DEVELOPMENT OF A REGIONAL INTEGRATED WATER RESOURCE PLAN FOR THE LOWER RIO GRANDE VALLEY, TEXAS

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ABSTRACT

This plan for the Lower Rio Grande basin management is designed to meet competing needs. The development of this comprehensive plan has considered demand-side and supply-side management options, an open and participatory decision-making process, the impacts of environmental concerns, and the multiple institutions concerned with water policy. Historically, approximately 85% of the 1,300,000 acre-feet of annual consumption has been in the agricultural production through irrigation. Cameron, Hidalgo, and Willacy Counties are currently experiencing high population growth rates with the combined population expected to increase from approximately 900,000 persons in 2000 to approximately 2,100,000 persons in the year 2050. The quantity of developed water readily available in Falcon-Amistad Reservoir System to the Lower Rio Grande Valley is essentially equal to the current usage level. Most of the adjudicated water rights are held by 28 irrigation districts that supply water diverted from the Rio Grande to both irrigators, municipalities, and water supply corporations through open canals and closed conduits with frequently conflicting demand patterns. Numerous meetings with the Lower Rio Grande Valley Development Council Policy Management Committee, local citizens, and stakeholder groups, under the guidance of a professional meeting facilitator, were included in an effort to achieve the maximum benefit from an open and participatory development process. The Lower Rio Grande Valley is a highly sensitive environmental area with major concerns for water quality as well as for endangered and threatened species, plant communities, fish communities, and animal populations. The management of water currently involves the irrigation districts, municipalities, water supply corporations, Texas Natural Resource Conservation Commission Watermaster, and International Boundary and Water Commission.

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DESCRIPTION OF THE PLANNING AREA

The planning area for the Lower Rio Grande Valley Integrated Water Plan consists of Cameron, Hidalgo and Willacy Counties as illustrated on Fig. 1. The Lower Rio Grande Valley, which developed in the twentieth century as a major agricultural center, is now experiencing one of the nation's highest population growth rates. This population growth causes a stronger competition for the finite quantity of water, primarily from Falcon-Amistad Reservoir System, that is currently available to the Lower Rio Grande Valley.

The vast majority of the water rights in the Lower Rio Grande Valley are held by the Irrigation Districts for use in the agricultural production. Approximately, eighty five percent of the current water consumption in the Lower Rio Grande Valley is used in the agricultural sector. Under the existing agreements, municipal and industrial water demands will always be protected and given a priority over agricultural demands. In other words if the quantity becomes limited, the water supply management rules are designed in such a manner to meet the municipal and industrial water demands and limit the amount available for lower priority uses.

Working within this framework of an integrated water resource plan, the following key goals were established for this study.

- Development of options for more effective, efficient and environmentally-sound ways to supply water to the region
- Review of the roles and potential working relationships among regional organizations involved in managing the supply of water
- Development of a Drought Management Plan

The recent drought conditions have made everyone aware of the significant impacts a dwindling water supply can have on a region. This integrated water resource plan was undertaken during the early stages of the drought in recognition of the following:

- Only a specific amount of water is currently available to the Lower Rio Grande Valley.
- The management of the available water is critical to the continued development of Cameron, Hidalgo, and Willacy Counties.

SOCIAL ECONOMIC CONDITIONS

The Lower Rio Grande Valley has received a lot of national attention as the area transitions from a predominately agricultural region to a center with increasing

