downstream of the confluence of Painted Canyon on the Pecos River Arm in Val Verde County and to a point 0.6 kilometer (0.4 mile) downstream of the confluence of Little Satan Creek on the Devils River Arm in Val Verde County, up to the normal pool elevation of 1117 feet (impounds Rio Grande)
2491 Laguna Madre *
2493 South Bay *
2494 Brownsville Ship Channel *
2501 Gulf of Mexico * - from the Gulf shoreline to the limit of Texas' jurisdiction between Sabine Pass and Brazos Santiago Pass

* The segment boundaries are considered to be the mean high tide line.

(milligrams per liter), which is considered fresh, but these levels can cause salt accumulation in agricultural soils if excess water is not applied periodically to leach the fields.

Near the mouth of the Rio Grande, which is known as the Rio Grande Tidal segment (TCEQ Classified Stream Segment 2301), the watershed is narrow and flat and extends only a few miles inland on either side of the river. The only significant water quality concern beyond the salinity influence from the Gulf of Mexico is a concern for elevated phosphorus levels.

3.9.2 Arroyo Colorado

The Arroyo Colorado lies in Willacy, Cameron, and Hidalgo counties, and is the major drainageway for approximately two dozen cities in this area, with the notable exception of Brownsville. Almost 500,000 acres in the three counties are irrigated for cotton, citrus, vegetables, grain sorghum, corn, and sugar cane production; and much of the runoff and return flows from these areas is discharged into the Arroyo Colorado. The Arroyo Colorado and the Brownsville Ship Channel both discharge into the Laguna Madre near the northern border of Willacy County.

The Arroyo Colorado includes TCEQ Classified Stream Segment 2201 and 2202. Use of the water in the Arroyo Colorado for municipal, industrial, or irrigation purposes is severely limited because of poor quality conditions. Salinity concentrations in the Arroyo typically exceed the limits considered desirable for human consumption, as well as those acceptable for irrigation of crops. Water quality and fish tissue testing have found that: (1) low dissolved oxygen levels have impaired the fish community and other aquatic life downstream from the Port of Harlingen; (2) elevated levels of pesticides (chlordane, toxaphene, and 1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene—DDE, and PCBs in the Donna Canal) have resulted in a fish consumption advisory upstream from the Port of Harlingen; and (3) bacteria levels are occasionally elevated indicating a potential health risk to people who swim or wade in the Arroyo upstream from the Port of Harlingen. The fish consumption advisory was modified in 2001, lifting restrictions except for one species, small-mouth buffalo. In response to these use impairments, the TCEQ has performed a Total Maximum Daily Load (TMDL) study to assess the specific causes of the observed pesticide and PCB problems and to determine the pollution controls necessary to restore water quality in the Arroyo Colorado. A plan to monitor pollutants is currently being implemented and fish advisories will be lifted as concentrations decline over time.

3.9.3 Laguna Madre

The Lower Laguna Madre (TCEQ Classified Stream Segment 2491), which encompasses the portion of the Laguna Madre south of the land bridge, receives runoff from watersheds in Cameron, Willacy, and Hidalgo counties primarily by way of the Arroyo Colorado. The concerns identified are depressed dissolved oxygen and elevated nitrogen, which results mainly from agricultural runoff and from municipal wastewater discharges. This segment is on the draft 303(d) list for 2004 because of depressed dissolved oxygen. Total dissolved solids concentrations in the range of 35,000 mg/L typically eliminate this water from being considered as a viable source for municipal or industrial uses. However, improvements in technology are continuing to reduce the cost of desalinization, especially where there is a waste heat source available.

Based on Texas Department of Health shellfish maps, 5.2 percent of the Lower Laguna Madre (18.1 square miles near the Arroyo Colorado and along the Intracoastal Waterway) does not support the oyster water use, and 38.8 percent (134.8 square miles) of the bay fully supports the oyster water use. The remaining 56 percent (194.6 square miles) of the Laguna Madre, from Port Mansfield to Corpus Christi, has not been assessed for oyster use. Non-supporting areas are restricted or prohibited for the growing and harvesting of shellfish for direct marketing due to potential contamination by human pathogens.

3.10 GROUND WATER QUALITY

In general, groundwater from the various aquifers in the region has total dissolved solids concentrations exceeding 1,000 mg/L (slightly saline) and often exceeds 3,000 mg/L (moderately saline). The salinity hazard for groundwater ranges from high to very high[30]. Localized areas of high boron content occur throughout the study area.

3.10.1 Gulf Coast Aquifer

The quality of groundwater found in the Gulf Coast aquifer in Starr, Hidalgo, Willacy, and Cameron counties is reviewed in the TWDB's Report No. 316[31]. Water quality is described from the deepest and oldest or Eocene series (as shown in Table 3.20, Stratigraphy of the Lower Rio Grande Valley) to the shallower and younger Pleistocene series. Wells in western Starr County draw from the Eocene-age strata, which lie below the more commonly known Evangeline aquifer, and provide small quantities of slightly to moderately saline water for domestic and livestock use. In many places water drawn from this strata is too mineralized for domestic use and, in some cases, even for livestock watering. The Miocene-age strata overly the Eocene strata, but are still below the Evangeline aquifer. These strata are characterized as yielding small to moderate quantities of slightly to moderately saline water to wells in the characterized as yielding small to moderate quantities of slightly to moderately saline water to wells in the area of northwestern Hidalgo and eastern Starr counties. (See Figure 3.19 above, Approximate Productive Areas of the Major Sources of Groundwater in the Lower Rio Grande Valley)

The Evangeline and Chicot aquifers lie within the Goliad Formation and the younger, Quaternary-age deposits, respectively. Both aquifers yield moderate to large quantities of fresh to moderately saline water in Cameron, Hidalgo, and Willacy counties. (see Figure 3.35, Chemical Quality of Water in the Evangeline and Chicot Aquifers) However, these aquifers are reported as containing high sodium concentrations. In addition, water quality analyses for the Chicot have shown chloride, bicarbonate, and sulfate concentrations in roughly equal proportions, with water quality deteriorating with distance from the Rio Grande. Analyses of water from the Evangeline aquifer indicate higher chloride and sulfate concentrations with respect to that of bicarbonate. Within both the Chicot and Evangeline aquifers there are two small areas yielding fresh-quality groundwater (total dissolved solids less than 1,000 mg/L). One

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[30] Salinity hazard is a measure of the potential for salts to be concentrated in the soil from high salinity groundwater. Accumulation or buildup of salts in the soil can affect the ability of plants to take in water and nutrients from the soil. Salinity hazard is usually expressed in terms of specific conductance in micromhos per centimeter at 25° C.

[31] Evaluation of Ground-Water Resources In the Lower Rio Grande Valley, Texas; T. Wesley McCoy; Texas Water Development Board Report 316; January 1990.

Table 3.20 – Stratigraphy of the Lower Rio Grande Valley

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

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

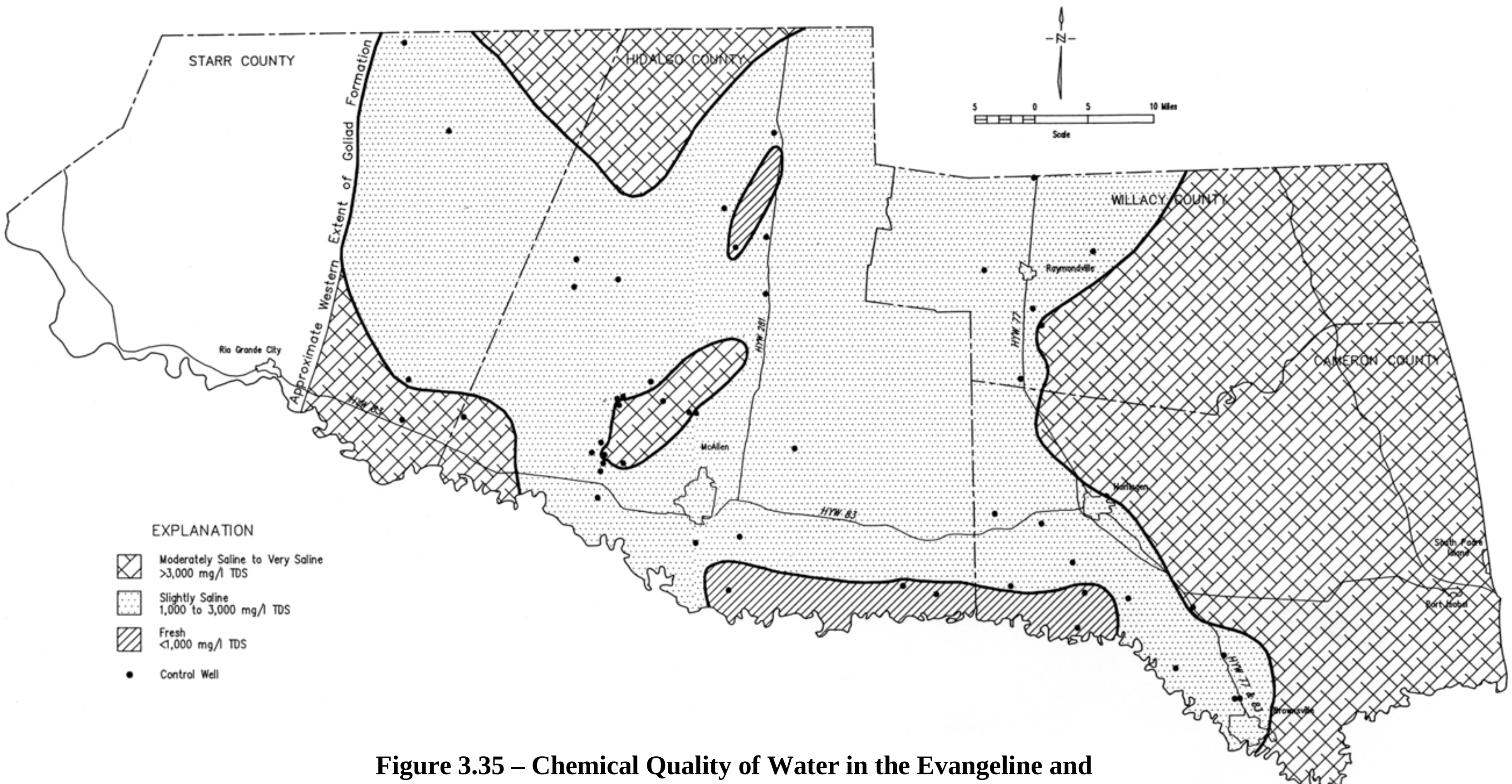

Figure 3.35 – Chemical Quality of Water in the Evangeline and Chicot Aquifers

of these areas is located in southeastern Hidalgo and southwestern Cameron counties and occurs in the alluvial and deltaic deposits of the Rio Grande Alluvium, and the other is located in north-central Hidalgo County and occurs in the shallow sediments found between the cities of Linn and Faysville. Scattered throughout the study area, many wells with depths of less than 100 feet have produced water with high nitrate levels. Additionally, wells drawing from the Oakville Sandstone in Starr, Willacy and northern Hidalgo counties can contain levels of sulfate in excess of 300 mg/L.

The TWDB well database was used to complete a more detailed water quality assessment of the Gulf Coast Aquifer. TWDB standard water quality constituent analytical results from wells within the region were compared to primary and secondary drinking water maximum contaminant level (MCL) when the database contained sufficient data. In the case of fluoride, the lower secondary MCL of 2 mg/L was used for comparison purposes. The standard water quality constituents studied were: sulfate, chloride, pH, TDS, nitrate, and fluoride.

TWDB infrequent water quality constituent analytical results were also compared to primary drinking water MCLs. Only constituents with primary drinking water MCLs and representative data records were selected for this effort. Only the most recent data for each well was used. The infrequent water quality constituents studied were: gross alpha, arsenic, barium, cadmium, chromium, copper, lead, and selenium. Organic and other regulated infrequent constituent data was very sparse and were not considered to be representative. Table 3-21 summarizes the results for the Gulf Coast Aquifer.

Following are summaries of the ground-water quality for specific constituents found in the Gulf Coast Aquifer.

Alpha

Eleven results for dissolved alpha particles exceeded the 15 pCi/L primary MCL in the Carrizo-Wilcox in Region M. Five of these were results from samples collected in the Catahoula Formation: three from wells in Bruni, one from a well in Oilton, and one from a well near Cuevitas. Two results that exceeded the MCL were collected from wells completed in the combined Beaumont Clay, Lissie Formation, and Goliad Sand in southeast Hidalgo County. The remaining four results were collected from wells in the Jasper Formation in Starr County, the Chicot in Cameron County, and the undifferentiated Gulf Coast in Jim Hogg and Cameron Counties. The alpha results are well distributed spatially in the Gulf Coast aquifer group in Region M.

Dissolved alpha particles exceeded the 15 pCi/L primary MCL in the Gulf Coast aquifer group in 17.5% of the results in Region M. The average for all of the results is 10 pCi/L, and the median for all of the results is 6 pCi/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Arsenic

Over one-third of available results for arsenic in the Gulf Coast aquifer group exceeded the 10 mg/L primary MCL. About one-third of the results that exceeded the MCL represented samples collected from wells completed in the Catahoula Formation in Webb, Starr, and Jim Hogg Counties. Several others represented samples collected from wells completed in the alluvium in Starr, Hidalgo, and Cameron Counties. Samples collected from wells completed in the Lissie Formation, the Goliad Sand, or a combination of the two in Starr, Hidalgo, Willacy, and Jim Hogg Counties accounted for another third of the results that exceeded the secondary MCL for arsenic. The remainder represented groundwater samples from wells in the Chicot (one result), the Evangeline (one result) and the undifferentiated Gulf Coast

Table 3-21. Summary of Groundwater Quality for the Gulf Coast Aquifer in the RGWPA

MCL Class	Constituent	Limit(s)	Units	Total Results	% Over Limit	Average	Median	Max	Min
primary	Alpha	15	µg/L	63	17.5%	10	6	74	0.5
primary	Arsenic	10	µg/L	160	36.3%	17	< 10	160	0.5
primary	Barium	2000	µg/L	161	0.0%	54	35	414	4
primary	Cadmium	5	µg/L	100	0.0%	< 1.3	< 1	< 5	< 1
primary	Chromium	100	µg/L	147	0.0%	10	7.4	36.4	< 1
primary	Lead	15	µg/L	119	1.7%	2	< 1	22	< 1
primary	Nitrate (as N)	10	mg/L	788	7.1%	3	0.63	85	0
primary	Selenium	50	µg/L	160	2.5%	12	6	64.7	1.6
secondary[a]	Fluoride	2	mg/L	442	12.4%	1	1	30	0
secondary[a]	Copper	1000	µg/L	160	0.0%	16	10	455	< 1
secondary	Sulfate	300	mg/L	823	56.3%	512	351	6300	6.8
secondary	Chloride	300	mg/L	823	67.6%	702	450	17900	14
secondary	pH	6.5 - 8.5		625	2.6%	7.7	7.6	9.7	6.51
secondary	Total Dissolved Solids	1000	mg/L	822	80.4%	2204	1618	37752	198
secondary	Iron	300	µg/L	218	21.1%	401	51	13600	0
secondary	Manganese	50	µg/L	170	21.2%	97	20	3300	0
advisory[b]	Boron	3750	µg/L	538	19.1%	2520	1700	25200	0

[a]Primary MCLs for fluoride (4 mg/L) and copper (1,300 µg/L) are higher than secondary MCLs.

[b]Advisory level for boron-tolerant crops

Aquifer (13 results). All the available results are well distributed spatially in the Gulf Coast aquifer group in Region M.

About 36% of available results for arsenic in the Gulf Coast aquifer group exceeded the 10 µg/L primary MCL. Arsenic was not detected in 32% of the results. The average for all of the results is 17 µg/L, and the median is less than 10 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Barium

No results for barium exceeded the 2,000 µg/L primary MCL in the Gulf Coast aquifer group in Region M. The available barium results were spatially well distributed within this region and aquifer group. Barium was not detected in any of the results above the 2,000 µg/L primary MCL in the Gulf Coast aquifer group in Region M. Barium was detected in more than 95% of the results, and the average for all of the results is 54 µg/L, and the median is 35 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Cadmium

Cadmium was not detected in any results in the Gulf Coast aquifer group in Region M, and so no results for cadmium exceeded the 5 µg/L primary MCL. The available cadmium results were spatially well distributed within this region and aquifer group. Most of the cadmium results for Region M were below detection limits, and the indicated color-coded values usually represent the detection limit for the result. There were 46 cadmium results that were below reporting limits that exceeded the current MCL (reporting limits greater than 5 µg/L). These results were not considered useful and were not included the figure or table for this aquifer group in Region M.

Chromium

No results for chromium exceeded the 100 µg/L primary MCL in the Gulf Coast aquifer group in Region M. The available chromium results were spatially well distributed within this region and aquifer group. Chromium was detected in less than 40% of the results, and the average for all of the results is 10 µg/L, and the median is 7.4 µg/L.

Lead

Two results for lead exceeded the 15 µg/L primary MCL in the Gulf Coast aquifer group in Region M. The available lead results were spatially well distributed within this region and aquifer group. There were 40 lead results were below reporting limits that exceeded the current MCL (reporting limits greater than 15 µg/L). These results were not included the figure for this aquifer group in Region M. Lead was detected in only 8% of the results in the Gulf Coast aquifer group in Region M, only two of which exceeded the 15 µg/L primary MCL. The average for all of the results is 2 µg/L, and the median for all of the results is less than 1 µg/L. There were 40 lead results with reporting limits greater than the 15 µg/L primary MCL. These results were not included the statistical calculations.

Nitrate as N

Several formations in the Gulf Coast aquifer group produced samples with nitrate results greater than the 10 mg/L (as N) primary MCL in Region M. These were: the Catahoula in central and northwestern Starr County, the Goliad Sand in northeastern Starr County, the Evangeline in southeastern Starr County, the Lissie and the Goliad Sand in central Hidalgo County near Linn, the generalized Gulf Coast Aquifer in southern Hidalgo County, and the Mercedes-Sebastian Aquifer southwestern Willacy County. With the exceptions of wells completed in the Catahoula and Evangeline formations, most of these results were from samples collected from shallow wells. The nitrate results available from most shallow alluvial wells did not appear elevated, although the most recent results from many of these wells were from samples collected in 1957. The available results were well distributed throughout the Gulf Coast aquifer group in Region M. Nitrate (as N) was detected in 7.1% of the results above the primary MCL of 10 mg/L in the Gulf Coast aquifer group in Region M. The average for all of the results is 3 mg/L, and the median for all of the results is 0.63 mg/L.

Selenium

Four results for lead exceeded the 50 µg/L primary MCL in the Gulf Coast aquifer group in Region M. There was no significant pattern to the results that exceeded the MCL. The available selenium results were spatially well distributed within this region and aquifer group. Selenium was detected above the 100 µg/L primary MCL in 2.5% of the results in the Gulf Coast aquifer group in Region M. Selenium was detected in approximately half of the results, and the average for all of the results is 12 µg/L, and the median is 6 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Copper

No results for copper exceeded the 1,000 µg/L secondary MCL or the 1,300 µg/L primary MCL in the Gulf Coast aquifer group in Region M. The available copper results were spatially well distributed within this region and aquifer group. Copper was detected in approximately half of the results, and the average for all of the results is 16 µg/L, and the median is 10 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Fluoride

Most formations in the Gulf Coast aquifer group produced samples with fluoride results greater than the 2 mg/L secondary MCL in the Gulf Coast aquifer group in Region M. These were: the Catahoula, the undifferentiated Gulf Coast Aquifer, Jasper, and Evangeline in central and northwestern Starr County; the Goliad Sand in northeastern Starr County; wells in the alluvium in southeastern Starr County; the Lissie and the Goliad Sand in Hidalgo County; and the undifferentiated Gulf Coast Aquifer in southern Hidalgo and Cameron Counties. There were also 11 results that exceeded the 4 mg/L primary MCL in the Gulf Coast aquifer group. Some extremely high values (11, 22, and 30 mg/L) were collected from wells in the Lissie and Goliad Sand formations in Hidalgo County. Other results exceeding the primary MCL were collected from wells completed in the undifferentiated Gulf Coast Aquifer in Hidalgo and Cameron Counties, and one result from a well completed in the Mercedes-Sebastian Aquifer in southern Willacy County.

Fluoride was detected in 12.4% of the results above the secondary MCL of 2 mg/L in the Gulf Coast aquifer group in Region M. Of these, 2.4% were also above the primary MCL of 4 mg/L. Fluoride was detected in 99% of the results, and the average for all of the results is 1 mg/L, and the median for all of the results is also 1 mg/L.

Chloride

Two-thirds of chloride samples in the Gulf Coast aquifer group in Region M exceeded the 300 mg/L secondary MCL. Two formations produced sample results that were often below the secondary MCL in certain areas: the Catahoula Formation in central Starr County and the undifferentiated Gulf Coast Aquifer in southern Cameron County. The available results were well distributed throughout the Gulf Coast aquifer group in Region M.

Chloride was detected in 67.6% of the results above the secondary MCL of 300 mg/L in the Gulf Coast aquifer group in Region M. The average for all of the results is 702 mg/L, and the median for all of the results is 450 mg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Iron

Approximately 21% of iron results in the Gulf Coast aquifer group in Region M exceeded the 300 µg/L secondary MCL. Formation-area combinations that produced a significant number of results that exceeded the MCL were those from wells completed in the Rio Grande Alluvium in Hidalgo and Cameron Counties, the undifferentiated Gulf Coast Aquifer in Cameron County, and the Goliad Sand in Willacy County. The available results were well distributed spatially throughout the Gulf Coast aquifer group in Region M.

Iron was detected in 21.1% of the results above the secondary MCL of 300 µg/L in the Gulf Coast aquifer group in Region M. Iron was detected in approximately 65% of the results, and the average for all of the results is 401 µg/L, and the median for all of the results is only 51 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Manganese

Several manganese results exceeded the 50 µg/L secondary MCL in the Gulf Coast aquifer group in Region M. A majority of results from the Rio Grande Alluvium in Hidalgo and Cameron Counties and the undifferentiated Gulf Coast Aquifer in Cameron County exceeded the secondary MCL. The only result available for the Mercedes-Sebastian Aquifer in Willacy County also exceeded the secondary MCL.

The available results were well distributed spatially throughout the Gulf Coast aquifer group in Region M.

Manganese was detected in 21.2% of the results above the secondary MCL of 50 µg/L in the Gulf Coast aquifer group in Region M. Manganese was detected in approximately 63% of the results, and the average for all of the results is 97 µg/L, and the median for all of the results is only 20 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

pH

A small number of the available pH results for the Gulf Coast aquifer group in Region M were outside of the 6.5 - 8.5 secondary MCL range. Of these results, all were more alkaline than the 8.5 upper pH limit. Most of these strongly alkaline results were from samples collected from wells completed in the undifferentiated Gulf Coast Aquifer in Cameron County. The available results were well distributed spatially throughout the Gulf Coast aquifer group in Region M. The pH of water samples was outside the secondary MCL range of 6.5 to 8.5 in 2.6% of the results in the Gulf Coast aquifer group in Region M. The range of all of the results was 6.51 to 9.7, and the average is 7.7, and the median is 7.6.

Sulfate

About 56% of sulfate chloride samples in the Gulf Coast aquifer group in Region M exceeded the 300 mg/L secondary MCL. However, several formations produced sample results that were often below the secondary MCL in certain areas: the Catahoula Formation in central Starr County, the Goliad Sand Formation in Jim Hogg and Starr Counties, the Evangeline Aquifer in southeastern Starr County, and the Lissie Formation near Linn in Hidalgo County. The available results were well distributed throughout the Gulf Coast aquifer group in Region M. Sulfate was detected in 56.3% of the results above the secondary MCL of 300 mg/L in the Gulf Coast aquifer group in Region M. The average for all of the results is 512 mg/L, and the median for all of the results is 351 mg/L.

Total Dissolved Solids

Over 80% of TDS results exceeded the 1,000 mg/L secondary MCL in the Gulf Coast aquifer group in Region M. The only formation-county combination in the Gulf Coast-Region M to have a majority of TDS results below the MCL was the Catahoula Formation in Webb County.

The total dissolved solids concentration was above the secondary MCL of 1,000 mg/L in 80.4% of the results in the Gulf Coast aquifer group in Region M. The average for all of the results is 2,204 mg/L, and the median for all of the results is 1,618 mg/L.

Boron

Generally, only wells identified as being completed in the undifferentiated Gulf Coast Aquifer in southern Hidalgo and Cameron Counties had boron concentrations below the 600 µg/L EPA suggested lifetime health advisory level. Most areas and formations also produced samples with boron concentrations above the 1,250 µg/L advisory level for sensitive crops suggested by Leeden, et al. Formation-area combinations that generally produced water above the 3,750 µg/L advisory level for tolerant crops were: the Goliad Sand in Willacy County, the Jasper in Starr County, and the Catahoula in Starr County. The available results were well distributed throughout the Gulf Coast aquifer group in Region M.

Boron was detected in 19.1% of the results above the advisory level for tolerant crops (Leeden et al, 1990) of 3,750 µg/L in the Gulf Coast aquifer group in Region M. The average for all of the results is 2,520 µg/L, and the median for all of the results is 1,700 µg/L.

3.10.2 Carrizo-Wilcox Aquifer

The Carrizo Sand Formation outcrops in a very small area in northwest Webb County and continues north into Dimmit, Zavala, and Maverick counties. It yields moderate to large quantities of fresh to slightly saline water. Groundwater quality and yield decrease with distance from the formation outcrop and are best down gradient of the outcrop in Dimmit and Zavala counties. The water remains fresh into northern Webb County, but yields decline as the formation dips southeastward. In central Webb County, total dissolved solids levels exceed 1,000 mg/L. Water quality and yield data from a few wells in southern and western Webb County suggest that the groundwater becomes more mineralized down-dip as aquifer permeability and yield decline.

The water quality of the Carrizo-Wilcox Aquifer was evaluated using the same approach as was used for the Gulf Coast Aquifer. The results of the detailed analysis are shown in Table 3.22.

Following are summaries of the ground-water quality for specific constituents found in the Carrizo-Wilcox Aquifer.

Alpha

No results for dissolved alpha particles exceeded the 15 pCi/L primary MCL in the Carrizo-Wilcox in Region M. The alpha results available were mostly collected from wells on or near the outcrop of the Carrizo-Wilcox in Region M. The average for all of the results is 6 pCi/L, and the median for all of the results is 4.55 pCi/L.

Arsenic

No results for arsenic exceeded the 10 µg/L primary MCL in the Carrizo-Wilcox in Region M. The arsenic results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Arsenic was detected in only two of the results. The average for all of the results is less than 3 µg/L, and the median is less than 2 µg/L.

Table 3.22 Summary of Groundwater Quality for the Carrizo-Wilcox Aquifer in the RGWPA

MCL Class	Constituent	Limit(s)	Units	Total Results	Results Over Limit	% Over Limit	Average	Median	Max	Min
primary	Arsenic	10	µg/L	13	0	0.0%	< 3	< 2	< 8	1.9
primary	Alpha	15	µg/L	8	0	0.0%	6	4.55	12	< 2
primary	Barium	2000	µg/L	13	0	0.0%	140	79	789	18.3
primary	Cadmium	5	µg/L	12	0	0.0%	< 2	< 1	< 2	< 0.5
primary	Chromium	100	µg/L	13	0	0.0%	13	8.36	98.4	< 1
primary	Lead	15	µg/L	13	0	0.0%	< 3	< 1	< 10	< 1
primary	Nitrate (as N)	10	mg/L	30	0	0.0%	2	0.4	14	0
primary	Selenium	50	µg/L	13	1	7.7%	12	4.01	105	< 4
secondary[a]	Fluoride	2	mg/L	30	1	3.3%	1	0.6	3.5	< 0.05
secondary[a]	Copper	1000	µg/L	14	0	0.0%	19	2.8	216	< 0.05
secondary	Sulfate	300	mg/L	30	4	13.3%	229	157.5	1699	9
secondary	Chloride	300	mg/L	30	5	16.7%	643	128.5	7494	19.1
secondary	pH	6.5 - 8.5		30	3	10.0%	7.7	7.7	8.8	6.31
secondary	Total Dissolved Solids	1000	mg/L	30	5	16.7%	1773	776.5	13596	270
secondary	Iron	300	µg/L	16	1	6.3%	81	50	423	0.09
secondary	Manganese	50	µg/L	14	3	21.4%	35	9.83	212	0.05
advisory[b]	Boron	3750	µg/L	12	1	8.3%	2080	575	19400	135.1

[a]Primary MCLs for fluoride (4 mg/L) and copper (1,300 µg/L) are higher than secondary MCLs.

[b]Advisory level for boron-tolerant crops

Barium
No results for barium exceeded the 2,000 µg/L primary MCL in the Carrizo-Wilcox in Region M. The barium results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Barium was detected in all of the results, and the average for all of the results is 140 µg/L, and the median is 79 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Cadmium
No results for cadmium exceeded the 5 µg/L primary MCL in the Carrizo-Wilcox in Region M. The cadmium results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Most of the cadmium results for Region M were below detection limits, and the indicated color-coded values usually represent the detection limit for the result.

Chromium
No results for chromium exceeded the 100 µg/L primary MCL in the Carrizo-Wilcox in Region M. The chromium results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Chromium was detected in approximately half of the results, and the average for all of the results is 13 µg/L, and the median is 8.36 µg/L.

Lead
No results for lead exceeded the 15 µg/L primary MCL in the Carrizo-Wilcox in Region M. The lead results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M.

Nitrate as N
No results for nitrate exceeded the 10 mg/L (as N) primary MCL in the Carrizo-Wilcox in Region M. The nitrate results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Nitrate (as N) was not detected above the primary MCL of 10 mg/L in any of

the results in the Carrizo-Wilcox aquifer in Region M. The average for all of the results is 2 mg/L, and the median for all of the results is 0.4 mg/L.

Selenium
One result for selenium exceeded the 50 µg/L primary MCL in the Carrizo-Wilcox in Region M. This result was from a well in the downdip Carrizo Sand in Webb County. Other results in the Carrizo-Wilcox indicated lower selenium concentrations on the outcrop and shallow downdip areas. Selenium was detected in less than half of the results, and the average for all of the results is 12 µg/L, and the median is 4 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Copper
No results for copper exceeded the 1,000 µg/L secondary MCL or the 1,300 µg/L primary MCL in the Carrizo-Wilcox in Region M. The copper results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. The average for all of the results is 19 µg/L, and the median is 2.8 µg/L, indicating that the average is significantly skewed upward due to the presence of a limited number of high values.

Fluoride
One result for fluoride exceeded the 2 mg/L secondary MCL in the Carrizo-Wilcox in Region M. No results exceeded the 4 mg/L primary MCL for fluoride. The result that exceeded the secondary MCL was from a well in the downdip Carrizo Sand in Webb County. Other results in the Carrizo-Wilcox indicated lower fluoride concentrations on the outcrop and shallow downdip areas.

Chloride
About 17% of available chloride results exceeded the 300 mg/L secondary MCL in the Carrizo-Wilcox in Region M. Most of the results that exceeded the secondary MCL were from samples collected from deep wells completed in the downdip Carrizo Sand. The average for all of the results is 643 mg/L, and the median for all of the results is 128.5 mg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Iron
One iron result exceeded the 300 µg/L secondary MCL in the Carrizo-Wilcox in Region M. This result was from a sample collected from a well in the downdip Carrizo Sand. The iron results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Iron was detected in approximately two-thirds of the results, and the average for all of the results is 81 µg/L, and the median for all of the results is only 50 µg/L.

Manganese
Three manganese results from the Carrizo-Wilcox in Region M exceeded the 50 mg/L secondary MCL. No significant pattern was observed in the manganese results. The manganese results available were collected from wells completed in both the outcrop of the Carrizo-Wilcox and downdip in Region M. Manganese was detected in approximately 80% of the results, and the average for all of the results is 35 µg/L, and the median for all of the results is approximately 10 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

pH

Three pH results were outside of the 6.5 - 8.5 secondary MCL range in Carrizo-Wilcox in Region M. Two of these results were more alkaline than the 8.5 upper limit; one result was more acid than the 6.5 lower limit. The pH results available tended to increase in the downdip wells. The range of all of the results was 6.31 to 8.8, and both the average and median are 7.7.

Sulfate
About 17% of available sulfate results exceeded the 300 mg/L secondary MCL in the Carrizo-Wilcox in Region M. Sulfate results tended to increase in wells located downdip in the Carrizo-Wilcox. The average for all of the results is 229 mg/L, and the median for all of the results is 157.5 mg/L.

Total Dissolved Solids
About 17% of available TDS results exceeded the 1,000 mg/L secondary MCL in the Carrizo-Wilcox in Region M. Like the chloride and sulfate that account for much of Total Dissolved Solis, these results tended to increase in wells located downdip in the Carrizo-Wilcox. The average for all of the results is 1,773 mg/L, and the median for all of the results is 776.5 mg/L.

Boron
Boron concentrations tended to increase with depth in the Carrizo-Wilcox in Region M. All results from the outcrop wells were below the EPA's 600 µg/L suggested lifetime health advisory level for drinking water, while most results from wells in downdip areas exceeded this value. Only one result exceeded either the 1,250 mg/L advisory level for sensitive crops or the 3,750 mg/L advisory level for tolerant crops suggested by Leeden, et al32. The average for all of the results is 2,080 µg/L, and the median for all of the results is 575 µg/L.

3.10.3 Yegua-Jackson Aquifer

The water quality of the Yegua-Jackson aquifer was evaluated using the same approach as was used for the Gulf Coast Aquifer. The results of the detailed analysis are shown in Table 3.23.

Following are summaries of the ground-water quality for specific constituents found in the Yegua-Jackson Aquifer.

Alpha
No results for dissolved alpha particles exceeded the 15 pCi/L primary MCL in the Yegua-Jackson in Region M. The alpha results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Alpha particles were detected in only one of the results. The average for all of the results is less than 8 pCi/L, and the median for all of the results is less than 4 pCi/L.

Arsenic
One result for arsenic exceeded the 10 µg/L primary MCL in the Yegua-Jackson in Region M. This result was from a sample collected from a well completed in the Jackson Group in southeastern Webb County. The remaining arsenic results available were mostly collected from wells on the southern end of the

Yegua-Jackson in Region M. Arsenic was detected in only one result. The average for all of the results is less than 3 µg/L, and the median is less than 2 µg/L.

[32] van der Leeden, F., F.L. Troise and D.K. Todd, 1990, The Water Encyclopedia, Lewis Publishers, 808p.

Barium

No results for barium exceeded the 2,000 µg/L primary MCL in the Yegua-Jackson in Region M. The barium results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Barium was detected in all of the results, and the average for all of the results is 98 µg/L, and the median is 21.85 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Cadmium

No results for cadmium exceeded the 5 µg/L primary MCL in the Yegua-Jackson in Region M. The cadmium results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. All of the cadmium results for Region M were below detection limits, and the indicated color-coded values usually represent the detection limit for the result.

Chromium

No results for chromium exceeded the 100 µg/L primary MCL in the Yegua-Jackson in Region M. The chromium results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Chromium was detected in only two of the results. The average for all of the results is less than 6 µg/L, and the median is less than 6 µg/L.

Table 3.23 – Summary of Groundwater Quality for the Yegua-Jackson Aquifer in the RGWPA

MCL Class	Constituent	Limit(s)	Units	Total Results	Results Over Limit	% Over Limit	Average	Median	Max	Min
primary	Arsenic	10	µg/L	9	1	11.1%	< 8	< 4	28.5	< 2
primary	Alpha	15	µg/L	9	0	0.0%	< 4	< 3	5.6	< 2
primary	Barium	2000	µg/L	10	0	0.0%	98	21.85	646	13.2
primary	Cadmium	5	µg/L	10	0	0.0%	< 3	< 2	< 5	< 1
primary	Chromium	100	µg/L	10	0	0.0%	< 6	< 6	10.1	< 1
primary	Lead	15	µg/L	10	0	0.0%	< 4	< 5	< 5	< 1
primary	Nitrate (as N)	10	mg/L	33	2	6.1%	1	0.1	12	0
primary	Selenium	50	µg/L	10	0	0.0%	< 10	< 6	6.9	< 2
secondary[a]	Fluoride	2	mg/L	22	1	4.5%	1	0.44	3.39	< 0.1
secondary[a]	Copper	1000	µg/L	10	0	0.0%	8	7.58	19.8	< 2
secondary	Sulfate	300	mg/L	38	26	68.4%	700	504	2026	1.47
secondary	Chloride	300	mg/L	38	34	89.5%	1477	755	15800	17
secondary	pH	6.5 - 8.5		38	2	5.3%	7.7	7.90	8.8	6.88
secondary	Total Dissolved Solids	1000	mg/L	38	35	92.1%	3746	2607	25930	502
secondary	Iron	300	µg/L	14	4	28.6%	666	159	4240	10
secondary	Manganese	50	µg/L	10	1	10.0%	29	19.95	121	5.01
advisory[b]	Boron	3750	µg/L	26	8	30.8%	4278	2350	15000	0.062

[a]Primary MCLs for fluoride (4 mg/L) and copper (1,300 µg/L) are higher than secondary MCLs.

[b]Advisory level for boron-tolerant crops

Lead

No results for lead exceeded the 15 µg/L primary MCL in the Yegua-Jackson in Region M, and no lead was detected. The lead results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M.

Nitrate as N

Two results for nitrate exceeded the 10 mg/L (as N) primary MCL in the Yegua-Jackson in Region M. These results were from samples collected from two shallow wells completed in the Jackson Group in Starr County. Deeper wells in the Jackson Group in this area had much lower nitrate results. The nitrate results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Nitrate (as N) was detected above the primary MCL of 10 mg/L in 6.1% of the results in the Yegua-Jackson aquifer in Region M. The average for all of the results is 1 mg/L, and the median for all of the results is 0.1 mg/L.

Selenium

No results for selenium exceeded the 50 µg/L primary MCL in the Yegua-Jackson in Region M. The selenium results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M.

Selenium was detected in only one of the results. The average for all of the results is less than 10 µg/L, and the median is less than 6 µg/L.

Copper

No results for copper exceeded the 1,000 µg/L secondary MCL or the 1,300 µg/L primary MCL in the Yegua-Jackson in Region M. The copper results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. The average for all of the results is 8 µg/L, and the median is 7.58 µg/L.

Fluoride

One result for fluoride exceeded the 2 mg/L secondary MCL in the Yegua-Jackson in Region M. This result was from a sample collected from a well completed in the Yegua Formation in southeastern Webb County. No fluoride results exceeded the 4 mg/L primary MCL. The remaining fluoride results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Fluoride was detected in only one of the results, and the average for all of the results is 1 mg/L, and the median for all of the results is 0.44 mg/L.

Chloride

Almost all the chloride results exceeded the 300 mg/L secondary MCL in Region M. The results that were less than the secondary MCL tended to be from the few wells less than 200 feet deep. Most of the available results represented the southern Yegua-Jackson in Region M. Chloride was detected in 89.5% of the results above the secondary MCL of 300 mg/L in the Yegua-Jackson aquifer in Region M. The average for all of the results is 1,477 mg/L, and the median for all of the results is 755 mg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Iron

Four results for iron exceeded the 300 µg/L secondary MCL in the Yegua-Jackson in Region M. Approximately half of the results available in both the Yegua Formation and the Jackson Group appear elevated with respect to iron. The iron results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Iron was detected above the secondary MCL of 300 µg/L in 28.6% of the results in the Yegua-Jackson aquifer in Region M. Iron was detected in nearly all of the results, and the average for all of the results is 666 µg/L, and the median for all of the results is 159 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Manganese

One result for manganese exceeded the 50 µg/L secondary MCL in the Yegua-Jackson in Region M. No significant pattern was observed in the manganese results in this aquifer group in Region M. The manganese results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Manganese was detected in 10% of the results above the secondary MCL of 50 µg/L in the Yegua-Jackson aquifer in Region M. Manganese was detected in all of the results, and the average for all of the results is 29 µg/L, and the median for all of the results is 19.95 µg/L.

pH

Two pH results were outside of the secondary MCL range of 6.5 to 8.5 in the Yegua-Jackson in Region M. Both of these were more alkaline than the secondary MCL. No significant pattern was observed in the pH results in this aquifer group in Region M. The pH results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. The pH of water samples was outside the secondary MCL range of 6.5 to 8.5 in 5.3% of the results in the Yegua-Jackson aquifer in Region M. The range of all of the results was 6.88 to 8.8. The average pH was 7.7, and the median pH was 7.90.

Sulfate

Over two-thirds of sulfate results exceeded the 300 mg/L secondary MCL. Almost all samples collected from wells in the Yegua Formation exceeded the MCL, and about half of samples collected from wells in the Jackson Group exceeded the MCL. The results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Sulfate was detected in 68.4% of the results above the secondary MCL of 300 mg/L in the Yegua-Jackson aquifer in Region M. The average for all of the results is 700 mg/L, and the median for all of the results is 504 mg/L.

Total Dissolved Solids

About 92% of TDS results exceeded the 1,000 mg/L secondary MCL. No significant spatial trends were observed in the TDS results. The results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. The total dissolved solids concentration was above the secondary MCL of 1,000 mg/L in 92.1% of the results in the Yegua-Jackson aquifer in Region M. The average for all of the results is 3,746 mg/L, and the median for all of the results is 2,607 mg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

Boron

Almost all Yegua-Jackson boron results were above the 600 µg/L EPA suggested lifetime health advisory level. Most areas and formations also produced samples with boron concentrations above the 1,250 µg/L advisory level for sensitive crops suggested by Leeden, et al. About one-quarter of results were above the 3,750 µg/L advisory level for tolerant crops. No spatial or geological pattern was observed in these results. The results available were mostly collected from wells on the southern end of the Yegua-Jackson in Region M. Boron was detected above the advisory level for tolerant crops (Leeden et al, 1990) of 3,750 µg/L in only one of the results in the Yegua-Jackson aquifer in Region M. The average for all of the results is 4,278 µg/L, and the median for all of the results is 2,350 µg/L, indicating that the average is skewed upward due to the presence of a limited number of high values.

3.10.4 Other Aquifers

The Catahoula Formation has a very narrow outcrop area in southeast Webb County that extends northeast into Duval County. It yields small amounts of highly mineralized water at the outcrop, and moderate quantities of fresh to slightly saline water at confined depths in southeast Webb County. Water quality is a concern in this formation due to the presence of arsenic and other metals in concentrations exceeding the limits for potable water. The Jackson Group has a substantial outcrop area in Webb County, but it is also a minor aquifer. It yields variable amounts of slightly to highly saline water. The Yegua Formation outcrops across Webb and La Salle counties. It is often ferruginous (iron bearing) and yields small to moderate quantities of slightly to moderately saline water.

The Laredo Formation yields small to moderate quantities of fresh to slightly saline water to wells in Webb County and also outcrops across Webb and La Salle counties. The El Pico Clay outcrops in Webb, Dimmit, and Zavala counties, but yields only small amounts of highly mineralized water. The Bigford Formation is a minor aquifer that outcrops in northwestern Webb County and to the north-northeast through Dimmit County. Groundwater from wells in the Bigford Formation is usually highly mineralized.

3.10.4.1 Rio Grande Alluvium

The material composing the Rio Grande alluvium is highly variable from one location to another. The alluvium has generally been divided into three layers or zones: shallow (less than 75 feet), middle (75 to 150 feet), and deep (150 to 225 feet). Yields are generally higher in the deeper zone and closer to the river. Recharge is primarily through interaction with the river, with some surface recharge. Water levels have generally been stable. There is currently additional research being done by the TWDB to further identify the thickness and properties of this groundwater source.

Water quality data is assigned to one of three zones defined by depth: shallow (50-100 feet below the land surface), middle (100 to 300 feet below the land surface) and lower (more than 300 feet below the land surface) for the Lower Rio Grande Valley aquifer (now referred to as the Gulf Coast aquifer).

Shallow Zone **-** In the area near Mission, the shallow zone is characterized by highly mineralized water that is unsuitable for most uses, except for the southern portion near the Rio Grande. Water samples taken in 1983 from some of the shallow zone wells revealed excessive levels of nitrate. In Cameron County, the shallow zone (depths less than 75 feet) was found to produce limited amounts of very poor quality ground water with dissolved solids ranging from 1,170 to 37,800 mg/L.

Middle Zone **-** Water samples from the middle zone indicate fresh to slightly saline water, with about 25 percent of the wells sampled also containing excessive nitrate levels in the area near Mission. The middle zone is not considered suitable for irrigation purposes due to its high salinity and sodium (alkali) hazards. Water drawn from this zone has yielded concentrations of dissolved solids and chlorides that appear to increase to the east and southeast in the range of 1,180 to 13,450 mg/L. Water quality data reported for wells in the area just west of Brownsville suggest that the middle zone may be in direct hydraulic contact with the shallow zone as indicated by high mineral concentrations.

Lower Zone **-** The lower zone is considered to contain better water quality than the other two zones. Water samples have indicated fresh to slightly saline water with nitrate levels found to be within safe limits (<45 mg/L). Nevertheless, this zone is generally considered not to be suitable for irrigation due to its high salinity and sodium (alkali) hazards. A few deep wells have produced groundwater of relatively good quality in an area north of the City of Brownsville along the Rio Grande. From there, the salinity of ground water produced from the deep zone increases steadily toward the southeast, east, northeast, and north, especially in the concentrations of sodium, sulfate, chloride, and dissolved solids.

3.10.4.2 Laredo Formation

The Laredo formation yields small to moderate quantities of fresh to slightly saline water to wells in Webb County. The total dissolved solids concentrations range from 1,000 to 3,000 mg/L. This formation has been identified as one of the potential alternative groundwater supply sources for the City of Laredo.

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CHAPTER 4.0: IDENTIFICATION, EVALAUTION, & SELECTION OF WATER MANAGEMENT STRATEGIES BASED ON NEEDS

In accordance with the Regional Planning Guidelines as indicated in Exhibit B 4.2.6 "All potential WMSs shall be included for and those selected as final recommendations should be annotated as such. The Planning Group shall evaluate potentially feasible WMSs for each WUG when future water supply needs are known to exist."

The primary emphasis of the regional water supply planning process established by Senate Bill (SB) 1 is the identification of current and future water needs and the development of strategies for meeting those needs. This chapter presents the results of the evaluation of various water management strategies; a conceptual framework and overview of the water management strategies recommended for implementation within the Rio Grande Region; and specific recommendations to meet the identified water supply shortages of individual water user groups (WUGs).

4.1. TWDB Guidelines for Preparation of Regional Water Plans

By rule, the Texas Water Development Board (TWDB) has set forth specific requirements for the preparation of regional water plans (31 Texas Administrative Code, Chapter 357). With regard to recommendations for meeting identified water supply needs, the regional water plans are to include:

- Specific recommendations for meeting near-terms needs (2010-2040) in sufficient details to allow the TWDB and the Texas Natural Resource Conservation Commission (TNRCC) to make financial assistance or regulatory decisions with regard to the consistency of the proposed action with an approved regional water plan.
- Specific recommendations or alternative scenarios for meeting long-term needs (2040-2060).

It should be noted, however, that TWDB rules provide that a regional water plan may also identify water needs for which no water management strategy is feasible, provided applicable strategies are evaluated and reasons are given as to why no strategies are feasible. For the Rio Grande Region, there are no feasible strategies for meeting a portion of the projected irrigation shortages. This will be explained in detail in subsequent sections of this chapter.

According to TWDB rules, potentially feasible water management strategies are to be evaluated by considering:

- The quantity, reliability, and cost of water delivered and treated for the end user's requirements;
- Environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico;
- Impacts on other water resources of the state including other water management strategies and groundwater surface water interrelationships;
- Impacts of water management strategies on threats to agricultural and natural resources;
- Any other factors deemed relevant by the regional water planning group including recreational impacts;
- Equitable comparison and consistent application of all water management strategies the regional water planning group determines to be potentially feasible for each water supply need;
- Consideration of the provisions in Texas Water Code, Section 11.085(k)(1) for interbasin transfers; and,
- Consideration of third party social and economic impacts resulting from voluntary redistributions of water.

In January 2000, the Rio Grande RWPG adopted a two-tiered approach to the evaluation of water management strategies. The first tier of criteria focused on the estimated water supply yield, cost, and environmental impact of each water management strategy. According to TWDB guidelines, yield is the quantity of water that is available from a particular strategy under drought-of-record hydrologic conditions. The cost of implementing a strategy includes the estimated capital or construction costs, total annual cost, and the unit cost expressed as dollars per acre-foot of yield. As indicated, cost estimates include the cost of water delivered and treated for end-user requirements. For example, water supplied to a municipal water user would typically include costs for diversion and delivery, as well as capital and O&M costs for treatment to meet current state and federal drinking water standards and distribution to the end user. Cost estimates were prepared in consideration of TWDB guidelines regarding interest rates, debt service, other project costs (e.g., environmental studies, permitting, and mitigation). In addition to environmental considerations that are included in estimates of cost for each strategy, environmental impacts were considered and assessed at a reconnaissance level.

The second tier of evaluation included consideration, as appropriate, of other factors outlined in TWDB rules, for example, impacts on recreation, third-party impacts, impacts on agricultural and natural resources.

4.2. Comparison of Water Demands with Water Supplies to Determine Needs

This chapter compares the water demand projections discussed in Chapter 2 with the water supply projections presented in Chapter 3. The objective is to determine which water users within the Rio Grande Region will have more water supplies than they will need during the planning period and which will fall short. As required by the TWDB, this comparison considers each "city, county and portion of a river basin within the regional water planning area for major providers of municipal and manufacturing water, and for categories of water use including municipal, manufacturing, irrigation, steam electric power generation, mining and livestock watering." In this analysis, a water supply "need" means that current or projected demands are greater than supply, producing a water supply "deficit" or shortage. Supply in "excess" of demand, on the other hand, results in a water supply "surplus" for the particular user. It is the water supply deficits and shortages that will require new water supply strategies in order to satisfy future projected demands.

The Rio Grande region faces significant water supply needs, as indicated in Table 4.1, even though there are surpluses of water available for some categories of use in some counties in some years, as indicated in Table 4.2. These tables summarize total water supply needs and excess supplies by category of use for the Rio Grande Region for each decade of the planning period. Following are detailed projections of water needs and excess supplies by each category of use: municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock. Projected demands are also provided for each of the two river basins and the one coastal basin that are encompassed within the Rio Grande Region. A list of the Wholesale Water Providers for the region is located in Table 4.3.

Table 4.1: Water Supply Needs for the Rio Grande Region by Category of Use (acre-feet/year)

Category of Use	2010	2020	2030	2040	2050	2060
Municipal	23,936	61,064	113,978	174,120	245,148	321,248
Manufacturing	1,921	2,355	2,748	3,137	3,729	4,524
Irrigation	410,637	336,224	242,442	248,903	255,366	261,330
Steam Electric	0	1,980	4,374	7,291	11,214	16,382
Mining	0	0	0	0	0	0
Livestock	1	1	1	1	1	1
TOTAL WATER NEEDS (ac-ft/yr)	**436,494**	**401,623**	**363,542**	**433,451**	**515,457**	**603,484**

Table 4.2: Water Supply Surpluses for the Rio Grande Region by Category of Use (acre-feet/year)

Category of Use	2010	2020	2030	2040	2050	2060
Municipal	66,272	43,847	32,027	22,960	18,355	16,059
Manufacturing	962	634	338	42	34	29
Irrigation	0	0	212	185	158	133
Steam Electric	2,753	1,332	874	315	0	0
Mining	755	747	736	726	717	704
Livestock	0	0	0	0	0	0
TOTAL WATER SURPLUS (ac-ft/yr)	**70,742**	**46,560**	**34,187**	**24,228**	**19,264**	**16,925**

Table 4.3: Wholesale Water Providers Surplus/Deficit Analysis

	2010	2020	2030	2040	2050	2060
Brownsville Irrigation & Drainage District	0	0	0	1	1	0
Cameron County WCID #2	0	0	0	0	0	0
Delta Lake Municipal Authority	0	0	0	0	0	0
Donna Irrigation District Hidalgo County #1	0	0	0	0	0	0
City of Eagle Pass	0	0	0	0	0	0
Harlingen Irrigation District	0	0	0	0	0	0
Harlingen Waterworks System	0	0	1	0	0	0
Hidalgo County Irrigation District #6	0	0	0	0	0	0
Hidalgo County WCID#1	0	0	0	0	0	0
Hidalgo County WCID#16	0	0	0	0	0	0
Hidalgo County WCID#2	0	0	0	0	0	0
Hidalgo County WCID#3	0	0	0	0	0	0
Hidalgo County WCID#9	0	0	0	0	0	0
La Feria WCID#3	0	0	0	0	0	0
Laguna Madre WD	0	0	0	0	0	0
City of McAllen	0	0	0	0	0	0
Sharyland WSC	0	0	0	0	0	0
Southmost Regional Water Authority	-11,844	-11,844	-11,844	-11,844	-11,844	-11,844

United Irrigation District	-4,394	-4,394	-4,394	-4,394	-4,394	-4,394
Valley MUD#2	0	0	0	1	0	1
North Alamo WSC	0	0	0	-2,450	-7,465	-12,565

4.2.1.Municipal Water Needs

Municipal water needs in the Rio Grande Region are projected to increase dramatically over the 50-year planning period, as a growing demand for water outstrips currently available water supplies. As shown in Figure 4.1 below, regional water supply deficiencies for municipal use are projected to increase from approximately 23,936 acre-feet per year (ac-ft/yr) in the year 2010 to more than 321,248 ac-ft/yr in 2060.

Figure 4.1: Municipal Water Needs Summary

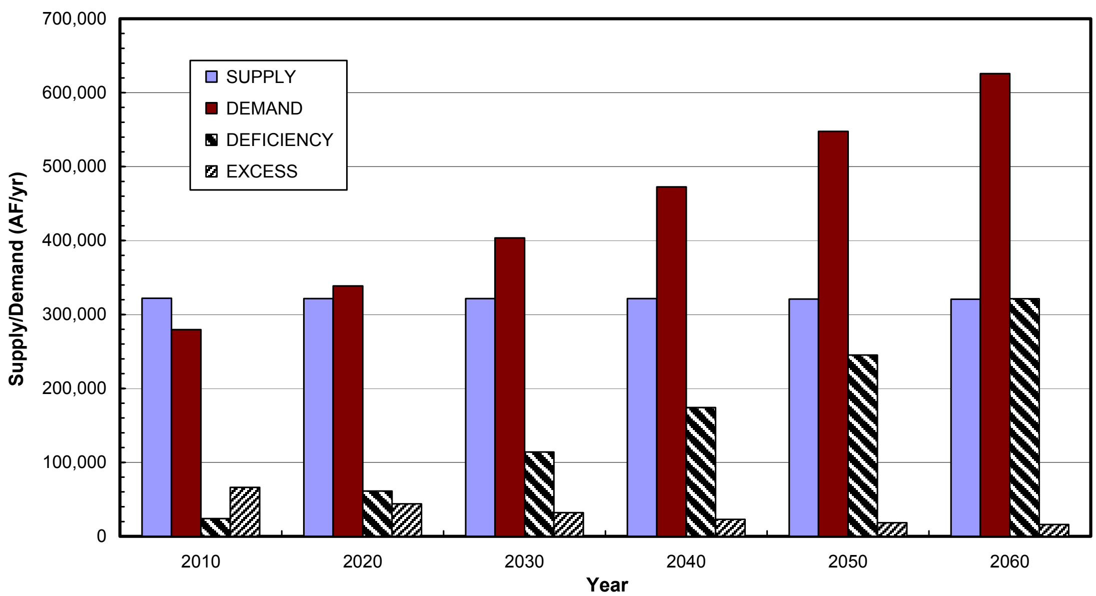


Figure 4.1 shows that total municipal demand will exceed total supplies beginning around the year 2020. However, this regional summary does not reflect the fact that some entities have secured water supplies in excess of projected demand for the entire planning period while others already are facing deficiencies. A county-by-county summary of the region's municipal water needs follows.

4.2.1.1.Cameron County - Municipal Summary

By 2010, eight communities or water supply corporations out of the 23 municipal water supply entities located in Cameron County are expected to experience water supply deficits. By 2030, six additional cities in the county are projected to have deficits, as shown in Table 4.4. A total of 21 of the 23 municipal water supply entities are projected to have deficits by the year 2050.

Table 4.4: Municipal Water Surplus/Needs for Cameron County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Brownsville	Nueces-Rio Grande	-6459	-14777	-23149	-31877	-40524	-49050
Brownsville	Rio Grande	-110	-175	-240	-308	-375	-442
Combes	Nueces-Rio Grande	222	201	174	149	121	89
East Rio Hondo WSC	Nueces-Rio Grande	2,638	1,939	1,184	491	-277	-1,006
El Jardin	Nueces-Rio Grande	-309	-729	-1,165	-1,607	-2,045	-2,482
El Jardin	Rio Grande	-1	-3	-6	-8	-10	-13
Indian Lake	Nueces-Rio Grande	-18	-26	-35	-45	-54	-64
Harlingen	Nueces-Rio Grande	5,247	3,841	2,446	1,017	-488	-2,022
Laguna Madre WD	Nueces-Rio Grande	1,638	562	-568	-1,674	-2,796	-3,864
La Feria	Nueces-Rio Grande	945	769	586	397	213	23
Laguna Vista	Nueces-Rio Grande	754	699	640	578	519	458
Los Fresnos	Nueces-Rio Grande	335	94	-145	-388	-643	-886
Los Indios	Nueces-Rio Grande	0	0	0	0	0	0
Military Highway WSC	Nueces-Rio Grande	1058	727	369	-45	-481	-930
Military Highway WSC	Rio Grande	15	11	5	-1	-7	-13
Olmita WSC	Nueces-Rio Grande	44	-318	-695	-1064	-1448	-1813
Palm Valley	Nueces-Rio Grande	-82	-121	-159	-194	-232	-267
Palm Valley Estates UD	Nueces-Rio Grande	-4	-14	-28	-43	-61	-78
Port Isabel	Nueces-Rio Grande	-1,889	-2,090	-2,296	-2,498	-2,714	-2,925
Primera	Nueces-Rio Grande	59	-44	-146	-254	-361	-469
Rancho Viejo	Nueces-Rio Grande	809	686	555	427	294	167
Rio Hondo	Nueces-Rio Grande	486	462	437	415	387	357
San Benito	Nueces-Rio Grande	2116	1548	982	402	-209	-831
Santa Rosa	Nueces-Rio Grande	569	524	471	422	369	312
South Padre Island	Nueces-Rio Grande	-750	-1382	-2035	-2689	-3341	-3968
Valley Mud 2	Nueces-Rio Grande	129	-387	-422	-457	-494	-532
Valley Mud 2	Rio Grande	22	5	-14	-31	-51	-69
County-Other	Nueces-Rio Grande	8,652	7,758	6,814	5,900	4,940	3,955
County-Other	Rio Grande	-8	-9	-12	-13	-15	-17
SUM OF DEFICITS		**-9,630**	**-20,075**	**-31,115**	**-43,196**	**-56,626**	**-71,741**
SUM OF EXCESS SUPPLIES		**25,738**	**19,826**	**14,663**	**10,198**	**6,843**	**5,361**

4.2.1.2.Hidalgo County - Municipal Summary

Six cities in Hidalgo County are projected to have a need for additional water supply in 2010. By 2030, 12 of the county's 25 municipal water suppliers plus its rural areas will experience deficits. Water needs for the county are projected to increase more than 50-fold in 50 years, from approximately 2,300 ac-ft/yr in 2010 to more than 131,000 ac-ft/yr in 2060, as shown in Table 4.5.

Table 4.5: Municipal Water Surplus/Needs for Hidalgo County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Alamo	Nueces-Rio Grande	-65	-768	-1,554	-2,421	-3,413	-4,430
Alton	Nueces-Rio Grande	0	0	-2,446	-3,419	-4,482	-5,602
Donna	Nueces-Rio Grande	1,881	1,625	1,348	1,034	669	266
Edcouch	Nueces-Rio Grande	841	793	736	672	596	512
Edinburg	Nueces-Rio Grande	2,451	297	-2,242	-4,803	-7,858	-10,992
Elsa	Nueces-Rio Grande	741	706	658	608	537	457
Hidalgo	Nueces-Rio Grande	690	319	-80	-519	-1,023	-1,541
Hidalgo	Rio Grande	-42	-57	-73	-91	-112	-133
Hidalgo Cty MUD	Nueces-Rio Grande	-1,319	-2,003	-2,777	-3,610	-4,531	-5,476
La Joya	Nueces-Rio Grande	239	220	200	178	152	123
La Joya	Rio Grande	-135	-179	-226	-279	-340	-408
La Villa	Nueces-Rio Grande	266	270	275	279	282	282
McAllen	Nueces-Rio Grande	3,731	-1,123	-6,797	-12,837	-19,601	-26,781
McAllen	Rio Grande	0	0	-1	-2	-3	-4
Mercedes	Nueces-Rio Grande	3,396	3,330	3,238	3,144	3,001	2,833
Military Hwy WSC	Nueces-Rio Grande	962	632	314	-38	-408	-801
Military Hwy WSC	Rio Grande	10	7	4	0	-4	-9
Mission	Nueces-Rio Grande	-269	-2,969	-5,999	-9,197	-12,934	-16,768
North Alamo WSC	Nueces-Rio Grande	8,983	5,627	1,853	-2,345	-7,180	-12,150
Palmhurst	Nueces-Rio Grande	0	0	209	-296	-929	-1,633
Palmview	Nueces-Rio Grande	0	0	0	0	-447	-906
Penitas	Nueces-Rio Grande	13	13	13	13	9	3
Pharr	Nueces-Rio Grande	1,307	-589	-2,730	-5,106	-7,667	-10,421
Progresso	Nueces-Rio Grande	0	0	0	0	0	0
San Juan	Nueces-Rio Grande	-478	-1,642	-2,933	-4,361	-6,008	-7,697
Sharyland WSC	Nueces-Rio Grande	1,624	-391	-397	-1,331	-2,296	-3,335
Sullivan City	Rio Grande	159	186	184	13	-197	-411
Weslaco	Nueces-Rio Grande	2547	1880	1115	262	-711	-1762
County-Other	Nueces-Rio Grande	1,028	-2,179	-5,775	-9,722	-14,197	-18,779
County-Other	Rio Grande	60	-187	-409	-652	-927	-1210
SUM OF DEFICITS		**-2,308**	**-12,087**	**-34,439**	**-61,029**	**-95,268**	**-131,249**
SUM OF EXCESS SUPPLIES		**30,929**	**15,905**	**10,147**	**6,203**	**5,246**	**4,476**

4.2.1.3. Jim Hogg County - Municipal Summary

Jim Hogg County currently indicates no water supply shortages for the only major city located in the region (Hebbronville), as shown in Table 4.6. However, the County-Other water user categories, which incorporate rural demands, show small shortages over the planning period. The total supply shortage for the County-Other category ranges from 67 ac-ft/yr to 72 ac-ft/yr.

Table 4.6: Municipal Water Surplus/Needs for Jim Hogg County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Hebbronville	Nueces-Rio Grande	169	141	120	108	122	152
County-Other	Nueces-Rio Grande	-60	-66	-70	-73	-71	-65
County-Other	Rio Grande	-7	-7	-8	-8	-8	-7
SUM OF DEFICITS		**-67**	**-73**	**-78**	**-81**	**-79**	**-72**
SUM OF EXCESS SUPPLIES		**169**	**141**	**120**	**108**	**122**	**152**

4.2.1.4. Maverick County - Municipal Summary

The most significant municipal water supply need in Maverick County occurs in the Rio Grande basin portion of the County-Other category. This need, estimated to be 280 ac-ft/yr by the year 2010, is projected to increase to over 2,400 ac-ft/yr in 2060. Table 4.7 presents the water surplus or deficit for each city or County-Other area in Maverick County.

Table 4.7: Municipal Water Surplus/Needs for Maverick County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2,050	2,060
Eagle Pass	Rio Grande	1,522	1,017	538	139	-272	-641
El Indio WSC	Rio Grande	0	0	0	0	0	0
County-Other	Nueces	253	252	251	250	249	249
County-Other	Rio Grande	-280	-801	-1293	-1733	-2122	-2,475
SUM OF DEFICITS		**-280**	**-801**	**-1293**	**-1733**	**-2,394**	**-3,116**
SUM OF EXCESS SUPPLIES		**1,775**	**1,269**	**789**	**389**	**249**	**249**

The City of Eagle Pass now has absorbed the El Indio WSC service area and is now supplying these users with municipal water. While the TWDB approved demand projections for Eagle Pass and El Indio are not being formally amended at this time, Table 4.7 shows that the demand for El Indio will be met by the City of Eagle Pass throughout the planning horizon. The City of Eagle Pass intends to request formal amendment of the Rio Grande Regional Water Plan to incorporate the El Indio WSC demands. The shortages for Eagle Pass in 2050 and 2060 are the result of fully supplying the El Indio WSC demands.

