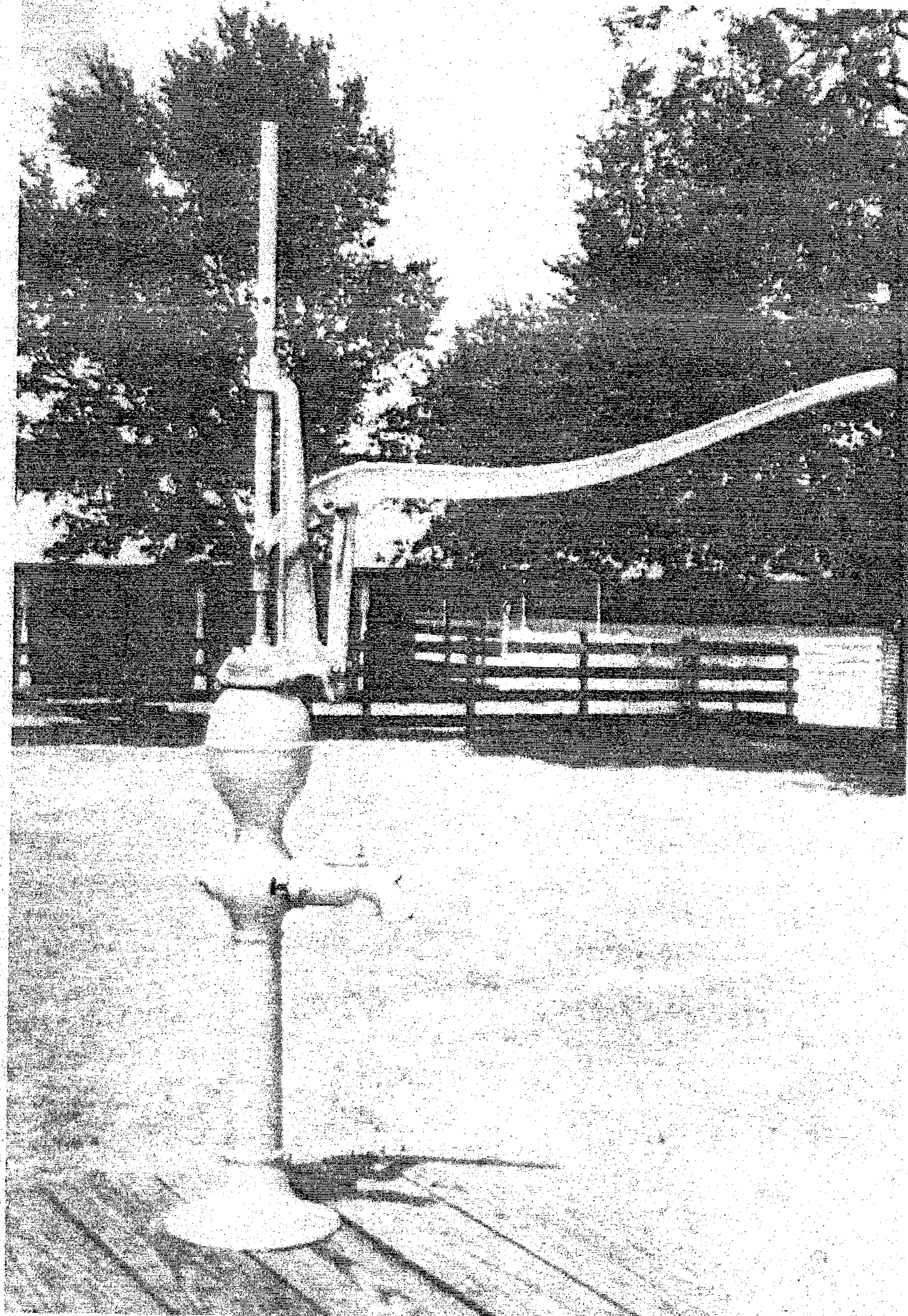

HAYS COUNTY
WATER
DEVELOPMENT
BOARD

HAYS COUNTY WATER AND WASTEWATER STUDY

MAY 1989

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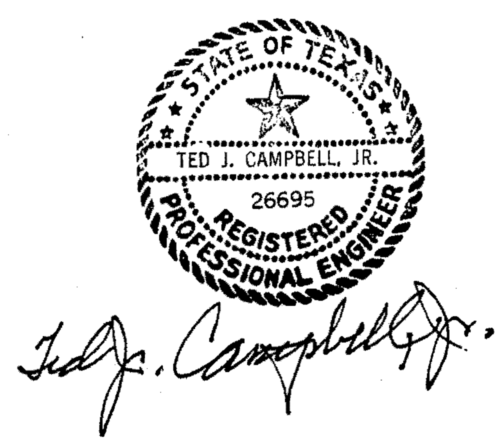
HAYS COUNTY

REGIONAL WATER AND WASTEWATER STUDY



HDR Engineering, Inc.

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EXECUTIVE SUMMARY REPORT

Hays County Regional Water and Wastewater Study

The Hays County Water Development Board (HCWDB) was formed in 1986 to develop a regional water supply and wastewater services plan for Hays County. The members of the Board were brought together by a common concern for the future supply and quality of the water resources in Hays County. This concern was precipitated by the 1984 drought conditions experienced in the county and the ongoing regional planning for the Edwards Aquifer being conducted by the San Antonio-Edwards Underground Water District Joint Committee. The HCWDB members include representatives from the County Commissioners Court, the Cities of San Marcos, Hays City, Buda, Kyle, Dripping Springs, Woodcreek, Niederwald, and Mountain City, and the Goforth and Wimberley Water Supply Corporations, which in turn represented the rural water supply corporations in the County.

The HCWDB is committed to the following broad goals.

* To preserve existing ground water resources;
* To provide water supply to meet the future needs of the County; and
* To preserve the water quality of all existing and future water supplies in the county.

In order to develop a regional plan, the HCWDB obtained funding from the Texas Water Development Board (TWDB) to perform a regional water supply and wastewater disposal study. Costs of the study are shared equally with the Texas Water Development Board by agreement between the two Boards.

The HCWDB subsequently contracted with HDR Engineering, Inc. to conduct this study. This study included the following major components:

1. Development of future population and water demand projections for the County;

2. Evaluation of existing water supplies;

3. Evaluation of existing wastewater disposal systems;

4. Development and evaluation of future water supply alternatives;

5. Development and evaluation of future wastewater disposal alternatives; and

6. Development of a plan for implementation of the recommended water and wastewater alternatives.

Findings and Recommendations

(Where HCWDB action is recommended, it is intended that either HCWDB or its successor implement the action.)

1. **Population and Water Demand Projections.**

   A. The population for Hays County was 40,594 in 1980 and is expected to increase to 70,000 in 1990, 99,000 in 2000, 127,000 by year 2010, and 251,000 by year 2040. This would be an increase in population of 4,130 per year from 2010 to 2040.

   B. The City of Austin has forecast growth within the Barton Springs-Edwards Aquifer region, which includes a portion of Hays County, to increase from 30,000 population in 1985 to 116,000 by year 2000, almost a 400% increase in 15 years. It is expected that the water supply for many of these people will be obtained from the aquifers of the area.

   C. Average daily water demand in the county in 1980 was 11.6 mgd and is projected to increase to 14.6 million gallons per day (mgd) in year 1990, 20.2 mgd in year 2000, and to 25.9 mgd by year 2010. The year 2040 demand is projected to be 50.7 mgd.

   D. Population projections are the basis for projecting future demands for water supply and wastewater disposal. Projections developed in this study should be periodically reviewed and schedules adjusted as appropriate.

2. **Existing water supplies.**

   A. Three aquifers serve the County: the Edwards, the Barton Spring-Edwards, and the Trinity Group Aquifers. The river basin divide between the Colorado River and Guadalupe River traverses east-west across the county.

   B. At the present time (December, 1988) Hays County obtains all of its water supply from ground water sources.

C. Approximately 90% of the County's current water supply is from the Edwards Aquifer, and the current average demand for the County is about 14 mgd.

D. The Trinity Group Aquifer supplies most of western Hays County and produces poor quality water from wells of relatively low yield.

E. Water elevations in wells in the Trinity Group are declining, and mining of the Trinity Group Aquifer will affect recharge to the Edwards Aquifer.

F. The Barton Springs-Edwards Aquifer serves most of the northeast part of the County and also provides water for a large area in Travis County. Barton Springs is an outlet for the Aquifer and supplies a popular recreation area in the City of Austin.

G. A recurrence of the drought of the 1950's, concurrent with present or forecasted pumping from the Edwards Aquifer, would result in drying up the Comal Springs for several years. It would also severely reduce the flow and could even dry up the flow of the San Marcos and Barton Springs.

H. Loss or significant reduction of the Comal and San Marcos Spring flows will deplete the flow in the Guadalupe River, causing serious economic hardship and environmental damage.

I. The projected 1990 pumping by all users plus spring flow from the Edwards Aquifer is approximately the same as the average annual recharge of the Aquifer, 608,000 acre-feet. The corresponding projected 1990 population served by the Edwards Aquifer is 1.36 million including the San Antonio region.

3. **Conservation Plan**

A. A water conservation plan has been prepared and should be implemented according to the Master Plan, page xii. Implementation of the recommended plan could reduce water use by approximately 10% by year 2000 and could gradually increase water savings by 22% by year 2040. The conservation plan includes the following general recommendations:

1. Appoint a committee to promote education regarding conservation activities applicable to the citizens of the county, specifically including water conserving landscaping;

2. Adopt a plumbing code which requires use of water conserving fixtures and insulation of hot water piping on all new buildings;

3. Implement a voluntary program for retrofitting existing buildings to replace plumbing fixtures with more efficient water conserving fixtures;

4. Require County water suppliers to adopt water rate structures which encourage conservation, such as increasing block pricing;

5. Require universal metering and regular meter testing and replacement;

6. Encourage County water suppliers to implement voluntary leak detection programs, water audits, and consider system pressure control; and

7. Adopt a drought contingency plan as described in the report (patterned after the Edward's Aquifer plan) which should be used to inform the public of drought conditions and, if enforced, would ensure reduction in water use during drought conditions.

4. **Existing wastewater disposal systems.** A survey of information on wastewater disposal systems was performed. The survey indicated the following:

A. Municipal wastewater treatment plants are in service in San Marcos, Buda, Kyle and Woodcreek;

B. Most of the County discharges waste through conventional septic tank drain fields, even though most of the County terrain and soils are not well suited for this type of disposal. On-site disposal will continue to be a major disposal option through the planning period; and

C. The Board should support organized efforts to develop further understanding of the impact of on-site disposal on the quality of water in the aquifers and should create the legal requirements for owners to modify or select systems which protect the quality of water in the aquifers and streams of Hays County.

5. **Development and Evaluation of future water supply alternatives.**

A. It was found in the study that local water service systems provide lower cost water supply than County-wide regional systems. Recommendations for implementation for future water supplies consist of four local systems. These systems have been phased to meet the demands and financial resources of the regions. The estimated project costs at mid-point of each phase including all facilities required to deliver treated water to the entities, the cost of water, and operations and maintenance have been included. The first phase of each of these systems and estimated costs are presented in the following sections:

a. Alternative 5a to supply Wimberley and Woodcreek from Blanco River with phased Canyon Reservoir backup. This plan would initially require an intake on the Blanco River, a water treatment plant, and a transmission pipeline. As the demand increases, a supplemental source from Canyon Reservoir would be added by construction of an intake in Canyon Reservoir and a transmission pipeline to the Blanco River.

First Phase Components (Year 1995)	Estimated Cost (1988 Dollars)
Construction	$2,740,000
Annual Costs	$550,000
Monthly Cost Increase per Connection	
Wimberley	$19
Woodcreek	$26

b. Alternative 7 to supply Buda and Hays City from City of Austin treated water. This plan requires pump stations and transmission pipeline(s) to connect Buda and Hays City.

First Phase Components (Year 1995)	Estimated Cost (1988 Dollars)
Construction Cost	$1,350,000
Annual Costs	$220,000
Monthly Cost Increase per Connection	
Hays City	$12
Buda	$19

c. Alternative 10b to supply San Marcos, Kyle, Mountain City, Plum Creek, Uhland, County Line, and Goforth from Canyon Reservoir releases. This plan includes an intake on the Guadalupe River to divert Canyon Reservoir releases, a water treatment plant, and transmission pipelines to serve the areas listed. First phase would serve San Marcos, Kyle, and Mountain City. The remaining area would begin service about 10 years following the first phase construction.

First Phase Components (Year 1995)	Estimated Cost (1988 Dollars)
Construction Cost	$22,610,000
Annual Cost	$3,480,000
Monthly Cost Increase per Connection	
San Marcos	$19
Kyle	$33
Mountain City	$67

Second Phase Components (Year 2005)	Estimated Cost (1988 Dollars)
Construction Cost	$8,520,000
Annual Cost	$4,640,000
Monthly Cost Increase per Connection	
Northeast County	
Entities added in 2005.	
San Marcos	$17
Kyle	$21

Mountain City	$50
Plum Creek	$35
Uhland	$35
County Line	$35
Goforth	$39

d. Alternative 11 or 12

1. Alternative 11. This plan would serve Dripping Springs from a new reservoir to be constructed on Onion Creek. A treatment plant and transmission pipelines would be required to deliver treated water to the City. About year 2015, it is projected that this supply would be needed from Lake Travis.

