TRANS–TEXAS WATER PROGRAM

SOUTHEAST AREA

Technical Memorandum

Water Conservation

January 30, 1998

Sabine River Authority of Texas
Lower Neches Valley Authority
San Jacinto River Authority
City of Houston
Brazos River Authority
Texas Water Development Board

This document is a product of the Trans–Texas Water Program: Southeast Area. The program's mission is to propose the best economically and environmentally beneficial methods to meet water needs in Texas for the long term. The program's three planning areas are the Southeast Area, which includes the Houston-Galveston metropolitan area, the South-Central Area (including Corpus Christi), North-Central Area (including Austin) and the West-Central Area (including San Antonio).

The Southeast Area of the Trans–Texas Water Program draws perspectives from many organizations and citizens. The Policy Management Committee and its Southeast Area subcommittee guide the program; the Southeast Area Technical Advisory Committee serves as program advisor. Local sponsors are the Sabine River Authority of Texas, the Lower Neches Valley Authority, the San Jacinto River Authority, the City of Houston and the Brazos River Authority.

The Texas Water Development Board is the lead Texas agency for the Trans–Texas Water Program. The Board, along with the Texas Natural Resource Conservation Commission, the Texas Parks & Wildlife Department and the Texas General Land Office, set goals and policies for the program pertaining to water resources management and are members of the Policy Management Committee.

This is the final version of this document.

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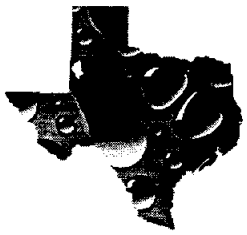


1. Introduction

The Trans-Texas Water Program (TTWP) Southeast Area *Phase I Report* identified seven water management alternatives for possible inclusion in its TTWP Southeast Water Management Plan. This current memorandum analyzes the viability of implementing one of these alternatives, water conservation.

In traditional water supply planning, projections of future water needs are used to determine the size of future water supply development options such as new reservoirs or groundwater well fields. Demand management analyses techniques are intended to manipulate water usage characteristics that alter the computed water need projections. Successful demand management strategies facilitate more efficient use of existing water supplies, allow existing supply sources to serve demands for a longer period of time, and delay the need to develop new supply options.

The specific management technique under consideration in this study is water conservation. The analysis develops assumptions about the implementation of specific conservation measures on total water demand and on specific water use types. The anticipated demand reduction associated with these measures is calculated as the volume of conservation "savings". The revised water demand projections reflecting conservation efforts are then evaluated against the originally projected water demand defined within the TTWP *Planning Information Update*. The value of advanced conservation as a demand management strategy in the Southeast Area is illustrated through an analysis of its impact on the area's future demand projections.

It should be noted that the water demand projections in the *Planning Information Update* are derived from a demand scenario that contains an "expected" amount of water conservation. These projections assume a per capita reduction in long-term water demand resulting from the implementation of the 1991 State of Texas Water Efficiency Plumbing Act. This Act mandates the exclusive use of low-flow plumbing fixtures in all new construction.

The water conservation management strategy defined in this study assesses the viability of an "advanced" degree of water conservation. "Advanced" water conservation is defined as the implementation of conservation measures sooner and in addition to the "expected" conservation scenarios. These measures are intended to strive aggressively for increased levels of water use reduction. Advanced conservation produces a larger quantity of water savings than the expected water conservation scenarios used in the Consensus State Water Plan and in the TTWP Phase II *Planning Information Update* document.

The Water Conservation memorandum is structured to discuss the following:

- Expected Conservation
- Advanced Conservation
- Water supply and availability with Advanced Conservation
- Environmental impacts
- Implementation costs

2. Expected Conservation

To assess the potential opportunity for advanced levels of conservation, we must review the analytical basis of the existing TTWP water demand projections. The TTWP *Planning Information Update* (September 1997) presented future water demand projections for the Southeast Area of the TTWP. Six water use classifications were defined for planning purposes: municipal, manufacturing, irrigation, livestock, mining, and power. Each category has specific variables affecting its demand projections.

2.1 Water Use Projections

The municipal water use projections are based upon assumptions regarding three components: population projections, per capita (or unit) water use, and forecasts of the efficiency of conservation measures. Municipal demands include both residential and commercial sector uses. A "Most Likely" municipal water use scenario was created for planning purposes. This scenario reflects the following parameters:

- "Most Likely" Population Migration,
- Per Capita Water Use associated with Below Normal Rainfall, and
- Expected or Advanced Conservation Savings.

The current TTWP municipal projections are based on an "expected" level of conservation. "Expected" conservation projects the potential water savings anticipated from both market forces and regulatory requirements, particularly the 1991 State of Texas Water Efficiency Plumbing Act. Table 1 defines the "expected" conservation factors embedded within the municipal use projections. A more detailed description of expected conservation scenarios and on the computation of the base level of conservation incorporated in TTWP water demand projections is included in both the *Planning Information Update* and the Texas Water Development Board's Consensus Planning documents.

Future demand projections for the manufacturing and irrigation use categories also have expected levels of water conservation defined. Conservation in these categories is a function of industry type, industry specific water use efficiencies, and the potential for improved efficiencies in irrigation The remaining water use categories, steam power, livestock, and mining, do not have an associated quantity of conservation included within the projections.

2.2 Projected Water Demands

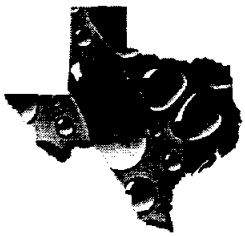
Demand projections within *the Planning Information Update* grow from 2,555,300 acre-feet per year in 1990 to 3,839,600 acre-feet per year in year 2050. The eight-county Houston region represents over 70

Table 1: Components of Municipal Water Conservation Savings

Area of Savings Potential	*Expected Conservation Savings*
Indoor Plumbing Savings	20.5 gal./capita/day
Seasonal Water Savings	7% of total seasonal use
Dry-Year Irrigation Savings	10.5% of dry-year seasonal use

percent of the total water demand for the entire 32 county TTWP Southeast study area. The eight counties of the Houston region are Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. These counties occupy all or part of the Trinity, San Jacinto and Brazos River basins as well as the Neches-Trinity, Trinity-San Jacinto and San Jacinto-Brazos coastal basins. The San Jacinto River basin, which includes Harris and Montgomery counties, represents over 30 percent of the total study area demand. The TTWP Southeast Area boundary divides Brazoria and Fort Bend Counties, therefore only the data corresponding to the TTWP region within those two counties is considered in this analysis. Figure 1 shows the TTWP Southeast Area and the eight-county Houston region. Within the Southeast Area, the counties with the largest total demand projections are Harris, Montgomery and Fort Bend. Appendix A has further detail on population and water demand projections for counties within the TTWP Southeast Area.

Figure 1: Trans-Texas Water Program Southeast Area



3. Advanced Conservation

An "Advanced" water conservation strategy is designed to produce reductions in water use greater than those produced under the "expected conservation" scenarios. The existing TTWP water demand projections, as defined in the *Planning Information Update*, do not incorporate any of the "advanced" conservation scenarios developed by TWDB in the Consensus Planning process. Developing a strategy for advanced conservation for the Southeast Area requires an analysis of the current water demand patterns and the potential impacts on demand as a result of implementing additional conservation measures.

3.1 Defining a Water Conservation Strategy

Water demand patterns in TTWP Southeast Area are characterized by a number of factors that help define an appropriate water conservation management strategy. These factors include the area's total water demand, the percentage of each type of water use demand within the total, the growth of specific water use demands, the ability of local governments to control water use, the cost of implementing conservation measures, and other locally specific issues. In the Southeast Area the following conditions must be considered.