4.2.1.5. Starr County - Municipal Summary

Total municipal water supply deficits in Starr County are projected to increase from approximately 5,500 ac-ft/yr in 2010 to approximately 16,000 ac-ft/yr in the year 2060. During this period, excess supplies are projected to decrease from about 660 ac-ft/yr down to about 250 ac-ft/yr. Table 4.8 presents the water surplus or deficit for each city or County-Other area in Starr County.

Table 4.8: Municipal Water Surplus/Needs for Starr County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2050
La Grulla	Rio Grande	-117	-113	-109	-105	-102	-102
Rio Grande City	Rio Grande	-96	-272	-478	-662	-874	-1097
Roma Los-Saenz	Rio Grande	120	-211	-555	-909	-1270	-1634
RIO WSC	Rio Grande	-174	-314	-462	-603	-753	-896
County-Other	Nueces-Rio Grande	539	483	426	367	309	251
County-Other	Rio Grande	-5,161	-6,540	-7,961	-9,424	-10,844	-12,276
SUM OF DEFICITS		**-5,548**	**-7,450**	**-9,565**	**-11,703**	**-13,843**	**-16,005**
SUM OF EXCESS SUPPLIES		**659**	**483**	**426**	**367**	**309**	**251**

4.2.1.6. Webb County - Municipal Summary

Webb County has projected water supply needs of approximately 5,500 ac-ft/yr by 2010. By 2060, these needs are projected to reach almost 97,000 ac-ft/yr. The City of Laredo, Webb County WID and portions of the County-Other water user categories will have shortages over the planning period. Table 4.9 presents the water surplus or deficit for each city or County-Other area in Webb County.

Table 4.9: Municipal Water Surplus/Needs for Webb County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
El Cenizo	Rio Grande	209	-58	-375	-726	-1128	-1554
Laredo	Rio Grande	-5,293	-18,858	-34,374	-51,672	-70,422	-90,774
Webb County WID	Rio Grande	-42	-140	-245	-363	-494	-633
Rio Bravo	Rio Grande	144	-285	-736	-1,232	-1,789	-2,374
County-Other	Nueces	-19	-38	-58	-82	-108	-138
County-Other	Nueces-Rio Grande	-30	-57	-88	-122	-162	-207
County-Other	Rio Grande	-148	-289	-448	-627	-832	-1,058
SUM OF DEFICITS		**-5,532**	**-19,725**	**-36,324**	**-54,824**	**-74,935**	**-96,738**
SUM OF EXCESS SUPPLIES		**353**	**0**	**0**	**0**	**0**	**0**

4.2.1.7. Willacy County - Municipal Summary

In Willacy County, water shortages have been identified for the city of Sebastian beginning in 2030. North Alamo WSC and the City of San Perlita are expected to experience shortages in 2040 and 2050 respectively. Table 4.10 presents the water surplus or deficit for each city or County-Other area in Willacy County.

Table 4.10: Municipal Water Surplus/Needs for Willacy County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Lyford	Nueces-Rio Grande	683	673	667	663	658	654
North Alamo WSC	Nueces-Rio Grande	563	316	94	-105	-285	-415
Raymondville	Nueces-Rio Grande	3,989	3,969	3,955	3,953	3,940	3,927
San Perlita	Nueces-Rio Grande	15	8	3	0	-4	-6
Sebastian	Nueces-Rio Grande	44	3	-33	-62	-82	-93
County-Other	Nueces-Rio Grande	483	366	259	159	57	58
SUM OF DEFICITS		**0**	**0**	**61**	**-167**	**-371**	**-514**
SUM OF EXCESS SUPPLIES		**5,777**	**5,335**	**4,884**	**4,775**	**4,655**	**4,639**

4.2.1.8. Zapata County - Municipal Summary

The City of Zapata has secured adequate water supplies to meet demand throughout the planning period. The total County-Other deficit is projected to increase from about 579 ac-ft/yr in 2010 to more than 1,800 ac-ft/yr in 2060. Table 4.11 presents the water surplus or deficit for each city or County-Other area in Zapata County.

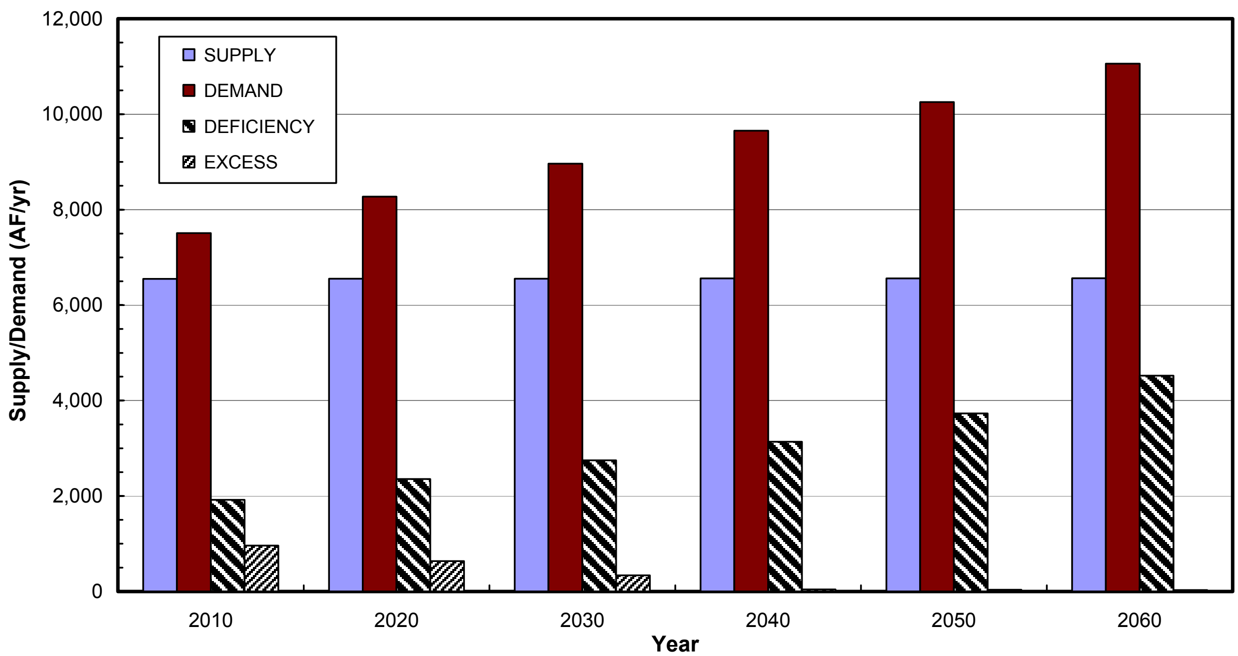
Table 4.11: Municipal Water Surplus/Needs for Zapata County

Water User Group	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Zapata	Rio Grande	872	888	904	920	931	931
County-Other	Rio Grande	-571	-853	-1131	-1387	-1632	-1813
SUM OF DEFICITS		**-571**	**-853**	**-1,131**	**-1,387**	**-1,632**	**-1,813**
SUM OF EXCESS SUPPLIES		**872**	**888**	**904**	**920**	**931**	**931**

4.2.2. Manufacturing Water Needs

The Rio Grande Region exhibits a supply shortage over the planning period for manufacturing water demands. Figure 4.2 presents a region-wide summary of manufacturing water supplies as compared to projected demands. The projected water needs (deficiencies) and excess supplies for the region also are indicated on the graph for each decade.

Figure 4.2: Manufacturing Water Needs Summary



The majority of the deficits in manufacturing water supplies are located in Cameron County, with much smaller deficits in Hidalgo and Willacy Counites. Table 4.12 presents manufacturing water surplus/deficit information by county and river basin.

4.2.3. Irrigation Water Needs

The Rio Grande Region does not have enough irrigation water supplies to meet projected irrigation water demands. At present, total water supply deficiencies are estimated to be more than 410,000 ac-ft/yr. The overall volumes of these water supply shortages are projected to remain relatively constant over the planning period. It should be noted that these deficits are based on normal levels of projected irrigation demand under drought conditions with adequate water available in storage in Amistad and Falcon Reservoirs to meet the irrigation demands. Figure 4.3 presents a region-wide summary of irrigation water supplies as compared to projected demands, along with water needs (deficiencies) and excess supplies.

Cameron, Hidalgo, Maverick, Starr, Webb, Willacy, and Zapata counties have identified irrigation water supply needs. Table 4.12 presents irrigation water surplus/deficit by county and by river basin.

Table 4.12: Manufacturing Water Surplus/Needs for the Rio Grande Region

County	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Cameron	Nueces-Rio Grande	-1,896	-2,330	-2,723	-3,112	-3,449	-3,905
Cameron	Rio Grande	0	0	0	0	0	0
Hidalgo	Nueces-Rio Grande	912	589	297	5	-255	-594
Hidalgo	Rio Grande	0	0	0	0	0	0
Jim Hogg	Nueces-Rio Grande	0	0	0	0	0	0
Jim Hogg	Rio Grande	0	0	0	0	0	0
Maverick	Nueces	50	45	41	37	34	29
Maverick	Rio Grande	0	0	0	0	0	0
Starr	Nueces-Rio Grande	0	0	0	0	0	0
Starr	Rio Grande	0	0	0	0	0	0
Webb	Nueces	0	0	0	0	0	0
Webb	Nueces-Rio Grande	0	0	0	0	0	0
Webb	Rio Grande	0	0	0	0	0	0
Willacy	Nueces-Rio Grande	-25	-25	-25	-25	-25	-25
Zapata	Rio Grande	0	0	0	0	0	0
SUM OF DEFICITS		**-1,921**	**-2,355**	**-2,748**	**-3,137**	**-3,729**	**-4,524**
SUM OF EXCESS SUPPLIES		**962**	**634**	**338**	**42**	**34**	**29**

Figure 4.3: Irrigation Water Needs Summar

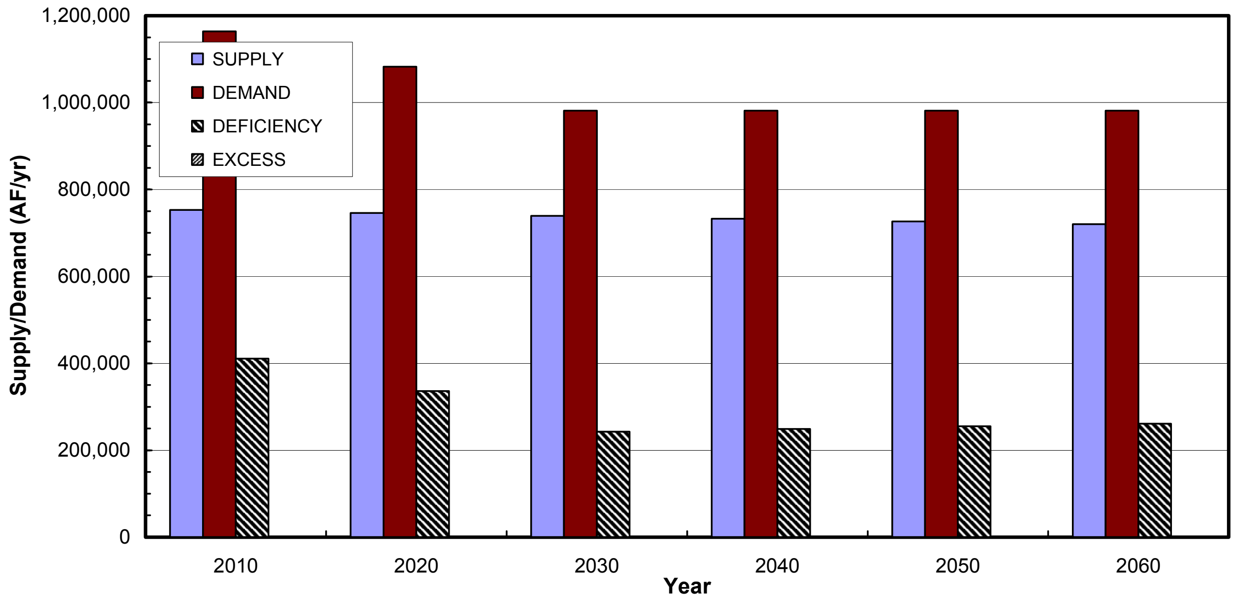


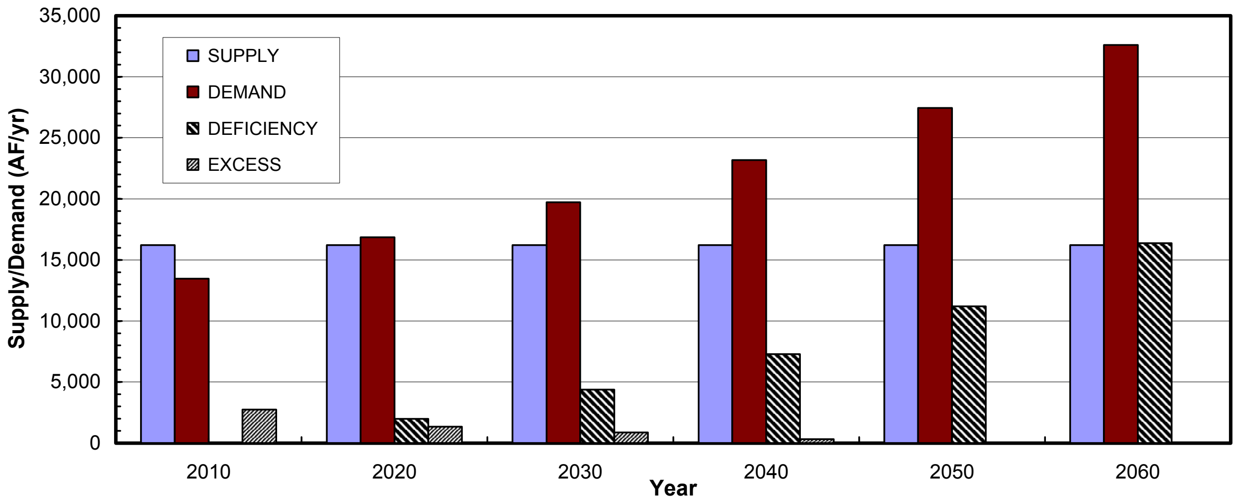
Table 4.13: Irrigation Water Surplus/Needs for the Rio Grande Region

		Surplus/Deficit (ac-ft/yr) Deficits are shaded					
City	**River Basin**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Cameron	Nueces-Rio Grande	-128,910	-112,295	-92,672	-94,636	-96,601	-98,415
Cameron	Rio Grande	-6,412	-5,612	-4,668	-4,762	-4,857	-4,944
Hidalgo	Nueces-Rio Grande	-197,048	-144,012	-75,704	-79,012	-82,320	-85,374
Hidalgo	Rio Grande	-775	-343	212	185	158	133
Jim Hogg	Nueces-Rio Grande	0	0	0	0	0	0
Maverick	Nueces	-3,506	-3,208	-2,867	-2,867	-2,867	-2,867
Maverick	Rio Grande	-31,920	-29,407	-26,415	-26,913	-27,410	-27,869
Starr	Nueces-Rio Grande	-8,823	-7,897	-7,005	-7,151	-7,297	-7,432
Webb	Rio Grande	-6,831	-5,977	-5,180	-5,277	-5,375	-5,464
Willacy	Nueces-Rio Grande	-24,035	-25,389	-26,126	-26,443	-26,760	-27,052
Zapata	Rio Grande	-2,378	-2,085	-1,805	-1,842	-1,879	-1,913
SUM OF DEFICITS		**-410,637**	**-336,224**	**-242,442**	**-248,903**	**-255,366**	**-261,330**
SUM OF EXCESS SUPPLIES		**0**	**0**	**212**	**185**	**158**	**133**

4.2.4.Steam Electric Water Needs

The Rio Grande Region is projected to have steam electric water demands in excess of existing supplies after the year 2010. Relatively large steam electric water supply deficits will occur due to the location of available supply though the year 2060. Figure 4.4 presents a region-wide summary of steam electric water supplies as compared to demand, along with water needs (deficiencies) and excess supplies for the region.

Figure 4.4: Steam Electric Water Needs Summary



Although the Rio Grande Region has no identified steam electric water demand needs in the year 2010, supply shortages are projected beginning in 2020 for Hidalgo County and beginning in 2050 for Cameron and Webb County. Table 4.14 presents steam electric water surplus/deficit by county and by river basin.

Table 4.14: Steam Electric Water Surplus/Needs for the Rio Grande Region

County	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Cameron	Nueces Rio Grande	784	877	620	306	-77	-544
Cameron	Rio Grande	0	0	0	0	0	0
Hidalgo	Nueces-Rio Grande	1816	-1,980	-4,374	-7,291	-10,847	-15,183
Hidalgo	Rio Grande	0	0	0	0	0	0
Jim Hogg	Nueces-Rio Grande	0	0	0	0	0	0
Jim Hogg	Rio Grande	0	0	0	0	0	0
Maverick	Nueces	0	0	0	0	0	0
Maverick	Rio Grande	0	0	0	0	0	0
Starr	Nueces-Rio Grande	0	0	0	0	0	0
Starr	Rio Grande	0	0	0	0	0	0
Webb	Nueces	0	0	0	0	0	0
Webb	Nueces-Rio Grande	0	0	0	0	0	0
Webb	Rio Grande	153	455	254	9	-290	-655
Willacy	Nueces-Rio Grande	0	0	0	0	0	0
Zapata	Rio Grande	0	0	0	0	0	0
SUM OF DEFICITS		**0**	**-1,980**	**-4,374**	**-7,291**	**-11,214**	**-16,382**
SUM OF EXCESS SUPPLIES		**2,753**	**1,332**	**874**	**315**	**0**	**0**

4.2.5. Mining Water Needs

Total mining water supply is projected to exceed water demand throughout the planning period. Figure 4.5, below, presents a region-wide summary of mining water supplies as compared to demand and water needs (deficiencies) and excess supplies for the region.

Table 4.145 presents mining water surplus/deficit by county and by river basin. This table shows that the largest surpluses are in Hidalgo, Webb, and Zapata counties.

4.2.6. Livestock Water Needs

Projections show no identified livestock water supply shortages in the Rio Grande Region during the next 50 years. Figure 4.6 presents a region-wide summary of livestock water supplies as compared to demand and a summary of water needs (deficiencies) and excess supplies for the region. The following table presents livestock water surplus/deficit by county and by river basin.

Figure 4.5: Mining Water Needs Summary

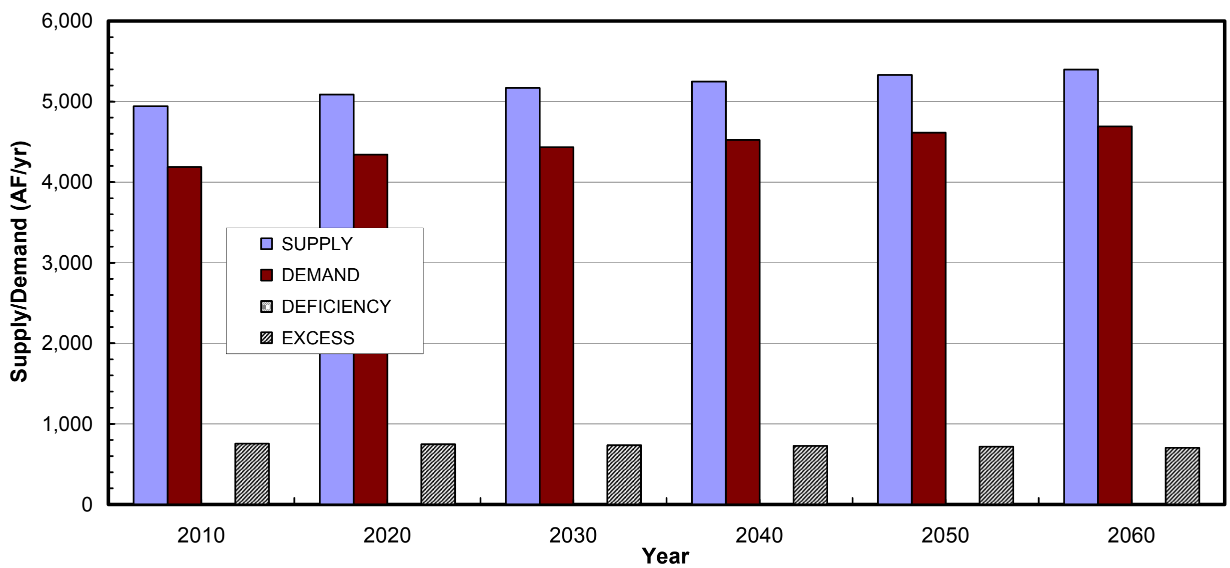


Table 4.15: Mining Water Surplus/Needs for the Rio Grande Region

County	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2050
Cameron	Nueces-Rio Grande	6	6	6	6	6	6
Cameron	Rio Grande	0	0	0	0	0	0
Hidalgo	Nueces-Rio Grande	183	182	181	179	177	175
Hidalgo	Rio Grande	23	22	21	21	21	20
Jim Hogg	Nueces-Rio Grande	8	5	4	3	1	1
Jim Hogg	Rio Grande	0	0	0	0	0	0
Maverick	Nueces	0	0	0	0	0	0
Maverick	Rio Grande	35	36	34	34	34	33
Starr	Nueces-Rio Grande	11	11	11	11	11	11
Starr	Rio Grande	9	9	9	9	9	8
Webb	Nueces	226	224	222	220	218	216
Webb	Nueces-Rio Grande	34	34	32	29	27	26
Webb	Rio Grande	110	109	108	107	106	104
Willacy	Nueces-Rio Grande	0	0	0	0	0	0
Zapata	Rio Grande	110	109	108	107	106	104
SUM OF DEFICITS		**0**	**0**	**0**	**0**	**0**	**0**
SUM OF EXCESS SUPPLIES		**755**	**747**	**736**	**726**	**716**	**704**

Figure 4.6: Livestock Water Needs Summary

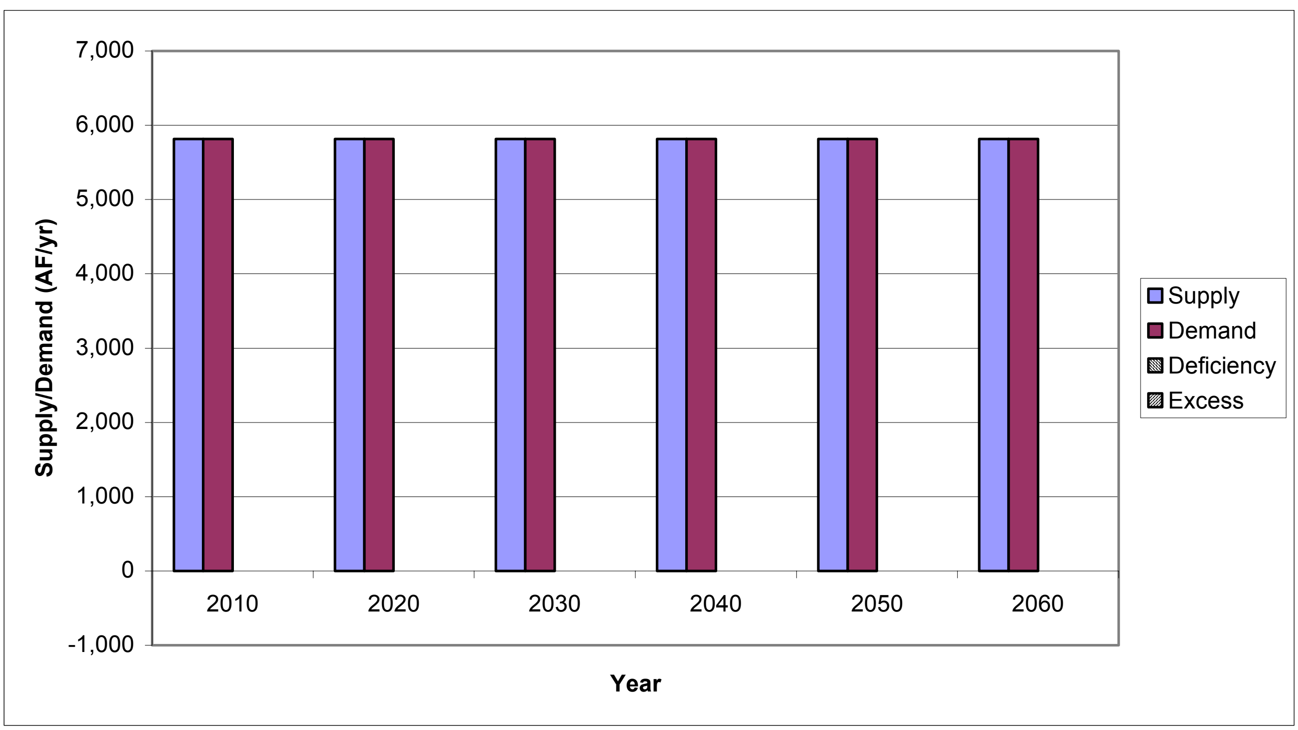


Table 4.16: Livestock Water Surplus/Needs for the Rio Grande Region

County	River Basin	Surplus/Deficit (ac-ft/yr) Deficits are shaded					
		2010	2020	2030	2040	2050	2060
Cameron	Nueces-Rio Grande	0	0	0	0	0	0
Cameron	Rio Grande	0	0	0	0	0	0
Hidalgo	Nueces-Rio Grande	0	0	0	0	0	0
Hidalgo	Rio Grande	0	0	0	0	0	0
Jim Hogg	Nueces-Rio Grande	0	0	0	0	0	0
Jim Hogg	Rio Grande	0	0	0	0	0	0
Maverick	Nueces	0	0	0	0	0	0
Maverick	Rio Grande	0	0	0	0	0	0
Starr	Nueces-Rio Grande	0	0	0	0	0	0
Starr	Rio Grande	0	0	0	0	0	0
Webb	Nueces	0	0	0	0	0	0
Webb	Nueces-Rio Grande	0	0	0	0	0	0
Webb	Rio Grande	0	0	0	0	0	0
Willacy	Nueces-Rio Grande	0	0	0	0	0	0
Zapata	Rio Grande	0	0	0	0	0	0
SUM OF DEFICITS		**0**	**0**	**0**	**0**	**0**	**0**
SUM OF EXCESS SUPPLIES		**0**	**0**	**0**	**0**	**0**	**0**

4.3. Overview of Recommended Water Management Strategies

The Rio Grande RWPG has adopted five basic goals or "pillars" that underlie this regional water plan. These are:

- Optimize the supply of water available from the Rio Grande;
- Reduce projected municipal water supply needs through expanded water conservation programs;
- Diversify water supply sources for DMI uses through the appropriate development of alternative water sources (e.g., brackish water desalination, seawater desalination, reuse of reclaimed water, groundwater); and
- Minimize irrigation shortages through the implementation of agricultural water conservation measures and other measures; and
- Recognize that the acquisition of additional Rio Grande water supplies will be the preferred strategy of many DMI users for meeting future water supply needs.

Consistent with these goals, the Rio Grande RWPG has adopted recommended water management strategies for each water user group (WUG) with identified water needs during the 50-year planning period. It should be noted that the water management strategies recommended and adopted by the Rio Grande RWPG and presented herein are for the entire 50-year planning period, applicable towards both near-term needs (2010-2040) and long-term needs (2040-2060). The sections that follow present a regional overview of recommended water management strategies for each major category of water use. Information for all of the potentially feasible water management strategies that were considered during the planning process is presented in Section 4.5 for meeting DMI needs in Section 4.9 for reducing irrigation shortages.

A summary of water management strategies is show in Table 4.17 and Figure 4.7. It is apparent that the most cost effective strategy with the greatest yield is Irrigation Conveyance System Improvements. This strategy is expected to yield in excess of 200,000 acre-feet of water at approximately one-third the cost of most other strategies with the exception of Municipal Water Conservation. Funds for these improvements have been the drawback to implementation and is further described in Chapter 10.

Figure 4.7: Municipal Water Management Strategies

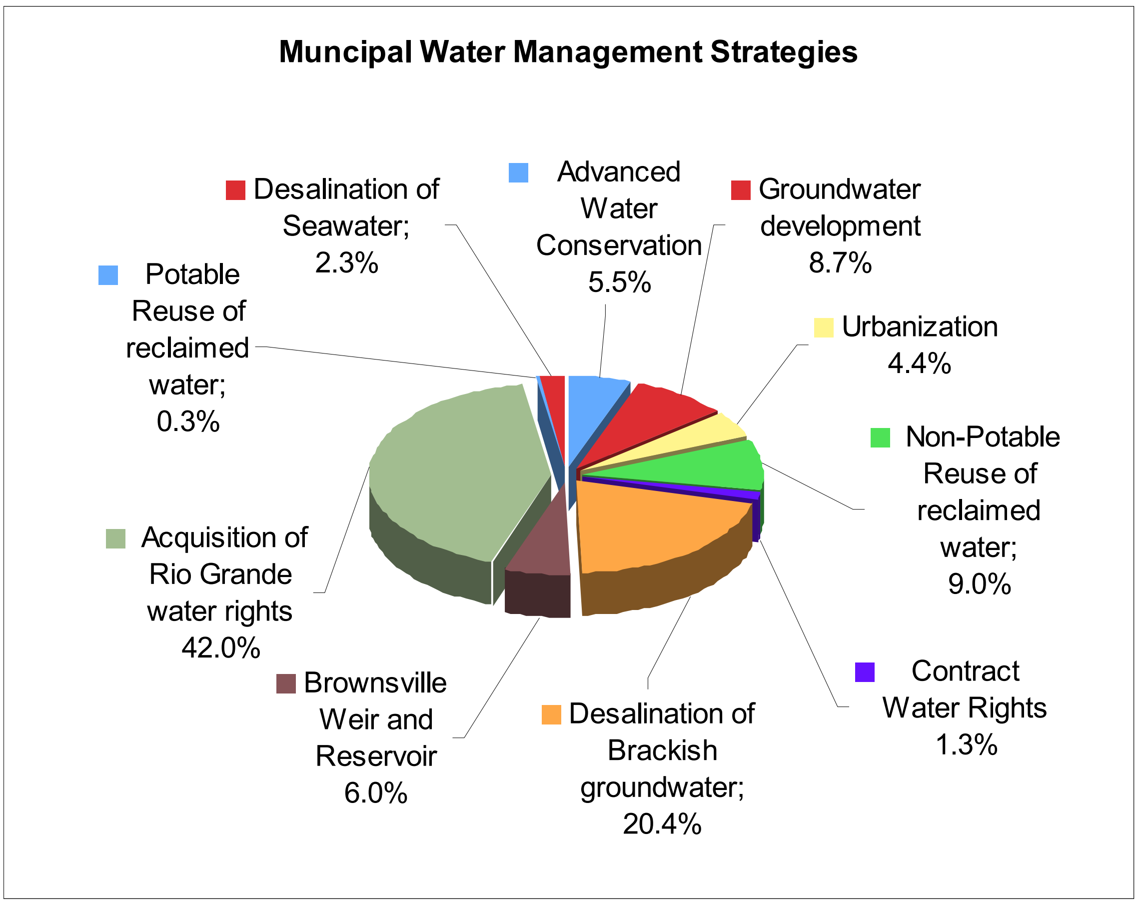


Table 4.17: Water Management Strategy Summary

Strategy	Yield, ac-ft	Acre-foot Cost	Total Annual Cost

	(Additional)		(Annual)		
Advanced Water Conservation	19,009	$	112.47	$	2,137,995
Groundwater development	29,824	$	304.46	$	9,080,215
Urbanization	15,245	$	368.37	$	5,615,801
Non-Potable Reuse of reclaimed water;	30,841	$	415.22	$	12,805,800
Contract Water Rights	4,577	$	455.56	$	2,085,053
Desalination of Brackish groundwater;	69,832	$	505.51	$	35,300,774
Brownsville Weir and Reservoir	20,643	$	537.27	$	11,090,865
Acquisition of Rio Grande water rights	143,944	$	542.74	$	78,123,949
Potable Reuse of reclaimed water;	1,120	$	705.89	$	790,597
Desalination of Seawater;	7,902	$	767.63	$	6,065,812
Total	342,937			$	163,096,861
Irrigation Demands					
Conveyance System Improvements	218,783	$	120.68	$	26,402,732.4
On-Farm Conservation	219,226	$	253.38	$	55,547,483.9

It should be noted, however, that irrigation yields less than municipal rights by a factor of two to one when comparing irrigation Class A rights to the of municipal rights. With the acquisition of water rights accounting for over 40% of the municipal strategies, the Rio Grande will remain the dominant source of water for the Region.

Alternate sources of water will also play an important part in providing the needs for the area. Brackish groundwater desalination will provide an alternate source of water not previously used and planned in the previous Rio Grande Regional Plan. Over 22% of the supplies will be from brackish desalination. The remaining strategies are shown below.

4.3.1. Recommended Strategies for Meeting Municipal Water Needs

Table 4.18: Municipal Demand by County

Municipal Demand by County (ac-ft/year)

County Name	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050	Year 2060
CAMERON	71,792	86,496	102,264	118,321	134,693	151,275	167,665
HIDALGO	88,037	110,286	135,454	163,992	194,819	229,913	266,564
JIM HOGG	852	884	918	944	959	943	906
MAVERICK	7,911	8,912	9,939	10,911	11,751	12,552	13,274
STARR	10,677	12,648	14,726	16,898	19,095	21,293	23,513
WEBB	42,118	54,855	69,401	86,001	104,503	124,614	146,420
WILLACY	3,098	3,287	3,483	3,651	3,779	3,890	3,953
ZAPATA	2,051	2,265	2,531	2,793	3,033	3,267	3,448
TOTAL	**226,536**	**279,633**	**338,716**	**403,511**	**472,632**	**547,747**	**625,743**

All projections referenced from TWDB approved data.

According to the data provided by the TWDB municipal water demands are projected to almost triple by 2060. With the factor of urbanization and the loss of acreage used for irrigation needs the growth of municipal water demands inevitable. TWDB rules specify that the regional water plans are to include the evaluation of all water management strategies the RWPG determines to be potentially feasible. For the Rio Grande Region, an initial determination of potentially feasible strategies was made by the Rio Grande RWPG and was incorporated into the approved scope-of-work for preparation of the regional water plan. Additional strategies were added over the course of the planning process.

For DMI users, the strategies looked at for this plan are:

- Municipal water conservation;
- Potable Reuse of reclaimed water;
- Non-Potable Reuse of reclaimed water;
- Acquisition of additional Rio Grande water through water rights purchase & contract;
- Desalination of Brackish groundwater;
- Desalination of Seawater;
- Brush Management;
- Groundwater development; and
- Brownsville Weir and Reservoir.

For DMI users, the strategies that were further evaluated according to TWDB standards for this plan are:

- Municipal water conservation;
- Non-Potable Reuse of reclaimed water;
- Acquisition of additional Rio Grande water through water rights purchase & contract;
- Desalination of Brackish groundwater;
- Desalination of Seawater;
- Groundwater development; and
- Brownsville Weir and Reservoir.

It should be noted that a given WUG may implement any combination and/or order of the above mentioned recommended strategies for DMI shortages to meet its specific needs. A municipal water supply/demand analysis has been performed for each WUG. This information can be viewed in the appendix.

The strategies selected for meeting DMI needs generally will not result in adverse impacts to other water resources of the state, will not threaten other natural resources (see Chapter 1), and will not result in significant adverse socio-economic impacts to third parties from voluntary redistributions of water (e.g., contractual water sales).

Because a portion of future DMI needs will be met through the acquisition of additional supply from the Rio Grande, reallocation of water from agricultural to DMI uses will be required, which will have the effect of reducing the availability of water for agricultural use. However, instead of aggravating this "threat to agricultural resources" (see Chapter 1), significant opportunities exist for constructive partnerships between DMI users and agricultural water users that will further the interests of both groups, and the region as a whole.

Desalination of brackish groundwater as a technology was evaluated and an amendment made to the previously adopted Regional Plan. There is an increased consideration of desalination water plants for DMI use when the cost efficiencies and environmental issues were economically addressed. Desalination of brackish groundwater is a recommended strategy in specific local areas where it already is cost-effective.

The Rio Grande RWPG considers groundwater as a viable alternative to augment supplies in some areas. This is a current practice that is likely to continue.

In addition, the Rio Grande RWPG recognizes that surface water uses that will not have significant impact on the region's water supply may be required above and beyond the recommended strategies even though they are not specifically recommended in the plan. Additionally, the region may also face the need to develop water supply projects that do not involve the development of or connection to a new water source even though such projects are not specifically recommended in the plan.

The following is a table of Water Management Strategies that were not evaluated in this plan. This a table states the why these strategies may not be practical in this particular region according to Title 31, TAC 357,7(a)(7)(D) and (E).

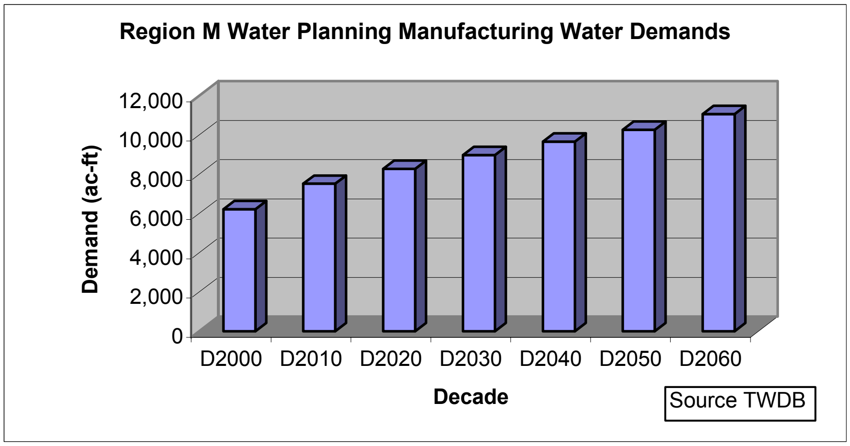
Table 4.19: Water Management Strategies Not Evaluated

Water Management Stragegy	

Systems optimization and conjunctive use of resources	Due to the current dependency on the Rio Grande by all water users in the region, the Regional Water Planning Group evaluated the conjunctive use of this source in all Water Management Strategies dealing with the Rio Grande. Systems optimization is also addressed as an irrigation WMS. Since many municipalities obtain their raw water via irrigation canals, improving conveyance efficiency directly benifits these users.
Reallocation of reservoir storage to new uses	Reservoir reallocation was analyzed. However, due to the large quantity and relatively small storage volume of the reservoirs in the region, this strategy is not a feasible option for overall consideration.
Voluntary Redistribution of Water Resources including contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements	Voluntary redistribution of water resources through contracts, sales, and options were evaluated as WMSs. Rio Grande Water Right acquisition by water marketing, water banks, leases, subordination agreements, and financing agreements have the possibility of being feasible WMSs. However, a lack of key information makes these strategies impossible to thoroughly evaluate.
Subordination of existing water rights through voluntary agreements	Municipalities, Water Supply Coorperations, and Irrigators are currently in the midst of discussions regarding the voluntary redistribution of water resources through a wide array of methods. In the past year, these issues have come to the forefront. With this in mind, there is no information available that would allow the Planning Group to include this Water Management Strategy in this round of regional planning.
Enhancements of yields of existing sources	The regional planning group evaluated the enhancement of yields of existing sources including groundwater (fresh and brackish) and raw water from the Rio Grande. Groundwater yields were thoroughly evaluated and included as a WMS. However, due to the water rights system currently in place for the Rio Grande, enhancing the raw water yield is not a feasible WMS.
Improvement of water quality including control of naturally occurring chlorides	Water quality was researched as part of the Regional Water Plan. The difficulty in including water quality as a WMS lies in Region M's close proximity to Mexico. Untreated or poorly treated discharges from inadequate wastewater treatment facilities, primarily in Mexico, are the principal source for fecal coliform bacteria contamination. Without knowing the extent of Mexico's contribution to water quality in the Rio Grande, a region specific water quality WMS cannot be developed. However, WMSs for reducing irrigation shortages through conservation will have a direct effect on water quality. By reducing non-precipitation irrigation runoff, water quality (predominantly in the Arroyo Colorado) will improve.

4.3.2. Recommended Strategies for Meeting Projected Manufacturing Needs

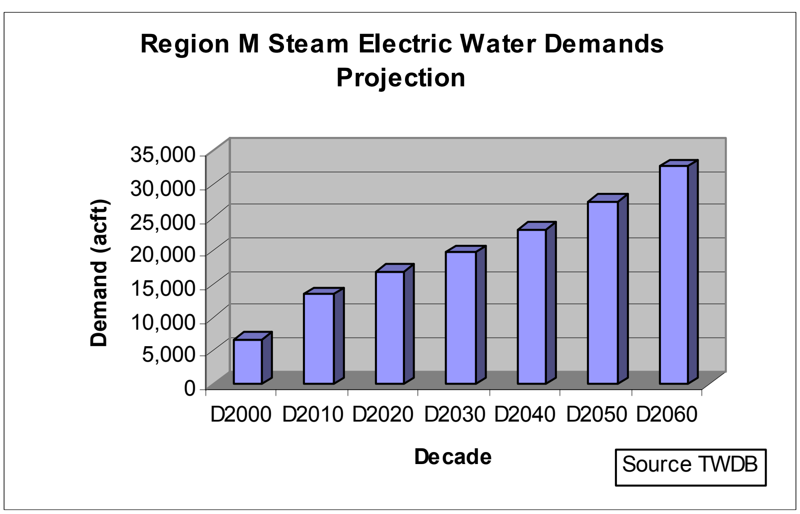
Figure 4.8: Water Planning Manufacturing Water Demands



Manufacturing deficits exist in Cameron, Hidalgo, and Willacy Counties. These deficits are expected to be supplied with a combination of additional groundwater, non-potable reuse, and water right purchase. Manufacturing needs are projected to in double by 2060. There will be a steady increase in this demand according to the data provide by the TWDB. The manufacturing water supply/demand analysis for each county can be viewed in the appendix.

4.3.3. Recommended Strategies for Meeting Projected Steam Electric Needs

Figure 4.9: Steam Electric Water Demands Projection



Combined, the county-level steam electric power generation WUGs in the region are expected to have a deficit of 649 acre-feet in 2020 increasing to 16,383 acre-feet in 2060. Water management strategies considered potentially applicable to this need include acquisition of additional Rio Grande supplies and non-potable reuse. It is recommended that all of the projected steam electric demands be met through a combination of these strategies. The steam electric water supply/demand analysis for each county can be viewed in the appendix.

4.3.4. Recommended Strategies for Meeting Projected Mining Needs

There are not projected to be any mining water supply shortages throughout the extent of this planning study. The mining water supply/demand analysis for each county can be viewed in the appendix.

4.3.5. Recommended Strategies for Meeting Projected Livestock Needs

There are not projected to be any livestock water supply shortages throughout the extent of this planning study. The livestock water supply/demand analysis for each county can be viewed in the appendix.

4.3.6. Recommended Strategies for Reducing Projected Irrigation Needs

The economics of the agriculture industry are such that water management strategies considered feasible for the Rio Grande Region are not sufficient to satisfy the projected deficits in their entirety. Consequently, development of new water supply sources for irrigated agriculture – whether surface or groundwater – is not seen as a viable strategy. There nevertheless are strategies that could significantly reduce irrigation demand or increase the available supply of water for irrigation.

For irrigation users, the water management strategies considered for this plan are:

- Agricultural water conservation (conveyance system)
- On-farm water use efficiency

In addition, because of assumptions made in estimated irrigation water availability during drought-of-record hydrologic conditions, additional irrigation supplies are projected to be available as a consequence of recommended strategies for DMI users that will lessen the need for DMI users to acquire additional Rio Grande supplies than would otherwise be the case. In essence, strategies such as municipal water conservation, desalination, and reuse of reclaimed water for DMI purposes are strategies for reducing the magnitude of projected irrigation shortages.

At the regional level, irrigation shortages of 410,066 acre-feet per year in 2010 and 260,626 acre-feet per year in 2060 are projected under normal conditions. The irrigation water supply/demand analysis for each county can be viewed in the appendix.

The Rio Grande RWPG believes that investment in agricultural water efficiency is one of the cornerstones of the region's near-term water management plan. Accordingly, the Rio Grande RWPG recommends that there be a comprehensive effort by local, state, and federal agencies to "capture" the maximum amount of water savings from irrigated agriculture over the 50-year planning period. The Rio Grande RWPG recommended the following water management strategies for reducing irrigation shortages:

- Conveyance system improvements
- On-farm water use efficiency.

4.4. Regional Drought Preparedness

Chapter Six of this Regional Water Plan deals with the water conservation and drought preparedness. Overall, the Rio Grande Region is well prepared for drought, as evidenced by manner in which the region has been able to cope with the current drought. The legal system under which Rio Grande water rights are administered acts like a regional drought contingency plan. DMI users have an assured annual supply of water from the Amistad-Falcon Reservoir System equal to their authorized annual water right. The DMI user, however, must be concerned during times of drought for irrigation district's ability to deliver water when they are unable to deliver irrigation water as a carrier. Irrigation and mining water rights accounts, as the "residual" users of water from the reservoir system, bear the entire brunt of water supply shortages during drought as those users only receive new allocations of water when inflows to the reservoir system are in excess of that required to satisfy municipal demands and offset system losses.

In effect, the existing TCEQ rules and regulations for operating the Amistad-Falcon Reservoir System provide the means for initiating a drought response. As the storage in the reservoirs falls during dry periods in response to decreased inflows, the existing rules automatically reduce the available supply of water in the irrigation and mining accounts. This action serves to protect the available supply for DMI users. In essence, this system functions as a drought contingency plan. Every DMI user that has a drought contingency plan in place, utilizes the reservoir system levels as a trigger for drought plan implementation.

Additionally, many irrigation districts have adopted district-level water allocation policies, which provide a market-based mechanism for minimizing the economic impacts of irrigation shortages. Specifically, during periods of shortage, some districts "go on allocation" and allow individual irrigators to sell all or a portion of their water allocations to other irrigators within the district and, in some cases, to irrigators outside the district. The benefit of these agriculture-to-agriculture water transfers is that the producers of higher value and more water-intensive crops, such as citrus and sugar cane, can gain access to additional water over and above their allocations from an irrigation district. The entire region benefits to the extent that these transactions minimize the economic impacts of irrigation shortages by allowing limited water supplies to move from lower to higher value uses. A recent study estimates that about 120,000 acre-feet of water was transferred within the agricultural sector during the 1995-1996 time period.

While DMI water users in the Rio Grande Region are generally afforded a very high degree of water supply reliability during drought, there are circumstances under which drought preparedness is somewhat deficient. One situation that has arisen during the current drought is the potential for interruption of DMI water deliveries by irrigation districts when irrigation water rights accounts are depleted. In many cases in the Lower Rio Grande Valley, DMI water deliveries are dependent upon adequate supplies of irrigation "push water." If irrigation supplies are exhausted, DMI water rights accounts or the reserves may have to be tapped to maintain adequate water flows in the conveyance facilities that deliver DMI water. One potential solution to this problem is to develop more conveyance/distribution interconnections between DMI users and irrigation districts and between DMI users and other DMI users. With state technical and financial assistance, efforts are currently underway to identify and implement such interconnections.

Based on current TCEQ records, it also appears that all municipal water suppliers have not complied with state requirements to prepare drought contingency plans. While such plans may not be necessary for responding to water supply shortages, there are other conditions, which may from time to time require voluntary or mandatory curtailment of non-essential municipal water uses. For example, local drought can result in elevated peak water demands, which may strain limited water treatment and distribution capacity. Also, it is not uncommon for water utilities to experience outages caused by major equipment failures and natural disasters. Such situations should be addressed in local drought contingency plans.

4.5. Strategies for Meeting Domestic, Municipal, and Industrial Water Needs

Opportunities for the development of additional water supplies for municipal use are limited in the Rio Grande Region, both because of the hydrologic characteristics of the region and by economics. As previously noted, there are few opportunities to increase the water supply yield of the Rio Grande. However, a number of strategies for augmenting municipal water supplies have been examined as part of this planning effort. These include advanced municipal water conservation, Brownsville Weir and Reservoir, and reuse of reclaimed water; strategies for optimizing surface water supply from the Rio Grande; groundwater development; brackish and sea water desalination; and acquisition of additional Rio Grande supplies for domestic-municipal-industrial (DMI) uses. The evaluations of these strategies are presented in the sections that follow. More detailed back-up information is provided in Appendix and in technical appendices to this plan.

4.5.1. Acquisition of Rio Grande Water Rights

4.5.1.1. Strategy Description

Water rights for the Lower Rio Grande were 100% adjudicated by the courts in the late 1960's to domestic, municipal, industrial, and agricultural users. In 1971, there were approximately 155,000 acre-feet of adjudicated water rights for DMI use. Currently there are approximately 390,000 acre-feet of DMI rights in the region. This increase in the quantity of DMI water rights is the result of the gradual, incremental conversion of irrigation and mining water rights to DMI use through voluntary, market-based transfers. This trend is expected to continue for the foreseeable future.

Because of the unique nature of the water rights system for the middle and lower Rio Grande, the Rio Grande Region enjoys one of the most active and robust water markets in the world. Because a water right is considered private property in Texas, it can be bought and sold or otherwise transferred subject to state administrative review and approval. Irrigation districts may sell Class A and B water rights to other irrigation users, or they may sell and convert those rights for municipal, industrial, or domestic use. In the middle and lower Rio Grande, such transfers have been common since the adjudication of water rights. Because of the nature of the water rights system for the Rio Grande, state administrative review is relatively simple and inexpensive.

Another common means of converting irrigation used rights to municipal urban use rights is the conversion of irrigation rights in conjunction with the "exclusion" of non-irrigable land, or land that is urban in nature, from a districts boundary. An irrigation district may, through an arrangement with a municipal supplier (a city, municipal utility district, or water supply corporation), convert all or a portion of the water previously used to irrigate the excluded land to municipal use, or the district may retain all or a portion of such water for irrigation use depending upon what is in the best interest of the district. One exclusion statute, § 49.314 of the Texas Water Code, provides that if land is excluded pursuant to this statute, a municipal supplier can petition an irrigation district to convert and reallocate the irrigation rights associated with land "excluded" to a non-irrigation use on terms agreeable to the parties. This is the process by which irrigation rights may be converted to municipal use. However, the specific terms of the water supply transfer is left to the parties' agreement.

In the past, some irrigation districts have converted some or all of their irrigation water rights associated with excluded lands to DMI rights. The DMI water is then supplied to a city or a water supply corporation on a contractual basis. Usually, this involves the district diverting and delivering the water supply for the City or water supply corporation for a specified charge based on the quantity of water delivered, or if delivered by another district, a specified charge for the water supply provided. These types of contracts are typically open ended and provide a pre-determined amount of water. However, contractual water right sales must comply with the following:

- Sales can only be approved between same type use of water (i.e. DMI water can only be sold to another DMI water user).
- Accounts with existing contract balances cannot sell water from that account until such time as all contract water has been diverted and used.
- Purchased water cannot exceed the total storage amount allowed under the water right.
- Purchased irrigation water is valid only for a 12-month period
- Purchased municipal water expires the last Saturday of each year.

In summary, there are three methods for obtaining additional water supplies through the acquisition of Rio Grande water rights: purchase, exclusion through urbanization, and contract. Each method involves the conversion of irrigation water rights into DMI water rights. However, since all circumstances surrounding the transfer of water rights are not similar, it is difficult to predict which acquisition method would be best suited for all interested parties.

4.5.1.2. Water Supply Yield

A significant quantity of water can be expected to become available for DMI use as a consequence of further urbanization of irrigated lands throughout the region. Table 4.20 shows the reduction in irrigation demands through 2060.

Table 4.20: Region M Irrigation Demands

	2000	2010	2020	2030	2040	2050	2060
Irrigation Demand (ac-ft/yr)	1,209,647	1,163,633	1,082,231	981,749	981,749	981,749	981,749

The numbers shown in Table 4.20 are a direct result of discussions with various irrigation districts. By looking at annual rainfall and reservoir levels, the planning group used a base year demand of 1.2 million acre-feet or water for irrigation. The decrease in irrigation demand is directly related to the effects of urbanization, among other factors. As land is transformed from agricultural use to urban use, the water rights associated with that land are often converted to DMI use. Irrigation water rights are converted to municipal water rights on a 2-to-1 basis. In other words, 2 acre-feet of irrigation water can be converted to 1 acre-foot of DMI water. As can be seen in Table 4.20, there will be a reduction in irrigation demand of 227,898 ac-ft of water by year 2060. Should all of that supply be fully converted to DMI use, a potential DMI supply of 113,949 would result.

Also, as described later in this chapter, there are significant opportunities for reducing irrigation water demands through measures to improve water conveyance system efficiency and on-farm water use efficiency. By looking at the Irrigation Summary WUG table in the appendix, one will notice a projected additional supply of over 430,000 acre-feet of water for irrigation use in 2060. To the extent that DMI users might help finance agricultural water conservation measures, additional irrigation rights might also become available for conversion to DMI use. Outright purchase of water rights from irrigation districts for DMI use will be required to help irrigation districts implement water conservation strategies. In some cases, it may be in the best interest of both the irrigation district and the WUG to acquire water through exclusions due to urbanization or long-term contracts. WUG tables are shown in the appendix. These tables give a breakdown of which water management strategy is most feasible for each WUG.

After considering the contributions to be made by all other water management strategies, the amount of additional Rio Grande supply that will be needed to meet the remaining municipal water needs is shown in Table 4.21. This information is a summary of the information shown in the Municipal WUG tables located in the appendix.

Table 4.21: Water Yield for Acquisition of Rio Grande Water Rights

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Purchase (ac-ft)	15,435	58,856	8	2,227	10,455	55,061	88	1,813
Urbanization (ac-ft)	0	15,245	0	0	0	0	0	0
Contract (ac-ft)	847	2,256	0	0	132	1,337	5	0
Total:	16,282	76,357	8	2,227	10,587	56,398	93	1,813

4.5.1.3. Cost

As indicated, it is not possible to predict when or how individual transactions will be structured by DMI users needing to acquire additional Rio Grande water supplies. It is also not possible to predict the exact cost of either future water rights purchases or the price of water provided to DMI users under contract. The specific terms of such transactions will be determined by the parties willing buyers and willing sellers, which will also dictate the specific components required to implement this strategy. However, for this planning process it is necessary to provide cost estimates for acquisition of additional Rio Grande water supplies for DMI use. Using the purchase prices for recent water transactions, the estimated cost to purchase water rights is approximated to range from $1,900 to $2,100 per acre- feet. A value of $2000/ac-ft was used. This is a significant increase of approximately $700/acre-foot charged only a decade ago. For long-term contract of water, the up-front cost for water right acquisition was assumed to be $1,000/ac-ft. Acquisition of water rights through urbanization does not have an associated up-front cost for acquisition. These costs include full water rights and responsibilities over one acre-foot. The cost estimate per acre-foot of water after delivery, treatment, distribution, and plant operations costs are taken into consideration. This analysis can be seen in the appendix. A summary of these costs can be seen below.

Table 4.22: WMS Strategy Cost Summary (Acquisition of Water Rights Through Purchase)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Acquisition of Water Rights Through Purchase	$ 542.74	$ 1.67	B of Cost Ananlysis Appendix

Table 4.23: WMS Strategy Cost Summary (Acquisition of Water Rights Through Urbanization)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Acquisition of Water Rights Through Urbanization	$ 368.37	$ 1.13	C of Cost Ananlysis Appendix

Table 4.24: WMS Strategy Cost Summary (Acquisition of Water Rights Through Contract)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Acquisition of Water Rights Through Contract	$ 455.56	$ 1.40	D of Cost Ananlysis Appendix

4.5.1.4.Environmental Impact

When this water management strategy is put into motion there will be temporary and permanent impacts associated with implementation of this strategy. The temporary environmental impacts would probably be evident with the construction activities associated with infrastructure improvements needed to facilitate additional municipal water. The construction activities dealing with this WMS would include a decrease in air and noise quality. The intensity of these construction related impacts would be minimal due to dust and noise measures to be implemented during construction, applicable permit conditions, and stipulations for the protection of air and water quality, and temporary localized nature of the effects. The construction activities could impact ecological and cultural resources to the extent that such resources occur in areas targeted for improvements. Specifically, areas in proximity to the known habitat of threatened and endangered species should be identified prior to construction activities and appropriate measures should be taken to minimize any adverse impacts. Permanent environmental impacts due to construction and operation of the WMS would be a decrease in air quality due to the maintenance activities required for this WMS. The permanent decrease in air quality would not be significant, as maintenance activities are periodic in nature and duration.

Since the majority of municipal water is delivered by irrigation districts, the transfer of water rights from irrigation use to municipal use will have a minimal effect on existing plant and animal habitat associated with the irrigation district conveyance system. However, an increase in DMI use will directly result in an increase in wastewater flows. Currently, excess irrigation results in water runoff. With the reduction in irrigable acres, these runoff flows will be reduced. Therefore, water supplied to irrigation drainage and seep ditches will be reduced. This effect will be somewhat offset with increased wastewater flows. However, the loss of agricultural land will have a negative impact on terrestrial wildlife and wetlands. Also, given that irrigation use is seasonally based and DMI demand would be continuous, there likely will be changes in the pattern of use of the Rio Grande water that may impact the environment.

Since the acquisition of additional Rio Grande water, either through purchase, exclusion, or contract, involves changes in the type, location, or owner of water rights, TCEQ handles it as a routine administrative process and does not require a detailed evaluation for proposed amendments to Rio Grande water rights.

4.5.1.5. Implementation Issues

As indicated, acquisition of additional Rio Grande water supplies for DMI use can be accomplished through outright purchase of water rights, through exclusions of irrigable land due to urbanization, or through contractual arrangements between a water right holder and a DMI user. The process for amending Rio Grande water rights to change the ownership, type of use, or place of use requires approval by TCEQ. However, because water rights amendments generally do not affect instream flows or other water rights holders, approval of amendments is accomplished administratively by the TCEQ's executive director. A second issue is the lack of a standard methodology and contractual obligation for implementing the exclusion process except as provided for in Section 1(1), Chapter 707, Acts of the 69th Legislature, Regular Session, 1985 (Article 973c, Vernon's Texas Civil Statutes). Although the process is defined by statute, the timeframes and terms under which the exclusion occurs vary considerably.

4.5.1.6. Recommendation

It is recommended that any remaining DMI water supply needs, after considering the effects of other recommended strategies for meeting DMI needs, be met through the acquisition of additional Rio Grande water supplies through purchase of water rights, exclusions due to urbanization, or water supply contracts.

4.5.2. Non-Potable Water Reuse

4.5.2.1. Strategy Description

As a water management strategy, direct reuse of reclaimed water provides a water supply benefit when reclaimed water is used as a substitute or as supplemental water source. Non-potable direct reuse is defined as the application of wastewater effluent directly from the waste treatment plant to the point of use without co-mingling with state waters.

Recycled water is most commonly used for non-potable (not for drinking) purposes, such as agriculture, landscape, public parks, and golf course irrigation. Other non-potable applications include cooling water for power plants and oil refineries industrial process water for such facilities as paper mills, carpet dyers, toilet flushing, dust control, construction activities, concrete mixing, and artificial lakes. In addition, there are potential opportunities for non-potable reuse of reclaimed water for existing and projected manufacturing and stream electric demands.

One negative aspect of non-potable reuse is the accumulation of byproducts over time in the irrigated soil. Since recycled wastewater normally contains higher levels of salts or other minerals, and those minerals may accumulate over time where the water is applied. Usually physical and biological processes in the soil offset this concern, unless the concentration of a pollutant is unusually high.

Another negative effect is the potential consumer confusion between potable and non-potable water piping. Mixing up potable and non-potable water pipes is a concern when users of recycled water include ordinary residences. Industrial users typically do not suffer such problems, but small children may drink form a home faucet that is intended solely for irrigation water. Because treated wastewater could contain harmful substances, the consequences of ingestion can be significant.

This WMS can be feasible if several factors are taken into consideration: 1) the location of wastewater treatment facilities relative to the locations of potential users of reclaimed water, 2) the level of treatment and quality of the reclaimed water, 3) the water quality requirements of particular users, and 4) the public acceptance of reuse.

These and other factors determine whether reuse of reclaimed water is economically feasible for specific uses. For example, the distance one has to convey reclaimed water from the source (i.e., a wastewater treatment plant) to a user (e.g., a golf course or power plant) is a significant cost factor and determinant of feasibility. Similarly, the water quality requirements of potential users may mean that additional treatment would be necessary. Also, state regulatory requirements for non-potable reuse of reclaimed water place constraints on both the types of uses considered acceptable and the manner in which reclaimed water is managed and used. Public acceptance of water reuse is also an important factor. Perceptions, or misperceptions, about the public health or environmental risks of non-potable reuse can make or break a water reclamation project.

4.5.2.2. Water Supply Yield

Theoretically, it is technically feasible to beneficially reuse all of the reclaimed water produced from municipal wastewater treatment plants for non-potable municipal and industrial uses. Achieving very high levels of water reuse requires the development of costly dual water systems capable of delivering water on demand to both large and small users over a large area. While extensive dual water systems have been developed in a handful of communities in California, Florida, and Texas, generally the costs of such systems are prohibitive, particularly in already developed communities. In most settings, cost considerations limit reclaimed water distribution systems to delivery of relatively large volumes of reclaimed water to a relatively small number of large non-potable water users. As such, the current realistically achievable reuse potential within a typical municipal water utility service area is generally a tenth of total water demand.

For this planning effort, a water supply and demand analysis was performed for each Water User Group (WUG). In this analysis, total water demand was compared to total water supply over the extent of the planning study. Many of the WUGs projected a water supply deficit. It is in these cases that non-potable reuse could provide relief to the supply shortage. The following WUGs expressed interest in non-potable reuse: Brownsville, Harlingen, Laguna Madre Water District, Alamo, Edinburg, McAllen, Mission, Pharr, Rio Grande City, and Laredo. Table 4.25 shows the proposed non-potable water supply yield for each county in the region. For a city-by-city breakdown, please reference the decision documents in the appendix.

Table 4.25: Water Supply Yield for Non-potable Reuse

	Cameron	Hidalgo	Jim Hogg	Maverick	Star	Webb	Willacy	Zapata
Yield (ac-ft)	600	18,991	0	0	50	11,200	0	0

Each of these WUGs has the potential to perform non-potable reuse since they are served by central wastewater collection and treatment systems. Experience suggests that reuse potential is limited in smaller communities due to lack of relatively large non-potable water users in proximity to treatment facilities. In rural areas that lack central wastewater collection and treatment systems, reuse potential is limited except at a small scale through individual on-site systems, neighborhood scale cluster systems, or local golf course and landscape irrigation.

4.5.2.3. Cost

The cost of a non-potable municipal reuse system can vary widely, primarily because of distribution system costs. It was beyond the scope of the regional planning process to evaluate the water reuse potential and develop cost estimates for each of the municipal entities. However, cost estimates developed for other systems in the state are considered representative. Brownsville (Robindale Wastewater Treatment Plant) performed a reuse study and evaluated cost based on three treatment alternatives: no treatment, ultra filtration, and a combination of ultra filtration and reverse osmosis. Table 4.26 shows the cost breakdown of each of these alternatives. The figures in that table were taken directly from the Border Environment Cooperation Commission Feasibility Report dated February 2001. The numbers are based on annual debt service of 6% for 20 years.

Table 4.26: Cost Breakdown for Brownsville PUB Reuse Facility

Formal Name	Project Description	Total Annual Cost	Cost per acre-foot	Capacity (mgd)

Wastewater Recovery and Reuse Facility – Brownsville PUB	No Additional Treatment	$153,893	$228.96	.6
	Ultra Filtration	$1,146,072	$243.59	4.2
	Ultra Filtration/Reverse Osmosis	$1,882,291	$420.07	4

The Rio Grande RWPG also obtained cost related information for other reuse facilities. Harlingen formerly had a reuse agreement with Fruit of the Loom, with a cost of $296 per acre-foot per year (ac-ft/yr) (30 years at 6%) being reported in the last round of regional planning. McAllen has a reuse agreement with the Calpine Electric Generation Plant for cooling water, but the cost was shared between the City and Calpine, and the total cost is not available. The cities of Austin and San Antonio have dual-water systems. The Rio Grande RWPG had discussions with operators at the Austin and San Antonio plants, and based on 20 year debt service at 6% per year, costs of $643/ac-ft/yr (Austin plant) and $500/ac-ft/yr (San Antonio plant) were reported. The Lakeway MUD in Travis County has a small reuse system and charges $1.80/1,000 gallons ($587/ac-ft), which they believe is approximately their cost.

