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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

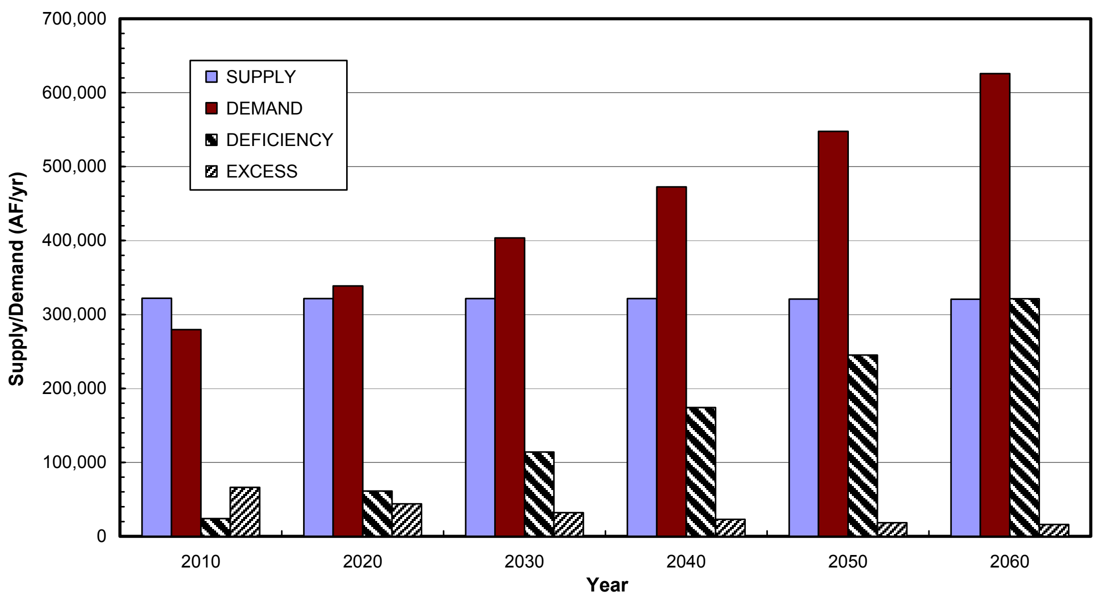


Figure 4.1 shows that total municipal demand will exceed total supplies beginning around the year 2020. However, this regional summary does not reflect the fact that some entities have secured water supplies in excess of projected demand for the entire planning period while others already are facing 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.

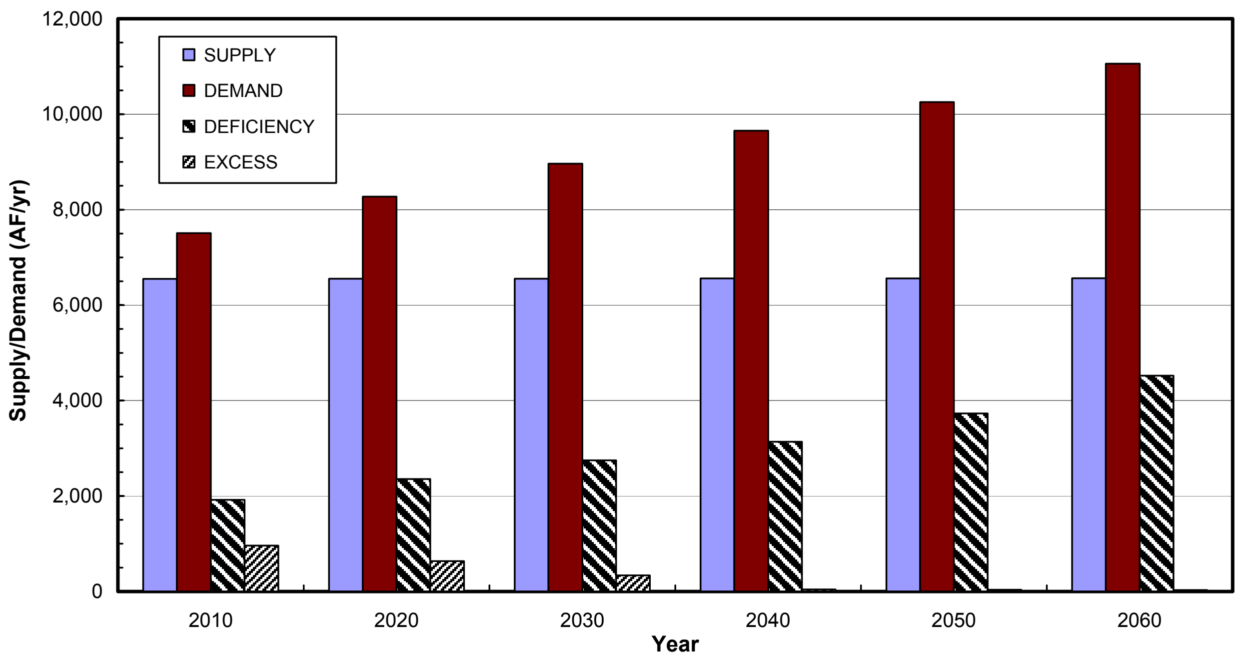
Table 4.11: Municipal Water Surplus/Needs for Zapata County