- Less than 15 percent of total Southeast Area demand is used for irrigation, livestock, steam power generation and mining uses. In addition to the relatively low projected water use, these uses predominately occur in the water-rich, eastern part of the study area. A conservation strategy aimed at these use categories would yield very low levels of water savings.
- Irrigation demands in the Southeast Area are projected to decrease from 721,092 acre-feet per year in year 1990 to 469,917 acre-feet per year in year 2050. This represents a 35 percent decline in irrigation water use principally brought about by market forces reducing agriculture in southeast Texas. Even within the highly urbanized Houston Metro Area, water use in the irrigation category is projected to decrease. With irrigation uses declining in the area there is little impetus to implement conservation measures within this use category. Table 3 from the *Planning Information Update* (included in Appendix A) provides detail on the declining irrigation demand in the Southeast Area.
- Increases in the manufacturing use demands across the Southeast Area indicate an opportunity for demand savings through conservation. The implementation of conservation measures within the manufacturing category, while warranted, are more difficult to mandate. In addition, developing effective manufacturing conservation measures requires detailed knowledge of specific industrial processes and the technological opportunities for water efficiencies within each industry. Public water suppliers and regulatory agencies establish conservation guidelines for the manufacturing industry but it is market forces associated with reduced cost of production that provide the greatest in-

centive for industrial conservation nation-wide.

The "expected" level of conservation included in the current demand projections is based on industry's implementation of more water efficient processes as a reaction to cost competitive forces. This "expected" level of conservation is realistic for the Southeast Area and is recommended as the appropriate manufacturing use projection for TTWP.

- The greatest potential for water savings from advanced conservation lies within the municipal use category. This category includes water uses, generally within cities, that include residential, commercial, retail, institutional, and light manufacturing. State and local governments and regional water suppliers have a wide range of alternative approaches available to implement advanced levels of conservation within this water use category. These approaches include legislation, pricing policies, building code requirement, and landscaping ordinances.

  Conservation savings resulting from the implementation of the 1991 State of Texas water-efficient plumbing fixture legislation vary across the Southeast Area. In general, rural areas with lower commercial retail institutions, and manufacturing demand, use less municipal water than urban areas and will not therefore realize the same levels of "expected" conservation savings. Anticipated water savings will also not accrue as quickly in rural areas.

Based on the distribution of total demand throughout the study area, an Advanced Conservation demand management strategy should be targeted to address those portions of the Southeast study area which exhibit the largest municipal water demands, and the greatest rates of growth. The implementation of advanced conservation measures in these areas has the greatest potential to yield significant water savings where they are most needed. The levels of savings produced under the "expected" conservation scenarios in low water demand areas, such as the East Texas regions within the Sabine and Neches River basins, are appropriate. These regions are projected to have a large quantity of surplus available water supply throughout the 60-year planning period as shown in the *Planning Information Update* data.

An advanced conservation management strategy designed to reduce water use in the high demand section of the study area is indicated. **Therefore, an advanced water conservation strategy consisting of water reduction measures specific to the municipal uses in the Houston Metro area is recommended.**

3.2 Expected vs. Advanced Conservation

The primary differences between the *expected* and *advanced* conservation savings scenarios are timing and the selection of appropriate conservation measures. The majority of additional savings reflected in the advanced conservation cases developed in the TWDB Consensus Planning program result from accelerating the implementation of the Texas Water Efficiency Plumbing Act and from water suppliers implementing other programs which

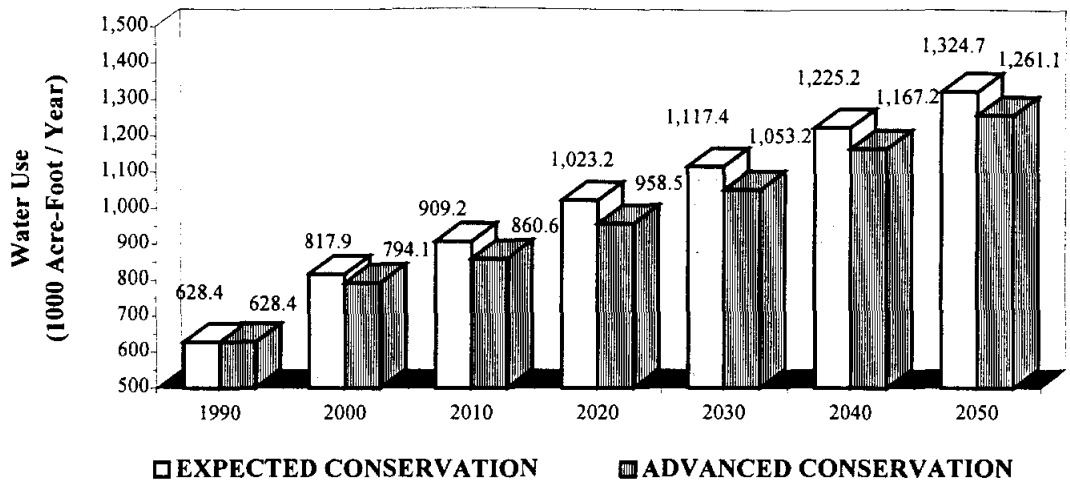


Figure 2: Comparison of Projected Municipal Water Demand with Conservation

encourage or require increased water efficiency from end-users.

The Consensus Planning process developed independent forecasts of unique advanced conservation patterns for each county in the Houston Metro area. These conservation patterns are incorporated into the advanced conservation scenario projections of municipal water use at the county level for each decade in the planning time frame.

To determine the amount of water demand specifically related to advanced water conservation, a comparison of water use projections between the expected and advanced conservation demand scenarios was made. The reduction in total water demand resulting from advanced conservation measures is computed by subtracting the projected municipal demand from the Advanced Conservation Scenario from the "Most Likely" municipal demand for each projected decade. Figure 2 illustrates the relationship of the expected versus the advanced conservation municipal demand projections for the Houston Metro Area. Appendix B contains several tables that detail the difference between the expected and advanced scenarios for each Houston Metro county and river basin. Table 2 contains the projected conservation savings resulting from an advanced level of conservation for counties within the Houston Metro area by basin.

The total quantity of conservation savings directly attributable to the advanced conservation measures varies from 23,880 acre-feet per year in year 2000 to a maximum level of 64,773 acre-feet per year in year 2020. The quantity of conserved savings decreases slightly from year 2020 to 63,626 acre-feet per year in year 2050. The total quantity of water savings for the entire planning period is approximately 2,657,000 acre-feet. The rate of conservation savings follows the same pattern with the maximum percentage of water savings from advanced conservation occurring around year 2020 and the rate of maximum of about 6.3 percent in year 2020. Advanced level savings as a percentage of total demand decrease from

Table 2: Houston Metro Advanced Conservation Savings on Municipal Demand

	WATER SAVINGS (acre-foot / year)						
COUNTY	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
BRAZORIA	n/a	972	1,945	2,551	2,415	2,139	2,616
CHAMBERS	n/a	123	259	339	337	307	325
FORT BEND	n/a	1,841	3,801	6,181	7,058	7,717	9,381
GALVESTON	n/a	1,312	2,737	3,447	3,406	3,133	3,353
HARRIS	n/a	17,887	36,150	46,891	45,209	38,805	41,031
LIBERTY	n/a	274	605	736	712	599	663
MONTGOMERY	n/a	1,309	2,664	4,054	4,454	4,677	5,539
WALLER	n/a	162	398	574	591	611	718
TOTAL	**0**	**23,880**	**48,559**	**64,773**	**64,182**	**57,988**	**63,626**

year 2020 to approximately 4.7 percent of water demand in year 2050.

Table 3 defines the projected water demand for the Advanced Conservation Scenario by basin, in the Houston Metro area.

3.3 Advanced Water Conservation Measures

The City of Houston recently completed their water conservation program. The final report, *City of Houston Water Conservation Plan, March 1997*, projected an annual average net water savings reduction of approximately 22 million gallons per day (24,700 acre-feet per year) through the year 2050 planning period. This represents an annual reduction in projected water demand of approximately 7 percent. This would represent approximately 40 percent of the amount projected in TTWP's advanced conservation scenario for the total Houston Metro area water conservation savings.

The City of Houston program savings are projected to result from implementation of a set of 12 specific conservation measures. These measures affect several water usage categories including: residential, commercial, public, and other programs. The Other category includes unaccounted-for water leak detection, rehabilitation, and educational programs for both the public and in schools. In general, the identified measures consist of water audits, appliance labeling, institutional water facility rehabilitation, and educational programs. Appendix C contains a listing of these measures.

These 12 programs were selected from an initial list of over 200 potential conservation measures using the computer simulation program, *Water Plan 2.0*. Determination of the most suitable measures was based on criteria including an acceptable benefit-cost ratio, reasonable cost, significance of water savings, and acceptable non-quantifiable impacts.