Based on the range of costs from the Brownsville study ($228.96/ac-ft/yr for no treatment to $420.07/ac-ft/yr for ultra filtration/reverse osmosis), the total estimated annual costs for the total projected reuse amounts would be approximately $49,000 to $90,000 in 2010, increasing to $6.3 million to $11.5 million in 2060. The range is based on the difference in treating the water by ultra filtration/ reverse osmosis and not treating it at all. Due to wide range or wastewater quality in the region, ultra filtration/ reverse osmosis construction costs from this feasibility study were referenced when calculating a new cost for Non-Potable Reuse which is shown below. Reference the appendix for a detailed breakdown.

Table 4.27: WMS Strategy Cost Summary (Non-Potable Reuse)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Non-Potable Reuse	$ 415.22	$ 1.27	I of Cost Analysis Appendix

*This is based off a feasibility study done for City of Brownsville; “ Robindale Wastewater Recovery and Reuse Facility Project” done through the Border Environment Cooperation Commission. The costs were derived from here but formulated through TWDB standards of costs for each WMS which includes interest during construction and various other factors. The cost is also brought to present cost since the derived cost was estimated in 2001.

4.5.2.4. Environmental Impact

When this water management strategy is put into motion there will be temporary and permanent impacts associated with implementation of this strategy. The temporary environmental impacts would probably be evident with the construction activities needed to make infrastructure improvements. The construction activities dealing with this WMS would include a decrease in air and noise quality. The intensity of these construction related impacts would be minimal due to dust and noise measures to be implemented during construction, applicable permit conditions, and stipulations for the protection of air and water quality, and temporary localized nature of the effects. The construction activities could impact ecological and cultural resources to the extent that such resources occur in areas targeted for improvements. Specifically, areas in proximity to the known habitat of threatened and endangered species should be identified prior to construction activities and appropriate measures should be taken to minimize any adverse impacts. Permanent environmental impacts due to construction and operation of the WMS would be a decrease in air quality due to the maintenance activities required for this WMS. The permanent decrease in air quality would not be significant, as maintenance activities are periodic in nature and duration.

One negative aspect of non-potable reuse for irrigation usage is the accumulation of byproducts over time in the irrigated soil. Since recycled wastewater normally contains higher levels of salts or other minerals, and those minerals may accumulate over time where the water is applied. Usually physical and biological processes in the soil offset this concern, unless the concentration of a pollutant is unusually high.

Mixing up potable and non-potable water pipes is a concern when users of recycled water include ordinary residences. Industrial users typically do not suffer such problems, but small children may drink form a home faucet that is intended solely for irrigation water. Because treated wastewater could contain harmful substances, the consequences of ingestion can be significant.

Bar the effects of urbanization, non-potable reuse will increase environmental water quality by reducing wastewater flows resulting in lower organic levels in receiving streams.

4.5.2.5. Implementation Issues

As with any project, necessary state and federal permits must be obtained before construction can begin. Additionally, a project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened or endangered species is impacted. The widespread implementation of reuse programs would require detailed utility and site-specific assessments to identify feasible reuse applications. Generally, direct non-potable reuse is economically feasible where there are central wastewater collection and treatment systems and where there are large demands for non-potable water within relatively close proximity to the supply source. However, some potential does exist in rural areas through the direct reuse of household gray water and through non-potable reuse in proximity to small wastewater systems and other types of alternative wastewater management systems. Consequently, there may be reuse potential for some WUGs in the Rio Grande Region that were excluded from the analysis summarized above. Similarly, some municipal water users included in the analysis may exceed goals for reuse while others may fall short. In any case, it is recommended that all municipal water suppliers with central wastewater collection and treatment systems undertake an assessment to identify and develop cost-effective reuse opportunities. This should include evaluation of opportunities to use reclaimed water as a substitute supply for municipal, manufacturing, steam electric, and agricultural uses.

The largest potential impact on cultural resources associated with this option comes from pipeline construction and operation. Therefore, pipelines should follow existing and shared rights-of-way whenever possible to minimize the area of disturbance.

4.5.2.6. Recommendations

The Rio Grande RWPG recommends that direct non-potable water reuse be considered a water management strategy for the following WUGs: Brownsville, Alamo, Edinburg, McAllen, Mission, Pharr, and Laredo.

It is further recommended that the non-potable use of reclaimed water be adopted as a strategy for meeting a portion of projected municipal water needs, as well as a portion of the projected steam electric power generation needs. It is also recommended that funding be provided by TWDB and from other sources for the purpose of conducting a more thorough assessment of non-potable reuse opportunities within the municipal, manufacturing, and steam electric water use categories. This assessment should be completed on a schedule that will allow the results to be incorporated into a future update of this regional water plan.

4.5.3. Potable Reuse

4.5.3.1. Strategy Description

There are two types of potable reuse, indirect and direct. Potable reuse of reclaimed water refers to the intentional reuse of highly treated wastewater effluent as a supplemental source of water supply for potable uses. While it is technically feasible to produce potable quality water from municipal wastewater effluent, direct potable reuse has not gained either regulatory or public acceptance. By contrast, indirect potable reuse is currently practiced elsewhere in Texas where surface water supplies are deliberately augmented with wastewater effluent or reclaimed water.

For this planning effort, a 1977 study that investigated the feasibility of indirect potable reuse in the McAllen-Edinburg area was reviewed. Based on the results of the pilot study, a potable reuse option was evaluated that would involve modification of existing wastewater treatment plants for biological nutrient removal, microfiltration, reverse osmosis, and ultraviolet disinfection. The reclaimed water would then be blended with raw water from the Rio Grande in a raw water storage reservoir from which the blended supply would be treated by existing water treatment plant processes, disinfected with ozone, and then sent to the potable water distribution system after adding chlorine. To more accurately assess the feasibility of potable reuse for the City of McAllen, a pilot study was performed as a separate project to assess the use of an integrated bioreactor and reverse osmosis treatment train to reclaim municipal wastewater for potable reuse. The results of the pilot study indicated that reverse osmosis filtration is capable of producing reclaimed water that meets all state and federal drinking water and reuse standards.

With indirect potable reuse, highly treated recycled water is returned to the natural environment and mixes with other waters for an extended period of time. The blended water is then diverted to a water treatment plant for sedimentation, filtration, and disinfection before it is distributed. The mixing and travel time through the natural environment provides several benefits: (1) sufficient time to ensure that the treatment system has performed as designed with no failures, (2) opportunity for additional treatment through natural processes such as sunlight and filtration through soil, and (3) increased public confidence that the water source is safe. Unplanned indirect potable reuse is occurring in virtually every major river system in the United States today.[1]

A national example can be found in Virginia. The Upper Occoquan Sewage Authority (UOSA) Regional Water Reclamation Plant has been discharging to the Occoquan Reservoir, a principal water supply source for approximately one million people in northern Virginia. Because of the plant's reliable, state-of-the-art performance and the high-quality of water produced, regulatory authorities have endorsed UOSA plant expansion over the years to increase the safe yield of the reservoir. UOSA recycled water is now an integral part of the water supply plans for the Washington metropolitan area. Other major projects with proven track records are in Los Angeles County and Orange County, California, and in El Paso, Texas. After decades of research, pilot studies, and demonstration, the City of San Diego is designing a 20-mgd indirect potable reuse project.

[1] National Academy of Science, "Issues in Potable Reuse: The Viability of Augmenting Potable Water Supplies With Reclaimed Water", 1998.

The option of direct potable reuse is technically demanding and socially contentious. In direct potable reuse, the effluent of a wastewater treatment plant is routed directly to the intake of a drinking-water treatment plant. Because of the seemingly closed-loop cycle this process achieves, it is often called "toilet-to-tap". In other words, this is the use of recycled water for drinking purposes directly after treatment.

There are several reasons that prevent the adoption of this type of water treatment. The first reason is that direct potable reuse is technically demanding because wastewater requires extensive treatment prior to re-introduction in the drinking water plant. Typically, wastewater is discharged to receiving bodies of water such as lakes and rivers. This is directly cycling the wastewater back into drinking water that requires physical and chemical treatment surpassing that necessary for surface water discharge.

The second reason is that direct potable reuse is socially contentious because of the negative associations of wastewater. Although many communities already practice indirect potable reuse because their drinking water lies downstream of another municipality's wastewater plant, the idea of direct reuse is often more upsetting. Citizen group reactions in areas where direct potable reuse has been proposed tend to be strongly negative.

While some of the initial issues with direct reuse can be attributed to general ignorance of the realities of water treatment, direct potable reuse does suffer some serious questions regarding health and hygiene. The dilution of pollutants by receiving bodies of water in traditional water plays a significant role in cleaning the water. A system that loops back a large quantity of its water volume has the risk of concentrating pollutants over time. While EPA-limited pollutants and pathogens are closely monitored, there are other potential problem chemicals whose effects are unknown. For example, many medications are excreted from the body and are detectable in wastewater. Such chemicals are not on the list of monitored pollutants, but would certainly be present in recycled wastewater.

4.5.3.2. Water Supply Yield

Conceptually, the amount of water that could be provided through indirect potable reuse of reclaimed water would be equal to the total amount of municipal wastewater discharges. However, economic and regulatory constraints, as well as public perceptions of the potential health risks associated with potable reuse, would likely represent major impediments to widespread implementation of potable reuse.

For this planning effort, a water supply and demand analysis was performed for each Water User Group (WUG). In this analysis, total water demand was compared to total water supply over the extent of the planning study. Many of the WUGs projected a water supply deficit. It is in these cases that potable reuse could provide relief to the supply shortage. Currently, only the City of Weslaco is interested in pursuing indirect potable water reuse. By 2010, their goal is to use 1 million gallons/day (1,120 ac-ft/yr) of reuse water to facilitate potable water demand by blending it with raw water before it enters a treatment facility. This quantity would be available to Weslaco for the extent of the planning study. The WUG supply and demand table for Weslaco can be viewed in the appendix.

4.5.3.3. Cost

The costs estimates developed for the full-scale potable reuse system evaluated for the City of McAllen were reviewed for this planning effort. In 2000 dollars, capital costs of the project would be approximately $17.8 million. The total annual cost, which includes debt service (6% for 30 years) and operations and maintenance costs, are estimated to be $3.9 million per year. On an annualized basis, the unit cost of the additional water supply would be $535 per acre-foot per year. However, it should be noted that these estimates do not include the costs associated with conventional treatment of the blended raw/reclaimed water supply. Table 4.28 shows a breakdown of these costs. These numbers were referenced from the previous regional plan and are based on the McAllen, TX – Demonstration of ZenoGem and RO for Indirect Potable Reuse Pilot Study performed by CH2M Hill.

Table 4.28: Cost Breakdown for McAllen Indirect Reuse Plant

Project Name	Total Annual Cost	Cost per acre-foot	Capacity (mgd)
City of McAllen Indirect Potable Reuse Plant	$3,871,172	$535	6.8

Table 4.29: WMS Strategy Cost Summary (Potable Reuse)

Water Management Strategy Cost Summary			
	Cost		
WMS	**$/Acre-ft**	**$/1000 gallons**	**Appendix**
Potable Reuse	$ 705.89	$ 2.17	**J of Cost Analysis Appendix**

4.5.3.4. Environmental Impacts

When this water management strategy is put into motion there will be temporary and permanent impacts associated with implementation of this strategy. The temporary environmental impacts would probably be evident with the construction activities associated with infrastructure improvements. The construction activities dealing with this WMS would include a decrease in air and noise quality. The intensity of these construction related impacts would be minimal due to dust and noise measures to be implemented during construction, applicable permit conditions, and stipulations for the protection of air and water quality, and temporary localized nature of the effects. The construction activities could impact ecological and cultural resources to the extent that such resources occur in areas targeted for improvements. Specifically, areas in proximity to the known habitat of threatened and endangered species should be identified prior to construction activities and appropriate measures should be taken to minimize any adverse impacts. Permanent environmental impacts due to construction and operation of the WMS would be a decrease in air quality due to the maintenance activities required for this WMS. The permanent decrease in air quality would not be significant, as maintenance activities are periodic in nature and duration.

Bar the effects of urbanization, potable reuse will increase environmental water quality by reducing wastewater flows resulting in lower organic levels in receiving streams.

4.5.3.5. Implementation Issues

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, the project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened and endangered species are impacted. The key issue associated with the implementation of non-potable reuse of reclaimed water is public acceptance of the strategy. While opinion surveys indicate that the public is generally supportive of strategies that involve the use of reclaimed water for non-potable purposes, public acceptance of indirect potable reuse is questionable no matter what degree of public health safeguards are provided. Also, while indirect non-potable use has been implemented elsewhere in Texas, the practice involves blending relatively small quantities of reclaimed water with very large volumes of raw water in a large surface water reservoir. While the potable reuse option evaluated for McAllen would meet current state and federal drinking water standards, permitting of such a project could be in doubt, particularly if there is significant public opposition to such a project.

The largest potential impact on cultural resources associated with this option comes from pipeline construction and operation. Therefore, pipelines should follow existing and shared right-of-ways whenever possible to minimize the area of disturbance.

4.5.3.6. Recommendations

The Rio Grande RWPG recommends indirect potable water reuse as a water management strategy for the City of Weslaco. It is also recommended that funding be provided by TWDB and from other sources for the purpose of conducting a more thorough assessment of potable reuse opportunities within the municipal water use category. This assessment should be completed on a schedule that will allow the results to be incorporated into a future update of this regional water plan.

4.5.4. Advanced Water Conservation

Past regional water planning studies included estimated water savings due to water conservation in the overall demand figure for each Water User Group (WUG). In this round of regional planning, the TWDB has determined that "reductions due to the installation of water-efficient plumbing fixtures in new construction, as well as from the replacement of older fixtures, will be included in the Regional Water Plans based on data provided by the TWDB." These measures are treated as a requirement for each municipal WUG thereby reducing per-capita water demand throughout the extent of the planning study. Any additional conservation measures will be treated as Advanced Water Conservation.

4.5.4.1. Strategy Description

Advanced water conservation methods were analyzed and evaluated based on the best management strategies developed by the Water Conservation Implementation Task Force. As defined in the Best Management Strategies Guide[2], strategies for municipal water users included residential clothes washer incentive program, school education, public information, landscape irrigation conservation and incentives, and water wise landscape design and conversion programs, among others.

After conversations with various municipal water users in the region, it was determined that the most feasible advanced conservation methods were public information, school education, and the installation of higher efficiency residential clothes washers.

<u>Public Information/School Education</u>
Advanced water conservation through public information and school education is both a short-term and long-term conservation measure. In the short-term, individuals may realize the benefit of water conservation themselves, resulting in increased water savings. In the long-term, the effected individual may encourage additional water conservation among peers

[2] Texas Water Development Board Water Conservation Implementation Task Force; Report 362, "Water Conservation Best Management Practices Guide", November 2004.

and family alike. This strategy is especially effective when combined with another conservation measure.

<u>Residential Clothes Washers</u>
In 2001, the Unites States Department of Energy (DOE) adopted a two-step phase-in of higher efficiency standards for residential clothes washers. In 2004, all clothes washers manufactured will be required to be 20 percent more efficient than the current standard. In 2007, all clothes washers manufactured will be required to be 35 percent more efficient than the current standard. Water conservation will be a direct result of increased efficiency.

4.5.4.2. Water Supply Yield

The goal and effect of implementing additional or advanced municipal water conservation measures is to reduce projected municipal water demands and thereby reduce future needs for additional supply. In a real sense, water demand management through properly designed and funded water conservation programs can be viewed as providing an additional source of water equivalent to new supply development and other supply acquisition strategies.

It is estimated that the conversion from an old clothes washer to a new, higher efficiency clothes washer can save 5.6 gallons per-capita per day. However, the DOE's mandate does not take effect until 2007. With this being said, it was assumed that all new washing machines purchased in D2010 and extending until the end of the planning study would incorporate a higher efficiency design and save 5.6 gallons per-capita per day. In order to model this scenario, the Regional Planning Group applied the washing machine water conservation figure as a function of increased population over the base year population. For instance, the year 2000 population of the entire region is 1,236,246. The year 2010 projected population is 1,581,207. Therefore, the difference in year 2000 population and year 2010 population is modeled as conserving 5.6 gallons per-person per day (344,961 people x 5.6 gallons per person = 1,931,782 gallons conserved daily). Similarly, in the year 2060, expected water conservation is calculated by multiplying the difference in year 2000 base population and year 2060 projected population by 5.6 gallons per-person per day. The following table represents a county-by-county breakdown of the water supply yield associated with washing machine conservation.

Table 4.30: Washing Machine Conservation

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Water Supply Yield	3,150	8,723	8	289	505	3,315	66	72

(AF/yr)								

Public information and school education measures have the possibility to conserve a considerable amount of water over the span of the planning study. However, according to the Best Management Practices Guide, "Water savings for school education programs are difficult to quantify and therefore estimated savings are not included in this BMP." The same scenario exists for Public Information. Most of the available water savings data associated with these methods includes other BMP's. For instance, if a retrofit kit is provided along with education, water savings can be calculated according to the Residential Retrofit BMP. In this region, public information and school education are stand alone water conservation measures. Therefore, the Regional Planning Group estimated potential savings to accrue at a rate of 1 gallon per-capita per day. Another issue facing the planning group is determining the extent of water savings. The method adopted by the Regional Planning Group is similar to that of the Washing Machine Installation Advanced Water Conservation Measure. By taking the projected increase in population over the base 2000 year population and multiplying it by the projected water savings associated with this conservation method (1 gallon per-capita per day), a reasonable conclusion is derived. The following table represents the Water Supply Yield associated with Public Information and School Education.

Table 4.31: Public Information/School Education Savings

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Water Supply Yield (AF/yr)	563	1,558	1	52	91	592	12	13

Combined water savings associated with Public Information, School Education, and Washing Machine Installation are shown in the following table. These findings represent the total water savings associated with Advanced Water Conservation.

Table 4.32: Advanced Water Conservation Savings

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Water Supply Yield (AF/yr)	3,713	10,281	9	341	595	3,907	78	85

Using this method Cameron County was assigned a yield of 3,713 acre-ft for advanced conservation. Hidalgo County was assigned a yield of 10,281 acre-ft which is the largest yield for the region. Webb County was assigned a yield of 3,907 acre-ft. Starr County was assigned a yield of 595 acre-ft. Maverick County was assigned a yield of 341 acre-ft. Zapata (85), Willacy (78), and Jim Hogg (9) counties were assigned a yield less than 100 acre-ft. Individual Water User Group Advanced Water Conservation figures can be seen in the Appendix.

4.5.4.3. Cost

To achieve the estimated water savings associated with the advanced municipal water conservation scenario, a significant commitment of funding and other resources to implement the measures will be required. Cost elements of a program to achieve the estimated savings include funding for educational and public awareness activities and staff to manage and implement the various programs. It is important to note that the investment in municipal water conservation requires substantial front-end funding at the outset and for the duration of the planning period. Because the effects of conservation are incremental and build over time, the initial costs on a unit basis are relatively high at the outset and then decline significantly over time.

The cost for Advanced Conservation will take into consideration the population of the region multiplied by the cost proposed for public education & school education by Best Management Practices Guide provided by TWDB which is estimated to be $5/person. The annual cost for public education was calculated by using the population projected for 2010 by the TWDB which is 1,581,207. The population for the region was then multiplied by the cost of conservation education (Cost of Public Education @$5 per person). The cost for public education was estimated to be $1,633,755. The annual cost for school education was calculated by using the population of school age children based on the 2003/ US Census which was calculated to be 326,751. This population was multiplied by the cost of school conservation education (Cost of Public Education @$5 per person). The cost for school education was estimated to be $4,743,621.

The two costs for education were combined and set to TWDB standards of analyzing water management strategies. The total cost of $6,377,376 was then compounded for twenty years at 6%. Then an annual cost was calculated taking interest, engineering, mitigation, and environmental costs which was calculated to be $801,492. This total annual cost was then divided by the annual savings that took into account the savings of the efficient washer machine (2007) mandate, public education, and school education, as described earlier. The cost for Advanced Water Conservation is estimated at $112 per acre-ft saved.

4.5.4.4. Environmental Impacts

Since this strategy deals specifically with conserving municipal water, there are no adverse effects to the environmental needs of the region.

4.5.4.5. Implementation Issues

In this round of regional planning, only three methods are being recognized as feasible: public information, school education, and residential clothes washer installation. In order to realize the full potential of advanced water conservation, additional strategies must be implemented. However, there are many factors hampering the willingness of municipal WUGs to apply such strategies.

Region-wide implementation of advanced municipal water conservation measures will require a commitment of funding and other resources by nearly all public water suppliers in the Rio Grande Region. In addition to funding, many public water suppliers in the region, particularly small systems, lack the staff resources to devote to the development and implementation of water conservation programs. Perhaps the most fundamental problem with implementation of this strategy is the number of small water systems with a large number of small diameter lines that prevent the opportunity to cost effectively save water. This could be addressed through the development of regional approaches to implementation of conservation measures including regionalization of the water transmission and distribution network. For example, larger municipal water suppliers might allow smaller neighboring suppliers to participate in the implementation of certain programs (e.g., rebates for plumbing fixture replacement).

4.5.4.6. Recommendations

The Rio Grande RWPG recommends region-wide implementation of municipal water conservation programs that incorporate the elements of public information, school education, and residential clothes washer installation as defined by the Water Implementation Conservation Task Force. It is further recommended that all municipal water users with projected shortages implement additional water conservation programs that will reduce projected water demands.

4.5.5. Seawater Desalination

On April 29, 2002, Governor Rick Perry directed the Texas Water Development Board (TWDB) to develop a recommendation for a demonstration seawater desalination project as one step toward securing an abundant water supply to meet Texas' future water supply needs. In

December 2004, TWDB released a Biennial Report on Seawater Desalination: "The Future of Desalination in Texas" Volume I & II. Proposals were received from several areas around the State. In Region M, Brownsville submitted a proposal to provide Sea Water Desalination as strategy to meet future demands of the area.

The available water supply for surface intake for brackish or saline supplies would be from the Gulf of Mexico via the Port of Brownsville Ship Channel. The quantity of supply would not be problem in quantities proposed for 25 MGD sea water plant. This would require a 45 MGD intake with discharge of approximately 20 MGD concentrate. Other potential intake could be closer to the Gulf of Mexico.

4.5.5.1. Strategy Description

There are several types of desalination methods to treat sea water. Such methods include thermal processes such as multistage flash distillation, multiple-effect distillation, and vapor compression. These energy intensive processes are more common in the Middle East where fuels are more abundant.

Membrane technologies are more prevalent today using reverse osmosis (RO). This process is also energy intensive where semi permeable membranes are used. For higher total dissolve solids (TDS) found in sea water, high pressures are used to separate the sea water into fresh water and a concentrated by-product. The RO process is the most common form of desalination of sea water. A typical pressure for sea water with 35,000 mg/l could be in excess of 1000 psi. That compares to less than 200 psi for 3,000 mg/l TDS groundwater. The higher TDS plants yield less than 50% of the water supplied. The remaining 50% is the concentrated by-product. This compares to approximately 80% with the lower brackish water facilities. Surface water intakes will require additional pretreatment of suspended solids prior to the RO treatment.

Sea Water Desalination still remains one of the higher cost water management strategies but cost is expected to continue to decline in the coming years as technology advances. Cost for sea water desalination is site dependant. It is expected that a sea water desalination facility would range in costs from $820 to $1,300 per acre-foot. When placed in conjunction with power generation facilities, power costs can be lower and a combined water intake and discharge will lower capital costs. Assessing the actual cost should be included in a feasibility analysis.

The TWDB recommends that feasibility studies for these projects be completed. These projects should be of a regional nature. Other TWDB recommendations include:

- Assessment of combined uses of seawater and brackish groundwater sources as a means of enhancing the cost-competitiveness of a desalination project;
- Identification and assessment of regional partnerships inclusive of local entities experienced in desalination research;
- Identification and assessment of water transfers resulting from net new water created by a desalination project that could enhance the benefits of the project to other large water users/municipalities in the Coastal, Lower Rio Grande, South Central and Lower Colorado planning regions, including approaches to structuring such transfers and draft agreements that would be required to secure their implementation;
- Identification and assessment of likely power sources and expected cost over the life of the project and, if from a co-located facility, description of the impact of current and proposed regulations on use of this source, plus costs; and
- Assessment of project funding and development alternatives.

Desalination of seawater was evaluated as a potential strategy for meeting DMI water demands within the Rio Grande Region. The evaluation was based on a study entitled "Seawater Desalination Feasibility Study in the Laguna Madre Area" that was completed in December 1997. This study provided background information, and described a reverse osmosis pilot study performed to assess the feasibility of using seawater as a water source. The study also determined key design parameters and estimated costs that would be associated with a full-scale seawater desalination facility. Additionally, the feasibility of seawater desalination was also evaluated in a report prepared for the TWDB entitled, *Desalination for Texas Water Supply*. This study included water supply yield and cost estimates for a full-scale desalination facility located in the vicinity of Port Isabel.

During the past 20 years, membrane technology has advanced significantly, resulting in more efficient and relatively lower cost membranes. Globally, desalination capacity has been increasing at approximately 12 percent a year and currently is estimated to be about 7 billion gallons per day (BGD).[3] There are more than 8,600 desalination plants installed globally, approximately 20 percent of which are in the U.S.A.[4]

As a potential water supply strategy for the Rio Grande Region, seawater desalination would involve the development of a full-scale facility in the vicinity of the Port of Brownsville and/or South Padre Island. This project would be sponsored by the Southmost Regional Water Authority to initially

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[3] U.S. Department of the Interior, Bureau of Reclamation,Technical Service Center. Desalting Handbook for Planners, 3rd Edition, 2002.
[4] Ibid.

serve southeast Cameron County but could grow to other cities in the lower and mid valley area including Cameron and Hidalgo Counties. The Laguna Madre Water District is planning an initial 1.0 mgd sea water plant in the near term to supplement their current supply. The plant is proposed on South Padre Island.

Table 4.33: Technical Characteristics

Technical Characteristics			
	Brownsville (25 MGD)	**Corpus Christi (25 MGD)**	**Freeport (10 MGD)**
Source Water	Brownsville Ship Channel	Gulf of Mexico	Gulf Coast Seawater or Brazos River Water
Intake	Screened Intake at Brownsville Ship Channel	Open sea intake: 8.2 miles of 72-inch pipeline	Existing Dow Chemical Seawater & Brazos River Intake System
Treatment Capacity	25 MGD expandable to 100 MGD by 2040	25 MGD	10 MGD
Concentrate Disposal	Open sea discharge with diffuser array: 15 miles of 36-inch concentrate transmission pipeline	Open sea discharge with diffuser array: 8.2 miles of 54-inch concentrate transmission pipeline	Existing Permitted Dow Freeport discharge canals and outfall

***Referenced Costs from the TWDB's Biennial Report on Seawater Desalination: "The Future of Desalination in Texas Volume 1**

4.5.5.2. Water Supply Yield

The water supply yield of a seawater desalination facility is variable. The facility considered in the Port of Brownsville would provide 25 MGD. A Laguna Madre study indicated to provide 1.0 MGD (1,120 ac-ft/yr) of water supply assuming 100 percent utilization. For the purpose of this plan, 5 MGD capacity is projected for Brownsville and roughly 1.0 MGD for the Laguna Madre Water District.

Table 4.34: Water Supply Yield for Seawater Desalination

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft)	7,902	0	0	0	0	0	0	0

4.5.5.3. Cost

Cost estimates were developed for a 1 mgd desalination facility near Port Isabel in 1996. Estimated total project costs are $6 million, with total annual costs of nearly $1.5 million. Based on an estimated firm yield of 1,120 acre-feet per year, the cost estimate per acre-foot is $1,300. During a presentation the project team for the Port of Brownsville project indicated a capital cost of $120 million with a combined debt service and operation cost of $2.50/1000 gallons or $820 per acre –foot.[5] This indicates that a larger facility is more cost effective due to economies of scale. It is also site specific where placed in conjunction with power generation facilities will lower power costs and provide a combined water intake. It should be noted that this presentation is only conceptual in nature. Assessing the actual cost should be included in the feasibility analysis. The following data was provided by the TWDB. It shows the costs for three feasible seawater desalination plants located along the Texas coast.

Table 4.35: Seawater Plants Cost Breakdown

	Brownsville 25 MGD	Corpus Christi 25 MGD	Freeport 10 MGD
$/1,000 gallons	2.14	3.51	3.37
$/ acre-ft	778	1,133	1,088

*Referenced Costs from the TWDB's Biennial Report on Seawater Desalination: "The Future of Desalination in Texas Volume 1

Table 4.36: Cost of Treated Desalinated Water Delivered to the Distribution System

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Seawater Desalination	$ 767.63	$ 2.36	G of Cost Analysis Appendix

*Referenced Costs from the TWDB's Biennial Report on Seawater Desalination: "The Future of Desalination in Texas Volume 1

[5] The Future of Desalination in Texas Workshop, Austin, Texas 2003, Concept Paper Presented by Dannenbaum Engineering Co. and URS Company.

Table 4.37: WMS Strategy Cost Summary (Seawater Desalination)

	Brownsville (25 MGD)	Corpus Christi (25 MGD)	Freeport (10 MGD)
Capital Cost	$ 151,388,000.00	$ 196,600,000.00	$ 93,183,000.00
Annual Cost of O&M	$ 11,776,000.00	$ 17,515,000.00	$ 7,364,100.00
Annual Potential Cost Off-sets to O&M	$2,372,500/yr (Sale/Lease of water rights)	$5,000,000/yr (Sale of raw water to San Antonio)	NONE

4.5.5.4. Environmental Impacts

Major environmental issues associated with a large-scale seawater desalination facility include disposal of the brine concentrate produced from the membrane filtration process, energy consumption associated with operation of the facility, and land and environmental resource impacts associated with the construction and operation of the facility and the construction of a treated water transmission pipeline. The impacts of concentrate disposal would be minimal with dispersion into seawater at an offshore location. Land and environmental resource impacts could be avoided or minimized through careful location planning.

The need for education in this area exists at all levels, including water utilities staff and officials, consultants, TCEQ, funding agencies, the public, environmental agencies, and environmentalists. The experience of each one of these groups in dealing with membrane technology and membrane concentrate disposal is somewhat different. Each one of these groups forms their own perspective related to these topics based on their particular experience. All these groups need to be educated about the permitting process related to membrane concentrate disposal, and the nature of membrane processes and the membrane concentrate.

The TCEQ will need to develop permit applications more relevant to membrane concentrate applications. The existing permit applications could be modified by removal and addition of sections that apply to membrane concentrate and tailored to meet the information needs peculiar to membrane processes. It will become necessary for the TCEQ to provide permit applicants with a more clear understanding of the needed information, guidelines, and procedures for the permitting process.

The label applied to the membrane concentrate as an “industrial” discharge could be misleading and creates some misunderstanding on the public eye. The permit process chart indicates that anything not a domestic waste is automatically an industrial waste. Membrane concentrate is, therefore, considered an industrial waste. The label of industrial discharge applied to the membrane concentrate can be construed as a discharge of a toxic or hazardous nature. The greatest concern is then public perception. This public perception can in turn affect the decisions of decision makers on how drinking water needs are to be met. It is necessary to communicate and interact with the public to provide a clear understanding of the membrane concentrate rather than avoiding short-term unpleasant confrontations which can typically lead to long-term problems.

The goal should be to increase our understanding of any environmental concerns for the protection of environmental resources. This understanding will allow for a more effective way of dealing with concentrate disposal based on a sound knowledge of the nature of membrane concentrate. The planning and implementation of a reverse osmosis facility will require the processing of a membrane concentrate disposal permit. It is important for the utility to have the confidence that the given permit will be allowed to be renewed after the expiration date. Therefore, it is necessary to push for well established regulations for evaluation of membrane concentrate permits.

4.5.5.5. Implementation Issues

A major implementation issue for a large-scale desalination facility is whether there are users that are willing to finance and implement such a project. Brownsville currently holds rights and contracts to Rio Grande water supplies sufficient to meet current demands. The City of Brownsville Public Utilities Board has also indicated that it intends to develop the Brownsville Weir and Reservoir, local groundwater supplies, and non-potable reuse of reclaimed water to meets its future water supply needs. Brownsville's local water supply plan does now include seawater desalination if proven feasible by further study in conjunction with power generation facilities. Costs could be further reduced with grant proceeds to assist in financing this option. There also exists a possibility that a large scale facility could serve other areas in the lower and mid valley area. A seawater desalination project could become more feasible water supply strategy for Brownsville if it were to sell all or a large portion of its existing Rio Grande water rights to other DMI users. This could have the benefit of providing a revenue source to offset a portion of the costs of a desalination project while also making DMI water rights available to meet the future needs of other DMI water users in the region.

The permits for a seawater desalination project, although not insignificant, do not appear to place unreasonable requirements on such a project. The first seawater desalination project to go through the permit phase shall nevertheless be closely monitored to identify specific areas in which permitting processes might need to be adjusted to facilitate future seawater desalination projects in Texas.[6]

[6] Texas Water Development Board, 2003

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved and with the Endangered Species Act if any threatened and endangered species is impacted. Regulatory permitting of a large-scale desalination facility in the vicinity of Port Isabel would require extensive coordination with numerous federal, state, and local agencies. Land acquisition for the desalination facility and acquisition of right-of-way for construction of the concentrate disposal pipeline and treated water pipeline would also be major implementation issues. The treatment facility should be located to minimize cultural resource impacts. Also, pipelines should follow existing and shared ROWs whenever possible to minimize the area of cultural disturbance.

4.5.5.6. Recommendation

Sea Water Desalination still remains one of the higher cost water management strategies but cost is expected to continue to decline in the coming years as technology advances. The large DMI demand centers in relative proximity to the Gulf of Mexico (e.g., Brownsville) have expressed an interest in pursuing seawater desalination as a future water supply strategy through the Governor's initiative. It is recommended that this be a recommended strategy to provide sea water desalinated water to the Southeast Cameron County area through the year 2010. A total of 5 MGD is allowed for this strategy at this time for Brownsville and 1.0 MGD for Laguna Madre Water District.

4.5.6. Brackish Water Desalination

4.5.6.1. Strategy Description

Desalination of brackish groundwater is most commonly accomplished through reverse osmosis (RO). A full scale RO system to treat of brackish groundwater would require pretreatment, which would include a cartridge filtration system to remove minimal suspended solids. Acid and a silica scale inhibitor would also be added to prevent scale formation. A full-scale system would be expected to have a membrane life of approximately five years. Chemical cleaning of the membrane would be required approximately one to four times per year. Concentrate from the RO system must be disposed of in an environmentally acceptable manner. Most of the current or proposed systems will utilize drainage ditch discharge, which ultimately will discharge into the Laguna Madre or the Gulf of Mexico. Other options include, disposal to a sewer system, and deep well injection.

Recent awareness of the cost effectiveness of RO treatment of brackish water has made this supply source of greater importance. The availability of brackish groundwater from the aquifer is moderate. There are large volumes of brackish water available from the Gulf Coast aquifer throughout Region M, however, the aquifer is significantly less productive than in other regions along the Gulf Coast. Even though the area where brackish water is found increases, the availability is only considered average due to the decreased productivity.

A full scale RO system to treat of brackish groundwater would require pretreatment, which would include a cartridge filtration system to remove minimal suspended solids. Acid and a silica scale inhibitor would also be added to prevent scale formation. A full-scale system would be expected to have a membrane life of approximately five years. Chemical cleaning of the membrane would be required approximately one to four times per year. Concentrate from the RO system must be disposed of in an environmentally acceptable manner. Most of the current or proposed systems will utilize drainage ditch discharge, which ultimately will discharge into the Laguna Madre or the Gulf of Mexico. Other options include, disposal to a sewer system, and deep well injection.

4.5.6.2. Water Supply Yield

Table 4.38: Brackish Desalination Project Capacitites

Brackish Desalination Project Capacities			
Formal Name	**Projects**	**Size**	**Location**
Valley Municipal Utilities District #2	VMUD#2 (Rancho Viejo)	0.25 MGD	Cameron County
Reverse Osmosis Facility North Alamo Water Supply Corporation-La Sara Site	La Sara (NAWSC)	1 MGD	Willacy County
North Regional Water Project	North Cameron (Primera,NAWSC, & ERWSC)	2 MGD	Cameron County
Reverse Osmosis Facility North Alamo Water Supply Corporation- Owassa Site #4	Owassa Site #4 (NAWSC)	3 MGD	Hidalgo County
Reverse Osmosis Facility North Alamo Water Supply Corporation-Dolittle Site #1	Dolittle Site #1 (NAWSC)	3 MGD	Hidalgo County
Southmost Regional Water Authority	SRWA	7.5 MGD	Cameron County

The total amount of water supply that could be made available from the Gulf Coast aquifer with advanced water treatment technology is estimated to be 262,330 acre-ft in 2010. It is projected that the Carrizo Aquifer to have a water availability of 19,150 in 2010. As indicated, the various desalination plants constructed or under construction in this region range from .25 MGD to 7.5 MGD being pumped from a wellfield.

Table 4.39 gives a county-by-county breakdown of proposed Brackish Water Desalination water supplies. The net sum of all counties is 69,832 acre-feet, well below the available water supply of 262,330 acre-feet.

Table 4.39: Water Supply Yield for Brackish Water Desalination

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft)	24,753	21,792	0	641	1,120	10,100	11,426	0

4.5.6.3. Cost

The annual cost per acre-ft for this strategy to be implemented in this region was estimated to be at $505.51. The sizes of the brackish desalination plants in this region range from .25 MGD to 7.5 MGD[7]. Further cost data updated to include current projects completed or in the planning and design stage are summarized in the Appendix part of this plan. Costs include Well Field, Well Field Collection and Treatment Facilities. It does not include pumping and distribution costs. A major factor not included in these figures is the cost of water rights. The latest cost to purchase water rights has been approximately $2,000/acre-foot. If financed for 20 years @6% interest, the annual cost per acre foot would be $542.74. This could be deducted from the following costs as the capital cost includes the development of the groundwater source. Costs vary due to plant size, location, and water source salinity.

Table 4.40: WMS Strategy Cost Summary (Brackish Water Desalination)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Brackish Water Desalination	$ 505.51	$ 1.55	H of Cost Analysis Appendix

4.5.6.4. Environmental Impact

The use of membrane systems for potable water production in the Region M area is expected to increase dramatically in the next ten years. The primary environmental issue associated with the development of brackish groundwater supplies is the disposal of the concentrate produced from the membrane process. Reverse osmosis (RO) concentrate disposal must be dealt with utilizing environmentally sound and cost effective methods developed to support membrane technology growth in this area. We know that membrane processes are technically and economically well suited to produce drinking water, however, the disposal of concentrate can be more difficult and more expensive.

[7] Data Provided By NRS Consulting Engineers

The need for education in this area exists at all levels, including water utilities staff and officials, consultants, TCEQ, funding agencies, the public, environmental agencies, and environmentalists. The experience of each one of these groups in dealing with membrane technology and membrane concentrate disposal is somewhat different. Each one of these groups forms their own perspective related to these topics based on their particular experience. All these groups need to be educated about the permitting process related to membrane concentrate disposal, and the nature of membrane processes and the membrane concentrate.

The TCEQ will need to develop permit applications more relevant to membrane concentrate applications. The existing permit applications could be modified by removal and addition of sections that apply to membrane concentrate and tailored to meet the information needs peculiar to membrane processes. It will become necessary for the TCEQ to provide permit applicants with a more clear understanding of the needed information, guidelines, and procedures for the permitting process. TCEQ should also include protective measures regarding mineral content of RO discharges.

The label applied to the membrane concentrate as an “industrial” discharge could be misleading and creates some misunderstanding on the public eye. The permit process chart indicates that anything not a domestic waste is automatically an industrial waste. Membrane concentrate is, therefore, considered an industrial waste. The label of industrial discharge applied to the membrane concentrate can be construed as a discharge of a toxic or hazardous nature. The greatest concern is then public perception. This public perception can in turn affect the decisions of decision makers on how drinking water needs are to be met. It is necessary to communicate and interact with the public to provide a clear understanding of the membrane concentrate rather than avoiding short-term unpleasant confrontations which can typically lead to long-term problems.

The goal should be to increase our understanding of any environmental concerns for the protection of environmental resources. This understanding will allow for a more effective way of dealing with concentrate disposal based on a sound knowledge of the nature of membrane concentrate. Also, the ability of receiving streams to receive desalination effluent should be evaluated. If the receiving stream system would be negatively affected in a manner that would cause severe and permanent damage, alternate receiving waters should be evaluated. The planning and implementation of a reverse osmosis facility will require the processing of a membrane concentrate disposal permit. It is important for the utility to have the confidence that the given permit will be allowed to be renewed after the expiration date. Therefore, it is necessary to push for well established regulations for evaluation of membrane concentrate permits.

There is data provided by cooperating agencies to address and reference the impacts to aquifer levels due to the removal groundwater supplies. A 100 ft/50yrs draw down is estimated through the projections calculated in Chapter Three. There are potential impacts associated with groundwater removal, but due to a lack of region specific studies performed in this regard, an accurate description of these impacts cannot be quantified. Simulations with available GAMs indicate that drawdown from proposed groundwater strategies will have very little impact on streamflow in Region M. Most of the groundwater from the Gulf Coast aquifer is produced from aquifer storage (Chowdhury and Mace, 2003). Groundwater production from the downdip portion of the Carrizo-Wilcox aquifer would also remove water mainly from confined storage within the aquifer.

4.5.6.5. Implementation Issues

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved and with either Section 7 or Section 10 Consultation under the Endangered Species Act if any threatened and endangered species is impacted. Potential impacts on cultural resources may result from pipeline construction and operation. Therefore, pipelines should follow existing and shared ROWs whenever possible to minimize the area of disturbance. The small area disturbed due to well construction and operation is not expected to have a large impact on cultural resources. There are no other significant implementation issues associated with this strategy. However, additional technical information is required on the availability, quality, and cost of developing groundwater as a supply source for DMI uses. Also, consideration should be given to converting some DMI users entirely from surface to groundwater.

4.5.6.6. Recommendations

Based on the success of previous pilot studies and implementation of the VMUD, SRWA, and North Alamo WSC projects, potential for water supply, it is recommended that brackish groundwater treatment be a water management strategy for DMI users. Much testing continues to take place to determine site-specific water availability and areas for concentrate disposal for many planned projects in the Region.

Additional study should continue to take place to more fully assess both the availability and cost of groundwater supplies from the Gulf Coast aquifer in Cameron, Hidalgo, Jim Hogg, Webb, and Willacy counties. The development of a groundwater model for this portion of the Gulf Coast aquifer will aid in determining how much groundwater could be withdrawn from the aquifer for municipal use on a sustainable basis. Once these data and analytical tools are available, it is recommended that a comprehensive assessment be conducted to identify areas most promising for groundwater development. Additional, opportunities for developing brackish groundwater as a substitute for current municipal supplies from the Rio Grande should be thoroughly explored.

4.5.7. Brownsville Weir and Reservoir

4.5.7.1. Strategy Description

The Brownsville Weir and Reservoir Project is being proposed by the Brownsville Public Utilities Board (BPUB) as a surface water development project on the Lower Rio Grande in Cameron County. The proposed project is intended to provide additional dependable water supplies for municipal and industrial use by capturing and diverting "excess" flows of United States waters in the Rio Grande that would otherwise flow past Brownsville and discharge to the Gulf of Mexico. The proposed project consists of a weir structure across the channel of the Rio Grande approximately eight miles downstream of the Gateway Bridge at Brownsville. Under normal operating conditions the reservoir created by the proposed weir will have a maximum surface area of 600 acres and store approximately 6,000 acre-feet of water. The reservoir would extend 42 river miles upstream of the proposed weir.

4.5.7.2. Water Supply Yield

In addition to other water rights, BPUB currently has authorization to divert up to 40,000 acre-feet per year of "excess flows" from the Rio Grande under TNRCC Permit No. 1838. Excess flows are defined as all U.S. waters passing the Brownsville stream flow gauging station above a base flow rate of 25 cfs. Excess U.S. River flows will be impounded in the Brownsville Reservoir under BPUB's TCEQ water rights Permit No. 5259. According to hydrologic studies preformed for the project sponsors, the proposed project would allow the diversion of the full 40,000 acre-feet per year authorized under the existing permit approximately 70 percent of the time. However, the firm yield of the project (based on hydrologic analysis for the period from 1960 to 1997) is estimated to be 20,643 acre-feet per year.

4.5.7.3. Cost

Based on information supplied in the last regional plan, the cost estimate to construct the Brownsville Weir and Reservoir is $31 million. This cost is at present cost compared to the $25.9 million it was projected to be in the last round of planning. TWDB guidelines require an annualized cost to construct the project to deliver water to meet end user based on firm yield requirements. Assuming the firm yield from the diversion is used as the basis for providing treated water for DMI use, the following determination of unit cost was developed. Using TWDB cost estimation guidelines, the inflation adjusted annualized cost to construct, operate, and maintain the project, and provide required treatment, is approximately $11.09 million dollars per year. Consequently, the unit cost of firm water supply from the project is approximately $537.27 per acre-foot (see WMS Cost Analysis report in Appendix). Of this amount, approximately $168 per acre foot is used to develop the water and the balance is used to treat and transfer the water.

Table 4.41: WMS Strategy Cost Summary (Brownsville Weir)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Brownsville Weir	$ 537.27	$ 1.65	F of Cost Ananlysis Appendix

4.5.7.4. Environmental Impact

Several environmental issues have been raised concerning the proposed Brownsville Weir and Reservoir. These include impacts on water quality (i.e., increased salinity) within and downstream of the reservoir; impacts to aquatic and riparian habitat as a result of changes in downstream flow and salinity patterns; potential impacts to habitat from reservoir construction and inundation; potential adverse impacts to the Audubon Society's Sabal Palm Sanctuary; and increased risk of flooding. Although data isn't available to determine the exact impacts, maintaining environmental flows downstream of the river should be a major concern. The project sponsors have indicated their intent to operate the proposed project in such a manner as to completely avoid or largely mitigate these concerns, resource advocates remain concerned about these issues.

A water right permit for the Brownsville Weir and Reservoir (BWR) Project was issued by the TCEQ on September 29, 2000. This permit authorizes on behalf of the State of Texas the construction of the Brownsville Weir on the Rio Grande and the impoundment of 6,000 acre-feet of Rio Grande water in the Brownsville Reservoir. Special conditions included in this permit require the BPUB to: (1) pass a minimum flow of 25-cfs whenever water is being impounded in the reservoir; (2) pass sufficient water through the reservoir to satisfy the demands of downstream water rights holders as directed by the Rio Grande Watermaster; (3) monitor salinity in the Rio Grande downstream of the weir near the riverine/estuarine interface (23.6 river miles upstream from the mouth of the river) and only impound water in the reservoir when the measured salinity is less than an established near-fresh (low salinity) condition; and (4) consult with the TCEQ, Texas Parks and Wildlife Department (TPWD), U.S. Fish and Wildlife Service (USFWS), and other appropriate agencies to develop and implement an acceptable mitigation plan for the overall BWR Project. The requirements in the TNRCC permit for the 25-cfs minimum streamflow and for the maximum salinity level at the riverine/estuarine interface are directed toward assuring that the BWR Project will not cause significant changes in estuarine habitat conditions so as to adversely impact existing aquatic resources, such as shrimp and finfish. In order to identify potential impacts of the Project on estuarine aquatic resources, the BPUB will fund a six-year monitoring study that is to be undertaken by the TPWD after the Project has been constructed and in operation.

The required mitigation plan for the Project will be developed and finalized through the Section 404/10 Federal permitting process that is now underway under the authority of the Galveston District of the Corps of Engineers (Corps). Although the mitigation plan will include a variety of measures dealing with the Project's environmental impacts, it will focus on protecting and/or re-establishing riparian habitat along the reservoir reach of the Rio Grande for two endangered species of cats, the ocelot and the jaguarundi. Other issues to be addressed as part of the mitigation plan will include runoff and pollution control strategies during construction activities, bank erosion control measures, temporarily and permanently impacted vegetation, wetland habitat impacts, passage facilities for supporting the upstream and downstream migration of aquatic species through the weir structure, and identification of potential impacts of the Project to federal, state and private environmental preserves and cultural/historical resources in the region. The BPUB currently is engaged in Section 7 Consultation of the ESA with the USFWS, Corps and other agencies regarding the Project's potential impacts on endangered species and the development of appropriate mitigation measures. Also, the Corps is evaluating public comments regarding the BWR Project and comments received from the various federal and state resource agencies to determine whether or not a full environmental impact statement needs to be prepared for the Project.

In summary, all of the environmental issues that have been raised regarding the BWR Project will have to be satisfactorily addressed through the Section 404/10 Federal permitting process and through the IBWC project approval process in order for the necessary authorizations for the Project to be issued by the various agencies. Otherwise, the Project cannot be constructed and operated. This also will include authorization for the Project from Mexico. The IBWC will be the lead agency for all discussions and dealings with Mexico, and these discussions and dealings will not be undertaken until after the Section 404/10 permit has been issued by the Corps.

4.5.7.5. Implementation Issues

In addition to environmental issues, there is significant concern about the effect that construction and operation of the project could have on the Rio

Grande water rights system and, in particular, the effect on "no-charge pumping." According to the 1994 Hydrology Report and as amended in 1999 "… the existence of the Brownsville Weir and Reservoir should not impact no-charge pumping conditions since these proposed facilities will be located near the lower end of the Rio Grande below where any excess flows might enter the river …". The report also states that when the Watermaster designates excess flow conditions below Anzalduas Dam water right holders are notified in consecutive river order going downstream. These diverters are then allocated water until the available no-charge pumping supply is exhausted. Diverters downstream of this point do not receive any of the available excess flows. Since the proposed project is downstream of most of these diverters, the project should not affect no-charge pumping. In addition, BPUB has agreed to pass any available no-charge water through the proposed weir if it is requested by existing downstream water rights holders. Nonetheless, some irrigation districts continue to express concerns that the project would reduce the amount of "free water" available during no-charge periods it could affect accounting of water under the 1944 Treaty.

A comprehensive cultural resources evaluation will be undertaken as part of the Section 404/10 permitting process for the BWR Project. Field surveys will be conducted for the purpose of identifying existing archeological and/or historical resources of significance that potentially may be impacted by the Project. Working with the Texas Historical Commission, procedures for avoiding or minimizing these impacts will be developed and incorporated into the mitigation plan for the Project.

The issue of flooding impacts associated with the BWR Project also is being addressed by the BPUB. Under the current regulations of the IBWC, the proposed BWR Project cannot cause any increase in flood levels along the Rio Grande for the design flood condition. This condition corresponds to a flood flow of 20,000 cfs in the river at Brownsville. Currently, the BPUB is evaluating the flooding impacts of the Project using a state-of-the-art hydraulic computer model of the reach of the river from the weir upstream to the Gateway Bridge. The IBWC has reviewed preliminary modeling results and has suggested revisions, which now are being incorporated into the analysis. The objective of these studies is to develop a design for the weir structure that will be satisfactory to the IBWC and that will not cause any increase in design flood levels along the river. This work also is important because of an existing agreement between the IBWC and the USFWS that authorizes maintenance of only certain portions of the floodway between the levees along the Rio Grande in the vicinity of Brownsville so as to preserve minimum habitat areas for the endangered species of cats.

Concerns have also been expressed that a new structure at Brownsville could be designated as the new final water accounting point under the treaty dividing Rio Grande waters between the U.S. and Mexico. At present, the final accounting point is designated as the Anzalduas Dam located approximately 120 river miles upstream of the proposed Brownsville Weir. The concern is that a change in the physical point in accounting could in some manner alter the availability of water for Texas diverters. The project sponsors have stated that under their proposal "no identifiable harm" will occur if the IBWC chooses to move the accounting point from Anzalduas Dam to the proposed Brownsville Weir. IBWC staff has indicated that the only treaty implication associated with the proposed project is that Mexico could request, under terms of the treaty, to participate in the project and use it to capture excess river flows owned by Mexico. Conceivably, Mexican participation in the project could reduce the yield associated with capturing excess U.S. flows by decreasing the amount of U.S. storage capacity in the proposed reservoir and affect water supply to other water right holders because the changes in water accounting or river operations by the IBWC. However, Mexico's involvement in the project could offset the initial and operating costs of the weir.

4.5.7.6. Recommendations

Based on the criteria established for the final recommendations for meeting the DMI shortages, Brownsville Weir and Reservoir was recommended by the Rio Grande RWPG as a water management strategy toward meeting Brownsville's future needs.

4.5.8.Groundwater: Wellfield in Gulf Coast Aquifer

4.5.8.1.Strategy Description

The Gulf Coast Aquifer contains fresh and brackish groundwater. The southern Gulf Coast GAM indicates that groundwater is available from the aquifer in this area. Well production estimates range from 200 to 600 gal/min. The quality of the groundwater is expected to meet most standards for public water supplies and require minimal treatment. If required, the groundwater may be mixed with treated surface water to improve water quality.

About 80% of 822 wells containing total dissolved solids (TDS) measurements exceeded the 1,000 mg/L. The average for all of the results is 2,204 mg/L, and the median for all of the results is 1,618 mg/L. Although there may be some local trends regarding water quality, the TDS data for the Gulf Coast aquifer in Region M do not appear to show trends at the regional level. In other words, there are wells containing relatively low TDS water between wells that have relatively high TDS water. Based on the groundwater quality assessment completed for the Gulf Coast aquifer, it is expected that about 20% of the wells in Region M would contain fresh water and about 80%

would contain brackish water. The GAM does not estimate the volume of brackish groundwater in storage. Therefore, it is assumed that the 80% of the available groundwater supplies will be brackish (>1000 mg/L TDS) and about 20% would be fresh water (<1000 mg/L TDS).

4.5.8.2.Water Supply Yield

The Gulf Coast Aquifer is projected to have a water supply of 262,330 acre-ft in 2010 through 2060. Out of the 262,330 acre-ft of water supply in the aquifer 52,466 acre-ft is estimated to be a freshwater source. The rest of the 80% is brackish. The fresh groundwater water yield amount falls under the projected supply for this aquifer. The wellfield project is expected to provide an estimated yield of 29,824 acre-feet per year of additional supply for this region if utilized as a strategy. Table 4.42 gives a county-by-county breakdown of potential water supply yields for groundwater.

Table 4.42: Groundwater Supply Yield

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft/yr)	2,250	7,774	73	0	4,188	15,539	0	0

4.5.8.3.Cost

The estimated construction cost of the wellfield is about $2,975,000 (2004 dollars). The estimated construction cost for the wells (assuming depth and production rate for each well of 300 feet and 7.5 MGD). Annual operation and maintenance costs for the wellfield are estimated at $3,239,443. TWDB guidelines require an annualized cost to construct the project and deliver water to the end user based on yield assumptions. Consequently, the estimated unit cost of firm water supply from the wellfield is approximately $304.46 per acre-foot per year (see Appendix). Of this amount, approximately $136.65 per acre-foot is for development of the water and the balance is for treatment and transfer of the water.

Table 4.43: WMS Strategy Cost Summary (Groundwater)

Water Management Strategy Cost Summary			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
Groundwater	$ 304.46	$ 0.93	K of Cost Ananlysis Appendix

4.5.8.4.Environmental Impact

No negative environmental effects are anticipated. There may be a water level decline in the deeper zones of the Gulf Coast Aquifer, but this is not expected to impact surface water resources or wetlands. Water level declines are not expected to be high enough to cause appreciable land subsidence. Increased groundwater production will impact the small springs located in the region. The small springs provide water to wildlife and livestock. Water source or loss of water source is discussed in Chapter Three.

Simulations with available GAMs indicate that drawdown from proposed groundwater strategies will have very little impact on streamflow in Region M. Most of the groundwater from the Gulf Coast aquifer is produced from aquifer storage.[8] Groundwater production from the downdip portion of the Carrizo-Wilcox aquifer would also remove water mainly from confined storage within the aquifer.

4.5.8.5.Implementation Issues

Potential implementation issues include the uncertainty of the aquifer production capacity and the water quality of produced water. Because there are a limited number of large production wells in the area, it may take some exploration and multiple borings to determine the best location for wells and the wellfield. These implementation issues may add to the overall project cost. In addition, if the aquifer production capacity is good, but the water quality is not as good as expected, additional water treatment costs may be incurred, which would also increase the cost of the water.

4.5.8.6.Recommendations

The wellfield project is a recommended WMS for this region. It will be a valuable component of the overall water supply for this regional area. The project adds to the overall water supply for Region M by developing additional water that has not been historically used.

[8] Chowdhury, A.H., R.E. Mace, 2003. A Groundwater Availability Model of the Gulf Coast Aquifer in Lower Rio Grande Valley, Texas: Numerical Simulations Through 2050.

4.6. Water Management Strategies for Wholesale Water Providers

Texas Water Development Board guidelines in Exhibit B state that a Wholesale Water Provider (WWP) is any person or entity, including river authorities and irrigation districts, that has contracts to sell more than 1,000 acre-ft of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. Table 4.3 indicates the Water providers that follow the TWDB guidelines to designate them as Wholesale Water Providers for this region. This table also shows the projected water surplus/deficit for each WWP.

Out of the 21 Wholesale Water Providers there are three that have a deficit in this region. They are Southmost Regional Water Authority (SRWA), United Irrigation District, and North Alamo Water Supply Corporation. SRWA has a deficit of 11,844 acre-ft from 2010 to 2060. SRWA has Brackish Desalination as a water management strategy to alleviate the deficit from the Nueces-Rio Grande Basin and Rio Grande Basin. United has a deficit of 4,394 acre-ft from 2010 to 2060. This irrigation district has the two recommended irrigation water management strategies of On-farm Conservation and Irrigation Conveyance System Conservation to alleviate the deficit from the Nueces-Rio Grande Basin. These irrigation strategies are explained in greater detail in section 4.9. North Alamo Water Supply Corporation has a deficit of 2,345 acre-ft starting in the decade 2040 and growing to 12,150 acre-ft in 2060. The two water management strategies are being recommended to alleviate the deficit on the Nueces-Rio Grande Basin are Brackish Desalination and the Acquisition of Water Rights through Purchase. Since WWPs supply water to WUGs, numerical comparisons of WMS Yields needed to overcome a deficit can be seen by looking at each applicable WUG in the decision documents located in the appendix.

4.7. Quantitative Environmental Analysis

Based on the recommendations of each Water User Group (WUG) in the Rio Grande Region, water supply yields have been developed for each Water Management Strategy (WMS). Based on these yields, the Regional Planning Group has developed a quantitative environmental analysis that allows for a direct comparison of environmental impacts to land and stream flows associated with each WMS.

As was previously discussed, 327,532 acre-feet of irrigation water rights are proposed to be converted into DMI water rights. The current Rio Grande water right structure requires the conversion of irrigation water rights to DMI water rights to occur at a 2-to-1 ratio. Therefore, 163,766 acre-feet of DMI water rights will be made available. The balance of this conversion (163,766 acre-feet) is used by the Rio Grande Watermaster to guarantee the delivery of municipal water, and the balance will not be allocated.

As population increases, irrigation acreage is lost and converted to urban use. Based on data provided by the Rio Grande Watermaster as well as a number of Irrigation District Managers, the current Irrigation Water Duty (acre-feet of irrigation water rights per irrigation acre) is 2.5. Dividing the number of irrigation water rights to be converted to DMI use (327,532 acre-feet) by the Irrigation Water Duty (2.5 acre-feet/acre) gives the total number of irrigable acres lost to urbanization by this conversion (131,013 acres). The following table represents these findings.

Table 4.44: Irrigation Acres Lost

Acquisition of Rio Grande Water Rights	Water Yield (acre-feet)	Converted Water Rights (acre-feet)	Irrigation Water Duty (acre-feet/acre)	Irrigation Acreage Lost
Purchase	143,944	287,888	2.5	115,155
Urbanization	15,245	30,490	2.5	12,196
Contract	4,577	9,154	2.5	3,662
Totals:	163,766	327,532	2.5	**131,013**

Since this method takes into consideration the direct conversion of irrigation water rights, it cannot be applied to the other WMS's. Therefore, another method must be used to determine the effect of each WMS on non-urbanized land.

Chapter 2 of this report described the TWDB's population and water demand projections for this region. The population density (people per acre) of the region in 2000 was .175 people/acre. In 2060, the projected population density of the region is .5403 people/acre. The city with the highest projected population density in 2060 is Laredo (12.77 people per acre). Since the City of Laredo has the highest population density in the region in 2060, it is assumed to be 100% urbanized. Percent urbanized is a relative term describing an areas population density in terms of the maximum regional population density. For the purpose of this text, urbanized land is defined as any such land parcel that serves as housing, industry, or any such relation of the two. As described earlier, the year 2000 population density of the region was .175 people per acre. By dividing this term by the maximum population density in the region (City of Laredo: 12.77 people per acre), the region was assumed to be 1.37% urbanized in 2000. Multiplying this figure (.0137) by the overall land area of the region (7,081,600 acres) gives the number of urbanized acres (97,017.92 acres). Similarly, the region is projected to be 4.23% urbanized in 2060. This correlates to 299,410.05 urbanized acres. Therefore, the difference in year 2060 urbanized acres and year 2000 urbanized acres (202,392 acres) represents the region wide increase in urban land.

As population grows, land must be converted from non-urban to urban. Consequently, as population grows, water use increases. It can therefore be assumed that land conversion is directly related to an increase in water use. As described earlier in Chapter 4, Water Management Strategies (WMSs) were developed to serve these rising populations. Overall, WMSs are projected to yield 324,937 acre-feet of water per year. By dividing each WMS's yield by the overall WMS yield, the contribution percentage can be discovered. For example, Non-Potable Water Reuse is projected to yield 30,841 acre-feet of water in 2060. By dividing this figure by the overall WMS yield (342,937 acre-feet/year), we conclude that Non-Potable Reuse accounts for 8.99% of all WMS yields.

As described earlier, 299,410 acres of land will be urban in 2060. This marks an increase of 202,392 acres from the year 2000. Taking the contribution percentage of each WMS and multiplying it by 202,392 acres, we arrive at a value representing the amount of urbanized land associated with each WMS. The following table represents these findings.

Table 4.45: Urbanized Acres

Water Management Strategy	Water Yield (acre-feet/year)	Contribution Percentage	Urbanized Acres
Additional Groundwater	29,824	8.54%	17,601
Advanced Water Conservation	19,009	5.54%	11,219
Non-potable Reuse	30,841	8.99%	18,202
Potable Reuse	1,120	0.33%	661
Brownsville Weir and Reservoir	20,643	6.02%	12,183
Acquisition of Water Rights			
Purchase	143,944	41.97%	84,952
Urbanization	15,245	4.45%	8,997
Contract	4,577	1.33%	2,701
Desalination			
Brackish	69,832	20.36%	41,213
Seawater	7,902	2.30%	4,664
Totals:	**342,937**	**100%**	**202,392**

It is estimated that 70% of all potable municipal water returns to the wastewater collection system. Further, 90% of flows entering a wastewater treatment plant are discharged into receiving bodies of water. Due to the increase demand of municipal water, wastewater receiving streams will see increased flows. It should be noted that source water for Non-potable Water Reuse and Potable Water Reuse comes from wastewater effluent. Therefore, these strategies actually decrease the amount of wastewater entering receiving streams. Advanced water conservation also reduces the amount of wastewater entering receiving streams.

The following table represents the overall increase/decrease in water flows in both the irrigation distribution network and wastewater receiving streams.

Table 4.46: Net Water Flow

Water	Water Yield	Wastewater

Management Strategy	(acre-feet/yr)	Discharge into Receiving Stream (acre-feet/yr)
Additional Groundwater	29,824	18,789
Advanced Water Conservation	19,009	-11,976
Non-potable Reuse	30,841	19,430
Potable Reuse	1,120	706
Brownsville Weir and Reservoir	20,643	13,005
Acquisition of Water Rights		
Purchase	143,944	90,685
Urbanization	15,245	9,604
Contract	4,577	2,884
Desalination		
Brackish	69,832	43,994
Seawater	7,902	4,978
Totals:	**342,937**	**216,050**

In summary, the Purchase of Rio Grande Water Rights is going to be responsible for the largest conversion of land to urban use, followed by Brackish Desalination, Non-Potable Reuse, Additional Groundwater, Brownsville Weir, Advanced Water Conservation, Acquisition of Water Rights through Urbanization, Seawater Desalination, Acquisition of Water Rights through Contract, and Potable Reuse, in order. As a Water Management Strategy, the Purchase of Rio Grande Water Rights will account for the largest amount of wastewater discharge, followed by Brackish Desalination, Non-Potable Reuse, Additional Groundwater, Brownsville Weir, Acquisition of Water Rights through Urbanization, Seawater Desalination, Acquisition of Water Rights through Contract, and Potable Reuse, in order. Implementation of Advanced Water Conservation will actually decrease the quantity of wastewater discharge.