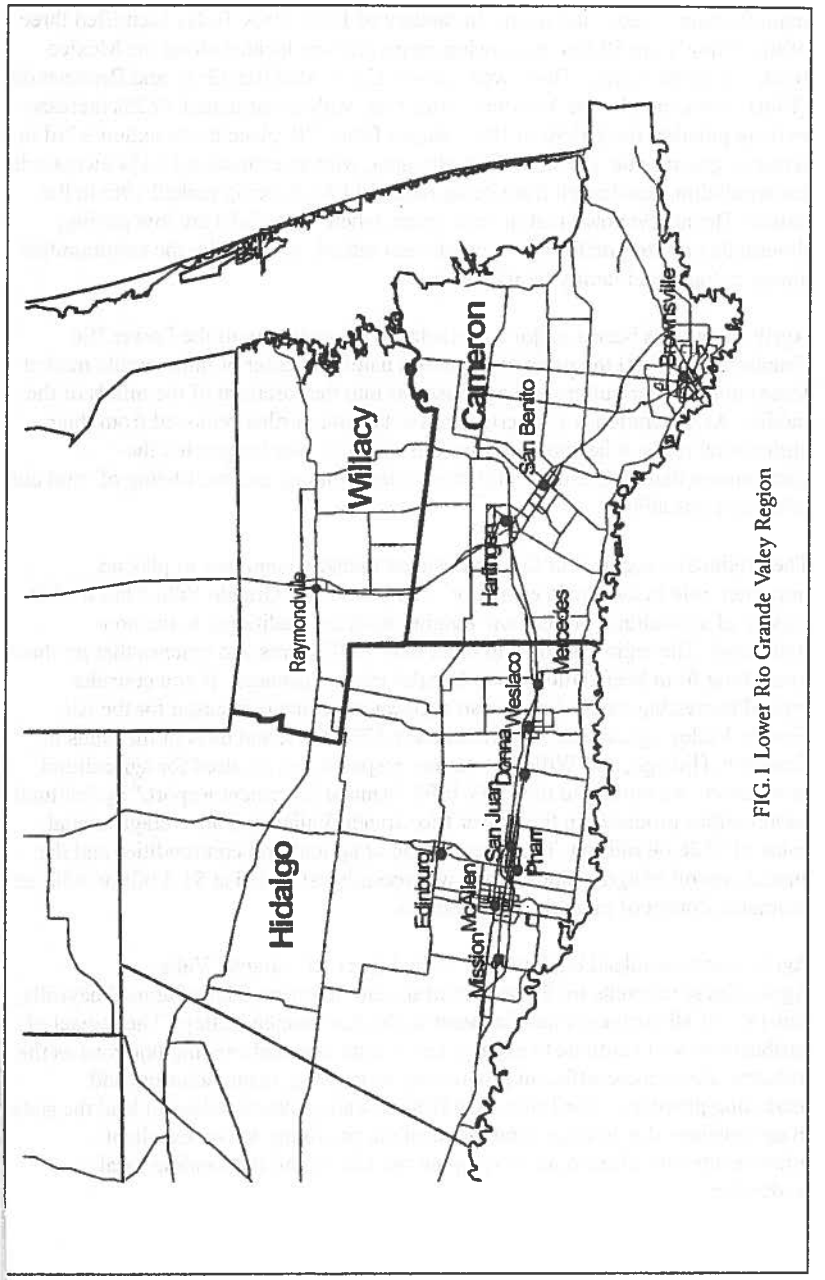

FIG.1 Lower Rio Grande Valey Region

manufacturing, trade, and retail. In January of 1998, USA Today identified three of the nation's top 10 fastest-growing metro areas as located along the Mexico border in South Texas. These were Laredo (2nd), McAllen (3rd), and Brownsville (10th). For example, the McAllen metro area, with an estimated 29.2% increase in its population from 1990 to 1996, leaped from 77th place to the nation's 3rd in terms of growth rate. Brownsville metro area, with an estimated 21.1% increase in its population, also leaped from being ranked 119th to being ranked 10th in the nation. The article noted that in these areas, where many jobs are low paying, thousands of immigrants have nevertheless settled, attracted by the communities' strong cultural and family tie with Mexico.

Agribusiness has been a major contributor to the economy of the Lower Rio Grande Valley. All too often, it requires a natural disaster or unfavorable market forces to boost agriculture and agribusiness into the forefront of the minds of the public. As generations of Americans have become further removed from their agricultural roots, it becomes all too convenient to take for granted the contribution that agribusiness provides to the economy and well-being of rural and urban citizens alike.

The production segment of the agribusiness industry continues to play an important role in the area's economy. The Lower Rio Grande Valley has a wide variety of agricultural production, ranging from the traditional to the non-traditional. The region is home to more than 1,600 farms and ranches that produce everything from beef cattle to bees to palm trees to peanuts. If you consider typical harvesting dates, there doesn't appear to be any off-season for the Rio Grande Valley agriculture. Approximately 57%, 66%, and 68% of the lands in Cameron, Hidalgo, and Willacy counties, respectively, are used for agricultural production. According to the 1993-1998 "Annual Increment Report," agricultural commodities produced in the Lower Rio Grande Valley had an average annual value of $528.68 million. The annual value of agricultural commodities and the annual payroll of agribusiness firms was recently estimated at $1.4 billion with an estimated impact of more than $3.4 billion.