First Phase Components (Year 1995)	Estimated Cost (1988 Dollars)
Construction Cost	$20,380,000
Annual Cost	$2,400,000
Monthly Cost Increase per Connection	$49

2. Alternative 12. An alternative to the Dripping Springs reservoir is the construction of an intake in Lake Travis, a water treatment plant, and a transmission pipeline to the Dripping Springs area.

First Phase Components (Year 1995)	Estimated Cost (1988 Dollars)
Construction Cost	$15,740,00
Annual Cost	$2,500,000
Monthly Cost per Connection	$51

B. Estimated cost for construction of the components by phase and projected capacity requirements for each recommended alternative are shown in Table

ES-1. The costs and capacities shown in the table are based on projected populations and current per capita water use amounts.

C. The HCWDB should take action to start developing surface water supplies to service areas within the Edwards and Barton Springs-Edwards Aquifer regions of Hays County by 1995; i.e., have additional supplies available by 1995.

D. The HCWDB should take action to start developing surface water supplies in order to have such supplies available by 1995 in the Wimberley/Woodcreek areas and the Dripping Springs area currently served by the Trinity Group Aquifer.

E. Because of the current and growing demand for water in the Guadalupe River Basin and the limited supply of water available, it is recommended that a contract for raw water from Canyon Reservoir be obtained as soon as possible.

6. **Development and Evaluation of future wastewater disposal systems.**

Through year 2040, it is expected that 31 to 38% of the County will use on-site waste disposal. Such widespread use increases the need for proper construction and management of operation of these systems. A county-wide regional wastewater disposal system is not considered feasible because of the topography and broad distribution of population. But four, localized regional areas were identified as feasible for development of regional wastewater collection and disposal systems.

A. Hays County, acting through its Commissioners Court, should have the responsibility to ensure that on-site systems are planned, designed, constructed, inspected, and maintained in accordance with federal, state, and County requirements.

B. The County should develop a mechanism whereby out-dated and failed on-site systems are detected and replaced with new systems which use accepted state-of-the-art disposal technology.

TABLE ES-1

RECOMMENDED ALTERNATIVES
CONSTRUCTION COST ESTIMATE SUMMARY WITHOUT CONSERVATION

Recommended Alternative and Component	1995 - 2005 Capacity (MGD) or Vol. (MG)	1995 - 2005 Est. Cost *($m)	2005 - 2015 Capacity (MGD) or Vol. (MG)	2005 - 2015 Est. Cost *($m)	2015 - 2025 Capacity (MGD) or Vol. (MG)	2015 - 2025 Est. Cost *($m)	2025 - 2035 Capacity (MGD) or Vol. (MG)	2025 - 2035 Est. Cost *($m)	2035 - 2040 Capacity (MGD) or Vol. (MG)	2035 - 2040 Est. Cost *($m)
#5a Serving Wimberley and Woodcreek										
- Intake & Dam	N/A	0.60								
- Pump Station	3.72	1.00								
- Raw Water Line	1.84	1.92			1.88	1.93				
- Treatment Plant	1.20	1.47	0.57	0.84	0.70	0.98	0.77	1.05	0.48	1.09
- Woodcreek Pump Station	1.83	0.07								
- Woodcreek Transmission	.73	0.60			1.11	0.68				
#5a Total		5.66		0.84		3.62		1.05		1.09
#7 Serving Hays and Buda										
- Pump Station	0.94	0.13								
- Ground Storage	0.20	0.07								
- Pipeline to Hays	0.62	0.55			0.32	0.53				
- Buda Pump Station	0.62	0.07								
- Pipeline to Buda	0.42	0.53			0.20	0.47				
#7 Total		1.35				1.00				
#10b Serving San Marcos, Kyle, Mt. City, Uhland, Goforth, Plum Creek and County Line										
- Dam, Intake, & Pump Station	33.30	1.20								
- Treatment Plant & Pump Station	10.42	9.83	6.72	6.45	5.81	5.76	6.67	6.41	7.35	6.96
- Main Transmission Line	15.10	7.24			18.20	7.30				
- Pump Station to Kyle	12.98	0.64								
- Transmission Line to Kyle	5.34	3.10			7.64	3.56				
- Pump Station to Mountain City	0.62	0.08								
- Transmission Line to Mountain City	0.37	0.52			0.25	0.49				
- Pump Station to Uhland			3.94	0.20						
- Transmission Line to Uhland			2.47	1.14			1.08	0.95		
- Pump Station to Goforth			2.31	0.16						
- Transmission Line to Goforth			1.51	0.57			0.50	0.45		
#10b Total		22.61		8.52		17.11		7.81		6.96

*($m) - Million Dollars

TABLE ES-1, continued

RECOMMENDED ALTERNATIVES CONSTRUCTION COST ESTIMATE SUMMARY WITHOUT CONSERVATION										
	1995 - 2005		2005 - 2015		2015 - 2025		2025 - 2035		2035 - 2040	
Recommended Alternative and Component	Capacity (MGD) or Vol. (MG)	Est. Cost *($m)	Capacity (MGD) or Vol. (MG)	Est. Cost *($m)	Capacity (MGD) or Vol. (MG)	Est. Cost *($m)	Capacity (MGD) or Vol. (MG)	Est. Cost *($m)	Capacity (MGD) or Vol. (MG)	Est. Cost *($m)
#11 Serving Dripping Springs										
- Reservoir	N/A	10.87								
- Raw Water Pump Station	15.50	0.46								
- Raw Water Line	5.55	0.35			9.95	0.44				
- Treatment Plant & Pump Station	3.51	3.57	2.04	2.23	2.96	3.07	4.38	4.36	5.22	5.18
- Transmission Line	5.55	1.49			9.95	1.75				
- Elevated Storage	1.00	1.07								
- Distribution Pump Station	7.75	0.51								
- East Transm. Line	1.30	1.03			1.30	1.03				
- North Transm. Line	1.30	1.03			1.30	1.03				
- West Transm. Line					1.30	1.03				
- Travis P.S. & Booster					8.50	2.70				
- Travis Supplement Line					4.74	5.90				
#11 Total		20.38		2.23		16.95		4.36		5.18
#12 Serving Dripping Springs										
- Intake & Pump Station	15.50	2.98								
- Raw Water Line	5.55	0.98			9.95	1.29				
- Treatment Plant	3.51	3.57	2.04	2.23	2.96	3.07	4.38	4.36	5.22	3.18
- T.W. Line	5.55	5.60			9.95	7.33				
- Elevated Storage	1.00	1.07								
- East Transm. Line	1.30	1.03			1.30	1.03				
- South Transm. Line			1.30	1.03			1.30	1.03		
- West Transm. Line					1.30	1.03			1.30	1.03
- Dist. Pump Station		0.51								
#12 Total		15.74		3.26		13.75		5.39		6.21

*($m) - Million Dollars

C. The County should delineate critical water quality zones, such as the entire area located over the Edwards Aquifer, the Barton Springs-Edwards Aquifer, and the contributing recharge zones of both aquifers, and prohibit and/or require systems in these areas to maintain ground and surface water quality. In these areas of the County, systems which would result in pollution of the Aquifer should be prohibited.

D. The Board should encourage and support the development of regional wastewater collection and disposal systems in that part of the County where development is occurring over the Aquifer; i.e., in the Kyle and San Marcos areas, in the Dripping Springs area, and in the Wimberley/Woodcreek area.

7. **Development of a plan for implementation of the recommended water supply and wastewater disposal alternatives.**

A. Several institutional alternatives which would facilitate the coordinated implementation of regional water and wastewater facilities in Hays County were identified and described. It is recommended that a special district (the "Hays County Water Development Authority") be created by Legislative act under the authority of Article XVI, Section 59, Texas Constitution. The Hays County Water Development Authority would encompass the entire County and would be granted broad powers to construct, finance, own, and operate water and wastewater facilities. In addition to financing projects with system revenues, the Authority would be authorized to finance projects with a limited tax on the entire County. It would also be authorized to define portions of the County which would benefit from particular projects and to finance those projects with taxes levied only within the defined area. The creation of the Authority, and its ability to levy any tax, would be subject to voter approval within the affected area. Additionally, levy of a tax within a defined, benefited area would be subject to consent by any city with overlapping taxing authority. The Authority could also coordinate septic tank regulation in the County.

B. Financing strategies will vary, depending on the institutional organization, but should include some of the following alternatives which are discussed in more detail in the following section.

1. User fees;
2. Revenue bonds;
3. Grants; and
4. Taxes.

8. **The Master Plan to implement the study recommendations should include the following steps:**

a) HCWDB informs the public of its plans and reasons for plans;
b) HCWDB decides on the regional agency or local agencies to be given the authority to implement the master plan;
c) HCWDB adjusts the plan as appropriate to suit needs of the participants, based on the public hearings;
d) Approval of study plan by TWDB;
e) Approval by all participating entities (Cities, Water Supply Corporations, River Authorities, and County);
f) HCWDB acts, as appropriate, to achieve legal status of Implementing Agency or Agencies through the Texas Legislature;
g) Implementing agency(s) implements conservation plan;
h) Implementing agency reviews and adjusts project schedules and contracts for water as required;
i) Implementing agency starts implementing the construction plan to meet the required schedules by finalizing financing, preparing plans and specifications, and obtaining permits and approvals;
j) Implementing agency continues to review population projections and water demand requirements periodically and to update plan and schedule as necessary; and
k) Implementing agency develops and manages the master plan for water and wastewater facilities for the County.

SECTION 1
INTRODUCTION

1.0 INTRODUCTION

1.1 Study Background

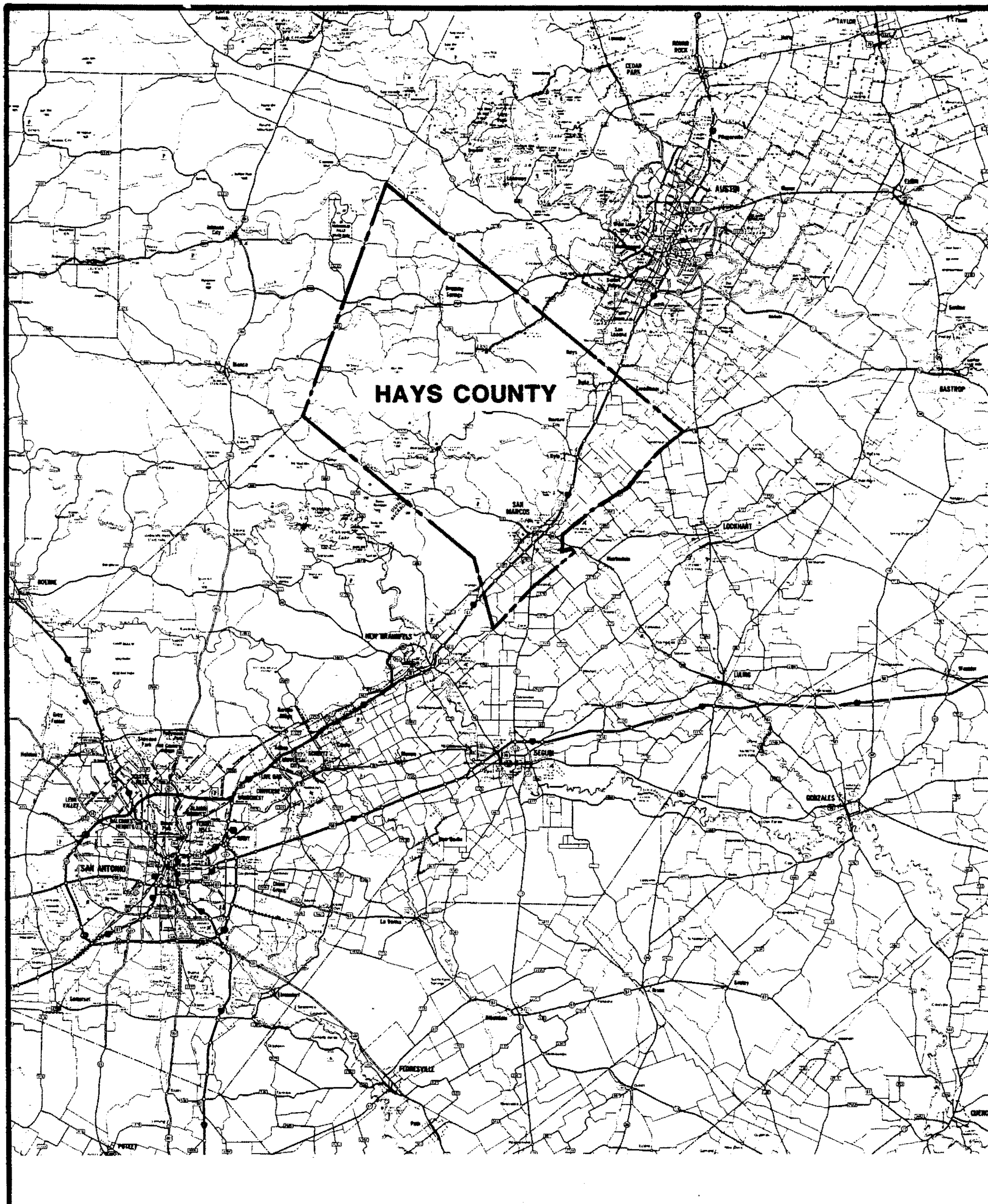
The Hays County Water Development Board (HCWDB) was created in 1986 by its member entities pursuant to the provisions of Article 4413 (32c), Texas Revised Civil Statutes Annotated, for the purpose of developing a County wide plan to provide dependable future water resources and wastewater disposal to protect the water quality of those resources. This concern for the water supply and water quality was generated as a result of the drought in 1984, when many areas in Hays County experienced water shortages, by the planning efforts of the Joint Committee of San Antonio and the Edwards Underground Water District, and by a recognition by local officials in Hays County that a long-range water supply and water quality protection plan is needed to insure the well-being of Hays County in the future.