4.8.Water Management Strategies Not Reevaluated from the Previous Plan

In addition to the strategies that were evaluated for this round of regional planning, there are several strategies in the last plan that were not reevaluated. A discussion of these specific strategies is presented below. Their descriptions were taken from the previous plan and their water yields and costs were not updated. Although specific water supply benefits for these strategies were not quantified in this plan, these strategies are believed to be of general benefit to all water users in this region. For example, the City of Laredo will be implementing inter-basin transfer as a groundwater source. Although this strategy was considered it was not confirmed, no information was afforded the Rio Grande RWPG in order to evaluate it as a recommended strategy.

4.8.1.Groundwater Supply Alternatives for the City of Laredo

The City of Laredo has been actively evaluating various groundwater supply alternatives. The results of these evaluations are presented in a report entitled, Groundwater Source Study Alternatives Evaluation: Final Report (November 1999), and are summarized below.

4.8.1.1.Strategy Description

A total of 13 groundwater supply alternatives were initially identified and subjected to a preliminary screening analysis. From this analysis, five alternatives were considered potential feasible and were evaluated in greater detail. The five alternatives are:

Carrizo aquifer in northwest Webb County with conveyance to Laredo via pipeline (Alternative 1);
Carrizo aquifer in northwest Webb County with bed and banks conveyance to Laredo via the Rio Grande (Alternative 2);
Laredo/Carrizo aquifers within 10 miles of Laredo (Alternative 3);
Edwards/Trinity aquifers in Kinney County with bed and banks conveyance via the Rio Grande (Alternative 4); and,
Carrizo aquifer in Dimmit County (Alternative 5).

A key engineering assumptions used in the analysis was that each option would be capable of producing 5.0 mgd of sustainable groundwater supply over the 30-year operating life of the projects. Additionally, for the two alternatives that involve bed and banks conveyance of supply via the Rio Grande, required water treatment would be provided at the City's existing water treatment plants.

4.8.1.2.Water Supply Yield

Each of the alternatives evaluated would provide 5,600 acre-feet per year of municipal water supply over a 30-year period. However, the long-term sustainability of each alternative is not certain and will require additional evaluation prior to implementation. Also, the potential to increase groundwater withdrawals beyond 5.0 mgd is moderate to poor for all of the alternatives. For low-yield aquifers such as the Laredo Formation and the Carrizo aquifer in southwest and south-central Webb County, increased production is limited by the length of the aquifer outcrop area as well as the prevalence of existing users of groundwater. For the higher yielding formations, such as the Edwards aquifer and the Carrizo in northwest Webb and Dimmit counties, the potential for increased groundwater production is limited by current competition and future increases in demand by other users.

4.8.1.3.Cost

Cost estimates for each of the alternatives were prepared which included capital and operations and maintenance costs for well fields, conveyance facilities, and water treatment.

The cost to develop groundwater varies significantly depending upon the groundwater source, well completion, and many other variables. The updated (2005) cost for this strategy would be the same as the groundwater costs found in the Appendix. The cost for groundwater is $304.46 this includes the treatment of water. Groundwater development is site specific so a range of $580 to $1,000 per acre-foot is reasonable still at present cost.

4.8.1.4.Environmental Impact

The potential environmental impacts associated with the groundwater development options evaluated for Laredo include impacts to other existing water users, wetlands, and stream flow due to a lowering of water levels. In addition, construction and operation of well fields and transmission pipelines could adversely impact sensitive environmental resources (e.g., native brush clearing) and should be evaluated in detail prior to project implementation.

4.8.1.5. Implementation Issues

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with either Section 7 or Section 10 Consultation under the Endangered Species Act if any threatened and endangered species is impacted. Each of the groundwater supply alternatives considered for Laredo will require regulatory approvals by the TNRCC Public Drinking Water Program. In addition, regulatory controls on groundwater withdrawal are in place for those alternatives that fall within the jurisdiction of the Winter Garden Water Management District. It is uncertain, however, whether the district's regulations would be effective in limiting withdrawals in excess of the recharge rate over the 30-year lifespan of the projects. The only fail-safe method for managing withdrawals is to control a sufficiently large land area that includes the contributing portion of the aquifer recharge zone. This can be accomplished through direct ownership, lease agreements, or other contractual arrangements.

Potential impacts on cultural resources may result from those conveyance options requiring pipeline construction and use. Therefore, pipelines should follow existing and shared ROWs whenever possible to minimize the area of disturbance. Conveyance via bed-and-banks will minimize the need for pipelines, consequently reducing the risk to cultural resources.

4.8.2.Gulf Coast Aquifer

4.8.2.1.Strategy Description

The use of brackish groundwater as a potable water source has been previously evaluated in the Brownsville area. The study, completed in November 1996, included a groundwater assessment, evaluation of treatment alternatives, reverse osmosis pilot study, and cost projections. The groundwater assessment in the Brownsville area indicated that it would be possible to develop a well field to produce 10.5 mgd of water supply.

The Brownsville, Texas study considered two methods for groundwater treatment – Reverse Osmosis (RO) and Electrodialysis (EDR). The analysis indicated that RO would be the least expensive option, so an RO pilot plant was constructed. This pilot scale system was used to determine the basic design parameters of a full scale RO system. A full scale RO system to treat 8-10 mgd of brackish groundwater would require pretreatment, which would include a desander to remove suspended material followed by a cartridge filtration system. Acid and a silica scale inhibitor would also be added to prevent scale formation. Based on the pilot testing, a full-scale system would be expected to have a membrane life of approximately five years. Chemical cleaning of the membrane would be required approximately four times per year. The results of the Brownsville pilot study imply that a full-scale RO system to treat brackish groundwater could successfully meet all state and federal primary and secondary drinking water standards

Concentrate from the RO system must be disposed of in an environmentally acceptable manner. Three options were proposed for a full-scale system including disposal to a brackish surface body, disposal to a sewer system, and deep well injection. Of these, disposal to a brackish surface by via a drainage ditch that ultimately discharges into the Brownsville Ship Channel and then to the Gulf of Mexico was the least cost.

4.8.2.2.Water Supply Yield

The total amount of water supply that could be made available from the Gulf Coast aquifer with advanced water treatment technology has not been determined. However, it is known that large quantities of poor quality groundwater occur throughout the Lower Rio Grande Valley. As indicated, the Brownsville study determined that it would be feasible to develop a groundwater well field capable of producing 8-10 mgd of groundwater supply (8,961 to 11,201 acre-feet per year).

4.8.2.3.Cost

The estimated capital costs to develop an 8.5 mgd groundwater supply project with advanced desalinization treatment technology is approximately $21 million. This strategy is being implemented by the construction of Southmost Regional Water Authority's Brackish Desalination Plant located in Cameron County. The cost is estimated to be $505.51 taking into consideration power costs, treatment costs, and interest accrued during construction.

4.8.2.4. Environmental Impact

The primary environmental issue associated with the development of brackish groundwater supplies is the disposal of the concentrated brine produced from the membrane filtration process. Disposal options include discharge to a surface water body, preferably one of similar or greater salinity, discharge to a sewer system, and deep well injection into a suitable underground formation. For most potential applications in the Lower Rio Grande Valley, a method of concentrate disposal would likely be through discharge to the Arroyo Colorado. However, this method would increase the salinity of this already impaired water body. Another environmental concern relates to the energy requirements of the desalinization process. Also, there would be disturbance and potential environmental impacts in the immediate vicinity of the well fields during drilling and other construction activities.

4.8.2.5. Implementation Issues

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with either Section 7 or Section 10 Consultation under the Endangered Species Act if any threatened and endangered species is impacted. Potential impacts on cultural resources may result from pipeline construction and operation. Therefore, pipelines should follow existing and shared ROWs whenever possible to minimize the area of disturbance. The small area disturbed due to well construction and operation is not expected to have a large impact on cultural resources. There are no other significant implementation issues associated with this strategy. However, additional technical information is required on the availability, quality, and cost of developing groundwater as a supply source for DMI uses. Also, consideration should be given to converting some DMI users entirely from surface to groundwater.

4.8.3. Additional Water Supply Reservoirs on the Rio Grande

4.8.3.1. Strategy Description

Article 5 of the 1944 Water Treaty between the United States and Mexico allows, but does not require, construction of a third dam along the Rio Grande River between Eagle Pass and Laredo. However, previous studies indicate that Falcon and Amistad reservoirs alone are sufficient to capture flood flows and provide for the maximum beneficial use of the waters of the Rio Grande River. Since 1986, the issue of developing a third reservoir on the Rio Grande has been revisited. In 1986, the United States section of the IBWC completed a preliminary feasibility study of three dam sites between Eagle Pass and Laredo for the generation of hydroelectric power and recreational benefit. Results of the study indicated that the dam would not provide additional conservation or flood control storage but that it might be feasible based on benefits derived from the generation and sale of hydroelectric power.

Several additional studies investigating the feasibility of similar projects in different locations have been completed since the original IBWC study. Most recently, in 1997 Webb County investigated the feasibility of a “low-water” dam just upstream Laredo. Interest in this latest project was fueled by potential federal assistance for the project as part of the American Heritage River’s Initiative. President Clinton announced this initiative in early 1997 to provide protection and restoration to qualifying rivers.

4.8.3.2. Water Supply Yield

As indicated, Falcon and Amistad reservoirs currently provide adequate water storage to capture flood flows in the Rio Grande. It has been determined from previous studies that he construction of a third dam would provide a significant increase in system firm yield relative the costs of developing the additional storage capacity.

4.8.3.3. Cost

Detailed cost estimates for the low-water dam and reservoir project proposed by Webb County have not been developed at this time. Webb County has indicated that it intends to proceed with more detailed engineering feasibility and environmental impact studies in the near future.

4.8.3.4. Environmental Impacts

The major environmental consequences of constructing a third reservoir include the potential loss of important riverine and riparian habitat, impacts to any endangered species that might occur in the project area, and impacts to downstream wetlands due to changes in the flood plains. The project may also impact water quality of Rio Grande in Zapata County and in the lower Rio Grande Valley.

4.8.3.5.Implementation Issues

Proponents of the development of a third reservoir near Laredo cite potential water quality benefits as a result of project. The reservoir would also provide a pool from which to divert water to a proposed new regional water treatment plant to be built by Webb County. The reservoir could also provide recreational and aesthetic benefits to the community. Opponents of the project contend that the reservoir will reduce downstream flows and will reduce water quality in Zapata County and the lower Rio Grande Valley. As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened and endangered species is impacted. Potential impact on cultural resources may result from reservoir construction. Additionally, coordination with Mexico will be necessary.

4.8.4.Capture and Use of Local Runoff in the LRGV

4.8.4.1.Strategy Description

Below Falcon Dam, the terrain along the Lower Rio Grande is characterized as coastal plain, with some rolling hills and numerous isolated low areas and depressions. Much of the area toward the Gulf once formed a broad, fan-shaped delta at the river's mouth that was dissected by multiple meandering channels. These channels carried river flows with heavy sediment loads through the delta to the Gulf. Today, these abandoned deltaic channels form finger lakes, which are called "resacas".

One of the possibilities for developing additional supplies of surface water in the Lower Rio Grande Basin would be to collect stormwater in the isolated low areas, depressions and resacas that are scattered throughout the area, primarily in Cameron and Hidalgo counties. Such water could be made available for local use, provided that the stormwater captured is not already appropriated to existing water rights. For stormwater to be considered unappropriated, it would have to drain into isolated low areas or water bodies which are not the source of supply for any existing water rights. Hence, any stormwater that eventually could flow into the Rio Grande would be considered to be appropriated and unavailable for development. Similarly, any stormwater flowing in the tributaries or the mainstem of the Arroyo Colorado also would likely be considered to be appropriated because of existing water rights located on this watercourse.

Cameron and Hidalgo counties cover an area of approximately 2,860 square miles. The Arroyo Colorado extends eastward for about 90 miles from near the city of Mission through southern Hidalgo County to the city of Harlingen in Cameron County, eventually discharging into the Laguna Madre near the Cameron-Willacy county line. The watershed of the Arroyo Colorado drains approximately 700 square miles. Excluding the watershed of the Arroyo Colorado because of potential conflicts with existing water rights, the remaining drainage area of Cameron and Hidalgo counties that potentially could be considered for collection of stormwater encompasses about 2,160 square miles. A general inspection of available topographic maps, county road maps, and aerial photographs indicates that no more than about 25 percent of this area would likely contribute stormwater flows into water bodies that are not subject to diversions by existing water rights such that the stormwater flows could be considered to be unappropriated. Hence, there appears to be no more than a total of about 700 square miles of drainage area within Cameron and Hidalgo counties from which stormwater flows could be collected and made available for water supply.

Annual rainfall in Cameron and Hidalgo counties averages about 25 inches according to data presented in the "Climatic Atlas of Texas" (Texas Department of Water Resources, LP 192, 1983). Assuming that approximately five percent of this annual rainfall actually occurs as runoff, which is reasonable for the coastal areas of lower Texas, the total volume of stormwater that could be potentially collected and made available for water supply in Cameron and Hidalgo counties would average approximately 50,000 acre-feet per year. Of course, depending on rainfall, this could range from only about 20,000 acre-feet during dry years (10 inches of rainfall) up to possibly 90,000 acre-feet in a very wet year (45 inches of rainfall).

Although as noted above, a significant quantity of stormwater potentially could be available for use on an annual basis, one of the major disadvantages with trying to develop stormwater as a source of supply is that it would not be dependable at a particular location because of the variable nature of rainfall, both spatially and temporally. Without a substantial amount of storage capacity in a low area, depression or resaca to hold the stormwater over extended periods of several months, the only supply of stormwater that might be available at any given location would be that which occurs as runoff during a single rainfall event. This, of course, would be of little value as a dependable water supply, but it could be useful as a short-term supplemental supply. The use of such stormwater on a short-term basis would reduce the need for releases from Falcon Reservoir and thereby extend the more permanent supply of water stored in the reservoir for later use.

Another issue regarding the stormwater supply option relates to the geographical area within which the stormwater could be effectively used as a water supply. Because of the relatively small amount of water that likely could be accumulated in a given low area, depression or resaca during a rainfall event, the subsequent use of the water probably would have to be limited to the immediate vicinity of the low area, depression or resaca. It is unlikely that it would be cost effective to design and install an extensive system of canals and/or pipes to transport and distribute the limited quantities of stormwater over a wide area. What would also complicate the distribution and use of such water would relate to who actually would own the water. Some type of agreement or institutional arrangement would have to be implemented whereby the ownership of the stormwater and the users of the water would be defined, together with their duties and responsibilities. These arrangements could vary widely depending on local circumstances regarding where a particular low area, depression or resaca is located and who owns it, which water users are to be supplied the associated stormwater, and who is to pay for development of the water supply project.

4.8.4.2. Water Supply Yield

As discussed above, the water supply yield from developing the stormwater option in Cameron and Hidalgo counties could potentially average about 50,000 acre-feet per year. Because of the variable nature of rainfall both spatially and temporally, the available water supply would not be dependable on a localized basis and could range between 20,000 acre-feet per year up to 90,000 acre-feet per year for the two-county region depending on annual rainfall conditions. These water supply yield amounts would be refined based on the results from the recommended pilot studies.

4.8.4.3. Cost

The costs of developing local stormwater runoff for use as a water supply source would be highly dependent upon site-specific factors including the amount of yield available at a given site and the sites proximity to potential users. It was beyond the scope of this planning effort to investigate the costs of this strategy for a specific site. It is recommended, however, that a study be conducted to develop water supply yield, cost, and environmental impact information for five localized areas.

4.8.4.4. Environmental Impact

The potential environmental impacts associated with this water supply strategy would be primarily localized in nature and related mostly to any disturbances of the existing environment resulting from modification of low areas, depressions or resacas to enhance their storage capabilities or from installation of water transport and distribution facilities. Such impacts would need to be minimized to the extent possible and mitigated where necessary.

4.8.4.5. Implementation Issues

The implementation issues that potentially could be factors affecting development of the stormwater supply strategy include the following:

Identification of low areas, depressions or resacas with stormwater inflows not subject to appropriation by existing water rights;
Definition of the reliability and dependability of water supplies developed using localized stormwater because of the spatial and temporal variability of rainfall;

Availability of adequate storage capacities to provide short-term stormwater supplies that can effectively supplement permanent Falcon Reservoir water;

Availability of local water users within the immediate vicinity of low areas, depressions or resacas where stormwater could be stored;

Cost of water transport and distribution facilities to serve local water users;

Ownership of stormwater and relationship to water users and cost of water distribution facilities; and,

Financing of project costs.

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with either Section 7 or Section 10 Consultation under the Endangered Species Act if any threatened and endangered species is impacted.

4.8.5.Conveyance of Rio Grande Water Supply - Pipeline from Falcon Reservoir to the LRGV

4.8.5.1.Strategy Description

Currently, both municipal and irrigation water supplies for Cameron, Hidalgo, and Willacy counties are released from Falcon Dam and conveyed down the Rio Grande where it is diverted for use. In most cases irrigation districts divert both irrigation and municipal water supplies through canal systems to delivery locations. For municipal water users, major disadvantages of the current water delivery system include relatively poor water quality water, reliability and the large transmission losses in the process. With regard to the latter, many municipal water users in the Lower Rio Grande Valley are assessed a 25 percent loss factor, or more, on delivery of their water supplies by an irrigation district. This loss factor effectively reduces the amount of water that is available for actual municipal water use. Also, during the current on-going drought, there has been concern that municipal water deliveries could be interrupted if irrigation supplies are exhausted. For many municipal water users in the region, delivery of water supplies requires that there be adequate irrigation “push” water.

As an alternative to the current system for the delivery of municipal water supplies, the feasibility of a water transmission pipeline from Falcon Reservoir to the lower Rio Grande Valley was evaluated in 1999 as part of the Integrated Water Resource Plan – Phase II.9 The pipeline would be designed to convey water an amount of water equivalent to the projected increases in municipal water demands from Falcon Reservoir to four delivery points in the Lower Rio Grande Valley. Use of a pipeline for transport would increase the efficiency of water delivery by eliminating channel losses. An update of that

[9] Route A, as discussed in the *Integrated Water Resources Plan*, is along a utility easement that extends from the hydropower facility at Falcon Dam toward Moore field.

study, published in March 2000, confined the proposed activity to municipal supplies in Hidalgo and Starr counties.10 Current municipal water demands would continue to be conveyed by the Rio Grande and through canals to existing water treatment and distribution facilities. Since the pipeline would convey more water as demand increases, the initial phase of the project would be sized to convey only half of the projected increase in municipal demands over a 50-year period. Initially, water treatment capacity would be provided for only about 20 percent of the ultimate water delivery capacity. These facilities would be expanded as needed to meet increasing demand.

4.8.5.2.Water Supply Yield

According to the analyses presented in the Falcon Reservoir Water Treatment lant and Pipeline System for Hidalgo and Starr Counties, Texas and Northern Mexico, domestic water transportation losses through the existing irrigation canal system below Falcon Reservoir are between 29 to 52 percent. While the proposed water transmission pipeline, would not affect the firm yield available from the Falcon Reservoir, it would eliminate much of the transportation losses associated with the portion of future municipal diversions that would be conveyed by the pipeline. The effect of reduced transportation losses would be felt proportionately with the increase in the amount of water conveyed in the pipeline. It is estimated that the transportation losses that would be prevented with the full development of the pipeline system would be 19,000 acre-feet per year.

4.8.5.3.Cost

The previous evaluation of the feasibility of the water transmission pipeline was preliminary with several alternatives considered. These alternatives include three identified pipeline routes, delivery of treated or raw water, system size, and four delivery points. The cost information presented in this section focuses on the costs for the system to deliver 100 millions of gallons of treated water per day from Falcon Reservoir to Hidalgo and Starr Counties. The annualized cost to construct the entire project is estimated to be approximately $24 million dollars. When compared to the maximum net water savings at full utilization of the project, the annualized unit cost per acre-foot of recovered municipal water supply is $1,025. The cost to deliver the total amount of treated water approximates $275 per acre foot. At present cost (2005) is estimated to be 29 million with the annualized unit cost per acre-foot of recovered municipal water supply now being at is $1,474.

[10] Falcon Reservoir Water Treatment Plant and Pipeline System for Hidalgo and Starr Counties, Texas and Northern Mexico, March 2000.

4.8.5.4.Environmental Impacts

Construction of a pipeline from Falcon Reservoir to the Lower Rio Grande Valley would have environmental impacts as a result of both the construction and operation of the project. Construction impacts would be predominately contained in the pipeline right-of-way (ROW) and could include disturbance to cultural resources, threatened and endangered species, wetlands, stream crossings, and prime farmland soils. Wildlife and migratory birds that depend on drinking water provided by the open canals will have a negative impact due to loss of canal areas.

4.8.5.5.Implementation Issues

In addition to reducing water transmission losses, the proposed pipeline project would have other potential benefits. For example, the pipeline would likely deliver higher quality water than the existing river and canal system and the pipeline project would facilitate the development of regional water treatment plants and perhaps induce further regionalization of water and wastewater utility services in the Lower Rio Grande Valley. A treated water transmission line routed through the northern portion of the Lower Rio Grande Valley could also provide important benefits in terms of providing water utility services in currently undeveloped area. However, a project of this nature would likely face significant institutional hurdles, for example, obtaining a high degree of regional participation by a large number of independent municipal water suppliers. Such participation would be required in order to finance a project of this magnitude. In addition, a project of this type could significantly alter existing relationships between municipal water users and the irrigation districts that deliver water and in many cases provide increasing amounts of water for municipal use.

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened and endangered species is impacted. Potential impacts on cultural resources may result from pipeline construction and operation. Therefore, pipelines should follow existing and shared ROWs whenever possible to minimize the area of disturbance. Lane easements for pipeline construction might be required. The existing Certificates of Adjudication (approximately 900) might need to be amended if there is a change in the diversion point.

4.8.6.Conveyance of Rio Grande Water Supply - Gravity Canal

4.8.6.1.Strategy Description

In the late 1940s and early 1950s the Lower Rio Grande Authority spearheaded an unsuccessful attempt to build a project that would divert water from Anzalduas Diversion Dam through a gravity canal that would supply downstream irrigation districts and other water users in Hidalgo and Cameron counties. The project was proposed largely in response to a similar diversion canal that was constructed in Mexico and in an attempt to increase the efficiency of water delivery to downstream irrigators. Projected benefits from the proposed project included the elimination of the need for existing river pumping stations, reduced sedimentation in the existing irrigation canal systems, and an increase in the reliability and rate of water deliveries to irrigators.

The gravity canal project was proposed to flow in a southeasterly direction, roughly parallel the Rio Grande. The first seven miles of the canal were to be unlined, with a bottom width of 160 feet. This section would act as a settling basin for sediments, with silt removal by means of a floating dredge. The remainder of the canal was to be concrete-lined in order to minimize water losses. The canal was to be sized large enough to convey the entire United States portion of releases from Falcon Reservoir. Feasibility studies completed in 1952 concluded that, at that time, the gravity canal project was feasible.

4.8.6.2.Water Supply Yield

The development of the project could increase the effective supply of water available for irrigation by reducing river channel and irrigation canal losses. Estimates of such savings were not previously developed. However, to the extent that minimum releases would likely be required from Anzalduas Diversion Dam to maintain downstream aquatic and riparian habitat, all or a portion of the water conservation benefits would be negated.

4.8.6.3.Cost

In 1952 the Gravity Canal Project was projected to cost approximately $18.32 million, with annual operation and maintenance costs of approximately $154,000. When these cost estimates are adjusted to1999 conditions, the Gravity Canal Project would cost over $193 million, with annual operation and maintenance costs of over $1.6 million. However, it should be noted that the original cost estimates likely do not account for such factors as permitting and mitigation of environmental impacts. At present cost (2005) conditions the project is projected to cost approximately $20.51 million with annual operation and maintenance costs of approximately $197,450.

4.8.6.4.Environmental Impacts

When this project was originally proposed and evaluated, current state and federal environmental regulations were not in effect. During that era, feasibility was defined almost exclusively in terms of economic feasibility. By today's environmental standards, the proposed project would likely be closely scrutinized due to its potential adverse effects on the Rio Grande River downstream of Anzalduas Diversion Dam. Operation of such a canal as originally proposed would have the effect of significantly dewatering the Rio Grande downstream of Anzalduas Diversion Dam. It would be likely that minimum releases would be required to preserve downstream aquatic and riparian habitat, which, as noted above, could negate much of the water supply benefit of such a project. Wildlife that are dependent on water from the existing canal system may be impacted. There would also likely be extensive environmental and socioeconomic impacts along the canal route and the canal itself could create a barrier to migration of indigenous threatened and endangered animals.

4.8.6.5.Implementation Issues

The development of a gravity canal to deliver water to irrigation and DMI users in Cameron and Hidalgo counties would face significant institutional impediments. The major issue would be the likely difficulty of gaining the very high degree of cooperation among the large number of DMI and irrigation users that would benefit from such a project. Such cooperation would be essential in securing financing. It could be expected that some water suppliers would be resistance to abandoning existing water diversion and delivery infrastructure.

As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened and endangered species is impacted. Potential impact on cultural resources may result from the canal development project.

4.8.7.Importation of Surface Water

Surface water importation (i.e., interbasin transfers) was evaluated at a reconnaissance-level, as a potentially feasible strategy for meeting DMI needs in the Rio Grande Region. A summary of the results of this analysis is provided below. Additional details are presented in a technical memorandum entitled, Interbasin Transfer Water Supply Options (January 2001).

4.8.7.1.Strategy Description

Three surface water importation options were evaluated, two involving delivery of additional water supply to the City of Laredo and one involving the delivery of additional water supply to DMI users in the Lower Rio Grande Valley. These options are:

Lavaca Basin Supply to Laredo: This option would involve the supply of 20 mgd (22,403 acre-feet per year) of raw water from the Lavaca River Basin to the City of Laredo. The diversion would be located near the town of Edna, Texas and a 36-inch diameter transmission pipeline approximately 220 miles long would generally follow the right-of-way of U.S. Highway 59. For the purposes of this analysis, it was assumed that the water supply would be available through a long-term water purchase contract with the Lavaca-Navidad River Authority.

Nueces Basin Supply to Laredo: This option would involve the supply of 20 mgd of raw water from the Nueces River to the City of Laredo. The diversion would be located downstream of the Choke Canyon reservoir in the vicinity of the town of George West, Texas. A 36-inch diameter transmission pipeline approximately 110 miles in length would follow the right-of-way of the U.S. Highway 59. It is assumed that the water supply would be available through a long-term water purchase contract with the City of Corpus Christi.

Nueces Basin Supply to the Lower Rio Grande Valley: This option would involve the supply of 17 mgd (19,042 acre-feet per year) of raw water from the Corpus Christi regional water system to the Lower Rio Grande Valley by extending the existing 42-inch "Sarita Pipeline" from Kingsville to Harlingen. The pipeline extension would be 33-inches in diameter, approximately 98 miles long, and would follow the U.S. Highway 77 right-of-way. As with the other options, it was assumed that the water supply would be available through a long-term water supply contract.

4.8.7.2.Water Supply Yield

As indicated, the two surface water importation options evaluated for Laredo would supply 22,403 acre-feet of additional water supply for DMI use. The water importation option examined for the Lower Rio Grande Valley would supply 19,042 acre-feet of additional DMI water supply.

4.8.7.3.Cost

Cost estimates for the three surface water importation options are presented in Table 4.47.

Table 4.47: Summary of Costs Associated with Surface Water Importation Options

	Lavaca Basin to Laredo	Nueces Basin to Laredo	Nueces Basin to LRGV
Supply	27,570	27,570	22,240
Unit Cost ($/ac-ft/yr)	$1,931	$1,374	$720

4.8.7.4.Environmental Impact

Large-scale interbasin transfers of surface water have potentially far-reaching environmental impacts. Of particular concern are the potential adverse effects of trans-basin diversions on instream flows and bay and estuary inflows. In addition, significant disturbance of land and environmental resources could occur from construction and operation of water transmission pipelines. Of particular concern would be the impacts on wetlands and riparian and aquatic habitat associated with pipeline stream crossings and native brush clearing. However, many of these potential impacts could be at least partially avoided by following existing highway right-of-ways.

4.8.7.5.Implementation Issues

There are a number of key issues associated with large-scale interbasin transfers of surface water. As with any project, necessary state and federal permits must be obtained before construction can begin, potentially including a Section 404, Clean Water Act Permit. Additionally, project may need to comply with the National Environmental Policy Act if federal funding is involved, and with the Endangered Species Act if any threatened and endangered species is impacted.

Other key issues include current state laws, which restrict new interbasin transfers by establishing a junior priority date to new or amended water rights involved in an interbasin transfer. Additionally, current state law includes provisions (Texas Water Code, Section 11.085) requiring the TNRCC to weigh the benefits of a proposed new interbasin transfer to the receiving basin against the detriments to the basin supplying the water. The criteria established in statute to be used by the TNRCC in the evaluation of proposed interbasin transfers are:

The need for the water in the basin-of-origin and in the receiving basin;
Factors identified in the applicable regional water plan(s);

The amount and purposes of use in the receiving basin;

Any feasible and practicable alternative supplies in the receiving basin;

Water conservation and drought contingency measures proposed in the receiving basin;

The projected economic impact that is expected to occur in each basin;

The projected impacts on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries; and,

Proposed mitigation and compensation to the basin-of-origin.

In addition to statutory and regulatory impediments to new interbasin transfers, public and political opposition in the basin-of-origin has become the norm throughout Texas.

Potential impacts on cultural resources may result from pipeline construction and operation. Therefore, pipelines should follow existing and shared ROWs whenever possible to minimize the area of disturbance.

4.8.8. Reallocation of Storage in the Amistad-Falcon Reservoir System

Approximately one-third of the controlled storage capacity in Amistad International Reservoir is below the top of the spillway gates and is the designated flood control pool. About 16 percent of the controlled storage capacity in Falcon International Reservoir is for flood control. The flood pool of each reservoir remains empty except during and following a flood event. As part of the Phase II Integrated Water Resources Plan for the Lower Rio Grande Valley, permanent and seasonal reallocation of a portion of the flood control storage capacity was investigated as a strategy for increasing the water supply yield of the reservoir system.

4.8.8.1. Strategy Description

Permanent or seasonal reallocation of the flood control storage capacity of the Amistad-Falcon Reservoir System could be implemented simply by raising the designated elevation of the top of the conservation pool. Increasing the conservation storage capacity of the reservoirs would allow additional inflows to be held in the reservoirs thereby increasing the firm yield of the system. Current reservoir operating procedures of the IBWC allow for storage of water in the flood control pool during the period from November through April when the threat of flooding, particularly related to tropical storm systems, is minimal. However, there are no set rules for this seasonal storage reallocation. Historically, the amount of water held in the flood control pool for water supply storage has ranged from zero to approximately 100,000 acre-feet in each reservoir.

A total of six alternative reservoir storage reallocation plans were evaluated for the Phase II Integrated Water Resources Plan. These included baseline scenarios for the current operating procedures with occasional seasonal storage in the flood pool, current-operating procedures without seasonal reallocation, and several scenarios for permanent reallocation of storage.

4.8.8.2.Water Supply Yield

The effects of alternative reservoir storage reallocation plans were estimated by simulating reservoir operations using the Reservoir Operations Model for the Amistad-Falcon reservoir System. Impacts were measured in terms of reducing diversion shortages, which represent failures to fully meet the water demands specified in the model. The results indicated that only relatively minor reductions in diversion shortages would occur with implementation of the alternative reallocation plans, except for the "extreme" scenario of reallocating most of the flood control storage in the two reservoirs to water supply. Furthermore, some shortages still occur even under the extreme reallocation scenario.

4.8.8.3.Cost

Previous studies did not assess whether implementation of flood storage reallocation would require modifications to the dams or control works of Amistad and Falcon reservoirs. It is implied in the study that modifications would not be required. There also would be no increase in reservoir system operations and maintenance costs.

4.8.8.4.Environmental Impacts

The previous study did not address potential environmental impacts associated with reallocation of flood storage in the Amistad-Falcon Reservoir System. However, it is not likely that there would be any significant environmental impacts.

4.8.8.5. Implementation Issues

Implementation of changes to IBWC reservoir operations policies and procedures to allow water supply storage in the flood control pools of the reservoirs would require the concurrence of Mexico. Also, any significant change in current procedures could generate public opposition if it is perceived that the change could increase the risks of flooding.

4.9. Strategies for Reducing Irrigation Shortages

4.9.1. On-Farm Water Conservation

4.9.1.1. Strategy Description

The Irrigation Technology Center (ITC) of Texas A&M University was responsible for providing data for this round of regional planning. The data was gathered by investigating both the effects of on-farm conservation in this region and the extent to which irrigation demands could be reduced through adoption of on-farm water conservation measures. These measures include farm-level water measurement and metering, replacement of field ditches with poly pipe, and adoption of improved water management practices and irrigation technologies. It should be noted that the investigation conducted by Texas A&M University provides documentation that 54% of agricultural water delivered within the region is measured or metered on a farm-level. Also, 36% of the agricultural water applied in the region is through poly or gated pipe and 30% is applied using advanced water management practices and/or improved irrigation technology. The ITC report can be reference in the Appendix.

On-farm water conservation offers a large potential to reduce the volume of water used for irrigation in agriculture. Technologies and methods currently available for on-farm water conservation include: 1) plastic pipe, 2) low energy precision application, 3) irrigation scheduling using an evapotranspiration network, 4) drip, 5) metering, 6) unit pricing of water, 7) water efficient crops, and 8) other options.

Water savings estimates were prepared for two scenarios: on-farm water savings without improvements to irrigation conveyance and distribution facilities and on-farm savings with such improvements. The amount of water that reaches the field turnout is partially dependent upon conveyance efficiency, which also influences the type of on-farm water conservation measures that can be applied. For example, insufficient “head” at the delivery point can make it difficult to deliver irrigation water evenly over the span of a field, no matter what irrigation methods or technologies are used. Approximately 50% of the area experiences insufficient head. Similarly, certain irrigation technologies, such as drip and micro-irrigation, require near continuous delivery of relatively small amounts of water. Most existing irrigation conveyance and distribution systems were designed to deliver large volumes of water over relatively short time periods.

4.9.1.2. Water Supply Yield

Three methods/practices were analyzed for this WMS: farm-level water measurement and metering, replacement of field ditches with poly/gated pipe, and adoption of improved water management practices and irrigation technologies. As detailed in the ITC report, 46% of the region still needs to be equipped with water measurement/metering devices, 54% of the region remains to be outfitted with poly/gated pipe, and 60% of the region needs improved management and irrigation technologies.

Two water supply conditions were evaluated for this WMS: normal and drought. Normal conditions were based on the average irrigation diversions for the highest 5 years during the period from 1986 to 2004. Drought conditions were based on the 2010 projected drought supply as detailed in Chapter 3. For the purpose of this plan, only the estimated savings under normal conditions will be evaluated. As was explained earlier, on-farm water savings are detailed for two cases: with and without improvements to irrigation conveyance and distribution facilities. Table 4.48 shows a county-by-county breakdown of achievable on-farm water savings with conveyance system improvements and normal water supply conditions. Table 4.49 shows savings without conveyance system improvements and with normal water supply conditions. No significant on-farm water savings are expected in Jim Hogg, Webb, or Zapata counties.

Table 4.48: On-Farm Water Savings with Conveyance Efficiency Improvements for Normal Water Supply Conditions (ac-ft/yr)

	Cameron	Hidalgo	Maverick	Starr	Willacy	Total
Measurement	12,714	25,809	0	0	0	38,523
Poly/Gated Pipe	18,795	38,153	1,438	0	2,927	61,313
Improved Mgmt./Tech.	45,938	98,823	14,709	7,894	6,833	174,197
Total	77,447	162,785	16,147	7,894	9,760	274,033

Table 4.49: On-Farm Water Savings without Conveyance Efficiency Improvements for Normal Water Supply Conditions (ac-ft/yr)

	Cameron	Hidalgo	Maverick	Starr	Willacy	Total
Measurement	4,700	8,700	0	0	0	13,400
Poly/Gated Pipe	8,500	16,000	1,100	0	2,000	17,600
Improved Mgmt./Tech.	15,400	50,800	6,000	7,894	4,100	84,194
Total	28,600	75,500	7,100	7,894	6,100	125,194

One can see that significantly more water can be conserved using on-farm techniques in conjunction with conveyance system improvements than can be conserved without conveyance improvements. Conveyance efficiency determines how much water reaches the field turnout. As improvements are made to the conveyance system, more water can be delivered to the turnouts and the full potential of on-farm improvements can be realized. For this report, the Rio Grande RWPG assumes that conveyance system improvements are being done in conjunction with on-farm improvements.

The Rio Grande RWPG will use an implementation scenario for on-farm water conservation measures based on implementation of the conveyance and distribution improvements previously described and in which investments in on-farm water conservation measures and the resultant water savings are to be "ramped up" or phased in over the 50-year planning period. This is in recognition that the implementation of on-farm water conservation measures requires acceptance and adoption by individual agricultural producers. The rate of implementation of on-farm water conservation measures is 13.3 percent of the estimated achievable on-farm water savings per decade, resulting in 80 percent of the estimated achievable on-farm savings being "captured" in decade 2060. This implementation schedule also allows for conveyance system improvements to take place before on-farm improvements are implemented thereby maximizing on-farm conservation. Therefore, our evaluation of on-farm savings uses data shown in Table 4.48: On-farm Water Savings with Conveyance Efficiency Improvements for Normal Water Supply Conditions. Table 4.50 shows on-farm savings throughout the extent of this planning study. Water savings are represented as a sum of the three conservation methods: farm-level water measurement and metering, replacement of field ditches with poly pipe, and adoption of improved water management practices and irrigation technologies. For a more detailed analysis, the ITC report can be viewed in the appendix.

Table 4.50: Projected Region M On-Farm Water Savings with Conveyance Efficiency Improvements and Normal Water Supply Conditions (ac-ft/yr)

	D2010	D2020	D2030	D2040	D2050	D2060
Cameron (ac-ft/yr)	10324	20655	30979	41302	51634	61958
Hidalgo (ac-ft/yr)	21699	43415	65114	86813	108529	130228
Maverick (ac-ft/yr)	2152	4306	6459	8611	10765	12918
Starr (ac-ft/yr)	1052	2105	3158	4210	5263	6315
Willacy (ac-ft/yr)	1301	2603	3904	5205	6507	7808
Total (ac-ft/yr)	36529	73085	109613	146142	182698	219226

4.9.1.3. Cost

Economists from the Texas Agricultural Experiment Station (TAES) performed a cost analysis for the implementation of on-farm improvements in the region. Their report was based on data collected for the last round of regional planning. It was assumed by the Rio Grande RWPG that on-farm implementation rates have remained consistent throughout the valley on a county-by-county basis. Therefore, the report completed by TAES is still accurate. However, the potential on-farm water savings have been updated, as was described earlier.

In the report done by TAES for the last round of regional planning, capital and O&M costs were reported in terms of water conserved due to volumetric measurement, poly or gated pipe, and improved management and technology. These values were then represented in terms of $/acre-foot. Since each county is in a different state of on-farm improvement implementation, current on-farm potential water savings were extrapolated using TAES's $/acre-foot analysis on a county-by county basis. These values were then combined to arrive at a general $/acre-foot value for the entire region. This value is representative of what it would take to implement general on-farm improvements throughout the region.

Table 4.51: WMS Cost Summary (On-Farm Conservation)

Water Management Strategy Cost Summary			
WMS	Cost		Appendix
	$/acre-foot	$/1000 gallons	
On-Farm Conservation	$253.38	$.78	K of Cost Analysis Appendix

Table 4.52 gives the resultant Region M annual unit cost analysis based on the aforementioned implementation rate of conserving 13.3 percent of the estimated achievable on-farm savings per decade, resulting in 80 percent of achievable savings being realized in 2060.

Table 4.52: Implementation Rate

	Implementation Rate					
	13.3%	26.7%	40.0%	53.3%	66.7%	80.0%
Annual Cost of Water	$9,255,616	$18,518,176	$27,773,793	$37,029,409	$46,291,969	$55,547,585

4.9.1.4. Environmental Impact

When this water management strategy is put into motion there will be temporary and permanent impacts associated with on-farm improvements. The temporary environmental impacts would probably be evident with the construction activities. The construction activities dealing with this WMS would include a decrease in air and noise quality. The intensity of these construction related impacts would be minimal due to dust and noise measures to be implemented during construction, applicable permit conditions, stipulations for the protection of air and water quality, and the temporary localized nature of the effects. The construction activities could impact ecological and cultural resources to the extent that such resources occur in areas targeted for improvements. Specifically, areas in proximity to the known habitat of threatened and endangered species should be identified prior to construction activities and appropriate measures should be taken to minimize any adverse impacts. Permanent environmental impacts due to construction and operation of the WMS would be a decrease in air quality due to the maintenance activities required for this WMS. The permanent decrease in air quality would not be significant, as maintenance activities are periodic in nature and duration. These on-farm improvements could also result in impacts to temporary wetlands and other habitats that occur in areas where over-watering contributed to the temporary water supply. Conversion of open ditches to poly or gated pipe would eliminate open water areas where vegetation is allowed to grow, albeit temporary, and allows for habitat when present. For the most part, many districts allow for the re-vegetation of native grasses where improvements have been made. Tail water would be minimized by undertaking this strategy. With this being the case, sediment/chemical runoff will be reduced thereby increasing drainage ditch water quality. There should be an investigation into these environmental impacts before any construction takes place.

4.9.1.5.Implementation Issues

In looking to the future and adoption of on-farm water conservation strategies, there are several factors that impact the rate of adoption. A major factor relates to water rights being held by the irrigation district. In the absence of an incentive structure for the producer, the investment in distribution technologies cannot be justified. The value of water savings needs to be shared with the agriculture producer.

Irrigation scheduling is being practiced across the U.S. and other regions of Texas. This technology requires an evaporation-transpiration network as well as specific crop water coefficients. Typically neither the network or crop coefficients are available for South Texas. This can be addressed by research and education but takes time and investment.

Metering and per unit pricing are typically resisted in regions where they are not used. Metering requires an initial investment by either the producer or the irrigation district, suggests bureaucracy, and imposes a cost for excessive water use. Plastic pipe is somewhat impacted by the initial investment and potential impact on labor requirements for irrigation.

Often, water efficient crops or breeding programs to reduce crop water requirements are proposed to save on-farm water use. Unfortunately, the lowest water-using crop is often the lowest value crop. Hence, economics and farm profitability become driving forces in farmer crop selections. Using plant breeding programs and biotechnology offer an opportunity to reduce plant water dependency. However, this requires sophisticated and expensive science as well as significant time.

Therefore, there are no quick fixes to reduce on-farm water use dramatically. Texas has a low interest loan program for agriculture which can be used to purchase water conserving distribution systems. However, the producer still must repay the loan. Without an incentive program to benefit producers who adopt reduced water use techniques, this has the potential to be a very slow process. The constraints to on-farm water conservation can be summarized as: 1) water rights do not reward producers for conservation, 2) investment requirements and disconnect of benefits to the producers, and 3) limitations of science on crop water requirements and time to develop new cultivars.

Implementation of on-farm water conservation measures will require individual agricultural producers to adopt new irrigation technologies and management practices. As noted previously, there has already been a significant degree of adoption of on-farm water conservation measures by producers in the Rio Grande Region. However, to achieve the recommended rates of implementation, it will be important to expand state and federal technical assistance programs, provide incentives (e.g., cost-sharing), and/or financial assistance (e.g., low-interest loans). Also previously noted, the degree to which on-farm water savings can be achieved is partially dependent upon improved efficiencies of irrigation conveyance and distribution facilities. To some extent, such improvements are required in advance of adoption of on-farm water conservation measures. It is therefore essential that the required technical assistance and financial resources be brought to bear on irrigation conveyance and distribution improvements as soon as possible.

4.9.1.6. Recommendations

The Rio Grande RWPG recommends the following on-farm improvements: farm-level water measurement and metering, replacement of field ditches with poly/gated pipe, and adoption of improved water management practices and irrigation technologies. Many technologies and methods are currently available including, but not limited to, plastic pipe, low energy precision application, irrigation scheduling using an evapotranspiration network, drip irrigation, metering, unit pricing of water, and planting water efficient crops.

Each irrigation district should perform an evaluation of their district to determine the most feasible and cost effective method for increasing on-farm efficiency. Key aspects in determining when and where these improvements should take place will be dependent on existing rate schedules, urbanization rates, and applicable on-farm technologies.

4.9.2. Conveyance System Conservation

4.9.2.1. Strategy Description

Water used for irrigation constitutes the largest portion of overall water demand in the region. Currently, 83% of the overall demand is used for irrigation purposes. However, by the year 2060, the projected irrigation demand will be reduced to 59% due to urbanization and other like factors. There are twenty-nine irrigation districts located in the United States below the International Falcon-Amistad Reservoir System, which supplies nearly 95 percent of their water needs[11].

Several studies and projects have proven that raw water delivered by irrigation districts can be conserved if more efficient distribution systems are put into place. The Irrigation Technology Center (ITC) of Texas A&M University developed and evaluated water savings for a comprehensive program to rehabilitate and improve the management of irrigation conveyance and distribution facilities in four of the five subject counties. Their study is the most recent data pertaining to irrigation districts. Cameron, Hidalgo, Maverick, and Willacy Counties were the only counties in the region evaluated because no irrigation districts operate in the other counties. A copy of this report can be referenced in the appendix.

The proposed conveyance efficiency program consists of six principal components, and they are as follows: installation of no-leak gates, installation of additional water measurement weirs, conversion of smaller concrete canals that are in poor condition to pipeline, lining of smaller earthen canals previously constructed of more porous soils, and implementation of a verification program to monitor and measure the effectiveness of the efficiency improvements.

Each proposed improvement conserves water in a number of different ways.

[11] U.S. Bureau of Reclamation Canal Rehabilitation Project Report. Cameron County Irrigation District No. 2. August 2003.

- Installation of no-leak gates: Canal gates are used to hold water in a canal upstream of the gate. If leaks are present in the gate structures, irrigation water cannot be effectively stored in portions of the canal where there is a high demand. Water lost in this manner is typically lost to either evaporation or seepage.
- Water measurement weirs: By installing water measurement weirs, irrigation districts can obtain an accurate description of water levels in their canals. Telemetry can also be used in this application. By allowing the district to view canal levels from a remote location, overflows will be significantly reduced, thereby conserving water. In the 2004 ITC study, there were at least 34 major spill sites in the region. A representative sample of four spill and recovery sites was monitored. Of these four, spill rates ranged from 28 ac-ft/yr to 4684 ac-ft/yr.
- Converting canals to pipeline: With an annual evaporation rate of approximately 67.2 inches per year, significant irrigation water is lost to evaporation. By converting open canals to pipelines, water is conserved by eliminating evaporation and seepage. However, there are currently a number of mortar joint concrete pipelines located in the region. The joints associated with this type of pipeline are generally inflexible and crack over time, causing seepage. New materials and methods of pipeline construction reduce, if not eliminate, this problem.
- Lining canals: The majority of canals in the region are constructed of earthen materials. Seepage rates in earthen canals found in the region range from .15 to 13.85 gal/sf/day. Seepage is also significant in concrete lined canals where rates ranging from .57 gal/sf/day to 8.82 gal/sf/day were reported throughout the region. There are four major types of canal lining systems: buried membrane linings, earth linings, soil sealants, and exposed linings. A study conducted by the U.S. Bureau of Reclamation concluded that a lining system consisting of a buried geomembrane liner with a concrete cover is 95% effective in eliminating seepage.
- Implementation of a verification program: In the initial implementation of this strategy, verifying water savings on improved canals will allow for an accurate description of overall savings, thereby giving detailed information regarding region specific conditions.

4.9.2.2. Water Supply Yield

ITC estimates that irrigation district conveyance and distribution losses could be reduced by 154,393 acre-feet per year during drought conditions and by 243,092 acre-feet per year under average conditions. The lower water savings estimates for drought conditions are based on lower overall water demands due to water availability constraints. Table 4.53 summarizes the estimated water savings from conveyance and distribution efficiency improvements for the four counties evaluated. These estimates are based on improving the average conveyance/distribution efficiency from present levels, which average 69.7 percent, to an average of 90 percent. Conveyance efficiency is calculated from the total amount of water delivered in order to supply the demand. Transportation losses, accounting losses, and operational losses are the three main components of conveyance efficiency. Transportation losses consist of evaporation and seepage/leakage in lined and unlined canals as well as pipelines. Leaking gates and valves also make up a significant portion of transportation losses. Accounting losses depend on accuracy of field-level deliveries, unauthorized use, metering at main pumping plant, and the water rights accounting system. Operation losses involve charging empty pipelines and canals, spills, and partial use of water in dead-end lines. For the purpose of this report, normal water conditions were used.

Table 4.53: Conveyance Data Table

County	Average Conveyance Efficiency (%)	Water Savings Potential (ac-ft/yr)	
		Normal	Drought
Cameron	68.0	72,817	50,191
Hidalgo	71.0	132,176	83,419
Maverick	67.0	27,716	13,770
Willacy	70.0	10,383	7,013
Region M	**69.7**	**243,092**	**154,393**

Realistically, the amount of water savings that can be achieved through distribution system improvements is likely to be less than the estimates show. This is due to the fact that not all conveyance improvements are economically attractive under current conditions, and other factors will likely limit the degree to which efficiency improvements are implemented. For example, investments in conveyance and distribution improvements would best be targeted at areas where urbanization will have a minimal effect on irrigated lands, and their irrigation water distribution facilities are likely to be in service for the long-term. Also, the limited financial capacity of irrigation districts, and limited sources of outside financial assistance, will likely affect the rate and degree to which savings are realized.

This plan will use an implementation scenario in which 37.5 percent of potential water savings from conveyance system improvements would be realized in decade 2010, and 75 percent of the potential water savings would be realized in decade 2020. The implementation rate would then increase at 3.75 percent per decade for the remainder of the planning period. Therefore, 90 percent of potential conveyance system improvements will be realized in decade 2060. Table 4.54 reflects the water savings under this scenario with normal water supply conditions.

Table 4.54: Water Savings

	D2010	D2020	D2030	D2040	D2050	D2060
Cameron (ac-ft/yr)	27306	54613	57343	60074	62805	65535
Hidalgo (ac-ft/yr)	49566	99132	104089	109045	114002	118958
Maverick (ac-ft/yr)	10394	20787	21826	22866	23905	24944
Willacy (ac-ft/yr)	3894	7787	8177	8566	8955	9345
Total (ac-ft/yr)	91160	182319	191435	200551	209667	218783

4.9.2.3. Cost

Cost estimates for this Water Management Strategy were derived based on information assembled by the United States Bureau of Reclamation. In their Canal Rehabilitation Project Report for Cameron County Irrigation District No. 2 (CCID2) submitted in August of 2003, 10 canal lining projects and 26 pipeline projects were evaluated based on construction costs and water savings. NRS Consulting Engineers also provided costs and water savings for one lining project and 5 pipeline projects for CCID2. Total capital costs for these 42 projects totaled $28,229,114 to conserve 23,605 acre-feet of water. This would bring the District up to an estimated 90% efficiency.

Under the assumption that CCID2 is a typical district in the region, total capital costs to conserve 243,092 acre-feet of water under normal conditions, as described previously by Texas A&M, can be extrapolated using project costs and expected water savings of the CCID2 projects. If 23,605 acre-feet of water can be conserved with $28,229,114 in capital costs, then it is expected that a capital cost of $290,716,949 will be needed to conserve 243,092 acre-feet throughout the region. Previous studies have indicated lower capital costs, based on available information. These revised figures are believed to be more accurate taking available information from the projects completed and proposed by CCID2. The Lower Rio Grande Authority is currently conducting a study of all irrigation districts and developing a capital improvement program that will better state the cost of improvements needed to bring the efficiency of the districts to 90%.

The comprehensive financial analysis performed by the United States Bureau of Reclamation takes into consideration the project component's initial construction cost, how many years the components will be useful and save water, the impact of inflation and time, the impact of changes in O&M costs, and the expected changes in energy costs, etc.

Table 4.55: Economic Data

Water Management Strategy Cost Summary			
WMS	*Cost*		Appendix
	$/Acre-ft	$/1000 gallons	
Conveyance System	$ 120.68	$ 0.37	N of Cost Ananlysis Appendix

When analyzing the costs associated with implementing the previously described irrigation strategies, it is important to realize that every irrigation conveyance system is unique and that no two individual canals are identical. With this in mind, implementation costs fluctuate depending on the size and type of no-leak gates to be installed, the size and type of water measurement weirs to be installed, the current and proposed layout of canals to be refurbished, the proposed flow of delivered water, and the type of lining system to be installed.

4.9.2.4. Environmental Impact

When this water management strategy is put into motion there will be temporary and permanent impacts associated with implementation of irrigation conveyance and distribution improvements itself. The temporary environmental impacts would probably be evident with the construction activities. The construction activities dealing with this WMS would include a decrease in air and noise quality. The intensity of these construction related impacts would be minimal due to dust and noise measures to be implemented during construction, applicable permit conditions, and stipulations for the protection of air and water quality, and temporary localized nature of the effects. The construction activities could impact ecological and cultural resources to the extent that such resources occur in areas targeted for improvements. Specifically, areas in proximity to the known habitat of threatened and endangered species should be identified prior to construction activities and appropriate measures should be taken to minimize any adverse impacts. Permanent environmental impacts due to construction and operation of the WMS would be a decrease in air quality due to the maintenance activities required for this WMS. The permanent decrease in air quality would not be significant, as maintenance activities are periodic in nature and duration. These improvements to irrigation conveyance and distribution facilities could also result in impacts to wetlands and other habitat that occur in areas where canal seepage indirectly contributes to the water supply. Conversion of canal systems to pipeline system would eliminate open water areas where vegetation is allowed to grow, albeit temporary, allows for habitat when present. For the most part, many districts allow for the re-vegetation of native grasses where improvements have been made. There should be an investigation into these environmental impacts before any construction takes place.

4.9.2.5. Implementation Issues

There are several impediments to the implementation of large-scale canal rehabilitation projects and other types of conveyance efficiency improvements. These include inadequate information at the irrigation district level about specific capital improvements, the potential impacts of urbanization on rehabilitation planning, and access to financing for capital improvements.

The information generated by the investigations undertaken for this planning effort fall short of what is required for large-scale investments to occur in conveyance and distribution efficiency improvements. Ideally, each irrigation district should undergo a systematic hydrologic and engineering evaluation of its water delivery facilities and management policies to identify cost-effective water efficiency improvements.

In developing a canal rehabilitation or capital improvement plan, most irrigation districts need to pay particular attention to identifying those portions of their distribution systems that should be targeted for improvements. For example, investments should generally be directed to areas where water distribution facilities are likely to stay in service for an extended period. Also, in areas that are experiencing rapid urbanization (e.g., western Hidalgo County), the evaluation of water efficiency improvements might best be done on a cooperative basis involving several districts. This would facilitate the identification and evaluation of strategies for the consolidation of district facilities. For example, significant water savings might occur if an isolated block of irrigated acreage were served by an adjoining irrigation district, thereby allowing retirement of under-utilized and inefficient water distribution facilities.

Despite the importance of further planning and engineering evaluations, irrigation districts may lack the financial and/or technical resources to undertake such planning on their own and may therefore require outside assistance. This could include technical assistance from state or federal agencies, such as the Texas Water Development Board (TWDB), the Texas Agricultural Extension Service (TAES), the USDA Natural Resources Conservation Service (NRCS), and the U.S. Bureau of Reclamation. Also, the costs of front-end project planning could be included in loans from the TWDB for agricultural water conservation projects. Another option is to "internalize" the costs of front-end planning as part of the overall costs of transactions involving the sale of "conserved" water to DMI users. For example, the buyer of conserved water might provide up-front funding for project planning and engineering with agreement that such costs would be credited to the purchase price for the water rights.

A lack of funding is often cited as the primary impediment to the implementation of irrigation conveyance and distribution improvements. A common view is that many irrigation districts lack the capacity to finance major capital improvements on their own. Districts often cite concerns about the ability of agricultural producers to absorb increases in either flat rate assessments or water delivery charges that might result from major capital improvement projects. Nonetheless, there are several options for self-financing of improvements by irrigation districts as well as for third party financing. These options are discussed below.

Options for self-financing of water efficiency improvements by irrigation districts include:

- Pay-as-you-go funding from operating revenues;
- Loans through commercial lending institutions; and,
- Loans from the Texas Water Development Board.

Pay-as-you-go funding of improvements from operating revenues would lend itself to a long-term system rehabilitation program whereby improvements are implemented in phases that are matched to revenue availability. For example, a district might budget a set amount annually from operating revenues for capital improvements. This approach has the advantage of avoiding the interest costs associated with debt financing. However, current water users would bear the full costs of such improvements through their flat rate assessments and/or water delivery charges. One way to minimize rate impacts on irrigators would be to dedicate a portion of any revenues derived from DMI water sales, or from DMI water deliveries, to fund capital improvements. If structured appropriately, this approach could provide an on-going source of revenue to fund improvements. Revenues from DMI water sales would be used for improvements that free-up additional water for conversion and sale to DMI use, which would generate additional revenues and so forth.

Under state law, irrigation districts have the authority to finance capital improvements through the issuance of general revenue bonds backed by tax revenues, through the issuance of revenue bonds, or through loans from commercial or public lending institutions, such as the TWDB. Irrigation districts also have the authority to impose special assessments for improvements made to a portion of their water conveyance and distribution system. Such assessments are made only on the users that benefit directly from the improvements. Voter approval of tax assessments and special assessments is required.

The feasibility and attractiveness of using debt financing of improvements depends in large measure on the overall financial health of each irrigation district. Some irrigation districts may not be considered credit worthy – due to a lack of credit history or poor fiscal performance – and would therefore find it difficult to attract investors to their revenue bonds or to obtain commercial loans without paying excessively high interest rates.

An advantage of debt financing of water irrigation efficiency improvements is that all of the funds required for a major capital improvement program could be obtained in advance, thus assuring a source of funds for completion of the program. However, as with pay-as-you-go funding, debt financing requires the commitment of a stable revenue stream to service the debt. Debt service could be from revenues derived from flat rate assessments and/or revenues from irrigation water sales. It would also be possible to establish a dedicated stream of revenues based on future DMI water sales. This would likely entail a long-term contractual relationship with one or more DMI users whereby the DMI user(s) would agree to purchase increasing amounts of conserved water as it becomes available on take-or-pay basis.

There are also a number of options for third party financing of irrigation water efficiency improvements. One approach would be for individual irrigation districts and DMI users to enter into partnership arrangements whereby the DMI user provides the funds required for improvements in exchange for access to some portion of the conserved water, either through outright purchase of water rights or through long-term water sale contract. Similarly, a voluntary consortium of DMI users could be formed to finance irrigation efficiency improvements in exchange for access to additional water supplies. Under this arrangement, each DMI user would obtain additional supplies proportionate to their share of the funding of improvements. Another potential approach would be to create a regional water authority for the purpose of financing irrigation efficiency improvements and to distribute DMI water supplies made available from such improvements. Finally, private sector entities could similarly finance efficiency improvements and acquire rights to conserved water for subsequent re-sale to DMI users.

4.9.2.6. Recommendations

The Rio Grande RWPG recommends the following conveyance system improvements: installation of no-leak gates, installation of additional water measurement weirs, conversion of smaller concrete canals that are in poor condition to pipeline, lining of smaller earthen canals previously constructed of more porous soils, and implementation of a verification program to monitor and measure the effectiveness of the efficiency improvements.

Each irrigation district should perform an evaluation of their district to determine the most feasible and cost effective methods to increase delivery efficiency. Identifying areas that will be in service for the life of the project is a key factor in determining feasibility, as is locating funding sources or structuring cash flow to perform the improvements.

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CHAPTER 5.0 : IMPACTS OF WATER MANAGEMENT STRATEGIES ON KEY PARAMETERS OF WATER QUALITY AND IMPACTS OF MOVING WATER FROM RURAL AND AGRICULTURAL AREAS

5.1 Water Quality Impacts

All Water Management Strategies (WMSs) explained in Chapter 4, except Advanced Water Conservation, Conveyance Improvements, and On-farm Improvements, involve transferring water or water rights from rural land to urban. This process is known as urbanization; as the region's population expands, irrigable land is lost. In order to make up the projected shortfall of water for municipal use, ten WMSs were developed; additional groundwater, advanced water conservation, non-potable reuse, potable reuse, Brownsville weir and storage, water rights purchase, water rights acquisition by long-term contract, water rights acquisition through urbanization, brackish desalination, and seawater desalination. Advanced water conservation is aimed at reducing the amount of water used per capita, thereby reducing overall municipal demand.

Since municipal water has the highest priority in the Amistad/Falcon system, irrigation water is in a constant state of shortage. Accordingly, conveyance and on-farm improvements are needed to reduce the impact of irrigation shortages. Municipal water management strategies are not cost-effective when applied to irrigation use.

Chapter 4 gives an in-depth look at each of these WMSs.

The following table breaks out the water quality impacts, both positive and negative, associated with each WMS. Note that the majority of WMSs deal similarly with urbanization's effects; in other words, as rural land is urbanized, water quality impacts are consistent from WMS to WMS. Pollutants in agricultural runoff include eroded soil particles (sediments), nutrients, pesticides, salts, bacteria, viruses, and organic matter.[1] Sediment and chemical runoff associated with rural land are eliminated when that land becomes urbanized. On the flip side, urban runoff will increase as reduced porous surface areas prevent rainwater from soaking into the ground. Urban runoff pollutants include sediment from construction sites, oil and gas, fertilizers, pesticides, and household chemicals.[2] Also, as municipal water use increases, wastewater production increases—both inevitable effects of rising populations.

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[1] Lowrance, R., Smith, M., & Vellidis, G. (2003). Impact and Control of Agricultural Runoff. *Stormwater, The Journal for Surface Water Quality Professionals*. Retrieved May 26, 2005 from World Wide Web. http://www.forester.net/sw_0305_impact.html

[2] United States Environmental Protection Agency. (1995, September). Economic Benefits of Runoff Control. Retrieved May 26, 2005 from World Wide Web. http://www.epa.gov/owow/nps/runoff.html

Table 5.1: Water Quality Impacts by Water Management Strategy

Water Management Strategy	Positive Impacts	Negative Impacts
Additional Groundwater	• Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased wastewater flows to receiving streams, i.e. higher organic levels • Increased urban runoff during storm event
Advanced Water Conservation	• Decreased wastewater flows	• Increases concentration of organic matter in wastewater
Non-potable Reuse	• Reduced wastewater flows • Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation • Decreased wastewater flows, resulting in lower organic levels in receiving streams	• Increased urban runoff during storm event
Potable Reuse	• Reduced wastewater flows • Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation • Decreased wastewater flows result in lower organic levels in receiving streams	• Increased urban runoff during storm event
Brownsville Weir and Storage	• Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows resulting in higher organic levels in receiving stream
Purchase of Water Rights	• Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows to receiving streams, i.e. higher

		organic levels
Acquisition of Water Rights by Urbanization	• Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows to receiving streams, i.e. higher organic levels
Acquisition of Water Rights by Long-term Contracts	• Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows to receiving streams, i.e. higher organic levels
Brackish Desalination	• Improved water quality in wastewater effluent • Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows to receiving streams, i.e. higher organic levels • Increased levels of TDS in receiving streams due to concentrate discharge
Seawater Desalination	• Improve water quality in wastewater effluent • Decreased sediment and/or agricultural chemical runoff due to storm events or excessive irrigation	• Increased urban runoff during storm event • Increased wastewater flows to receiving streams, i.e. higher organic levels • Increased levels of TDS in receiving streams due to concentrate discharge
Conveyance Improvements	• none	• none
On-farm Improvements	• Decreased sediment and/or agricultural chemical runoff due to increased management and metering	• none

5.2 Socioeconomic Impacts

The socioeconomic impacts of unmet water needs in the region have been analyzed by the TWDB. In the year 2060, there will be over $2 billion lost due to decreased sales, $2 billion in lost income, over 26,000 lost jobs, and over $75 million in lost taxes. A copy of this report can be found in Appendix D.