Agribusiness is indeed big business in the Lower Rio Grande Valley. Agribusiness accounts for 30 percent of the employment, 24% of annual payrolls, and 19% of all business establishments in the Rio Grande Valley. The impact of agribusiness will continue to expand across both new and existing horizons as the industry adopts more-efficient production, processing, manufacturing, and marketing practices. The Lower Rio Grande Valley stands poised to lead the state in agribusiness due to its geographic location, proximity to and excellent relationship with Mexico, its developing workforce and outstanding local leadership.

FALCON-AMISTAD RESERVOIR SYSTEM

The Falcon-Amistad Reservoir System and two downstream channel diversion dams (Anzalduas and Ratamal) are operated as a system by the International Boundary and Water Commission (IBWC) to regulate streamflows in the Lower Rio Grande. Several dams have been constructed on the upper reaches of the Rio Grande, and many other dams are located on tributaries in both Mexico and the United States. The Falcon-Amistad Reservoir System provides primary storage to meet the water supply needs of the Lower Rio Grande Valley. Reduction of flood flows along the Lower Rio Grande is also a primary objective of the system operation.

In terms of either total capacity or conservation storage capacity, Amistad Reservoir is the second largest reservoir in Texas. Falcon is the fifth largest reservoir in Texas. The two-reservoir storage system has a combined total conservation storage capacity of 5,800,000 acre-feet. An additional storage capacity of 2,1000,000 acre-feet below the top of the spillway gates in the two reservoirs is used for flood control.

Using a reservoir operations model, the current annual dependable yield has been estimated to be 1,194,000 acre-feet per year for the United States and 992,000 acre-feet per year for Mexico. This annual dependable yield is based on historical hydrologic conditions. Additional hydrologic analysis are underway to improve the firm yield estimate by: 1) reviewing and improving the estimate of the historical reservoir inflows, 2) accounting for the changes to the historical inflows due to tributary reservoir development, and 3) extending the hydrologic record to cover more of the 1994-1998 drought.

The Falcon-Amistad Reservoir System is owned and operated jointly by the Mexican and United States Sections of the IBWC under the Treaty of 1944. The system is operated to store, conserve, and regulate the waters of the Rio Grande and to generate hydroelectric energy. During normal non-flood periods, releases from conservation storage are made as necessary to meet water supply demands. Hydroelectric power is generated almost entirely by water released for downstream water supply or spills to evacuate the flood control pools.

Most of the water used in the Lower Rio Grande Valley is regulated by the Falcon-Amistad Reservoir System. Most of the water from these two large reservoir projects is diverted form the river below Falcon Dam. To the extent possible, the Amistad conservation pool is maintained at fairly constant high storage levels, with most of the pool level fluctuations occurring in Falcon Reservoir. In the United States, water users divert water from the river at hundreds of locations throughout the entire length of the lower Rio Grande. The majority of the diversions are made by irrigation districts that supply water to

municipalities and industries as well as agricultural users. The Watermaster's Office of the Texas Natural Resource Conservation Commission (TNRCC) administers the water rights allocation system for use of water in Texas.

Allocation of the water resources of the Rio Grande Basin is governed by two international treaties and, within the United States, by two interstate compacts. Allocation of the Texas share of the water to irrigators, cities, and other water users is based on state law.

The United States share of the water supply in the Falcon-Amistad Reservoir System is used to meet the demands in the lower basin as administered by the TNRCC in accordance with the water rights system. Irrigation districts, individual farmers, and cities communicate their water needs directly to the TNRCC Rio Grande Watermaster Office, with headquarters in McAllen, Texas which in turn schedules releases from the Falcon-Amistad Reservoir System with IBWC.

The Watermaster makes daily requests to the IBWC for releases from the reservoirs. In determining Falcon Reservoir releases for the Lower Rio Grande Valley, the Watermaster Office considers the quantities of water requested by all users and their diversion locations, potential channel losses and gains, watershed runoff and tributary inflows, channel and bank storage, waters stored by weirs, and storage at Anzalduas Dam. Some water users near the coast are more than 200 river miles below Falcon Dam. Requests for releases are made five to seven days in advance to allow for travel time.