The HCWDB is an interlocal agency, its members consisting of representatives from the Hays County Commissioners Court; the cities of Buda, Dripping Springs, Hays City, Kyle, Mountain City, Niederwald, San Marcos, and Woodcreek; and Goforth Water Supply Corporation (WSC) and Wimberley WSC, who in turn represent all the rural water supply corporations in Hays County.

The HCWDB subsequently contracted with the Texas Water Development Board to share funding of a regional water supply and wastewater planning study for Hays County. The study has been conducted by HDR Engineering, Inc. under contract with the HCWDB, and this report serves to present its findings.

The purpose of the study was to provide a plan to conserve existing ground water supplies and to guide the implementation of new water resources and wastewater disposal facilities for Hays County. A location map showing Hays County and surrounding regions is presented in Figure 1.1-1.

The process of developing this plan involved many aspects of water supply and water quality planning. First, in order to determine the water and wastewater needs of the County, historic population and water use data were collected for regions of concentrated growth.



LOCATION MAP

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 1.1-1

This was limited to those regions with designated Incorporated and Extraterritorial Jurisdictions (ETJ's) as shown on Figure 1.1-2. Hereafter in this report the service area of the respective entities is referred to as that area's ETJ. Based on the data, population and water demand projections were developed for these ETJ's.

Second, an assessment of the existing ground water supplies was performed, to determine the estimated quantities and expected life or length of duration of these supplies, based on the water demand projections and estimated drought conditions in the aquifers.

Third, a water conservation plan and a drought contingency plan were developed to extend the life of the existing supplies and reduce the costs of new or supplemental water supplies.

Fourth, many new water supply alternatives were identified and evaluated as supplemental sources, when the demands exceed the existing ground water supplies. The alternatives considered include county-wide regional systems and local systems which were planned to serve rapidly developing regions within the County. In all of the alternatives, the needs and concerns of the people, costs, water availability, conservation, and potential environmental impacts were considered.

Fifth, water quality issues were addressed by performing an assessment of the existing wastewater disposal systems and evaluating alternatives for future wastewater disposal and water quality control in the County. A plan for providing these services was developed, taking into consideration the needs and concerns of the people, costs, regulatory requirements, conservation, and potential environmental impacts.

Sixth, the legal and institutional issues relating to the implementation of water supply and wastewater disposal facilities in the County were addressed. A number of organizational structures capable of providing these services were identified and evaluated for providing water supplies and wastewater disposal facilities.

Finally, plans for future water supply and wastewater disposal have been recommended for implementation, and time schedules have been developed. These plans include water conservation, phased construction, cost estimates for debt service, operations and maintenance, and a projected schedule showing required facilities, water demand, and costs.

1.2 Study Area and Existing Ground Water Supplies

Hays County is located in south central Texas between the rapidly growing metropolitan areas of San Antonio and Austin (see Figure 1.1-1). Portions of the County are located in two river basins, and the County overlies three ground water aquifers. Hays County is separated into the Colorado River Basin and the Guadalupe River Basin by a watershed divide which passes in an east-west direction through the center of the County (Figure 1.2-1). In general, the northern portion of the County lies in the Colorado River Basin, and the southern portion lies in the Guadalupe River Basin.

The County currently takes all its water supply from ground water sources. The three aquifers which serve Hays County are the Edwards Aquifer (San Antonio region), the Barton Springs-Edwards Aquifer, and the Trinity Group Aquifer (see Figures 1.2-1 & 1.2-2). Two of the aquifers, the Edwards Aquifer and the Barton Springs-Edwards Aquifer, provide good quality water but are greatly influenced by drought conditions and substantial pumping of ground water inside and outside the County. The Edwards Aquifer is affected significantly by pumpage for municipal use in the San Antonio metropolitan area and by pumpage for irrigation use in Uvalde and Medina Counties. The Barton Springs-Edwards Aquifer is affected by increasing rates of pumpage by residents and businesses located primarily in the Austin metropolitan area.

Large springs located in and to the south of Hays County and in Travis County function as outlets for the Edwards Aquifer and the Barton Springs-Edwards Aquifer and discharge part of the water which enters the aquifers through the recharge zones. The Comal Springs and San Marcos Springs, the largest two springs in Texas, discharge from the Edwards Aquifer (San Antonio region), and Barton Springs, the fourth largest spring in Texas,

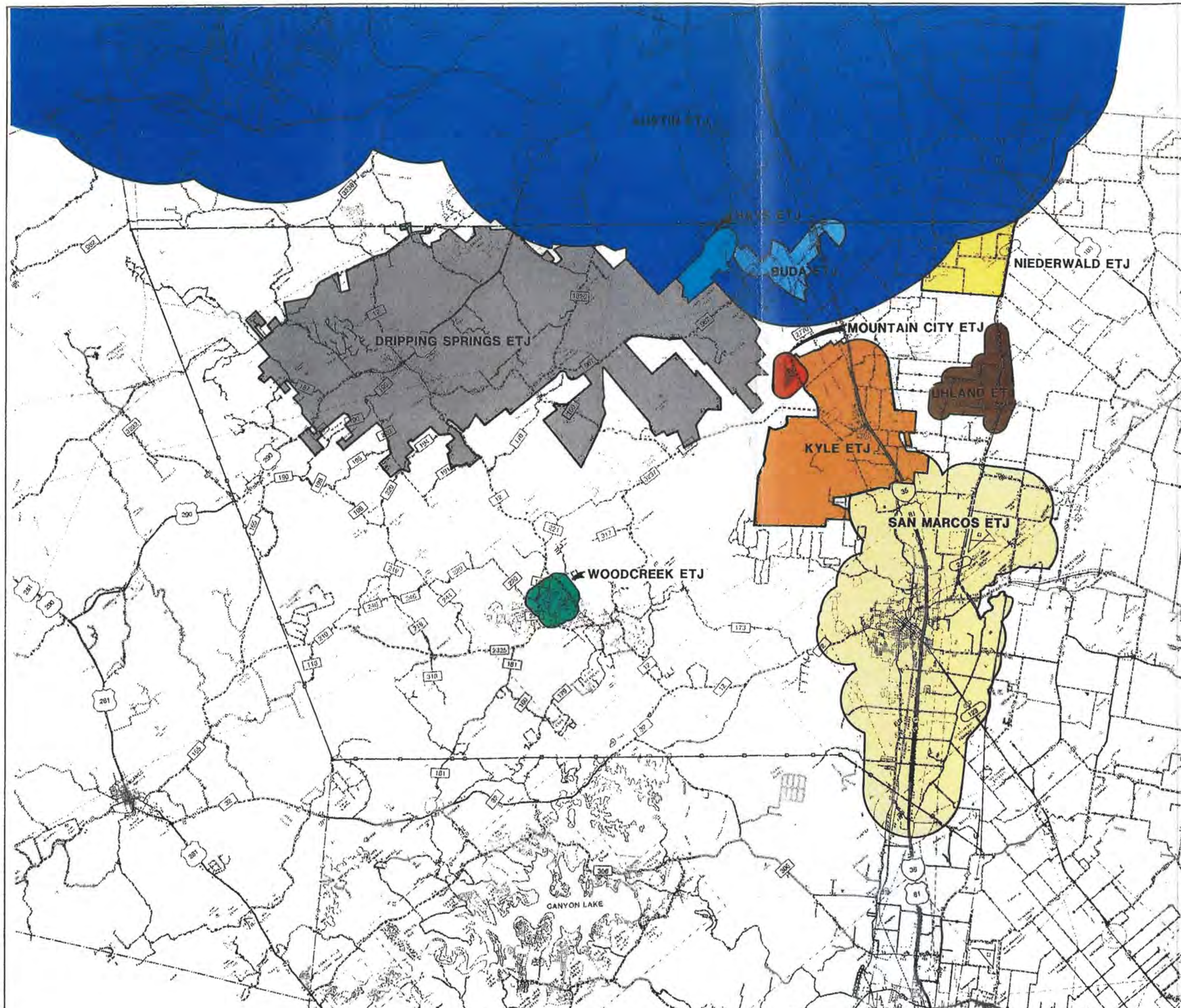


FIGURE 1.1-2

ETJ BOUNDARY MAP

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REGIONAL WATER AND WASTEWATER STUDY

FOR

HAYS COUNTY WATER DEVELOPMENT BOARD

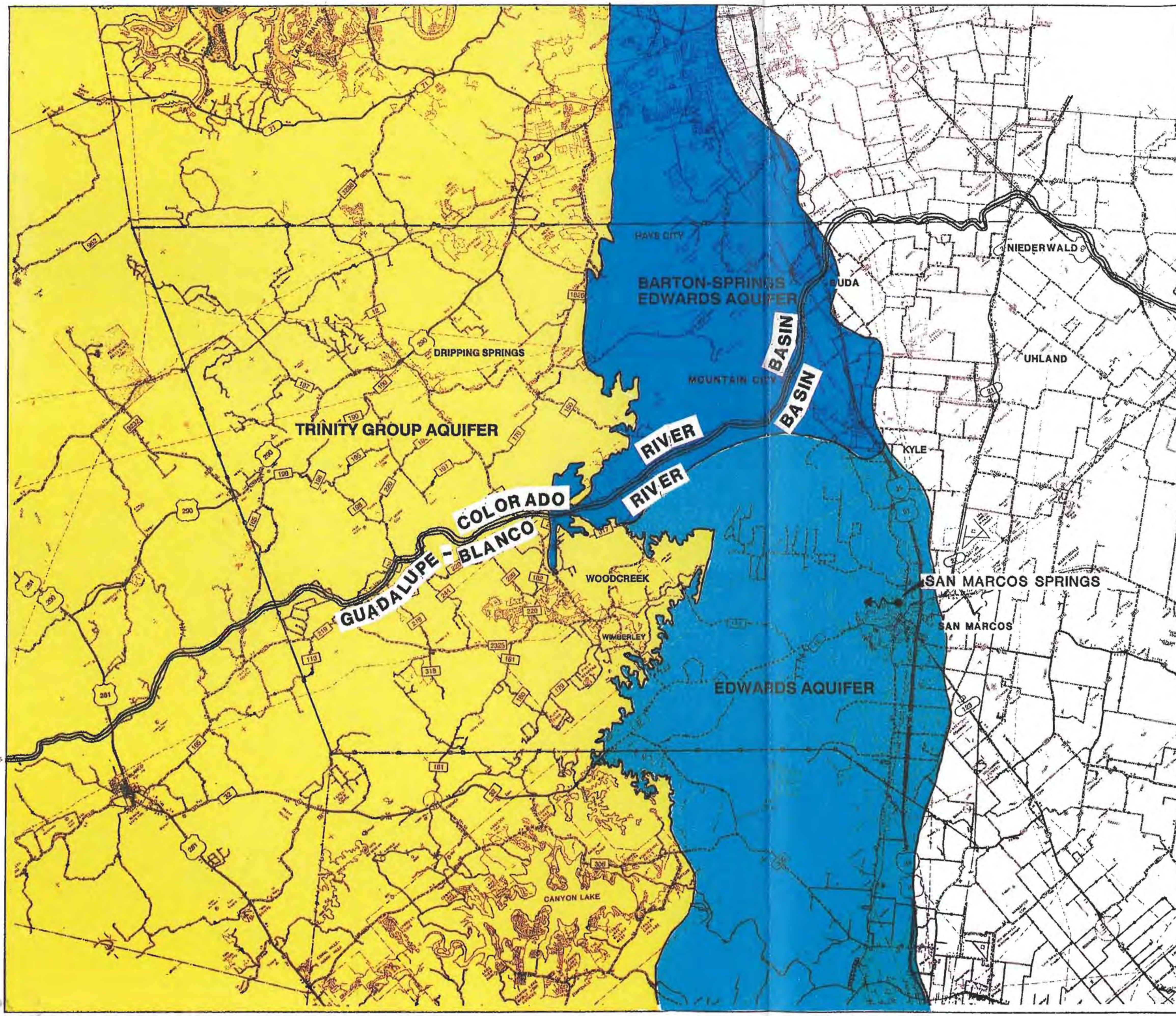

FIGURE 1.2-1

AQUIFER BOUNDARY AND RIVER BASIN MAP

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REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