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CHAPTER 6.0 : CONSOLIDATED WATER CONSERVATION & DROUGHT MANAGEMENT RECOMMENDATIONS OF THE REGIONAL WATER PLAN

Until one occurs, people tend to ignore or forget the difficulties caused by severe drought. This chapter will aid in preparing for drought conditions and establishing water conservation methods.

"Drought is a complex physical and social process of widespread significance. Although drought affects the entire State, it frequently is a regional problem due to the vast geography and varying climatic conditions within the state. Despite the frequency and economic damage caused by drought, the term drought remains difficult to define" (State Drought Preparedness Plan).

In order to ensure a region's water source(s), each town/city in the region should prepare its own drought management and water conservation plan by first identifying needs and establishing goals for water conservation.

6.1 *WATER CONSERVATION PLAN*

This chapter's attachment section contains various drought management and water conservation plans that have been researched as effective strategies by state agencies such as TCEQ and TWDB.

The following strategies are referenced from TWDB's *Water Conservation Best Management Practices Guide*, Report 362. Under Senate Bill 1094, the 78th Texas Legislature created the Texas Water Conservation Implementation Task Force and charged the group with reviewing, evaluating, and recommending optimum levels of water use efficiency and conservation for the state. Report 362 was prepared in partial fulfillment of this charge. The *Guide* is organized in three sections for municipal, industrial, and agricultural user groups and includes 55 Best Management Practices (BMPs). Each BMP describes efficiency measures, implementation techniques and schedules, program scope, cost considerations, water-savings estimating procedures, and other references to assist end-users in implementing the plan. This document can be accessed at TWDB's web site:
http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

The objective of a specific water plan is reducing the quantity of water required within a given water entity's service area through implementation of efficient water use procedures. The key to success is implementing and enforcing effective city ordinances. This policing approach has proved effective in various Texas communities.

These water conservation strategies from Report 362 to help reduce effects of drought in this region:

1. golf course conservation
2. metering all new connections & retrofitting existing connections
3. showerhead, aerator, and toilet flapper retrofitting
4. educating through schools
5. landscape irrigation conservation
6. water-wise landscape design
7. athletic field conservation
8. dissemination of public information
9. rainwater harvesting
10. parklands conservation
11. residential clothes washer incentives

Attachment 6-4 includes the Report 362's strategy descriptions.

6.2 *EXAMPLES OF WATER CONSERVATION PLANS IMPLEMENTED IN REGION M*

Several cities have taken precautions to conserve water with formal plans. Here are brief descriptions of conservation plans for two cities within Region M.

6.2.1 The City of McAllen Water Conservation & Drought Contingency Plan

Water conservation goals for the City of McAllen are based on the City's utility profile and water practices. The City's goals are:

1. to reduce daily municipal per-capita water use to 125 gpcd (gallons per capita per day) by the year 2005, and to reduce unaccounted-for water loss to 12 percent by 2005;
2. to implement long-term cost-effective recovery measures for major causes of unaccounted-for water losses related to metering;
3. to increase both public and employee awareness regarding water conservation and water-related issues;
4. to investigate the potential for wastewater effluent reuse;
5. to promote xeriscaping (low-water-using shrubs and plants, patios, rocks, decks, and walkways) in order to reduce the number of high-water-consuming landscape areas on business and residential properties; and,
6. to promote more efficient irrigation techniques for agriculture, industry, and private use through rebates, retrofit, and education.

Water conservation strategies have helped the City of McAllen reach goals. To carry out its education strategy, McAllen uses public service announcements and periodic mailings about indoor and outdoor water conservation, while utility employees are trained in conservation and water-wise uses. The City of McAllen even proclaimed Water Utilities Awareness Week in May. Under this strategy, new customers are required to read and agree to Water Conversation Plan provisions. Attachment 6-5 is an actual copy of this plan.

A second strategy of recycling and reuse is accomplished by adopting an efficient water reuse plan that includes elements ranging from golf course irrigation to non-potable industrial water usage.

McAllen's third strategy involves updating metering devices and employing universal metering. All new meters must meet the AWWA New Meter Standard for Cold-Water Meters.

The fourth strategy is a water distribution audit and leak survey, whose results sparked a continuous leak detection and repair program carried out by the utilities department.

McAllen's fifth strategy, following the 1994 Standard Plumbing Code, is an update-and-retrofit plumbing fixtures program issued by the Southern Building Code of Congress International.

The sixth strategy is conservation education through landscaping techniques which advocate drip irrigation at commercial establishments. McAllen's municipal pools were evaluated for efficient water use. Landscape architects and local nurseries were asked to utilize efficient irrigation systems and native low-water plantings and grasses. Irrigation contractors were asked to evaluate and improve their own water use efficiencies.

The City's seventh strategy updates the rate structure more conservatively. In effect, the rates are higher for heavier water use.

The City of McAllen is known for the stage and zone setup of its Drought Contingency Plan, made effective primarily due to its policing efforts. Rules are based on five stages of drought:

Stage 1: Voluntary Conservation
Stage 2: Mandatory Compliance - Water Alert
Stage 3: Mandatory Compliance - Water Warning
Stage 4: Mandatory Compliance - Water Shortage
Stage 5: Mandatory Compliance - Water Shortage Emergency

Descriptions of each stage and the respective compliances can be found in the Appendix of this water plan, including penalties for violations.

6.2.2 The City of Weslaco Water Conservation and Emergency Water Demand Management Plan

The City of Weslaco's water conservation plan aims to reduce quantities required within a service area when efficient water use procedures have been implemented. Objectives are long-term, with needs clearly identified and goals established. A system water audit is required to determine unaccounted-for water volumes and probable causes of losses. Peak, maximum-day, average, and per capita usage will be monitored. Accomplishment phases include:

1. By 2007, reduce per capita water usage of 150 gpcd (gallons per capita per day) to 110 gpcd.
2. Implement long-term cost-effective recovery measures for major causes of unaccounted-for water losses related to metering.
3. Increase public and employee awareness of water conservation and water-related issues, especially during summer months when water consumption increases significantly.
4. Investigate the feasibility of wastewater effluent reuse;
5. Promote xeriscape landscapes wherever feasible to reduce total square footage planted with shrubs and grasses requiring high water consumption.
6. Implement rebates for retrofitting, and implement education programs to promote more efficient agricultural, industrial, and private irrigation techniques.

Weslaco's plan will implement water conservation in several ways. Logically, a crucial element for success is educating and informing the public about both short- and long-term conservation objectives. The plan charges more to high-volume customers and offers tips on water-smart household, landscaping, and irrigation procedures. Customers with older-model fixtures will be encouraged to retrofit their plumbing as Weslaco adopts updated water codes.

Furthermore, pressure reduction in the water system will save water by reducing excessive mechanical stress on fixtures, appliances, and distribution systems. Water wells for personal use will be disallowed in all circumstances. During drought conditions the City of Weslaco will follow a phase-driven Emergency Water Demand Management Plan. A copy of this plan is provided in the Appendix.

6.3 *TEXAS DROUGHT MANAGEMENT STRATEGIES*

Without substantial rains, the next ten years may produce a severe drought worse for Texas agriculture than the disastrous drought of 1996. No amount of scientific knowledge can make up for lack of rain and the resultant water depletion in soil profiles and in ground and surface water supplies.

This information was gleaned from information provided by specialists with the Texas Agricultural Extension Service (TAES) and others to provide information that might reduce further losses to Texas' beleaguered agricultural industry. TAES has access to many resources helpful in reducing water usage and losses associated with drought. The text is provided also to help assemble the State Drought Preparedness Plan for the Texas

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3. MANAGEMENT OF IMPROVED PASTURES
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   Protecting Plant Vigor during a Drought

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(7) The Farm Labor Housing Loans and Grants Program offers project grants and/or guaranteed/insured loans to provide decent, safe, and sanitary low-rent housing and related facilities for domestic farm laborers.

Another program in this category, the Rural Housing Site Loan provides direct loans for purchasing and developing adequate sites for water and sewer facilities (if otherwise unavailable), including necessary equipment (which becomes a permanent part of the development) and money for legal fees and closing costs.

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Another source of assistance is the U.S. Department of Commerce's Economic Development Administration Program (EDA), which provides grants to pay for developing strategies to alleviate long-term economic deterioration or sudden and severe economic dislocation, or to pay for a project to implement such a strategy.

Programs with official declaration are also available. For example, with a U.S. Declaration the Secretary of Agriculture offers emergency loans to assist established family farmers, ranchers, and aquaculture operators in covering losses from disasters such as drought. With an SBA Declaration, the Small Business Administration offers Economic Injury Disaster Loans (EIDL) to assist businesses suffering economic injury created by certain presidential-, Secretary of Agriculture-, and/or SBA-declared disasters.

Moreover, Special Agriculture Designation of the Emergency Conservation Program provides CIS assistance to agriculture producers who have suffered severe damage to farmland as a result of natural disasters such as drought. Damage must be of such magnitude that the producer cannot afford to rehabilitate without federal assistance; direct payments are made for specified uses. Alternatively, a Governor's Declaration offers two available programs. One, the Emergency Water Supply/Drought Assistance Program, is implemented by the U.S. Army Corps of Engineers (COE). The COE is authorized to construct wells and transport water for human consumption only during emergencies in drought-distressed areas (not including recreational uses). Another avenue of relief comes through the Reclamation State Emergency Drought Relief Act of 1991. The Act's Title I provides for construction, management, and conservation activities to minimize losses and damages resulting from drought conditions.

Finally, several programs to make drought more bearable may be offered in case of a Presidential Disaster Declaration. The Disaster Relief and Emergency Assistance Program, Workforce Investment Program, Disaster Unemployment Assistance (DUA), and Emergency Community Water Assistance Grants (ECWAGs) are only available when the President himself declares an official disaster.

ATTACHMENT 6-1 Model Drought Contingency Plan for Water Supply Corporations

September 2004

Texas Commission on Environmental Quality

DROUGHT CONTINGENCY PLAN
FOR

____
(Name of Utility)

____
(Address, City, Zip Code)

____
(CCN#)

____
(PWS #s)

____
(Date)

TABLE OF CONTENTS – CHAPTER SIX

CHAPTER 6.0 : CONSOLIDATED WATER CONSERVATION & DROUGHT MANAGEMENT RECOMMENDATIONS OF THE REGIONAL WATER PLAN

Until one occurs, people tend to ignore or forget the difficulties caused by severe drought. This chapter will aid in preparing for drought conditions and establishing water conservation methods.

"Drought is a complex physical and social process of widespread significance. Although drought affects the entire State, it frequently is a regional problem due to the vast geography and varying climatic conditions within the state. Despite the frequency and economic damage caused by drought, the term drought remains difficult to define" (State Drought Preparedness Plan).

In order to ensure a region's water source(s), each town/city in the region should prepare its own drought management and water conservation plan by first identifying needs and establishing goals for water conservation.

6.1 *WATER CONSERVATION PLAN*

This chapter's attachment section contains various drought management and water conservation plans that have been researched as effective strategies by state agencies such as TCEQ and TWDB.

The following strategies are referenced from TWDB's *Water Conservation Best Management Practices Guide*, Report 362. Under Senate Bill 1094, the 78th Texas Legislature created the Texas Water Conservation Implementation Task Force and charged the group with reviewing, evaluating, and recommending optimum levels of water use efficiency and conservation for the state. Report 362 was prepared in partial fulfillment of this charge. The *Guide* is organized in three sections for municipal, industrial, and agricultural user groups and includes 55 Best Management Practices (BMPs). Each BMP describes efficiency measures, implementation techniques and schedules, program scope, cost considerations, water-savings estimating procedures, and other references to assist end-users in implementing the plan. This document can be accessed at TWDB's web site:
http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WCITFBMPGuide.pdf

The objective of a specific water plan is reducing the quantity of water required within a given water entity's service area through implementation of efficient water use procedures. The key to success is implementing and enforcing effective city ordinances. This policing approach has proved effective in various Texas communities.

These water conservation strategies from Report 362 to help reduce effects of drought in this region:

1. golf course conservation
2. metering all new connections & retrofitting existing connections
3. showerhead, aerator, and toilet flapper retrofitting
4. educating through schools
5. landscape irrigation conservation
6. water-wise landscape design
7. athletic field conservation
8. dissemination of public information
9. rainwater harvesting
10. parklands conservation
11. residential clothes washer incentives

Attachment 6-4 includes the Report 362's strategy descriptions.

6.2 *EXAMPLES OF WATER CONSERVATION PLANS IMPLEMENTED IN REGION M*

Several cities have taken precautions to conserve water with formal plans. Here are brief descriptions of conservation plans for two cities within Region M.

6.2.1 The City of McAllen Water Conservation & Drought Contingency Plan

Water conservation goals for the City of McAllen are based on the City's utility profile and water practices. The City's goals are:

1. to reduce daily municipal per-capita water use to 125 gpcd (gallons per capita per day) by the year 2005, and to reduce unaccounted-for water loss to 12 percent by 2005;
2. to implement long-term cost-effective recovery measures for major causes of unaccounted-for water losses related to metering;
3. to increase both public and employee awareness regarding water conservation and water-related issues;
4. to investigate the potential for wastewater effluent reuse;
5. to promote xeriscaping (low-water-using shrubs and plants, patios, rocks, decks, and walkways) in order to reduce the number of high-water-consuming landscape areas on business and residential properties; and,
6. to promote more efficient irrigation techniques for agriculture, industry, and private use through rebates, retrofit, and education.

Water conservation strategies have helped the City of McAllen reach goals. To carry out its education strategy, McAllen uses public service announcements and periodic mailings about indoor and outdoor water conservation, while utility employees are trained in conservation and water-wise uses. The City of McAllen even proclaimed Water Utilities Awareness Week in May. Under this strategy, new customers are required to read and agree to Water Conversation Plan provisions. Attachment 6-5 is an actual copy of this plan.

A second strategy of recycling and reuse is accomplished by adopting an efficient water reuse plan that includes elements ranging from golf course irrigation to non-potable industrial water usage.

McAllen's third strategy involves updating metering devices and employing universal metering. All new meters must meet the AWWA New Meter Standard for Cold-Water Meters.

The fourth strategy is a water distribution audit and leak survey, whose results sparked a continuous leak detection and repair program carried out by the utilities department.

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September 2004

Texas Commission on Environmental Quality

DROUGHT CONTINGENCY PLAN
FOR

____
(Name of Utility)

____
(Address, City, Zip Code)

____
(CCN#)

____
(PWS #s)

____
(Date)

Section 1 Declaration of Policy, Purpose, and Intent
of a public meeting to accept input on the Plan

The meeting took place at: ____.
In cases of extreme drought, periods of abnormally high usage, system contamination, or extended reduction in ability to supply water due to equipment failure, temporary restrictions may be instituted to limit nonessential water usage. The purpose of the Drought Contingency Plan (Plan) is to encourage customer conservation in order to maintain supply, storage, or pressure or to comply with the requirements of a court, government agency, or other authority.
Please note: Water restriction is not a legitimate alternative if a water system does not meet the Texas Commission on Environmental Quality (TCEQ) capacity requirements under normal conditions **or** if the utility fails to take all immediate and necessary steps to replace or repair malfunctioning equipment.

Section 2 Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by:
(check at least one of the following)

□ *scheduling and providing public notice*

Date: ______________ Time: ____________ Location: ____________________

□ *mailed survey with summary of results* **(attach survey and results)**

□ *bill insert inviting comment* **(attach bill insert)**

□ *other method* ____

Section 3 Public Education

The ___________________________ (*name of utility*) will periodically provide the public with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage.

Drought plan information will be provided by:
(check at least one of the following)

□ *public meeting*

□ *press releases*

□ *utility bill inserts*

□ *other* ______________________________

Section 4 Coordination with Regional Water Planning Groups

The service area of the ______________________________ (*name of your utility*) is located within Regional Water Planning Group (RWPG) _____.

______________________________ (*name of your utility*) has mailed a copy of this Plan to the RWPG.

Section 5 Notice Requirements

Written notice will be provided to each customer **prior to implementation or termination of each stage of the water restriction program**. Mailed notice must be given to each customer 72 hours prior to the start of water restriction. If notice is hand-delivered, the utility cannot enforce the provisions of the plan for 24 hours after notice is provided. The written notice to customers will contain the following information:

1. the date restrictions will begin;
2. the circumstances that triggered the restrictions;
3. the stages of response and explanation of the restrictions to be implemented; and,
4. an explanation of the consequences for violations.

The utility must notify the TCEQ by telephone at (512) 239-4691 or by electronic mail at *watermon@tceq.state.tx.us* prior to implementing Stage III and must notify, in writing, the Public Drinking Water Section at MC - 155, P.O. Box 13087, Austin, Texas 78711-3087 within five (5) working days of implementation, including a copy of the utility's restriction notice. The utility must file a status report of its restriction program with the TCEQ at the initiation and termination of mandatory water use restrictions (i.e., Stages III and IV).

Section 6 Violations

1. First violation: The customer will be notified by written notice of their specific violation.

2. Subsequent violations:

   a. After written notice, the utility may install a flow restricting device in the line to limit the amount of water which will pass through the meter in a 24-hour period. The utility may charge the customer for the actual cost of installing and removing the flow restricting device, not to exceed $50.00.

   b. After written notice, the utility may discontinue service at the meter for a period of seven (7) days, or until the end of the calendar month, whichever is LESS. The normal reconnect fee of the utility will apply for restoration of service.

Section 7 Exemptions or Variances

The utility may grant any customer an exemption or variance from the drought contingency plan for good cause **upon written request**. A customer who is refused an exemption or variance may appeal such action of the utility, in writing, to the Texas Commission on Environmental Quality. The utility will treat all customers equally concerning exemptions and variances, and shall not discriminate in granting exemptions and variances. No exemption or variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section 8 Response Stages

Unless there exists an immediate and extreme reduction in water production or some other absolute necessity to declare an emergency or severe condition, the utility will initially declare Stage I restrictions. If, after a reasonable period of time, demand is not reduced enough to alleviate outages, reduce the risk of outages, or comply with restrictions required by a court, government agency or other authority, Stage II may be implemented with Stage III to follow, if necessary.

STAGE I - CUSTOMER AWARENESS

Stage I will begin:
Every April 1st, the utility will mail a public announcement to its customers.
No notice to TCEQ is required.

Stage I will end:
Every September 30th, the utility will mail a public announcement to its customers. No notice to TCEQ is required.

Utility Measures:
This announcement will be designed to increase customer awareness of water conservation and to encourage the most efficient use of water. A copy of the current public announcement on water conservation awareness shall be kept on file available for inspection by TCEQ.

Voluntary Water Use Restrictions:
Water customers are requested to voluntarily limit the use of water for nonessential purposes and to practice water conservation.

STAGE II - VOLUNTARY WATER CONSERVATION:

Target: Achieve a ______ percent reduction in __________ *(example: total water use, daily water demand, etc.).*

The water utility will implement Stage II when any one of the selected triggers is reached.

Supply-Based Triggers: (Check at least one and fill in the appropriate value.)

- ☐ Well level reaches __________ ft. mean sea level (m.s.l.).
- a. Overnight recovery rate reaches __________ ft.
- b. Reservoir elevation reaches __________ ft. (m.s.l.).
- c. Stream flow reaches __________ cfs at USGS gauge # __________.
- d. Wholesale supplier's drought Stage II ______________________________
- e. Annual water use equals _______ % of well permit/water right/purchased water contract amount.
- f. Other ______________________________

Demand- or Capacity-Based Triggers: (Check at least one and fill in the appropriate value.)

- g. Drinking water treatment as % of capacity __________ %
- h. Total daily demand as % of pumping capacity __________ %
- i. Total daily demand as % of storage capacity __________ %
- j. Pump hours per day __________ hrs.
- k. Production or distribution limitations
- l. Other ______________________________

Upon initiation and termination of Stage II, the utility will mail a public announcement to its customers. No notice to TCEQ is required.

Requirements for Termination:
Stage II of the Plan may end when all of the conditions listed as triggering events have ceased to exist for a period of three (3) consecutive days. Upon termination of Stage II, Stage I becomes operative.

Utility Measures:
Visually inspect lines and repair leaks on a daily basis. Review customer use records monthly, and follow up on any that have unusually high usage.

Describe additional measures, if any, to be implemented directly by the utility to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, activation and use of alternative supply source(s), and use of reclaimed water for non-potable purposes.

The second water source for ______________________________ (*name of utility*) is: (check one)

- ☐ other well
- ☐ inter-connection with other system
- ☐ purchased water
- ☐ other ______________________________

Voluntary Water Use Restrictions:

1. Restricted Hours: Outside watering is allowed daily, but only during periods specifically described in the customer notice *(between 10:00 pm and 5:00 am, for example).*

2. Restricted Days/Hours: Water customers are requested to voluntarily limit the irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems. Customers are requested to limit outdoor water use to **Mondays for water customers with a street address ending in 1, 2, or 3; Wednesdays for water customers with a street address ending in 4, 5, or 6; and Fridays for water customers with a street address ending in 7, 8, 9, or 0.** Irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 am and between 8:00 pm and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at any time by means of a hand-held hose, a faucet-filled bucket or watering can of five (5) gallons or less, or a drip irrigation system.

3. Other uses that waste water, such as water running down gutters.

STAGE III - MANDATORY WATER USE RESTRICTIONS:

Target: Achieve a ______ percent reduction in __________ (example: total water use, daily water demand, etc.)

The water utility will implement Stage III when any one of the selected triggers is reached.

Supply-Based Triggers: (Check at least one and fill in the appropriate value.)

1. Well level reaches __________ ft. (m.s.l.)
2. Overnight recovery rate reaches __________ ft.
3. Reservoir elevation reaches __________ ft. (m.s.l.)
4. Stream flow reaches __________ cfs at USGS gauge # __________
5. Wholesale supplier's drought Stage III
   ____
6. Annual water use equals _______ % of well permit/water right/purchased water contract amount
7. Other ____

Demand- or Capacity-Based Triggers: (check at least one and fill in the appropriate value)

8. Drinking water treatment as % of capacity __________ %
9. Total daily demand as % of pumping capacity __________ %
10. Total daily demand as % of storage capacity __________ %
11. Pump hours per day __________ hrs.

12. Production or distribution limitations
13. Other ________________________________

Upon initiation and termination of Stage III, the utility will mail a public announcement to its customers. Notice to TCEQ is required.

Requirements for Termination:

Stage III of the Plan may end when all of the conditions listed as triggering events have ceased to exist for a period of three (3) consecutive days. Upon termination of Stage III, Stage II becomes operative.

Utility Measures:

Visually inspect lines and repair leaks on a regular basis. Flushing is prohibited except for dead end mains.

Describe additional measures, if any, to be implemented directly by the utility to manage limited water supplies and/or reduce water demand. Examples include activation and use of alternative supply source(s), use of reclaimed water for non-potable purposes, and offering low-flow fixtures and water restrictors.

Mandatory Water Use Restrictions

The following water use restrictions shall apply to all customers:

1. Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems **shall be limited to Mondays for water customers with a street address ending in 1, 2, or 3; Wednesdays for water customers with a street address ending in 4, 5, or 6; and Fridays for water customers with a street address ending in 7, 8, 9, or 0.** Irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 am and between 8:00 pm and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at any time if it is by means of a hand-held hose, a faucet-filled bucket or watering can of five (5) gallons or less, or a drip irrigation system.

2. Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 am and between 8:00 pm and 12:00 midnight. Such washing, when allowed, shall be done with a hand-held bucket or a hand-held hose equipped with a positive shutoff nozzle for quick rinses. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public are contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

3. Use of water to fill, refill, or add to any indoor or outdoor swimming pool, wading pool, or "jacuzzi" type pool is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 am and between 8:00 pm and 12:00 midnight.

4. Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

5. Use of water from hydrants or flush valves shall be limited to maintaining public health, safety, and welfare.

6. Use of water for the irrigation of golf courses, parks, and green belt areas is prohibited except by hand-held hose, and then only on designated watering days between the hours of 12:00 midnight and 10:00 am and between 8:00 pm and 12:00 midnight.

7. The following uses of water are defined as nonessential and are prohibited:

    a. washing down of any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
    b. use of water to wash down buildings or structures for purposes other than immediate fire protection;
    c. use of water for dust control;
    d. flushing gutters or permitting water to run or accumulate in any gutter or street;
    e. failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and
    f. any waste of water.

STAGE IV - CRITICAL WATER USE RESTRICTIONS:

Target: Achieve a ______ percent reduction in __________ (example: total water use, daily water demand, etc.) .

The water utility will implement Stage IV when any one of the selected triggers is reached.

Supply-Based Triggers: (Check at least one and fill in the appropriate value.)

14. Well level reaches __________ ft. (m.s.l.)
15. Overnight recovery rate reaches __________ ft.
16. Reservoir elevation reaches __________ ft. (m.s.l.)
17. Stream flow reaches __________ cfs at USGS gauge # _________

18. Wholesale supplier's drought Stage IV ____________________
19. Annual water use equals _______ % of well permit/water right/purchased water contract amount
20. Supply contamination
21. Other ____________________

Demand- or Capacity-Based Triggers: (Check at least one and fill in the appropriate value.)

22. Drinking water treatment as % of capacity __________ %
23. Total daily demand as % of pumping capacity __________ %
24. Total daily demand as % of storage capacity __________ %
25. Pump hours per day __________ hrs.
26. Production or distribution limitations
27. System outage
28. Other ____________________

Upon initiation and termination of Stage IV, the utility will mail a public announcement to its customers. Notice to TCEQ is required.

Requirements for Termination:
Stage IV of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of three (3) consecutive days. Upon termination of Stage IV, Stage III becomes operative.

Operational Measures:

The utility shall visually inspect lines and repair leaks on a daily basis. Flushing is prohibited except for dead end mains and only between the hours of 9:00 pm and 3:00 am. Emergency interconnects or alternative supply arrangements shall be initiated. All meters shall be read as often as necessary to insure compliance with this program for the benefit of all customers. *Describe additional measures, if any, to be directly implemented to manage limited water supplies and/or reduce water demand.*

Mandatory Water Use Restrictions: (All outdoor use of water is prohibited.)

1. Irrigation of landscaped areas is absolutely prohibited.
2. Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is absolutely prohibited.

SYSTEM OUTAGE or SUPPLY CONTAMINATION

Notify the TCEQ Regional Office immediately.

EXAMPLE RESOLUTION FOR ADOPTION OF A DROUGHT CONTINGENCY PLAN

RESOLUTION NO. _________

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE ________________ (name of water user group) ADOPTING A DROUGHT CONTINGENCY PLAN.

WHEREAS, the Board recognizes that the amount of water available to the ___________ (name of water supplier) and its water utility customers are limited and subject to depletion during periods of extended drought;

WHEREAS, the Board recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes;

WHEREAS, Section 11.1272 of the Texas Water Code and applicable rules of the Texas Commission on Environmental Quality require all public water supply systems in Texas to prepare a drought contingency plan; and

WHEREAS, as authorized under law, and in the best interests of the customers of the _______________ *(name of water supply system),* the Board deems it expedient and necessary to establish certain rules and policies for the orderly and efficient management of limited water supplies during drought and other water supply emergencies;

NOW THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE _______________ *(name of water user group):*

SECTION 1. That the Drought Contingency Plan attached hereto as Exhibit "A" and made a part hereof for all purposes be, and the same is hereby, adopted as the official policy of the _______________ (*name of water supplier*).

SECTION 2. That the ______________ *(e.g., general manager)* is hereby directed to implement, administer, and enforce the Drought Contingency Plan.

SECTION 3. That this resolution shall take effect immediately upon its passage.

DULY PASSED BY THE BOARD OF DIRECTORS OF THE ______________ (*name of water user group*), ON THIS ___ day of _____________, 20___.

____

President, Board of Directors

ATTESTED TO:

____

Secretary, Board of Director

ATTACHMENT 6-2 Model Water Conservation Plan FOR MUNICIPAL WATER USE

September 2005

Texas Commission on Environmental Quality

REQUIREMENTS FOR WATER CONSERVATION PLANS FOR MUNICIPAL WATER USE BY PUBLIC WATER SUPPLIERS

TCEQ

In addition to the utility profile, a water conservation plan for municipal use by a public water supplier must include, at a minimum, additional information as required by Title 30, Texas Administrative Code, §288.2. <u>Note: If the water conservation plan does not provide information for each requirement, an explanation must be included as to why the requirement is not applicable.</u>

Specific, Quantified 5 & 10-Year Targets

The water conservation plan must include specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for ***municipal use in gallons per capita per day*** (see Appendix A). Note that the goals established by a public water supplier under this subparagraph are not enforceable.

Metering Devices

The water conservation plan must include a statement about the water supplier's metering device(s), within an accuracy of plus or minus five percent (5.0%), in order to measure and account for the amount of water diverted from the source of supply.

Universal Metering

The water conservation plan must include a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement.

Unaccounted-For Water Use

The water conservation plan must include measures to determine and control unaccounted-for uses of water. Examples are periodic visual inspections along distribution lines, annual or monthly audits of the water system to determine illegal connections, abandoned services; etc.).

Continuing Public Education & Information

The water conservation plan must include a description of the program of continuing public education and information regarding water conservation by the water supplier.

Non-Promotional Water Rate Structure

The water supplier must have a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water. This rate structure must be listed in the water conservation plan.

Reservoir Systems Operations Plan

The water conservation plan must include a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies.

Enforcement Procedure & Plan Adoption

The water conservation plan must include a means of implementation and enforcement which shall be evidenced by 1) a copy of the ordinance, resolution, or tariff indicating **official adoption** of the water conservation plan by the water supplier; and, 2) a description of the authority by which the water supplier will implement and enforce the conservation plan.

Coordination with the Regional Water Planning Group(s)

The water conservation plan must include documentation of coordination with the regional water planning group(s) for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

Example statement to be included within the water conservation plan:

The service area of the _____________ (name of water supplier) is located within the ___________ (name of regional water planning area or areas) and ___________ (name of water supplier) has provided a copy of this water conservation plan to the ____________ (name of regional water planning group or groups).

Additional Requirements:

(for suppliers serving populations of 5,000 or more or a projected population of 5,000 or more within ten years)

1. **Program for Leak Detection, Repair, and Water Loss Accounting**

   The plan must include a description of the program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted for uses of water.

2. **Record Management System**

   The plan must include a record management system (to record water pumped, water deliveries, water sales, and water losses) which allows for the desegregation of water sales and uses into the following user classes--residential, commercial, public and institutional, and industrial.

Plan Review and Update

Beginning May 1, 2005, a public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. The revised plan must also include an implementation report.

Best Management Practices Guide

On November 2004, the Texas Water Development Board's (TWDB) Report 362 was completed by the Water Conservation Implementation Task Force. Report 362 is the Water Conservation Best Management Practices (BMP) Guide. The BMP Guide is a voluntary list of management practices that water users may implement in addition to the required components of Title 30, Texas Administrative Code, Chapter 288. The BMP Guide is available on the TWDB's website at the link below or by calling (512) 463-7847.

http://www.twdb.state.tx.us/assistance/conservation/TaskForceDocs/WC

ATTACHMENT 6-3 Model Water Conservation & Drought Contingency Plan For A (Water User Group)

Water Conservation &
Model Drought Contingency Plan
For [WATER USER GROUP]

Date

CONTENTS OF PLAN

1. Objectives for Water User Group
2. Texas Commission on Environmental Quality Rules (Texas Administrative Codes)
3. Water Conservation Plan
4. Public& School Education
5. Coordination with Region M Planning Group
6. Drought Contingency Plan
7. Review and Update of Drought Contingency Plan

1. Water Conservation Plan for [Public Water Supplier]
Objectives

- To reduce the loss and waste of water
- To reduce water consumption
- To improve the efficiency in the use of water

Model Drought Contingency Plan for [Public Water Supplier]
Objectives

This drought contingency plan (the Plan) is intended for use by [municipal water supplier]. The plan includes all current TCEQ requirements for a drought contingency plan.

This drought contingency plan serves to:

- To conserve available water supplies during times of drought and emergency.
- To reduce adverse impacts of water supply shortages.
- To reduce the adverse impacts of emergency water supply conditions.
- To preserve public health, welfare, and safety.

2. Texas Commission on Environmental Quality Rules
Water Conservation & Drought Contingency Plans

The TCEQ rules governing development of water conservation plans for public water suppliers are contained in Title 30 part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code. According to TCEQ rules, water conservation plans for public water suppliers must have a certain minimum content, Must have additional content for public water suppliers that are projected to supply 5,000 or more people in the next ten years and may have additional optional content.

The TCEQ rules governing development of drought contingency plans for public water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.20 of the Texas Administrative Code.

<u>Minimum Conservation Plan Requirements</u>

The minimum requirements in the Texas Administrative Code for Water Conservation

Plans for Public Water Suppliers are covered in this report as follows:

- 288.2(a)(1)(A) – Utility Profile,
- 288.2(a)(1)(B) – Specification of Goals,
- 288.2(a)(1)(C) – Accurate Metering ,
- 288.2(a)(1)(D) – Universal Metering,
- 288.2(a)(1)(E) – Determination and Control of Unaccounted Water,
- 288.2(a)(1)(F) – Public Education and Information Program,
- 288.2(a)(1)(G) – Non-Promotional Water Rate Structure,
- 288.2(a)(1)(H) – Reservoir System Operation Plan,
- 288.2(a)(1)(I) – Means of Implementation and Enforcement, and
- 288.2(a)(1)(J) – Coordination with Regional Water Planning Group

<u>Additional Conservation Strategies</u>
TCEQ rules also list additional optional but not required conservation strategies, which may be adopted by suppliers. The following optional strategies are included in this plan:

- 288.2(a)(3)(A) – Conservation Oriented Water Rates,
- 288.2(a)(3)(B) – Ordinances, Plumbing Codes or Rules on Water-Conserving
- 288.2(a)(3)(F) – Considerations for Landscape Water Management Regulations
- 288.2(a)(3)(G) – Monitoring Method

<u>Conservation Additional Requirements (Population over 5,000)</u>
The Texas Administrative Code includes additional requirements for water conservation plans for cities with a population over 5,000:

- 288.2(a)(2)(A) – Leak Detection, Repair, and Water Loss Accounting – Sections 5.3, 5.4, and 5.5,
- 288.2(a)(2)(B) – Record Management System – Sect. 5.2, and
- 288.2(a)(2)(C) – Requirement for Water Conservation Plans by Wholesale

3.

WATER CONSERVATION PLAN
FOR THE
(Name of Water User Group)
(Date)

[Water User Group] will give customers the opportunity to provide public input into the preparation of the plan by one of the following methods:
• Holding a public meeting.
• Providing written notice of the proposed plan and the opportunity to comment on the plan by newspaper or posted notice.

Utility Profile
The utility profile will provide information which will include population and customer data, water use data, water supply system data, and wastewater system data.

Utility Profile	
Water Service Area	
Population	
Projected Population in 2060	
Projected Population in 2010	
Current Population	
Current Connections	
Total Increase in Connections in Last Ten Years	
Total Increase in Connections in Last Five Years	
Miles of Distribution Pipe	
Water Supply Sources	
Number of Water Treatment Plants	
Treatment Plant Capacity #1	
Treatment Plant Capacity #2	
Number of Ground StorageTanks	
Ground Storage Tank Capacity #1	
Ground Storage Tank Capacity #2	
Number of Elevated StorageTanks	
Elevated StorageTank Capacity #1	
Elevated StorageTank Capacity #2	
Current Total Annual Wastewater Flow	

Specification of Water Conservation Goals
This section must include 5, 10, & 20 year targets for water savings. This will include goals for water loss programs and goals for municipal use in gallons per capita per day.

1. The Water User Group's water conservation Goals for the ____ years:

2. Achieve_____ per capita municipal water use of ____gpcd or less, as shown in following table. This will represent a reduction of ___ gpcd from TWDB's projected per capita municipal water use without low-flow plumbing fixtures or other conservation measures.

3. Implement and maintain a meter replacement program.

4. Keep the level of unaccounted water in the system less than ___ percent in____ (Target year) and subsequent years.

5. Raise Public Awareness of water conservation and encourage responsible public behavior through a public/school education and information program.

6. Implement a Reservoir System Operation Plan

   The _________________(WUG Name) has the following rights to divert water from _______________Reservoir.

   *This plan must include a reservoir system operation plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies.

7. (Optional) Decrease waste in lawn irrigation through implementation and enforcement of a landscape water management ordinance.

8. (Optional) Decrease outdoor water use by implementing; residential customer water audit, landscape irrigation systems rebate program, and landscape design and conversion program.
9. (Optional) Create a non-promotional water rate structure

   Must include a water rate structure that is not "promotional" i.e, a rate structure which is cost based and which does not encourage excessive use of water with the intent of encouraging water conservation.

***Attachment 6-4 of Chapter Six of this Water plan has several Best Management Practices that can be used for water conservation.**

4. Public Education & School Education
[Public water supplier] will notify the public & public Schools about the drought contingency plan, including changes in Stage and drought measures to be implemented, by one or more of the following methods:

• Prepare a description of the Plan and make it available to customers at appropriate locations.
• Include utility bill inserts that detail the Plan
• Provide radio announcements that inform customers of stages to be initiated or terminated and drought measures to be taken
• Include an ad in a newspaper of general circulation to inform customers of stages to be initiated or terminated and drought measures to be taken

5. Coordination with the Region M Water Planning Group
This drought contingency plan will be sent to the Chair of the Region M Water Planning Group in order to ensure consistency with the Region M Water Plan. If any changes are made to the model conservation plan, a copy of the newly adopted plan will be sent to the Regional Water Planning Group.

6.

DROUGHT CONTINGENCY PLAN
FOR THE
(Name of Water User Group)
(Date)

Section I: Declaration of Purpose, Policy, and Intent

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the ___________________ *(name of water user grour)* hereby adopts the following regulations and restrictions on the delivery and consumption of water through an ordinance/or resolution. (see Appendix C for an example.)

Water uses regulated or prohibited under this Drought Contingency Plan (the Plan) are considered to be non-essential, and continuation of such uses during times of water shortage or other emergency water supply conditionS are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section XI of this Plan.

Section II: Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by the ______________ *(name of wateruser group)* by means of ________________ *(describe methods used to inform the public about the preparation of the plan and provide opportunities for input; for example, scheduling and providing public notice of a public meeting to accept input on the Plan).*

Section III: Public Education

The ________ *(name of water user group)* will periodically provide the public with information about the Plan, including the conditions under which each stage is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of _________________ *(describe methods to be used to provide information to the public about the Plan; for example, public events, press releases, or utility bill inserts).*

Section IV: Coordination with Regional Water Planning Groups

The service area of the ____________ *(name of water user group)* is located within the ___________ *(name of regional water planning area or areas)* and ___________ *(name of water user group)* has provided a copy of this Plan to the ___________ *(name of regional water planning group or groups).*

Section V: Authorization

The __________________ *(designated official; for example, the mayor, city manager, utility director, general manager, etc.)* or his/her designee is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The ______________ *(designated official) or his/her designee)* shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by the _________________ *(name of supplier).* The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Definitions

For the purposes of this Plan, the following definitions shall apply:

<u>Aesthetic water use</u>: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens

<u>Commercial and institutional water use</u>: water use which is integral to the operations of commercial and non-profit establishments and governmental entities such as retail establishments, hotels and motels, restaurants, and office buildings.

<u>Conservation</u>: practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficienT use of water, or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses

Customer: any person, company, or organization using water supplied by
_________________ *(name of water user group)*

Domestic water use: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution

Even number address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses

Industrial water use: the use of water in processes designed to convert materials of lower value into forms of greater value and usability

Landscape irrigation use: water used for irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, and rights-of-way and medians

Non-essential water use: water uses that are not essential or required for the protection of public, health, safety, and welfare including:

(a) irrigation of landscape areas including parks, athletic fields, and golf courses, except otherwise provided under this Plan;
(b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle;
(c) use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
- use of water to wash down buildings or structures for purposes other than immediate fire protection
- flushing gutters or permitting water to run or accumulate in any gutter or street
- use of water to fill, refill, or add to any indoor or outdoor swimming pool or jacuzzi-type pool
- use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic life
- failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s)
- use of water from hydrants for construction purposes or any purposes other than fire-fighting

Odd numbered address: street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9

Section VIII: Criteria for Initiation and Termination of Drought Response Stages

The ____________ *(designated official)* or his/her designee shall monitor water supply and/or demand conditions on a _____ (*e.g., daily, weekly, monthly*) basis and shall determine when conditions warrant initiation or termination of each stage of the Plan; that is, when the specified "triggers" are reached.

The triggering criteria described below are based on

____

____

(Provide a brief description of the rationale for the triggering criteria; for example, statistical analysis of the vulnerability of the water source under drought of record conditions, or known system capacity limits.)

Stage 1 Triggers -- MILD Water Shortage Conditions

Requirements for initiation
Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain water uses, defined in Section VII–Definitions, when

____

(Describe triggering criteria / trigger levels; see examples below.)

Following are examples of the types of triggering criteria that might be used in one or more successive stages of a drought contingency plan. One or a combination of such criteria must be defined for each drought response stage, but usually not all will apply. Select those appropriate to your system:

Example 1: Annually, beginning on May 1 through September 30.

Example 2: When the water supply available to the ____________ *(name of water user group)* is equal to or less than _______ *(acre-feet, percentage of storage, etc.).*

Example 3: When, pursuant to requirements specified in the ____________ *(name of water user group's)* wholesale water purchase contract with ____________ *(name of wholesale water user group),* notification is received requesting initiation of Stage 1 of the Drought Contingency Plan.

Example 4: When flows in the _______ *(name of stream or river)* are equal to or less than _____cubic feet per second.

Example 5: When the static water level in the _______________ *(name of water user group's)* well(s) is equal to or less than _____ feet above/below mean sea level.

Example 6: When the specific capacity of the __________________ *(name of water user group*'s) well(s) is equal to or less than _____ percent of the well's original specific capacity.

Example 7: When total daily water demand equals or exceeds ______ million gallons for ___consecutive days of ____ million gallons on a single day (e.g., based on the "safe" operating capacity of water supply facilities).

Example 8: Continually falling treated water reservoir levels which do not refill above___ percent overnight *(e.g., based on an evaluation of minimum treated water storage required to avoid system outage)*.

The public water user group may also devise other triggering criteria which are tailored to its system.

Requirements for Termination
Stage 1 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ *(e.g., 3)* consecutive days.

Stage 2 Triggers -- MODERATE Water Shortage Conditions

Requirements for Initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses provided in Section IX of this Plan when ____________ *(describe triggering criteria; see examples in Stage 1)*.

Requirements for Termination
Stage 2 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ____ *(e.g., 3)* consecutive days. Upon termination of Stage 2, Stage 1 becomes operative.

Stage 3 Triggers – SEVERE Water Shortage Conditions

Requirements for Initiation
Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when ____________ *(describe triggering criteria; see examples in Stage 1)*.

Requirements for Termination
Stage 3 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ____ *(e.g., 3)* consecutive days. Upon termination of Stage 3, Stage 2 becomes operative.

Stage 4 Triggers -- CRITICAL Water Shortage Conditions

Requirements for Initiation

Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when ___________ (*describe triggering criteria; see examples in Stage 1*).

Requirements for Termination
Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ *(e.g., 3)* consecutive days. Upon termination of Stage 4, Stage 3 becomes operative.

Stage 5 Triggers -- EMERGENCY Water Shortage Conditions

Requirements for Initiation
Customers shall be required to comply with the requirements and restrictions for Stage 5 of this Plan when ___________ *(designated official)* or his/her designee determines that a water supply emergency exists based on:

1. major water line breaks or pump or system failures, which cause unprecedented loss of capability to provide water service; **or**

2. natural or man-made contamination of the water supply source(s).

Requirements for Termination
Stage 5 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ *(e.g., 3)* consecutive days.

Stage 6 Triggers -- WATER ALLOCATION

Requirements for Initiation
Customers shall be required to comply with the water allocation plan prescribed in Section IX of this Plan and to comply with the requirements and restrictions for Stage 5 of this Plan when ______________________ (*describe triggering criteria, see examples in Stage 1*).

Requirements for Termination -- Water allocation may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of ___ *(e.g., 3)* consecutive days.

> Note: The inclusion of WATER ALLOCATION as part of a drought contingency plan may not be required in all cases. For example, for a given water user group, an analysis of water supply availability under drought-of-record conditions may indicate essentially no risk of water supply shortage. Hence, a drought contingency plan for such a water user group might only address facility capacity limitations and emergency conditions *(e.g., supply source contamination and system capacity limitations).*

Section IX: Drought Response Stages

The ________ *(designated official)* or his/her designee shall monitor water supply and/or demand conditions on a daily basis and, in accordance with the triggering criteria set forth in Section VIII of this Plan, shall determine that a mild, moderate, severe, critical, emergency, or water-shortage condition exists and shall implement the following notification procedures:

Notification

Notification of the Public:

The ___________ *(designated official)* or his/ her designee shall notify the public by means of:

Examples:
publication in a newspaper of general circulation
direct mail to each customer
public service announcements
signs posted in public places
take-home fliers at schools

Additional Notification:

The ___________ *(designated official)* or his/ her designee shall notify directly, or cause to be notified directly, the following individuals and entities:

Examples:
mayor / chairman and members of the city council / utility board
fire chief(s)
city and/or county emergency management coordinator(s)
county judge and commissioner(s)
state disaster district / Department of Public Safety
TCEQ *(required when mandatory restrictions are imposed)*
major water users
critical water users *(i.e. hospitals)*
parks / streets superintendents & public facilities managers

Note: The plan should specify direct notice only as appropriate to respective drought stages.

Stage 1 Response -- MILD Water Shortage Conditions

Target: Achieve a voluntary ___ percent reduction in _________ *(e.g., total water use, daily water demand, etc.).*

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by _______________ *(name of water user group)* to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, activation and use of an alternative supply source(s), and use of reclaimed water for non-potable purposes.

Voluntary Water Use Restrictions for Reducing Demand:

(a) Water customers with a street address ending in even numbers (0, 2, 4, 6 or 8) are requested to voluntarily limit the irrigation of landscaped areas to Sundays and Thursdays. Water customers with a street address ending in odd numbers (1, 3, 5, 7 or 9) are requested to limit the irrigation of landscaped areas to Saturdays and Wednesdays. All water customers are to irrigate only between the hours of midnight and 10:00 am and 8:00 pm to midnight on designated days.

(b) All operations of the _____________ (name of water user group) shall adhere to water use restrictions prescribed for Stage 2 of the Plan.

(c) Water customers are requested to practice water conservation and to minimize or discontinue water use for non-essential purposes.

Stage 2 Response – MODERATE Water Shortage Conditions

Target: Achieve a ___ percent reduction in _________ *(e.g., total water use, daily water demand, etc.).*

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ___________ *(name of water user group)* to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas, use of alternative supply source(s), and use of reclaimed water for non-potable purposes.

Water Use Restrictions for Demand Reduction:

Under threat of penalty for violation, the following water use restrictions shall apply to all persons:

- Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems shall be limited to Sundays and Thursdays for customers with a street address ending in an even number (0, 2, 4, 6 or 8), and

Saturdays and Wednesdays for water customers with a street address ending in an odd number (1, 3, 5, 7 or 9). Irrigation of landscaped areas is further limited to the hours of 12:00 midnight until 10:00 am and between 8:00 pm and 12:00 midnight on designated watering days. However, irrigation of landscaped areas is permitted at any time by means of a hand-held hose, a faucet-filled bucket or watering can of five (5) gallons or less, or a drip irrigation system.

- Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 am and between 8:00 pm and 12:00 midnight. Such washing, when allowed, shall be done with a hand-held bucket or a hand-held hose equipped with a positive shutoff nozzle for quick rinses. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public are contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

- Use of water to fill, refill, or add to any indoor or outdoor swimming pool, wading pool, or jacuzzi-type pool is prohibited except on designated watering days between the hours of 12:00 midnight and 10:00 am and between 8 pm and 12:00 midnight.

- Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountain or pond is equipped with a recirculation system.

- Use of water from hydrants shall be limited to fire-fighting, related activities, or other actions necessary to maintain public health, safety, and welfare; **except** that use of water from designated fire hydrants for construction purposes may be allowed under special permit from the ____________________ *(name of water user group)*.

- Use of water to irrigate golf course greens, tees, and fairways is prohibited except on designated watering days between the hours 12:00 midnight and 10:00 am and between 8 pm and 12:00 midnight. However, if the golf course utilizes a water source other than that provided by the ________________ *(name of water user group)*, the facility shall not be subject to these regulations.

- All restaurants are prohibited from serving water to patrons except upon request of the patron.

- The following uses of water are defined as non-essential and are prohibited:

- □ wash down of any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas
- □ use of water to wash down buildings or structures for purposes other than immediate fire protection
- □ use of water for dust control
- □ flushing gutters or permitting water to run or accumulate in any gutter or street
- □ failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s)

Stage 3 Response -- SEVERE Water Shortage Conditions

Target: Achieve a ___ percent reduction in _________ *(e.g., total water use, daily water demand, etc.).*

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ___________ *(name of water user group)* to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas, use of alternative supply source(s), and use of reclaimed water for non-potable purposes.

Water Use Restrictions for Demand Reduction:

All requirements of Stage 2 shall remain in effect during Stage 3 except:

- Irrigation of landscaped areas shall be limited to designated watering days between the hours of 12:00 midnight and 10:00 am and between 8 pm and 12:00 midnight, and shall be by means of hand-held hoses, hand-held buckets, drip irrigation, or permanently installed automatic sprinkler systems only. The use of hose-end sprinklers is prohibited at all times.

- The watering of golf course tees is prohibited unless the golf course utilizes a water source other than that provided by the ___________________ *(name of water user group).*

- The use of water for construction purposes from designated fire hydrants under special permit is to be discontinued.

Stage 4 Response -- CRITICAL Water Shortage Conditions

Target: Achieve a ___ percent reduction in _________ *(e.g., total water use, daily water demand, etc.).*

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ___________ *(name of water user group)* to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas, use of alternative supply source(s), and use of reclaimed water for non-potable purposes.

Water Use Restrictions for Reducing Demand:

All requirements of Stage 2 and 3 shall remain in effect during Stage 4 except:

- Irrigation of landscaped areas shall be limited to designated watering days between the hours of 6:00 am and 10:00 am and between 8:00 pm and 12:00 midnight and shall be by means of hand-held hoses, hand-held buckets, or drip irrigation only. The use of hose-end sprinklers or permanently installed automatic sprinkler systems is prohibited at all times.

- Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle not occurring on the premises of a commercial car wash or commercial service station and not in the immediate interest of public health, safety, and welfare is prohibited. Further, such vehicle washing at commercial car washes and commercial service stations shall occur only between the hours of 6:00 am and 10:00 am and between 6:00 pm and 10 pm.

- The filling, refilling, or adding of water to swimming pools, wading pools, and jacuzzi-type pools is prohibited.

- Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

- No application for new, additional, expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or water service facilities of any kind shall be approved, and time limits for approval of such applications are hereby suspended for such time as this drought response stage or a higher-numbered stage shall be in effect.

Stage 5 Response -- EMERGENCY Water Shortage Conditions

Target: Achieve a ___ percent reduction in _________ *(e.g., total water use, daily water demand, etc.).*

Best Management Practices for Supply Management:

Describe measures, if any, to be implemented directly by ___________ *(name of water user group)* to manage limited water supplies and/or reduce water demand. Examples include reduced or discontinued flushing of water mains, reduced or discontinued irrigation of public landscaped areas, use of alternative supply source(s), and use of reclaimed water for non-potable purposes.

Water Use Restrictions for Reducing Demand:

All requirements of Stage 2, 3, and 4 shall remain in effect during Stage 5 except:

- Irrigation of landscaped areas is absolutely prohibited.
- Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane, or other vehicle is absolutely prohibited.

Stage 6 Response -- WATER ALLOCATION

In the event that water shortage conditions threaten public health, safety, and welfare, the ___________ *(designated official)* is hereby authorized to allocate water according to the following allocation plan:

Single-Family Residential Customers

The allocation to residential water customers residing in a single-family dwelling shall be as follows:

Persons per Household	Gallons per Month
1 or 2	6,000
3 or 4	7,000
5 or 6	8,000
7 or 8	9,000
9 or 10	10,000
11 or more	12,000

"Household" means the residential premises served by the customer's meter. "Persons per household" includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period. It shall be assumed that a particular customer's household is comprised of two (2) persons unless the customer notifies the ___________ *(name of water user group)* of a greater number of persons per household using a form prescribed by the _________ *(designated official),* who shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every residential customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ___________ *(name of water user group)* offices to complete and sign the form claiming more than two (2) persons per household. New customers may claim more persons per household at the time of applying for water service using the form prescribed by the __________ *(designated official)*. When the number of persons per household increases so as to place the customer in a different allocation category, the customer may notify the _________ *(name of water user group)* on such form, and the change will be implemented in the next practicable billing period. If the number of persons in a household is reduced, the customer shall notify the _________ *(name of water user group)* in writing within two (2) days. In prescribing the method for claiming more than two (2) persons per household, the _________ *(designated official)* shall adopt methods to insure the accuracy of claims. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the ___________ *(name of water user group)* of a reduction in the number of person in a household shall be fined not less than $________.

Residential water customers shall pay the following surcharges:

$____ for the first 1,000 gallons over allocation
$____ for the second 1,000 gallons over allocation
$____ for the third 1,000 gallons over allocation
$____ for each additional 1,000 gallons over allocation

Surcharges shall be cumulative.

Master-Metered Multi-Family Residential Customers

The allocation to a customer billed from a master meter which jointly measures water to multiple permanent residential dwelling units *(e.g., apartments, mobile homes)* shall be allocated 6,000 gallons per month for each dwelling unit. It shall be assumed that such a customer's meter serves two dwelling units unless the customer notifies the ___________ *(name of water user group)* of a greater number on a form prescribed by the __________ *(designated official)*. The _________ *(designated official)* shall give his/her best effort to see that such forms are mailed, otherwise provided, or made available to every such customer. If, however, a customer does not receive such a form, it shall be the customer's responsibility to go to the ___________ *(name of water user group)* offices to complete and sign the form claiming more than two (2) dwellings. A dwelling unit may be claimed under this provision whether it is occupied or not. New customers may claim more dwelling units at the time of applying for water service on the form prescribed by the __________ *(designated official)*. If the number of dwelling units served by a master meter is reduced, the customer shall notify the _________ *(name of water user group)* in writing within two (2) days. In prescribing the method for claiming more than two (2) dwelling units, the _________ *(designated official)* shall adopt methods to insure the accuracy of claims. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units served by a master meter or fails to timely notify the ___________ *(name of water user group)* of a reduction in the number of persons in a household shall be fined not less than $________.

Customers billed from a master meter under this provision shall pay the following monthly surcharges:

$____ for 1,000 gallons over allocation up through 1,000 gallons for each dwelling unit.
$____ thereafter, for each additional 1,000 gallons over allocation up through a second 1,000 gallons for each dwelling unit.
$____ thereafter, for each additional 1,000 gallons over allocation up through a third 1,000 gallons for each dwelling unit.

$____ thereafter, for each additional 1,000 gallons over allocation.

Surcharges shall be cumulative.

Commercial Customers

A monthly water allocation shall be established by the __________ *(designated official)* or his/her designee for each nonresidential commercial customer other than an industrial customer who uses water for processing purposes. The non-residential customer's allocation shall be approximately ___ percent *(e.g. 75%)* of the customer's usage for a corresponding month's billing period during the previous 12 months. If the customer's billing history is shorter than 12 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists; provided, however, a customer, ___ percent of whose monthly usage is less than ____ gallons, shall be allocated ____ gallons. The _________ *(designated official)* shall give his/her best effort to see that notice of each non-residential customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ____________ *(name of water user group)* to determine the allocation. Upon request of the customer or at the initiative of the ___________ *(designated official),* the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the customer's normal water usage, (2) one nonresidential customer agrees to transfer part of its allocation to another nonresidential customer, or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the ___________ *(designated official or alternatively, a special water allocation review committee).* Nonresidential commercial customers shall pay the following surcharges.

Customers whose allocation is _____ gallons through ______ gallons per month:

$____ per thousand gallons for the first 1,000 gallons over allocation
$____ per thousand gallons for the second 1,000 gallons over allocation
$____ per thousand gallons for the third 1,000 gallons over allocation
$____ per thousand gallons for each additional 1,000 gallons over allocation

Customers whose allocation is ______ gallons per month or more:

___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation
___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation
___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation
___ times the block rate for each 1,000 gallons more than 15 percent above allocation

Surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Industrial Customers

A monthly water allocation shall be established by the _________ *(designated official)* or his/her designee for each industrial customer which uses water for processing purposes. The industrial customer's allocation shall be approximately ___ percent *(e.g., 90%)* of the customer's water usage baseline. Ninety (90) days after the initial imposition of the allocation, the industrial customer's allocation shall be further reduced to ___ *percent (e.g., 85%)* of the customer's water usage baseline, computed on the average water use for the ___-month period ending prior to the date of implementation of Stage 2 of the Plan. If the industrial water customer's billing history is shorter than ___ months, the monthly average for the period for which there is a record shall be used for any monthly period for which no billing history exists. The ________ *(designated official)* shall give his/her best effort to see that notice of each industrial customer's allocation is mailed to such customer. If, however, a customer does not receive such notice, it shall be the customer's responsibility to contact the ___________ *(name of water user group)* to determine the allocation, and the allocation shall be fully effective notwithstanding the lack of receipt of written notice. Upon request of the customer or at the initiative of the __________ *(designated official)*, the allocation may be reduced or increased (1) if the designated period does not accurately reflect the customer's normal water use because the customer had shut down a major processing unit for repair or overhaul during the period, (2) the customer has added or is in the process of adding significant additional processing capacity, (3) the customer has shut down or significantly reduced the production of a major processing unit, (4) the customer has previously implemented significant permanent water conservation measures such that the ability to further reduce water use is limited, (5) the customer agrees to transfer part of its allocation to another industrial customer, or (6) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions.. A customer may appeal an allocation established hereunder to the __________ *(designated official or alternatively, a special water allocation review committee)*. Industrial customers shall pay the following surcharges:

Customers whose allocation is _____ gallons through _______ gallons per month:

$____ per thousand gallons for the first 1,000 gallons over allocation

$____ per thousand gallons for the second 1,000 gallons over allocation
$____ per thousand gallons for the third 1,000 gallons over allocation
$____ per thousand gallons for each additional 1,000 gallons over allocation.

Customers whose allocation is ______ gallons per month or more:

___ times the block rate for each 1,000 gallons in excess of the allocation up through 5 percent above allocation
___ times the block rate for each 1,000 gallons from 5 percent through 10 percent above allocation
___ times the block rate for each 1,000 gallons from 10 percent through 15 percent above allocation
___ times the block rate for each 1,000 gallons more than 15 percent above allocation.

Surcharges shall be cumulative. As used herein, "block rate" means the charge to the customer per 1,000 gallons at the regular water rate schedule at the level of the customer's allocation.

Section X: Enforcement

(a) No person shall knowingly or intentionally allow the use of water from the _________________ *(name of water user group)* for residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this Plan, or in an amount in excess of that permitted by the drought response stage in effect at the time pursuant to action taken by ____________*(designated official* or his/her designee in accordance with provisions of this Plan.

(b) Any person who violates this Plan is guilty of a misdemeanor and, upon conviction, shall be punished by a fine of not less than _______ dollars ($__) and not more than ______ dollars ($__). Each day that one or more of the provisions in this Plan is violated shall constitute a separate offense. If a person is convicted of three or more distinct violations of this Plan, the _____________ *(designated official)* shall, upon due notice to the customer, be authorized to discontinue water service to the premises where such violations occur. Services discontinued under such circumstances shall be restored only upon payment of a reconnection charge, hereby established at $______, and any other costs incurred by the __________________ *(name of water user group)* in discontinuing the service. In addition, suitable assurance must be given to the ________________ *(designated official)* that the same action shall not be repeated while the Plan is in effect. Compliance with this plan may also be sought through injunctive relief in the district court.

(c) Any person, including a person classified as a water customer of the ______________ *(name of water user group),* in apparent control of the property where a violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on the person's property shall constitute a rebuttable presumption that the person in apparent control of the property committed the violation, but any such person shall have the right to show that he/she did not commit the violation. Parents shall be presumed to be responsible for violations of their minor children, and proof that a violation committed by a child occurred on property within the parents' control shall constitute a rebuttable presumption that the parent committed the violation, but any such parent may be excused if he/she proves that he/she had previously directed the child not to use the water as it was used in violation of this Plan, and that the parent could not have reasonably known of the violation.

(d) Any employee of the ______________ *(name of water user group),* police officer, or other _____ employee designated by the __________ *(designated official,* may issue a citation to a person he/she reasonably believes to be in violation of this Ordinance. The citation shall be prepared in duplicate and shall contain the name and address of the alleged violator, if known, and the offense charged, and shall direct him/her to appear in the ____________ *(e.g., municipal court)* on the date shown on the citation, for which the date shall not be less than 3 days nor more than 5 days from the date the citation was issued. The alleged violator shall be served a copy of the citation. Service of the citation shall be complete upon delivery of the citation to the alleged violator, to an agent or employee of a violator, or to a person over 14 years of age who is a member of the violator's immediate family or is a resident of the violator's residence. The alleged violator shall appear in _________ (e.g., municipal court) to enter a plea of guilty or not guilty for the violation of this Plan. If the alleged violator fails to appear in _________ *(e.g., municipal court),* a warrant for his/her arrest may be issued. A summons to appear may be issued in lieu of an arrest warrant. These cases shall be expedited and given preferential setting in _________ *(e.g., municipal court)* before all other cases.

Section XI: Variances

The ________________ *(designated official)* or his/her designee may, in writing, grant temporary variance for existing water uses otherwise prohibited under this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance, and if one or more of the following conditions is met:

(a) Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.

(b) Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Ordinance shall file a petition for variance with the ________________ *(name of water user group)* within 5 days after the Plan or a particular drought response stage has been invoked. All petitions for variances shall be reviewed by the __________ *(designated official)* or his/her designee and shall include the following:

(a) name and address of the petitioner(s)
(b) purpose of water use
(c) specific provision(s) of the Plan from which the petitioner is requesting relief
(d) a detailed statement as to how the specific provision of the Plan adversely affects the petitioner, or what damage or harm will occur to the petitioner or others, if petitioner complies with this Ordinance
(e) a description of the relief requested
(f) the period of time for which the variance is sought
(g) Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.
(h) Other pertinent information.

Variances granted by the ___________________ *(name of water user group)* shall be subject to the following conditions, unless waived or modified by the ____________ *(designated official)* or his/her designee:

(a) Variances granted shall include a timetable for compliance.
(b) Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or shall otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

7. Review and Update of Drought Contingency Plan

This drought contingency plan will be updated at least every 5 years as required by TCEQ regulations.

ATTACHMENT 6-4 Municipal Water Conservation Strategies

These water conservation strategies from Report 362 for this region:

1. golf course conservation
2. metering all new connections & retrofitting existing connections
3. showerhead, aerator, and toilet flapper retrofitting
4. educating through schools
5. landscape irrigation conservation
6. water-wise landscape design
7. athletic field conservation
8. dissemination of public information
9. rainwater harvesting
10. parklands conservation
11. residential clothes washer incentives

Golf Course Conservation

Description
This water conservation strategy is designed for WUGs that serve golf course customer(s). Because golf courses in Region M's dry climate use significant amounts of water for maintenance, they attract public scrutiny. Fortunately, golf courses are often good candidates for reuse water (discussed in detail in Chapter 4) or other alternative water sources. In fact, non-potable water reuse is a recommended water management strategy for WUGs. Some utilities may already be implementing one or more of the elements of this strategy, and they may want to adopt additional features outlined below. Once a strategy is adopted, the utility should monitor it closely to achieve maximum water efficiency benefit.

The main goal of each WUG's water conservation plan is to reduce demand by predetermined goal amounts. WUGs should require each golf course to develop its own conservation plan to meet water savings goals, including calculating amounts needed to adequately maintain greens and referencing evapotranspiration (ET). A golf course's plan should utilize enhanced water conservation methods such as Computer-Controlled Irrigation Systems (CCIS) or similar technology. To achieve maximum efficiency, a CCIS should incorporate at least the following components: computer controller, software, interface modules, satellite field controller, soil sensors, and weather station. The CCIS should be designed to prevent over-watering, flooding, pooling, and losses from evaporation and run-off; further, sprinkler heads should be calibrated so as not to exceed the soil's saturation capacity.

Non-potable water strategies explained in Chapter 4 can also be incorporated into this conservation scheme. Switching from a potable to non-potable water source requires implementation dates for the conversion. Remember that reclaimed, reused, and/or recycles water used at golf courses must meet TCEQ quality standards for treated effluent and human contact.