Based on the level of projected water savings, each measure was evaluated on its viability for achieving the TTWP advanced conservation goals. The measures selected for the City of Houston program should be considered typical of the types of measures necessary to achieve the TTWP advanced conservation goals for total Houston Metro area's water demands.

Table 3: Projected Metro Area Municipal Water Demand with Advanced Conservation

BASIN / COUNTY	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
Brazos Basin	**15,590**	**19,595**	**22,728**	**26,730**	**32,858**	**39,682**	**47,067**
Brazoria	1,678	2,160	2,142	2,205	2,461	2,657	3,012
Fort Bend	9,937	12,953	15,558	18,860	23,911	29,597	35,467
Waller	3,975	4,482	5,028	5,665	6,486	7,428	8,588
NechesBasin/ Liberty Co.	287	280	280	286	308	336	355
Neches-Trinity Basin	**1,883**	**1,787**	**2,001**	**2,334**	**2,572**	**2,702**	**2,703**
Chambers	925	1,180	1,402	1,680	1,875	2,015	2,131
Galveston	935	596	588	642	684	673	557
Liberty	23	11	11	12	13	14	15
San Jacinto Basin	**483,803**	**606,032**	**653,300**	**724,062**	**783,659**	**859,433**	**917,765**
Fort Bend	12,117	12,855	16,097	20,159	25,817	32,249	40,327
Harris	441,790	552,559	589,858	648,252	690,348	747,024	783,369
Liberty	2,133	2,284	2,403	2,550	2,873	3,028	3,195
Montgomery	26,851	37,086	43,457	51,420	62,642	74,831	88,164
Waller	912	1,248	1,485	1,681	1,979	2,301	2,710
San Jacinto - Brazos Basin	**106,896**	**140,936**	**155,509**	**175,874**	**202,454**	**230,743**	**256,562**
Brazoria	22,046	25,131	26,723	29,022	33,599	37,432	42,749
Fort Bend	14,987	26,546	32,965	40,873	52,331	65,329	79,082
Galveston	32,752	38,716	40,572	44,079	49,436	53,464	56,651
Harris	37,111	50,543	55,249	61,900	67,088	74,518	78,080
Trinity Basin	**5,671**	**5,929**	**6,040**	**6,476**	**7,212**	**7,791**	**8,403**
Chambers	656	644	728	877	991	1,074	1,132
Liberty	5,015	5,285	5,312	5,599	6,221	6,717	7,271
Trinity-San Jacinto Basin	**14,292**	**19,510**	**20,744**	**22,697**	**24,173**	**26,516**	**28,195**
Chambers	1,264	1,620	1,699	1,871	2,010	2,142	2,232
Harris	12,951	17,806	18,962	20,739	22,067	24,269	25,849
Liberty	77	84	83	87	96	105	114
Metro Area Total	**628,422**	**794,069**	**860,602**	**958,459**	**1,053,236**	**1,167,203**	**1,261,050**

4. Water Supply and Availability

The TTWP *Planning Information Update* determined the period of time for which existing water supplies (groundwater and surface water) within the Southeast Area can satisfy future projected water demands. This analysis was conducted for each river basin and shown in Table 12 of that report. Table 13 of that report then assessed the availability of existing Southeast Area water supplies to meet the future projected water demands for the state-wide TTWP region. These tables are included in Appendix D. Tables 12 and 13 support the following general conclusions:

- Current existing Southeast Area water supplies can meet all projected Southeast Area demands through year 2010.
- The Brazos river basin will experience the earliest water supply shortfalls within the Southeast Area by year 2020.
- The San Jacinto River basins (San Jacinto, San Jacinto-Brazos and Trinity-San Jacinto) within the Houston Metro area will experience initial water supply shortages by year 2030 and these shortfalls will become increasingly significant thereafter.
- East Texas river basins retain significant quantities of available supply through the 2050 planning period.
- The Southeast Area has sufficient existing water supplies to serve the state-wide TTWP region.

The value of the advanced water conservation strategy can be measured by assessing its ability to extend the length of time that existing available water supplies can serve projected demands. The advanced water conservation strategy is evaluated by inserting basin level reduced water demands, as determined in Section 3, into the above referenced water supply availability tables. The revised tables reflect the reduced demands associated with an Advanced Conservation Scenario for the municipal demand of counties in the Houston Metro area. Table 4 and Table 5 illustrate the impact of accelerated conservation in the Houston Metro region on the Southeast Area and state-wide TTWP water availability.

A comparison of Table 12 and Table 4 indicates that many of the conclusions supported by Table 12 of the *Planning Information Update* remain valid in the Advanced Conservation Scenario. The exception is with regard to supply shortfalls in the San Jacinto River and Coastal basins. Conservation savings are dispersed throughout the Houston Metro area. Existing supply can satisfy projected demand in the San Jacinto River basin through 2030 and meet demand in the coastal basins through 2040.

Table 5 computes the impact of the advanced conservation water demands for the entire TTWP region. It indicates that under Scenario 1, the worst case scenario, an excess of 134,000 acre-feet per year will be available in year 2050. This is approximately 63,600 acre-feet per year more than was available in year 2050 under the Expected Conservation Scenario.

Table 4: Southeast Area Water Availability with Advanced Conservation Strategy[1]

	Amount (Thousands of Acre/Feet-Year)								
Category	*Sabine*	*Neches*	*Neches-Trinity*	*Trinity*	*Trinity-San Jacinto*	*San Jacinto*	*San Jacinto-Brazos*	*Brazos*	*Total Southeast*
2000									
In-Basin Demands	86.0	261.4	329.8	138.3	142.5	932.1	459.5	426.6	2776.3
In-Basin Supplies									
Groundwater	23.3	110.5	7.5	34.3	26.6	451.7	74.9	130.5	859.3
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	488.2	4197.4
TOTAL	1213.7	957.4	7.5	1390.7	26.6	709.4	132.7	618.7	5056.7
Surface Water Transfers									
Imported Supplies	0.9	1.4	322.3	0.0	115.9	282.7	326.8	0.0	1050.1
Export Demands	1.4	280.7	0.0	559.2	0.0	60.0	0.0	148.694	1050.0
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**844.3**	**207.6**	**0.0**	**693.2**	**0.0**	**0.0**	**0.0**	**43.4**	**1788.5**
2010									
In-Basin Demands	93.9	275.4	316.5	140.5	146.6	995.4	488.0	462.0	2918.3
In-Basin Supplies									
Supplied by Groundwater	23.3	111.6	7.9	36.6	25.7	292.3	80.9	141.9	720.2
Supplied by Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.6	4196.8
TOTAL	1213.7	958.5	7.9	1393.0	25.7	550.0	138.7	629.5	4917.0
Surface Water Transfers									
Imported Supplies	1.0	2.0	308.6	0.0	120.9	505.4	349.3	0.0	1287.2
Export Demands	2.0	279.6	0.0	792.4	0.0	60.0	0.0	153.2	1287.1
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**835.9**	**196.4**	**0.0**	**460.1**	**0.0**	**0.0**	**0.0**	**14.3**	**1506.7**
2020									
In-Basin Demands	102.4	287.3	304.3	143.4	150.9	1081.9	516.2	490.6	3077.0
In-Basin Supplies									
Groundwater	23.3	112.8	8.3	38.7	31.1	251.1	87.1	156.1	708.5
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.1	4196.3
TOTAL	1213.7	959.7	8.3	1395.1	31.1	508.8	144.9	643.2	4904.8
Surface Water Transfers									
Imported Supplies	1.0	2.6	296.0	0.0	119.8	633.1	371.3	0.0	1423.9
Export Demands	2.6	267.0	0.0	931.9	0.0	60.0	0.0	162.3	1423.8
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**826.8**	**199.0**	**0.0**	**319.8**	**0.0**	**0.0**	**0.0**	**-9.7**	**1335.8**

[1] Adapted from Trans-Texas Water Program Southeast Area *Planning Information Report*. Table 12: Southeast Area Water Supply Availability: 2000-2050. Brown & Root, Inc. September 1996.