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

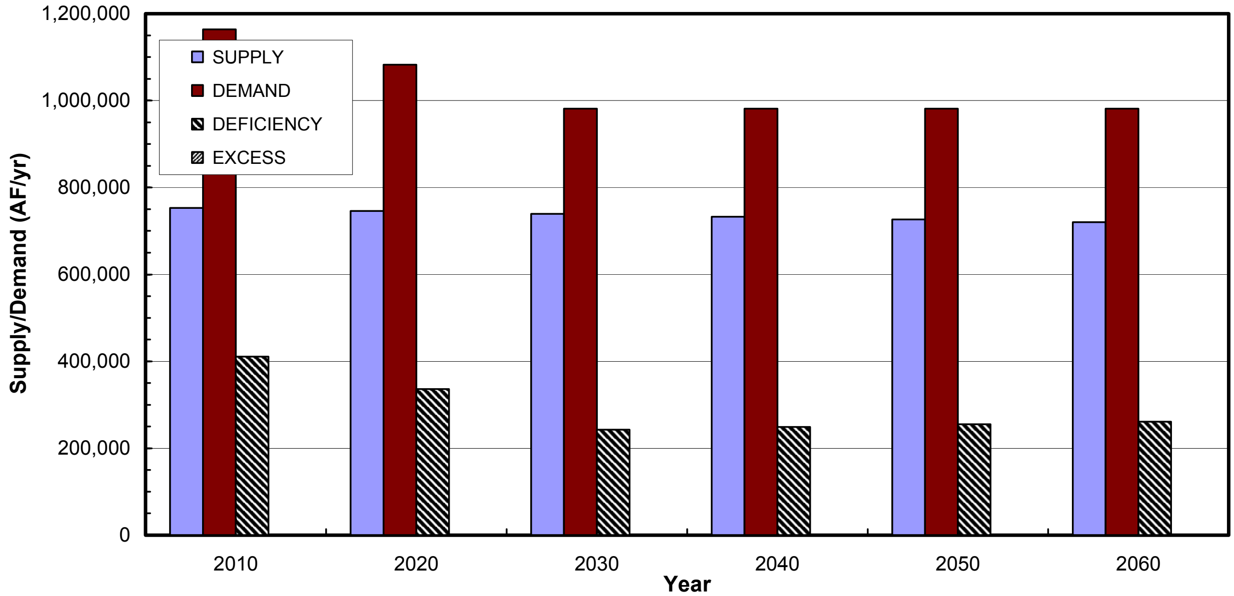


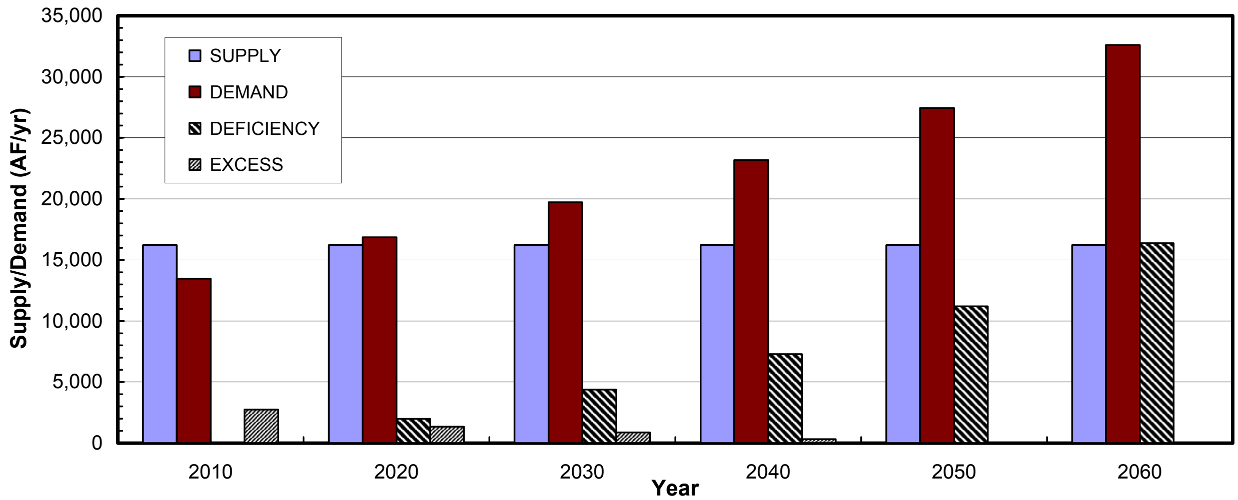
Table 4.13: Irrigation Water Surplus/Needs for the Rio Grande Region