Soil improvement is another effective method for reducing irrigation water usage. Soil improvement programs on high-visibility areas such as golf courses can demonstrate to the public the efficacy of this strategy. For golf courses, annual compost applications of ¼ to ½ inch on turf areas and 1 inch on flower beds are recommended. In addition, compost is most beneficial when applied in the fall.

Metering all New Connections and Retrofitting Existing Connections

Description
This strategy is intended for WUGs that do not have 100 percent metering of customer connections. Its purpose is to ensure that all aspects of meter installation, replacement, testing, and repair are managed for optimal water use efficiency. Increased maintenance efforts contributing to improved meter accuracy should result in higher revenue and less water loss. Metering of new customer connections and retrofitting of existing connections are effective methods of accounting for total water usage within a utility's service area.

Proper installation of correct sizes and types of meters is essential for good utility management. (The American Water Works Association [AWWA] provides numerous resources in the reference section of this strategy.) The purpose of this strategy is to ensure that all aspects of meter installation, replacement testing, and repair are managed for optimal water use efficiency.

To qualify as a bonafide strategy, a utility's meter program must include:

1) mandatory metering of existing connections and new connections;
2) a policy governing installation of adequate and properly-sized meters, as determined by a customer's current water use patterns. Using compound meters for multifamily residential connections or other industrial and commercial accounts is also recommended;
3) direct utility metering of each duplex, triplex, and fourplex unit, whether each occupies a separate lot, and whether multiple buildings occupy a single commercial lot;
4) metering of all utilities, publicly owned facilities, and customers;
5) mandatory construction meters and access keys to account for water used in new construction;
6) mandatory separate irrigation meters for all new commercial buildings having a site plan area of more than 10,000 square feet and for all duplexes, triplexes, and fourplexes;
7) implementation of the State requirements in HB 2404, passed by the 77th Legislature Regular Session and implemented through Texas Water Code 13.502, which requires that all new apartments be either directly metered by the utility or submetered by the owner;
8) review of capital recovery fees to determine whether fees provide any disincentive for developers to use utility metering of apartment units;
9) annual testing and maintenance of all meters larger than two inches, since a meter may under-register water use as it ages;
10) regular testing and evaluation of ⅝- and ¾-inch meters which have been in service 8 to 10 years, to determine meter accuracy OR a periodic, consistent replacement program based on the meter's age or cumulative water volume through the meter. This program

should be based on testing of meters at each utility to determine the optimal replacement/repair period, since it depends on both the quality of water and the average flow rate through the meter, versus the meter's capacity;
11) an effective monthly meter-reading program where readings are not estimated except due to inoperable meters or extenuating circumstances. Broken meters should be fixed within 7 days or an otherwise-stated reasonable time frame; and,
12) an accounting of water savings and revenue gains through implementation of the Meter Repair and Replacement Program.

Every year, the utility should estimate its annual water savings resulting from the strategy. Savings can be estimated based upon a statistical sample analyzed as part of the meter-testing program. The utility can then project potential future annual savings and include those figures in the plan's water savings targets and goals.

Showerhead, Aerator, and Toilet Flapper Retrofits

Description
This strategy is intended for WUGs that serve homes and apartment units constructed before 1995, when no active retrofit program existed for efficient showerheads and faucet aerators. Once a WUG adopts this strategy, it should closely monitor the strategy to achieve maximum water efficiency benefits.

Plumbing retrofits usually include showerheads as well as kitchen and bathroom faucet aerators. More recent studies show that toilet flappers should be included in this effective strategy to conserve water used by the residential sector. Four types of high-quality, low-flow plumbing devices are to be installed under this program:
showerheads rated at 2.0 gallons per minute ("gpm") or less;
kitchen faucet aerators of 2.2 gpm or less;
bathroom faucet aerators of 1.5 gpm or less; and,
toilet flappers that operate at the designed flush volume for a given toilet model.

Studies have shown that many 1.6 gallons-per-flush ("gpf") toilets actually use more water. Therefore, if 1.6 gpf toilets are installed, their flush volume should be checked and, if necessary, the water level in their tanks should be adjusted to restore the flush volume to 1.6 gpf. If after adjustment a tank's flush volume is still well above 1.6 gpf, the toilet is likely to originally have had an early closure flapper. If so, the replacement flapper needed to restore a 1.6 gpf volume can often be determined by comparing the model number (usually located on the inside of the tank) with research on compatibility of flappers. If the device is one of several early models, the flapper could be replaced during the utility's survey, and/or information about the correct replacement flapper should be provided to the customer. The utility may meet this strategy's requirements through inspection programs and enforceable ordinances requiring replacement of inefficient plumbing when ownership of the property transfers, or by date certain no later than five years.

Under this strategy, the utility should:

1) Identify the total number of single-family ("SF") and multi-family ("MF") residences constructed prior to 1995. The utility may have data showing the number of SF homes existing at the end of 1994, or census data can be used; however, that data cannot be separated into SF and MF units. Another approach is to use the census data from 1990 and 2000, which does include the number of housing units by type. This information can then be used to estimate SF units ("detached units" in the census data) at the end of 1994. A linear growth assumption yields the following approach: Take the difference (2000 detached units minus 1990 detached units) and multiply by 40 percent (4 years), and add this to the number of 1990 detached units. The answer produces an estimate of SF units at the end of 1994. Similar calculations can be used to determine MF units.

2) Develop a plan to directly install plumbing devices in single-family homes and multi-family residential facilities or, alternatively, provide kits for installation with follow up inspections.

3) If feasible, include a program to restore the flush volume of 1.6 gpf toilets to their designed flush volume. After determining the potential number of participants, select at least one of these approaches:
1) Direct Install and Kit Distribution Program
2) Ordinance Approach Upon Change of Ownership of Property
3) Ordinance Approach By Date Certain

School Education

Description
The goal of this strategy is to launch an elementary school-level education program since lessons learned by students about good water use habits are often shared with the whole family. The strategy is intended for WUGs that serve schools as a regular part of the customer base. A WUG may have already accomplished this strategy if it has a current school education program that meets the criteria. Before deciding whether this strategy is necessary, the utility should review existing curricula to see if the local school district is already offering water conservation-related courses. Once a WUG decides to adopt this strategy, the strategy must be closely monitored to achieve the maximum water efficiency benefit.

School education programs, while not directly related to any equipment change, may nevertheless result in both short- and long-term water savings. Students' behavioral changes based upon greater knowledge are often shared with parents and implemented at home. To be effective, a school education program should provide grade-level-appropriate curriculum materials which increase in complexity from elementary school through high school. If such a curriculum does not already exist, local experts may be willing to help develop the desired materials.

Implementation should consist of at least the following actions:

1) Evaluate available local and regional materials to determine their applicability to the WUG's local water conditions. Consider creating an advisory committee of local educators to assist in choosing or creating the curriculum.

2) Implement a school education program to promote water conservation and related benefits. Programs include providing instructional assistance, educational materials, and classroom presentations to public and private schools in the utility's service area that identify urban, agricultural, and environmental issues and conditions in the local watershed and water service area. When possible, educational materials should meet the TEKS guidelines.

3) A water-oriented curriculum focused on conservation and resource issues should be made available for all grades.

a. Grade-appropriate programs and/or materials should first be implemented for grade levels 1 to 6. Alternatively, a presentation or educational show can be offered for some or all of these grade levels.

b. For grades 7 and 8 and for high school students, the WUG should do one of the following: distribute grade-appropriate materials for high school science, political science, or other appropriate classes; present assembly-type programs to high schools; sponsor science fairs with emphasis on conservation; implement education programs with community groups like Scouts, 4-H clubs, etc. The WUG can elect to meet this strategy by focusing only on grades 1 to 6 or 7 to 12 but with higher participation rates. In conjunction with the Showerhead and Aerator Strategy, consider providing a water audit unit as part of the curriculum whereby the students take flow measurements of showerheads and faucet aerators at their homes. If their showerheads and faucet aerators operate at higher than the current standard, the students would receive efficient showerheads and faucet aerators to install with their parents' assistance. This study unit can be successfully implemented as early as grade 5.

To track progress of this strategy, the WUG should gather and have available the following documentation (according to TWDB):
number of school presentations made during reporting period;
number and type of curriculum materials developed and/or provided by water user group, including confirmation that curriculum materials meet state education framework requirements and are grade-level appropriate;
number and percent of students reached by presentations and by curriculum;
number of students reached outside the WUG's service area;
number of in-service presentations or teacher's workshops conducted during thereporting period;
results of evaluation tools used, such as pre- and post-tests, student surveys, and teacher surveys;
copies of program marketing and educational materials; and,
annual budget for school education programs related to conservation.

Landscape Irrigation Conservation

Description
This strategy is intended for use by a WUG having a substantial percentage of customers using automated landscape irrigation systems. If data are lacking or absent, the summer peak/winter average ratio can be used to determine whether to proceed with this strategy. A ratio of 1.6 or greater indicates the potential for substantial water savings upon implementation and enforcement of this strategy. For maximum water-use efficiency benefit, the WUG should adhere closely to the measures described below.

Landscape irrigation conservation practices are an effective method of accounting for and lowering outdoor water usage while maintaining landscapes and avoiding run-off. With this strategy, the WUG provides residential and non-residential customers with education, incentives, and assistance in improving their landscape water-use efficiency. Incentives include rebates for purchase and installation of water-efficient equipment. Successful implementation of this strategy can be accomplished by performing one or a combination of the approaches listed below.
1) ETo-Based Water Budgets
2) Water-Use Surveys, Metering, and Budgeted Water Use
3) Landscape Design
4) Minimum Standards and Upgrades

As a means of rapidly increasing cost-effectiveness and water savings, the WUG should consider offering the Landscape Irrigation Program to large-landscape customers first. Incentives can include rebates for irrigation audits and systems upgrades, recognition for water-efficient landscapes through signage and award programs, and certification of trained landscapers and volunteers who can promote the program. WUG staff can also be trained to provide irrigation audits which can include resetting irrigation controllers for more efficient schedules.

Water-wise Landscape Design

Description
This strategy is intended for a WUG with 20 percent or more of its residential customers having landscapes consisting of high-water-use materials that consume more than 20,000 gallon per month or which use more than twice as much water in summer as in winter. Using this strategy, the WUG would offer financial incentives for conversion to water-wise landscaping or would require by ordinance that all new landscapes incorporate water-wise principles (which involve not only plant selection but also the tactics listed below). Financial incentive programs further contain an educational component based on the seven principles of water-wise landscaping.

Because water-wise landscaping materials often consume whatever quantity of water the customer supplies, careful follow-up is necessary to guard against excess irrigation. From the outset, incentives should be designed to be rescinded if water use returns to previous levels or exceeds the projected water budget for the new landscape. For new customers and change-of-service customer accounts, the WUG should provide information on water-wise landscape design plus efficient irrigation equipment and management. The WUG should install water-wise landscaping at water its facilities and offices. Other tactics of water-wise landscaping include encouraging capture of rainwater and limiting irrigation to the quantity of rainwater captured.

Some cities with lawmaking powers have adopted ordinances that define water-conserving landscapes to be installed in buffer areas, new commercial buildings, new homes, and apartment complexes. Any ordinance for new homes should incorporate requirements for water-wise principles, specifying water-efficient landscaping materials only. Soil improvement programs in high-visibility areas can publicly demonstrate their effectiveness. For most landscapes, recommendations are for compost applications of ¼ to ½ inch annually on turf areas and 1 inch annually on flower beds. (Compost is most beneficial when applied in the fall.) Water-wise landscape programs follow the seven principles of XeriscapeTM, from the Texas A&M Horticulture Website, listed below and explained in greater detail in resources listed in the reference section:

planning and design
soil analysis and improvement
appropriate plant selection
practical turf areas
efficient irrigation
use of mulches
appropriate maintenance

1) Rebate and Incentive Approach
a. Within one year of implementation, develop and implement a plan to market a low-water landscape design and conversion program.
b. Within one year of implementation, develop and implement a customer incentive program.
c. Rescind incentives, including rebates, if water use returns to previous levels within two years.
2) Ordinance Approach

In the first twelve (12) months, plan a program that includes stakeholder meetings as needed. Consider offering rebates for a portion or all of the time this program is in place. For example, offer rebates for five years and publicize this so customers will participate early in the program. Develop a plan for educating realtors and landscape companies about the requirements. Plan a follow-up inspection program after retrofit. Develop and pass the ordinance. Implement the ordinance and a tracking plan for the number of units retrofitted. In the second year and thereafter, continue the implementation and outreach program for realtors and landscape companies. Continue verification inspections. Provide estimates of water savings from landscape conversions based upon actual metered data.

Athletic Field Conservation

Description
Athletic field conservation is an effective method of reducing water system demand. The athletic field manager implements a water regimen using only what is necessary to maintain the turf's viability and protect users' health. Water is applied only to areas essential to the field's use. Athletic fields often involve visible water use during daylight hours, leading to perceptions by both the public and utility operators that water use may be excessive.

Measures listed for this strategy can be implemented individually or in combination; some utilities may already employ one or more measures and may decide to include others. Once adopted, the strategy should be monitored closely to achieve the maximum water efficiency benefits.

Using this strategy, a WUG provides the customer (through staff or a third party) a landscape water-use survey and uses the results to develop reference evapotranspiration ("ETo")-based water-use budgets equal to no more than 100 percent ETo per square foot of landscape area.

At a minimum, the athletic field strategy should mandate replacement of all manually controlled and quick-couple irrigation systems with automatic irrigation systems and controllers. The automatic controllers should be capable of shutting off flows when sudden pressure loss occurs, as with a system break. Access to such controllers should be limited to the authorized landscape manager or should be designed to shut off flows automatically if the irrigation system is activated manually.

When the practice is cost-effective, athletic field users should be required to install computer-controlled irrigation systems (CCISs) or similar technology. To achieve maximum efficiency, a CCIS should incorporate at least the following components: computer controller, software, interface modules, satellite field controller, soil sensors, and weather station. The CCIS should be designed to prevent over-watering, flooding, pooling, and losses from evaporation and run-off; further, sprinkler heads should be calibrated so as not to exceed the soil's saturation capacity.

Use of reclaimed, reused, and/or recycled water for athletic fields is both recommended and encouraged; however, such use must meet TCEQ water quality standards for treated effluent and human contact. When utilizing reclaimed water or water with high levels of total dissolved solids (TDS) or hardness, the water budget must be adjusted to permit leaching of salts below the root zone of turf grass. Consultation with local extension agents can assist athletic field managers in properly utilizing lower-quality water for irrigation.

Figuring total water savings for this strategy may be difficult, but increased efficiencies can be estimated for each water-wasting action that is eliminated through this strategy. In replacing inefficient equipment, water savings are realized by using new or upgraded equipment. For landscape water, savings can be calculated based on each water waste incident. In an irrigation survey, water savings are expected in the range of 15-20 percent for athletic fields with no CCIS if recommended efficiency measures are implemented. Switching to artificial turf, reusing waste water, or employing other non-potable alternatives can save up to 100 percent of the potable water supply used in irrigation. Simple measurement of water use before and after conversions will reveal savings.

Public Information

Description
Public education about water conservation should begin at a young age. Elementary schools should incorporate a curriculum with lessons in water conservation methods starting at kindergarten. Varied activities could range from poster contests promoting water conservation in early grades to teaching xeriscape techniques in middle school. Projects with a hands-on approach enhance students' interest and might include field trips to water plants, guest speakers, lessons about water usage when bathing, brushing teeth, and washing dishes, cars, and pets. Providing pamphlets and newsletters also raises public awareness.

Any WUG can adopt this public information strategy to effectively promote specific water conservation programs and practices which emphasize the importance of using water efficiently. A WUG may have already accomplished this strategy if it is conducting a public information program that meets the criteria of this strategy. Once a WUG decides to adopt this strategy, the utility should monitor it closely to achieve maximum water efficiency benefits.

The goal is to provide an overall understanding of water resources in the community relating to the importance of managing and sustaining existing water supplies so that construction of new facilities can be delayed or avoided. An equally important objective of the program is to provide information about specific actions individual water users should take to implement these goals.

A broad variety of tools can be used to effectively communicate water conservation measures to the public including print, radio, and television media; billboards; direct distribution; special events such as exhibits and facilities tours; and maintenance of an informative website. Print media activities can take the form of press releases and regular columns in gardening periodicals. Electronic media efforts include talk shows, news conferences, public service announcements, and even paid commercials. Utilities can also distribute materials directly through bill inserts, newsletters, fliers, and door hangers---all of which allow targeting of specific messages to specific audiences. In addition, special events provide excellent opportunities for direct interaction with the public at facility tours, exhibits, trade shows, group presentations, landscape conservation competitions, and seminars. And remember--web sites are now an essential and economical method of reaching the public since the same information can be posted electronically. Remember to include links to the WUG's web site.

Integrating a WUG's public information efforts with programs of other local agencies multiplies the impact. Other agencies which stress water conservation include Texas

Cooperative Extension Service offices, Texas Water Development Board, Texas Parks & Wildlife, Texas Soil & Water Conservation Board, Texas Commission on Environmental Quality, and Texas Forest Service. Some business associations, neighborhood associations, and not-for-profit groups may also offer partnering opportunities for an overall WUG conservation program or specific strategies.

Rainwater Harvesting and Condensate Reuse

Description
TWDB publishes a guide for rainwater harvesting that is available upon request.
All rainwater harvesting systems are comprised of six basic components:

A. catchment surface (such as a roof) -- the surface upon which the rain falls
B. gutters and downspouts -- transport channels from catchment surface to storage
C. leaf screens and roof-washers -- systems that remove contaminants and debris
D. cisterns or storage tanks -- where collected rainwater is stored
E. conveying -- the delivery system for stored rainwater, either by gravity or pump
F. water treatment – filters, equipment, and additives to settle, filter, and disinfect

This strategy is intended for use by WUGs concerned with reducing outdoor irrigation demands on their potable water systems. Calculation of potential savings will vary according to regional climate patterns. Rainwater harvesting and condensate reuse are applicable to ICI buildings, but private homes can also benefit from rainwater harvesting. Utilities may help to realize savings possible with this strategy by customer education efforts. For maximum water-use efficiency benefits, the WUG should adhere closely to the measures described below.

Rainwater harvesting and condensate reuse ("RWH/CR") conservation programs are practical methods of reducing potable water usage while maintaining healthy landscapes and avoiding run-off problems. Using this strategy, the WUG provides customer support, education, and incentives and assists with proper installation and use of RWH/CR systems. RWH/CR systems are most effective when used in conjunction with other water efficiency measures such as water-saving equipment and habits. Today's rainwater harvesting is based on ancient practices of collecting (usually from rooftops)and storing rainwater close to its source, in cisterns or surface impoundments, and using it for nearby needs. Industrial, commercial, and institutional ("ICI") users already save money by collecting condensate from large cooling systems and returning it to their cisterns. Facilities with large cooling demands are best positioned to take advantage of condensate reuse which due to its quality has potential uses for landscape irrigation, cooling tower make-up water, and some industrial processes. Because precipitation varies in rate and occurrence, rainwater or condensate should be used with maximum efficiency. Incentives to motivate rainwater collection may include rebates for purchasing and installing water-efficient equipment.

Several factors should be considered in the design of rainwater harvesting and condensate reuse systems. Components include the collection area, a first-flush device, a roof washer, an opaque storage structure with capacity for anticipated demand, and a distribution system. Design consideration should be given to the highest feasible elevations for collection and storage systems to take advantage of gravity flow. For proper design and implementation of RWH/CR guidelines, the Texas Water Development Board's Texas Manual on Rainwater Harvesting 2004 should be used as a resource, as should technical assistance from professional installers and manufacturers of RWH/CR equipment.

Programs should consider these elements:

1) Retrofit or Rain Barrel Program
Using bill inserts to market the program will allow a WUG to target its largest summer-peak users first. The WUG should also consider asking local weather announcers, radio gardening show hosts, and newspaper columnists for assistance in publicizing the program. Public and/or private partnerships with non-profits (gardening clubs, neighborhood associations, and Texas Cooperative Extension Service offices), local building groups, and green-industry businesses are other potential avenues to leverage resources. Incentives can include rebates for RWH/CR systems, recognition through signage and award programs, and certification of trained landscape company employees and volunteer representatives.
2) New Construction -- In addition to retrofitting existing homes and buildings, a WUG may also choose to focus support for RWH/CR systems in new construction. Under this approach, the WUG could:
a. adopt regulations requiring all new ICI properties to install a RWH/CR system that collects and stores rainwater and condensate from all eligible sources and distributes it to an irrigation system and/or a cooling tower make-up system;
b. implement an incentive program to encourage builders and owners of new ICI properties to install RWH/CR systems that collect and store rainwater and condensate from all eligible sources, then distribute to irrigation and/or a cooling tower make-up system. In large ICI buildings requiring cooling towers, designers should consider returning condensate flows from air conditioning coils to cooling tower make-up. This strategy could also be effective as part of a Green Builder- type rating system incorporating water-wise landscaping and adequate soil depth;
c. implement an incentive program to encourage builders and homeowners to install RWH systems for landscapes to reduce potable water consumption in hot weather; and,
d. adopt regulations requiring all new homes and/or multi-unit properties to install plumbing that separately collects and stores rainwater from all eligible sources and distributes the rainwater through a subsurface irrigation system, either around the foundation or for landscape use.

Park Conservation

Description
This strategy is targeted at all WUGs which manage parks or serve customers with parklands. Most WUGs fall into this category. Target areas include public facilities such as irrigated parks, recreation centers, fountains, and pools. These facilities use significant volumes of water and sometimes come under public scrutiny as a result. Specific

measures listed under this strategy can be implemented individually or in combination. WUGs may already have adopted one or more of these principles since irrigation conservation practices and careful water use for operation and maintenance of park facilities can effectively reduce demand.

Under the park conservation strategy, WUGs require managers of every park having an irrigation system to develop a conservation plan. Municipal parks departments should develop comprehensive written policies and procedures for all irrigated parks under their jurisdiction. Operating and Maintaining pools is also addressed. All park facilities should be metered so all water use can be billed as means of reinforcing the importance efficient water use. For parks with athletic fields, irrigation should be in accordance with the Athletics Fields strategy of this Plan. WUGs should encourage park managers to cease irrigation in areas not affected by public use.

Prior to developing a specific park conservation plan, the WUG should consider a series of planning meetings with park irrigation personnel and management to discuss water conservation issues and to prepare an adequate scope of action. Additionally, park irrigation staff could participate in voluntary environmental management programs.

Residential Clothes Washer Incentive Program

Description
This strategy can be implemented by any WUG serving residential customers. Under this strategy, the WUG would develop and implement an incentive program to encourage customers to purchase water-efficient clothes washers, best described by using water factor (WF) terminology. WF is calculated by dividing the gallons of water used to wash a full load of clothes by the capacity of the washer tub in cubic feet. An efficient washer using 27 gallons for a full load of clothes in a 3-cubic-foot tub would have a WF of 9. According to the tiers determined by the Consortium for Energy Efficiency ("CEE") in 2004, a clothes washer needs a WF equal to or less than 9.5 to be considered "efficient." In 2001, Texas enacted legislation requiring washing machine manufacturers to report the efficiency of clothes washers sold in the state. According to the 2002 report, only 4.4 percent of washers sold in Texas qualified by having a WF equal to or less than 9.5. The 2003 report showed mild improvement, in that 9.4 percent of washers imported into Texas had a WF equal to or less than 9.5. While the trend in Texas is positive, market share is well below the reported 30 percent market share in Washington State and far lower than the 50 percent market share in the Seattle area, where a regional incentive and marketing program for efficient washers has been in place for several years. Conventional top-loading clothes washers use 41 gallons of water per load, on average, while efficient clothes washers use only 11 to 25 gallons per load.

Manufacturers started producing efficient clothes washer models in the late 1990s in anticipation of rules being adopted by the Department of Energy ("DOE") setting higher efficiency standards. The DOE did adopt rules in 2001 with a two-step phase-in of higher efficiency standards. Clothes washers manufactured after 2004 will be required to meet a modified energy factor ("MEF") of 1.04 (20 percent more efficient than the current standard). This level will remain in effect until 2007, at which time an MEF of 1.26 (35 percent higher than the current standard) will be required. If manufacturers continue with current design trends for efficient clothes washers, the 2007 standard should result in significant water savings.

Of course, cost is a basic consideration. Full-featured inefficient machines cost only about $400 while the least expensive 'efficient' machines range between $600 to more than $1000. For low-income customers, this price difference is the most important factor influencing buying decisions, so low- and moderate-income customers would logically be more likely to purchase efficient machines if they were offered discount incentives at the time of purchase rather than after a four-to-six-week wait.

A clothes washer incentive program is most effective when offered in conjunction with local gas and/or electric utilities since the incentive can be increased through multiple-sponsorship, and the marketing reach can be expanded. Energy savings result from more efficient motors, less energy required for heating hot water, less hot water actually used, and shorter drying times (since spin cycles on 'efficient' washers is much faster.

Incentives should be directed only to customers who can verify installation of washers qualifying as water efficient. A list of such washers is maintained and regularly updated by the Consortium for Energy Efficiency ("CEE"), a nonprofit public benefits corporation which develops national initiatives to promote manufacture and purchase of energy-efficient products and services. The U.S. Department of Energy and the Environmental Protection Agency both support CEE through active participation and funding. The CEE Residential Clothes Washer Program consists of tiers for both water efficiency and energy efficiency. Many utilities across America use the CEE list as the source of qualifying their consumers' incentive payments.

Develop and implement an incentive program designed to increase the market share of 'efficient' clothes washers to at least 20 percent by the second year of implementation. Offer the program to customers in single-family homes (including duplexes and triplexes) and in multi-family units with individual washer connections. Ask local gas and/or electric energy providers to participate, as many water utilities in Texas and other parts of the country have already successfully partnered with local energy companies. Organize stakeholder meetings. Develop a marketing plan to educate customers, appliance retailers, and realtors about this program. Initiate the program.

REFERENCES FOR SPECIFIC CONSERVATION STRATEGIES

I. References for Additional Information

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II. References for Additional Information

1) *Water Loss Control Manual,* Julian Thornton, McGraw-Hill, 2002.
2) *M6 Water Meters – Selection, Installation, Testing and Maintenance,* AWWA 4th Edition, 1999.
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III. References for Additional Information

1) Department of Energy 1998 Plumbing Product Rules http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/plmrul.pdf
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ATTACHMENT 6-5 Agricultural Water Conservation Template

Irrigation Water Conservation & Model Drought Contingency Plan For [WATER USER GROUP] Date

CONTENTS OF PLAN

1. Water Conservation Plan for [Public Water Supplier]

Recognizing the need for efficient use of existing water supplies, TCEQ has developed rules governing the development of water conservation and drought contingency plans for irrigation users. Region M has provided a conservation plan pursuant to TCEQ rules.

Objectives

- To reduce the loss and waste of water
- To reduce water consumption
- To improve the efficiency in the use of water

Model Drought Contingency Plan for [Public Water Supplier]

Objectives

This drought contingency plan (the Plan) is intended for use by [Irrigation]. The plan includes all current TCEQ requirements for a drought contingency plan.
This drought contingency plan serves to:

- To conserve available water supplies during times of drought and emergency.
- To reduce adverse impacts of water supply shortages.
- To reduce the adverse impacts of emergency water supply conditions.
- To preserve public health, welfare, and safety.

2. Texas Commission on Environmental Quality Rules Water Conservation & Drought Contingency Plans

The TCEQ rules governing development of water conservation plans for public water suppliers are contained in Title 30 part 1, Chapter 288, Subchapter A, Rule 288.4 of the Texas Administrative Code.
A water conservation plan is defined as "A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water." The minimum requirements plans for agricultural use (" individual irrigation user" _ Are as follows:

Minimum Conservation Plan Requirements

The minimum requirements in the Texas Administrative Code; Chapter 30:

- 288.4(a)(2)(A) – Description of Irrigation Production Process
- 288.4(a)(2)(B) – Description of the Irrigation Method or System and Equipment,
- 288.4(a)(2)(C) – Accurate Metering ,
- 288.4(a)(2)(D) – Specification of Conversion Goals before May 1,2005,
- 288.4(a)(2)(E) – Specification of Conversion Goals after May 1,2005,
- 288.4(a)(2)(F) – Description of Water Conserving Irrigation Equipment and Application System,
- 288.4(a)(2)(G) – Leak Detection, Repair, and Water-Loss Control,
- 288.4(a)(2)(H) – Irrigation Timing an/or Measuring the amount of Water Applied,
- 288.4(a)(2)(I) – Land Improvements for Retaining or Reducing Runoff and Increasing the Infiltration of Rain and Irrigation Water,
- 288.4(a)(2)(J) – Tailwater Recovery & Resuse, and
- 288.4(a)(2)(K) – Other Conservation Practices, Methods, or Techniques.

3.

WATER CONSERVATION PLAN
FOR THE
(Name of Water User Group)
(Date)

Description of the Irrigation Production Process

[This section will include a description of the irrigation production process which shall include, but is not limited to, the type of crops and acreage of each crop to be irrigated, monthly irrigation diversions, any seasonal or annual crop rotation, and soil types of the land to be irrigated] Here is a sample list below.

Location:____________________________________
County:_____________________________________
Types of Crops Planted:__________________________
Acreage of each crop:____________________________
Acreage of land:________________________________

Description of land:______________________________
____

Acreage and Type of Vegetation to be Irrigated

List the acreage irrigated as part of the description of the irrigation production process.

Example Table

Type of Crop	Growing Season	Acres Irrigated/Year
Example Crop 1	May- October	200
Example Crop 2	May- September	200
Example Crop 3	April- September	200
	Total Number of Acres	600

Blank Table

Type of Crop	Growing Season	Acres Irrigated/Year
	Total Number of Acres	

Monthly Irrigation Diversions

List the monthly irrigation diversions to complete the description part of the irrigation production process

Month	Acre-ft
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	
Total	

Description of Soil Types

The Irrigation WUG_____________________________ has ____ soil types within the _______acres as determined by the soil survey for________________ County, published by the United States Department of Agriculture, Soil Conservation Service, in cooperation with the Texas Agricultural Experiment Station.

Soil Type	Permeability
Example: Valley Clay	Moderate

Description of the Irrigation Method or System and Equipment
[Include a description of the irrigation Method or system and equipment including pumps, flow rates, plans, and/or sketches of the system layout]

Accurate Measuring
[Include a description of the device or devices and/or methods being used in order to measure and account for the amount of water diverted from the source of supply.]

Specification of Water Conservation Goals
This section must include 5, 10, & 20 year targets for water savings. This will include goals for water loss programs and goals for municipal use in gallons per capita per day.

<u>These are example Goals:</u> (They are not mandatory)

10. Switch to a central, computer-controlled irrigation system with weather monitoring stations located throughout the ______ acre property. This change is projected to save ________ acre-ft/yr.

11. Line 500 miles of pipeline for conveyance conservation.

12. Implement and maintain a meter replacement program.

13. Keep the level of unaccounted water in the system less than ___ percent in____ (Target year) and subsequent years.

14. Raise Public Awareness of water conservation and encourage responsible public behavior through a public/school education and information program.

*Best Management Practices provided for Irrigation can be used as a supplement for irrigation water conservation.

Description of Water-Conserving Irrigation Equipment and Application System
[Include a description of water- conserving irrigation equipment and application system or method including, but not limited to, surge irrigation, low pressure sprinkler, drip irrigation, and non leaking pipe.]

Scheduling the Timing and/or Measuring the Amount of Water Supplied
[Include a schedule of the timing and /or measuring the amount of water applied for example soil moisture monitoring.]

Tailwater Recovery and Reuse
[Include a description of tailwater recovery and reuse.]
Land Improvements for Retaining or Reducing Runoff and Increasing the Infiltration of Rain and Irrigation

[Include a description of any land improvements for retaining or reducing runoff and increasing the infiltration of rain and irrigation water. For example weed controlling & furrow diking.]

Other Conservation Practices, Methods, or Techniques
[Provide any information on any other water conservation practice, method, or technique which the user shows to be appropriate fro preventing waste and achieving conservation.]

ATTACHMENT 6-6 McAllen's Plan

City of McAllen
McAllen Public Utilities

Water Conservation and Drought Contingency Plan

August 1999

CITY OF McALLEN
McALLEN PUBLIC UTILITIES

WATER CONSERVATION
and
DROUGHT CONTINGENCY PLAN

TABLE OF CONTENTS

CITY OF MCALLEN
McALLEN PUBLIC UTILITIES

WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

August 1999

I. INTRODUCTION

McAllen Public Utilities (MPU) provides the public with its water and sewer services within the city limits of McAllen. The water and wastewater system is owned and operated by the City of McAllen in Hidalgo County, Texas, and is governed by the McAllen Public Utility Board of Trustees.

The amount of water the McAllen water system can store, treat, divert, and distribute to customers is limited. MPU wants to avoid waste or unreasonable use of water, which could lead to a possible drought and emergency conservation strategies. Therefore, it is imperative that water resources available to MPU be put to the maximum beneficial use to which they are capable, while simultaneously implementing strong conservation measures to eliminate waste. While short-term water shortages and water supply emergencies are often unpreventable, response measures can be determined and implemented in advance, to avoid, minimize, or mitigate the risks and impacts of drought-related water shortages and other emergencies.

The purpose of this plan is to establish a Water Conservation and Drought Contingency Plan for the City of McAllen in accordance with Texas Administrative Code Title 30, Chapter 288. The basic goal of the water conservation and drought contingency plan is to ensure an uninterrupted supply of water in an amount sufficient to satisfy essential human needs. First, the water conservation plan develops a water conservation strategy for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. Secondly, the drought contingency plan is a strategy for temporary supply management and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies.

II. UTILITY PROFILE

A. Demographics

MPU provides water supply and wastewater services with the city limits of McAllen, Texas. The service area is 48 square miles. The current 1999 estimated dynamic population of the City is 117,000. This figure includes people who live in McAllen permanently, as well as winter visitors and people who commute here from Mexico.

B. Water Supply

<u>Raw Water Supply</u>

The Rio Grande River is the sole source of water for citizens of McAllen, and MPU has water delivery contracts with three (3) districts, as follows:

Hidalgo County Irrigation District No. 2	7,640 acre ft/year
Hidalgo County Water Improvement District no. 3	13,980 acre ft/year
United Irrigation District	6,250 acre ft/year

Water Treatment System

The City has two (2) Water Treatment Plants:

Water Plant No. 1 hydraulic capacity	4.2	MGD
Southwest Water Plant hydraulic capacity	38.0	MGD
	42.2	MGD

Water Plant No. 1 has a 4.2 MGD capacity, but is used only during periods of peak demand. Water Plant No. 1 will be decommissioned upon completion of Module A of the new northwest water treatment plant, which is anticipated to be on-line by October 2003.

Water Pumpage and Storage

Current average annual pumpage for 1998 was 6,774 MG of water. MPU has various pumps located at the Southwest Water Plant to pump raw water from the raw water reservoir into the plant facilities for treatment. The plant also has high service pumps to pump water from the ground storage tanks into the distribution system. Booster pumps were installed at the Southwest Water Plant to increase the high service pumps' capacity for pumping.

MPU relies on elevated storage and high service pumps for pressure maintenance. MPU has a total of 3.75 million gallons of elevated storage, and 9.0 million gallons of ground storage. MPU recently installed a Supervisory Control and Data Acquisition (SCADA) system that allows on-line monitoring of equipment and process control for the water treatment and distribution system. All ground storage and elevated towers are monitored by the SCADA system. The system allows MPU to monitor flow data and record historical trends in the treatment and distribution system.

MPU has a total of 597 miles of water lines, of which approximately 20% percent are 12-inches in diameter or larger. Additionally, the MPU system has 5,712 water valves and 2,563 fire hydrants.

Water Master Plan

A Water Master Plan was developed for MPU by Rust Lichliter/Jameson Environment and Infrastructure December 1997. The master plan is conceptual in nature and is intended to serve as a framework and guide for planning future improvements to MPU's water system. MPU recently received municipal bonds to begin addressing some of the recommendations made by the Master plan.

C. Water Use Characteristics

MPU supplies water for residential, commercial, industrial, and public uses. The total per capita use for McAllen in 1998 was 133 gallons per capita per day (gpcd).

Municipal per capita water use is total water pumped into the system for residential, commercial, and public uses, divided by the population served. Industrial water use is not included in this calculation. McAllen's municipal per capita use was 128 gpcd for 1998.

McAllen's industrial users account for 4.2 percent of total water use. The largest volume industrial user for 1998 was Valley Coca-Cola Bottling Company, which purchased approximately 63.5 MG of water for 1998, or 1.08 percent of total water usage.

Large sized meters, or those 1-1//2 inch and larger in size, make up only 4.3 percent of the meters used but use 32 percent of the water. Conversely, small sized meters, or those 1-inch and below, make up 95.7 percent of all meters, but account for less than 68 percent of metered sales.

D. Unaccounted-For Water

McAllen's unaccounted-for water is due to breaks, leaks, meter under-registration, processing, flushing mains, system loss, and unmetered fire hydrants. The amount of unaccounted-for water is determined by the difference between production and sales of water. The average amount of unaccounted-for water loss for the past three years was 13.0 percent. The unaccounted-for loss of water for 1998 was 12.9 percent, or 854 MG.

E. Wastewater Services

MPU operates two (2) wastewater treatment plants. Both treatment plants are based upon extended aeration activated sludge system, with secondary effluent limitations. Treated effluent is discharged into floodways and eventually into the Arroyo Colorado and Laguna Madre Estuary. The average annual treated wastewater volume for 1997-1998 was 3,226 million gallons. The average monthly amount of treated wastewater for that same period was 269 million gallons per month, or 8.83 MGD. The sanitary sewer infrastructure consists of 500 miles of sanitary sewer line, with 43 lift stations.

The South Wastewater Treatment Plant is a 10 MGD design flow with 16.2 MGD peak flow capabilities. It is currently 75 percent hydraulically loaded with effluent limitations of 10 mg/l of carbonaceous biochemical oxygen demand; 15 mg/l of total suspended solids; and 3 mg/l of ammonia nitrogen.

The North Wastewater Treatment Plant is a 6 MGD design flow with a 9 MGD peak flow capability. The permit limitations include 20 mg/l of biochemical oxygen demand, and 20 mg/l of total suspended solids.

Wastewater Master Plan

In April 1998, a Wastewater Master Plan was developed for MPU by WSBC Civil Engineers, Inc. The Wastewater Master Plan developed recommendation for a wastewater capital improvement projects (CIP) plan to address existing system deficiencies and future needs based on projected development within the City.

The following is a description of the McAllen Public Utilities System.

WATER SUPPLY AND USE DATA

1998 Data

Population:	117,000
Water Sources:	
Hidalgo County Irrigation District No. 2	7,640 acre ft
Hidalgo County Water Improvement District No. 3	13,980 acre ft
United Irrigation District	6,250 acre ft
City of McAllen Public Utilities	679 acre ft
	28,549 acre ft
Water Production:	
Average annual pumpage (3-year average)	6,583 MG/year
Maximum daily treatment capacity	42.2 MGD
Average daily pumpage (3-year average)	18.0 MGD
Unaccounted-for water (3-year average) (from river to end-users)	854.0 MG/year or 13 %
Metered Potable Water Uses by Classes: (3-year average)	
Residential	3,418.6 MG/year
Commercial	2,003.7 MG/year
Industrial	25.5 MG/year
Wastewater Production:	
Average annual amount treated (3 year average)	3,229.6 MG
Maximum treatment capacity	16 MGD
Average daily treated	8.83 MGD

III. WATER CONSERVATION GOALS

Based on the data found in the utility profile and on careful evaluation of McAllen's water consumption and practices, MPU has set the following goals to be achieved through the adoption of this Water Conservation Plan:

1. To reduce daily municipal per capita water use to 125 gpcd by the year 2005 and to reduce the unaccounted-for water loss to 12 percent by 2005.

2. To implement long term cost-effective recovery measures for major causes of unaccounted-for water related to metering.

3. To increase both public and employee awareness regarding water conservation and water related issues. This will especially be encouraged during summer months when water consumption increases significantly.

4. To investigate the potential for wastewater effluent reuse.

5. To promote Xeriscape landscape use, like low-water using shrubs and plants, patios, rocks, decks, and walkways in order to reduce the amount of high-water consuming landscape area. Businesses as well as residential users will be encouraged to participate.

6. To promote more efficient irrigation techniques for agriculture, industry, and private use through rebates, retrofit, and education.

IV. WATER CONSERVATION STRATEGIES

A. Public Education

Water conservation is promoted in the City of McAllen through the following:

1. **Public service announcements** have been and will continue to be made regarding water conservation inside and outside the home, as well as in the workplace. For example, tips on efficient lawn watering, repairing leaks in the home, and installing low-flow showerheads and faucet aerators have been publicized on local radio stations, in newspapers, and on televisions stations. The City public announcement section in the local newspaper has water conservation tips included. Educational videos with service announcements are and will continue to be shown periodically on the McAllen Cable Network.

2. **Brochures** with water conservation tips are mailed out to water utility customers periodically. New customers are also given information such as brochures about water conservation when they open a new account with the City. Informative brochures as well as flyers are also on display at City Hall, where many customers come in to pay their water bill or take care of business with the Utilities Department and at other City offices.

3. **Employee education** will also be furthered in the Utilities Department by periodically showing videos in regards to wise water use and conservation. Posters and additional

brochures will also be distributed in City Hall for employee use. City of McAllen employees who do not work at City Hall will also be sent materials such as pamphlets and brochures to be displayed and read at their facilities.

4. The City has officially proclaimed the first full week of May as "Water Utilities Awareness Week" in order to improve public perception and awareness of the functioning of public utilities. This event involves various activities such as tours of the water and/or wastewater facilities, press releases, the involvement of other local groups, and a poster contest with either a conservation or water related theme.

5. New customers, including residential, industrial, and commercial, will be required to do the following:

   a. Read and agree to provisions of the Water Conservation Plan so that customers understand the description and goals of the program;
   b. Read information attached to Water Conservation Plan regarding water conservation, water conserving plumbing devices, and Xeriscape landscaping.

6. Contests that involve school age children at the McAllen public schools will be sponsored by MPU. Poster contests and coloring contests will be initiated by MPU and conducted through the schools. Such contests will promote water conservation and help teach children more about wise water use. The winning posters or pictures will then be displayed and publicized in local newspapers and at City Hall. When funding is available, MPU promotes the use of the Learning to be Water Wise program for elementary age students.

B. Recycling And Reuse

MPU currently has a recycle or reuse program for water via irrigation of treated wastewater effluent on the City's Golf course. Additionally, MPU has contracts to sell Calpine and Duke Energy 5 MGD and 4.8 MGD, respectively, of treated wastewater effluent for reuse. Wastewater will be redirected from the South Wastewater Treatment Plant to the North Wastewater Treatment Plant to maximize reuse of wastewater effluent.

C. Metering Devices And Universal Metering

Metering Devices

New meters, two inches 2-inches and smaller in size, are bought according to the latest revision of "AWWA New Meter Standard for Cold-Water Meters" in order to specify all materials, design, manufacture, and testing of all meters. The manufacturer will guarantee that all new meters will test at 98.1 to 101 percent accurate at the maximum rate and 95 to 101 percent at the "low flow" rate as designed by AWWA Standards Manual M-6 on a meter size for size basis. This ensures accurate and precise measurement of water diverted.

Older meters that may be registering too high or low will be replaced as time permits in order to accurately account for water and lower any unaccounted-for water loss.

Metering

MPU currently meters all water usage except that of fire hydrants and water loss due to leaks, breaks, processing, flushing of mains, and system loss. MPU, however, does keep track of water used by fire hydrants through the McAllen Fire Department.

MPU uses computers to maintain billing, to keep accurate records of water consumption, and to identify high and low water users. MPU will test all meters that appear to show unusually high or low water usage based on fluctuating meter data.. Meter readers test meters based on an "as needed" basis, when customers complain or a problem arises.

The MPU Utility Billing/Meter Readers Department is responsible for maintaining the 29,837 accounts. Meter readers use a portable meter tester and/or a Read-A-Flow Recorder to test meters in the field. When meters cannot be read in the field, they are taken into a meter shop to be assessed. Priority is always given to water leaks with all other tasks including, service calls, maintenance calls, and other water distribution projects..

Meter Management Study

In October of 1993, JBS Associates, Inc. prepared a Report of Meter Management Study for the City of McAllen. The study included an analysis of production and metered sales through the period ending August 1993, and of individually metered water consumption accounts through June 1993. The report also made recommendations that are currently being addressed.

For example, based on JBS recommendations, the City has installed individual totalizers on each finished water meter at Plant No. 2, so that more consistent data can be produced. The City has also begun to test all production meters annually. Commercial and industrial usage will also be more carefully monitored and considered in developing programs and budgets, due to high consumption levels.

D. Water Distribution Audit and Leak Survey

In November 1997, JBS Associates, Inc. completed a Water Distribution Audit and Leak Survey. The audit was conducted to determine causes for unaccounted-for water and develop recommendations for unaccounted-for water recovery in a cost-effective manner.

A continuous leak detection and repair program is carried out by MPU. Meter readers also check for leaks while reading meters and performing regular maintenance.

E. Plumbing Codes and Retrofit Program

The City does have plumbing codes pursuant to the 1994 Standard Plumbing Code issued from the Southern Building Code of Congress International. Additionally, the 72nd Texas Legislature passed legislation which requires plumbing fixtures sold in Texas after January 1, 1992 to meet strict standards that incorporate efficient water use and conservation in new structures. This law subsequently effects plumbing fixtures sold in McAllen and will help to eliminate inefficient plumbing fixtures.

MPU does encourage businesses and homeowner's to replace older water fixtures like low-flow showerheads, faucet aerators, and toilet dams, purchased before January 1, 1992, with the newer water efficient replacements. MPU will also advocate the use of low demand water appliances instead of older, high use ones in homes and businesses.

F. Water Conservation Landscaping

When practical, MPU will advocate the use of drip irrigation for the watering of landscapes for commercial establishments. Also, the use of ornamental fountains will be discouraged except when they recycle and use minimal quantities of water.

MPU will work with the City of McAllen Parks and Recreation Department in order to eliminate any wasteful water use. The watering of parks for example will be evaluated and done according to efficient water conserving methods. Municipal pools will also be evaluated for efficient water use.

Local landscape architects and local nurseries will be asked and encouraged to utilize efficient irrigation systems and native low water using plants and grasses. Xeriscape gardening, and landscaping techniques will also be asked to be promoted.

Licensed irrigation contractors will be asked to use drip irrigation systems, where possible, and to use water conserving irrigation systems like sprinklers which produce large drips instead of a fine mist and a sprinkler layout which accommodates prevailing wind patterns.

G. Conservation Oriented Water Rate Structure

The City of McAllen has established three schedules of rates to be charged for the consumption of water supplied through the city water system, as follows:

1. Standard water rate schedule within the city for City of McAllen customers under the city's certificate of convenience and necessity.
2. Standard water rate schedule for areas previously covered by Sharyland Water Supply Corporation Certificate of Convenience and Necessity relating to any buyout phases whereby the city has entered into agreements with Sharyland Water Supply Corporation for buyout of their certified area.
3. Standard water rate schedule outside the city.

The standard rate to be charged for water furnished and consumed by single-family residence, multi-family, commercial, and industrial customers within the city is as follows:

1. (1)	Meter charge	$3.00 per meter
2. Commodity Charge:		
	a) effective May 1, 1999	$1.10 per 1,000 gallons or any part thereof
	b) effective December 1, 1999	$1.20 per 1,000 gallons or any part thereof.

Water and sewer rates are periodically evaluated and updated as needed, so the above information is subject to future change.

V. DROUGHT CONTINGENCY PLAN

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the City of McAllen/McAllen Public Utilities hereby adopts the following regulation and restrictions on the delivery and consumption of water.

Water uses regulated or prohibited under this Drought Contingency Plan (Drought Plan) are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply condition are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in this section.

A. Public Involvement

Opportunity for the public to provide input into the preparation of the Drought Plan was provided by the MPU by scheduling and providing public notice of public meetings considering adoption of the Water Conservation and Drought Contingency Plan.

B. Public Education

MPU will periodically provide the public with information about the Drought Plan, including information about the conditions under which each stage of the Drought Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of periodic publications in the local newspaper and utility bill inserts or mail-outs.

C. Coordination with Regional Water Planning Groups

The service area of the MPU is located with the Lower Rio Grande Valley and MPU has provided a copy of this Water Conservation and Drought Contingency Plan to the Lower Rio Grande Valley Development Council.

D. Implementation and Enforcement

The Utility Manager or his designee is hereby authorized and directed to implement the applicable provisions of this Drought Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The Utility Manager, or his designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan. In the case of an emergency situation, such as canal breakdown, pump failures, line ruptures, etc., the Utility Manager is authorized to take immediate actions deemed necessary to minimize or mitigate the risks and impacts of the water supply emergency.

VI. TRIGGERING CRITERIA FOR DROUGHT RESPONSE STAGES

The Utility Manager, or his designee, shall monitor water supply and/or demand conditions on a monthly basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Notification will be made through major media outlets. The designated city representative will notify water users when water use restrictions have been eased due to lessening of drought conditions.

The triggering criteria described below are based on the level of United States share of water in the Falcon-Amistad Reservoirs, as reported by the TNRCC Watermaster, and demand on the municipal system capacity. The stages of the Drought Plan may be rescinded when all of the conditions listed as triggering events have ceased for a period of 3 consecutive days.

Stage 1 of the Drought Plan may be put into effect when the level of U. S. water stored in the Amistad-Falcon Reservoirs reaches 50% of Conservation Level or when the demand on McAllen's system is at 37.0 MGD.

Stage 2 of the Drought Plan may be put into effect when the level of U. S. water stored in the Amistad-Falcon Reservoirs reaches 40% of Conservation Level or when the demand on McAllen's system is at 38.0 MGD.

Stage 3 of the Drought Plan may be put into effect when the level of U. S. water stored in Amistad-Falcon Reservoirs reaches 25% of Conservation Level or when the demand on McAllen's system is at 39.0 MGD.

Stage 4 of the Drought Plan may be put into effect when the level of U. S. water stored in Amistad- Falcon Reservoirs reaches 20% of Conservation Level or when the demand on McAllen's system is at 40.0 MGD.

Stage 5 of the Drought Plan may be put into effect when the level of U. S. water stored in Amistad- Falcon Reservoirs reaches 15% of Conservation Level, when the demand on McAllen's system is at 41.0 MGD, or in response to emergency conditions. Emergency conditions, may include but not limited to, supply source contamination; system outage due to the failure, or; damage of major water system components.

VII. DROUGHT RESPONSE STAGES

The City of McAllen/McAllen Public Utilities has an emergency conservation plan that outlines five stages for possible water shortage and/or emergency conditions. A brief description is summarized below.

Stage 1: Voluntary Conservation. Customers of the city utility during stage 1 are requested to voluntarily limit the amount of water used to that amount absolutely necessary for health, business, and irrigation. Notice of such request shall be given by the utility manager through appropriate circulars, television, radio, and newspaper media at his discretion.

Stage 2: Mandatory Compliance-Water Alert. During stage 2, the following restrictions shall apply to all persons:

a. Irrigation of outdoor vegetation shall be limited except for during the days and times as provided in this section and in such zones as designated herein. Irrigation by drip method or hand-held buckets is permitted at any time in any zone.

1. Zone 1 - Northern city limits on the North, 10th Street on the East, Nolana Avenue on the South and Western city limits on the West – Sunday and Wednesday during the time periods as provided for below.
2. Zone 2 – Northern city limits on the North, Eastern city limits on the East, Nolana on the South and 10th Street on the West – Monday and Thursday during the time periods as provided for below.
3. Zone 3 – Nolana on the North, 10th Street on the East, Business 83 on the South and Western city limits on the West – Tuesday and Friday during the time periods as provided for below.
4. Zone 4 – Nolana on the North, Eastern city limits on the East, Business 83 on the South, 10th Street on the West – Wednesday and Saturday.
5. Zone 5 – Business 83 on the North, 10th Street on the East, Southern city limits on the South and Western city limits on the West – Thursday and Monday during the times as provided for below.
6. Zone 6 – Business 83 on the North, Eastern city limits on the East, Southern city limits on the South, and 10th Street on the West – Friday and Tuesday during the time period as provided below.

Irrigation may only be conducted during the hours of midnight to 10:00 a.m. and 6:00 p.m. to midnight on the authorized days.

b. The washing of automobiles, trucks, trailers, boats, airplanes and other types of mobile equipment is prohibited except on designated irrigation days between the hours of 6:00 p.m. to 10:00 a.m. Such washing, when allowed, shall be done with a handheld bucket or a handheld hose equipped with a positive shutoff nozzle for quick rinses.

Exception: Washing may be done at any time on the immediate premises of a commercial carwash or commercial service station. Further, such washing may be exempted from this provision if the health, safety and welfare of the public is contingent upon frequent vehicle cleaning, such as garbage trucks and vehicles to transport food and perishables.

c. The washing or sprinkling of foundations is prohibited except on designated irrigation days between the hours of 8:00 p.m. and 12:00 midnight.

d. The refilling or adding of water to residential swimming and/or wading pools is prohibited except on designated irrigation days between the hours of 8:00 p.m. to 10:00 a.m.

e. The operation of any ornamental fountain or other structure making similar use of water is prohibited except for those fountains or structures with a recycling system.

f. The use of water for irrigation for golf greens and tees is prohibited except on designated irrigation days between the hours of 6:00 p.m. to 10:00 a.m. The irrigation of golf course fairways is absolutely prohibited. Provided, however, any golf course utilizing wastewater effluent or raw water is excepted from the provision of this division.

g. Use of water from fire hydrants shall be limited to firefighting and related activities, and/or other governmental use activities necessary to maintain the health, safety, and welfare of the citizens of the city.

h. The following uses of water are defined as waste of water and are absolutely prohibited:

1. Allowing irrigation water to run off into a gutter, ditch or drain;
2. Failure to repair a controllable leak;
3. Washing sidewalks, driveways, parking areas, tennis courts, or other paved areas, except to alleviate immediate fire hazards.

i. No bulk water sales shall be made from city or other sources for any purpose when such water will be transporter by any tanker truck or similar type vehicle.

Stage 3: Mandatory Compliance-Water Warning. During stage 3, the following restrictions shall apply to all persons. All elements of stage 2 shall remain in effect in stage 3 except that:

a. It shall be unlawful for any person to irrigate any outdoor vegetation other than in zones and on the days as designated in stage 2 and only during the hours of midnight to 10:00 a.m. and 7:00 p.m. to midnight on such designated days. Irrigation by drip or hand-held buckets is permitted at any time in any zone.

b. The watering of golf fairways areas is prohibited unless done with treated wastewater, reused water, or well water.

A water surcharge shall be levied against all customers in the following amounts:

1. Residential/domestic metered customers (⁵/₈-inch, ¾-inch 1-inch meters) shall pay a 50 percent surcharge for any water used over an amount of 15,000 gallons per month.
2. Those irrigation-metered customers shall pay a 50 percent surcharge for any water used over 10,000 gallons per month.
3. Those commercial and industrial metered customers shall pay a 10 percent surcharge for any water used over an amount equal to 80 percent of the maximum monthly consumption over any one billing cycle out of the last 12 months preceding the month in which the stage 3 designation was implemented.

Stage 4: Mandatory Compliance-Water Shortage. During stage 4, the following restrictions shall apply to all persons. All elements of stage 3 shall remain in effect in stage 4 except that it shall be unlawful for any person to outdoor irrigate any vegetation except on the following designated days in the zones established herein:

1. Zone 1 – Sunday
2. Zone 2 – Monday
3. Zone 3 – Tuesday
4. Zone 4 – Wednesday
5. Zone 5 – Thursday
6. Zone 6 – Friday

and only during the times established under stage 3 of this section.

a. All outdoor irrigation of vegetation shall be allowed only between the hours of midnight to 10:00 a.m. and 8:00 p.m. to midnight on designated days.

b. The washing of automobiles, trucks, trailers, boats, airplanes, and other types of mobile equipment not occurring upon the immediate premises of commercial carwashes and commercial service stations and not in the immediate interest of the public health, safety and welfare shall be prohibited except on designated irrigation days and only on the owners of such vehicles, etc., premises.

c. Commercial carwashes and commercial service stations in the immediate interest of the public health, safety and welfare shall be limited to 50 percent of their monthly average usage based on the last 12 billing periods for each of such customer. After such usage, the utility manager shall enforce this subsection by terminating water service.

d. Commercial nurseries, commercial sod farmers, and similarly situated establishments shall water only on designated days between the hours of 10:00 p.m. and 5:00 a.m. and shall use only handheld hoses, drip irrigation systems, or handheld buckets.

e. The filling, refilling or adding of water, except to maintain the structure integrity of the pool, to swimming and/or wading pools is prohibited.

f. The operation of any ornamental fountain or similar structure is prohibited.

g. A water surcharge shall be levied against all customers during stage 4 in the following amounts:

   1. Residential/domestic metered customers ($^5/_8$-inch, ¾-inch, and 1-inch meters) shall pay a 75 percent surcharge for any water used over an amount 10,000 gallons per month.
   2. Those irrigation-metered customers shall pay a 75 percent surcharge for any water used.
   3. Those commercial and industrial metered customers shall pay a 10 percent surcharge for any water used over an amount equal to 60 percent of the maximum monthly consumption over any one billing cycle out of the last 12 months preceding the month in which the stage 4 designation was implemented.

Stage 5: Mandatory Compliance-Water Shortage Emergency. During stage 5, the following restrictions shall apply to all persons. All elements of stage 4 shall remain in effect in stage 5 except that:

a. No applications for new, additional, further expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or other water service facilities of any kind shall be allowed, approved or installed except as approved by the public utility board.

b. All allocations of water use to non-essential industrial and commercial customers shall be reduced to amounts as established by the public utility board.

c. The maximum monthly water use allocation for residential customers may be established with revised rate schedules and penalties by the board of commissioners on recommendation by the public utility board.

d. Irrigation is permitted only by:

   1. Continuously handheld hoses;
   2. Handheld or faucet filled bucket;
   3. Drip irrigation

   during the hours from 6:00 p.m. to 8:00 a.m., once every ten days by a schedule established by the Utility Manager.

e. The washing of automobiles, trucks, trailers, boats, airplanes, and other types of mobile equipment not occurring upon the immediate premises of commercial carwashes and commercial service stations and not in the immediate interest of the public health, safety and welfare shall be prohibited.

f. A water surcharge shall be levied against all customers during stage 5 in the following amounts:

   1. Residential/domestic metered customers ($^5/_8$-inch, ¾-inch, and 1-inch meters) shall pay a 100 percent surcharge for any water used over an amount of 8,000 gallons per month.
   2. Those irrigation-metered customers shall pay a 100 percent surcharge for any water used.
   3. Those commercial and industrial metered customers shall pay a 10 percent surcharge for any water used over an amount equal to 20 percent of the maximum monthly consumption over any one billing cycle out of the last 12 months preceding the month in which the stage 5 designation was implemented.

Nothing shall prohibit the utility manager from taking those actions deemed necessary to meet emergency conditions resulting from unforeseen circumstances such as canal breakdown, pump failures, line ruptures, etc. Such actions shall remain in full force and effect until the situation causing such emergency is abated or until the public utility board shall have the opportunity to consider such matter.

VIII. VARIANCES

The Utility Manager, or his designee, may grant temporary variance from the provisions of the Drought Plan if the person requesting the variance can satisfactorily demonstrate that failure to grant such variance would adversely affect the health, sanitation, or fire protection for the public or the person requesting such variance, and if one or more of the following conditions are met:

a. Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.

b. Alternative methods can be implemented which will achieve the same level of reduction in water use.

IX. PENALTY OF VIOLATION

Any person violating any provision of the water conservation plan after order and notice as specified in this division shall be deemed guilty of an offense, and, upon conviction, shall be punished as prescribed in the McAllen Code of Ordinances, Section 1-14, provided, however, a first offense shall be punishable by a fine of not to exceed $200.00, exclusive of court costs. In the event of a second subsequent conviction of said person for violating any provision of this division during an emergency conservation period, the minimum fine shall be not less than $300.00 exclusive of court costs. A third conviction during the emergency conservation period by the same person shall be punished by a fine of not less than $400.00 exclusive of court costs. The violation of each provision of this division, and each separate violation thereof, shall be deemed a separate offense, and shall be punished accordingly. Provided, however, compliance may be further sought through injunctive relief in the district court.

For purposes of this division, in any case where water has been used in any manner contrary to any provision of this section, It shall be presumed that the person, individual, corporation, or partnership in whose name a water meter connected is registered with the utility department as the customer on the water account for the property where the violation occurs or originates shall be presumed to be the violator.

It shall be presumed that the utility customer has intentionally and knowingly, recklessly, or negligently made, caused, used, or permitted to be used, the water in such a contrary manner.

In any prosecution charging a violation of this section:

Proof that the violations occurred in this property serviced by the utility connection the name of the account holder therof shall constitute in evidence a prima facie presumption that the registered customer of such account was the person responsible at the place and time during which such violation occurred.

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CHAPTER 7.0 :LONG TERM PROTECTION OF THE STATE'S WATER RESOURCES, AGRICULTURAL RESOURCES, AND NATURAL RESOURCES

7.1 *Long-term Protection of the State's Water Resources*

The population of the region is expected to increase by over 300 percent over the next 50 years. In order to meet the associated DMI water demands, the Rio Grande Regional Water Planning Group has identified three goals aimed at curbing DMI water use through conservation and diversification: (1) optimize the supply of water available from the Rio Grande, (2) reduce projected DMI water demands through expanded water conservation programs, and (3) diversify water supply sources for DMI use through appropriate development of alternate water supply sources (i.e., reuse of reclaimed water, groundwater, desalination, etc.).

Chapter 2 of this report contains projected demands data provided by TWDB. Chapter 3 of this report gives an in-depth analysis of current and future water supplies for each WUG.

Past regional water planning studies included estimated water savings due to water conservation in the overall demand figure for each Water User Group (WUG). In this round of regional planning, the TWDB has determined that "reductions due to the installation of water-efficient plumbing fixtures in new construction, as well as from the replacement of older fixtures, will be included in the Regional Water Plans based on data provided by the TWDB." These measures are treated as a requirement for each municipal WUG thereby reducing per-capita water demand throughout the extent of the planning study. In addition, the Regional Planning Group recognizes the effect of additional conservation measures on the water supply in the region. For this reason, Advanced Water Conservation was recognized as a Water Management Strategy. This strategy consists of public information, school education, and residential clothes washer conversion. Any additional conservation measures will be treated as Advanced Water Conservation. Water conserved actually decreases overall demand resulting in less potential supply needed to meet that demand. This strategy is explained in more detail in Chapter 4.

Optimizing the supply of water available from the Rio Grande is another important aspect of protecting the State's water resources since the river is the main source for both DMI use and irrigation use. As populations grow, irrigable land is lost and the associated irrigation water demand is also reduced. Logically, large portion of the region's future DMI water supply will come from the Rio Grande. Municipalities can acquire Rio Grande water rights through purchase, urbanization, and contract. Chapter 2 explains projected reductions in irrigation demand. By 2060, irrigations demands are expected to decrease by 227,898 acre-feet. Since irrigation water rights can be converted to DMI use on a two-to-one basis, an additional CMI Rio Grande water supply of 113,949 acre-feet is possible. However, not all of this water is feasible for conversion to DMI use. A portion should be retained to reduce existing irrigation deficits.

Diversifying water supply sources for DMI use will also aid in protecting the State's water resources. Water management strategies such as brackish and seawater desalination, potable and non-potable reuse, and groundwater development will reduce the impact on existing water sources for DMI use, especially the Rio Grande.

7.2 Long-term Protection of the State's Agricultural Resources

Over the next 20 years, an irrigation water supply deficit of over 410,000 acre-feet is projected. Considering the effects of urbanization on irrigable land, this deficit may decline slightly, to 210,000 acre-feet by 2060. (This information can be seen in the Irrigation Water User Group supply/deficit tables in the appendix.) In Chapter 4, the Rio Grande RWPG recommends two Water Management Strategies (WMSs)—on-farm conservation and conveyance system improvements--to reduce this impact. On-farm improvements include field-level water measurement, installation of poly or gated pipe, and improved water management practices. Conveyance system improvements include installation of no-leak gates, water measurement, canal linings, and conversion of canals to pipelines. Potential water savings associated with on-farm improvements is 274,000 acre-feet, while conveyance system improvements could yield savings of 243,000 acre-feet[1]. In the long run, total water savings associated with both strategies would allow irrigators to offset water supply deficits. However, the implementation timeframe will not offer immediate relief.