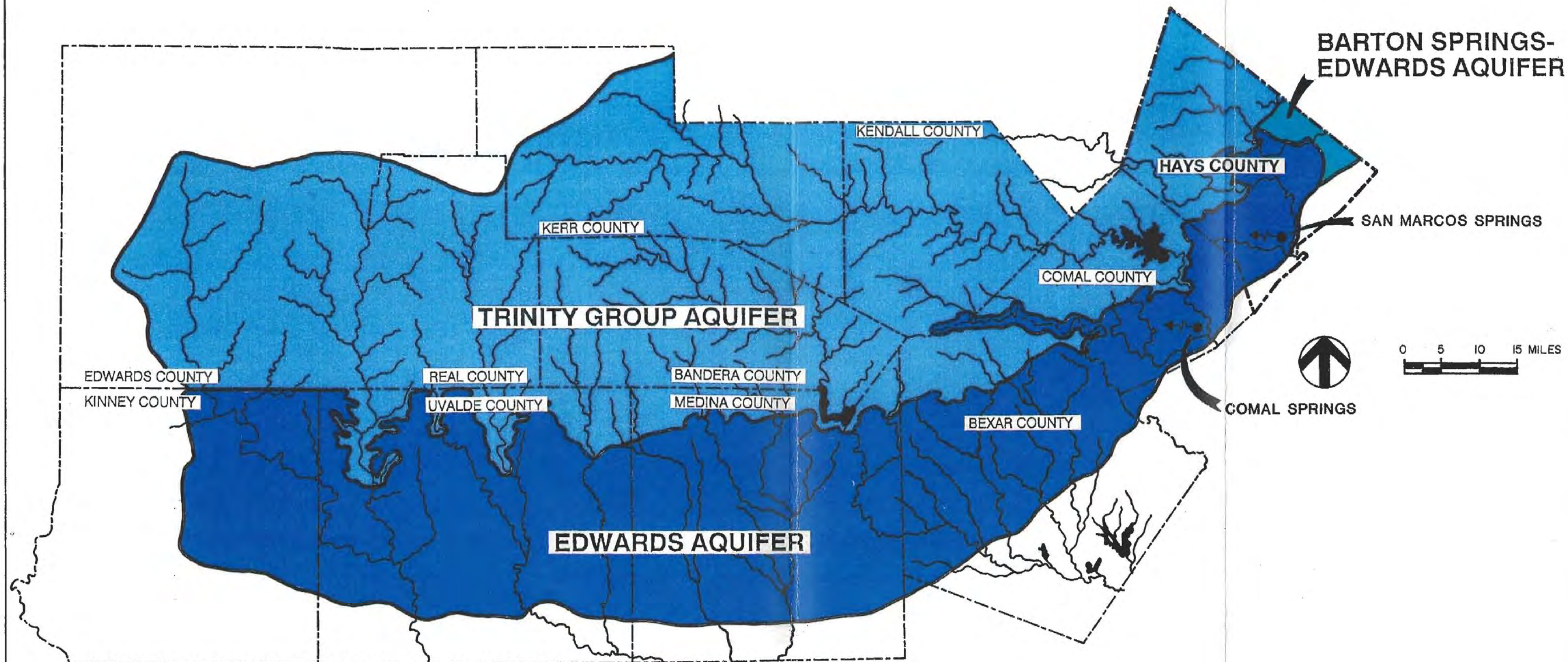

FIGURE 1.2-2

REGIONAL AQUIFER MAP

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REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY
WATER DEVELOPMENT BOARD

discharges from the Barton Springs-Edwards Aquifer. The flows from these springs are sensitive to pumpage and drought conditions. Comal Springs dried up in 1956 during the drought of record, and while neither the San Marcos Springs nor Barton Springs have ever dried up, both flowed at their lowest rates during 1956.

The Trinity Group Aquifer, which serves western Hays County, produces water of extremely variable quality. In particular, very poor quality water has been found in the Dripping Springs area. While the maximum desirable total dissolved solids (TDS) level in water supplies is 500 mg/l, samples from wells located near Dripping Springs have shown TDS ranging up to 3,000 milligrams/liter (mg/l). The Trinity Group Aquifer water in this area is also typically very hard and often is high in sulfates and mineral content. Depending on the recharge rate and population growth, the Trinity Group may yield enough water to supply Wimberley, Woodcreek, and Dripping Springs for 2 to 3 decades. However, the poor water quality and relatively low yield of wells combine to make it an undesirable source to serve the expanding growth in these areas.

The Edwards and Barton Springs-Edwards Aquifers have environmentally sensitive recharge areas, parts of which outcrop in Hays County. Contamination of these ground water supplies by development in the recharge areas is a major concern in the County. The predominant residential waste disposal systems in the County are septic tank and drain field disposal systems, and these systems have been found to be a source of contamination in some areas of the Texas Hill Country, which typically have only a thin layer of soil over outcropping limestone. Another potential source of contamination is located along the eastern boundary or "bad water" line of these aquifers. This "bad water" line is the limit of good quality water in the aquifers and the beginning of water of extremely poor quality. Over-pumpage of the aquifers could result in encroachment of this "bad water" into parts of the aquifer which supply Hays County.

Overpumpage is a real concern due to the growth trends in the County. The growth of Dripping Springs, Buda, Kyle, Hays City, and the northeast part of the County are all being influenced by the expansion of nearby Austin and Travis County.

The southeast portion of the County is being impacted by the growth of the San Marcos area. Western portions of the County have experienced some growth from the Wimberley and Woodcreek resort areas, though it is primarily rural and sparsely populated.

A combination of drought conditions and increased growth of demand in all these areas would further accelerate the shortages, as discussed in detail in the following section.

1.3 Potential Drought and Regional Pumping Impact on Groundwater Supplies

Hays County is located in an area of Texas which experiences average annual rainfall of about 33 inches and an average annual evaporation rate of approximately twice the average rainfall. Recorded annual precipitation amounts are shown in Table 1.3-1. The historic annual rainfall is highly variable, ranging from about 13 inches to near 50 inches. As a result, short duration droughts and long severe droughts have occurred and are likely to occur again in the County, causing well levels to drop significantly. The other major factor which will impact the well levels is the amount of pumpage of the aquifers. The impact of both these factors was evaluated for the three aquifer supplies in Hays County as described in this section and Section 2.0.

1.3.1 Edwards Aquifer

The Edwards Aquifer is unique in several ways when compared to a typical aquifer where water percolates through sands at very slow rates. Dissolution of limestone has created a network of openings --crevices and caverns-- in the Edwards Aquifer through which water can flow. This results in a relatively rapid rate of movement of water in the aquifer, which has been described by some as an underground river. The storage volume in the aquifer

Table 1.3-1

Characteristics of Edwards Aquifer (1934 - 1987)									
	Annual Rainfall (inches)				Discharges*			Change	Year-End
Year	Uvalde	San Antonio	San Marcos	Recharge*	Wells	Springs	Total	in Storage Since 1933*	J-17 Well** Level AMSL
1934	16.42	27.65	35.67	179.6	101.9	336.0	437.9	-258.3	669
1935	41.15	42.93	41.09	1258.2	103.7	415.9	519.6	480.3	680
1936	24.18	34.11	33.48	909.6	112.7	485.5	598.2	791.7	682
1937	17.88	26.07	28.05	400.7	120.2	451.0	571.2	621.2	678
1938	13.62	23.26	28.17	432.7	120.1	437.7	557.8	496.1	674
1939	25.30	18.83	18.59	399.0	118.9	313.9	432.8	462.2	668
1940	27.46	30.79	43.57	308.8	120.1	296.5	416.6	354.5	671
1941	31.52	26.34	48.41	850.7	136.8	464.4	601.2	604.0	677
1942	19.12	38.46	44.65	557.8	144.6	450.1	594.7	567.1	680
1943	19.77	20.51	25.45	273.1	149.1	390.2	539.3	300.9	669
1944	33.00	33.19	47.42	560.9	147.3	420.1	567.4	294.4	670
1945	22.37	30.46	-	527.8	153.3	461.5	614.8	207.4	673
1946	24.91	45.17	52.24	556.1	155.0	428.9	583.9	179.6	680
1947	22.67	17.32	27.53	422.6	167.0	426.5	593.5	8.7	668
1948	18.31	23.64	-	178.3	168.7	281.9	450.6	-263.6	657
1949	34.42	40.81	36.22	508.1	179.4	300.4	479.8	-235.3	664
1950	18.27	19.86	21.10	200.2	193.8	272.9	466.7	-501.8	656
1951	16.06	24.44	30.88	139.9	209.7	215.9	425.6	-787.5	646
1952	18.24	26.24	39.91	275.5	215.4	209.5	424.9	-936.9	645
1953	18.34	17.56	33.39	167.6	229.8	238.5	468.3	-1237.6	646
1954	15.87	13.70	13.42	162.1	246.2	178.1	424.3	-1499.8	637
1955	20.34	18.18	26.44	192.0	261.0	127.8	388.8	-1696.6	626
1956	9.29	14.31	18.37	43.7	321.1	69.8	390.9	-2043.8	626
1957	39.30	48.83	46.51	1142.6	237.3	219.2	456.5	-1357.7	653
1958	39.03	39.69	39.08	1711.2	219.3	398.2	617.5	-264.0	678
1959	31.51	24.50	43.47	690.4	234.5	384.5	619.0	-192.6	675
1960	23.98	29.76	45.48	824.8	227.1	428.3	655.4	-23.2	679
1961	26.26	26.47	30.02	717.1	228.2	455.3	683.5	10.4	676
1962	14.12	23.90	28.47	239.4	267.9	321.1	589.0	-339.2	666
1963	16.70	18.65	19.90	170.7	276.4	239.6	516.0	-684.5	653
1964	22.30	31.88	30.27	413.2	260.2	213.8	474.0	-745.3	653
1965	26.21	36.72	45.00	623.5	256.1	322.8	578.9	-700.7	669
1966	20.87	21.42	27.12	615.2	255.9	315.3	571.2	-656.7	657
1967	20.10	29.09	26.41	466.5	341.3	216.1	557.4	-747.6	660
1968	25.20	30.39	37.13	884.7	251.7	408.3	660.0	-522.9	670
1969	33.33	31.41	36.59	610.5	307.5	351.2	658.7	-571.1	670
1970	13.59	22.74	32.30	661.6	329.4	397.7	727.1	-636.6	663
1971	31.01	31.80	31.10	925.3	406.8	272.7	679.5	-390.8	674
1972	15.49	31.48	31.90	756.4	371.3	375.8	747.1	-381.5	673
1973	30.85	52.28	47.91	1486.5	310.4	527.6	838.0	267.0	690
1974	30.94	37.00	42.42	658.5	377.4	483.8	861.2	64.3	682
1975	24.92	25.67	48.64	973.0	327.8	540.4	868.2	169.1	676
1976	45.62	39.13	47.46	894.1	349.5	503.9	853.4	209.8	693
1977	19.91	29.64	27.69	952.0	380.6	580.3	960.9	200.9	684
1978	18.65	35.99	33.08	502.5	431.8	375.5	807.3	-103.9	679
1979	32.35	36.64	38.74	1117.8	391.5	523.0	914.5	99.4	680
1980	23.05	24.23	29.56	406.4	491.1	328.3	819.4	-313.6	669
1981	28.24	36.37	49.62	1448.4	387.1	407.3	794.4	340.4	679
1982	23.25	22.96	35.29	417.7	453.1	333.3	786.4	-28.3	667
1983	26.81	26.06	36.95	420.1	418.5	301.6	720.1	-328.3	653
1984	17.65	25.95	35.29	197.9	529.8	172.5	702.3	-832.7	648
1985	28.49	40.31	35.29	1003.3	522.5	334.0	856.5	-685.9	673
1986	29.59	42.76	40.50	1153.7	429.1	405.3	834.6	-366.7	685
1987	36.85	37.22	37.94	2003.6	–	–			685

*Thousands of acre-feet per year.

**Located in San Antonio.

Source: Table E-2, Regional Water Resources Plan, Joint Committee on Water Resources of San Antonio City Council and the Edwards Underground Water District Board of Directors, July, 1988.

within the recorded levels is also relatively small when compared to other large aquifers. It is estimated that about 2 million acre-feet is held in storage between the average level and the lowest recorded level for the aquifer. Total aquifer storage has been estimated to be 15 million acre-feet.

