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APPENDICES

Abbreviations used in the Report

Ac-ft/yr	Acre-feet per year
BRA	Brazos River Authority
CLCND	Chambers-Liberty Counties Navigation District
COH	City of Houston
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
GBFIG	Galveston Bay Freshwater Inflows Group
GCWA	Gulf Coast Water Authority
MGD	Million gallons per day
MWP	Major Water Provider
RWPG	Regional Water Planning Group
RHWPG	Region H Water Planning Group
SB1	Senate Bill 1 from the 1997 State Legislature
SJRA	San Jacinto River Authority
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TWDB	Texas Water Development Board
WUG	Water User Group

Water Measurements

Acre-foot (AF) = 43,560 cubic feet = 325,851 gallons
Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day
Gallons per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr
Million gallons per day (mgd) = 1,000,000 gallons per day = 1120 ac-ft/yr

County Codes used in the Tables

8	Austin County
20	Brazoria County
36	Chambers County
79	Fort Bend County
84	Galveston County
101	Harris County
145	Leon County
146	Liberty County
157	Madison County
170	Montgomery County
187	Polk County
204	San Jacinto County
228	Trinity County
236	Walker County
237	Waller County

Basin Codes used in the Tables

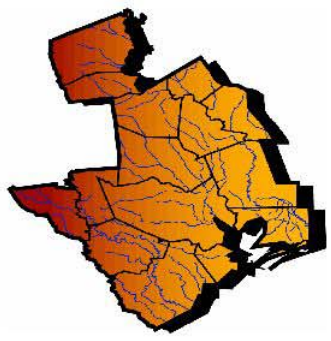
6	Neches River Basin
7	Neches-Trinity Coastal Basin
8	Trinity River Basin
9	Trinity-San Jacinto Coastal Basin
10	San Jacinto River Basin
11	San Jacinto-Brazos Coastal Basin
12	Brazos River Basin
13	Brazos-Colorado Coastal Basin

5.1. INTRODUCTION

This Task 5 report describes the analysis required within 31 TAC 357.7 (a) (5-7) regarding identification, evaluation and selection of appropriate water management strategies for the Region H water planning area. Management strategies have been defined for each of the previously identified future water shortages within Region H as required by the regional water planning process. Included within this report are:

- Review of the projected water shortages.
- Description of the potentially available water management strategies.
- Definition of the recommended management strategies.
- Allocation of selected strategies to specific Water User Groups (WUGs).
- The Region H Water Management Plan.

In addition to the above, this report contains a description of socioeconomic, environmental and institutional management aspects of the recommended plan. See the Exhibit 1, Location Map, for a general map description of the Regional H area.



Region H
Water Planning Group
Location Map

Legend

- Region H
- Streams
- Cities
- Counties

LEON
MADISON
BRAZOS
GRIMES
WALLER
AUSTIN
TRINITY
POLK
SAN JACINTO
LIBERTY
MONTGOMERY
HARRIS
FORT BEND
BRAZORIA
GALVESTON
CHAMBERS
HUNTSVILLE
CONROE
TOMBALL
HUMBLE
HOUSTON
PASADENA
BAYTOWN
DEER PARK
LA PORTE
LIVINGSTON
CLEVELAND
DAYTON
ALVIN
PEARLAND
SUGAR LAND
MISSOURI CITY
ROSENBERG
RICHMOND
KATY
JERSEY VILLAGE
LEAGUE CITY
TEXAS CITY
LAKE JACKSON
FREEPORT
ANGLETON
HITCHCOCK
SANTA FE
Lake Limestone
Twin Oak Reservoir
Houston County Lake
Lake Livingston
Lake Conroe
Lake Houston
Lake Anahuac
Smither Lake
Navasota River
Trinity River
Lake Creek
Peach Creek
East Fork San Jacinto River
Caney Creek
West Fork San Jacinto River
Spring Creek
Cypress Creek
Greens Bayou
Whiteoak Bayou
San Jacinto River
Cedar Bayou
Pine Island Bayou
Taylor Bayou
Oyster Creek
Brazos River
Clear Creek
Armand Bayou
Houston Ship Channel
Galveston Bay
Gulf Intracoastal Waterway
Dickinson Bayou
Chocolate Bayou
Chocolate Bay
Bastrop Bayou
San Bernard River
Oakley Creek

N
W E
S

70000 0 70000 140000 Feet

Source: TWDB, TNRCC

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5.2 WATER SHORTAGES REVIEW

Water User Groups

The Task 4 Report for Region H described the methodology and resulting definition of projected water shortages for WUGs within the region. In summary, the Task 4 Report stated that Region H contains approximately 229 WUGs (excludes subdividing of WUGs by river basin and county boundaries.) The following summary illustrates the result of the comparison of water supply versus projected demand for the Region H WUGs:

a. Total WUGs	229
b. WUGs with sufficient supply (surpluses)	136
c. WUGs with insufficient supply (shortages)	93

The following distribution exists across WUG categories for those 93 WUGs with projected water shortages:

a. Municipal WUGs served by a Regional Provider	43
b. Municipal WUGs not served by a Regional Provider	29
c. Municipal County-Other WUGs	8
d. Non-Municipal WUGs	13

In the above summary, note that the municipal category is defined within two subcategories; those municipal WUGs currently served by a regional water provider versus those WUGs not currently served by a regional water provider. Within Region H, a significant number of municipal WUGs currently receive surface water by contract from some type of regional water provider. It is assumed that the water supply relationship of these water providers and water customers will continue into the future.

Conversely, a significant number of municipal WUG communities have historically obtained their water supply from available groundwater. Analysis performed on groundwater availability (described within the Region H Task 3 Report) suggests that groundwater will cease being available in the quantities needed to many communities currently dependent on groundwater within the next 50-year period. This is particularly true of Fort Bend, Montgomery, and Brazoria counties which are projected to experience significant growth. These WUGs will need to acquire surface water supplies in the future. The category of the municipal WUGs not currently served by a regional water provider indicates that these communities will need to form a relationship with a water provider.

The regional planning process requires development of two types of water management strategies: near-term and long-term. Near-term regional planning is defined as water analysis through the year 2030, while long-term planning focuses on the 2040 and 2050 periods. Water shortages have been defined for these two time periods. Table 5-1 shows the projected water shortages by WUG category within the region.

Table 5-1- Water Shortages by WUG Category

Year	2030 (acre-feet per year)	2050 (acre-feet per year)
WUGs Served by Regional Provider	31,758	56,739
WUGs Not Served by Regional Provider	45,083	71,793
Municipal County-Other	250,981	329,471
Non-Municipal	171,706	335,180
Total	**499,438**	**793,183**

The Region H Task 3 Report concluded that there is more available water supplies than there is projected water shortages throughout the region. While this is true, as shown above, there are 72 specific municipal communities with projected water shortages. Further, there are WUGs within the region with total water shortages of approximately 500,000 acre-feet per year by year 2030 and these shortages increase to approximately 800,000 acre-feet per year by the end of the long-term planning period.

Major Water Providers

Of the available regional water providers within Region H, five of them have been designated as Major Water Providers (MWPs):

- Brazos River Authority
- City of Houston
- Gulf Coast Water Authority
- San Jacinto Water Authority
- Trinity River Authority

Major Water Providers are those entities that will be viewed as developing and implementing future water management strategies that will satisfy the projected water shortages. Table 8A which is contained within the Region H Task 4 Report, illustrates the quantity of available water supplies that these MWPs are projected to maintain based on satisfying their current water customer contracts. Table 5-2 provides data excerpted from Table 8A.

Table 5-2- Major Water Provider Available Supplies

Year	2030* (acre-feet per year)	2050* (acre-feet per year)
Brazos River Authority	0	0
City of Houston	341,143	271,609
Gulf Coast Water Authority	(7,363)	(7,363)
San Jacinto Water Authority	53,177	53,845
Trinity River Authority	265,585	265,488
Total	**652,452**	**583,579**

* Values reflect remaining balance after meeting contract obligations. All contracts extended through 2050.

The purpose of reviewing this data is to relate the potential current availability of supply to the previously illustrated water shortages. As shown, the Brazos River Authority (BRA) has no currently available water supplies within Region H. The Gulf Coast Water Authority (GCWA) shows immediate water supply needs which continue throughout the planning period. These two MWPs are noteworthy in that they both serve the Brazos River basin. This situation would suggest that the focus of future management strategies within the region may need to occur within the western portion of Region H and particularly within the Brazos River basin. Conversely, the Trinity River Authority (TRA) has a significant availability of water supply throughout the planning period suggesting that uncommitted supplies are available within the eastern portion of the region.