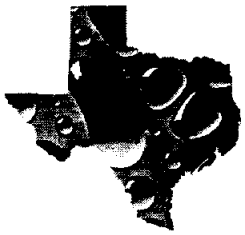
Table 4: Southeast Area Water Availability with Advanced Conservation Strategy Continued

	Amount (Thousands of Acre/Feet-Year)								
Category	*Sabine*	*Neches*	*Neches-Trinity*	*Trinity*	*Trinity-San Jacinto*	*San Jacinto*	*San Jacinto-Brazos*	*Brazos*	*Total Southeast*
2030									
In-Basin Demands	111.0	299.4	302.9	147.6	155.3	1155.6	554.0	526.8	3252.5
In-Basin Supplies									
Groundwater	23.4	114.6	8.7	41.2	27.9	266.3	87.8	169.4	739.3
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.6	4195.8
TOTAL	1213.8	961.5	8.7	1397.6	27.9	524.0	145.6	656.0	4935.1
Surface Water Transfers									
Imported Supplies	1.0	4.1	294.2	0.0	127.4	691.6	408.4	0.0	1526.7
Export Demands	4.1	265.2	0.0	1023.7	0.0	60.0	0.0	173.7	1526.7
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**816.8**	**191.9**	**0.0**	**226.3**	**0.0**	**0.0**	**0.0**	**-44.5**	**1190.5**
2040									
In-Basin Demands	123.1	321.7	306.6	158.8	165.6	1258.2	604.5	580.7	3519.2
In-Basin Supplies									
Groundwater	23.5	116.3	8.8	43.8	29.6	280.5	88.8	181.1	772.4
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.0	4195.2
TOTAL	1213.9	963.2	8.8	1400.2	29.6	538.2	146.6	667.1	4967.6
Surface Water Transfers									
Imported Supplies	1.0	4.6	297.8	0.0	136.0	698.0	457.9	0.0	1595.3
Export Demands	4.6	268.8	0.0	1072.6	0.0	60.0	0.0	189.3	1595.3
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**804.3**	**168.3**	**0.0**	**168.8**	**0.0**	**-82.0**	**0.0**	**-103.0**	**956.4**
2050									
In-Basin Demands	135.8	344.8	310.5	174.0	178.3	1343.2	653.2	636.2	3776.0
In-Basin Supplies									
Groundwater	23.6	118.3	9.0	46.7	31.0	291.8	89.7	197.3	807.4
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	485.4	4194.6
TOTAL	1214.0	965.2	9.0	1403.1	31.0	549.5	147.5	682.7	5002.0
Surface Water Transfers									
Imported Supplies	1.1	4.9	301.5	0.0	136.0	698.0	473.1	0.0	1614.6
Export Demands	4.9	272.6	0.0	1072.6	0.0	60.0	0.0	204.5	1614.5
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**791.5**	**143.7**	**0.0**	**156.5**	**-11.3**	**-155.7**	**-32.6**	**-158.0**	**734.0**

Table 5: Trans-Texas Water Program Supply Availability with Advanced Conservation Strategy[2]

Scenario	Amount (Thousands of Acre-Feet/Year)					
	2000	2010	2020	2030	2040	2050
Scenario 1						
Available Southeast Supply	1788.5	1506.7	1335.8	1190.5	956.4	734
West-Central Demand			150	300	450	600
Net Surface Water Availability	**1788.5**	**1506.7**	**1185.8**	**890.5**	**506.4**	**134**
Scenario 2						
Available Southeast Supply	1788.5	1506.7	1335.8	1190.5	956.4	734
West-Central Demand				100	200	300
Net Surface Water Availability	**1788.5**	**1506.7**	**1335.8**	**1090.5**	**756.4**	**434**
Scenario 3						
Available Southeast Supply	1788.5	1506.7	1335.8	1190.5	956.4	734
West-Central Demand	0	0	0	0	0	0
Net Surface Water Availability	**1788.5**	**1506.7**	**1335.8**	**1190.5**	**956.4**	**734**

[2] Adapted from Trans-Texas Water Program Southeast Area Planning Information Report. Table 13: Trans-Texas Water Program Supply Availability: 2000 - 2050. Brown & Root, Inc. September 1996.



5. Environmental Impacts

Demand management strategies are designed to affect the patterns and characteristics of water use. These types of water resource management strategies generally require little or no construction and are not associated with the environmental disruption brought about by traditional supply development activities. There are however potential environmental impacts as a result of conservation activities.

The types of anticipated environmental impacts resulting from a water conservation strategy can be seen by using the City of Houston Water Conservation Program as a model. The City of Houston program contains 12 conservation measures. Only three of the measures, Public Fountain/Pool Audit and Repair, Standards for New Fountains/Pools, and Unaccounted-For Water, involve structural rehabilitation of water system facilities. Construction related activities associated with these types of measures will be limited to existing public rights-of-way and utility easements, generally located within the urban environment of the city. Compliance with current construction related environmental protection regulations (i.e. National Pollutant Discharge Elimination System (NPDES) stormwater, etc.) will limit the potential for environmental disruption.

Other potential types of environmental impacts relate to water quantity reduction within rivers, streams, bays and estuaries. While conservation reduces the quantity of flow entering receiving streams, the relative rate of reduction is minimal. The quantity of conserved water is small relative to the total amounts of flow within the Houston Metro water systems. As such, the anticipated impact to flow volumes within receiving streams will be very minor.

A potential social impact is related to the cost of water to residents. Water conservation has the potential to increase water rates to compensate for a loss of revenue from water sales by the utility. The *City of Houston Water Conservation Plan* discussed this issue and concluded that the rate of reduced water use from water conservation would have a minimal impact (1.5 percent) on the price of water to the customer. That report documented that the price impact from reduced water sales is offset from the positive impact of deferred capital cost expenditures of water and wastewater treatment facilities that would have been required at a sooner date without water conservation[3]. See Sections 6 and 7 from that report for a complete discussion of this issue.

[3]*City of Houston Final Draft Water Conservation Plan*. March 1997.

6. Implementation Costs

The cost of implementing the recommended advanced conservation strategy is based on the cost of implementing each of the various conservation measures. A detailed cost analysis of the City of Houston conservation measures was used as a basis to develop an advanced conservation strategy program cost for the Houston Metro area of the TTWP.

The cost of implementing the various conservation measures varies significantly. *Appendix D of the City of Houston Conservation Plan,* contains projected implementation costs and resultant quantities of water savings for each of the recommended conservation measures for each year through the planning period. This TTWP analysis uses the same cost basis for each measure as was used within the City of Houston study. As shown, many of the measures require a short-term initial cost investment that then produces a long-term water savings. This data is shown in Appendix E of this report. To determine the cost of implementing the advanced conservation management strategy for the entire Houston Metro area, the total annual program cost was applied to the projected conservation savings for the entire region.

Table 6 shows that the total cost of implementing an advanced conservation strategy for the TTWP Southeast Area for the 50 year planning period is approximately $319 million. This equates to an average water cost of approximately $120 per acre-foot of water. As shown, the annual cost varies from $3.5 million during the decade from year 2000 through year 2009, to $7.6 million during the decade from year 2030 through year 2039.

A life cycle cost analysis was performed to illustrate the present worth cost of this strategy. The following financial factors were used in the life cycle cost analysis:

- Program implementation was assumed to begin in year 2000 and to continue through the planning period until year 2050.
- Capital costs were assumed to be financed over 50 years at an interest rate of 8.5 percent per year.
- The discount rate was set at 4.5 percent.
- The inflation rate was set at 4.5 percent.

Table 6 shows that the total present worth of the entire 50-year conservation program is approximately $97 million. As shown, the computed annual present worth cost ranges from $3.1 million in year 2000 to $686,000 in year 2049. Financing of a conservation program however functions differently than most of the other potential TTWP water management strategies. Water conservation can be implemented on an annual basis with resultant costs financed at the time of implementation of each measure. Other management strategies require the total financing of the capital improvement at the time of construction of that improvement. A conservation strategy allows more flexibility concerning the use of available funds. An additional benefit occurs with water conservation should the entire 50-year program be financed in year one of

the program. The total cost of the program is significantly reduced.