		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

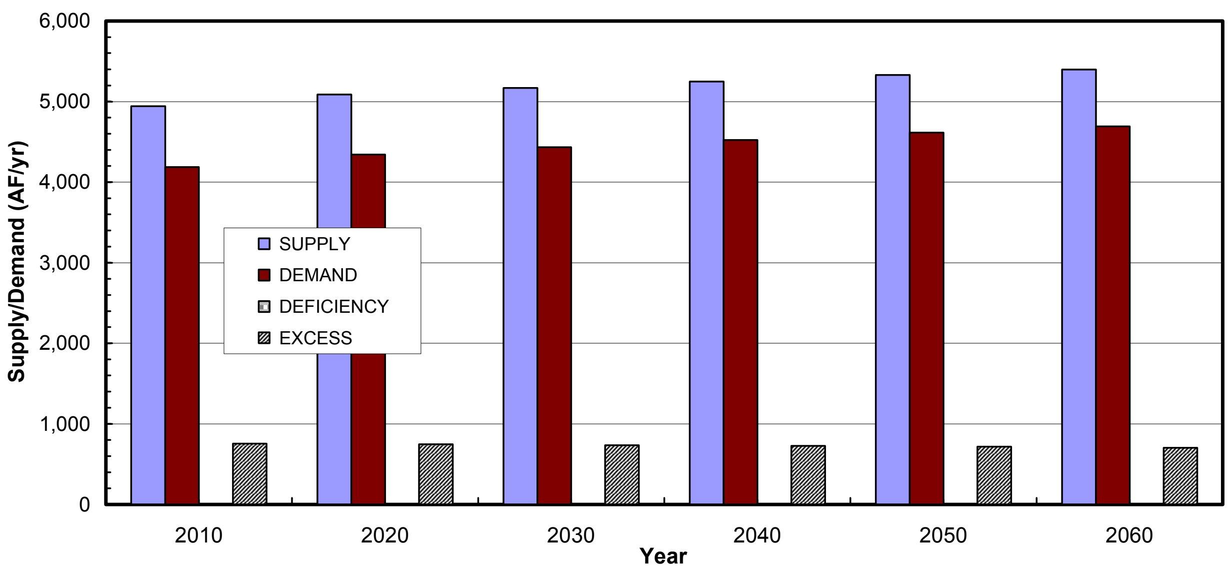


Table 4.15: Mining Water Surplus/Needs for the Rio Grande Region

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

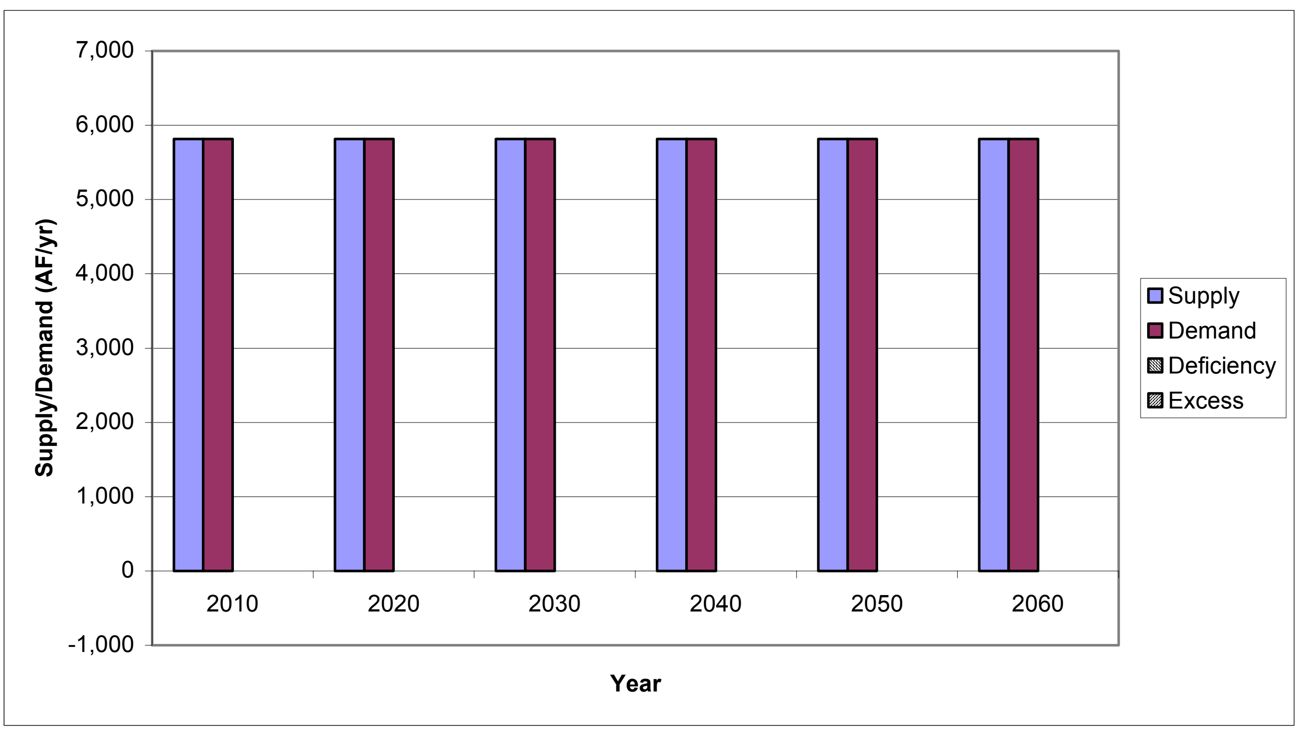


Table 4.16: Livestock Water Surplus/Needs for the Rio Grande Region

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