Comal Springs (New Braunfels) and San Marcos Springs (San Marcos) are outlets of the aquifer. Flows from these springs are used as barometers to indicate the conditions of the aquifer relative to recharge and withdrawals. The elevations of the Comal and San Marcos Springs are 623 feet and 574 feet msl, respectively.

During the drought of record, 1948-1956, estimated inflows to the Edwards averaged approximately 213,000 acre-feet per year, and the level in the aquifer dropped below 623 feet and dried up the Comal Springs. As recent as 1984, a short, relatively dry period occurred resulting in a significant drop in the flow rate of Comal Springs, from in excess of 200 cubic feet per second (cfs) in February to approximately 27 cfs in mid-July. The water level at index well J-17, located in San Antonio, fell to within 12 feet of the lowest level ever recorded, and within approximately one foot of the elevation of Comal Springs. The Comal Springs could have dried up during the 1984 drought had the severe weather conditions and pumping lasted a few months longer. Although the San Marcos Springs have not yet dried up under historic drought conditions, if the aquifer level were drawn to an elevation below the San Marcos Springs, there would be no spring flow. Once this stored water is withdrawn, it could take years to replenish the storage volume sufficiently to resume spring flow, assuming pumping continues along present trends.

In addition to the economic and recreational benefits provided to Hays County by the springs, the San Marcos Springs and Comal Springs have historically provided an average of about 31% of the combined Guadalupe and San Marcos River flows below the San Marcos River confluence and about 25% of the Guadalupe River flow near Victoria. During the 1948-1956 drought period, the springs provided an average of 48% of the flow of the Guadalupe and San Marcos Rivers below the confluence of the San Marcos River. The springs provided as much as 76% of total flow in 1954 and over 60% in 5 of 9 years of the drought. Therefore, it is concluded that the San Marcos Springs as well as Comal Springs are vital in maintaining river flows in the Guadalupe River downstream of the spring flow entrances to the river.

Regional pumping from the Edwards Aquifer has been well documented and index wells have been identified. Table 1.3-1 shows an annual summary of precipitation, recharge, discharge from wells and springs, changes in storage in the Edwards Aquifer, and the end of the year level recorded in index well J-17, in San Antonio, for the 1934-1986 period. The table shows long-term annual trends but does not include detailed data for short duration time increments.

Assuming a recurrence of the 1950's drought, storage in the aquifer of 3 million acre-feet above the San Marcos Springs, and the historic average annual rate of withdrawal of 450,000 acre-feet of water, it is calculated from the data in Table 1.3-1 that Comal Springs would cease flowing in 4 to 5 years and the San Marcos Springs would be dried up in 7 to 8 years. This is approximate, since it is based on annual data and since the total amount of storage is not known. It does point out, however, that water shortages could occur within a few years under drought conditions, or under increased pumping conditions. Much more rapid dry up of the Comal Springs could have occurred in 1984 had the severe dry conditions and pumping lasted a few months longer. Withdrawals from the Edwards have been increasing rapidly in recent times and have more than doubled from 1960 to 1984. In 1984, annual pumpage from the Edwards was 530,000 acre-feet, the maximum of record.

Pumping to the extent to cause the San Marcos Springs to cease flowing would cause water levels in wells in the Edwards Aquifer to be lowered. This would result in increased pumping costs and the probability of having to redrill many wells and lower pumps. Because the largest withdrawals will occur in the San Antonio area and further west, the hydraulic gradient in the Edwards Aquifer would probably change so it slopes toward the southwest from the San Marcos area, once the springs stopped flowing. This could result in the decline of water quality in the aquifer near San Marcos and possibly drying up the areas along the northern edge of the recharge zone in Hays County.

1.3.2 Barton Springs-Edwards Aquifer

A 1986 report by the U.S. Geological Survey, titled "Hydrology and Water Quality of the Edwards Aquifer associated with Barton Springs in the Austin Area, Texas" shows that the Barton Springs-Edwards Aquifer provided good quality water for about 30,000 people in 1985. The City of Austin has predicted that about 86,000 more people will be living in the aquifer area by year 2000 and many of these will be supplied from the aquifer. During periods of high ground water levels, pumping does not significantly affect the water level in the aquifer nor the Barton Springs flow. During dry conditions when ground water levels recede, pumpage effects will lower the water level in the aquifer, reduce spring flow, and possibly cause subsurface recharge from the poor quality sources within the Trinity Group and Edwards "bad water" zones. The pumpage from the aquifer should be held to withdrawal rates which will not dry up the Barton Springs. The USGS report indicates that the historic minimum and maximum flows for Barton Springs are 10 cfs and 166 cfs, respectively. Based on a monthly mean flow-duration curve, a flow of 25 cfs or greater occurs 80 percent of the time. Below this flow, the curve flattens off significantly indicating that 10 cfs is close to a base (minimum) flow for the aquifer.

In a 1985 USGS report titled "Simulation of the Flow System of Barton Springs and Associated Edwards Aquifer in the Austin Area, Texas", an analysis of the aquifer was performed for the year 2000 projected pumpage for the Austin area. The results indicated that in the eastern area of the aquifer, declines would vary from zero near Barton Springs to more than 100 feet near Kyle. In the western area, the aquifer would be dewatered. It was considered that these declines were minimum values for the projected pumpage because it did not include pumpage from the Edwards Aquifer nor Trinity Group outside the Barton Springs-Edwards Aquifer.

The impact of projected pumpage is significant, and close monitoring of water levels, pumpage, and spring flows will be necessary to determine the impact of the growth and pumpage in the aquifer system.

1.3.3 Trinity Group Aquifer

The major areas in Hays County using the Trinity Group Aquifer for supply are Dripping Springs, Wimberley, and Woodcreek. According to the 1987 Texas Water Development Board Report LP-205, titled "Ground Water Conditions of the Trinity Group Aquifer in Western Hays County", the water levels in the wells in this area have remained essentially stable for a number of years. However, recent reports from well drillers indicate declining water levels. The quality of the water in the three aquifers forming the Trinity, including the Lower, Middle and Upper Trinity Aquifers, is extremely variable, and it is projected that increased pumpage will cause leakage from regions with low quality water into the higher quality water regions. This is of great concern because the water quality in some regions precludes the use of water for public supply unless treated by a demineralizer process. The report recommended using monitoring well networks to evaluate the availability of ground water to meet projected growth.

In the 1985 Water and Wastewater Master Plan report for the City of Dripping Springs and surrounding area, it was estimated that the ground water supply from the Trinity Aquifer could support approximately 21,500 people with marginal quality drinking water. Based on population projections in the 1985 report, these ground water supplies could be exceeded by the year 2002.

Investigations by the Texas Department of Water Resources (TDWR) (predecessor of the TWDB) indicated that some of the recharge to the Trinity emerges as streamflow to rivers which recharge the Edwards Aquifer. Therefore, overpumpage of the Trinity will actually reduce the recharge to the Edwards Aquifer.

1.4 Recommended Level of Ground Water Withdrawal

1.4.1 Regional Planning for Edwards Aquifer

In September 1988, the Joint Committee on Water Resources of the San Antonio City Council and the Edwards Underground Water District proposed a ground water management plan for the Edwards Aquifer. The plan includes a goal of maintaining the average annual withdrawal from the aquifer at or below 450,000 acre-feet, which is 75% of the average annual recharge of 608,000 acre-feet.

In addition, the systematic retirement of ground water rights through purchase from willing sellers, the reduction of pumping rights by development of new water resources, and creation of a program of water rights transfers is proposed. Another major component of the plan is the development of new surface water sources to supplement the ground water supplies and a water conservation plan to conserve existing supplies and reduce the cost of new surface water supplies.

In conjunction with the ground water management plan, a drought management plan has also been prepared by the Joint Committee containing the following goals:

* Protect human health and safety;
* Protect water quality in the Edwards Aquifer;
* Share the impact of hardships caused by drought;
* Minimize disruption of the economic interest of the region, including the agricultural sector, so that employment and jobs are protected;
* Minimize the length of time Comal Springs will be dry in order to protect downstream water rights and preserve economic opportunities; and
* Prevent San Marcos Springs from going dry in order to protect downstream rights, maintain the aquatic ecosystem, and preserve economic opportunities.

The goals listed above are consistent with the goals of the HCWDB pertaining to the Edwards Aquifer. The HCWDB should cooperate with and assist the Joint Committee when appropriate in accomplishing these goals.

The plan is currently being presented to the public, and it is scheduled to go to the Texas Legislature in 1989, to create a vehicle for the implementation of the plan.

1.4.2 Hays County

Two primary factors were considered in determining the recommended level of ground water withdrawal for Hays County. The first factor was the Joint Committee's proposed goal not to exceed an average annual withdral rate of 450,000 acre-feet from the Edwards Aquifer. It was considered important to work closely with the Joint Committee's plan to conserve the supply and quality of the Edwards Aquifer. The second factor was the regional impacts of drought and pumpage in Hays County.

In 1984, Hays County and the surrounding region experienced a moderate drought. The San Marcos Springs, which has an average flow of 166 cfs, produced a mean monthly discharge of 73 cfs in September, 1984, which is the lowest since the 1956 drought. Barton Springs which averages 50 cfs, produced a mean monthly discharge of 25 cfs in September, 1984, which is the fifth lowest since the 1956 drought and which is exceeded about 80% of the time. The average annual pumpage from the Edwards Aquifer that year reached a high of 529,800 acre-feet. Shortages were experienced in Hays County making it necessary to lower some wells due to the lowered water levels in the aquifer.

Based on these factors, it is recommended that the 1984 conditions for pumpage in Hays County be used for developing an allowable ground water withdrawal rate which would not produce long-term shortages in the aquifer under moderate drought conditions. The following factors were considered in selecting the 1984 pumping rate as the allowable ground water withdrawal rate for Hays County:

1. The annual average withdrawal from the Edwards Aquifer in 1984 reached 529,800 acre-feet, which is in excess of the Joint Committee's recommendation of 450,000 acre feet per year;

2. The impact of the 1984 drought in Hays County was significant, but did not severely deplete the base flow of the Guadalupe River or lower the Barton Springs-Edwards to the level which would dry up the springs;

3. Even though the drought continued for less than a year, significant impacts occurred because of increases in pumpage. The probability of these conditions occurring again is considered very high, and as the growth in pumpage increases, the effects of a similar drought will become more severe; and

4. In the event of a recurrence of the drought of the 1950's, it would be necessary to curtail the pumping rates to levels below that experienced in 1984 in order to meet the goals of the Joint Committee for the Edwards Aquifer.

1.5 The Need for New Water Sources

1.5.1 Edwards Aquifer

The Edwards Aquifer currently provides water for over 1 million people. Projections by the San Antonio/Edwards Underground Water District Joint Committee estimate the population to be supplied by the aquifer will reach 1.36 million persons in the year 1990, 1.64 million in 2000, and 1.95 million in 2010. The projected average annual demand on the aquifer for the year 1990 is 450,000 acre-feet, which when combined with the Joint Committee's goal for a minimum spring flow of 150,000 acre-feet per year, totals 600,000 acre-feet (the approximate annual recharge of the aquifer). Therefore, after the year 1990, the average annual demand on the aquifer is projected to exceed the average annual recharge.

Assuming the Edwards Aquifer is completely recharged and if the drought of the 1950's were to recur beginning in 1988, concurrent with an annual demand of 450,000 acre-feet, it is estimated that San Marcos Springs could dry up within 7 to 8 years, and Comal springs could dry up in 4 to 5 years. Much more rapid dry up of the Comal Springs could have occurred during the 1984 drought if the severe conditions had lasted a few months longer. This emphasizes that planning for future growth should start immediately to preserve Comal Springs and San Marcos Springs. Implementation of a drought contingency plan with conservation practices should be an early step in planning in order to reduce overall demands for water. However, it is clear that drought contingencies and conservation are not sufficient by themselves to meet the goals of Hays County and the Joint Committee, and surface water sources will be required. The timing and sizing of the new sources are dependent on growth. Based on the projections developed in this study, new sources should be on line by 1995 for all service areas which pump from the Edwards Aquifer. The potential sources and projects are presented in Section 3 of this report.

1.5.2 Barton Springs-Edwards Aquifer

During dry periods when pumping exceeds recharge, the flow from Barton Springs in Zilker Park is materially reduced. The spring flow is quite sensitive to precipitation and pumpage from the aquifer. In the face of projections for rapid increase in population in the area over the aquifer, the annual withdrawals should be managed to assure that the spring flow is maintained and water quality of the aquifer is protected. Based on the projections developed in this study, surface supplies should be on-line by 1995 for the Hays City and Buda areas. Northeast Hays County, which includes Plum Creek, Goforth, and County Line Water Supply Corporations, is projected to need new water supplies by 2005. See Section 3 of this report for a description of the plans to meet these needs.

1.5.3 Trinity Group Aquifer

Water quality of the Trinity Group is variable and a large portion of the water pumped from the aquifer is unsuitable for drinking purposes. Most wells in the Trinity have low yields for municipal service purposes, as evidenced by the experience of Dripping Springs, Woodcreek, and Wimberley, which are in the western area of the County.