Table 6: Houston Metro Area - Advanced Conservation Savings Life Cycle Cost Analysis

Year	*Savings Acre-feet per year*	*Annual Conservation Implementation Cost*	*Present Value of A.C.I.C. (1997 $)*
2000	23,880	3,505,508	3,071,865
2001	23,880	3,505,508	2,939,584
2002	23,880	3,505,508	2,812,999
2003	23,880	3,505,508	2,691,865
2004	23,880	3,505,508	2,575,947
2005	23,880	3,505,508	2,465,021
2006	23,880	3,505,508	2,358,872
2007	23,880	3,505,508	2,257,294
2008	23,880	3,505,508	2,160,090
2009	23,880	3,505,508	2,067,072
2010	48,559	5,482,441	3,093,586
2011	48,559	5,482,441	2,960,369
2012	48,559	5,482,441	2,832,889
2013	48,559	5,482,441	2,710,899
2014	48,559	5,482,441	2,594,162
2015	48,559	5,482,441	2,482,451
2016	48,559	5,482,441	2,375,552
2017	48,559	5,482,441	2,273,255
2018	48,559	5,482,441	2,175,364
2019	48,559	5,482,441	2,081,688
2020	64,773	7,500,524	2,725,316
2021	64,773	7,500,524	2,607,958
2022	64,773	7,500,524	2,495,654
2023	64,773	7,500,524	2,388,186
2024	64,773	7,500,524	2,285,345
2025	64,773	7,500,524	2,186,933
2026	64,773	7,500,524	2,092,759
2027	64,773	7,500,524	2,002,640
2028	64,773	7,500,524	1,916,402

Table 6: Houston Metro Area - Advanced Conservation Savings Life Cycle Cost Analysis - Continued

Year	Savings Acre-feet per year	Annual Conservation Implementation Cost	Present Value of A.C.I.C. (1997 $)
2029	64,773	7,500,524	1,833,877
2030	64,182	7,572,345	1,771,711
2031	64,182	7,572,345	1,695,417
2032	64,182	7,572,345	1,622,409
2033	64,182	7,572,345	1,552,544
2034	64,182	7,572,345	1,485,688
2035	64,182	7,572,345	1,421,711
2036	64,182	7,572,345	1,360,489
2037	64,182	7,572,345	1,301,903
2038	64,182	7,572,345	1,245,841
2039	64,182	7,572,345	1,192,192
2040	57,988	7,072,640	1,019,682
2041	57,988	7,072,640	975,772
2042	57,988	7,072,640	933,753
2043	57,988	7,072,640	893,544
2044	57,988	7,072,640	855,066
2045	57,988	7,072,640	818,245
2046	57,988	7,072,640	783,009
2047	57,988	7,072,640	749,291
2048	57,988	7,072,640	717,025
2049	57,988	7,072,640	686,149
2050	63,626	7,760,291	720,441
TOTAL	***2,657,446***	***319,094,875***	***97,317,777***

7. Conclusion

The key findings of the water conservation management strategy analysis consist of the following:

- The recommended "advanced" water conservation strategy consists of an aggressive program of conservation measures focused on the municipal water use category for the eight county Houston Metro area.
- The proposed City of Houston water conservation measures will produce water reductions compatible with the level of reductions defined within this TTWP water conservation management strategy. Potential conservation measures include education, water audits, unaccounted-for water system rehabilitation, and appliance labeling.
- The projected level of reduced municipal water demand for the entire Houston Metro area ranges from 23,880 to 64,773 acre-feet per year. This represents a savings of approximately 2.9 to 6.3 percent of the total projected Houston Metro water demand. The total quantity of water savings for the 50-year planning period is approximately 2,657,000 acre-feet.
- The recommended conservation management strategy will reduce the short-term water demand shortfalls projected within the Brazos basin in decades 2020 and 2030, and will meet the San Jacinto basin shortfall in year 2030. Existing water supplies and the recommended conservation management strategy will satisfy long-term Southeast Area water demand projections in all other basins through approximately year 2040.
- Existing water supplies coupled with the conservation management strategy can theoretically satisfy all of the water demands for the state-wide TTWP study area through year 2050 and retain an excess of over 134,000 acre-feet per year within the Southeast Area river basins.
- The environmental impacts associated with a water conservation strategy appear to be minimal. Construction related impacts will be limited to locations within the interiors of buildings and within the existing urban streetscape. Social impacts may result in the form of potential short-term price increases, but the rate of introduction of conservation water use change appears small enough to minimize customer rate impacts.
- The total capital cost of implementing the advanced water conservation strategy for the entire Houston Metro area is approximately $319 million. This equates to a per unit water cost of approximately $120 per acre-foot.

8. Appendices

Appendix A Population and Water Requirements

Appendix B Houston Metro Conservation Data

Appendix C Expected Conservation Alternatives

Appendix D Water Supply Availability

Appendix E City of Houston's Recommended Conservation Plan

APPENDIX A: Population and Water Requirements

Population Projections for the Southeast Study Area, 1990 - 2050

	Population (Thousands)						
River Basin	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
Sabine	107	116	124	130	137	142	148
Neches	315	354	384	414	447	478	509
Neches-Trinity	194	210	220	231	238	244	249
Trinity	153	180	201	225	250	270	289
Trinity-San Jacinto	96	118	136	159	173	191	206
San Jacinto	2,771	3,208	3,737	4,389	4,839	5,365	5,783
San Jacinto-Brazos	705	857	1,034	1,247	1,459	1,675	1,874
Brazos	304	347	408	473	544	617	697
Total, Southeast Area	4,646	5,390	6,244	7,267	8,086	8,983	9,755

Population Projections for the Houston Metro Region

BASIN	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
San Jacinto	2744.4	3176.3	3700.2	4346.7	4791.1	5313.3	5727.4
San Jacinto - Brazos	705.4	857.3	1033.6	1246.7	1458.9	1674.6	1873.9
Brazos	94.1	112.2	142.7	180.1	224.7	273.9	327.6
Neches	1.9	2.1	2.3	2.5	2.8	3.1	3.3
Neches-Trinity	10.8	11.6	15.0	19.1	21.8	23.2	23.1
Trinity	39.4	44.3	50.1	58.0	65.8	72.2	78.7
Trinity-San Jacinto	95.8	118.0	136.4	159.3	172.6	191.3	206.3
METRO TOTAL	3691.7	4321.8	5080.4	6012.4	6737.8	7551.5	8240.3

Water Requirements for the Southeast Area

Total Water Demand (thousands of acre-feet per year)

River Basin	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
Sabine River Basin	79.5	86.0	93.9	102.4	111.0	123.1	135.8
Neches River Basin	245.7	261.4	275.4	287.3	299.4	321.7	345.2
Neches-Trinity Coastal Basi	397.2	329.9	316.6	304.3	303.1	306.7	310.6
Trinity River Basin	141.3	138.5	141.0	144.0	148.1	159.3	174.5
Trinity-San Jacinto Coastal	128.5	143.2	147.9	152.6	156.9	167.0	179.9
San Jacinto River Basin	786.4	949.7	1030.9	1128.7	1201.4	1298.3	1386.4
San Jacinto-Brazos Coastal	405.1	464.2	497.8	529.7	567.3	617.9	668.4
Brazos River Basin	371.6	427.3	463.4	492.7	529.1	583.2	639.2
Total, Southeast Area	2555.3	2800.0	2967.0	3141.8	3316.4	3577.0	3840.0

State of Texas Total Water Demand by Water Use Type

Water Demand (Millions of Acre-Feet/Year)

		1990			*2050*	
Use Types	*Texas*	*SE Area*	*%*	*Texas*	*SE Area*	*%*
Municipal	3,178,398	777,542	24.5%	3,601,657	1,536,382	42.7%
Manufacturing	1,560,047	900,037	57.7%	2,564,547	1,435,446	56.0%
Irrigation	10,123,335	721,092	7.1%	8,177,217	469,917	5.7%
Livestock	274,069	27,780	10.1%	330,305	28,962	8.8%
Mining	148,839	18,263	12.3%	291,397	115,371	39.6%
Power	434,116	110,477	25.4%	937,900	253,500	27.0%
Total	15,718,804	2,555,191	16.3%	15,903,023	3,839,578	24.1%

Water Requirements for the Houston Metro Area

Water Demand (Thousands of Acre-Feet/Year)