A cursory comparison of this data suggests that currently uncommitted supplies within the eastern portion of Region H may need to be conveyed to the western portions of the region to satisfy projected water shortages. One focus of the Region H water management plan may then be to consider conveyance means to transfer water across the region to the areas of need.

5.3 POTENTIAL WATER MANAGEMENT STRATEGIES

A detailed analysis process was developed to define potential water management strategies. The process was based on addressing the specific shortages of the 93 WUGs per the four WUG categories discussed above and then developing associated specific strategies assuming the MWPs would be the vehicle to solve WUG shortages. The process generally consisted of the following steps in the order shown:

1. Contract Extension - For the all WUGs served by a MWP, first use a strategy of "contract extension" throughout the planning period for the current contracted amount.

2. Contract Expansion - For the Municipal WUG category served by a MWP, then use a second strategy of "contract increase" to meet future water needs of Municipal WUGs currently associated with a specific provider.

3. MWP Association - For the Municipal WUGs, not served by a MWP, the Municipal County-Other and Non-Municipal WUGs with shortages- First associate a MWP to each of these WUGs.

4. Allocation of Uncommitted Supplies - Determine the total required shortage of the WUGs defined in Step 3 as it relates to each specific MWP. Then allocate current uncommitted supplies of each MWP to these WUGs with shortages until the existing MWP supplies are fully allocated.

5. Define Strategies - Determine the remaining required water supplies needed to satisfy the water shortages associated with each MWP. Define potential water management strategies for each specific MWP based on the identified water shortages.

A description of each of the above steps is provided below.

Step 1- Contract Extension

Tables 3 and 5 included in the Region H Task 2 Report were used to identify contract extensions required for continued provision of water at the existing contract volume for all Municipal and Non-Municipal WUGs with shortages. This strategy was applied to every WUG with a contract that expires during the planning period. Table 5-3 below shows those WUGs for which shortages are fully addressed through these contract extensions.

Table 5-3- WUG Shortages Met Through Contract Extension

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy
WUGs with Shortages Met by Extending Existing Contracts at Current Levels			
ANAHUAC	793	954	Extend existing contract of 1,049 af/y through 2050
CROSBY	634	707	Extend existing contract of 1,050af/y through 2050
HUNTSVILLE	4,411	5,373	Extend existing contract of 9,209 af/y through 2050
LA PORTE	2,363	3,325	Year 2000 shortage met with facility expansion scheduled in 2001. Scheduled step increase of 6.6 mgd through 2050.
LIVINGSTON	1,920	2,179	Extend existing contract of 5,601 af/y through 2050
MISSOURI CITY –Harris	1,298	1,664	Extend existing contract of 16,797 af/y with GCWA through 2050 - split by county (1/2 Harris - 1/2 Fort Bend)
NASSAU BAY	214	493	Scheduled step increase of 0.65 mgd
PASADENA	6,207	7,700	Year 2000 shortage met with facility expansion scheduled in 2001. Scheduled step increase of 19.35 mgd
PEARLAND	2,951	6,048	Extend existing contract of 11,198 af/y through 2050
SOUTH HOUSTON	769	1,037	Year 2000 shortage met with facility expansion scheduled in 2001. Contract increase of 1.25 mgd through 2050.
STAFFORD	1,810	3,809	Extend existing contract of 11,449 af/y through 2050
SUGAR LAND	9,310	18,947	Extend existing contract through 2050
POLK COUNTY-OTHER	299	657	Extend existing contract of 672 af/y through 2050
SAN JACINTO COUNTY-OTHER	252	930	Extend existing contract of 1,118 af/y through 2050
WALKER COUNTY-OTHER	1,712	1,677	Extend existing contract of 1,993 af/y through 2050
CHAMBERS MANUFACTURING	-	757	Extend existing contract of 7,796 af/y through 2050
FORT BEND STEAM ELECTRIC POWER	-	48,600	Extend existing contract of 83,000 af/y through 2050

Table 5-3 shows the near-term and long-term quantities of water shortages met through simple contract extension. A total of fifteen Municipal and two Non-Municipal WUG shortages can be solved through contract extension at the current contract quantity. This strategy addresses a total year 2050 WUG shortage of 104,857 acre-feet per year. It is important to recognize that this strategy is not limited to the MWPs. Contract extensions are used for all of the regional water providers within the region with current water contracts.

Step 2- Contract Increases

Similar to Step 1, the previous Regional Planning Tables 3 and 5 were used to identify those Municipal WUGs with projected shortages that would be met if their existing contracts were increased in quantity. Table 5-4 lists the Municipal WUGs that can be addressed in this fashion. This could not be applied to collective WUGs, such as County-Other or Manufacturing.

Table 5-4 – Municipal Shortages Met Through Contract Increases

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy	
WUGs Currently Served by Regional Water Providers				
Angleton	1,622	2,868	Extend and Increase existing contract by	2,868 ac-ft/yr
Bayou Vista	222	332	Extend and Increase existing contract by	332 ac-ft/yr
Baytown	3,157	5,552	Extend and Increase existing contract by	5,552 ac-ft/yr
Brazoria	127	179	Extend and Increase existing contract by	179 ac-ft/yr
Channelview (CDP)	1,974	1,915	Extend and Increase existing contract by	2,203ac-ft/yr
Clute	643	837	Extend and Increase existing contract by	837 ac-ft/yr
Deer Park	2,339	2,977	Extend and Increase existing contract by	2,977ac-ft/yr
Dickinson	2,643	3,315	Extend and Increase existing contract by	3,315 ac-ft/yr
El Lago	239	295	Extend and Increase existing contract by	295ac-ft/yr
Freeport	723	1,131	Extend and Increase existing contract by	1,131ac-ft/yr
Friendswood	2,987	7,185	Contract step increase of 1.5 mgd, but still need to increase by	7,185ac-ft/yr
Galena Park	559	568	Extend and Increase existing contract by	568ac-ft/yr
Galveston	-	1,391	Contract step increases by 4 mgd	
Hedwig Village	934	1,081	Extend and Increase existing contract by	1,081ac-ft/yr
Highlands	446	512	Extend and Increase existing contract by	512 ac-ft/yr
Hitchcock	332	471	Extend and Increase existing contract by	471 ac-ft/yr
Hunters Creek Village	1,557	1,676	Extend and Increase existing contract by	1,676 ac-ft/yr
Jacinto City	429	535	Extend and Increase existing contract by	535ac-ft/yr
La Marque	120	275	Extend and Increase existing contract by	275 ac-ft/yr
Lake Jackson	1,145	1,960	Extend and Increase existing contract by	1,960 ac-ft/yr
Mcnair	62	61	Extend and Increase existing contract by	62 ac-ft/yr
Missouri City -Fort Bend	271	10,468	Extend and Increase existing contract by	1,0468 ac-ft/yr
Oyster Creek	46	62	Extend and Increase existing contract by	62 ac-ft/yr
Piney Point Village	1,499	1,699	Extend and Increase existing contract by	1,699ac-ft/yr
Richwood	266	401	Extend and Increase existing contract by	401 ac-ft/yr
Santa Fe	1,457	1,700	Extend and Increase existing contract by	1,700 ac-ft/yr
Seabrook	1,727	1,879	Extend and Increase existing contract by	1,879ac-ft/yr
Southside Place	144	191	Extend and Increase existing contract by	191ac-ft/yr
The Woodlands	3,514	2,846	Extend and Increase existing contract by	4,048ac-ft/yr
West University Place	574	611	Extend and Increase existing contract by	611ac-ft/yr

A total of thirty Municipal WUGs can have all of their projected water shortages satisfied through increasing the supply provided by their current contracts. A significant number of these WUGs receive their water supply from the City of Houston which will be able to meet the Municipal WUG shortages throughout the planning period. Contract increases address a total of 56,739 acre-feet per year of shortages in the year 2050.

Step 3- MWP Association for Remaining WUGs

The remaining WUGs with shortages are entities that have historically obtained water supplies exclusively from groundwater but for which the projections indicate that future groundwater supplies will not be available. For each of these WUGs, an "association" was made with one or more of the MWPs.

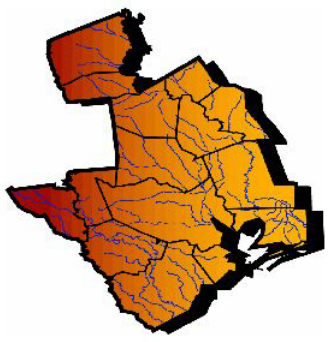
The association process for the Municipal WUGs Not Served by a Regional Provider, Municipal County-Other, and Non-Municipal WUGs consisted of first identifying the geographic location of the current service areas for each of the MWPs. Within the region, the MWPs maintain both a jurisdictional service area and an actual customer service area. The actual customer service area consists of areas which have developed due to convenience of service and other reasons. One example is that the GCWA was established to serve only customers within Galveston County (its jurisdictional service area). The GCWA, however, has an extensive canal system that conveys flow from the Brazos River through Brazoria County to Galveston County. The existence and location of the canal system has resulted in the provision of service to Brazoria County customers in close proximity to the GCWA canals. See the exhibit titled "Raw Surface Water Conveyance Systems" for a location of canal systems within the region. Table 5-5 indicates the location of the MWP service areas while Table 5-6 shows the association of the remaining Municipal WUGs with shortages to the Region H MWPs.