Based on projections developed in this study, additional supplies of water will be required from other water sources by the year 1995. See Section 3 of this report for a description of the alternatives identified and the recommended plans to meet the water supply needs of Western Hays County.

SECTION 2
PROJECTIONS, WATER SOURCES AND EXISTING SYSTEMS

2.0 PROJECTIONS, WATER SOURCES AND EXISTING SYSTEMS

2.1 Population Projections

Hays County has experienced substantial growth in the past few decades. From 1970 to 1980, the population of Hays County increased from 27,642 to 40,594, an increase of 47%. The current population is estimated to be 67,473, a 66% increase over 1980. Table 2.1-1 shows the historic County population from 1900 to 1988 along with the average annual growth rate. The growth rate prior to 1960 was generally less than 1.5% per year. However, since 1960 the average growth rate has exceeded 3.0% per year and during the 1980's averaged in excess of 6.0%. Factors contributing to the rapid increase include the expansion of nearby Austin, the growth of smaller urban areas such as San Marcos, Kyle, and Dripping Springs, and the growth of retirement communities such as Wimberley and Woodcreek.

Table 2.1-1

Hays County Historical Population Growth

Year	Population	Average Annual Growth Rate
1900	11,142	
1910	15,158	3.1%
1920	15,920	0.5%
1930	14,915	-0.6%
1940	15,349	0.3%
1950	17,840	1.5%
1960	19,934	1.1%
1970	27,642	3.3%
1980	40,594	3.9%
1988*	66,473	6.4%

*Estimated

Population projections for this study were generated for individual areas within Hays County, which were identified as the major growth centers in the County. Table 2.1-2 lists each area along with their corresponding population projections. The sum of these individual

Table 2.1-2

Hays County Population Projections						
CITY OR REGION	1990	2000	2010	2020	2030	2040
Hays County	70,427	98,790	126,831	159,586	200,051	250,801
Colorado R. Basin	13,523	20,417	27,816	37,871	52,232	72,965
Guadalupe-Blanco R. Basin	56,904	78,374	99,016	121,715	147,820	177,837
Edwards Aquifer	52,341	72,869	92,115	113,236	137,238	165,449
Trinity Group Aquifer	18,086	25,921	34,716	46,350	62,813	85,352
San Marcos ETJ	35,400	50,700	63,350	76,000	88,650	101,300
Kyle ETJ	5,129	7,592	11,238	16,634	24,623	36,448
Dripping Springs ETJ	6,314	12,120	18,385	27,215	40,284	59,630
Buda ETJ	1,930	2,260	2,580	2,910	3,240	3,562
Hays City ETJ	633	857	1,080	1,303	1,527	1,750
Woodcreek ETJ	1,004	1,349	1,813	2,436	3,274	4,400
Uhland ETJ	213	320	446	584	766	1,004
Mountain City ETJ	400	490	590	720	860	1,040
Wimberley WSC	3,276	4,176	5,376	6,600	8,100	9,000
Goforth WSC	3,746	4,873	6,000	7,000	8,000	9,000
Plum Creek WSC	3,224	3,861	4,624	5,537	6,630	7,940
County Line WSC	834	997	1,192	1,425	1,703	2,036
Rural Area, Other WSC	8,325	9,196	10,158	11,221	12,395	13,691
Outside Hays Co.	17,227	23,006	30,918	41,778	56,715	77,297
Hays Co. including Outside	87,564	121,796	157,749	201,364	256,766	328,098

projections was computed, resulting in the projections for Hays County. Population projections for Hays County were categorized by river basin (i.e., Colorado or Guadalupe-Blanco River Basin), and also by aquifer system, (i.e. Edwards, Barton Springs-Edwards, or Trinity Group Aquifers). Population projections were also made for areas outside Hays County to which Hays County water is exported. These areas are located near the eastern boundaries of Hays County, generally consisting of water supply corporations having well fields in the Edwards and Barton Springs-Edwards Aquifers in Hays County.

Table 2.1-2 shows that over 50% of the existing population of the County is located in the San Marcos area, while Kyle and its ETJ and Dripping Springs together with its ETJ account for 7% and 9%, respectively. The rural area of Hays County is estimated to contain almost 12% of the County's population and the rest of the County's population is centered in the Buda/Hays City area (4%), the Wimberley/Woodcreek area (6%), Mountain City (1%), and northeast Hays County (11%). The population of Hays County is expected to more than double by the year 2020, and more than triple by the year 2040. Most of the growth in Hays County will occur in the San Marcos, Kyle, and Dripping Springs areas. For example, in the year 2040, San Marcos is projected to account for 40% of the County's population while Kyle and its ETJ and Dripping Springs and its ETJ are projected to expand their portions to 15% and 24%, respectively. The rural area's share of the County's population is projected to decrease to 5%, while the other areas will account for the remaining 16%.

Several sources were utilized to arrive at the population projections listed in Table 2.1-2. Many cities and municipalities in Hays County have population projections from previous individual reports. Many of these previous projections were adopted, some with minor modifications, into this report. For other areas of the County, data from the Texas Department of Health, U.S. Census Bureau, Texas A&M University Department of Rural Sociology, Edwards Aquifer Research and Data Center (EARDC), and Capital Area Planning Council (CAPCO) were utilized to develop projections.

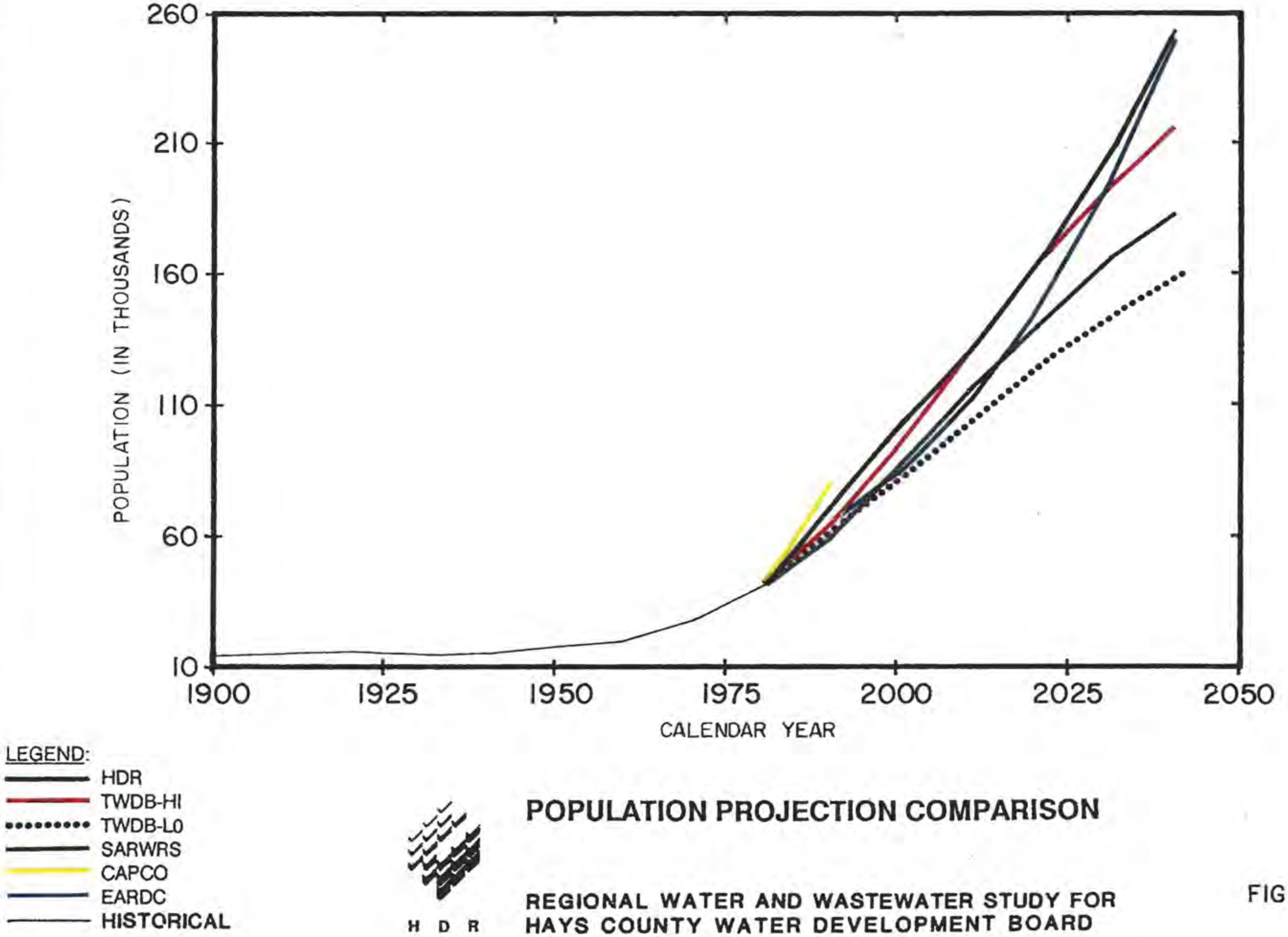
Other agencies and studies have produced population projections for Hays County. Among these are the Texas Water Development Board (TWDB) and the San Antonio Regional Water Resource Study (SARWRS). A comparison of these projections along with those computed or assembled by HDR for use in this study are listed in Table 2.1-3 and shown graphically in Figure 2.1-1. The Texas Water Development Board and the San Antonio Regional Water Resource Study projections for Hays County are lower than the projections computed by HDR. However, the population projections for 1990 by the TWDB and the SARWRS are lower than current estimates of the existing population in Hays County. The Texas A & M University Department of Rural Sociology estimates that the population of Hays County in 1986 was 65,358, and CAPCO estimates the existing population to be 69,299. Both of these estimates exceed the 1990 projected population by the TWDB and SARWRS and could explain the overall differences in the projections. For this study, HDR estimates that the existing (1988) population of Hays County is 66,473.

Table 2.1-3

Hays County Population Projection Comparison

Year	HDR Projection	TWDB Projection[1] Low	TWDB Projection[1] High	SARWRS[2] Projection	CAPCO[3] Projection	EARDC[4] Projection
1990	71,364	60,661	63,244	58,527	79,311	64,120
2000	100,314	80,771	93,047	84,410		84,062
2010	129,270	102,160	128,276	113,169		110,207
2020	162,587	123,215	161,006	139,169		144,484
2030	202,785	141,402	190,906	163,114		189,421
2040	253,036	157,328	215,942	181,561		248,335

[1]Texas Water Development Board Projections - February, 1986
[2]San Antonio Regional Water Resource Study - April, 1986
[3]Capital Area Planning Council, Growth Trends Report #5 - April, 1988
[4]Edwards Aquifer Research and Data Center - January, 1988



HDR

POPULATION PROJECTION COMPARISON

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 2.1-1

2.2 Water Demand Projections

Water demand projections were developed for each area of the County by using individual system demands, along with the population projections discussed in Section 2.1. The average daily water demand for Hays County is approximately 150 gpcd (gallons per capita per day). However, average day demands vary throughout the County from 90 gpcd to 220 gpcd. Maximum day demands (i.e. the most water used on any one day, which generally occurs in the late summer) also vary in the County from 1.5 times the average day demand (i.e. total annual use divided by 365 days) to 4.1 times the average day demand. Table 2.2-1 lists the individual system information.

Table 2.2-1

Hays County Water Demands

Area or City	1988 Population	Average Water Demand (gpcd)	Maximum Day Factor
San Marcos ETJ	34,400	180	1.5
Kyle ETJ	4,742	140	1.9
Dripping Springs	4,774	140	1.9
Buda ETJ	1,865	110	2.2
Woodcreek ETJ	946	220	2.2
Uhland ETJ	201	100	1.8
Mountain City ETJ	325	160	4.1
Wimberley WSC	3,036	115	2.2
Goforth WSC	3,520	105	2.5
Plum Creek WSC	3,110	90	1.8
County line WSC	805	100	1.8

Notes: 1988 population includes ETJ

Texas Department of Health data were the primary source used to determine existing water use data. The Texas Department of Health provided annual surveys of the County's water supply systems and also provided daily and monthly pumpage data for some systems. The most recent surveys and pumpage data were used as a starting point to project water demands for each system. Future water demands were determined by multiplying the average per capita water demand by the corresponding future population for each area. A summary of projected water demands is shown in Table 2.2-2.

As stated in Section 1.4.2, 1984 pumping rates were used as the maximum allowable demand on ground water resources for the purpose of computing future water requirements from other sources. The 1984 water demands were estimated for each community or area in Hays County based upon available data from the Texas Department of Health and the Edwards Underground Water District. A summary of 1984 demand estimates is listed in Table 2.2-3.

Future additional water requirements from new sources were computed for each city or area in Hays County. Additional water required is defined as the difference between the projected water demand (Table 2.1-2) and the existing water available (equivalent to demands as listed in Table 2.2-3). Additional water requirements for Hays County and individual areas are presented in Table 2.2-4. Figure 2.2-1 shows additional requirements for all of Hays County as well as water available from existing supplies. Figures 2.2-2 through 2.2-4 show existing supplies and additional requirements for each individual city or area.