River Basin	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
Neches	9	7	6	6	6	5	5
Neches-Trinity	106	87	79	72	70	68	66
Trinity	116	109	101	97	97	96	96
Trinity-San Jacinto	128	143	148	153	157	167	180
San Jacinto	782	943	1,024	1,122	1,194	1,291	1,379
San Jacinto-Brazos	405	464	498	530	567	618	668
Brazos	262	302	326	342	358	387	416
Total, Houston Metro	1,808	2,056	2,183	2,321	2,449	2,632	2,810

APPENDIX B: Houston Metro Conservation Data

HoustonMetro - Advanced Conservation

BASIN/COUNTY		WATER SAVINGS (Acre-Feet/Year)						
		1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
BRAZOS		n/a	672	1,379	2,148	2,303	2,480	2,964
	BRAZORIA	n/a	81	149	198	179	151	175
	FORT BEND	n/a	470	932	1,523	1,680	1,868	2,253
	WALLER	n/a	121	298	427	444	461	536
NECHES	LIBERTY	n/a	10	24	27	25	20	23
NECHES-TRINITY		n/a	58	124	149	163	148	146
	CHAMBERS	n/a	45	96	131	133	127	129
	GALVESTON	n/a	12	27	17	29	20	16
	LIBERTY	n/a	1	1	1	1	1	1
SAN JACINTO		n/a	17,621	35,469	46,759	45,798	40,110	43,152
	FORT BEND	n/a	426	959	1,476	1,706	1,754	2,201
	HARRIS	n/a	15,770	31,571	40,871	39,276	33,346	35,035
	LIBERTY	n/a	75	175	211	215	183	195
	MONTGOMERY	n/a	1,309	2,664	4,054	4,454	4,677	5,539
	WALLER	n/a	41	100	147	147	150	182
SAN JACINTO-BRAZOS		n/a	4,657	9,820	13,461	13,747	13,404	15,201
	BRAZORIA	n/a	891	1,796	2,353	2,236	1,988	2,441
	FORT BEND	n/a	945	1,910	3,182	3,672	4,095	4,927
	GALVESTON	n/a	1,300	2,710	3,430	3,377	3,113	3,337
	HARRIS	n/a	1,521	3,404	4,496	4,462	4,208	4,496
TRINITY		n/a	209	451	555	532	454	503
	CHAMBERS	n/a	24	53	66	69	65	66
	LIBERTY	n/a	185	398	489	463	389	437
TRINITY-SAN JACINTO		n/a	653	1,292	1,674	1,614	1,372	1,637
	CHAMBERS	n/a	54	110	142	135	115	130
	HARRIS	n/a	596	1,175	1,524	1,471	1,251	1,500
	LIBERTY	n/a	3	7	8	8	6	7
	TOTAL	*n/a*	*23,880*	*48,559*	*64,773*	*64,182*	*57,988*	*63,626*

** Water Saving quantities represent the differential required to meet the goals of the "Advanced" Water Conservation Scenario in Phase II (given the current "Expected" Water Conservation Scenario). 1990 values are historical data (same in both scenarios).*

Houston Metro Area: Advanced Water Conservation Analysis

BASIN / COUNTY	*WATER SAVINGS (acre-foot / year)*						
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
BRAZOS / BRAZORIA							
Expected Conservation Measures	1,678	2,241	2,291	2,403	2,640	2,808	3,187
Advanced Conservation Measures	1,678	2,160	2,142	2,205	2,461	2,657	3,012
Water Saving (acre-foot)	**0**	**81**	**149**	**198**	**179**	**151**	**175**
BRAZOS / FORT BEND							
Expected Conservation Measures	9,937	13,423	16,490	20,383	25,591	31,465	37,720
Advanced Conservation Measures	9,937	12,953	15,558	18,860	23,911	29,597	35,467
Water Savings	**0**	**470**	**932**	**1,523**	**1,680**	**1,868**	**2,253**
BRAZOS / WALLER							
Expected Conservation Measures	3,975	4,603	5,326	6,092	6,930	7,889	9,124
Advanced Conservation Measures	3,975	4,482	5,028	5,665	6,486	7,428	8,588
Water Savings	**0**	**121**	**298**	**427**	**444**	**461**	**536**
NECHES / LIBERTY							
Expected Conservation Measures	287	290	304	313	333	356	378
Advanced Conservation Measures	287	280	280	286	308	336	355
Water Savings	**0**	**10**	**24**	**27**	**25**	**20**	**23**
NECHES-TRINITY / CHAMBERS							
Expected Conservation Measures	925	1,225	1,498	1,811	2,008	2,142	2,260
Advanced Conservation Measures	925	1,180	1,402	1,680	1,875	2,015	2,131
Water Savings	**0**	**45**	**96**	**131**	**133**	**127**	**129**
NECHES-TRINITY / GALVESTON							
Expected Conservation Measures	935	608	615	659	713	693	573
Advanced Conservation Measures	935	596	588	642	684	673	557
Water Savings	**0**	**12**	**27**	**17**	**29**	**20**	**16**
NECHES-TRINITY / LIBERTY							
Expected Conservation Measures	23	12	12	13	14	15	16
Advanced Conservation Measures	23	11	11	12	13	14	15
Water Savings	**0**	**1**	**1**	**1**	**1**	**1**	**1**
SAN JACINTO / FORT BEND							
Expected Conservation Measures	12,117	13,281	17,056	21,635	27,523	34,003	42,528
Advanced Conservation Measures	12,117	12,855	16,097	20,159	25,817	32,249	40,327
Water Savings	**0**	**426**	**959**	**1,476**	**1,706**	**1,754**	**2,201**

Houston Metro Area: Advanced Water Conservation Analysis

BASIN / COUNTY	*WATER SAVINGS (acre-foot / year)*						
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
SAN JACINTO / HARRIS							
Expected Conservation Measures	441,790	568,329	621,429	689,123	729,624	780,370	818,404
Advanced Conservation Measures	441,790	552,559	589,858	648,252	690,348	747,024	783,369
Water Savings	**0**	**15,770**	**31,571**	**40,871**	**39,276**	**33,346**	**35,035**
SAN JACINTO / LIBERTY							
Expected Conservation Measures	2,133	2,359	2,578	2,761	3,088	3,211	3,390
Advanced Conservation Measures	2,133	2,284	2,403	2,550	2,873	3,028	3,195
Water Savings	**0**	**75**	**175**	**211**	**215**	**183**	**195**
SAN JACINTO / MONTGOMERY							
Expected Conservation Measures	26,851	38,395	46,121	55,474	67,096	79,508	93,703
Advanced Conservation Measures	26,851	37,086	43,457	51,420	62,642	74,831	88,164
Water Savings	**0**	**1,309**	**2,664**	**4,054**	**4,454**	**4,677**	**5,539**
SAN JACINTO / WALLER							
Expected Conservation Measures	912	1,289	1,585	1,828	2,126	2,451	2,892
Advanced Conservation Measures	912	1,248	1,485	1,681	1,979	2,301	2,710
Water Savings	**0**	**41**	**100**	**147**	**147**	**150**	**182**
SAN JACINTO - BRAZOS / BRAZORIA							
Expected Conservation Measures	22,046	26,022	28,519	31,375	35,835	39,420	45,190
Advanced Conservation Measures	22,046	25,131	26,723	29,022	33,599	37,432	42,749
Water Savings	**0**	**891**	**1,796**	**2,353**	**2,236**	**1,988**	**2,441**
SAN JACINTO - BRAZOS / FORT BEND							
Expected Conservation Measures	14,987	27,491	34,875	44,055	56,003	69,424	84,009
Advanced Conservation Measures	14,987	26,546	32,965	40,873	52,331	65,329	79,082
Water Savings	**0**	**945**	**1,910**	**3,182**	**3,672**	**4,095**	**4,927**
SAN JACINTO - BRAZOS / GALVESTON							
Expected Conservation Measures	32,752	40,016	43,282	47,509	52,813	56,577	59,988
Advanced Conservation Measures	32,752	38,716	40,572	44,079	49,436	53,464	56,651
Water Savings	**0**	**1,300**	**2,710**	**3,430**	**3,377**	**3,113**	**3,337**
SAN JACINTO - BRAZOS / HARRIS							
Expected Conservation Measures	37,111	52,064	58,653	66,396	71,550	78,726	82,576
Advanced Conservation Measures	37,111	50,543	55,249	61,900	67,088	74,518	78,080
Water Savings	**0**	**1,521**	**3,404**	**4,496**	**4,462**	**4,208**	**4,496**
TRINITY / CHAMBERS							
Expected Conservation Measures	656	668	781	943	1,060	1,139	1,198
Advanced Conservation Measures	656	644	728	877	991	1,074	1,132
Water Savings	**0**	**24**	**53**	**66**	**69**	**65**	**66**