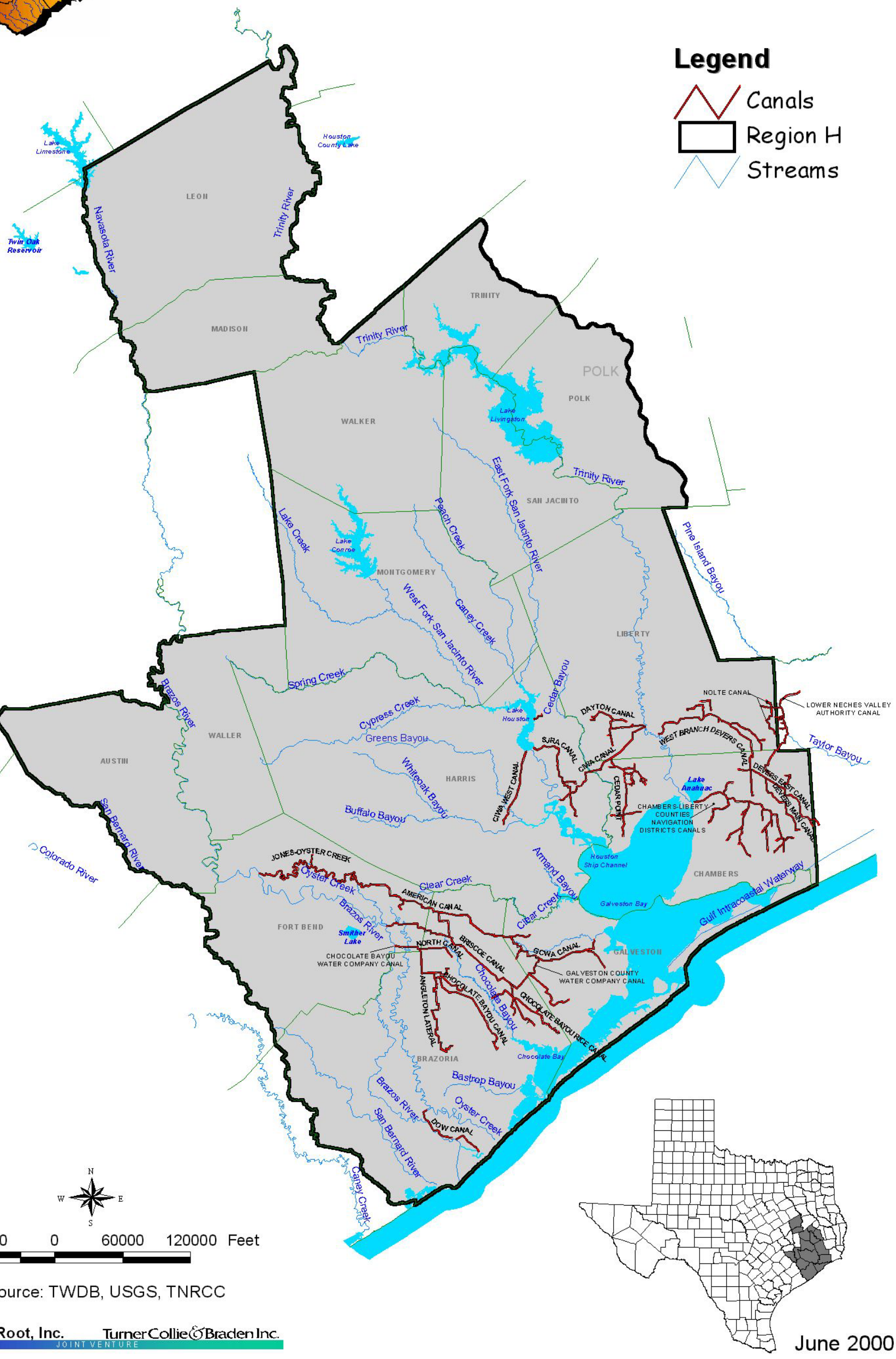
Table 5-5- Major Water Provider Service Areas

County	BRA	GCWA	City of Houston	SJRA	TRA
Brazoria	*	x			
Chambers					*
Fort Bend	*	x	x		
Galveston		*	x		
Harris			x	x	
Liberty				*	*
Montgomery				*	
Waller	*				

Table 5- - Jurisdictional Service Area
x Actual Current Service Area

Region H
Water Planning Group
Raw Surface Water Conveyance Systems





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June 2000

Table 5-6- Municipal WUGs Associated with MWPs

Water User Group	2030 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)	Recommended Water Management Strategy
WUGs Not Currently Served by Regional Water Provider			
Aldine (CDP)	1,503	1,463	Associate with Houston
Alvin	-	1,201	Associate with GCWA
Barrett	626	662	Associate with SJRA
Bellaire	3,567	3,632	Associate with Houston
Brookshire	493	1,047	Associate with BRA
Bunker Hill Village	1,016	1,075	Interconnect with City of Houston
Conroe	10,632	21,398	Associate with SJRA
Fulshear	59	180	Associate with BRA
Hempstead	82	381	Associate with BRA
Humble	5,490	6,456	Interconnect with City of Houston
Jersey Village	1,465	1,685	Associate with Houston
Katy	2,860	3,877	Associate with BRA
Meadows	693	1,582	Associate with Houston
Mission Bend (CDP)	2,219	2,663	Associate with Houston
Oak Ridge North	371	504	Associate with SJRA
Panorama Village	421	993	Associate with SJRA
Prairie View	290	1,136	Associate with BRA
Richmond	1,757	4,224	Associate with BRA
Rosenberg	1,872	4,995	Associate with BRA
Sheldon	353	408	Associate with Houston
Shenandoah	-	386	Associate with SJRA
Spring (CDP)	5,416	5,899	Associate with Houston
Spring Valley	538	571	Associate with Houston
Tomball	2,203	2,669	Associate with Houston
Town West (CDP)	205	478	Associate with Houston

Table 5-6 also shows the year 2030 and 2050 shortages that can be met by the MWPs based on the established association. The total quantity of year 2050 water shortages addressed within this category of WUGs is 71,793 acre-feet per year.

A similar process was followed to create an association for the MWPs to the Municipal County-Other and the Non-Municipal WUG categories. The Municipal County-Other WUGs were defined by county and watershed basin to create as accurate an association as possible. Table 5-7 shows the projected water shortages by decade for each of the Municipal and Municipal County-Other WUGs that have been associated with each of the five MWPs. Municipal County-Other shortages reflect the remaining shortage after all current contracts are extended through 2050.