In the year 2000, Hays County is projected to have an average day water demand of 17.85 mgd. This would require an additional 5.25 mgd over what is currently available. To satisfy the projected 2040 average day water demand of 42.86 mgd, the County will require an additional 30.04 mgd.

Presently over 50% of the Hays County's water demand is located in the San Marcos area, while the Kyle ETJ and the Dripping Springs ETJ account for 6% and 7%, respectively. The rural area of Hays County is estimated to have 10% of the County's existing water demand and the rest of the County's water demand is generated by smaller cities such as Buda, Hays City, Mountain City, the Wimberley/Woodcreek area, and rural water supply corporations. By the year 2040, the San Marcos area is projected to account for 43% of the County's water demand while the Kyle ETJ and the Dripping Springs ETJ are projected to expand their shares to 11% and 20%, respectively. And, although the rural area's

Table 2.2-2

Hays County Water Demand Projections (MGD)												
	1990		2000		2010		2020		2030		2040	
City or Region	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day
Hays County	12.85	21.86	17.85	30.26	22.78	38.58	28.21	48.20	34.80	59.92	42.86	74.47
Colorado R. Basin	1.86	3.84	2.83	5.73	3.85	7.76	5.25	10.52	7.25	14.45	10.15	20.12
Guadalupe-Blanco R. Basin	10.99	18.01	15.03	24.52	18.85	30.81	22.96	37.67	27.55	45.47	32.71	54.35
Edwards Aquifer	10.25	16.59	14.14	22.79	17.74	28.63	21.59	34.96	25.84	42.05	30.66	50.26
Trinity Group Aquifer	2.61	5.27	3.72	7.47	4.96	9.95	6.62	13.23	8.96	17.87	12.20	24.22
San Marcos ETJ	6.36	9.55	9.14	13.70	11.41	17.09	13.68	20.51	15.95	23.93	18.24	27.35
Kyle ETJ	0.71	1.37	1.07	2.05	1.57	3.02	2.33	4.47	3.45	6.62	5.10	9.80
Dripping Springs ETJ	0.87	1.70	1.71	3.28	2.58	4.97	3.81	7.35	5.63	10.88	8.35	16.11
Buda ETJ	0.21	0.46	0.25	0.56	0.28	0.62	0.32	0.70	0.36	0.78	0.39	0.86
Hays City ETJ	0.07	0.13	0.09	0.20	0.12	0.24	0.14	0.29	0.17	0.34	0.19	0.39
Woodcreek ETJ	0.22	0.49	0.30	0.65	0.40	0.88	0.54	1.18	0.72	1.58	0.97	2.13
Uhland ETJ	0.02	0.03	0.03	0.06	0.04	0.08	0.06	0.11	0.08	0.14	0.10	0.18
Mountain City ETJ	0.06	0.25	0.08	0.31	0.09	0.38	0.12	0.46	0.14	0.55	0.17	0.67
Wimberley WSC	0.38	0.82	0.48	1.07	0.62	1.36	0.76	1.67	0.93	2.05	1.04	2.28
Goforth WSC	0.43	1.07	0.47	1.17	0.63	1.55	0.74	1.81	0.84	2.07	0.95	2.32
Plum Creek WSC	0.29	0.52	0.35	0.65	0.42	0.77	0.50	0.92	0.60	1.10	0.71	1.31
County Line WSC	0.08	0.14	0.10	0.18	0.12	0.22	0.14	0.26	0.17	0.30	0.20	0.36
Rural Area, other WSC	1.25	2.49	1.39	2.77	1.52	3.05	1.68	3.37	1.86	3.72	2.05	4.11
Industrial	1.90	2.85	2.40	3.60	2.90	4.35	3.40	5.10	3.90	5.85	4.40	6.60
Outside Hays Co.	1.77	3.54	2.36	4.71	3.16	6.31	4.25	8.50	5.75	11.50	7.82	15.64
Hays Co. including Outside	14.62	25.40	20.21	34.98	25.86	44.90	32.46	56.70	40.55	71.42	50.68	90.11

Note: Water demand projections do not include water conservation

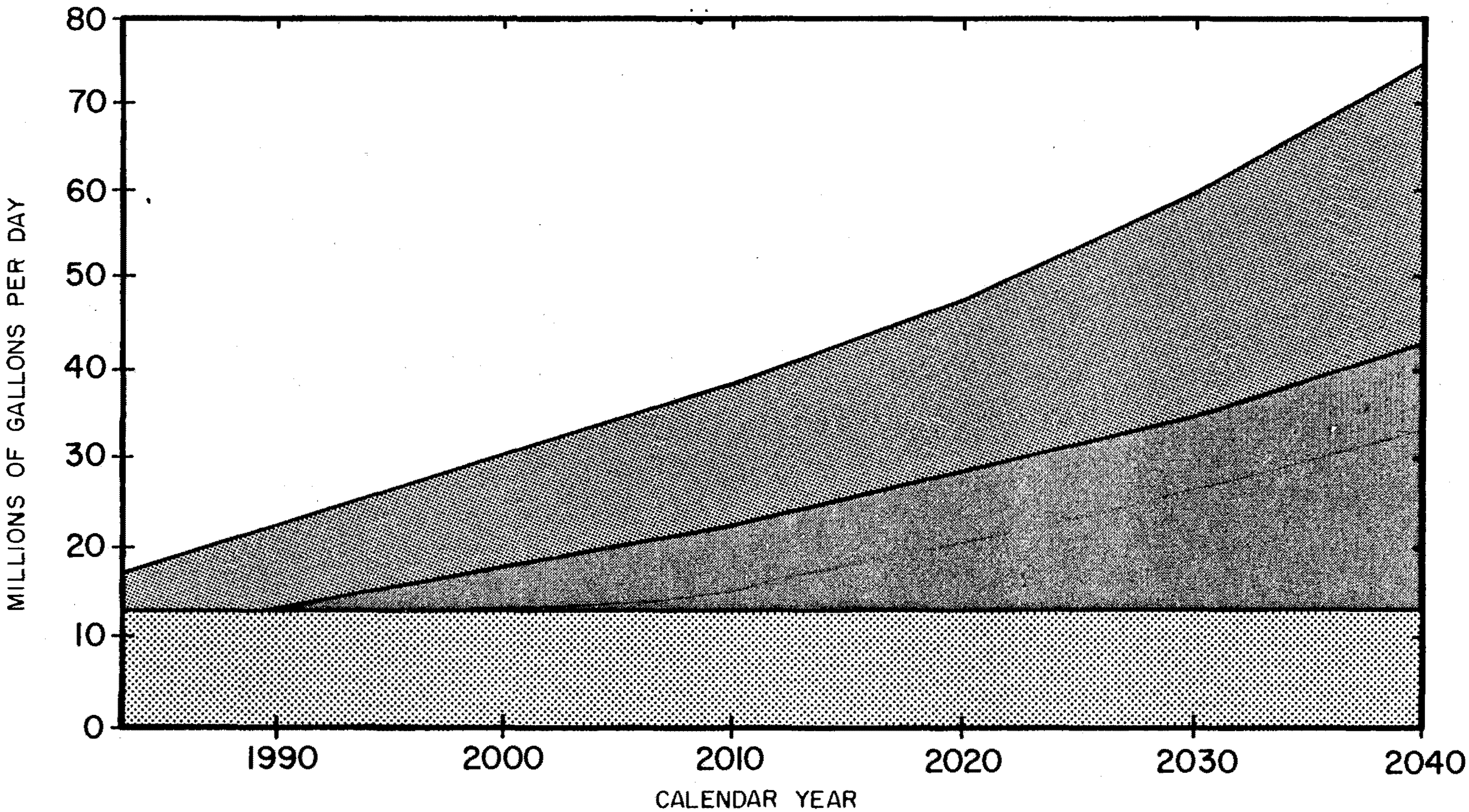
Table 2.2-3

Water Demand Estimates for 1984	
Area or City	Water Demand (mgd)
San Marcos ETJ	7.03
Kyle ETJ	0.74
Dripping Springs ETJ	0.61
Buda ETJ	0.24
Hays City ETJ	0.07
Woodcreek ETJ	0.29
Uhland	0.03
Mountain City ETJ	0.05
Wimberley WSC	0.40
Goforth WSC	0.43
Plum Creek WSC	0.33
County Line WSC	0.10
Rural Area	1.44
Industrial	0.90
Outside Hays County	1.94
Total	14.60

Table 2.2-4

Additional Water Requirements for Hays County (MGD)

	1990		2000		2010		2020		2030		2040	
City or Region	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day	Avg Day	Max Day
Hays County	1.28	9.31	5.22	17.52	10.02	25.92	15.56	35.55	22.16	47.26	30.19	61.81
San Marcos ETJ	0.00	2.53	2.10	6.66	4.37	10.07	6.65	13.49	8.93	16.91	11.20	20.32
Kyle ETJ	0.00	0.64	0.32	1.30	0.83	2.28	1.59	3.73	2.71	5.88	4.36	9.06
Dripping Springs	0.27	1.10	1.09	2.66	1.96	4.36	3.20	6.74	5.03	10.27	7.74	15.50
Buda ETJ	0.00	0.22	0.01	0.32	0.04	0.38	0.08	0.46	0.12	0.54	0.15	0.62
Hays City ETJ	0.00	0.07	0.02	0.12	0.05	0.17	0.07	0.22	0.10	0.27	0.12	0.32
Woodcreek ETJ	0.00	0.20	0.01	0.36	0.11	0.59	0.25	0.89	0.43	1.29	0.68	1.84
Uhland ETJ	0.00	0.01	0.00	0.03	0.01	0.05	0.03	0.08	0.05	0.11	0.07	0.15
Mountain City ETJ	0.01	0.21	0.03	0.26	0.04	0.33	0.07	0.41	0.09	0.50	0.12	0.62
Wimberley WSC	0.00	0.43	0.08	0.66	0.22	0.96	0.36	1.27	0.53	1.65	0.64	1.88
Goforth WSC	0.00	0.64	0.04	0.74	0.20	1.12	0.31	1.38	0.41	1.64	0.52	1.89
Plum Creek WSC	0.00	0.20	0.02	0.31	0.09	0.44	0.17	0.59	0.27	0.77	0.38	0.98
County Line WSC	0.00	0.05	0.00	0.08	0.02	0.11	0.04	0.16	0.07	0.20	0.10	0.26
Rural Area	0.00	1.06	0.00	1.32	0.08	1.61	0.24	1.93	0.42	2.28	0.61	2.67
Industrial	1.00	1.95	1.50	2.70	2.00	3.45	2.50	4.20	3.00	4.95	3.50	5.70



LEGEND:

- MAXIMUM DAY REQUIRED
- AVERAGE DAY REQUIRED
- TOTAL GROUND WATER

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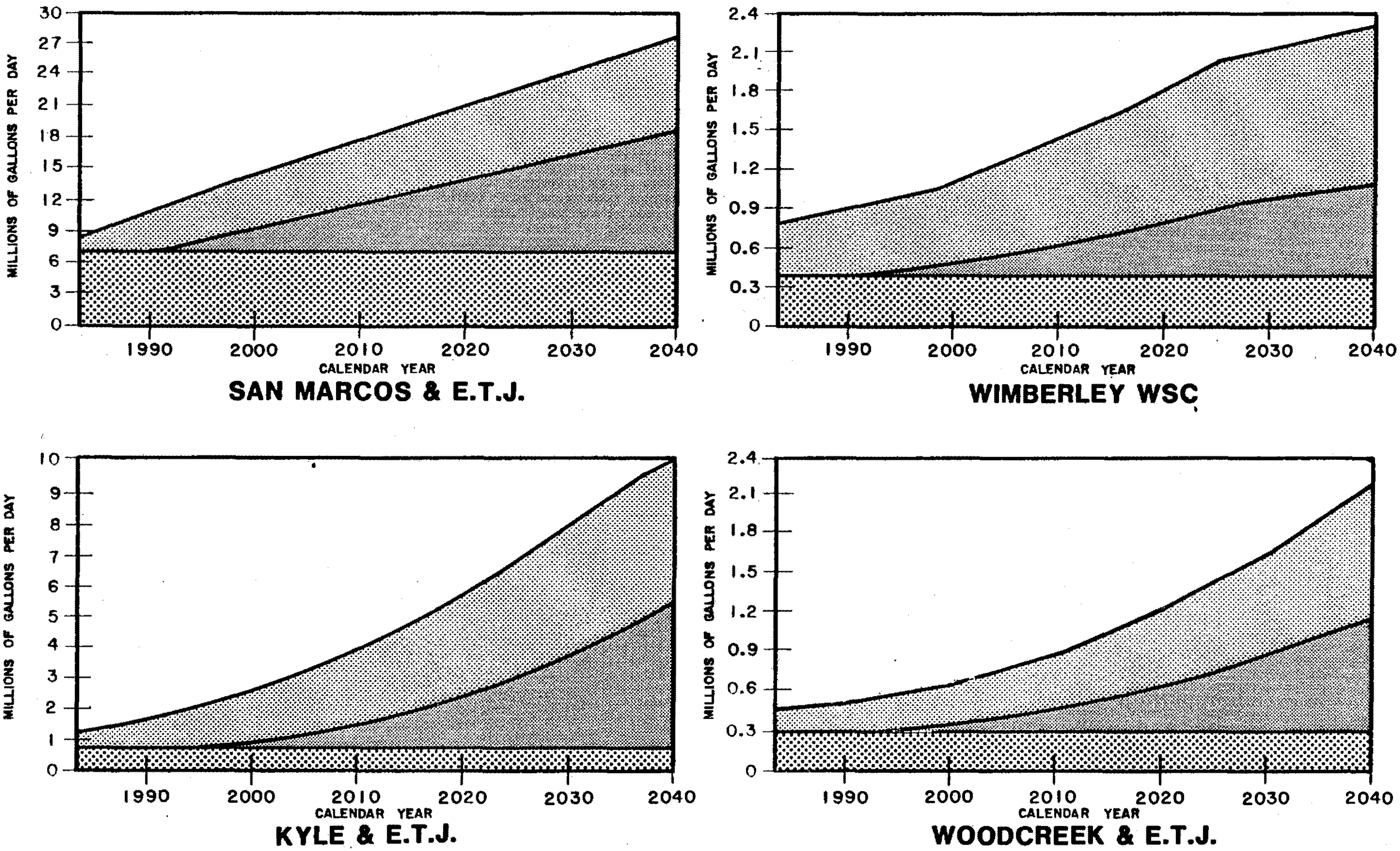
WATER DEMAND PROJECTIONS FOR HAYS COUNTY