Houston Metro Area: Advanced Water Conservation Analysis

BASIN / COUNTY	*WATER SAVINGS (acre-foot / year)*						
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
TRINITY / LIBERTY							
Expected Conservation Measures	5,015	5,470	5,710	6,088	6,684	7,106	7,708
Advanced Conservation Measures	5,015	5,285	5,312	5,599	6,221	6,717	7,271
Water Savings	**0**	**185**	**398**	**489**	**463**	**389**	**437**
TRINITY - SAN JACINTO / CHAMBERS							
Expected Conservation Measures	1,264	1,674	1,809	2,013	2,145	2,257	2,362
Advanced Conservation Measures	1,264	1,620	1,699	1,871	2,010	2,142	2,232
Water Savings	**0**	**54**	**110**	**142**	**135**	**115**	**130**
TRINITY - SAN JACINTO / HARRIS							
Expected Conservation Measures	12,951	18,402	20,137	22,263	23,538	25,520	27,349
Advanced Conservation Measures	12,951	17,806	18,962	20,739	22,067	24,269	25,849
Water Savings	**0**	**596**	**1,175**	**1,524**	**1,471**	**1,251**	**1,500**
TRINITY - SAN JACINTO / LIBERTY							
Expected Conservation Measures	77	87	90	95	104	111	121
Advanced Conservation Measures	77	84	83	87	96	105	114
Water Savings	**0**	**3**	**7**	**8**	**8**	**6**	**7**

APPENDIX C: Expected Conservation Alternatives

Expected Conservation Alternatives [1]

Residential	
• Water Audits	Local officials would offer indoor/outdoor water audits to existing single-family & multi-family residential customers w/ high water use.
• Appliance Labeling	Local officials would promote a program at the State level to provide point-of-sale information about water-efficient washing machines and dishwashers.
Commercial	
• Indoor Audits	Local officials would offer on-site interior inspection & produce a customized report describing fixture inspections, leak tests, retrofit possibilities, cooling tower operation & improvements, etc.
• Cooling Tower Audits	Local officials would offer audits to measure the number of cycles of concentration and to suggest improvements in operations, such as addition of a chemical feed system to increase the cycles of concentration.
Public	
• Indoor/Exterior Audits	Local officials would perform water audits at all public buildings focusing on indoor plumbing fixtures & irrigation water uses.
• Pool/Fountain Audits (for government & public facilities)	Local officials would provide audits on-site & produce a customized report that describes fixture & valve inspections, leak tests, retrofit possibilities, pool/fountain cleaning & backwashing operation & improvements, & recycling opportunities for each site. A leak detection by a private contractor would be provided if warranted.
• Pool/Fountain Standards	All new publicly owned pools and fountains would be required to meet water efficiency minimum standards as established.
• In-House Programs	Targets all local government departments not currently charged for water. Directors/managers of these would receive an "in-house" bill, detailing their water usage. A goal of 20% water usage (by a specific time period) would be established.
Other Programs	
• Unaccounted-for-Water	Local officials would increase its leak protection & repair program w/ goal of reducing "lost-and-unaccounted-for" water to 10% (from current average of 17%)
• Public Education	Local officials would offer water conservation education to all schools, civic associations, Girl Scout & Boy Scout troops, etc.
• *Waterwise & Energy Efficient* Program	Local officials would maintain a partner w/ the Harris-Galveston Coastal Subsidence District to provide 5th grade students in the area w/ a 2-week conservation education program that provides retrofit devices (low-flow shower head, kitchen aerator, bathroom aerator, etc.).

[1] Meeting Notes, City of Houston Water Conservation Program, April 3, 1997. Presentation of *City of Houston Final Draft Water Conservation Plan*,. March 1997.

APPENDIX D: Water Supply Availability

Table 12: Southeast Area Water Supply Availability: 2000—2050

	Amount (Thousands of Acre/Feet-Year)								
Category	*Sabine*	*Neches*	*Neches-Trinity*	*Trinity*	*Trinity-San Jacinto*	*San Jacinto*	*San Jacinto-Brazos*	*Brazos*	*Total Southeast*
2000									
In-Basin Demands	86.0	261.4	329.9	138.5	143.2	949.7	464.2	427.3	2800.2
In-Basin Supplies									
Groundwater	23.3	110.5	7.5	34.3	26.6	451.7	74.9	130.5	859.3
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	488.2	4197.4
TOTAL	1213.7	957.4	7.5	1390.7	26.6	709.4	132.7	618.7	5056.7
Transfers									0.0
Imported Supplies	0.9	1.4	322.4	0.0	116.6	300.3	331.5	0.0	1073.1
Export Demands	1.4	280.5	0.0	582.5	0.0	60.0	0.0	148.7	1073.1
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**844.3**	**207.8**	**0.0**	**669.7**	**0.0**	**0.0**	**0.0**	**42.7**	**1764.5**
2010									
In-Basin Demands	93.9	275.4	316.6	141.0	147.9	1030.9	497.8	463.4	2966.9
In-Basin Supplies									
Supplied by Groundwater	23.3	111.6	7.9	36.6	25.7	292.3	80.9	141.9	720.2
Supplied by Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.6	4196.8
TOTAL	1213.7	958.5	7.9	1393.0	25.7	550.0	138.7	629.5	4917.0
Transfers									
Imported Supplies	1.0	2.0	308.7	0.0	122.2	540.9	359.1	0.0	1333.9
Export Demands	2.0	279.5	0.0	839.2	0.0	60.0	0.0	153.2	1333.9
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**835.9**	**196.5**	**0.0**	**412.8**	**0.0**	**0.0**	**0.0**	**12.9**	**1458.1**
2020									
In-Basin Demands	102.4	287.3	304.4	144.0	152.6	1128.7	529.7	492.7	3141.8
In-Basin Supplies									
Groundwater	23.3	112.8	8.3	38.7	31.1	251.1	87.1	156.1	708.5
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.1	4196.3
TOTAL	1213.7	959.7	8.3	1395.1	31.1	508.8	144.9	643.2	4904.8
Surface Water Transfers									
Imported Supplies	1.0	2.6	296.1	0.0	121.5	679.9	384.8	0.0	1485.9
Export Demands	2.6	266.9	0.0	993.4	0.0	60.0	0.0	163.0	1485.9
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**826.8**	**199.0**	**0.0**	**257.7**	**0.0**	**0.0**	**0.0**	**-12.5**	**1271.0**