Table 5-7- Municipal and Municipal County-Other WUG Needs from MWPs

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
Brazos River Authority Service Area						
Brookshire	0	0	-217	-493	-742	-1,047
Fulshear - Basin 11	0	0	-26	-54	-122	-162
Fulshear - Basin 12	0	0	-3	-5	-14	-18
Hempstead	0	0	0	-82	-210	-381
Katy – Fort Bend County	0	0	-98	-225	-359	-543
Katy – Harris County	0	-571	-1,644	-2,181	-2,316	-2,692
Katy – Waller County	0	-102	-308	-454	-534	-642
Prarie View	0	0	0	-290	-674	-1,136
Richmond	0	0	-712	-1,757	-2,819	-4,224
Rosenberg	0	0	-752	-1,872	-3,248	-4,995
Brazoria County Other Basin 12	0	0	-13	-96	-250	-469
Brazoria County Other Basin 13	0	0	-71	-392	-947	-1,576
Fort Bend County Other Basin 12	0	-1,355	-6,620	-13,995	-19,844	-25,416
Fort Bend County Other Basin 13	0	0	0	-1,877	-3,999	-6,033
Waller County Other Basin 10	0	0	-540	-1,307	-1,411	-1,576
Waller County Other Basin 12	0	0	-1,461	-3,381	-3,565	-3,887
Total	**0**	**-2,028**	**-12,465**	**-28,460**	**-41,054**	**-54,797**
City of Houston Service Area						
Aldine (CDP)	0	-600	-1,348	-1,503	-1,467	-1,463
Bellaire	-3,072	-3,265	-3,494	-3,567	-3,489	-3,632
Bunker Hill Village	0	-982	-1,018	-1,016	-998	-1,075
Humble	0	-1,571	-4,486	-5,490	-5,789	-6,456
Jersey Village	0	-439	-1,266	-1,465	-1,495	-1,685
Meadows	0	-157	-364	-693	-1,064	-1,582
Mission Bend (CDP) - Fort Bend Co	0	-312	-372	-553	-730	-914
Mission Bend (CDP) - Harris Co	0	-650	-1,608	-1,666	-1,668	-1,749
Sheldon	0	-306	-335	-353	-367	-408
Spring (CDP)	0	-1,961	-4,596	-5,416	-5,559	-5,899
Spring Valley	0	-176	-483	-538	-536	-571
Tomball	0	-603	-1,702	-2,203	-2,326	-2,669
Town West (CDP)	0	-103	-140	-205	-321	-478
Harris County Other Basin 10 (90%)	0	-31,740	-115,528	-132,845	-146,093	-141,442
Harris County Other Basin 11	0	-6,905	-23,876	-27,314	-29,898	-29,099
Total	**-3,072**	**-49,770**	**-160,617**	**-184,827**	**-201,800**	**-199,122**
Gulf Coast Water Authority Service Area						
Alvin	0	0	0	0	-541	-1,201
Brazoria County Other Basin 11	0	0	-134	-988	-2,493	-4,259
Fort Bend County Other Basin 10	0	-46	-229	-487	-695	-893
Fort Bend County Other Basin 11	0	-3,849	-9,386	-18,626	-27,260	-35,600
Galveston County Other Basin 7	-132	-149	-229	-311	-285	-76
Galveston County Other Basin 11	-387	-453	-794	-1,220	-1,088	-207
Total	**-519**	**-4,497**	**-10,772**	**-21,632**	**-32,362**	**-42,236**

Table 5-7- Municipal and Municipal County-Other WUG Needs from MWPs (Cont'd)

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
San Jacinto River Authority Service Area						
Barrett - Basin 9	0	-2	-6	-6	-6	-7
Barrett - Basin 10	0	-218	-581	-620	-615	-655
Conroe	0	-1,610	-6,183	-10,632	-15,388	-21,398
Oak Ridge North	0	0	-164	-371	-432	-504
Panorama Village	0	0	-185	-421	-680	-993
Shenandoah	0	0	0	0	-178	-386
Harris County Other Basin 9	0	-1,380	-4,772	-5,462	-5,988	-5,819
Harris County Other Basin 10 (10%)	0	-3,527	-12,836	-14,761	-16,233	-15,716
Liberty County Other Basin 10	0	0	0	-534	-779	-1,087
Montgomery County Other Basin 10	0	-4,346	-10,714	-24,600	-38,325	-52,585
Total	**0**	**-11,082**	**-35,441**	**-57,407**	**-78,623**	**-99,150**
Trinity River Authority Service Area						
Chambers County Other Basin 8	0	0	0	0	0	-7
Liberty County Other Basin 6	0	0	0	-70	-105	-150
Liberty County Other Basin 7	0	0	0	-10	-11	-13
Liberty County Other Basin 8	0	0	0	-1,425	-2,072	-2,889
Liberty County Other Basin 9	0	0	0	-42	-62	-86
Total	**0**	**0**	**0**	**-1,547**	**-2,250**	**-3,145**

Table 5-8 shows the association of Non-Municipal WUGs for each of the MWPs. Non-Municipal WUGs were defined by each specific Non-Municipal category of manufacturing, mining, irrigation, and steam electric power.

Table 5-8 Suggested Major Providers for Non-Municipal WUGs

WUGs	Regional Provider
Brazoria Manufacturing	BRA,GCWA,CBWC*
Brazoria Mining	BRA
Brazoria Irrigation	BRA,CBWC*
Fort Bend Manufacturing	BRA
Fort Bend Irrigation	BRA
Galveston Manufacturing	GCWA
Harris Manufacturing	Houston, SJRA
Harris Power	Houston
Harris Mining	Houston
Liberty Mining	TRA
Montgomery Manufacturing	SJRA
Montgomery Mining	SJRA
Waller Irrigation	BRA
	* Chocolate Bayou Water Company

Table 5-9 shows the resultant Non-Municipal WUG shortages associated with each MWP. The values in this table reflect the remaining shortages after current contracts are extended through 2050.

Table 5-9 Non-Municipal WUG Needs from MWPs

Water User Group	2000 Shortage af/y	2010 Shortage af/y	2020 Shortage af/y	2030 Shortage af/y	2040 Shortage af/y	2050 Shortage af/y
Brazos River Authority Service Area						
Brazoria Manufacturing	0	-16,853	-30,454	-44,521	-68,042	-91,332
Brazoria Mining	-302	-266	-234	-213	-213	-1,012
Brazoria Irrigation	-30,479	-49,106	-38,872	-34,508	-32,815	-34,125
Fort Bend Manufacturing	-16,277	-18,185	-19,934	-21,373	-23,862	-26,238
Fort Bend Irrigation	0	0	0	0	-101	-632
Waller Irrigation	-1,515	-2,634	-3,117	-3,750	-4,577	-5,640
Total	**-48,573**	**-87,044**	**-92,611**	**-104,365**	**-129,610**	**-158,979**
City of Houston Service Area						
Harris Manufacturing	0	-18,625	-32,142	-48,890	-85,317	-121,746
Harris Power	0	-380	-380	-380	-380	-380
Harris Mining	0	-7	-5	-4	-4	-4
Total	**0**	**-19,012**	**-32,527**	**-49,274**	**-85,701**	**-122,130**
Gulf Coast Water Authority Service Area						
Galveston Manufacturing	0	0	0	-3,625	-12,214	-20,816
Total	**0**	**0**	**0**	**-3,625**	**-12,214**	**-20,816**
San Jacinto River Authority Service Area						
Harris Manufacturing	0	-3,457	-7,597	-10,801	-18,157	-25,209
Montgomery Manufacturing	0	-265	-458	-647	-934	-1,227
Montgomery Mining	-196	-98	-53	-30	-19	-15
Total	**-196**	**-3,820**	**-8,108**	**-11,478**	**-19,110**	**-26,451**
Trinity River Authority Service Area						
Liberty Mining	0	0	0	-3,113	-4,333	-6,952
Total	**0**	**0**	**0**	**-3,113**	**-4,333**	**-6,952**

Step 4- Allocation of Existing Uncommitted Supplies of MWPs

This step entailed defining the total quantity of WUG water shortages associated with each of the MWPs. Then based on the above associations, existing uncommitted supplies of the MWPs were determined. Table 5-10 is a summary of the total WUG shortages that have been associated to each MWP. Included within this table are the needed shortages associated with the contract extensions defined in Step 2 of this process. The shortages are shown by decade to illustrate both the near-term and long-term water shortages by MWP.

Table 5-10 Water User Group Needs from Major Water Providers

Water User Group	2000 Shortage (ac-ft/yr)	2010 Shortage (ac-ft/yr)	2020 Shortage (ac-ft/yr)	2030 Shortage (ac-ft/yr)	2040 Shortage (ac-ft/yr)	2050 Shortage (ac-ft/yr)
Brazos River Authority Service Area						
Municipal Contract Increases	0	0	0	0	0	0
Municipal WUGs	0	-2,028	-12,465	-28,460	-41,054	-54,797
Non-Municipal WUGs	-48,573	-87,044	-92,611	-104,365	-129,610	-158,979
Total	**-48,573**	**-89,072**	**-105,076**	**-132,825**	**-170,664**	**-213,776**
City of Houston Service Area						
Municipal Contract Increases	-5,637	-11,280	-15,119	-18,627	-20,965	-26,737
Municipal WUGs	-3,072	-49,770	-160,617	-184,827	-201,800	-199,122
Non-Municipal WUGs	0	-19,012	-32,527	-49,274	-85,701	-122,130
Total	**-8,709**	**-80,062**	**-208,262**	**-252,728**	**-308,467**	**-347,989**
Gulf Coast Water Authority Service Area						
Municipal Contract Increases	-180	-2,823	-3,613	-5,045	-10,134	-17,952
Municipal WUGs	-519	-4,497	-10,772	-21,632	-32,362	-42,236
Non-Municipal WUGs	0	0	0	-3,625	-12,214	-20,816
Total	**-699**	**-7,320**	**-14,385**	**-30,302**	**-54,710**	**-81,004**
San Jacinto River Authority Service Area						
Municipal Contract Increases	0	-3,456	-4,048	-3,514	-2,980	-2,846
Municipal WUGs	0	-11,082	-35,441	-57,407	-78,623	-99,150
Non-Municipal WUGs	-196	-3,820	-8,108	-11,478	-19,110	-26,451
Total	**-196**	**-18,359**	**-47,597**	**-72,399**	**-100,714**	**-128,447**
Trinity River Authority Service Area						
Municipal Contract Increases	0	0	0	0	0	0
Municipal WUGs	0	0	0	-1,547	-2,250	-3,145
Non-Municipal WUGs	0	0	0	-3,113	-4,333	-6,952
Total	**0**	**0**	**0**	**-4,660**	**-6,583**	**-10,097**

Table 5-11 compares the uncommitted supply by MWP (taken from Regional Planning Table 8A-Task 4 Report) to the WUG shortages defined within Table 5-10. Table 8A represents total MWP supply less current contract demands (all contracts extended through 2050.) The resultant balance in Table 5-11 represents that quantity of uncommitted supply available to the MWP or the quantity of additional supply needed to address the projected WUG shortages. If it is a

shortage, it is the remaining quantity that must be provided through the use of new water management strategies.