Using the diversion information and IBWC reported available storage, the Wastermaster allocates the storage in the Falcon-Amistad Reservoir System to each of the water rights each month. Each water right is limited by both its permitted annual diversion amount and the water available in storage to supply the diversion.

Each month, the IBWC informs the TNRCC Watermaster of the total volume of water in storage in the Falcon-Amistad Reservoir System allocated to the United States. The Watermaster Office distributes the storage to all the water rights accounts. The allocation procedure followed by the Wastermaster is based on the steps outlined below.

1. From the total amount of usable United States water stored in the Falcon-Amistad Reservoir System conservation pools, the first step consists of reserving 225,000 acre-feet for domestic, municipal and industrial uses. This is called the municipal pool. Domestic, municipal, and industrial uses are given highest priority by deducting the municipal pool as the first step in the monthly reallocation.

2. From the remaining storage, the total end-of-month account balances for all irrigation and mining rights are deducted.

3. Next, available water is allocated to an operating reserve that normally fluctuates between 380,000 acre-feet and 275,000 acre-feet, depending on the amount of water in storage. If the amount of water available is between 275,000 acre-feet and 150,000 acre-feet, that amount is allocated to the operating reserve. However, if the balance available for the operating reserve happens to fall below 150,000 acre-feet, deductions are made from the irrigation and mining accounts as necessary to provide 150,000 acre-feet for the operating reserve. The operating reserve provides for loss of water by seepage and evaporation, adjustments required as the United States-Mexico water ownership computations are finalized each month, and emergency requirements.

4. Any remaining water in storage is allocated among all the irrigation and mining rights accounts. The storage is basically allocated in proportion to annual diversion rights, except the Class A rights are multiplied by a factor of 1.7 to allow them a greater storage allocation than Class B rights. Other provisions include limiting each storage allotment to not exceed more than 1.41 times its authorized diversion right. If an irrigation right is use for two consecutive years, its storage amount is reduced to zero.

COORDINATION WITH IBWC

During the development of this study, a number of contacts and coordination meetings were conducted with the IBWC. Much of the coordination has focused on developing a better understanding of the IBWC methodology used in the monthly water accounting procedures.

The analysis of the IBWC monthly water accounting data for the 1945-1996 period was prepared and reviewed with IBWC. This step was extremely important in establishing an official set of hydrologic data for the Falcon-Amistad Reservoir System that can be used to measure the combined impacts of developments that have occurred in the total watershed during the existence of the reservoirs and to evaluate potential changes in basin reservoir operating procedures, in both the United States and Mexico, that will impact the quantity of water available from the system in the future.

COORDINATION WITH MEXICO

Representatives from the Lower Rio Grande Valley have been joining with representatives from Mexico in meetings arranged by IBWC for a number of years. A meeting was held in February 1998 to discuss the reservoir operation models. A meeting was also held in Monterrey, Mexico on June 16 and 17, 1998 to discuss a number of issues of concern to both countries. Presentations were made by United States representatives on the initial results of Falcon-Amistad Reservoir System modeling work that was underway at that time. The representative from Mexico also presented optimization studies of the Mexico reservoirs in the Rio Conchos watershed. The Rio Conchos is a major tributary to the Rio Grande in Mexico.

One result of the above meeting was the scheduling of another meeting to discuss in greater detail the methodologies and hydrologic data utilized by each country in the development of the reservoir system models. That meeting occurred in McAllen, Texas on July 10, 1998. Representatives of both the United States and Mexico presented detailed descriptions of their country's development of the reservoir model system.

POPULATION PROJECTIONS

The State of Texas most-likely scenario populations adjusted for known municipal changes for the Lower Rio Grande Valley Integrated Water Resource Plan study area have been summarized in Table 1. The total 1990 three-county population was 661,370. Of the total, 58.0 percent resided in Hidalgo County, 39.3 percent in Cameron County, and 2.7 percent in Willacy County. In Hidalgo County, 68.3 percent of the population resided in the cities with the remaining 31.7 percent representing the rural county population. For Cameron County, 76.6 percent of the population resided in the cities with the balance, 23.4 percent, local rural county area. In Willacy County, 59.6 percent of the population is located in the cities while the remainder, 40.4 percent, representing the rural county population.