Another factor in maintaining and supplementing irrigation water supplies is Mexico's compliance with the 1944 treaty with the U.S. Even though Mexico is in the midst of repaying its water debt, there is little assurance future compliance should the region be gripped by another severe drought. Due to Mexico's breach of its treaty obligations from 1992 to 2002, Texas A&M studies have shown that the Lower Rio Grande Valley lost nearly $1 billion in decreased economic activity and 30,000 jobs as a direct result of that shortfall.[2]

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[1] Fipps, Guy. "Potential Water Savings in Irrigated Agriculture for the Rio Grande Planning Region (Region M)." May 6, 2005.

[2] Press Release. Marzulla & Marzulla: Attorneys at Law. "Texas Water Rights Holders Still Seeking $500 Million in Compensation for Economic Injuries Caused by Mexico". March 14, 2005.

7.3 *Long-term Protection of the State's Natural Resources*

Environmental flow needs are in the forefront of all issues dealing with long-term protection of the Texas' natural resources. As water is diverted from the Rio Grande, river flows also drop. With the potential for increasing reliance on the Rio Grande, the issue of maintaining and/or increasing environmental flows should be a concern now and in coming years.

One possibility for maintaining and increasing environmental flows is the purchase or donation of Rio Grande water rights for environmental usage into the Texas Water Trust. These water rights could be managed to produce sufficient flows throughout the region. However, this option may not be viable because of the current water rights purchase and transfer structure.

Even though environmental flows on the Rio Grande were previously discussed, flows in the Arroyo Colorado and other regional estuaries are equally as important.

Given the WUG format currently being implemented by the TWDB, no option exists to formally allocate projected water supplies for environmental use. Alternatively, environmental flows in the Rio Grande could be included as a separate WUG in the next round of regional planning to ensure minimums would be met in a manner consistent with all other WUGs.

International cooperation (i.e., Mexico's) is critically needed to maintain flow levels. The United States Fish and Wildlife Service is currently in talks with Mexico regarding the introduction of fish to the Rio Grande. Even though this is the case, if the United States were to implement an environmental flow program without Mexico's participation, the desired effect would be significantly reduced.

Another of the region's critical environmental issues is the growth of Salt Cedar and other invasive plants such as Water Hyacinth and Hydrilla, among others. Salt Cedar has begun to make its way through the region. Water Hyacinth and Hydrilla are already well established. Unfortunately, eradication methods are both costly and physically strenuous. The natural rise and fall of water elevation in rivers and streams somewhat curtails these plants by drowning out new seedlings. However, in areas of minimal water flow, a perfect scenario exists for invasive plant growth.

7.4 *Supplemental Evaluation of Potential Long-Term Changes in Freshwater Inflows to the Lower Laguna Madre Estuary*

The National Wildlife Federation (NWF) has approached the Lower Rio Grande Planning Group with a proposal to supplement the assessment of potential cumulative effects of regional water plan implementation on the Lower Laguna Madre Estuary. This would be accomplished by calculating changes in freshwater inflow expected to the Lower Laguna Madre Estuary with the Region M Plan in place, comparing these inflows to two baselines, and providing two ecologically-based assessments. The baselines for comparison include freshwater inflows under "Natural" and "Present" conditions. The two ecologically-based assessments rely, in part, upon the freshwater inflow recommendations of the Texas Parks and Wildlife Department and the TWDB and focus upon spring/early summer freshwater inflow pulses and drought periods during the months of March through October as used in a recent NWF publication.

As indicated in Attachment 7-2, there is no significant impact to the freshwater inflows into the Laguna Madre as a result of this region's Water Management Strategies. Even with an increase in wastewater reuse, this is offset with an increase in population and subsequent wastewater flows.

ATTACHMENT 7-1

CHECKLIST FOR COMPARISON OF THE REGIONAL WATER PLAN TO APPLICABLE WATER PLANNING REGULATIONS

The purpose of this attachment is to help determine how the Regional Water Plan is consistent with long-term protection of the water, agricultural, and natural resources of the State of Texas. Accordingly, the following checklist includes a regulatory citation (Column 1) for all subsections and paragraphs contained in the applicable portions of water planning regulations:

- 31 TAC Chapter 358.3
- 31 TAC Chapter 357.5
- 31 TAC Chapter 357.7
- 31 TAC Chapter 357.8
- 31 TAC Chapter 357.9

CHECKLIST FOR REVIEW OF 2006 IPPS		
Rule	**Description (See Rule or Contract for Complete Description)**	**Chap.**
Chapter 357	**REGIONAL WATER PLANNING GUIDELINES**	
§357.5	**Guidelines for Development of Regional Water Plans**	Exhibit B
§357.5(d)(1)&(2)	Use state population and water demand projections that have been adopted by the TWDB board	Chapter 2 Sections 2.2 & 2.3
§357.5(e)(1)	Adjusted WMSs for appropriate environmental water needs	Chapter 4 Chapter 5 Chapter 7
§357.5(e)(2)	Provided WMSs to be used during a drought of record	Chapter 4 Chapter 6
§357.5(e)(3)	Protected water rights, water contracts and option agreements. May consider amendments of water rights, contracts etc.	Chapter 4 Chapter 7
§357.5(e)(4)	Specific recommendations of WMSs were based on analysis and comparison of all potentially feasible WMSs	Chapter 4 Sections 4.3, 4.5, & 4.7
§357.5(e)(4)	Prior to identifying potentially feasible WMSs, RWPG documented its process for identifying potentially feasible WMSs	Chapters 4,10 Sections 4.0 & 4.1
§357.5(e)(5)	Incorporated water conservation and drought contingency planning	Chapters 4,6 Sections 4.4 & 4.5.4
§357.5(e)(6)	Conducted planning to achieve efficient use of existing water supplies	Chapter 4 Chapter 6

§357.5(e)(6)	Explored opportunities and benefits of regional water supply facilities or providing regional management of regional facilities	Chapter 4
§357.5(e)(6)	Coordinated actions of local and regional water resource management agencies	Chapter 1 Chapter 4 Chapter 10
§357.5(e)(6)	Provided substantial involvement by the public in the decision-making process and provide full dissemination of planning results	Chapter 10
§357.5(e)(7)(A)	Specific factors were considered to initiate a drought response for each water supply source designated in §357.7(a)(3)	Chapter 6
§357.5(e)(7)(B)	Actions to be taken as part of the drought response	Chapter 6 Attachments
§357.5(e)(8)	Effect of the regional water plan on navigation	Chapter 7
§357.5(f)	Prepared the regional water plan to be consistent with all laws applicable to water use in the RWPA	Chapter 4 Chapter 7
§357.5(h)	For special water resources, protected water rights, water supply contracts, etc. for demands outside the RWPA	Chapter 4
§357.5(h)	For special water resources, provided holders of interests in water rights, water supply contracts, etc. notice of and an opportunity to comment on the scope of work and proposed water plan.	Chapter 10
§357.5(i)	Consider emergency transfers of surface water to meet non-municipal use pursuant to TWC §11.139	Chapter 4 Chapter 7
§357.5(k)(1)	Consider existing plans and information, including the following:	
§357.5(k)(1)(A)	Water conservation plans	Chapter 6 Attachments
§357.5(k)(1)(B)	Drought contingency plans	Chapter 6 Attachments
§357.5(k)(1)(C)	Information from water loss audits - N/A until 2011 Regional Water Plans	
§357.5(k)(1)(D)	Certified groundwater conservation district management plans	Chapter 3 Chapter 4
§357.5(k)(1)(E)	Publicly available plans of major agricultural, municipal, manufacturing and commercial water users	Chapter 3 Chapter 4
§357.5(k)(1)(F)	Water management plans	Chapter 3 Chapter 4
§357.5(k)(1)(G)	Water availability requirements promulgated by a county commissioners court pursuant to TWC §35.019	Chapter 3 Chapter 4
§357.5(k)(1)(H)	Any other information available from existing local or regional water planning studies	Chapter 3 Chapter 4

§357.5(k)(2)	Considered existing programs and goals, including the following:	
§357.5(k)(2)(A)	The state Clean Rivers Program	Chapter 3 Chapter 5
§357.5(k)(2)(B)	The federal Clean Water Act	Chapter 3 Chapter 5
§357.5(k)(2)(C)	Other planning goals, including but not limited to regionalization of water and wastewater services, where appropriate	Chapter 4 Chapter 5
§357.5(l)	Considered environmental water needs including instream flows and bay and estuary inflows	Chapter 3 Chapter 4 Chapter 7
§357.7	**Regional Water Plan Development**	
§357.7(a)(1)	Prepared description of regional water planning area, including:	Chapter 1
§357.7(a)(1)(A)	Wholesale water providers	Chapter 1
§357.7(a)(1)(B)	Current water use (for identified water use categories)	Chapter 1
§357.7(a)(1)(C)	Identified water quality problems	Chapter 1
§357.7(a)(1)(D)	Sources of groundwater and surface water including springs important for water supply or natural resource protection	Chapter 1
§357.7(a)(1)(E)	Major demand centers	Chapter 1
§357.7(a)(1)(F)	Agricultural and natural resources	Chapter 1
§357.7(a)(1)(G)	Social and economic aspects: current population and economic activities (primary and ones depend. on natural water resources)	Chapter 1
§357.7(a)(1)(H)	Assessed current preparations for drought	Chapter 1
§357.7(a)(1)(I)	Summarized existing regional water plans	Chapter 1
§357.7(a)(1)(J)	Summarized recommendations in state water plan	Chapter 1
§357.7(a)(1)(K)	Summarized of local water plans	Chapter 1
§357.7(a)(1)(L)	Any threats to agricultural and natural resources due to water quantity or water quality problems related to water supply	Chapter 1
§357.7(a)(2)	Presented current and projected population and water demands for the following:	Chapter 2
§357.7(a)(2)(A)(i)	Cities with populations greater than 500 people	Chapter 2
§357.7(a)(2)(A)(ii)	Retail public utilities for counties with less than five retail public utilities	Chapter 2
§357.7(a)(2)(A)(iii)	Individual retail public utilities or collective data for such utilities that form a logical reporting unit for counties with five or more	Chapter 2
§357.7(a)(2)(A)(iv)	Categories of water use for each county or portion of county in RWPA and by river basin if county is in more than one basin	Chapter 2

§357.7(a)(2)(B)	Categories of water use for WWPs considering counties and river basins. Include WWP's contractual obligations and demands.	Chapter 2
§357.7(a)(2)(C)	How water-saving plumbing fixtures (per Chapter 372 of Health and Safety Code) impact projected municipal water use	Chapter 2
§357.7(a)(3)	Evaluated water supplies legally and physically available during drought of record using TWDB approved methods	Chapter 3
§357.7(a)(3)(A)(i)	Cities with populations greater than 500 people	Chapter 3
§357.7(a)(3)(A)(ii)	Retail public utilities for counties with less than five retail public utilities	Chapter 3
§357.7(a)(3)(A)(iii)	Individual retail public utilities or collective data for such utilities that form a logical reporting unit for counties with five or more	Chapter 3
§357.7(a)(3)(A)(iv)	Categories of water use for each county or portion of county in RWPA and by river basin if county is in more than one basin	Chapter 3
§357.7(a)(3)(B)	Categories of water use for WWPs considering counties and river basins	Chapter 3
§357.7(a)(4)	Analyzed water supplies and demands	Chapter 3
§357.7(a)(4)(A)	Compared water demands developed in §357.7(a)(2) with current supplies developed in §357.7(a)(3) to determine surpluses and needs.	Chapter 3
§357.7(a)(4)(A)(i)	Cities with populations greater than 500 people	Chapter 4
§357.7(a)(4)(A)(ii)	Retail public utilities for counties with less than five retail public utilities	Chapter 4
§357.7(a)(4)(A)(iii)	Individual retail public utilities or collective data for such utilities that form a logical reporting unit for counties with five or more	Chapter 4
§357.7(a)(4)(A)(iv)	Categories of water use for each county or portion of county in RWPA and by river basin if county is in more than one basin	Chapter 4
§357.7(a)(4)(A)	Evaluated social and economic impact of not meeting needs and report by RWPA and river basin.	Chapter 5
§357.7(a)(4)(B)	Categories of water use for WWPs considering counties and river basins	Chapter 4
§357.7(a)(5)	Developed Water Management Strategies	
§357.7(a)(5)(A)(i)	Cities with populations greater than 500 people	Chapter 4
§357.7(a)(5)(A)(ii)	Retail public utilities for counties with less than five retail public utilities	Chapter 4

§357.7(a)(5)(A)(iii)	Individual retail public utilities or collective data for such utilities that form a logical reporting unit for counties with five or more	Chapter 4
§357.7(a)(5)(A)(iv)	Categories of water use for each county or portion of county in RWPA and by river basin if county is in more than one basin	Chapter 4
§357.7(a)(5)(B)	Categories of water use for WWPs considering counties and river basins	Chapter 4
§357.7(a)(5)(C)	Water Management Strategies not selected for WUGs or WWPs with need	Chapter 4
§357.7(a)(5)(C)(i)	Evaluation of WMSs must be shown and reasons given why no WMSs are feasible	Chapter 4
§357.7(a)(5)(C)(ii)	If political subdivision does not participate in planning process, has RWPG adopted equitable and reasonable terms of participation?	Chapter 4
§357.7(a)(6)	Presented data in additional reporting units, such as splitting a county into two, if desired by the RWPG	Chapter 4
§357.7(a)(7)	Evaluated all Water Management Strategies the RWPG determines to be potentially feasible:	Chapter 4
§357.7(a)(7)(A)	RWPG considered water conservation practices for each need identified in §357.7(a)(4)	Chapter 4
§357.7(a)(7)(A)(i)	Water conservation practices must be included for each WUG to which TWC §11.1271 applies in a manner consistent with §11.1271	Chapter 4
§357.7(a)(7)(A)(ii)	The RWPG shall adopt water conservation practices that exceed §11.1271 for affected WUGs or document the reason	Chapter 4
§357.7(a)(7)(A)(iii)	The highest practicable level of water conservation and efficiency achievable for interbasin transfers to which TWC §11.085(l) applies	Chapter 4
§357.7(a)(7)(A)(iv)	Considered strategies in response to an issues identified through water loss audits	Not available for 2006 RWP
§357.7(a)(7)(B)	RWPG considered drought management measures for each need identified in §357.7(a)(4)	Chapter 4
§357.7(a)(7)(B)	Drought management measures must be included for each WUG to which TWC §11.1272 applies in a manner consistent with §11.1272	Chapter 4
§357.7(a)(7)(B)	The RWPG shall adopt drought management measures that exceed §11.1272 for affected WUGs or document the reason	Chapter 4
§357.7(a)(7)(C)	Reuse of wastewater	Chapter 4
§357.7(a)(7)(D)	Expanded use of existing supplies: systems optimization, conjunctive use, reallocation of reservoir storages, voluntary redistribution, etc.	Chapter 4

§357.7(a)(7)(E)	New supply development: construction and improvement of surface water and groundwater resources, brush control, etc.	Chapter 4
§357.7(a)(7)(F)	Interbasin transfers	Chapter 4
§357.7(a)(7)(G)	Other measures	Chapter 4
§357.7(a)(8)	Evaluated all Water Management Strategies the RWPG determines to be potentially feasible	
§357.7(a)(8)(A)(i)	Quantitative reporting of quantity, reliability, and cost of water delivered and treated for end user's requirements	Chapter 4
§357.7(a)(8)(A)(ii)	Quantitative reporting of environmental factors including effects on environmental water needs, wildlife habitat, etc.	Chapter 4
§357.7(a)(8)(A)(iii)	Quantitative reporting of impacts on agricultural resources	Chapter 4
§357.7(a)(8)(B)	Impacts on other water resources of the state including other WMSs and groundwater surface water relationships	Chapter 4
§357.7(a)(8)(C)	Discussed how threats to agricultural and natural resources identified in §357.7(a)(1)(L) will be addressed or affected	Chapter 4
§357.7(a)(8)(D)	Other factors deemed relevant by the RWPG including recreational impacts	Chapter 4
§357.7(a)(8)(E)	Equitable comparison and consistent application of all WMSs the RWPGs determine to be potentially feasible for each need	Chapter 4
§357.7(a)(8)(F)	Consideration of the provisions in TWC §11.085(k)(1) for interbasin transfers of surface water, including summing needs	Chapter 4
§357.7(a)(8)(G)	Third party impacts from voluntary redistributions of water and moving water from rural and agricultural areas	Chapter 4
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§357.7(a)(9)	WMSs described in sufficient detail to allow state agencies to make financial or regulatory decisions to determine consistency	Chapter 4
§357.7(a)(10)	Regulatory, admin., or legislative recommendations that RWPG believes are needed and desirable to meet purpose of SB 1	Chapter 8
§357.7(a)(11)	Chapter consolidating the water conservation and drought management recommendations of the RWP	Chapter 6

§357.7(a)(12)	Described the major impacts of WMSs on key parameters of water quality important to the use of the water resource	Chapter 5
§357.7(a)(13)	Chapter describing how the Plan is consistent with long-term protection of water, agricultural, and natural resources	Chapter 7
§357.7(a)(14)	Chapter describing the financing needed to implement the WMSs. How local governments and others will pay for WMSs.	Chapter 9
§357.7(c)	Regional water plan includes a model water conservation plan pursuant to TWC §11.1271	Chapter 6
§357.7(d)	Regional water plan includes a drought contingency plan pursuant to TWC §11.1272	Chapter 6
§357.8	**Ecologically Unique River and Stream Segments**	
§357.8(a)	Recommendation package containing physical description and site characterization submitted to and evaluated by TPWD	Chapter 8
§357.8(c)	Impact of RWP on unique river and stream segments, comparing current conditions and conditions with WMSs	Chapter 8
§357.9	**Unique Sites for Reservoir Construction**	
§357.9	Description of the sites, reasons for the unique designation, and expected beneficiaries of water supply to be developed	Chapter 8
§357.10	**Format of Information to be Presented in RWPs**	
§357.10(a)(1)	Technical report and data prepared pursuant to rules and Exhibit B	Appendix
§357.10(a)(2)	Executive summary that documents the key RWP findings and recommendations	Attached to Report
§357.10(a)(3)	Summaries of comments from TWDB, any federal or state agency, and the public with RWPG response	Chapter 10
§357.10(b)	Transfer copies of all data and reports to TWDB	RWP
§357.10(b)	To extent possible data shall be in digital format per Exhibit B	RWP
§357.10(b)	One copy of all reports shall be in digital format per Exhibit B	RWP
§357.11	**Adoption of RWPs by RWPGs**	
§357.11(a)	IPP submitted in electronic and paper format as specified in Exhibit B	RWP
§357.11(a)	RWPG certification that IPP is complete and adopted by the RWPG	RWP
§357.12	**Notice and Public Participation**	
§357.12(a)(1)	Public meeting prior to preparation of the RWP	Chapter 10
§357.12(a)(2)	Opportunities for public input during preparation of	Chapter 10

	RWP	
§357.12(a)(3)	Public hearing following adoption of initially prepared RWP	Chapter 10
§357.12(a)(5)	Notice published in newspaper of general circulation before 30th. day preceding date of public hearing and mailed to the following:	Chapter 10
§357.12(a)(5)(A)	Mayors of municipalities with population of 1000 or more	Chapter 10
§357.12(a)(5)(B)	County judges of counties located in whole or part of RWPA	Chapter 10
§357.12(a)(5)(D)	Retail public utilities that serve any part of RWPA or receives water from RWPA	Chapter 10
§357.12(a)(5)(E)	Holders of water rights for surface water diverted from RWPA	Chapter 10
§357.12(a)(6)	Notices shall include the following:	Chapter 10
§357.12(a)(6)(A)	Date, time and location of the public hearing	Chapter 10 Section 10.1
§357.12(a)(6)(B)	Summary of the proposed action to be taken	Chapter 10 Section 10.1
§357.12(a)(6)(C)	Name, telephone number, and address of the person for questions and requests for additional information	Chapter 10 Section 10.1
§357.12(a)(6)(D)	That RWPG will accept written and oral comments at hearing	Chapter 10 Section 10.1
§357.12(a)(6)(D)	How public may submit written comments separate from hearing	Chapter 10 Section 10.1
§357.12(a)(6)(D)	Deadline for submitting written comments not earlier than 30 days after the hearing	Chapter 10 Section 10.1
§357.12(b)	Copies of RWP available for public inspection at least one month before hearing at the following locations:	Chapter 10 Section 10.1
§357.12(b)	At least one public library in each county	Chapter 10 Section 10.1
§357.12(b)	Either the county courthouse's law library, county clerk's office, or some other accessible place within the county courthouse	Chapter 10 Section 10.1
§357.12(b)	Notice shall include locations of copies of RWP	Chapter 10 Section 10.1
§357.14	**Approval of RWP by the Board**	
§357.14(2)(B)	RWP must include water conservation and drought management practices that incorporate §357.7(7)(a)(A), a(B), (c), and (d)	Chapter 4 Section 4.5.4 Chapter 6
§357.14(2)(C)	Consistent with long-term protection of water, agricultural, and natural resources	Chapter 5 Chapter 7
§357.14(3)	No interregional conflict exits	Chapter 3 Chapter 4

Chapter 358	**STATE WATER PLAN DEVELOPMENT**	
§358.3	**Guidelines**	
§358.3(b)	Development of the state and regional water plans shall be guided by the following principles:	
§358.3(b)(1)	Identified policies and actions to meet water needs and to respond to drought conditions to assure sufficient water supply for Texas	Chapter 4 Chapter 7
§358.3(b)(2)	Decision-making open to and accountable to the public; based on accurate, objective and reliable information	Chapter 4 Chapter 10
§358.3(b)(3)	Considered effects of policies or WMS on public interest, water supply, and those entities that provide water supply	Chapter 4 Chapter 5 Chapter 7
§358.3(b)(4)	Considered all WMS the board considers potentially feasible that are cost effective and which are consistent with long-term protection of water, agricultural, and natural resources	Chapter 4 Chapter 7
§358.3(b)(5)	Opportunities that encourage and result in voluntary transfers of water, including regional water banks, sales, leases etc.	Chapter 4
§358.3(b)(6)	Balance of economic, social, aesthetic, and ecological viability	Chapter 4
§358.3(b)(8)	Orderly development, management, and conservation of water resources	Chapter 4 Chapter 7
§358.3(b)(9)	Principles that all surface water is held by the state, use is via rights administered by the TCEQ, and prior appropriation applies	Chapter 3 Chapter 4
§358.3(b)(10)	Protection of existing water rights, water contracts, and option agreements	Chapter 3 Chapter 4
§358.3(b)(11)	Principal that use of groundwater is governed by the right of capture, unless under a local groundwater management district	Chapter 3
§358.3(b)(12)	Considered recommendations of river and stream segments of unique ecological value	Chapter 8
§358.3(b)(13)	Considered recommendation of sites of unique value for the construction of reservoirs	Chapter 8
§358.3(b)(14)	Coordinate water planning and management activities of local, regional, state and federal agencies	Chapter 4
§358.3(b)(15)	Designated water quality and related water uses shown in the state water quality plan should be improved or maintained	Chapter 5

§358.3(b)(16)	Coordination of water planning/management activities of RWPGs to identify common needs, issues, and/or problems and working together to resolve conflicts equitably and fairly	Chapter 3 Chapter 4
§358.3(b)(17)	Describe WMSs in sufficient detail for state agencies to make financial/regulatory decisions that are consistent with the RWP	Covered by §357.7(a)(9)
§358.3(b)(18)	Evaluated alternative WMS using environmental criteria	Chapter 4
§358.3(b)(19)	Considered environmental water needs including instream flows and bay and estuary inflows	Chapter 7
§358.3(b)(20)	Planning consistent with all laws applicable to water use	Chapter 3 Chapter 4
§358.3(b)(21)	Inclusion of ongoing water development projects for which TCEQ has issued a permit	Chapter 3 Chapter 4
Exhibit B	**GUIDELINES FOR REGIONAL WATER PLAN DEVELOPMENT**	
PART 1	**Regional Water Plan Tasks and Requirements for Deliverables**	
1.2	Requirements for Deliverables	
1.2.1	Introduction	
1.2.1	All computer files and formats 100 percent compatible with PC-type computers.	RWP
1.2.1	Copies of electronic files (disc or CD) and electronic file lists and file description print outs (including metadata files).	RWP
1.2.1	Formats of all computer files shall be compatible with the widely distributed versions of the following programs:	RWP
1.2.1	Word processor files - Microsoft Word (MS Office 97 or newer)	RWP
1.2.1	GIS coverages - Arc/Info (7.21 or newer)	RWP
1.2.1	GIS shape files – Arc View (3.1 or newer)	RWP
1.2.1	Database files - Microsoft Access (MS Office 97 or newer)	RWP
1.2.1	Internet browsers – Internet Explorer (5.5 or newer) or Netscape (6 or newer)	RWP
1.2.1	Spreadsheets Files - Microsoft Excel (MS Office 97 or newer)	RWP
1.2.1	Graphs, bar-charts, pie-charts - Microsoft Excel (MS Office 97 or newer)	RWP
1.2.1	Drawings and graphs shall be provided in an Encapsulated PostScript format with tiff preview using Pantone process colors	RWP

1.2.2	Data Units	
1.2.2	The following units shall be used, although equivalents in other units may be shown simultaneously:	
1.2.2	Land area - square miles (mi^2)	RWP
1.2.2	Water area - acres (ac)	RWP
1.2.2	Water volume - acre-feet (ac-ft)	RWP
1.2.2	Demand and supply rates - acre-feet per year (ac-ft/yr)	RWP
1.2.2	Treatment plant capacities - million gallons per day (mgd)	RWP
1.2.2	Water use per capita - gallons per capita per day (gpcd)	RWP
1.2.2	Stream flows and reservoir releases - cubic feet per second (cfs)	RWP
1.2.2	Pumping rates - gallons per minute (gpm) or million gallons per day (mgd)	RWP
1.2.2	Cost – 2002 US Dollars (Engineering News Record (ENR) Construction Cost Index)	Chapter 4
1.2.3	Maps	
1.2.3	Minimum requirements of the maps are:	
1.2.3	Figures should be designed so that a black and white photocopy of the original is readable	RWP
1.2.3	Maps shall include title, border, and a title box that includes the Planning Group letter name, map name and number, and date prepared	RWP
1.2.3	For maps drawn to scale, the scale shall be clearly shown and clearly labeled including a scale bar.	RWP
1.2.3	Reference source of both the base map and any substantial additions to the base map.	RWP
1.2.3	Where possible, all maps shall be developed from source maps available from TWDB	RWP
1.2.5	Data Time Frame and Time Steps:	
1.2.5	Time periods and increments shall be 2000 (current year) and 2010, 2020, 2030, 2040, 2050, and 2060 for planning	RWP
1.2.7	Initially Prepared and Adopted Regional Water Plans	
1.2.7	The RWP will consist of the following:	
1.2.7	Executive summary of 30 pages or less	ES
1.2.7	Ten chapters:	
1.2.7	Planning area description	Chapter 1
1.2.7	Population and water demand projections	Chapter 2
1.2.7	Water supply analysis	Chapter 3
1.2.7	Identification, evaluation, and selection of WMS based on needs	Chapter 4

1.2.7	Impacts of WMSs on key parameters of water quality and impacts of moving water from rural and agricultural areas	Chapter 5
1.2.7	Consolidated water conservation and drought management recommendations	Chapter 6
1.2.7	Description of how the RWP is consistent with long-term protection of water, agricultural and natural resources	Chapter 7
1.2.7	Unique stream segments/reservoir sites/Legislative recommendations	Chapter 8
1.2.7	Report on water infrastructure funding recommendations	Not due until 1/6/2006
1.2.7	Adoption of RWPs	Chapter 10
PART 2	**Introduction to Regional Water Planning Data**	
2.1	Overview	
2.1	Access and update data in DB07 via the internet	RWP
2.1	Data in the final RWP cannot contradict DB07	RWP
2.2	General Requirements	
2.2	Water availability determined as the maximum amount of water from current source during DOR , after accounting for legal constraints and management philosophies	Chapter 3
2.2	Water supply determined as the volume of water for a WUG or WWP from existing and connected water sources as of January 1, 2002 or anticipated prior to end of current planning cycle	Chapter 3
2.2	Data submitted shall be accurate and the best available	RWP
PART 3	**Water Sources**	
3.1	Introduction	
3.1	Document all current water sources and their water availability	Chapter 3
3.1.1	Sources identified and quantified by county and basin location	Chapter 3
3.2.1	Sources not over-allocated on a permanent basis; Sum of supplies on county-basin basis does not exceed DOR availability	Chapter 3
3.2.2	Groundwater	Chapter 3
3.2.2	Calculated largest amount of groundwater that can be pumped annually without violating most restrictive physical, regulatory or policy condition	Chapter 3
3.2.2	TWDB's GAM used to determine groundwater availability	Chapter 3
3.2.3	Surface Water	Chapter 3

3.2.3	Surface water availability for lakes and reservoirs reported as firm yield, TCEQ-permitted yield or operational supply	Chapter 3
3.2.3	Documented any modifications of input data set for WAM Run 3 to reflect return flows and changed conditions	Chapter 3
3.2.3.b	TCEQ's official WAM Run 3 used to determine firm yields of reservoirs	Chapter 3
3.2.3.c	Reservoir firm yield developed in accordance with eight criteria in 3.2.3.c as applicable	Chapter 3
3.2.3.d	TCEQ's official WAM Run 3 used to determine firm diversions from diversion sites	Chapter 3
3.2.3.e	Firm diversion developed in accordance with five criteria in 3.2.3.e as applicable	Chapter 3
3.3	Required Data Elements - Form 1	Chapter 3
3.3	RWP shall document the sources of information and methodologies used to estimate source availability values	Chapter 3
3.3	RWP shall list all water rights permit numbers for each availability source	Chapter 3
3.3	All water used by a WUG must be attributed to one or more sources	Chapter 3
3.3	DB07 Form 1 - Sources completed in accordance with Section 3.3 of Exhibit B	DB07
PART 4	`	
4.1	Introduction	
4.1	All required WUGs shall be included in the Water User Group Form	DB07
4.2.6	Water quality considered as a factor in evaluation of WMS	Chapter 4
4.2.6	Cost of water delivered and treated to end user requirements included for all potentially feasible WMS	Chapter 4
4.2.7.a	Conservation WMS that achieves the most practicable, achievable level of water conservation and efficiency included for each WUG or WWP that will obtain water from a new IBT	Chapter 4
4.2.7.b	Conservation WMS identified by type of measure, estimated savings, timeline and anticipated costs	Chapter 4
4.2.8.c	Use site-specific studies if available, if not the 1997 Consensus Criteria for environmental flows for WMS needing new permits	Chapter 4
4.2.9	Costs of Strategies	Chapter 4

4.2.9	Calculation of debt service in accordance with Exhibit B	Chapter 4
4.2.9	Capital costs to include construction costs, engineering, land and easements, environmental, interest during construction, and purchased water cost (if applicable)	Chapter 4
4.2.9	Annual costs to include operations and maintenance, power cost, purchased water cost (if applicable), and debt service	Chapter 4
4.2.9	Total costs to be discounted and shown in terms of present value	Chapter 4
4.3	DB07 Form 2 - Water User Groups completed in accordance with Section 4.3 of Exhibit B	DB07
PART 5	**Data by Wholesale Water Providers**	
5.1	Introduction	
5.1	All WWPs must be included in the Wholesale Water Providers form	DB07
5.1	All the WWPs contractual or non-contractual obligations throughout the 50-year planning horizon must be included	Chapter 3
5.2.2	If a recipient shows a need, WWP must include a WMS to address that need	Chapter 4
5.3	DB07 Form 3 - Wholesale Water Providers completed in accordance with Section 5.3 of Exhibit B	DB07

ATTACHMENT 7-2

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CHAPTER 8.0 : UNIQUE STREAM SEGMENTS/RESERVOIR SITES/LEGISLATIVE RECOMMENDATIONS

In addition to making recommendations regarding strategies for meeting current and future water needs, TWDB rules for SB 1 regional planning allow the regional water planning groups (RWPG) to include recommendations in the regional water plan with regard to legislative designation of ecologically unique streams, sites for future reservoir development, and policy issues. The Rio Grande RWPG elected to consider recommendations in each of these areas, which are presented in this chapter.

8.1 LEGISLATIVE DESIGNATION OF ECOLOGICALLY UNIQUE STREAM SEGMENTS

TWDB rules for SB 1 regional water planning describe the process by which RWPGs may prepare and submit recommendations for legislative designation of ecologically unique river and stream segments. This process involves multiple steps with the Rio Grande RWPG, the Texas Parks and Wildlife Department (TPWD), the TWDB and, ultimately, the Texas Legislature each having a role. According to SB 1, the Rio Grande RWPG may recommend legislative designation of river or stream segments within the region as "ecologically unique." TWDB rules (30 Texas Administrative Code 357.8) state:

> *Regional water planning groups may include in adopted regional water plans recommendations for all or parts of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the segment documented by supporting literature and data.*

According to state law (Texas Water Code Sections §6.101 and §10.053), state agencies and local units of government cannot develop a water supply project that would destroy the ecological value of a river or stream segment that has been designated by the Texas Legislature as ecologically unique. Also, the TWDB is prohibited from financing water supply projects that would be located on a stream segment that has been designated as ecologically unique.

TWDB rules provide that the RWPGs forward any recommendations regarding legislative designation of ecologically unique streams to the TPWD and include TPWD's written evaluation of such recommendations in the adopted regional water plan. The RWPG's recommendation is then to be considered by the TWDB for inclusion in the state water plan. Finally, the Texas Legislature will consider any recommendations presented in the state water plan regarding designation of stream segments as ecologically unique.

8.1.1 Criteria for Designation of Ecologically Unique Stream Segments

TWDB rules also specify the criteria that are to be applied in the evaluation of potential ecologically unique river or stream segments. These are:

- Biological Function: stream segments that display significant overall habitat value, including both quantity and quality, considering the degree of biodiversity, age and uniqueness observed, and including terrestrial, wetland, aquatic or estuarine habitats;
- Hydrologic Function: stream segments that are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization or groundwater recharge and discharge;
- Riparian Conservation Areas: stream segments that are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas or other areas held by governmental organizations for conservation purposes, or segments that are fringed by other areas managed for conservation purposes under a governmentally-approved conservation plan;
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; and/or,
- Threatened or Endangered Species/Unique Communities: sites along streams where water development projects would have significant detrimental effects on state- or federally-listed threatened and endangered species, and sites along segments that are significant due to the presence of unique, exemplary, or unusually extensive natural communities.

8.1.2 Candidate Stream Segments

To assist each of the 16 RWPGs, the TPWD developed a list of candidate stream segments in each region that appear to meet the criteria for designation as ecologically unique. For the Rio Grande Region, TPWD prepared a report entitled *Ecologically Significant River and Stream Segments of Region M, Regional Water Planning Area* (May 2000) that presents information on four (4) stream segments within the region that meet one or more of the criteria for designation as ecologically unique. (The report is available on-line at http://www.tpwd.state.tx.us/texaswaters/sb1/rivers/unique/regions text/region m.htm.) The Rio Grande RWPG also received suggestions from the U.S. Fish & Wildlife Service, Zapata County, and the Texas Shrimp Association through two stakeholder “focus group” meetings during the previous plan. The focus group meetings were held in December 1999 and January 2000 and over 200 individuals representing local, state, and federal agencies, environmental groups, and other parties with a known interest in the subject received written invitations to attend and provide input. Nominations for stream segment designations, as well as support for TPWD-nominated segments, were received at both meetings. The information provided by the TPWD and through the focus group meetings is summarized in Table 8.2.

Subsequent to the last plan, a request for additional consideration of unique stream segments was made. An Environmental Subcommittee to the RGRWPG was formed to look in greater detail at various environmental issues related water management strategies, unique stream segments and other items affecting environmental considerations. The subcommittee met on several occasions with discussion relating to the unique stream segments on the Rio Grande. The U.S. Fish and Wildlife Service and the TPWD made formal requests for designation of unique stream segments on the Rio Grande. A workshop was held by the RGRWPG for a presentation by the TPWD on January 25, 2005. No action was taken then. A meeting of the subcommittee was held February 16, 2005 to consider the proposals. A motion was made to accept the designation of the segment of the Rio Grande from the mouth of the Rio Grande upstream to the upstream boundary of the U.S. Fish and Wildlife Service Tulosa tract. The motion died for a lack of a second.

8.1.3 Recommendation

The Rio Grande RWPG reviewed the nominations submitted by TPWD and others with regard to legislative designation of river or stream segments as ecologically unique. The Environmental Subcommittee had no recommendation for the RGRWPG for inclusion in the plan. Designation would have the advantage of allowing entities to receive federal and state financial assistance for the preservation of lands adjoining these segments. The perceived disadvantage to the RGRWPG would be that a designation could cause that segment to be more susceptible to such issues as environmental flows and water quality issues upstream of the designation. Lack of action by the RGRWPG indicates a non-designation of unique stream segments recommendation at this time. It was agreed that the issue could be brought up and considered in the future.

Figure 8.1: TPWD Proposed Ecologically Significant Stream Segments

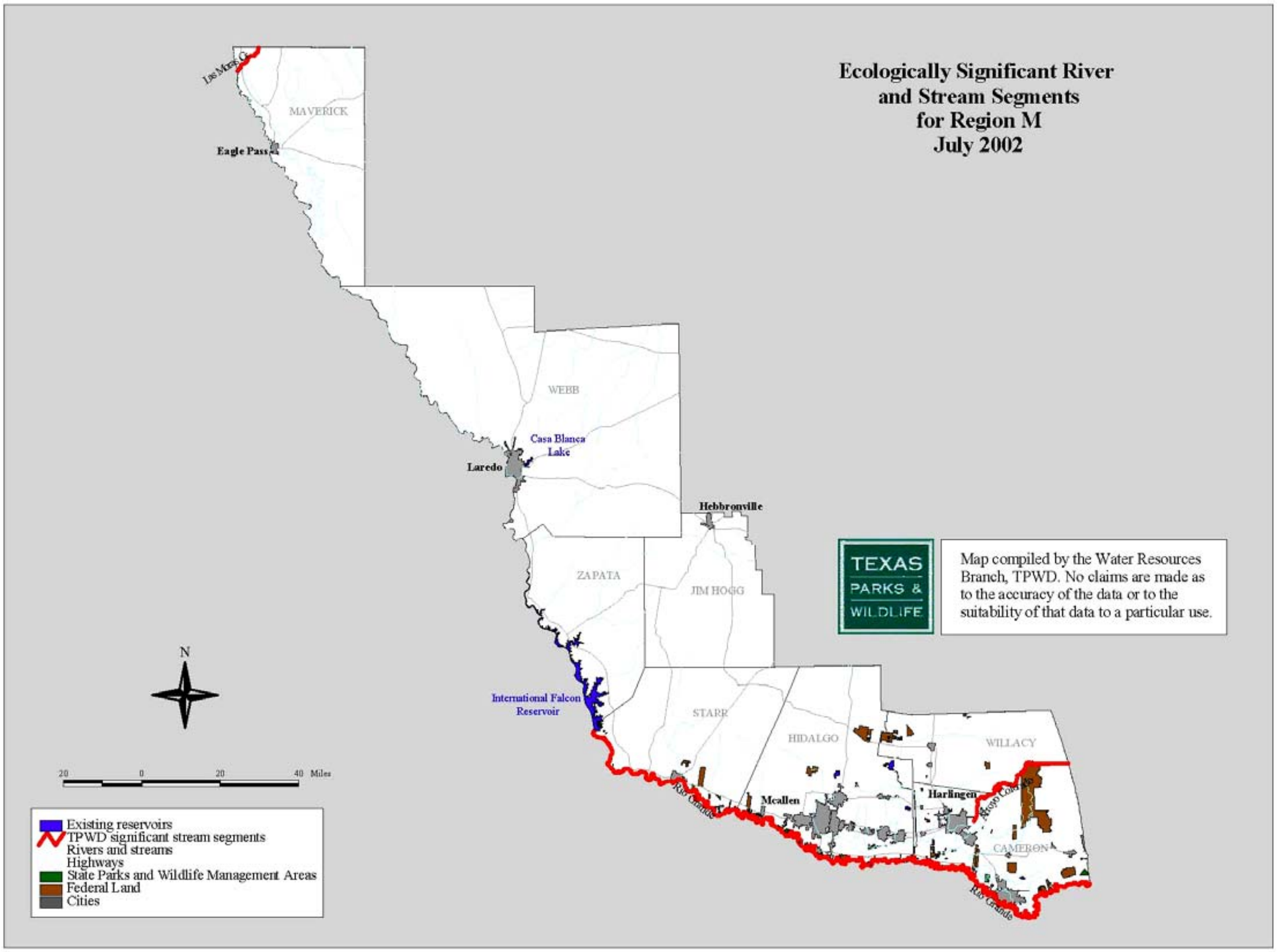


Table 8.1: Potential Ecologically Unique River and Stream Segments within the Rio Grande Region Group

River segment number	TCEQ segment ID number	Basin/ Waterway	Location/ Sublocation	Remarks and Nominating Entity	Functions **B:** Biological **H:** Hydrological **RCA:** Riparian Conservation Areas **Q:** High Water Quality, Exceptional Aquatic Life, High Aesthetic Value **S:** Threatened or Endangered Species, Unique Communities
1		Lower Rio Grande /Las Moras Creek	From confluence with Rio Grande in Maverick County upstream to Maverick/Kinney County line	Entire segment identified as significant, but primary area of concern due to spring-fed springs lies in Kinney County, outside Region M boundaries. Selection criteria from *Ecologically Significant River & Stream Segments of the Rio Grande (Region M) Regional Water Planning Area* (TPWD) Nominated by: TPWD	**B:** Riparian habitat with trees & shrubs; habitat & associated water very valuable for fish/wildlife **H:** Regulation & protection of baseflows, fisheries habitat, water supplies & groundwater **RCA:** None identified on this segment **Q:** Ecoregion stream, dissolved oxygen, benthic macroinvertebrates; aesthetic & economic value for fishing, birding, hiking, picnicking, camping **S:** wood stork, least tern, Proserpine shiner, ocelot, jaguarondi, several other state-threatened species
2	2301 2302	Lower Rio Grande/Rio Grande	From confluence with Gulf of Mexico in Cameron County upstream to Falcon Dam in Starr County	Selection criteria from *Ecologically Significant River & Stream Segments of the Rio Grande (Region M) Regional Water Planning Area* (TPWD) Nominated by: TPWD with support from FWS – Lower Rio Grande National Wildlife Refuge, Zapata County, and Texas Shrimp Association	**B:** Extensive freshwater and estuarine wetland habitat, resaca woodlands, lomas, emergent saltmarsh, seagrass beds in South Bay **H:** Flood control; regulation/protection of fisheries, water supplies, groundwater & baseflows in the river; freshwater inflow prevents saltwater intrusion **RCA:** Lower Rio Grande Valley NWR; Bentsen Rio Grande SP; Santa Ana NWR; Sabal Palm Sanctuary; Boca Chica SP; S. Bay Coastal **Q:** Overall use; benthic macroinvertebrates; high economic value for fishing, boating & birding; important for common snook population **S:** Texas ayenia, piping plover, Blackfin goby, several other state threatened species; Black Mangrove Series; Texas Palmetto
2A		Lower Rio Grande/Rio Grande	From confluence with Gulf of Mexico in Cameron County upstream to Falcon Dam in Starr County/ From Roma area upstream to Falcon Dam	No documentation submitted Nominated by: FWS – Lower Rio Grande National Wildlife Refuge	**S:** Wild muscovy duck, hookbill kite, breeding populations of brown jay and red-billed pigeon
2B		Lower Rio Grande/Rio	From confluence with Gulf of Mexico	No documentation submitted	**S:** Unique marine organisms, including blue land crab & red land crab

		Grande	in Cameron County upstream to Falcon Dam in Starr County/ From confluence with Gulf of Mexico upstream to just east of Brownsville	Nominated by: FWS – Lower Rio Grande National Wildlife Refuge	
2C		Lower Rio Grande/ Rio Grande	From confluence with Gulf of Mexico in Cameron County upstream to Falcon Dam in Starr County/ From Rio Grande City area upstream to south of Falcon Dam	No documentation submitted Nominated by: Project Coordinator, Zapata County	
2D		Lower Rio Grande/Rio Grande	From confluence with Gulf of Mexico in Cameron County upstream to Falcon Dam in Starr County/ From confluence with Gulf of Mexico upstream to Laredo area	No documentation submitted Nominated by: Texas Shrimp Association	**B:** Recruitment value/ productivity of estuary, importance to marine shrimp of Laguna Madre and Gulf **H:** Geology/function of the Rio Grande/ Nueces Basin and the Tamaulipan Plain
3		Lower Rio Grande/Rio Grande	Rapids in 3 to 5-mile stretch, from just south of Rio Bravo in Zapata County, near Laredo	No documentation submitted Nominated by: Project Coordinator, Zapata County	**H:** Water-quality data indicate aeration improves water quality below rapids
4	2201	Lower Rio Grande/Arroyo Colorado	From confluence with lower Laguna Madre upstream to Harlingen area	Selection criteria from *Ecologically Significant River & Stream Segments of the Rio Grande (Region M) Regional Water Planning Area* (TPWD) Nominated by: TPWD with support from Rio Grande RWPG member on behalf of Cameron County Commissioner; and Texas Shrimp Association	**B:** Unique because inflow from Arroyo provides main source of freshwater to Laguna Madre; recruitment value/ productivity of estuary, importance to marine shrimp of Laguna Madre and Gulf **H:** Downstream flood control; regulation of baseflows; protection of fisheries, water supply, groundwater; helps prevent saltwater intrusion upstream **RCA:** Laguna Atascosa NWR, Goat Island Wildlife Management. Area, City of Harlingen property **Q:** High water quality/exceptional aquatic life/high aesthetic value **S:** Brown pelican, piping plover, ocelot, jaguarundi, Texas ayenia, sheep frog, common black-hawk, Coues' rice rat, and several other state threatened species
5		Lower Rio Grande/Los Olmos Creek		Only upon confirmation that stream is not intermittent	

8.2 RESERVOIR SITES

TWDB rules (31 TAC, Section 357.9) for the preparation of regional water supply plans provide that the regional water planning groups "…may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and the expected beneficiaries of the water supply to be developed at the site." TWDB rules further specify that the following criteria be applied to determine whether a site is unique for reservoir construction:

1. *site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted regional water plan; and,*
2. *the location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics or other pertinent factors make the site uniquely suited for:*

a. *reservoir development to provide water supply for the current planning period; or,*

b. *where it might reasonably be needed to meet needs beyond the 50-year planning period*.

Two reservoir sites have been considered by the Rio Grande RWPG: (1) the proposed Brownsville Weir and Reservoir; and (2) the proposed Webb County low water dam. Each project is briefly discussed below.

8.2.1 Brownsville Weir and Reservoir

An overview of the proposed Brownsville Weir and Reservoir is provided in Chapter 5 of this plan. The City of Brownsville Public Utilities Board (PUB) has acquired the required state water right permit and the federal Section 10/404 permit for this project and has obtained federal funding for engineering design and construction. Currently, the PUB is working with the U.S. and Mexican Sections of the International Boundary and Water Commission (IBWC) to develop an implementation plan for the project, including consideration of ownership, financing and operational issues. Implementation of the project will require approvals from the IBWC and Mexico. The PUB also is discussing a partnership with the City of Matamoros for the project whereby the two cities would share in the benefits of the project. It is anticipated that the earliest that the project would be in operation is the end of 2008.

The Brownsville Weir and Reservoir project is expected to provide approximately 20,000 acre-feet per year of additional dependable surface water supply for the City of Brownsville. This additional supply will play an important role in meeting Brownsville's projected water supply needs through the planning period. The development of the project is included as a recommended water supply strategy in the first (2001) Rio Grande Regional Water Plan (Region M) and in the resulting (2002) State Water Plan. It is also recommended in this Regional Plan (2005).

8.2.2 Webb County Low Water Dam

Webb County has been investigating the feasibility of developing a low water dam on the Rio Grande approximately one-mile upstream of the World Trade Center Bridge. The project will not develop additional water supply. Rather, the project is proposed to improve water quality, provide a diversion location for a new regional water treatment plant, and provide hydroelectric power. Recreational amenities may also be developed. The proposed structure would be 30 feet high, which would provide a water surface elevation below the 100-year flood plain. The design and operation of the structure would not alter the normal flows of the Rio Grande. The dam would impound 20,000 acre-feet of water. Webb County intends to lease irrigation water rights for the initial filling of the reservoir.

At the request of Webb County, the Rio Grande RWPG has endorsed further investigation of the feasibility of the Webb County low water dam. This would include more detailed evaluation of project costs, benefits, impacts, and permitting requirements.

8.2.3 Recommendations

Neither the Brownsville Weir and Reservoir nor the Webb County Low Water Dam is recommended for designation as a unique reservoir site at this time.

8.3 LEGISLATIVE RECOMMENDATIONS

Texas Water Development Board rules provide that regional water plans may include "regulatory, administrative, or legislative recommendations that the regional water planning group believes are needed and desirable to facilitate the orderly development, management, and conservation of water resources and preparation for and response to drought conditions…." [31 TAC 357.7(a)(10)]

8.3.1 Recommendations in 2000 Plan

In the initial round of planning that culminated with the 2000 regional plan, the Rio Grande RWPG identified 12 issues affecting water policy and planning. The group elected to make recommendations on 10 of those issues. These issues, the group's recommendations, and subsequent developments on the issues are presented in Table 8.2.

Table 8.2: RGRWPG 2000 Recommendations and Update

Issue	2000 Plan Recommendations	Status
Creation of a regional water management entity	The Texas Legislature create a regional water entity for the purposes of management of the waters of the Rio Grande, development of water conservation and water supply projects, water quality monitoring and planning, and other purposes and functions typically performed by agencies created under Article 16, Chapter 59 of the *Texas Constitution*.	The Lower Rio Grande Authority, created in 1951 reconstituted itself. Composed of irrigation districts in Cameron, Willacy, Hidalgo Counties; added nonvoting members representing municipal water interests. The LRGA was abolished in 2005 by HB 2639 Rio Grande Regional Water Authority created by SB 1902 by Sen. Lucio. Encompasses Rio Grande Regional Water Planning Area, minus City of Laredo and Jim Hogg County. Irrigation and municipal interests represented. Four vacancies remain unfilled.
Mexico's compliance with the 1944 Treaty	1. The U.S. government take all necessary and appropriate actions to ensure full compliance by Mexico with the terms of the 1944 Treaty and Minute No. 234	1. Mexico repaid the water debt in the fall of 2005.

	governing the development and use of the waters of the Rio Grande. 2. The dialogue continue between the U.S. and Mexico with regard to the development of an operating plan for Mexican tributary reservoirs that will ensure full compliance with the treaty while also optimizing the amount of water supply available to Mexico for beneficial use. 3. The U.S. Section of the International Boundary and Water Commission continue to seek and provide opportunities for direct stakeholder participation in bi-national discussions regarding the management of the waters of the Rio Grande.	2. No definite plan for ensuring compliance. 3. IBWC has organized stakeholder groups, including the Lower Rio Grande Citizens' Forum (LRGCF), to act as a focal point for the exchange of information between it and local communities regarding USIBWC projects in the area. The LRGCF Board has 11 members representing diverse interests and approximately four times per year.
Agricultural lands preservation	Municipalities and irrigation districts in the LRGV coordinate closely on matters of urbanization and its implications for both urban and agricultural water supply infrastructure planning and development because reduction of irrigated acreage as a result of urbanization has important implications for district operations and deliveries to municipalities as well as agricultural producers.	2004 and 2005 Valley Water Summits have created opportunities for dialogue between municipalities and irrigators and new understanding of issues. The parties are working together to develop list of mutually beneficial projects.
Regionalization of water & wastewater utility services	Further regionalization of water and wastewater utility services be investigated and implemented where appropriate, because regionalization of urban water supply and/or wastewater systems offers the potential for significant cost savings in acquiring water supplies for urban use, as well as the potential for reduced costs and improved reliability of water and wastewater utility services.	Several consortia are implementing regional projects, particularly brackish groundwater desalination. These include the Southmost Regional Water Authority and projects involving North Alamo Water Supply Corp.
Irrigation district water allocation policies	Irrigation districts review their water allocation policies, procedures, and practices to facilitate water transfers among agricultural users. In addition to providing a method for equitable water distribution during periods of shortage, water allocation by irrigation districts has also enabled an active water market within the agricultural sector.	The Lower Rio Grande Authority servrf as a forum for districts to work together. The LRGA created an on-line Water Market to facilitate sales of wet water and water rights among all users. The Rio Grande Regional Water Authority may continue these initiatives.
Water availability models	State funding be provided for development of a state water availability model for the Rio Grande River Basin.	The Rio Grande WAM was completed in Sept. 2004, providing important data on inflows and firm yield.
Re-channeliza-tion/ Restoration of the Rio Grande	Federal funding be provided to the IBWC for an in-depth investigation of the costs, benefits, and impacts of re-channelizing a portion of the Rio Grande upstream of the Amistad Reservoir. The proposed study would examine whether periodic removal of salt cedar and other vegetation, along with channel improvements, would increase water flows in this stretch of the Rio Grande and allow passage of more flows from upstream reaches of the river.	
Desalination	The State consider funding additional research/ development of groundwater desalination projects and offer financial assistance and incentives for implementation.	TWDB has selected three groundwater desalination projects as demonstrations, including one coordinated by the North Cameron Regional WSC. Funding for the projects is expected in January 2006.

		The Boardalso funded feasibility studies for three potential seawater desalination projects, including a project of the Brownsville PUB. TWDB anticipates funding pilot plant for each of the three projects, beginning in the spring of 2006. In August 2003, the Rio Grande RWPG amended the 2001 adopted regional water plan to include brackish groundwater and seawater desalination as water management strategies.
Funding for data collection, review, reporting activities and for preparation of feasibility level studies	1. TWDB provide funding for data collection activities in rural areas, including establishing and adequately funding the collection and distribution of groundwater availability data. 2. The Legislature provide funding for the cooperative, federal-state-local program of basic water data collection, including collection, assimilation and analysis of basic data needed to assess the ground and surface water resources of each region to a 90 percent accuracy level. 3. TWDB and Texas Natural Resource Conservation Commission (now the Texas Commission on Environmental Quality) facilitate access to water data essential for local and regional planning and plan implementation purposes. 4. TWDB and TNRCC expand activities in collecting, managing, and disseminating information on groundwater conditions and aquifer characteristics. 5. SB1 be amended to allow state funding of ongoing regional data collection activities that are sponsored by RWPGs. 6. TWDB study the effects of groundwater consumption on springflow.	TWDB currently has a water-level and water-quality monitoring program that covers the entire state, including rural areas. TWDB has obtained groundwater availability models for all of the major aquifers of the state and continues to develop models for the minor aquifers. TWDB provides GAM runs to groundwater conservation districts and regional water planning groups free of charge. The Legislature provides the TWDB with funding to monitor the flow in the state's rivers in cooperation with the U.S. Geological Survey and local cooperators. However, costs have increased while state funding has remained level. TWDB has placed all regional water plans on its web page for public access, plus some information from the plan databases. TWDB plans to place most if not all information from the databases for the 2007 State Water Plan on the web. TWDB continues to strive to collect, manage, and disseminate information on the state's aquifers. Through the GAM program, TWDB has collected considerable information on the state's aquifers. TWDB is working to organize this information is geodatabases to make available over the web. TWDB has also continued to support basic research in groundwater with work on brackish groundwater, recharge, and evapotranspiration.
Modifications to planning process	1. The grass roots regional water planning process enacted by SB1 be continued with appropriate funding. 2. TWDB and TNRCC evaluate the effect of groundwater withdrawal on surface water availability and streamflows. 3. The planning process provide for consistency in whether normal water conservation assumptions should be included in the supply and demand projections, or as water management strategies for	The second round of water planning has included funding of activities necessary for grass-roots participation. The planning process also must consider impacts to natural resources and the environment and must consider water quality factors in developing water management strategies. Funding for implementation continues to be an issue.

	conserving/developing water supplies. 4. The next phase of planning include the review of population estimates immediately after 2000 census results are available. 5. TWDB revise its rules for regional water planning to allow multiple options rather than a single scenario to be put forth as recommended strategies for meeting the needs of individual water user groups. 6. Water quality play a more important role in future planning efforts. 7. Wildlife and environmental water needs be established as a category of water use and be quantified by the TPWD for input into the next planning phase and that the definition of beneficial use regarding water rights permit be expanded to include usage by natural resources, wildlife, and wildlife habitat. 8. TWDB work to expedite funding for implementing strategies on a localized level.	Review completed. Envirornmental flows are considered in the 2006 regional water plan.

8.3.2 Issues Identified in Current Planning Process

In the second round of regional water planning, the TWDB emphasized "input from RWPGs for the policy portion of the 2007 State Water Plan." (Memo from William Mullican, Deputy Executive Administrator, Office of Planning, July 2, 2003) The Board disseminated an "Initial List of Policy Topics" as a catalyst for discussion among the planning groups. In September 2003, Rio Grande Regional Water Planning Group members ranked each issue on the list as to level of importance in the region's water planning efforts ("not at all important", "somewhat important," important," "extremely important").

The policy issues receiving top rankings from Rio Grande RWPG members fell into four major categories:

A. International Treaty Compliance

B. Competing Water Demands Between Agricultural & Municipal Interests
   - Sustainable growth, including impacts of growth
   - assessment of the current water resources regulatory system to meet water management needs of the 21st century
   - impacts on water supply and quality resulting from conversion of agricultural lands to urban lands
   - protecting agricultural and rural water supplies, considering economic constraints and competing purposes
   - conservation of agricultural water for additional agricultural use, urban use or for environmental purposes

C. Alternative Water Supply/Water Quality
   - integrating water quality and water supply considerations
   - watershed planning/source water protection
   - sustainability and groundwater management

D. Technical & Financial Resources
   - state participation

- potential funding sources for water supply
- retail customer water pricing
- incentives for planning implementation
- improving groundwater availability data
- education

The Rio Grande RWPG also approved a resolution encouraging the formation of groundwater conservation districts and greater oversight by of sales of groundwater produced from State-owned lands. The group also approved motions supporting the following:

- capping abandoned oil and gas wells;
- improving the stretch of the Rio Grande known as the "Forgotten River";
- identifying and eradicating growing stands of salt cedar; and
- supporting Valley Water Summits.

The Rio Grande RWPG firmly believes that these issues are tightly interconnected and that they cannot be discussed, much less resolved, in a vacuum.

Many of the issues and needs of the region arise from the fact that the Rio Grande is an international river whose waters are shared by the U.S. and Mexico. No other regional water planning area faces this reality. Water right holders in Texas lack any ready recourse to compel Mexico to observe the 1944 Treaty that apportions inflows between the countries. In addition, international protocols impact efforts to address water quality and resolve problems created by aquatic weeds, such as hydrilla and water hyacinth, and other invasive species, including salt cedar.

Although Mexico now has repaid its water debt, there are no enforcement mechanisms for preventing similar situations in the future.

Because of the unique way in which water rights are prioritized along the Rio Grande, the Mexican water debt has first and foremost directly impacted agricultural interests. However, repercussions from the debt also have affected municipal and industrial users. With the few exceptions of the Brownsville Public Utility Board, Laguna Madre Water District (serving Port Isabel, South Padre Island and Laguna Vista) and the City of Laredo, municipal users of surface water depend on irrigation districts to pump and convey water supplies to their treatment plants. When irrigation flows are curtailed, municipalities must either find new ways to push raw water or turn to alternative sources.

Brackish groundwater resources have rapidly become a viable alternative for municipal suppliers located at a distance from the Rio Grande. In the first round of planning, the Rio Grande RWPG recommended that desalination be considered, but did not list it as a water management strategy for any water user group; in 2003, the plan was amended to incorporate desalination as a strategy for almost half of the 63 municipal water user groups in the region. Improvements in technology, coupled with the soaring cost of surface water rights, are making groundwater desalination an economical and reliable option. However, limited research has been conducted on the quality and quantity of groundwater supplies in the region. Furthermore, groundwater in certain parts of the region is threatened by abandoned uncapped oil and gas wells.

Irrigation districts also are looking to new technology and improved processes to minimize conveyance and evaporation losses attributable to an aging infrastructure. Districts do not have ready access to low-cost loans that are readily available to municipal suppliers. Several districts have secured funding from the North American Development Bank and the U.S. Bureau of Reclamation, but others cannot meet the local match requirements.

The water debt has created both challenges and opportunities for municipal and irrigation users to work together. The Rio Grande RWPG has supported initiatives such as the Valley Water Summits that bring different interests together to share problems and jointly create solutions.

The Watermaster Advisory Committee (WAC) also has proven to be an effective forum for addressing issues. Subsequent to the first planning cycle, the committee developed a rule change that freed up water in storage for irrigation use with no detriment to municipal supplies. Operations of the Rio Grande Watermaster are paid entirely by fees levied on water right holders. However, appropriations to the Watermaster are capped at a level that is significantly lower than revenues. This limits the ability of the office to provide services to meet changing needs, such as maintaining and updating the newly developed Rio Grande Water Availability Model.

Particular attention should be directed to rules pertaining to water rights. Currently, when the intended use of irrigation water rights is changed to municipal and industrial use, a conversion factor provided in 30 TAC § 303.43 is applied so that the municipal use after conversion will receive a "definite quantity of water in acre-feet per annum." This rule is consistent with the treatment of certain municipal, industrial and domestic allocations approved in the Final Judgment of the Valley Water Suit, which provided for a reserve of 60,000 AF/year to be held for domestic use and use by cities to support these allocations. This reserve was increased to 225,000 AF/year, under a conversion rule adopted by the then Texas Water Rights Commission on July 2, 1986, following the conclusion of the Middle Rio Grande Adjudication. Information developed through the WAM and as part of the Regional Planning process would indicate that this practice should be reviewed with respect to long term water management practices on the Lower and Middle Rio Grande downstream from Amistad Reservoir. Additional studies are required to analyze the long term impact of reducing authorized municipal and industrial reserves on two fronts: (1) providing a defined entitlement and (2) promoting water conservation in both Amistad and Falcon Reservoirs. Environmental flows also have been critically impacted by the water debt and over-reliance on surface water supplies. During the second round of regional planning, the Rio Grande actually ceased flowing into the Gulf of Mexico.

As noted in Chapter 7, one possibility for maintaining and increasing environmental flows is the purchase of Rio Grande water rights by an environmental entity. Deposited in a trust, these water rights could be managed to produce sufficient flows throughout the region. However, this option may not be viable because of the current water rights purchase and transfer structure. In addition, because of the WUG format currently being implemented by the TWDB, no option exists to formally allocate projected water supplies for environmental use. Environmental flows in the Rio Grande could be included as a separate WUG in the next round of regional planning to ensure minimums would be met in a manner consistent with all other WUGs.

International cooperation is critically needed to maintain flow levels. If the United States were to implement an environmental flow program without that country's participation, the desired effect would be significantly reduced.

Finally, international attention also could enhance water quality as well as safety. Lower valley water interests have been responsible for a significant portion of the construction and upkeep of El Morillo Drain, built in 1969 to divert salty water from the Rio Grande. Currently, The International Boundary and Water Commission has proposed to assume complete responsibility for the U.S. share of the upkeep, including maintenance of levees. The Rio Grande Regional Water Planning Group supports this move.

8.3.3 Recommendations

Because of the issues summarized above, the Rio Grande RWPG makes a number of recommendations for action to address regional water needs. Some of these recommendations fall within the authority of the State of Texas; others must be addressed through the auspices of the International Boundary and Water Commission and/or other international and federal agencies. Accordingly, the recommendations have been categorized, as follows.

Recommendations on State Issues

- The State of Texas should consider factors other than merely population in funding the planning process in Region M because of the unique circumstances affecting water supply in the area.
- The State should continue financing brackish groundwater projects and the demonstration seawater desalination project as means to increase water supply alternatives in the region.
- The State should authorize the Rio Grande Watermaster to manage the Rio Grande WAM and should fully appropriate to the Texas Commission on Environmental Quality fees paid by Rio Grande water right holders as specified in Section 11.329 of the Texas Water Code for the purpose of fully funding Rio Grande Watermaster operations.
- The State should assist in finding new technical and financial resources to help the region combat aquatic weeds and salt cedar and thus protect its water supplies. The Rio Grande RWPG joins with the Far West Texas and Plateau RWPGs to encourage funding for projects aimed at eradicating salt cedar in the Rio Grande watershed and for ongoing long-term brush management activities.
- The State should continue providing technical and financial resources to fully develop the regional GAM.
- The State should amend the planning process to allow for treating each irrigation district with the region as a WUG, rather than as part of "County-Other," in order to allow for development of individual water management strategies for the districts.