Table 5-11- Projected Major Water Provider Availability

Major Water Provider	2000 (ac-ft/yr)	2010 (ac-ft/yr)	2020 (ac-ft/yr)	2030 (ac-ft/yr)	2040 (ac-ft/yr)	2050 (ac-ft/yr)
Brazos River Authority						
Uncommitted Supply	0	0	0	0	0	0
Water User Group Needs	48,573	89,072	105,076	132,825	170,664	213,776
Balance	**-48,573**	**-89,072**	**-105,076**	**-132,825**	**-170,664**	**-213,776**
City of Houston						
Uncommitted Supply	524,348	474,179	383,169	341,143	318,195	271,609
Water User Group Needs	8,709	80,062	208,262	252,728	308,467	347,989
Balance	**515,639**	**394,117**	**174,907**	**88,414**	**9,728**	**-76,380**
Gulf Coast Water Authority						
Uncommitted Supply	-10,694	-7,363	-7,363	-7,363	-7,363	-7,363
Water User Group Needs	699	7,320	14,385	30,302	54,710	81,004
Balance	**-11,393**	**-14,683**	**-21,748**	**-37,665**	**-62,073**	**-88,367**
San Jacinto River Authority						
Uncommitted Supply	56,691	53,235	52,643	53,177	53,711	53,845
Water User Group Needs	196	18,359	47,597	72,399	100,714	128,447
Balance	**56,495**	**34,876**	**5,045**	**-19,222**	**-47,003**	**-74,602**
Trinity River Authority						
Uncommitted Supply	278,220	273,421	271,891	265,585	265,712	265,488
Water User Group Needs	0	0	0	4,660	6,583	10,097
Balance	**278,220**	**273,421**	**271,891**	**260,925**	**259,129**	**255,392**

As shown in Table 5-11, the TRA is projected to have a significant quantity of uncommitted water supply through the planning period. Both GCWA and BRA are projected to have immediate and significant near-term water shortages prior to year 2030. The City of Houston has sufficient supplies until approximately year 2050 and the SJRA is projected to need additional supplies by approximately year 2030.

Step 5- Potential Water Management Strategy Definition

A series of potential water management strategies were defined based on the above determination of need illustrated within Table 5-11. Strategies were configured to address the specific types and nature of identified shortages. For instance, no strategies were effectively defined for the TRA due to the extent of the available uncommitted supplies. A number of potential strategies were defined for the Brazos River basin due to the needs of the BRA and GCWA. The following potential management strategies were identified:

1. Municipal Water Conservation
2. Irrigation Conservation
3. Contractual Transfer
4. New Surface Water Reservoirs
5. Wastewater Reclamation
6. Desalination
7. San Jacinto River Authority/City of Houston Water Transfer
8. Luce Bayou Conveyance
9. City of Houston/Trinity River Authority Contract Agreement
10. Sabine Basin to Region H Interbasin Transfer
11. Lake Bedias to Lake Conroe Transfer
12. Houston To Gulf Coast Water Authority Transfer
13. San Jacinto River Authority/Chambers-Liberty Counties Navigation District Contract

A detailed technical memorandum for each of these management strategies is provided within Appendix A. Not all of the strategies are based on creation of additional water. Several strategies consist of water transfer facilities only (for instance, Luce Bayou or Bedias Transfer) Other strategies only involve the contractual exchange of water supplies between various water suppliers (for instance, SJRA/City of Houston water transfers). These strategies recognize the need to transfer supply from areas of excess to the specific areas of need.

A total of 19 different surface water reservoir projects were reviewed. Ten of these projects were evaluated in detail due to their increased potential for development. A summary listing of the potential reservoir projects is provided in Table 5-12.

No groundwater development strategies were investigated since there is a complete utilization of the sustainable safe yield of all of the aquifers within the counties of highest water demand need. The only counties with available groundwater within Region H are distant from the areas of water need. It is generally not considered prudent to transfer groundwater between counties due to the potential adverse impact on growth within the local communities and due to the political ramifications of such a strategy. If specific groundwater transfer projects were determined to be cost effective, there would still be a significant degree of uncertainty and therefore risk associated with the long-term viability of such a project.

Assessment of each of the potential management strategies conducted as a part of this study included an evaluation of cost, environmental, socioeconomic and other types of impacts. Discussion of necessary implementation activities associated with various strategies is also

included in this report. In order to assess the strategies on a comparable cost basis, a detailed set of unit costs was developed and applied to each alternative. A description of the costing methodology is contained within Appendix B.

Table 5-12 Potential Reservoir Sites

Reservoir Name	River Basin	County(s)	Project Yield	Project Cost	Unit Water Cost ($/ac-ft)
Allens Creek	Brazos	Austin	99,650	$157,300,000	$121
Little River	Brazos	Milam	129,000	$361,065,000	$197
Millican-Panther	Brazos	Brazos Grimes Robertson Leon	235,200	$1,237,300,000	$366
Millican-Bundic Crossing	Brazos	Brazos Grimes Robertson Leon	73,800	$552,370,000	$541
Cleveland	San Jacinto	San Jacinto	65,900	$199,000,000	$231
Lake Creek	San Jacinto		67,200	$339,500,000	$387
Humble	San Jacinto	Montgomery	Not Developed	Not Developed	NA
Spring Creek	San Jacinto	Harris Montgomery	7,500	$21,255,000	$217
Bedias	Trinity	Madison Walker Grimes	90,700	$132,000,000	$112
Caney	Trinity	Trinity	15,700	Not Developed	NA
Harmons	Trinity	Walker	10,100	Not Developed	NA
Hurricane Bayou	Trinity	Houston	17,900	Not Developed	NA
Long King	Trinity	Polk	20,200	Not Developed	NA
Lower Keechi	Trinity	Leon	25,800	Not Developed	NA
Mustang	Trinity	Houston	15,700	Not Developed	NA
Nelson	Trinity	Walker	17,900	Not Developed	NA
Tehuacana	Trinity	Freestone	61,100	$169,000,000	$212
Tennessee Colony	Trinity	Anderson Freestone	405,800	$2,061,000,000	$389
Upper Keechi	Trinity	Freestone	15,700	Not Developed	NA

Table 5-13 provides a summary comparison of the water management strategies analyzed for Region H. A detailed comparison is provided in Table 5A-1 at the end of Appendix A. The RHWPG discussed each potential water management strategy at the time it was presented, weighing the economic, social and environmental costs and benefits. Special attention was paid to the impacts of interbasin transfers, which figured prominently due to the surplus of supply in the Trinity basin and projected shortages in the San Jacinto and Brazos basins. The issues were again discussed during the final management selection process. Regional water planning Table 11, which associates the potential management strategies in Table 5-13 to the WUGs, is contained within Appendix C.