For Cameron County, the most-likely population projection is based on the assumption that the migration rate will continue at the 1980-1990 through 2000. The migration rate is then assumed to decline over the 2000-2050 period. If the migration rate remained at the 1980-1990 level throughout the planning period, the projected population for the year 2050 would be 794,045, or approximately 22.4% greater than the most-likely population scenario. If the assumed reduction in the immigration into the U.S. from Mexico does not occur, then the total population could be significantly increased and, therefore, the total municipal water demand.

Table 1. Most Likely Scenario of Population Projection for Counties in Planning Area (1990-2050)

County	1990	2000	2010	2020	2030	2040	2050
Municipal	199,317	262,690	309,586	423,258	451,926	451,926	482,386
County Res.	60,803	72,483	93,010	116,014	127,655	158,705	166437
Total Cameron	260,120	335,173	402,596	473,775	550,913	610,631	648,823
Municipal	262,019	378,774	459,902	553,272	658,502	761,592	881,694
County Res.	121,526	166,225	234,589	305,319	395,902	467,028	522,603
Total Hidalgo	383,545	544,999	694,491	858,591	1,054,404	1,228,620	1,404,297
Municipal	10,554	12,674	14,231	15,541	16,436	17,076	17,741
County Res.	7,151	7,484	8,354	9,089	9,579	9,915	10,048
Total Willacy	17,705	20,158	22,585	24,630	26,015	26,991	27,789
Total Regional	661,370	900,330	1,119,672	1,356,996	1,631,332	1,866,242	2,080,909

For Hidalgo County, the most-likely population projection is also based on the assumption that the migration rate will continue at the 1980-1990 rate through 2000 and then decline over the 2000-2050 period. If the migration rate remained at the 1980-1990 level throughout the planning period, the projected population for the year 2050 would be 2,113,180, or 50.5% greater than the most-likely population scenario. The assumed decline in the immigration rate represents a major decrease in the migration rate.

For Willacy County, the most-likely population projection is the same as that projected for zero migration rate. The data indicate that, if the 1980-1990 migration rate is extended through the planning period, lower population projections would be obtained. This condition must indicate that a negative migration rate occurred in Willacy County during the 1980-1990 period.

The number of citizens residing in the counties outside of the municipalities represents a significant percentage of the total county population. Summarized in Table 2 are the changes in these percentages projected for the most-likely scenario populations. Both Cameron and Hidalgo Counties show an increase in the percentage over the 60-year planning period, while Willacy County shows a decrease in the percentage. In terms of actual numbers, Cameron County is projected to have approximately 200,000 citizens outside the municipalities by the year 2050 and Hidalgo is projected to have approximately 575,000 citizens outside the municipalities by the year 2050. These populations equate to a

significant water requirement and raise significant issues for the County governments and the water supply corporations to address.

Table 2. Percent of County Population Outside of Municipalities

	1990	2020	2050
Cameron	23.4%	24.5%	25.9%
Hidalgo	31.7%	39.1%	41.0%
Willacy	40.4%	36.9%	36.2%

PROJECTED WATER REQUIREMENTS

The total regional water requirements are summarized in Table 3. The total domestic requirements increase to slightly more than 400,000 acre-feet per year in the year 2050. The rate of consumption is approximately one third of the yield of the Falcon-Amistad Reservoir System. Even with domestic consumption at this increased level, a significant amount of water remains available for other uses including agricultural irrigation.

The projections are based on the important assumption that certain water conservation and water management programs will be implemented and that urban development will occur. A primary assumption associated with the definition of municipal water conservation is that these levels of saving are likely to occur from both market forces and regulatory requirements. The typical plumbing fixtures and appliances available for purchase are noticeably more water-efficient than those sold in earlier decades. The availability of water-efficient landscaping in the marketplace and improved landscaping practices are changing outdoor water uses. Better public education on efficient indoor and outdoor water uses and pricing "signals" from the marketplace is also changing consumer behavior.

In addition to the market-type forces, a driving force underlying the expected municipal water conservation savings is the likely effect produced by the State Water-Efficient Plumbing Act passed in 1991. Not only are these potential water savings from the implementation of the Act substantial, but they are also economically sound from a cost-saving perspective, do not require day-to-day behavior changes by the consumer, affect the larger year-round base water use, and will occur with a relatively high degree of predictability.