Table 12: Southeast Area Water Supply Availability: 2000—2050, Continued

	Amount (Thousands of Acre/Feet-Year)							
Category	*Sabine*	*Neches*	*Neches-Trinity*	*Trinity*	*Trinity-San Jacinto*	*San Jacinto*	*San Jacinto-Brazos*	*Brazos*
2030								
In-Basin Demands	111.0	299.4	303.1	148.1	156.9	1201.4	567.7	529.1
In-Basin Supplies								
Groundwater	23.4	114.6	8.7	41.2	27.9	266.3	87.8	169.4
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.6
TOTAL	1213.8	961.5	8.7	1397.6	27.9	524.0	145.6	656.0
Surface Water Transfers								
Imported Supplies	1.0	4.1	294.4	0.0	129.0	726.2	422.1	0.0
Export Demands	4.1	265.3	0.0	1072.6	0.0	60.0	0.0	174.7
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0
Net Surface Water Availability	**816.8**	**191.8**	**0.0**	**176.9**	**0.0**	**-11.2**	**0.0**	**-47.8**
2040								
In-Basin Demands	123.1	321.7	306.7	159.3	167.0	1298.3	617.9	583.2
In-Basin Supplies								
Groundwater	23.5	116.3	8.8	43.8	29.6	280.5	88.8	181.1
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.0
TOTAL	1213.9	963.2	8.8	1400.2	29.6	538.2	146.6	667.1
Surface Water Transfers								
Imported Supplies	1.0	4.6	297.9	0.0	123.5	710.9	460.8	0.0
Export Demands	4.6	268.7	0.0	1075.3	0.0	60.0	0.0	190.1
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0
Net Surface Water Availability	**804.3**	**168.3**	**0.0**	**165.6**	**-13.9**	**-109.2**	**-10.5**	**-106.2**
2050								
In-Basin Demands	135.8	344.8	310.6	174.5	179.9	1386.4	668.4	639.2
In-Basin Supplies								
Groundwater	23.6	118.3	9.0	46.7	31.0	291.8	89.7	197.3
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	485.4
TOTAL	1214.0	965.2	9.0	1403.1	31.0	549.5	147.5	682.7
Transfers								
Imported Supplies	1.1	5.1	301.6	0.0	123.5	710.9	476.3	0.0
Export Demands	5.3	272.2	0.0	1075.4	0.0	60.0	0.0	205.6
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0
Net Surface Water Availability	**791.1**	**144.2**	**0.0**	**153.2**	**-25.4**	**-186.0**	**-44.6**	**-162.1**

Table 13: Trans-Texas Water Program Supply Availability: 20000 - 2050

	Amount (Thousands of Acre-Feet/Year)					
Category	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***
Scenario 1						
Available Southeast Supply	1764.5	1458.1	1271	1126.4	898.4	670.4
West-Central Demand			150	300	450	600
Net Surface Water Availability	1764.5	1458.1	1121	826.4	448.4	70.4
Scenario 2						
Available Southeast Supply	1764.5	1458.1	1271	1126.4	898.4	670.4
West-Central Demand				100	200	300
Net Surface Water Availability	1764.5	1458.1	1271	1026.4	698.4	370.4
Scenario 3						
Available Southeast Supply	1764.5	1458.1	1271	1126.4	898.4	670.4
West-Central Demand	0	0	0	0	0	0
Net Surface Water Availability	1764.5	1458.1	1271	1126.4	898.4	670.4

APPENDIX E: Recommended Conservation Plan

Excerted from the City of Houston *Final Draft Water Plan*, Section 7. March 1997.

Table 12: Southeast Area Water Supply Availability: 2000—2050[1]

Amount (Thousands of Acre/Feet-Year)

Category	*Sabine*	*Neches*	*Neches-hes-Trinity*	*Trinity*	*Trinity-ity-San*	*San Jaci*	*San Jacinto*	*San Jacinto-an Jacinto*	*Brazos*	*Total Southeast*
2000										
In-Basin Demands	86.0	261.4	329.9	138.5	143.2	949.7	464.2	427.3	2800.2	
In-Basin Supplies										
Groundwater	23.3	110.5	7.5	34.3	26.6	451.7	74.9	130.5	859.3	
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	488.2	4197.4	
TOTAL	1213.7	957.4	7.5	1390.7	26.6	709.4	132.7	618.7	5056.7	
Transfers										
Imported Supplies	0.9	1.4	322.4	0.0	116.6	300.3	331.5	0.0	1073.1	
Export Demands	1.4	280.5	0.0	582.5	0.0	60.0	0.0	148.7	1073.1	
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0	
Net Surface Water Availability	**844.3**	**207.8**	**0.0**	**669.7**	**0.0**	**0.0**	**0.0**	**42.7**	**1764.5**	
2010										
In-Basin Demands	93.9	275.4	316.6	141.0	147.9	1030.9	497.8	463.4	2966.9	
In-Basin Supplies										
Groundwater	23.3	111.6	7.9	36.6	25.7	292.3	80.9	141.9	720.2	
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.6	4196.8	
TOTAL	1213.7	958.5	7.9	1393.0	25.7	550.0	138.7	629.5	4917.0	
Transfers										
Imported Supplies	1.0	2.0	308.7	0.0	122.2	540.9	359.1	0.0	1333.9	
Export Demands	2.0	279.5	0.0	839.2	0.0	60.0	0.0	153.2	1333.9	
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0	
Net Surface Water Availability	**835.9**	**196.5**	**0.0**	**412.8**	**0.0**	**0.0**	**0.0**	**12.9**	**1458.1**	
2020										
In-Basin Demands	102.4	287.3	304.4	144.0	152.6	1128.7	529.7	492.7	3141.8	
In-Basin Supplies										
Groundwater	23.3	112.8	8.3	38.7	31.1	251.1	87.1	156.1	708.5	
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	487.1	4196.3	
TOTAL	1213.7	959.7	8.3	1395.1	31.1	508.8	144.9	643.2	4904.8	
Surface Water Transfers										
Imported Supplies	1.0	2.6	296.1	0.0	121.5	679.9	384.8	0.0	1485.9	
Export Demands	2.6	266.9	0.0	993.4	0.0	60.0	0.0	163.0	1485.9	
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0	
Net Surface Water Availability	**826.8**	**199.0**	**0.0**	**257.7**	**0.0**	**0.0**	**0.0**	**-12.5**	**1271.0**	

[1] Trans-Texas Water Program Southeast Area *Planning Information Update,* Brown & Root, Inc., September 1996.

Table 12: Water Supply Availability: 2000—2050, Continued

Catagory	*Sabine*	*Neches*	*Neches-Trinity*	*Trinity*	*Trinity-San Jacinto*	*San Jacint*	*San Jacint Brazos*	*Brazos*	*Total Southeast*
				Amount (Thousands of Acre/Feet-Year)					
2030									
In-Basin Demands	111.0	299.4	303.1	148.1	156.9	1201.4	567.7	529.1	3316.7
In-Basin Supplies									
Groundwater	23.4	114.6	8.7	41.2	27.9	266.3	87.8	169.4	739.3
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.6	4195.8
TOTAL	1213.8	961.5	8.7	1397.6	27.9	524.0	145.6	656.0	4935.1
Surface Water Transfers									
Imported Supplies	1.0	4.1	294.4	0.0	129.0	726.2	422.1	0.0	1576.8
Export Demands	4.1	265.3	0.0	1072.6	0.0	60.0	0.0	174.7	1576.7
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**816.8**	**191.8**	**0.0**	**176.9**	**0.0**	**-11.2**	**0.0**	**-47.8**	**1126.5**
2040									
In-Basin Demands	123.1	321.7	306.7	159.3	167.0	1298.3	617.9	583.2	3577.2
In-Basin Supplies									
Groundwater	23.5	116.3	8.8	43.8	29.6	280.5	88.8	181.1	772.4
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	486.0	4195.2
TOTAL	1213.9	963.2	8.8	1400.2	29.6	538.2	146.6	667.1	4967.6
Surface Water Transfers									
Imported Supplies	1.0	4.6	297.9	0.0	123.5	710.9	460.8	0.0	1598.7
Export Demands	4.6	268.7	0.0	1075.3	0.0	60.0	0.0	190.1	1598.7
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**804.3**	**168.3**	**0.0**	**165.6**	**-13.9**	**-109.2**	**-10.5**	**-106.2**	**898.4**
2050									
In-Basin Demands	135.8	344.8	310.6	174.5	179.9	1386.4	668.4	639.2	3839.6
In-Basin Supplies									
Groundwater	23.6	118.3	9.0	46.7	31.0	291.8	89.7	197.3	807.4
Surface Water	1190.4	846.9	0.0	1356.4	0.0	257.7	57.8	485.4	4194.6
TOTAL	1214.0	965.2	9.0	1403.1	31.0	549.5	147.5	682.7	5002.0
Transfers									
Imported Supplies	1.1	5.1	301.6	0.0	123.5	710.9	476.3	0.0	1618.5
Export Demands	5.3	272.2	0.0	1075.4	0.0	60.0	0.0	205.6	1618.5
In-Basin Reserves	282.9	209.1	0.0	0.0	0.0	0.0	0.0	0.0	492.0
Net Surface Water Availability	**791.1**	**144.2**	**0.0**	**153.2**	**-25.4**	**-186.0**	**-44.6**	**-162.1**	**670.4**