- The Texas Commission on Environmental Quality should provide assistance to the Rio Grande RWPG as it reviews rules on converting water rights from one use to another and considers appropriate rule amendments, if necessary.

- Entities within the region are encouraged to cooperate to resolve water issues through such means as regional water and wastewater utilities.

- The formation of groundwater conservation districts is encouraged as a means to protect groundwater supplies, which are increasingly being tapped as a new water supply for municipal and industrial use.

- The State should appropriate sufficient funds to the Texas Railroad Commission to allow for capping abandoned oil and gas wells that threatened groundwater supplies.

- The Texas Legislature should provide technical and financial assistance to implement water management strategies identified in the regional water plans.

- The Texas Legislature should appropriate funds to continue the regional water planning process.

- The Texas Legislature should appropriate funds to the Texas Water Development Board to implement and provide assistance to water user groups in developing and implementing appropriate Advanced Water Conservation measure, including a statewide public outreach and education program.

Recommendations on National and International Issues

- The International Boundary and Water Commission (IBWC) should renew efforts to ensure that Mexico complies with Minute 309 and set in place means to achieve full compliance with the 1944 Treaty, including enforcement of Minute 234, which addresses the actions required of Mexico to completely eliminate water delivery deficits within specified treaty cycles. Water saved in irrigation conservation projects in Mexico should be dedicated to ensure deliveries to the Rio Grande pursuant to the 1944 Treaty under Article 4B(c) and Minute No. 234.

- The United States and Mexico should reinforce the powers and duties of both Sections of the IBWC pursuant to Article 24(c) which provides, among other things, for the enforcement of the Treaty and other Agreement provisions that "… *each Commissioner shall invoke when necessary the jurisdiction of the Courts or other appropriate agencies of his Country to aid in the execution and enforcement of these powers and duties.*"

- The Minute 309 conservation projects funded by the North American Development Bank and other projects funded by national and international agencies to modernize and improve the facilities of irrigation districts in the Rio Grande Basin should be supported and given priority. In particular, both countries should support continued grant funding for conservation projects through the NADBank's Water Conservation Investment Fund.

- The conservation irrigation projects currently underway through the Bureau of Reclamation for improvement to the irrigation systems of irrigation districts in the Rio Grande Basin in the United States should be supported and implemented.

- For purposes of clarity, the IBWC should approve a Minute setting out the definition of "extraordinary drought" as that term is implicitly defined in the second subparagraph of Article 4B(d) as an event which makes it difficult for Mexico " … to make available the *run-off* of 350,000 acre feet (431,721,000 cubic meters) annually." A drought condition occurs when there is less than 1,050,000 acre feet annually of *run-off waters* in the water sheds of the named Mexican tributaries in the 1944 Treaty, measured as water enters the Rio Grande from the named tributaries.

- Accounting of water between the United States and Mexico pursuant to the 1944 Treaty should be consistent with the 1906 Convention, which provides that all waters measured at Fort Quitman, Texas, are 100 percent allocated to the United States.

- For better water management in the Lower Reach of the Rio Grande, downstream of Anzalduas Dam, both countries should reaffirm operational policies that Mexico continue to take its share of waters through the Anzalduas canal diversion at the Anzalduas Dam or account for its water at that point, including any diversions by Mexico from the proposed Brownsville Weir Project storage, to the extent of its participation in the project.

- IBWC should convene a binational meeting of water planners and water use stakeholders in both countries within six months following completion of the annual water accounting in which an annual deficit in flows from the named Mexican tributaries in the 1944 Treaty occurs. This meeting would be designed to share data and information useful in planning for water needs and contingencies in the intermediate future.

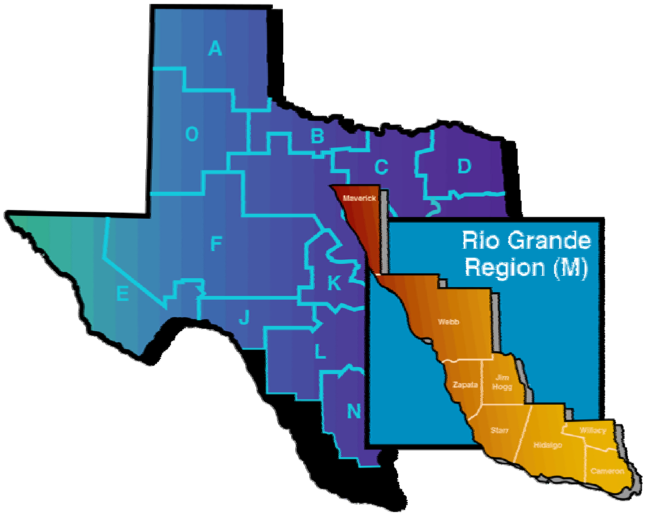
- IBWC should restore the Rio Grande below Fort Quitman, Texas.

- The IBWC should assume all local and regional financial responsibility for upkeep and maintenance of El Morillo Drain.

- IBWC should coordinate bilateral efforts to review and evaluate existing sources of data regarding groundwater development in both countries in the Rio Grande Basin below Fort Quitman to the Gulf of Mexico. This effort should be focused on the potential impact on surface water supply in the Rio Grande watershed, with the goal of pursing such actions as may be necessary to evaluate present conditions and promote programs protecting the historical surface water supply in affected regions.

- Regional watershed planning should be encouraged on both sides of the Rio Grande throughout the basin, including efforts to promote binational coordination of long-range water plans.

- Interstate compacts between affected states in Mexico, similar to the Rio Grande Compact and Pecos River Compact between affected states in the United States, which deal with apportionment of available water supply from the Rio Grande and its tributaries to each state consistent with existing domestic and international law should be encouraged.



CHAPTER NINE:
Infrastructure Financing Report

Region M Regional Water Planning Group

November 2005

Prepared by:
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Infrastructure Financing Report
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Background

The Infrastructure Financing Report (IFR) requirement was incorporated into the regional water planning process in response to Senate Bill 2 (77th Texas Legislature). For purposes of the IFR, each regional water planning group (RWPG) is required to determine proposed financing for all of the water management strategies that were proposed in the first round of planning. For each of these strategies, the RWPG must determine the funding needed to implement the strategy, and what types of funding are likely to be accessed.

According to TWDB guidelines, the primary objectives of the IFR are:

- To determine the number of political subdivisions with identified needs for additional water supplies that will be unable to pay for their water infrastructure needs without some form of outside financial assistance;
- To determine how much of the infrastructure costs in the regional water plans cannot be paid for solely using local utility revenue sources;
- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and,
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

NRS Consulting Engineers was authorized to prepare the Infrastructure Financing Report (IFR) and Policy Statement for the Region M Regional Water Planning Group (RWPG). The list, as provided as a template by the Texas Water Development Board, was used to develop the list of water user groups in need. Names and address lists were developed for each group. A sample letter is included as Appendix A. As per the discussion with the RWPG, it was decided to expand the survey and add additional questions to aid in the current planning process. The supplemental survey is included as Appendix B.

There was also a discussion at the RWPG meeting to include all water supply corporations in the survey that would have fallen under the County-Other category. To help give a better understanding of the irrigation groups, surveys were sent to them also. Data has been summarized to incorporate the general consensus of these groups.

The consultant team attempted to visit each WUG to discuss the surveys and their approach to the financing their water management strategies. 90% percent of the municipal user groups, water supply corporations, and irrigation districts were personally visited within June through November of 2004. In the irrigation category, a presentation and verbal discussion was held at the Irrigation District Managers meeting to get input and attempt to receive a consensus amongst the irrigation districts.

Findings

Information found in the template formulated by the TWDB, was used to merge data into the required survey forms. During the last round of regional planning upon the development of these forms, all but four user groups had zero dollars listed for their future capital expenditures. This was confusing to the recipients of the survey. In addition, the WUG's did not know, for the most part what was in the plan and why these strategies were picked for them.

In the second round of planning most of the WUGs were visited to obtain an in depth representation of the WUG. Decision documents showing the strategies chosen by the entities in 2004 were compiled and revisited in a survey mailed out in October 2005. The entities were given ample time to add comments and corrections to the data gathered for this regional water plan written. The first survey in 2004 asked let the entity state what strategies were they interested in implementing in the next fifty years. At that time they were asked how they were planning to fund it. The second survey pertained more to the financing of the strategies. The data in these surveys were compiled and being used for this plan. Sample letters and surveys can be found in Appendix A and B attached to this report.

Water User Group Summaries

Municipal Water User Groups

The majority of municipal WUG's had strategies that include urbanizatation, advanced water conservation measures and purchase of Rio Grande supplies. There are total of eight counties, 52 cities, and 15 water supply corporations in this regional planning area. Surveys were sent to only those that had been listed in the plan with a need during the fifty-year plan. Of these municipal WUGs, 90% received a personal visitation made by one or more of the consultant team during the months June through November of 2004. As part of the visitation, the survey was explained as to its purpose and the Regional Planning Group's role in the planning process.

The RWPG also sent out two surveys throughout this second round of planning. The first was sent out in the summer 2004 and the second was sent out in October 2005. Samples of the surveys are attached to this report. The surveys were used to obtain additional information about their current thought about water planning and their involvement with the RWPG. The survey also discussed what their focus was with regard to providing water for their future. For the most part, the interviewees indicated that there was a better line of communication between the WUG and the RWPG compared to the last round of planning. They understood that it should be their responsibility to attend public hearings and find out what is going on. Those that had attended the monthly RWPG meetings did not have the time to go to the meetings for four hours. It was noted by interviewees that the brief monthly newsletters being sent to the municipalities to inform them of what actions and updates occurred at the RWPG meeting was beneficial. This region has an estimated total annual cost of $152,096,384 for all municipal water management strategies. The Acquisition of Water Rights through Purchase has the highest yield for municipal strategies at 144,991 acre-ft. Desalination of Brackish Groundwater came in second with 57,880 acre-ft assigned to municipal water user groups.

Summary of Municipal Water Management Strategies

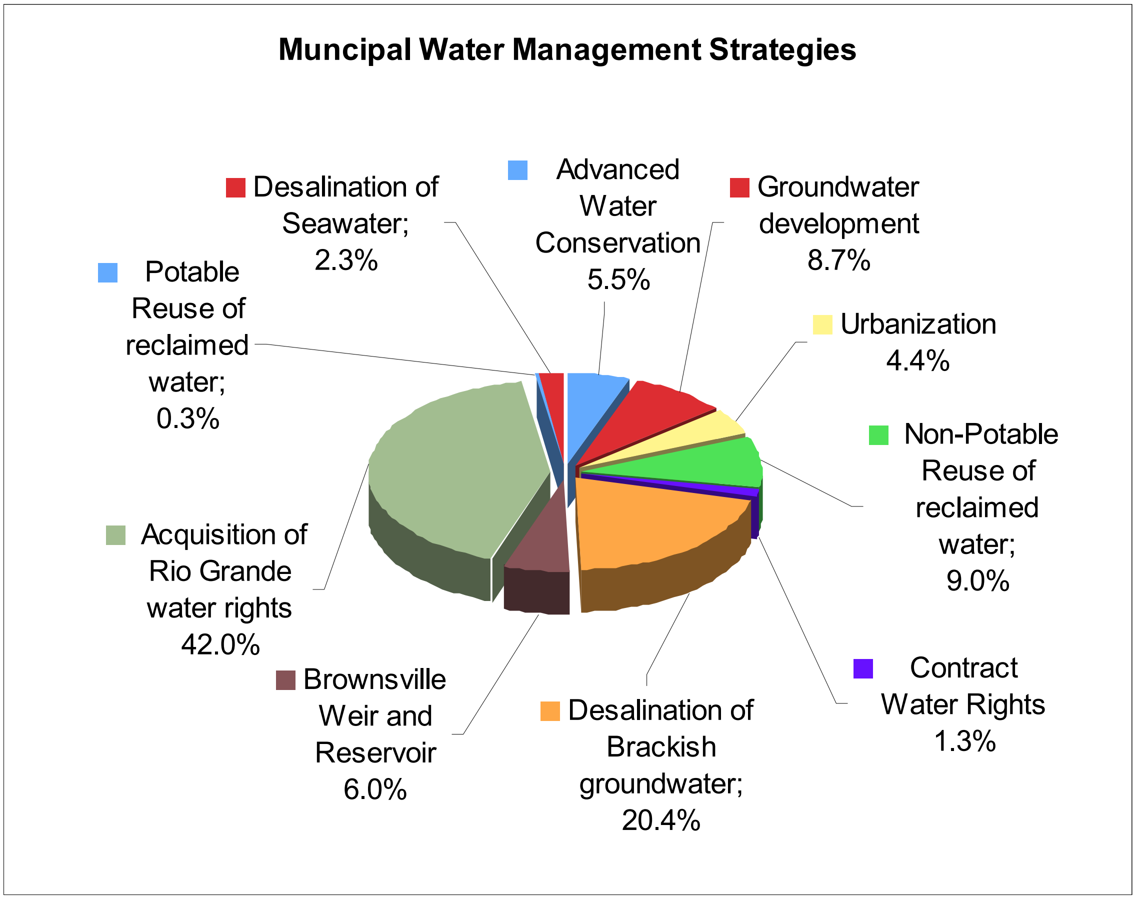
For Municipal users, the strategies recommended for this regional planning area are:

- Advanced Water Conservation;
- Potable Reuse of Reclaimed Water;
- Non-Potable Reuse of Reclaimed Water;
- Acquisition of additional Rio Grande Water through Water Rights Purchase;
- Acquisition of additional Rio Grande Water through Urbanization;
- Acquisition of additional Rio Grande Water through Contract;
- Desalination of Brackish groundwater;
- Desalination of Seawater;
- Groundwater Development; and
- Brownsville Weir and Reservoir.

Table 1: Summary of WMS Yields & Annual Costs

Strategy	Yield, ac-ft (Additional)	Acre-foot Cost (Annual)	Total Annual Cost
Advanced Water Conservation	19,009	$ 112.47	$ 2,137,995
Groundwater development	29,824	$ 304.46	$ 9,080,215
Urbanization	15,245	$ 368.37	$ 5,615,801
Non-Potable Reuse of reclaimed water;	30,841	$ 415.22	$ 12,805,800
Contract Water Rights	4,577	$ 455.56	$ 2,085,053
Desalination of Brackish groundwater;	69,832	$ 505.51	$ 35,300,774
Brownsville Weir and Reservoir	20,643	$ 537.27	$ 11,090,865
Acquisition of Rio Grande water rights	143,944	$ 542.74	$ 78,123,949
Potable Reuse of reclaimed water;	1,120	$ 705.89	$ 790,597
Desalination of Seawater;	7,902	$ 767.63	$ 6,065,812
Total	342,937		$ 163,096,861

Chart 1: Municipal WMSs



The following table shows how the Water User Groups in this region plan to fund the recommended strategies. The majority of the WUGs plan to fund their projects through Bonds. We had several surveys that stated that they wanted 100% of their projects to be funded through bonds.

Table 2: Summary of Funding for Municipal Strategies

	Total Annual Costs	Bonds	Cash Reserves	Federal Government Programs	State Government Programs	Other
Municipal WMSs	152,096,384	40%	8%	33%	16%	3%

1. <u>Advanced Water Conservation Measures</u> – All municipal WUGs listed this strategy for water supply needs. All cities had a water conservation plan in place according to TCEQ regulations. The larger entities usually had a budget for

information and education. McAllen has a full time staff member to implement water conservation measures.

To achieve the estimated water savings associated with the advanced municipal water conservation scenario, a significant commitment of funding and other resources to implement the measures will be required. Cost elements of a program to achieve the estimated savings include funding for educational and public awareness activities and staff to manage and implement the various programs. It is important to note that the investment in municipal water conservation requires substantial front-end funding at the outset and for the duration of the planning period. Because the effects of conservation are incremental and build over time, the initial costs on a unit basis are relatively high at the outset and then decline significantly over time. The cost for Advanced Conservation will take into consideration the population of the region multiplied by the cost proposed for public education & school education by Best Management Practices Guide provided by TWDB which is estimated to be $5/person. The population will be multiplied by the cost of conservation education and divided by the savings of water annually for public education. The population of school age children based on the 2003/ US Census will be multiplied by the cost of school conservation education and divided by the savings of water annually for school education. The cost of Advanced Water Conservation cost is estimated at $112.47 per acre-ft saved.

A total annual cost of $2,137,942 for a 19,009 acre-ft yield. All indicated that the extended portion strategy would have to be funded by some other source than local funds.

2. Acquisition of Water Rights Through Urbanization – Discussions with the WUG have resulted in some confusion as to what urbanization is and how the costs were generated by the RWPG. Some of the entities require development to provide water required from the development of agricultural land into residential/commercial development. The process varies considerably from entity to entity. Most areas receive some sort of funds or water rights through development in the form of impact fees, direct transfer of water rights, tap-in fees or other method of accounting for the growth within the city. Other entities receive no compensation for development and water rights are retained within the irrigation district without compensation to the city. Most of these indicated that they are pursuing changes in this procedure.

   Most of the WUGs in the survey did not realize that treatment costs were included in this strategy as it was only for the cost of the water supply to the facilities.

3. Acquisition of Water Rights Through Purchase of Additional Rio Grande Supply - The cost of water rights in this area has increased significantly over the last few years. Current costs exceed the range of $1,900 to $2,100 per acre-foot for municipal rights compared to approximately $700 per acre-foot only five years ago. Most entities have planned purchases as they need water rights. Mostly

smaller entities have listed a need for assistance in the purchase of water rights to meet their needs.

A total annual cost for this strategy is estimated to be $78,692,415 at a 144,991 acre-ft yield which comes out to $542.74 an acre-ft.

Table 3: Water Yield for Acquisition of Rio Grande Water Rights

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Purchase (ac-ft)	15,435	58,856	8	2,227	10,455	55,061	88	1,813
Urbanization (ac-ft)	0	15,245	0	0	0	0	0	0
Contract (ac-ft)	847	2,256	0	0	132	1,337	5	0
Total:	16,282	76,357	8	2,227	10,587	56,398	93	1,813

will be determined by the parties willing buyers and willing sellers, which will also dictate the specific components required to implement this strategy. However, for this planning process it is necessary to provide cost estimates for acquisition of additional Rio Grande water supplies for DMI use. Using the purchase prices for recent water transactions, the estimated cost to purchase water rights is approximated to range from $1,900 to $2,100 per acre- feet. A value of $2000/ac-ft was used.

A total annual cost for this strategy is estimated to be $2,110,154 at a 4,632 acre-ft yield which comes out to $505.51 an acre-ft.

5. Non-Potable Reuse – Ten WUGs in the region listed Non-Potable Reuse as a water management strategy. They are: Brownsville, Harlingen, Laguna Madre Water District, Alamo, Edinburg, McAllen, Mission, Pharr, Rio Grande City, and Laredo. Those entities that have listed this strategy generally agreed that the costs associated with this strategy were projected to be too high. Most of these entities utilize effluent as currently treated for irrigation of golf courses or provide this water for industrial or power plant use. Many of those of which this strategy is not listed are planning on using effluent as strategy in the future.

   A total annual cost for this strategy is estimated to be $2,110,154 at a 4,632 acre-ft yield which comes out to $505.51 an acre-ft.

Table 4: County Yields for Non-Potable Reuse

	Cameron	Hidalgo	Jim Hogg	Maverick	Star	Webb	Willacy	Zapata
Yield (ac-ft)	600	18,991	0	0	50	11,200	0	0

6. Potable Reuse- Currently, only the City of Weslaco is interested in pursuing indirect potable water reuse. By 2010, their goal is to use 1 million gallons/day (1120 ac-ft/yr) of reuse water to facilitate potable water demand by blending it with raw water before it enters a treatment facility. This quantity would be available to Weslaco for the extent of the planning study.

   The costs estimates developed for the full-scale potable reuse system evaluated for the City of McAllen were reviewed for this planning effort. In 2000 dollars, capital costs of the project would be approximately $17.8 million. The total annual cost, which includes debt service (6% for 30 years) and operations and maintenance costs, are estimated to be $3.9 million per year. On an annualized basis, the unit cost of the additional water supply would be $535 per acre-foot per year. However, it should be noted that these estimates do not include the costs associated with conventional treatment of the blended raw/reclaimed water supply. These numbers were referenced from the previous regional plan and are based on the McAllen, TX – Demonstration of ZenoGem and RO for Indirect Potable Reuse Pilot Study performed by CH2M Hill.

   A total annual cost for this strategy is estimated to be $790,752 at a 1,120 acre-ft yield which comes out to $767.63 an acre-ft

7. Brownsville Weir and Reservoir – Of all the municipal WUGs in Region M, 1 was listed as using this strategy for water supply needs. Brownsville is the only WUG that lists this strategy as a long term approach to their water supply needs. In addition to other water rights, BPUB currently has authorization to divert up to 40,000 acre-feet per year of "excess flows" from the Rio Grande under TNRCC Permit No. 1838. However, the firm yield of the project (based on hydrologic analysis for the period from 1960 to 1997) is estimated to be 20,643 acre-feet per year. It is currently in process of funding and environmental and international approvals.

   Based on information supplied in the last regional plan, the cost estimate to construct the Brownsville Weir and Reservoir is just less than $36.2 million. TWDB guidelines require an annualized cost to construct the project to deliver water to meet end user based on firm yield requirements. Assuming the firm yield from the diversion is used as the basis for providing treated water for DMI use, the following determination of unit cost was developed. Using TWDB cost estimation guidelines, the inflation adjusted annualized cost to construct, operate, and maintain the project, and provide required treatment, is approximately $13.6 million dollars per year.

A total annual cost for this strategy is estimated to be $11,090,865 at a 20,643 acre-ft yield which comes out to $537.27 an acre-ft. Of this amount, approximately $168 per acre foot is used to develop the water and the balance is used to treat and transfer the water.

8. Develop Local Groundwater – Twelve water user groups in the region listed this strategy. This is a major growth from the last round of regional planning where Laredo was the only WUG that listed groundwater development for their current water management strategy.

   The estimated construction cost of the wellfield is about $2,975,000 (2004 dollars). The estimated construction cost for the wells (assuming depth and production rate for each well of 300 feet and 7.5 MGD). Annual operation and maintenance costs for the wellfield are estimated at $3,239,443. TWDB guidelines require an annualized cost to construct the project and deliver water to the end user based on yield assumptions. Consequently, the estimated unit cost of firm water supply from the wellfield is approximately $304.46 per acre-foot per year (see Appendix). Of this amount, approximately $136.65 per acre-foot is for development of the water and the balance is for treatment and transfer of the water.

   A total annual cost for this strategy is estimated to be $8,891,450 at a 29,204 acre-ft yield which comes out to $304.46 an acre-ft.

Table 5: Groundwater Supply Yield

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft/yr)	2,250	7,774	73	0	4,188	15,539	0	0

9. Seawater Desalination – There are three water user groups with seawater desalination as a water management strategy. They are Laguna Madre Water District (864 acre-ft), The City of Brownsville (7,013 acre-ft), and Laguna Vista (25 acre-ft). Cost estimates were developed for a 1 mgd desalination facility near Port Isabel in 1996. Estimated total project costs are $6 million, with total annual costs of nearly $1.5 million. Based on an estimated firm yield of 1,120 acre-feet per year, the cost estimate per acre-foot is $1,300. During a presentation the project team for the Port of Brownsville project indicated a capital cost of $120 million with a combined debt service and operation cost of $2.50/1000 gallons or

$820 per acre –foot.[1] This indicates that a larger facility is more cost effective due to economies of scale. It is also site specific where placed in conjunction with power generation facilities will lower power costs and provide a combined water intake. It should be noted that this cost representation is only conceptual in nature. It leaves out pipelines and discharge costs that a plant would have to take into consideration also.

A total annual cost for this strategy is estimated to be $682,423 at an 889 acre-ft yield which comes out to $767.63 an acre-ft.

10. Brackish Desalination – The annual cost per acre-ft for this strategy to be implemented in this region was estimated to be at $505.51. The sizes of the brackish desalination plants in this region range from .25 MGD to 7.5 MGD[2]. Further cost data updated to include current projects completed or in the planning and design stage are summarized in the Appendix part of this plan. Costs include Well Field, Well Field Collection and Treatment Facilities. It does not include pumping and distribution costs. A major factor not included in these figures is the cost of water rights. The latest cost to purchase water rights has been approximately $2,000/acre-foot. If financed for 20 years @6% interest, the annual cost per acre foot would be $542.74. This could be deducted from the following costs as the capital cost includes the development of the groundwater source. Costs vary due to plant size, location, and water source salinity.

Table 6: Water Supply Yield for Brackish Water Desalination

	Cameron	Hidalgo	Jim Hogg	Maverick	Starr	Webb	Willacy	Zapata
Yield (ac-ft)	24,753	21,792	0	641	1,120	10,100	11,426	0

A total annual cost for this strategy is estimated to be $29,258,919 at a 57,880 acre-ft yield which comes out to $505.51 an acre-ft.

County Other User Groups

The County-Other groups consist of entities other than Cities within the county. These are listed as Cameron County-Other, Hidalgo County-Other, Willacy County-Other, Starr County-Other, Jim Hogg County-Other, Maverick County-Other, Webb County-Other, and Zapata County-Other. The official survey was sent to the County Judge in each of these counties.

[1] The Future of Desalination in Texas Workshop, Austin, Texas 2003, Concept Paper Presented by Dannenbaum Engineering Co. and URS Company.
[2] Data Provided By NRS Consulting Engineers

Summary of County-Other Water Management Strategies

1. Advanced Water Conservation Measures – Of the 8 County-Other WUGs, 8 were listed as using this strategy for water supply needs. All indicated that the extended portion strategy would have to be funded by some other source than local funds.

   A total annual cost of $2,137,942 for a 19,009 acre-ft yield. The cost of Advanced Water Conservation cost is estimated at $112.47 per acre-ft saved. All indicated that the extended portion strategy would have to be funded by some other source than local funds.

2. Develop Local Groundwater – Of the 8 County-Other WUGs, 4 were listed as using this strategy for water supply needs.

   A total annual cost for this strategy is estimated to be $8,891,450 at a 29,204 acre-ft yield which comes out to $304.46 an acre-ft.

3. Purchase Additional Rio Grande Supply - Of the 8 County-Other WUGs, 6 were listed as using this strategy for water supply needs.

   A total annual cost for this strategy is estimated to be $78,692,415 at a 144,991 acre-ft yield which comes out to $542.74 an acre-ft.

Irrigation Water User Groups

The adopted plan lists irrigation groups by county without specific irrigation districts listed with needs. For each county irrigation group, two strategies are listed. These are on-farm improvements and conveyance system improvements.

Table 7 – Summary of Irrigation Strategies

Irrigation Data			
WMSs	Yields	Total Annual Cost	Unit Cost
On Farm	219,226.00	55,547,585.23	253.38
Conveyance	218,783.00	26,402,708.30	120.68
The counties that used these strategies are Willacy (Both), Starr (On-Farm), Maverick (Both), Hidalgo (Both), and Cameron (Both)			

Summary of Water Management Strategies

1. On-Farm Improvements – This strategy consists of improvements to flow measurements, installation of polypipe delivery systems, improved management and technology, installation of SCADA system and implementation of a verification program to monitor effectiveness of the program. A wide range of

comments were received at the Irrigation District Mangers Association meeting subsequent to the previous plan and this plan. It was made clear that it was not their responsibility to fund on-farm improvements. A range of affordability included the inability for the farmer to pay for any improvements to 50% of on-farm improvements. At the meeting, a reluctant consensus, representing several irrigation districts in Cameron and Hidalgo Counties, felt like 40% of on farm improvements could be paid for locally with the remaining 60% from outside sources including the Texas Water Development Board, Bureau of Reclamation and legislative appropriations. It was encouraged at the meeting that each irrigation district returns their survey to confirm this information. The surveys returned indicate similar findings; Based on discussions with the irrigation districts and the RWPG it was suggested that the affordability of irrigation improvements be changed to 10%, as many districts could not afford any improvement cost. This was recommended and approved at the RWPG.

A total annual cost for this strategy is estimated to be $55,547,585 at a 219,226 acre-ft yield which comes out to $253.38 an acre-ft.

2. Irrigation Conveyance System Improvements - The Texas Agricultural Experiment Station (TAES) evaluated and developed water savings and cost estimates for a comprehensive program to rehabilitate and improve the management of irrigation conveyance and distribution facilities The program would consist of six principal components: 1)Installation of no-leak gates; 2) Installation of additional water measurement weirs; 3) Conversion of smaller concrete canals that are in poor condition to pipeline; 4) Relining of concrete-lined canals that are in poor condition; 5) Lining of smaller earthen canals constructed of more porous soils; and, 6) Implementation of verification program to monitor and measure the effectiveness of the efficiency improvements.

   Like on farm improvements, comments varied greatly amongst the District Managers. Unlike the previous Plan's IFR, there was gained a great deal of experience in the funding of these projects. Several projects have been completed since the previous plan. The Districts that were prepared for construction, i.e. had approved Project Reports for the U.S. Bureau of Reclamation (Reclamation) and subsequent Cost-Share agreements executed were able to take advantage of funding from the North American Development Bank (NADBank) to supplement the 50% share from Reclamation. Most Districts were able to achieve at least a 90% combined funding level with Federal and NADBank funds. Districts have recognized the realization that the 50% cost share agreement with the Bureau does not mean that reimbursement will occur rapidly and actually may take several years to get reimbursement of the Bureau's share. This means that the Districts will need to finance that portion in some way in addition to their own portion. This alone, the Districts cannot afford the construction of new facilities given the fact of up front 100% financing. The addition of the NADBank funds allowed Districts to complete the projects while awaiting reimbursement. One district was unable to complete their project even with the 50% cost share with the Bureau and the 40% share and withdrew from NADBank consideration. According to NADBank, these funds will not be used for other projects and it is not expected that additional funds will be available in the future. A summary of projects and funding levels are show in a table located in Appendix C courtesy of the U. S. Bureau of Reclamation as of December 28, 2005.

A general consensus was given for the ability to afford 40% financing. Discussions however indicate that even that would be far too costly for the irrigator to afford. When presented to the Region M RWPG, it was approved to use 10% affordability. Even at that, some could still not afford.

A total annual cost for this strategy is estimated to be $26,402,708.30 at a 218,783 acre-ft yield which comes out to $120.68 an acre-ft.

Table 8 – Funding for Irrigation Strategies

Irrigation WMSs	Funded Locally	Outside Sources
On Farm Conservation	40%	60%
Irrigation Conveyance System Improvements	10%	90%

Manufacturing

The Rio Grande Region, for the most part, has adequate supplies to meet manufacturing water demands. Throughout the planning period currently available water supply for manufacturing exceeds projected water demand. However, certain local areas do have small manufacturing water supply deficits. Cameron and Hidalgo County show a water supply deficit. The shortages were assigned two water management strategies. They are Non-Potable Reuse and Acquisition of Water Rights through the Purchase of Water Rights.

1. Non- Potable Reuse- A total annual cost for this strategy is estimated to be $2,110,154 at a 4,632 acre-ft yield which comes out to $505.51 an acre-ft.

2. Acquisition of Water Rights through the Purchase of Water Rights- A total annual cost for this strategy is estimated to be $78,692,415 at a 144,991 acre-ft yield which comes out to $542.74 an acre-ft.

There were no surveys sent in this category. It was assumed that manufacturing would pay what was necessary to finance their water needs.

Steam Electric Power

The Rio Grande Region is projected to have steam electric water supplies in excess of demand through the year 2020. After that point, demand will be slightly greater than supply, and relatively large steam electric water supply deficits will occur due to the location of available supply. Although the Rio Grande Region currently has no identified steam electric water demand needs, water shortages are projected to occur beginning in 2050 in Cameron County, in 2050 in Webb County, in 2020 in Hidalgo County. Hidalgo County is projected to have shortages of 1,980 acre-feet in year 2020 and to continue thereafter through 2060 with a deficit of 15,183 acre-feet. Combined, the county-level steam electric power generation WUGs in Cameron, Hidalgo, and Webb counties are projected to have shortages of 11,215 acre-feet combined per year by 2050 and thereafter through 2060. Water management strategies considered potentially applicable to this need include acquisition of additional Rio Grande supplies, use of reclaimed water, and groundwater. It is recommended that all of the projected steam electric demands be met through a combination of the three listed strategies. No surveys were sent to these entities. These strategies were considered to be financed through the steam electric power companies through the cities.

1. Non- Potable Reuse- A total annual cost for this strategy is estimated to be $2,110,154 at a 4,632 acre-ft yield which comes out to $505.51 an acre-ft.

2. Acquisition of Water Rights through the Purchase of Water Rights- A total annual cost for this strategy is estimated to be $78,692,415 at a 144,991 acre-ft yield which comes out to $542.74 an acre-ft.

3. Develop Local Groundwater - A total annual cost for this strategy is estimated to be $8,891,450 at a 29,204 acre-ft yield which comes out to $304.46 an acre-ft.

APPENDIX A

SAMPLE LETTER SENT TO IRRIGATION DISTRICTS IN JULY 2004

July 1, 2004

Joe A. Barrera
Manager
Brownsville Irrigation District
6925 Coffee Port Rd.
Brownsville, Texas 78521

Re: Long-Range Regional Water Planning – Region M

Dear Mr. Barrera:

Attached please find a survey to verify information regarding Brownsville Irrigation District. Please take a few minutes to verify the accuracy of the information that the Rio Grande Regional Water Planning Group has about Brownsville Irrigation District. The Rio Grande Regional Water Plan will be updated and submitted to state officials in September 2005. Updating this plan will assist each of the entities to better plan water strategies and properly provide water resources for the next fifty years.

Over the next few weeks we will contact you or your designated representative to set up an appointment to review the requested items.

I thank you in advance for your continued cooperation in the water planning process for our region. If you have any questions, please do not hesitate to call me at (956) 423-7409.

Sincerely,
NRS Consulting Engineers

Joseph W. Norris, P.E.
Region M Planning Engineer

cc: Kenneth N. Jones, Jr.

SAMPLE LETTER SENT TO MUNICIPAL WATER SUPPLIERS IN JULY 2004

July 1, 2004

John Bruciak
General Manager & CEO
Brownsville PUB
1425 Robinhood Dr.
Brownsville, Texas 78520

Re: Long-Range Regional Water Planning – Region M

Dear Mr. Bruciak:

Attached please find a survey to verify water planning information regarding the Brownsville PUB. Please take a few minutes to review the accuracy of the information that the Rio Grande Regional Water Planning Group has about Brownsville PUB. The Rio Grande Regional Water Plan will be updated and submitted to state officials in September 2005. Updating this plan will assist each of the entities in Region M to better plan water strategies and properly provide water resources for the next fifty years.

Over the next few weeks we will contact you or your designated representative to set up an appointment to review the requested items.

I thank you in advance for your continued cooperation in the water planning process for our region. If you have any questions, please do not hesitate to call me at (956) 423-7409.

Sincerely,
NRS Consulting Engineers

Joseph W. Norris, P.E.
Region M Planning Engineer

cc: Kenneth N. Jones, Jr.
Charles Cabler

SAMPLE SURVEY FOR IRRIGATION

REGIONAL WATER PLANNING INFORMATION FOR:

Cameron County Irrigation, Cameron County Irrigation District #2

Long-range regional water planning is only as good as the information on which it's based.

Please take a few minutes to verify the accuracy of the information that the Rio Grande Regional Water Planning Group has about your organization. The Rio Grande Regional Water Plan will be updated and submitted to state officials in September 2005.

This is especially important if you are developing projects that will require state permits and/or state funding. Under Texas state law, any water project must be consistent with the regional water plan in order to be eligible for a state permit or state funding.

For more information about the regional planning process, go to www.RioGrandeWaterPlan.org

For help with this questionnaire, call Rebekah Guardiola with NRS Consulting Engineers, at 956-423-7409. NRS is managing development of the regional plan for the Rio Grande RWPG.

A. Contact Information

Please make any necessary corrections and/or fill in blanks.

Person providing official information: **Sonia Kaniger**
Title: **Manager**
Mailing address: **P.O. Box 687, San Benito,Texas 78586**
Tel:
Fax:
e-mail address:

B. Customer Information

Please make any necessary corrections and/or fill in blanks.

Service area: **Cameron County**

Type of use: **Agricultural**

C. Water Demand Data

Please make any necessary corrections and/or fill in blanks.

	Current	2010	2020	2030	2040	2050	2060
Irrigated acres							
Delivery Capacity (ac-ft)							
Total demand							

Municipal/Industrial Cust.	Water Right Holder	Quantity	Contract Exp.

D. Conversion of Irrigated Land to Urban Use in the last 5 years

E. Water Supply Reports/Plans completed in the last 5 years (list)

F. Does your District have a GIS Mapping System? Is if available in electronic format? Do you have areas that you would like to have mapped that are currently unavailable?

G. Current Water Resources

Please make any necessary corrections and/or fill in blanks.

Source	Use (ag, municipal, industrial)	Amount of water from source in 2003	Maximum amount available from this source	Factors limiting use of water from source
Rio Grande				
Fresh groundwater				
Reused water				

E. Potential Resources for the Future

Please indicate whether you are considering any new water supply options.

Option	NO, we have NOT considered this option	YES, we have considered this option*	*If yes, please indicate with a check mark if you have:		
			conducted any feasibility studies	developed any cost estimates	begun any capital improvement plans
Ag Water conservation					
On-Farm Water Use Efficiency					

Reuse					
Fresh groundwater					
Water rights purchase					

F. Infrastructure Financing Options

Please indicate what options you have to finance water infrastructure improvements in the future to meet water demands.

Revenue Bonds	%	GO Bonds	%	Grants	%	Sale of Water Rights	%	Reserves	%	Other	%

G. Additional Comments

SAMPLE SURVEY FOR MUNICIPAL

RIO GRANDE REGIONAL WATER PLANNING GROUP

REGIONAL WATER PLANNING INFORMATION FOR:

City of Brownsville

Long-range regional water planning is only as good as the information on which it's based.

Please take a few minutes to verify the accuracy of the information that the Rio Grande Regional Water Planning Group has about your organization. The Rio Grande Regional Water Plan will be updated and submitted to state officials in September 2005.

This is especially important if you are developing projects that will require state permits and/or state funding. Under Texas state law, any water project must be consistent with the regional water plan in order to be eligible for a state permit or state funding.

For more information about the regional planning process, go to www.RioGrandeWaterPlan.org

For help with this questionnaire, call Rebekah Guardiola with NRS Consulting Engineers, at 956-423-7409. NRS is managing development of the regional plan for the Rio Grande RWPG.

A. Contact Information

Please make any necessary corrections and/or fill in blanks.

Person providing official information: **Charles Cabler**
Title: **City Manager**
Mailing address: **P.O. Box 911, Brownsville, Texas 78520**
Tel:
Fax:
e-mail address:

B. Customer Information

Please make any necessary corrections and/or fill in blanks.

Service area: **City of Brownsville**
% of Service Area by County:
Type of use: **Municipal**

C. Population & Water Demand Data (per 2000 Water Plan?)

Please make any necessary corrections and/or fill in blanks.

	2010	2020	2030	2040	2050	2060
Service area population	**173986**	**210210**	**247653**	**284979**	**322316**	**357828**
Capacity (gallons/day)						
Total demand	**43655**	**52038**	**60475**	**69270**	**77985**	**86577**

D. Water Supply Reports/Plans completed in the last 5 years (list)

E. Current Water Resources

Please make any necessary corrections and/or fill in blanks.

Source	Use (agricultural, municipal, industrial)	Amount of water from source in 2003	Maximum amount available from this source	Factors limiting use of water from source	Entity that diverts & pumps the water	Is this water purchased under contract?	If purchased under contract, provide: 1. contract amount 2. expiration date 3. seller's name & address
Rio Grande COA/Permit No. _____ COA/Permit No. _____							

COA/Permit No. ______							
Other Surface Water: ____________________							
Fresh groundwater							
Brackish groundwater							
Reuse water							
Seawater							

F. Potential Resources for the Future

Please indicate whether you are considering any new water supply options.

Option	NO, we have NOT considered this option	YES, we have considered this option	If option has been considered, please indicate with a check mark if you have and provide related information:		
			conducted any feasibility studies	developed any cost estimates	begun any capital improvement plans
Water conservation					
Reuse					
Fresh groundwater					
Desalinated groundwater					

Desalinated seawater					
Water rights purchase					
Converting agricultural water to municipal use					

G. Infrastructure Financing Options

Please indicate what options you have to finance water infrastructure improvements in the future to meet water demands.

Revenue Bonds	%	GO Bonds	%	Grants	%	Sale of Water Rights	%	Reserves	%	Other	%

H. Do you have a Plumbing Fixture Replacement Program?

I. Do you have a Water Conservation Program?

J. Additional Comments

APPPENDIX B

SAMPLE LETTER WITH SURVEY SENT TO WATER USER GROUPS IN OCTOBER 2005

October 19, 2005

Charles Cabler
City Manager
City of Brownsville
P.O. Box 911
Brownsville, Texas 78520

RE: Water Infrastructure Financing Survey

Dear Mr. Cabler:

Attached please find a survey to determine various issues to assist us in the planning and implementation of water management strategies for the region. The survey reviews the water management strategies outlined by the adopted regional plan for the and asks to answer several questions with regard to financing these strategies. This is a requirement of Senate Bill 2. As part of the survey, we must receive your response no later than November 11, 2005.

I thank you in advance for your continued cooperation in the water planning process for our region. If you have any questions, please do not hesitate to call me at (956) 682-3481 or Bill Norris, NRS, at (956) 423-7409.

Sincerely,

Kenneth N. Jones, Jr.

Executive Director

RIO GRANDE REGIONAL WATER PLANNING GROUP
WATER INFRASTRUCTURE FINANCING SURVEY

Region Name: Region M - Rio Grande Regional Planning Group

Name of Political Subdivision: City of Brownsville

Contact Person: Charles Cabler Title: City Manager

Telephone: E-mail:

Background: On January 6, 2006, Regional Water Planning Groups (RWPGs) all across the State of Texas will formally submit 16 adopted regional water plans to the Texas Water Development Board (TWDB) per requirements of Senate Bill 1 (75^{th} Texas Legislature). The adopted regional water plans examined and analyzed the water supply needs for all water users in the State. Based on the analysis, the RWPGs identified water management strategies necessary to ensure a sufficient supply of water for the 50-year planning period. The RWPGs also developed preliminary capital cost estimates for each of the strategies recommended in the approved regional water plan.

Senate Bill 2 (77^{th} Texas Legislature) expanded the RWPG's assignment. Senate Bill 2 charges the RWPGs with examining what financial assistance, if any, is needed to implement the water management strategies and projects recommended in the most recently approved regional water plan.

Senate Bill 2 specifically requires that the RWPG report to the TWDB how political subdivisions all across Texas propose to pay for future water infrastructure needs.

The purpose of this survey is to complete this charge with your input.

Please return the completed survey by __November 11, 2005________ to:

Charlene Torres
P.O. Box 2544
Harlingen, Texas 78550
(956) 423-7482 fax
E-mail address: ctorres@nrsengineers.com

If you have any questions regarding this survey, please contact:

Bill Norris
Telephone Number : (956) 423-7409
E-mail address: bnorris@nrsengineers.com

SURVEY TO OBTAIN INFRASTRUCTURE FINANCING INFORMATION FROM POLITICAL SUBDIVISIONS WITH NEEDS

Planning Group: Region M - Rio Grande Regional Planning Group

Political Subdivision (WUG or WWP): City of Brownsville

*** See Attached Water Supply and Water Management Strategy Table**

(Information to be provided by the Political Subdivision)

Are you planning to implement the recommended projects/strategies?

☐ ***YES*** ☐ ***NO***

If 'no,' describe how you will meet your future water needs.

____

____

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by your Regional Water Planning Group?

Please indicate:

1) Funding source(s)[1] by checking the corresponding box(es) and

2) Percent share of the total cost to be met by each funding source.

☐ __________% Cash Reserves
☐ __________ % Bonds
☐ __________ % Bank Loans
☐ __________ % Federal Government Programs
☐ __________ % State Government Programs
☐ __________ % Other______________________
__________ *% TOTAL – (Sum should equal 100%)*

If state government programs are to be utilized for funding, indicate the programs and the provisions of those programs.

____

____

[1]Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

Person Completing this Form:

____________________	____________________	____________________
Name	Title	Phone

APPENDIX C
Bureau of Reclamation Table for Irrigation Section

LRGV Program, Texas: **LRGV Project Summary** *December 28, 2005*

	PROJECT COMPONENTS						ESTIMATED COSTS			PROJECT VALUE			
	Canals & Laterals			Control & Measurement						Estimated Annual Conservation Savings			Economic Value
	Lining	Replacement (Pipeline)	Rehabilitation / Construction	Telemetry / Metering	Pump Replacement / Rehabilitation	Gate Replacement	Federal	Non-Federal	**Total**	Water	Energy	O&M Dollars	Average Comprehensive Cost
	miles	miles	miles	sites	sites	sites	$	$	$	acre-ft/yr	kwh/yr	$/yr	$/acre-ft
AUTHORIZED PROJECTS													
11 Projects under construction	42.4	54.1	5.6	97	8	0	27,706,708	29,030,705	**$56,737,414**	63,926	4,522,929	$571,566	$38
8 Projects under development	6.2	33.3	1.8	16	4	6	18,177,770	21,247,330	**$39,425,099**	16,219	2,893,448	$203,886	$63
Subtotal	**48.5**	**87.4**	**7.4**	**113**	**12**	**6**	**45,884,478**	**50,278,035**	**$96,162,513**	**80,145**	**7,416,377**	**$775,452**	**$43**
PROPOSED PROJECTS													
19 Projects proposed	-	-	-	-	-	-	42,356,146	42,356,146	**$84,712,291**	-	-	-	-
TOTAL													
Potential Program Total	-	-	-	-	-	-	**88,240,623**	**92,634,181**	**$180,874,804**	-	-	-	-

Cost shares for 11 Projects under construction		
TOTAL Project Costs	**$56,737,414**	**100%**
Federal (Reclamation)	**27,706,708**	**49%**
Non-Federal	**29,030,705**	**51%**
District	10,499,471	19%
State	2,201,811	4%
NADBank	16,329,424	29%

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LIST OF TABLES

CHAPTER 10.0 : PUBLIC PARTICIPATION, FACILITATION AND PLAN IMPLEMENTATION ISSUES

10.1 PUBLIC PARTICIPATION

Public participation is the basis of the regional water planning process initiated by Senate Bill 2 in 1997. Under Texas Water Development Board (TWDB) rules laid out in 31 TAC §357, Regional Water Planning Groups (RWPGs) must include a broad cross-section of stake-holder groups representing communities throughout the region. Voting members of the Rio Grande Regional Water Planning Group (Rio Grande RWPG) as of October 18, 2005, are listed in
TABLE 10.1. The group now includes a member representing the category of river authority as a result of state legislation enacted in 2003.

The Rio Grande RWPG amended its bylaws in July 2003 to allow members to serve con-secutive five-year terms.

TWDB rules require RWPGs to have at least one meeting prior to preparation of the regional water plan, provide ongoing opportunities for public participation during the planning proc-ess, and hold at least one public hearing prior to adoption of the "initially prepared" regional water plan. The RWPGs are also required to comply with TWDB rules specifying how and to whom notice of public meetings and public hearings is to be provided.

As in the first cycle of regional water planning, the Rio Grande RWPG has gone well beyond minimum requirements set by the state for public participation, providing multiple opportuni-ties for public input and for direct participation in the planning process and development of the draft plan. The group also intensified efforts in the second round of planning to ensure public involvement and participation in the process.

The Rio Grande RWPG has held regular meetings throughout the planning process, generally on a monthly basis. Each meeting has provided opportunity for public comment. As planning progressed, the opportunity for comment was moved from the end of the agenda to the be-ginning in order to better accommodate the needs of the public.

A variety of mechanisms have been used to publicize Rio Grande RWPG meetings. Media advisories are distributed via fax and e-mail to community newspapers well in advance of meetings; advisories also are sent to daily newspapers and radio and television stations one to two days prior to meetings.

In addition, notices of meetings, agendas, and minutes are posted to the Rio Grande RWPG's new website: www.RioGrandeWaterPlan.org. The website was developed in late 2003 as a resource for the public on issues of concern to regional water planning and information on the planning process.

A simple, easy-to-read trifold brochure about the region and the regional planning process was developed in August 2004 and has been distributed at a variety of forums and through direct mail. The brochure also directs readers to the website for additional, in-depth information.

Four newsletters have been published and distributed in the second round of regional water planning. The November 2002 newsletter discussed the process for the second round of regional water planning. The June 2003 newsletter focused on the plan amendment to add desalination as a water management strategy and provided details on opportunities for public review of and comment on the proposed changes. The July 2005 newsletter summarized the Initially Prepared Plan, highlighting major issues and water management strategies and cost-efficiencies. It also provided information on the public hearing to consider the plan and listed the locations, including the website, where the public could review the plan. (Those locations are provided in Table 10.2.) The August 2005 newsletter provides a Spanish translation of the summary. These last newsletters were made available at public meetings on the Initially Prepared Plan. All four newsletters are posted on the website.

A fifth newsletter will be produced once the plan is finalized and forwarded to the TWDB.

Electronic versions of the summary newsletters were made available to all regional media as a way of promoting interest in the plan. Names on the mailing list for the newsletters were compiled from previous regional water planning efforts.

Table 10.1: Voting Members of the RGRWPG

INTEREST	NAME	RESIDENT COUNTY
Public	Mary Lou Campbell, Secretary* Sierra Club, Mercedes	Hidalgo
Counties	Jose Aranda County Judge	Maverick
	John Wood County Commissioner, Brownsville	Cameron
Municipalities	Roberto Gonzalez* Water Works, Eagle Pass	Maverick
	John Bruciak, General Manager Brownsville PUB	Cameron
	Adrian Montemayor Water Utilities, Laredo	Webb
Industries	Gary Whittington Unifirst Linen Service, Harlingen	Cameron
Agriculture	Robert E. Fulbright* Hinnant & Fulbright, Hebbronville	Jim Hogg
	Ray Prewett Texas Citrus Mutual, Mission	Hidalgo
Environmental	Karen Chapman Environmental Defense, Brownsville	Cameron
Small Business	Donald K. McGhee Hydro Systems, Inc., Harlingen	Cameron

	Xavier Villareal T&J Office Supply, Zapata	Zapata
Electric Generating Utilities	Kathleen Garrett Sempra Texas Services, LP/Topaz Power Group	Cameron, Hidalgo, Webb
River Authorities	James Darling Rio Grande Regional Water Authority	Hidalgo
Water Districts	Sonny Hinojosa HCID No. 2, San Juan	Hidalgo
	Sonia Kaniger CCID No. 2, San Benito	Cameron
Water Utilities	Charles Browning, Vice-Chair* North Alamo Water Supply Corp., Edinburg	Hidalgo
Other	Glenn Jarvis, Chair* Attorney, McAllen	Hidalgo
	James Matz Mayor, Palm Valley	Cameron

*Executive Committee
Planning Group members as of October 2005.

The Executive Summary of the plan is being translated into Spanish, and will be posted on the website.

The Rio Grande RWPG and its consultant team also actively solicited comment from local entities on the basic data used to develop the plan:

- A water infrastructure financing survey and supplemental survey was mailed to each water user group (WUG) in February 2002 with follow up interviews and phone calls with each entity. The infrastructure survey was completed to determine the capability to pay for water management strategies listed in the previous plan. The supplemental survey was to collect input from the WUGs related to water supply issues and their strategies to solve long-term water shortages.
- Draft population and water demand projections were mailed to officials representing each city and county in the region October 2002. The mailing list included county judges, city managers and public works officials. Comments were received from several entities.
- Survey information was mailed out in February 2003 related to interest in desalination as a water management strategy for inclusion in a proposed plan amendment. Over 30 WUGS responded positively their desire to include desalination in short term planning for their entity.
- Survey Information regarding the water supply issues was mailed out to each WUG in July 2004, to set up interviews for discussion of long term needs, review of their need for satisfying 50-year demand projections. Face to face meetings were held with each WUG where possible and as a minimum, a second, supplemental survey was faxed in November 2004 and telephone interviews were conducted to gather data needed to complete each WUG supply/demand and water management strategies.

Members of the consultant team also made several presentations to a variety of groups with an interest in water planning, including water utility associations, citrus growers, and irrigation district boards of directors.

The Rio Grande RWPG provided extensive notice of and opportunity for public comment on the Inititally Prepared Plan. As required by TWDB rule, copies of the draft plan were placed in at least one public library in each county within the regional planning area as well as in the office of the county clerk in each county within the regional planning area. Copies also were placed at the offices of councils of governments in the region, including the Lower Rio Grande Valley Development Council and the South Texas Development Council. (See TABLE 10.2.)

A public hearing on the Initially Prepared Plan was held in Zapata, TX, on July 20. 2005. Formal notices of the public hearing were placed in newspapers of general circulation in each county of the regional planning group. Although the TWDB rules stipulate only one public hearing on the draft plan, the regional planning group elected to host an additional public meetingin Zapata, on Aug. 17, 2005, because severe weather had limited public attendance at the July hearing. In addition, the RGRWPG opted to extend the comment period on the plan through Sept. 30, 2005.

The extended comment period enabled further presentations at public meetings throughout the region. Instead of scheduling stand-alone meetings, the planning group was able to piggyback on opportunities provided by other policy groups. These included:

- Lower Rio Grande Development Council Board of Directors, Harlingen – July 28, 2005
- Laredo City Council, Laredo – Aug. 1, 2005
- Eagle Pass City Council, Eagle Pass – Aug. 2, 2005
- South Texas Development Council Board of Directors – Sept. 8, 2005, Zapata

All public outreach on the Initially Prepared Plan included information on procedures and deadlines for submitting comments.

TABLE 10.2: OPPORTUNITIES FOR PUBLIC REVIEW OF THE DRAFT RIO GRANDE REGIONAL WATER PLAN

COUNTY	LOCATION
Cameron	County Clerk’s Office, County Courthouse, 964 E. Harrison, Harlingen, 956-544-0815
	Harlingen Public Library, 410 ’76 Drive, Harlingen, 956-430-6652
	Brownsville Public Library, 2600 Central Blvd., Brownsville, 956-548-1055
Hidalgo	County Clerk’s Office, County Courthouse, 100 North Closner, Edinburg, 956-318-2100
	McAllen Memorial Library, 601 N. Main, McAllen ,956-682-4531
	Lower Rio Grande Valley Development Council, 311 N. 15th St., McAllen, 956-682-3481
Jim Hogg	County Clerk’s Office, County Courthouse, 102 E. Tilley, Hebbronville, 361-527-3015
	Jim Hogg County Library, 210 S. Smith, Hebbronville, 361-527-3421
Maverick	County Clerk’s Office, County Courthouse, 500 Quarry St., Eagle Pass, 830-773-3824
	Eagle Pass Public Library, 589 Main St., Eagle Pass, 830-773-2516
Starr	County Clerk’s Office, County Courthouse, Rm. 201, 401 N. Briggon, Rio Grande City, 956-487-2101

	Starr County Library, 700 E. Canales, Rio Grande City, 956-487-4389
Webb	County Clerk's Office, County Courthouse, 1000 Houston St., Laredo, 956-721-2640
	City of Laredo Library, 1120 E. Calton St., Laredo, 956-795-2400
	South Texas Development Council, 1718 E. Calton Rd., Suite 14, Laredo, 956-722-2670
Willacy	County Clerk's Office, County Courthouse, 540 W. Hidalgo Ave., Raymondville, 956-689-2710
	Reber Memorial Library, 193 N. 4th, Raymondville, 956-689-2930
Zapata	County Clerk's Office, County Courthouse, 600 Hidalgo Blvd., Zapata, 956-765-9915
	Zapata County Library, Zapata, 901 Kennedy St., 956-765-5351

10.2 FACILITATION OF THE REGIONAL WATER PLANNING PROCESS

Facilitation of the regional water planning process for the Rio Grande Region has been provided by the staff of the Lower Rio Grande Valley Development Council (LRGVDC), with assistance from the consultant team. In addition to performing administrative duties relating to the management of State funds, the LRGVDC also made all arrangements for meetings of the Rio Grande RWPG, which included posting required meeting notices, preparing meeting agendas, and distributing agenda back-up materials to members of the RWPG. The LRGVDC also tape recorded all Rio Grande RWPG meetings and prepared the official meeting minutes. For non-voting Spanish-speaking members of the Rio Grande RWPG, an interpreter was provided at all RWPG meetings.

The consultant team also assisted in facilitating the planning process by providing presentations of technical information at RWPG meetings and assisting in identifying key water planning and policy issues.

10.3 PLAN IMPLEMENTATION ISSUES

There are a number of key issues that will affect whether this plan is successful in achieving its primary purpose – to provide recommendations regarding strategies for meeting the near and long-term water needs of the Rio Grande Region. Many of these issues are identified and discussed in previous chapters, particularly in association with recommended water management strategies and policy issues. Generally, the key issues relating to the implementation of this plan can be grouped into three categories:

- Issues and water management strategies that require additional in-depth evaluation;
- Local buy-in and action to implement local water supply strategies; and,
- Funding for the implementation of plan recommendations.

Each of these areas of concern is briefly discussed below. No interregional conflicts have been identified in the planning process or contained in the plan.

10.3.1 Additional Planning Studies

The recommendations presented in this regional water plan are based on a reconnaissance-level evaluation of projected water demands, water supply, needs, and various strategies for meeting future needs. It is important to note that additional, more detailed feasibility-level planning will be necessary prior to implementation of the many of the recommended strategies. Also, in many cases, feasibility-level planning will need to be followed by engineering design and permitting activities. For the most part the additional planning and project development activities required for strategy implementation will be the responsibility of local water suppliers (e.g., cities, water supply corporations, and irrigation districts). However, state and/or federal technical and financial assistance would greatly facilitate timely project development and implementation.

There are a number of specific issues and water management strategies that require additional investigation and which should be considered as potential candidates for state funding prior to the first update of this regional water plan. These are:

- **Water Supply Planning for Rural Areas**. The Rio Grande RWPG recommends that future updates to the regional water plan include a thorough evaluation of water supply, projected water demands, needs, and strategies for the individual public water systems currently aggregated into the "County-Other" water user groups. This evaluation should include projected water supply needs associated with serving economically distressed areas (i.e., colonias) in the rural portions of each county.

- **Assessment of Individual Irrigation Districts.** The Rio Grande RWPG recommends that the irrigation districts be evaluated as individual water user groups to better assess their water management strategies in the future updates to the regional water plan.

- **Municipal water conservation program design**. Advanced or additional municipal water conservation measures are recommended to provide a significant contribution toward meeting projected municipal water demands. Funding is needed to support the development of a detailed program implementation plan that can serve to guide local water suppliers in the implementation of these programs. Particular attention needs to be given to developing approaches for cooperative, regional implementation of municipal water conservation programs.

- **Assessment of non-potable water reuse opportunities.** As with conservation, non-potable reuse of reclaimed water is a key strategy recommended for meeting a portion of future municipal water needs and a portion of the projected supply needs for steam electric power generation. However, as discussed in Chapter 5 of this plan, estimates of the achievable municipal reuse potential in the Rio Grande Region are based on limited information and broad planning assumptions. For this strategy to achieve the recommended level of implementation, it is essential that a more comprehensive and thorough assessment be performed to identify feasible reuse applications. This assessment should examine each individual municipal water and wastewater utility system to characterize the quality of available wastewater effluent; identify potential users of reclaimed water within reasonable proximity to existing wastewater treatment facilities; evaluate the requirements of potential users (e.g., quantity and quality); and develop site-specific cost estimates for implementation of reuse projects.

- **Groundwater development**. State efforts to improve data and assess groundwater availability in the Rio Grande Region should continue. Specifically, current efforts to gather additional data on the occurrence, quantity, and quality of recoverable groundwater from the Gulf Coast aquifer and to develop a new simulation model of the Gulf Coast aquifer in South Texas should be completed expeditiously. In addition, state funding should be made available for regional facility planning studies to develop regional groundwater supply projects as a substitute source of water supply for some DMI users currently using Rio Grande supplies (e.g., municipal suppliers in Willacy County). Also, the cities of Brownsville, Eagle Pass, and Laredo are encouraged to continue their local efforts to identify and develop cost-effective sources of groundwater supply.

- **Irrigation district rehabilitation**. An extensive discussion of issues associated with the implementation of irrigation conveyance and distribution efficiency improvements is provided in Chapter 5. A key issue is the need for additional, district-specific assessments to identify cost-effective improvements and to develop comprehensive rehabilitation plans. Continuing and expanded state and federal assistance, technical and financial, is essential.

- **Use of Stormwater Runoff**. It is recommended that a study be conducted to determine the feasibility and impacts of capturing and using stormwater runoff as a supplemental water supply source in Cameron and Hidalgo counties. As described in Chapter 5, the study would investigate supply availability, potential uses, and other issues for five localized areas. The results would then be extrapolated to other areas of the two counties to develop a better estimate of the amount of stormwater that could be developed as supply source, as well as the costs of implementing the strategy on a sub0regional scale.

- **Re-channelization/Restoration of portions of the Rio Grande**. As indicated both in Chapter 5 and Chapter 6, the Rio Grande RWPG supports the International Boundary and Water Commission's request for federal appropriations to conduct a detailed assessment of the costs, benefits, and environmental impacts of improvements to the river channel above Amistad International Reservoir. Of particular interest is the quantification of the potential water supply benefits of such a project.

- **Surface water availability models.** As indicated in Chapter 6, the Rio Grande RWPG recommends that state funding be provided for the development of a water availability model for the Rio Grande watershed. In addition, the Rio Grande RWPG supports additional state funding for continued refinement of the existing Reservoir Operations Model for the Amistad/Falcon Reservoir System. Of particular interest is the expansion of the existing model to include portions of the Rio Grande watershed in Mexico that contribute inflows to the reservoir system.

- **Development of the Webb County low-water dam**. The Rio Grande RWPG supports Webb County's efforts to obtain funding for a detailed feasibility and environmental impact study of the proposed low-water dam.

- **Reservoir Sedimentation.** The Rio Grande RWPG recommends that a study be conducted to evaluate the technical and economic feasibility and potential environmental impacts of alternatives for the control and/or removal of sediment from the Amistad/Falcon Reservoir System

10.3.2 Local Water Supply Planning and Implementation

This regional water plan is best viewed as providing a framework for local action to implement strategies for meeting future water needs. The role of the Rio Grande RWPG is purely advisory. The RWPG has no authority to compel other entities to implement the actions recommended in this plan. Nor does it have the authority or resources to undertake implementation activities on its own initiative. Rather, implementation of strategies recommended for meeting future water needs is a primary responsibility of local water suppliers, which include cities, water supply corporations, other public water supply entities, and irrigation districts. With or without outside assistance, more detailed feasibility-level planning studies and engineering design is largely the responsibility of local water suppliers. Similarly, the costs of implementing water conservation and water supply strategies will be borne largely by the ratepayers served by local water suppliers. It is therefore essential that there be a strong commitment on the part of the governing bodies and management of local water suppliers to implement the strategies recommended in this plan.

Locally, there has been a great deal of progress in stakeholders working together. The RGRWPG highly recommends that this continue to aid in the implementation of water strategies throughout the region. The formation of the Rio Grande Regional Water Authority encompasses the entire planning region. The purpose is to have regional representation to assist in the completion of projects to conserve water.

Water rights conversion has been and continues to be an important issue between irrigation districts and municipalities as more irrigation land is lost to urbanization. There is no set formula for the transfer or conversion of water rights associated with this urbanization. A committee consisting of irrigation district managers and water utility managers is currently ongoing set some standards for conversion and taking into consideration each party's needs. The RGRWPG recommends that this group continue to strive for solutions.

10.3.3 Funding for Plan Implementation

The availability of and access to funding for the implementation of recommended water management strategies is crucial. Most local water suppliers in the Rio Grande Region are governmental or quasi-governmental entities (e.g., water supply corporations) that have the authority to charge and collect taxes and/or fees for the services they provide. These entities also have the ability to borrow money for the acquisition of additional water supplies and for water-related infrastructure development and rehabilitation. For the most part, the direct costs for the services provided by these entities should be borne by the individual water users through taxes and/or fees for services. However, it should be recognized that there is also an appropriate role for the state and federal governments in the financing of water conservation, water supply development, and infrastructure projects. At present, there are a number of state and federal financial assistance programs for water-related infrastructure projects that are available to municipal water suppliers. However, there are few programs that provide financial assistance to irrigation districts for infrastructure improvements. Because agricultural water conservation is a central element of this regional water plan – and is essential to maintaining the viability of this sector of the regional economy – the Rio Grande RWPG recommends that new public funding sources be developed to assist irrigation districts with the implementation of conservation programs.