On the agricultural side, the savings due to on-farm conservation are assumed to

Table 3. Projected Lower Rio Grande Valley Water Requirements, Below-normal Weather, Expected Case (Values in Acre-Feet)

	2000	2010	2020	2030	2040	2050
Cameron County Municipal	55,000	62,058	68,669	79,947	84,540	89,974
Cameron County Citizens	11,448	13,544	15,854	17,016	20,622	21,626
Hidalgo County Municipal	77,280	88,456	99,623	115,707	132,075	151,887
Hidalgo County Citizens	25,136	31,007	37,620	47,894	55,453	62,051
Willacy County Municipal	6,834	7,407	7,807	8,192	8,449	8,753
Willacy County Citizens	1,190	1,254	1,283	1,320	1,333	1,317
Total Domestic Demand	176,888	203,726	230,856	270,076	302,472	335,608
Domestic Transmission Losses @ 20%	35,378	40,745	46,171	54,015	60,494	67,122
Total Domestic Requirement	212,266	244,471	277,027	324,091	362,966	402,730
Agricultural Demand	1,053,863	761,507	699,912	623,342	556,003	491,062
Agricultural Transmission Losses	295,521	217,238	203,404	186,027	170,788	156,031
Total Agricultural Requirement	1,349,384	978,745	903,316	809,369	726,791	647,093
Manufacturing	4,975	5,506	5,878	6,169	6,731	7,292
Steam Electric Power Cooling	4,500	5,000	5,000	5,000	5,000	5,000
Mining	701	686	717	754	796	850
Livestock	2,363	2,363	2,363	2,363	2,363	2,363
Total Other Requirement	12,539	13,555	13,958	14,286	14,890	15,505
Total Water Requirement	1,574,189	1,236,771	1,194,301	1,147,746	1,104,647	1,065,328

be achieved. The basis of the analysis considers in-depth three key factors that should influence the total quantity of water required for irrigation in the Lower Rio Grande Valley in future years. These key factors are:

- Assumptions on the amount and general location of currently rural areas that will be converted to urban to accommodate the population increase
- Assumptions on the impact of metering irrigation water as well as an increase in the use of poly or gated pipe for on-field applications
- Assumptions on appropriate irrigation application rates based on projected crop mixes.

The potential impacts of urbanization of the irrigation requirements can be clearly seen traveling through the Lower Rio Grande Valley. This impact not only includes acres that are taken out of production by actual construction, but also limitations that are placed on agricultural practices due to its proximity to an urbanizing area. Summarized in Table 4 are the estimated current rural acres inside irrigation districts and the projected reductions in acres by decades that are anticipated to occur due to the urbanization of the Lower Rio Grande Valley. The Cameron County irrigation district rural acres are reduced by 27.4 percent during the planning period. Hidalgo and Willacy Counties' irrigation districts rural acres are reduced 52% and 1.7%, respectively. Obviously, the impact on the Hidalgo county irrigation districts is much greater than occurs in the other two counties.

Early on in the study it became apparent that one of the most promising areas for saving water within agriculture lay with the increased use of metering as well as poly or gated pipe. Metering, in lieu of pricing water on an estimated per acre basis, gives the producer and the irrigation district much better information on total water use, and when combined with some form of volumetric pricing, provides strong incentives for water conservation. Use of gated and poly pipe has increased significantly in the Valley in recent years and reduces seepage losses in conveying water from the lateral to the individual furrows. It can also reduce overall labor requirements, and it, if adequate head is available in the system, provides additional water savings over conventional furrow application with siphon tubes and dirt ditches.