Table 5-13- Comparison of Alternative Management Strategies

Management Strategy	Yield (ac-ft/yr)	Strategy Cost ($)	Unit Cost ($/ac-ft)	Starting Decade	Basin
Municipal Conservation	30,563	$3,667,600	$120	2000	All
Irrigation Conservation					
Brazoria County	24,312	$1,876,000	$70	2000	Brazos, Brazos-Colo.
Fort Bend County	14,259	$1,085,000	$59	2040	Brazos, Brazos-Colo.
Waller County	5,010	$391,000	$78	2000	San Jacinto
Contractual Transfers	28,500	None	None	2000	San Jacinto-Brazos
Reservoirs					
Allens Creek	99,650	$157,300,000	$121	2000	Brazos
Little River	129,000	$361,065,000	$197	2000	Brazos
Millican – Panther	235,200	$1,237,300,000	$366	2000	Brazos
Millican – Bundic Crossing	73,800	$552,370,000	$541	2000	Brazos
Cleveland	65,900	$199,000,000	$231	2030	San Jacinto
Lake Creek	67,200	$339,500,000	$387	2030	San Jacinto
Spring Creek	7,500	$21,255,000	$217	2030	San Jacinto
Bedias	90,700	$132,000,000	$112	2030	Trinity
Tehaucana	61,100	$169,000,000	$212	>2050	Trinity
Tennessee Colony	405,800	$2,061,000,000	$389	>2050	Trinity
Wastewater Reclamation	90,700	$175,498,000	$299	2030	San Jacinto-Brazos
Desalination	44,600	$151,177,000	$500	2030	San Jacinto-Brazos
SJRA/Houston Transfer	67,029	Unknown	Unknown	2030	San Jacinto
Luce Bayou	None	$84,000,000	$24	2020	Trinity to San Jacinto
SJRA/ Lake Livingston	None	$133,800,000	$204	2030	Trinity to San Jacinto
Houston/TRA Contract	200,000	Unknown	Unknown	2050	Trinity to San Jacinto
Bedias / SJRA Transfer	None	$62,340,000	$79	2030	Trinity to San Jacinto
Houston/GCWA Transfer	23,000	$63,270,000	$230	2050	Trinity to San Jacinto-Brazos
Sabine/Region H Transfer					
Sabine to Trinity Transfer	453,000	$311,004,000	$56	2030	Sabine, Neches, Trinity
Trinity to Brazos Transfer	377,000	$498,940,000	$127	2010	Trinity, San Jacinto, Brazos
Voluntary Redistribution	75,000	None	None	2000	Brazos
SJRA / CLCND Contract	30,000	$8,250,000	$275	2000	Trinity to San Jacinto

- **SELECTED WATER MANAGEMENT STRATEGIES**

Decision Process

All of the information developed within Section 3 of this report was provided to the Region H Water Planning Group for their review and comment. Each of the analysis steps was presented to the RHWPG and discussed during a series of RHWPG meetings. At the conclusion of the information development stage, the RHWPG conducted an open meeting to discuss the merits of each strategy and select recommended strategies for inclusion in the Region H plan. This meeting began with a review of the projected water shortages for both the WUGs and the MWPs. Emphasis on the location, quantity and timing of need of projected shortages was reviewed. The RHWPG subsequently conducted a three-step selection process as follows.

Step 1 consisted of consideration of the use of conservation-based demand-management strategies. These strategies apply directly to the WUGs as opposed to the MWPs and will result in a decrease of the projected remaining water shortages.

The RHWPG selected four types of conservation strategies including:

- Municipal Conservation (for WUGs with shortages only)
- Irrigation Conservation within Brazoria County
- Irrigation Conservation within Fort Bend County
- Irrigation Conservation within Waller County

The municipal conservation strategy applies to 30 Municipal WUGs and 8 Municipal County-Other WUGs. The irrigation conservation strategy applies to three counties. This strategy within Fort Bend County also assists in the resolution of the Municipal WUG shortage for the City of Needville. This strategy consists of the City of Needville assisting in the reduction of irrigation water usage in exchange for the ability of Needville to continue to pump groundwater. This is significant in that groundwater is limited within Fort Bend County. All of the other potential strategies available to the City of Needville would cost significantly more than the cost of irrigation conservation.

Step 2 consisted of consideration of specific management strategies for each of the MWPs. The water shortage quantity needed by each water provider was defined and that quantity of supply, at a minimum, was met by selected management strategies. The RHWPG selected the following strategies:

Strategies	MWP Sponsor
• Contractual Transfer	None
• Allens Creek Reservoir	BRA, City of Houston
• Little River Reservoir	BRA, GCWA
• Bedias Reservoir	SJRA, TRA
• Wastewater Reclamation	City of Houston
• Luce Bayou	City of Houston
• City of Houston/TRA Contract Agreement	City of Houston, TRA
• BRA Voluntary Redistribution	BRA
• SJRA / CLCND Contract Agreement	SJRA

The BRA Voluntary Redistribution was introduced by the BRA, which is in the process of obtaining water currently committed under contract to BRA customers but which is not needed in the long-term by those customers. The BRA has the ability to enter into new contracts with their current customers for a smaller contract quantity and then sell this "freed-up" water to new customers. The BRA reports that approximately 75,000 acre-feet per year can be made available.

The SJRA Contract Agreement with the Chambers-Liberty Counties Navigation District was executed in December 2000. A conveyance method has yet to be determined for this supply.

Step 3 consisted of consideration of long-term strategies that would not be needed until significantly beyond the 2050 timeframe. These strategies might be those that have some technical and economic merit but would not be likely to be pursued in the short-term by any particular MWP. Three management strategies were selected by the RHWPG as long-term strategies:

- Desalination
- Sabine to Region H Interbasin Transfer
- Millican - Bundic Crossing Reservoir

The RHWPG believed that the cost of desalination may decrease in the future as technology improves and that this strategy might merit consideration at that time, especially for certain isolated WUGs. The Sabine to Region H transfer was included due to its potential to provide a significant quantity of supply. The RHWPG discussed issues associated with that strategy including the current interbasin transfer limitations within the Texas Water Code, potential freshwater inflow impacts within the Sabine Lake estuary, and political opposition within East Texas as reasons why this strategy would not be pursued in the short-term. Millican-Bundic Crossing Reservoir was included as the next most economical means of increasing supply in the Lower Brazos River basin.

Regional Water Planning Table 12, which defines each of the water management strategies for each WUG, is shown in Appendix C. The major strategies outlined above are shown in Table 12. Additional strategies are shown which allocate supplies from each MWP to each WUG or from each MWP to a 2nd tier water supplier (Brazosport Water Authority or Baytown Area Water Authority) and then to a WUG. An analysis was performed to determine the cost of expanding the water supply facilities of each WUG with a projected shortage. This methodology is outlined in Appendix C, and the current facility expansion plans reviewed for this analysis are in Appendix D. The costs defined within Tables 11 and 12 represent these WUG facility costs. Facility expansion and maintenance costs for WUGs without projected shortages are not addressed.

Major Water Providers

Each of the Region H MWPs will be involved in development of new surface water reservoirs and in making more efficient usage of existing water supplies. Regional water planning Table 13, which defines the water management strategies associated with each MWP, is shown in Appendix C. Table 13 shows the allocation of supply for each management strategy. This table also shows the allocation of supply from a strategy when multiple MWPs serve as strategy sponsors. Table 5-14 (below) summarizes the proposed management strategies under each MWP, and relates them to the WUG shortages allocated to the MWPs. The BRA will include these strategies in the annual planning process for the BRA Long-Range Plan.

The selected water supply management strategies can potentially make available to the region an additional 485,000 acre-feet per year. Further, the City of Houston/TRA Contract Agreement strategy will utilize 200,000 acre-feet of existing supply. Importantly, the defined strategies either locate supply in closer proximity to areas of need or include development of transfer facilities (specifically Luce Bayou and the Bedias Transfer) that can convey supplies to areas of need. Based on the recommended strategies, in total, the Region H MWPs will have adequate supplies to meet projected water needs beyond the year 2050.

Water User Groups

Strategies were also developed that include demand-management practices. The selected conservation strategies reduced projected water demands by approximately 74,000 acre-feet per year. Additionally, the Contractual Transfer strategy reduces needs by approximately 28,500 acre-feet per year without the expenditure of additional capital investment. Each of the conservation strategies and the Contractual Transfer strategy would be implemented by specific WUGs and not developed by a MWP.

Summary tables were prepared for each WUG, listing projected population, supply, demand and supply from management strategies (if needed), by decade. These tables are in Appendix E.