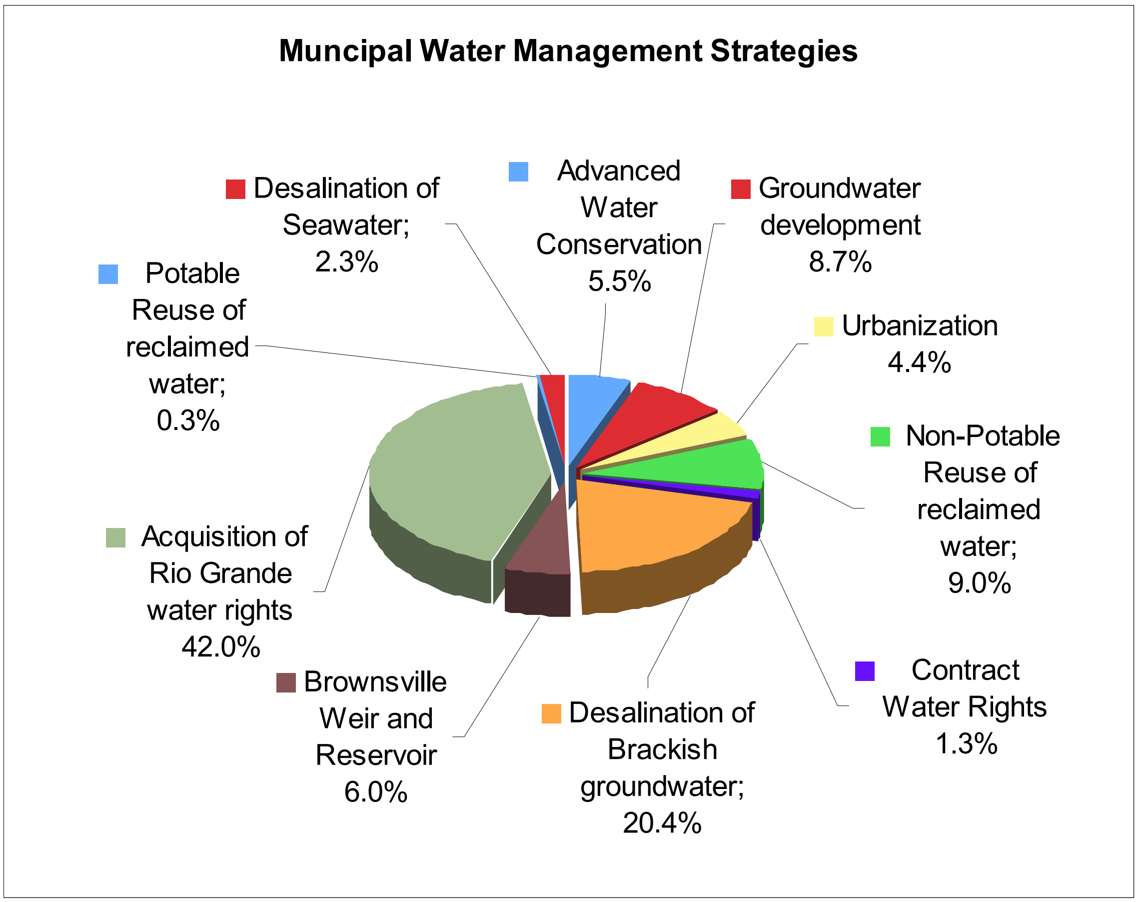


Table 4.17: Water Management Strategy Summary

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).

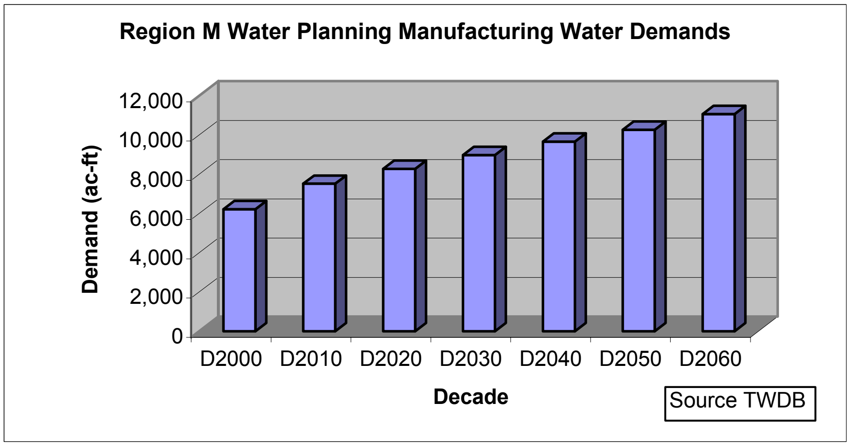
Table 4.19: Water Management Strategies Not Evaluated

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

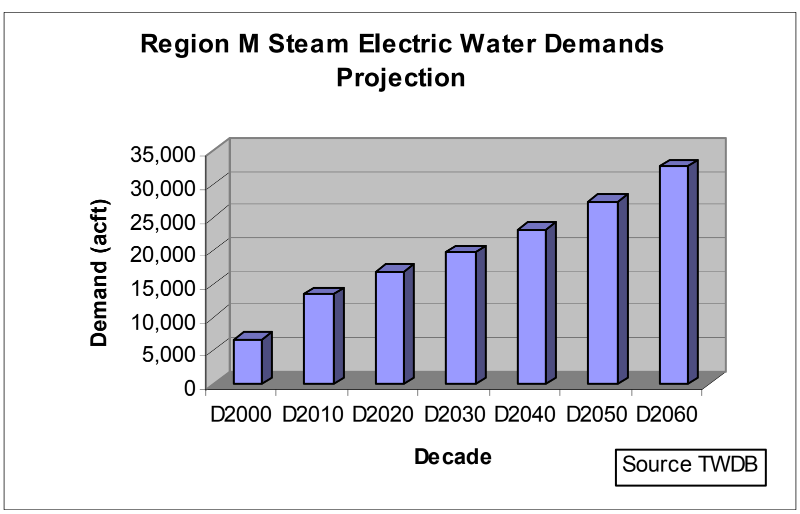
Figure 4.8: Water Planning Manufacturing Water Demands



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.

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[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.

Public Information/School Education
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.

Residential Clothes Washers
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			
	Cost		
WMS	$/Acre-ft	$/1000 gallons	Appendix
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.