Efficiency reported in the Lower Rio Grande Valley range from 10% to 44%. Consultation with several irrigation district managers revealed the opinion that although widespread use of metering and poly-pipe was possible, a third potential area that needed to be considered was the issue of system delivery pressure as well as the soil types. Differences among the various district's delivery systems and the resulting water delivery pressure (or head) as well as the presence of lighter soils in some areas made Valley-wide high use of these two techniques improbable. High levels of management were assumed possible only when metering and/or poly-pipe were in use as well as only in those areas in which

Table 4. Projected Rural Acres in Irrigation Districts Lost due to Urbanization

	Cameron County	Hidalgo County	Willacy County	Total
Current Rural Acres	265,745	396,611	36,906	699,262
Lost 2000 to 2010	15,656	35,858	209	51,722
Lost 2010 to 2020	16,524	39,362	176	56,062
Lost 2020 to 2030	17,909	46,969	117	64,995
Lost 2030 to 2040	13,885	41,791	81	55,737
Lost 2040 to 2050	8,868	42,136	32	51,037
Total	72,822	206,116	615	279,553

adequate head could be assured. As a result of this observation, the potential areas considered for improvement included the three components of use of metering, the use of poly or gated pipe, and the adoption of higher management levels at the field level were reduced.

The overall estimated reductions in water requirements that result from these assumptions are summarized in Table 5. The total savings are the additional amounts of water that would be required if the water conservation measures were not implemented and if the impacts of urbanization were not taken into account.

In the planning an integrated regional water system for an area as large as the Lower Rio Grande Valley, consideration should be given to the general distribution of the water demands. This information is needed to assist in the planning improvements to diversion pump stations, main delivery canals, transmission pipelines, and local and regional water treatment plants.

Table 5 Reductions in Water Requirements Due To Assumed Water Conservation Measures and the Impacts of Urbanization (Values in Acre-feet per Year)

Year	Domestic Water Conservation Savings	On-farm Water Conservation Savings	Urbanization Impact on Irrigation Water Requirements	Total
2000	8,900	0	0	8,900
2010	22,400	221,000	71,000	314,400
2020	40,100	201,000	153,000	394,100
2030	52,800	176,000	255,000	483,800
2040	64,700	153,000	345,000	562,700
2050	73,700	132,000	431,000	637,700

The impacts of the population increases on the domestic water requirements without the transmission losses for both the municipal and rural areas can be reviewed in Table 3. Several important facts can be determined from the data. By the year 2050 nearly twice as much demand will occur in Hidalgo County as in Cameron and Willacy Counties combined. Within Hidalgo County, approximately forty percent of the demand will be in the rural areas which will place a significant responsibility on the water supply corporations and the county government if no other institutional changes are made. In Cameron County, approximately twenty percent of the domestic demand in 2050 will occur in the rural area.

CONCLUSIONS

The Falcon-Amistad Reservoir System does not provide all the water requirements of the Lower Rio Grande Valley, but it does provide the vast majority of the water consumed. The projected domestic and other water requirements and the total water requirements are compared to the current estimate of the yield of the Falcon-Amistad Reservoir System, 1.021,514 acre-feet per year available to the study area, in Table 6. These water requirements are based on the assumptions that water conservation methods described above will be implemented and that the projected impacts of urbanization will occur.

Two important conclusions can be drawn from this comparison. First, the domestic and other water requirements will represent approximately forty percent

of the estimated yield of the Falcon-Amistad Reservoir System during the year 2050. The TNRCC current operating rules for the Falcon-Amistad Reservoir System of providing a reserve for these demands and of recognizing a higher priority for these uses should continue to provide a high level of protection. The portion of the estimated yield of the Falcon-Amistad Reservoir System available to the Lower Rio Grande Valley is less than the projected total requirements throughout the planning period. Normally, a greater reserve for the total demand would be appropriate, but in the case of the Lower Rio Grande Valley, this is provided in the irrigation water which can be reduced under the operating rules.

Table 6.Comparison of Water Requirements and Supply

Year	Domestic and Other Water Requirements	Percent of Falcon-Amistad Reservoir System	Total Water Requirements	Percent of Falcon-Amistad Reservoir System
2000	224,805	22.0%	1,574,189	154.1%
2010	258,026	25.3%	1,236,771	121.1%
2020	290,985	28.5%	1,194,301	116.9%
2030	338,377	33.1%	1,147,741	112.4%
2040	377,856	37.0%	1,104,647	108.1%
2050	418,235	40.9%	1,065,328	104.3%

Second, the water requirement projections for both domestic and irrigation are based on a very proactive water conservation program as well as considering the impacts of urbanization on the irrigation demand. Because these activities will have a significant impact of the balance between the available supply and the requirements, an annual program to collect the basic data and monitor the changes is recommended.