Table 5-14 Management Strategies for Major Water Providers

Major Water Provider Management Strategy	2000 af/y	2010 af/y	2020 af/y	2030 af/y	2040 af/y	2050 af/y
Brazos River Authority						
Balance Without Strategies *	-48,573	-89,072	-105,076	-132,825	-170,664	-213,776
Voluntary Redistribution	50,000	50,000	50,000	75,000	75,000	75,000
GCWA	-18,000	-18,000	-21,000	-35,000	-35,000	-35,000
Brazosport Water Authority ***	0	0	0	0	0	-1,200
Municipal Conservation	0	762	3008	4101	4302	5207
Irrigation Conservation	0	29,332	43,581	43,581	43,581	43,581
Needville's shortage ***			-123	-282	-462	-711
Allens Creek Reservoir	0	0	29,900	29,900	29,900	29,900
Little River Reservoir **	0	0	0	0	71,000	71,000
Contractual Transfer - MFR to IRR	28,500	28,500	28,500	28,500	28,500	28,500
Balance	11,927	1,522	28,790	12,975	46,157	2,501
City of Houston						
Balance Without Strategies *	515,639	394,117	174,907	88,414	9,728	-76,380
Municipal Conservation	98	7,763	17,055	16,783	13,652	13,366
Allens Creek Reservoir	0	0	69,750	69,750	69,750	69,750
Luce Bayou	0	0	0	0	0	0
Wastewater Reclamation	0	90,700	90,700	90,700	90,700	90,700
Houston / GCWA Transfer	0	0	0	0	0	-23,000
Houston / TRA Contract	0	200,000	200,000	200,000	200,000	200,000
Balance	515,737	692,580	552,412	465,647	383,830	274,436
Gulf Coast Water Authority						
Balance Without Strategies *	-11,393	-14,683	-21,748	-37,665	-62,073	-88,367
Municipal Conservation	92	840	1,676	2,676	2,858	3,682
Little River Reservoir	0	0	0	0	28,000	28,000
New BRA Contract	18,000	18,000	21,000	35,000	35,000	35,000
Houston / GCWA Transfer	0	0	0	0	0	23,000
Balance	6,699	4,157	926	11	3,785	1,316
San Jacinto River Authority						
Balance Without Strategies *	56,495	34,876	5,045	-19,222	-47,003	-74,602
Municipal Conservation	0	2,632	5,080	6,175	6,586	7,707
SJRA CLCND Contract	30,000	30,000	30,000	30,000	30,000	30,000
Bedias Reservoir / Interbasin Transfer	0	0	0	75,000	75,000	75,000
Balance	86,495	67,509	40,125	91,953	64,583	38,105
Trinity River Authority						
Balance Without Strategies *	278,220	273,421	271,891	260,925	259,129	255,392
Municipal Conservation	0	0	0	579	451	531
Bedias Reservoir	0	0	0	15,700	15,700	15,700
Houston / TRA Contract	0	-200,000	-200,000	-200,000	-200,000	-200,000
Balance	278,220	73,421	71,891	77,204	75,280	71,623

* Starting balance reflects extensions of current contracts

** Little River Reservoir total yield is 129,000 afy. 30,000 afy will go to BRA in Region G, 71,000 afy will go to BRA in Region H, and 28,000 afy will go to the GCWA

*** Entities previously designated for self-supply

5.5. PROPOSED REGION H WATER MANAGEMENT PLAN

Table 5-15 summarizes the final recommended Region H Water Management Plan as developed through the RHWPG selection process. The Task 4 Report, based on a severe set of assumptions, paints a pessimistic picture of Region H's future if action is not taken to address projected water shortages. In contrast, this section outlines the regional impacts if the Region H Water Plan is implemented.

Table 5-15 Region H Selected Management Strategies

Management Strategy	Yield (ac-ft/yr)	Strategy Cost ($)
Municipal Conservation	30,563	$3,667,600
Irrigation Conservation		
Brazoria County	24,312	$1,876,000
Fort Bend County	14,259	$1,085,000
Waller County	5,010	$391,000
Contractual Transfers	28,500	None
Reservoirs		
Allens Creek	99,650	$157,300,000
Little River	129,000	$361,065,000
Bedias	90,700	$132,000,000
Wastewater Reclamation	90,700	$175,498,000
Luce Bayou	None	$84,000,000
Houston/TRA Contract	200,000	Unknown
BRA Voluntary Redistribution	75,000	None
Bedias/SJRA Transfer	None	$62,340,000
Houston/GCWA Transfer	23,000	$63,270,000
SJRA / CLCND Contract	30,000	$8,250,000

Implementation Methods

Several of the selected management strategies will be developed jointly by multiple MWPs. These projects include each of the reservoir projects:

Allens Creek Reservoir	BRA and City of Houston
Little River Reservoir	BRA and GCWA
Bedias Reservoir	SJRA and TRA

The location of each of these reservoir sites is shown on the exhibit titled, "Recommended Reservoir Sites". As these projects move forward in the development process, the regional benefits of each project can be supported by each of the joint project sponsors. Each of the MWPs has the legal, management and financial capability to develop the proposed reservoir projects.

Successful implementation of the conservation strategies requires that a specific WUG support and guide adoption of the conservation practices. Development of these strategies should begin with definition of the appropriate institutional entity that can enact the conservation measures.

In general, the remainder of the management strategies requires monitoring of local municipal and customer needs to determine when development of specific projects should begin. Reservoir projects require approximately 10 to 20 years to develop. Detailed planning and permitting should be begun many years in advance of the actual time of water supply need. Identification of customers associated with each project will assist the MWP project sponsors assessment of the appropriate time to initiate each project. To a lesser extent, the same is true of each of the other strategies. Market forces based on the localized supply needs of the MWP customer base will determine the appropriate time to initiate each project.

The Region H Water Management Plan ensures that there is adequate water supply available for all water user groups in the Region. It does not identify the facility expansion requirements for water user groups without projected shortages, nor does it address the facility requirements of aggregate WUGs such as Manufacturing and Municipal County-Other. Water supply projects required at the WUG level for water treatment, storage or conveyance, which do not involve the development of or connection to water sources not included in the plan, are consistent with this regional water plan. Planned facility projects identified to the RHWPG are listed in Appendix D. Similarly, this plan addresses water demands and supplies at the WUG level, while water rights, permits and contracts can be held by companies or individuals. Surface water uses that will not have a significant impact on the region's water supply, even though not specifically recommended, are consistent with this regional water plan.

Social, Environmental, and Economic Impacts

Social Impact

Water supply development under the proposed Region H Water Plan will enable continued population increases in the region. With population growth comes urban and suburban residential development, increases in school enrollments, commercial expansions, more demands for governmental social services and a host of other changes, both beneficial and otherwise, that accompany an expanded population in the region. Governmental agencies will be challenged to provide the infrastructure and services required to maintain an acceptable quality of life within the region while keeping taxes and fees at reasonable levels.

Many of the actions proposed under the Region H Water Plan involve increased intra-regional dependencies due to new water provider/consumer relationships. These relationships will help efficiently allocate regional water supplies and provide supply redundancy. However, there is also the potential for political and legal tensions arising from these interrelationships if groups or individuals perceive that their interests are compromised.

Conservation, primarily by municipal and irrigation users, plays a small, but significant role in the Region H Water Plan. While irrigation conservation costs are low, use of irrigation conservation measures may push some marginal farms out of production, even if the cost of irrigation conservation improvements are borne primarily by the industries or municipalities benefiting from the supplies which otherwise would have met irrigation demands. To promote municipal water conservation, consumers will see higher unit water costs as consumption increases. Urban residents will be required to adjust to low-flow plumbing fixtures and will be encouraged to landscape their homes using grasses and shrubs requiring little water.

Reservoir development as envisioned in the plan will have significant social consequences. Reservoirs provide substantial recreational opportunities for residents within and outside the region and promote local development and population growth. Social costs of reservoir construction include displacement of homes and businesses within the reservoir footprint and possible displacement of low-income area residents as the value of lakefront property escalates.

Environmental Impact

Construction of the physical facilities required by the Water Plan, particularly the planned reservoirs, will have significant environmental impact. Even under the best circumstances, reservoirs will inundate wooded bottomlands, wetlands, prime farmland or other ecologically significant areas. Real estate and recreational development of the lakeshore areas brings congestion to previously rural area, noise and some unavoidable air and water pollution. On the other hand, virtually all residents of the region will welcome the new camping, fishing, picnicking and boating opportunities. Construction of facilities other than reservoirs (i.e., pipelines, storage tanks, pumping stations, and water treatment plants) will have local, and generally temporary, effects on air and water quality.

Freshwater inflow impacts within the rivers of the region and within Galveston Bay have been identified as an issue through the course of this planning effort. Detailed analysis of the potential environmental water quantity issues associated with each strategy should be studied in detail prior to implementation of that strategy.

Mandated groundwater withdrawal reductions in Harris and Galveston Counties are accounted for in the plan. Less groundwater pumpage will result in less land subsidence and will reduce potential flood damages. The development of additional surface water supplies will serve to assist in the successful achievement of the Harris-Galveston Coastal Subsidence District (Subsidence District) Regulatory Plan.

Several strategies involve the interbasin transfer of water. The physical, chemical and biological consequences of large-scale mixing of, for example, Trinity River water with San Jacinto River

water in Lake Houston are somewhat undefined. A detailed study of the ecological effects of these proposed transfers will be necessary to determine the extent of any negative impacts and of any required environmental mitigation.

Economic Impact

As the Task 4 Report noted, economic growth in the region will be severely constrained without adequate water supplies. Conversely, the proposed Region H plan will allow the projected population and economic growth and its concomitant development. This growth will fuel residential, commercial and infrastructure construction and will result in higher school enrollments. Local and state governments will realize higher property tax revenues as land is developed for new homes, stores and industries. As population grows, sales tax receipts will increase.

A major component of the Region H plan is the shift of many consumers from groundwater to surface water supplies. The costs of source development, conveyance and treatment are generally greater with surface water than with groundwater. Consumers converting to surface water will see higher bills, in some instances significantly higher. In Harris and Galveston counties, conversion to surface water from current groundwater supplies is mandated by Subsidence District regulations. Although consumers will pay more for water, the reduction in the rate of land subsidence will decrease potential property damages from flooding.

Reservoir construction enhances property values in the vicinity, promotes recreational development and creates employment. Offsetting some of these economic gains are losses of timber, wildlife, cropland and mineral resources (such as oil, gas or lignite) resulting from inundation.

Plan Costs

Tables 11, 12, and 13 include capital and/or annual costs for various management strategies. These costs were estimated in accordance with the criteria outlined by the TWDB's Exhibit B, "Data and Format Guidelines for SB1 Regional Water Plan—Technical Reports." Complete details of the methodology for estimating costs is included in Appendix B, "Cost Estimating Procedures."

Capital costs are based on historical costs of similar facilities, adjusted in scale and updated as required to the second quarter of 1999 using recognized cost indices. TWDB-recommended factors (30% for pipeline projects, 35% for all other projects) have been used for the engineering cost estimates. Land and easement costs were estimated on a case-by-case basis, as were environmental, archeological and mitigation costs. Interest during construction was calculated using TWDB guidelines. Construction durations were assigned based on the size and complexity of an individual project and ranged from one year (e.g., a short pipeline) to three years (e.g., a large reservoir).

The annual cost component of debt service, O&M costs and energy were estimated in accordance with TWDB criteria. The cost of water varies greatly depending on the specific

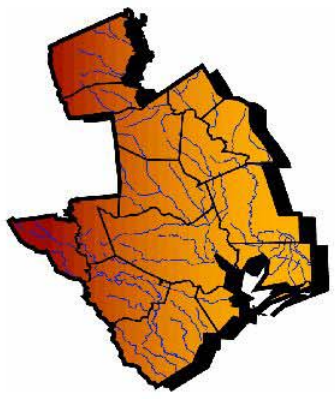
provider, the provider's source and whether an end user receives raw or treated water. Published rates were used when available. Many providers have sliding raw water cost schedules; in these cases, the highest published rate was generally used. Table 5-16 shows the prices of water, raw and treated, being furnished by major and minor suppliers.

Table 5-16 Costs of Purchased Water

Provider	Raw Water Rate	Treated Water Rate
BRA	$26/af	-
TRA	$95/af	-
SJRA	$75/af	-
GCWA	$27/af (canal) $53/af (pipeline)	$225/af
COH	$130/af	$368/af
BWA	-	$515/af
BAWA	-	Use COH rate
MVWA	-	-
Galena Park	-	-
Pasadena	-	-
Clear Lake	-	-
Seabrook	-	-
CBWC	Use GCWA canal rate	-
Fort Bend WCID	-	Use GCWA rate
Galveston WCID	-	-
Crosby MUD	Use SJRA rate	-
Freeport	-	Use BWA rate
CLCND	$35/af	-

BAWA—Baytown Area Water Authority
BRA—Brazos River Authority
BWA—Brazosport Water Authority
CBWC—Chocolate Bayou Water Company
CLCND—Chambers-Liberty Counties Navigation District
COH—City of Houston
GCWA—Gulf Coast Water Authority
MVWA—Memorial Villages Water Authority
SJRA—San Jacinto River Authority
TRA—Trinity River Authority

The tabulated costs above represent the current costs of existing water supplies. These prices were applied in Table 11 as the annual water cost for contracts from existing supplies. Where new raw water or treated water sources are needed, the costs of new facilities were generated and annualized using the methodology in Appendix B. These costs were then converted to a price per acre-foot and used as the unit cost of water in Table 11 for WUGs receiving water from new



Region H
Water Planning Group
Recommended Reservoir Sites

Legend

- Region H
- Streams
- Recommended Reservoir Sites
- Lakes
- Counties

FREESTONE
LIMESTONE
LEON
Lake Limestone
Houston County Lake
FALLS
ROBERTSON
MADISON
TRINITY
Bedias Reservoir
Little River Reservoir
WALKER
POLK
TYLER
Lake Livingston
GRIMES
SAN JACINTO
BURLESON
BRAZOS
Lake Conroe
Somerville Lake
LEE
WASHINGTON
LIBERTY
MONTGOMERY
Lake Houston
FAYETTE
AUSTIN
WALLER
HARRIS
CHAMBERS
Allens Creek Reservoir
Galveston Bay
COLORADO
FORT BEND
WHARTON
GALVESTON
LAVACA
BRAZORIA
MATAGORDA
Gulf of Mexico

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90000 0 90000 Feet

Source: TWDB, TNRCC, USGS

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JOINT VENTURE

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sources. It is understood that the costs shown in Table 5-16 represent system costs for these providers, and the development of new water sources will increase the average system cost, but for Table 11 the rates for existing and new water sources were kept separate to facilitate comparison of alternatives.

The capital costs of treatment plants, conveyance pipelines, storage tanks and pumping stations are assigned to the WUG receiving the water. If a strategy provides water to multiple WUGs via common facilities, the capital costs are prorated among the WUGs. Capital expenditures for new reservoirs accrue only to the MWPs as shown in Table 13; the cost to the WUGs is reflected in the price of water from the MWP. Many WUGs meet their future shortages simply by extending existing supply contracts. Contract extensions were assigned no capital cost. However, if a WUG requires additional conveyance or treatment facilities to use the full quantity of its contracted supply (or any increase in its contracted amount), then an appropriate capital cost was estimated and included in Table 11. No capital cost was assigned to supplies generated by municipal conservation because no concentrated construction expense is involved. On the other hand, irrigation conservation has identifiable capital expenditures, notably canal lining and field re-leveling costs, and these have been entered as appropriate in Table 11. Per TWDB guidance, no attempt has been made to estimate the costs of improvements that the WUGs must make to their internal distribution systems.

Cost Impact on Each Water User Category

This section addresses the cost impact of the recommended Region H Water Plan on the six user categories:

- Municipal
- Manufacturing
- Irrigation
- Mining
- Steam-Electric Power
- Livestock

Generally, the lowest cost water comes from sources already developed and in close proximity to the point of use, including those supplies “created” by conservation. Somewhat higher in cost are those supply strategies that transfer water owned by a user or provider within a basin (or between basins in some cases) to where the demand exists. Some strategies will require the purchase of water outside the basin of need and construction of facilities for conveying the water to the consumers. This approach adds significantly to the cost of water supply since sellers of water may demand the price of “replacement” sources of water. Finally, new sources of water—reservoirs, wastewater reclamation, desalination, etc.—cost the most.

Municipal users, including those in the “County—Other” groups, will see a variety of effects from the proposed plan. Many WUGs currently on groundwater are in areas with sufficient groundwater supplies. These WUGs will remain on groundwater throughout the planning period and can expect little cost impact on their customers. Users whose supply will shift partially or wholly to surface water can expect significant water rate increases over time. This will primarily affect residents in Waller, Montgomery, Harris, Fort Bend, Brazoria and Galveston counties.

Only manufacturers in Brazoria, Fort Bend, Galveston and Harris counties have projected supply shortages within the planning period. As the MWPs from whom these manufacturers obtain their water develop new and more costly sources of water, the costs of the new sources will be "blended" into the MWPs' cost bases. All consumers served by a particular MWP will share the incremental costs. The cost of water for industrial customers, as well as all other categories of customers served by the MWP, will increase over time as new sources are brought on line.

The wastewater reclamation strategy deserves specific discussion. Under this strategy, reclaimed Houston domestic wastewater will be further treated and delivered to industrial users along the Houston Ship Channel. The reclaimed water will be of higher quality than current supplies and will reduce the industries' costs of process water treatment in many cases. Ship Channel industries should be willing to pay a somewhat higher price for reclaimed water because of this advantage. However, the primary benefit of this strategy will accrue to the City since Houston avoids the cost of developing a new water source. Therefore, the bulk of this strategy's cost should be borne by the broad Houston customer base.

Irrigation shortfalls occur only in Brazoria, Fort Bend and Waller counties. Irrigation conservation will cover these shortfalls and more. Since reductions in irrigation demand allow meeting the needs of other categories of users (e.g., meeting of the City of Needville's shortage), the capital costs of irrigation conservation should be borne by those who benefit. Consequently, the cost to irrigators for conservation implementation should be minimal. As with the manufacturing category, irrigators will face gradual water cost increases as their suppliers develop new and more costly sources of water. As the MWP "blends" the increased cost into its overall system rates, water price increases should be gradual and predictable for irrigators.

Mining, steam-electric power and livestock categories have relatively small (if any) shortfalls predicted. These users will be affected, as the other user categories, by gradual and predictable water cost increases as the MWPs bring new, and more costly, sources of water on line.