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 2.2-1



LEGEND:

- MAXIMUM DAY REQUIRED
- AVERAGE DAY REQUIRED
- TOTAL GROUND WATER

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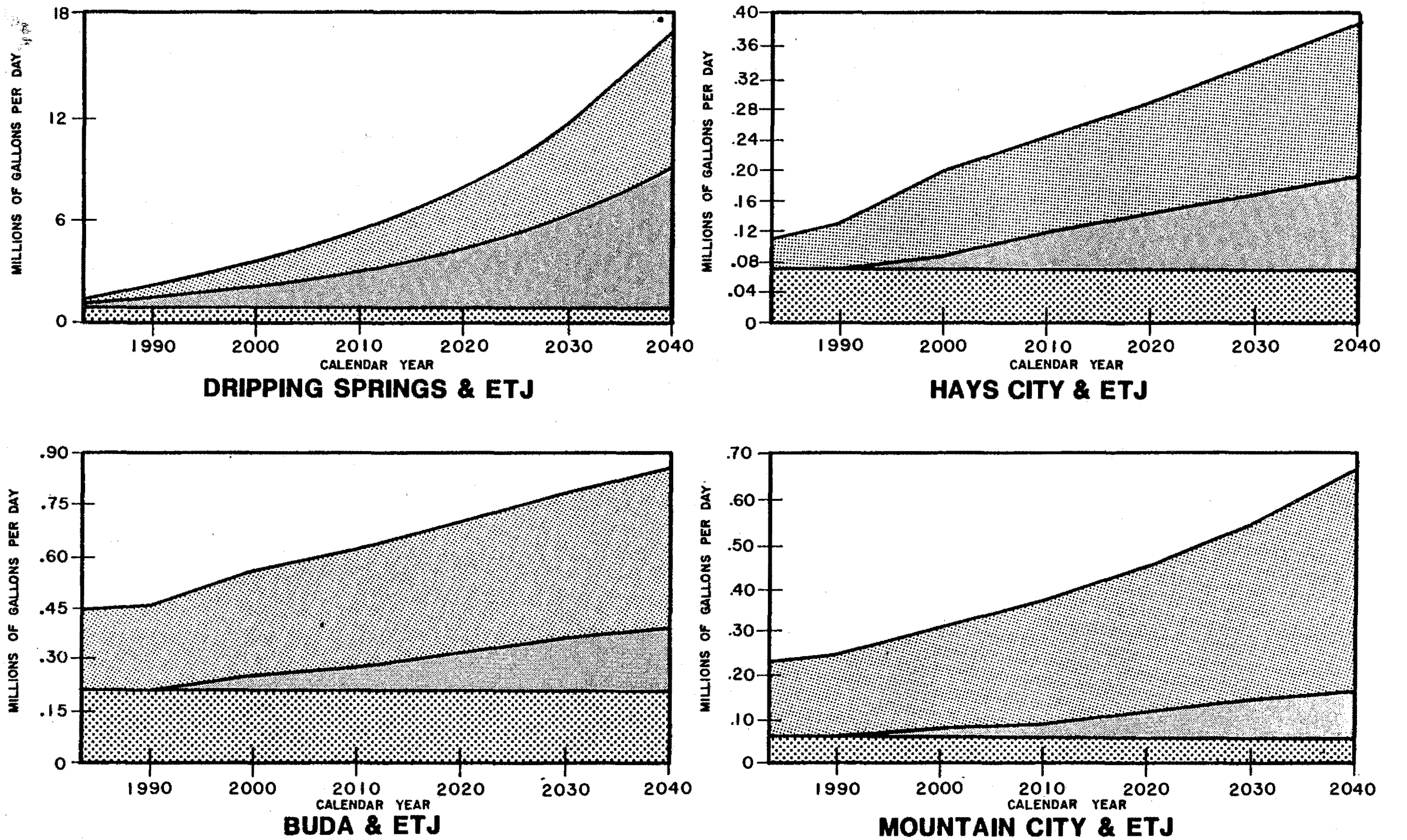
WATER DEMAND PROJECTIONS FOR HAYS COUNTY

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 2.2-2



LEGEND:

- MAXIMUM DAY REQUIRED
- AVERAGE DAY REQUIRED
- TOTAL GROUND WATER

WATER DEMAND PROJECTIONS FOR HAYS COUNTY

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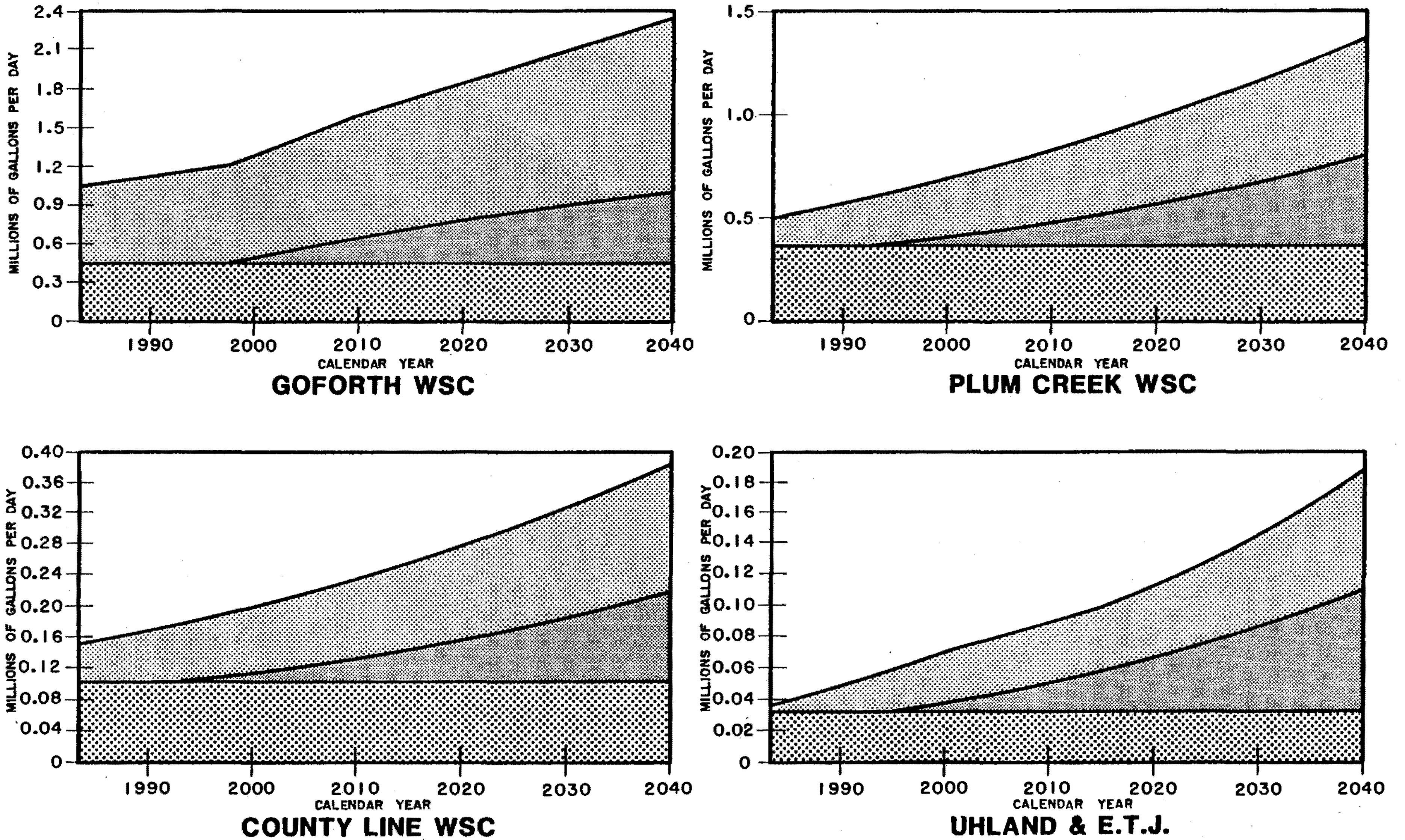
REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 2.2-3



LEGEND:

- MAXIMUM DAY REQUIRED
- AVERAGE DAY REQUIRED
- TOTAL GROUND WATER

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WATER DEMAND PROJECTIONS FOR HAYS COUNTY

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 2.2-4

water use will increase, its share of the County's water demand is projected to drop to 5%, while other areas will account for the remaining 21%.

2.3 Description of Water Sources

2.3.1 Surface Water Supplies

Stored water is available for purchase from existing reservoirs including Lake Travis, which is operated by the Lower Colorado River Authority, and from Canyon Lake, which is operated by the Guadalupe Blanco River Authority. At present, sufficient water can be made available from either Lake Travis or Canyon Lake to meet the 2040 projected water requirements for each of the alternatives recommended.

Several additional surface water supplies were identified as potential new sources to supply the needs of the County. These include the Pedernales River, Barton Creek, Onion Creek, Blanco River, and San Marcos River. Water available from these streams to a new project is affected by both the physical supply of water and the use of water by existing senior water rights. Water available on a given stream after all water rights demands have been met is commonly referred to as unappropriated water.

The quantity of unappropriated water available from area rivers and streams was determined based on the Texas Water Commission's water availability computer model. This model includes adjustments to recorded streamflow for most water rights in each basin, however, they are not entirely up to date. For this reason they are used in this study only to provide a reasonable approximation of water available (on a monthly basis) to the locations of interest in the study.

The TWC model provides two sets of flow data at each point of interest. The first set of flow data (i.e. unappropriated flows) includes the simulation of the effects of water rights from the whole basin that are both upstream and downstream of the point of interest. The second set of flow data (i.e. runoff flows as referred to in this report) includes only the effects of water rights located upstream of the point of interest. Both data sets are calculated assuming water rights holders divert their full permitted (i.e. appropriated) amounts. The results are printed in tabular form in the Appendix showing the monthly quantity of water available in acre-feet.

For each point of interest in this study, both sets of flow data were considered. The period, 1940-1972, was used for streams in the Colorado River Basin, and the period 1940-1979 was used as the modeling period for streams in the Guadalupe River Basin. Therefore all data sets contain the 1950's drought which is important in developing a firm and dependable supply.

The Colorado River model includes water rights and claims through April, 1978. The Guadalupe River model includes water rights and claims through July, 1982. The TWC model results were considered appropriate for the level of detail required for this study. If any of the plans presented herein are pursued, detailed investigations will be necessary to more accurately determine water availability for the particular site. These investigations will need to include all water rights through the current year and a more detailed analysis of available stream flow data at the particular site being considered.

Estimates of average annual quantities of water available at selected locations are shown on Figure 2.3-1. These amounts are representative of the long term average quantities available, but do not show the monthly and yearly fluctuations which are very important when planning for firm yield or dependable water supplies. In this study, monthly values were used in determining flows available for each plan. (The monthly values at the selected locations shown on Figure 2.3-1 are included in the Appendix.) "Unappropriated" flows were generally used as the basis for estimating water available on a firm yield basis. However, in some cases "Runoff" flows were used to determine the maximum amount of water which could be diverted at a site without considering downstream water rights. This approach was only undertaken at those sites where an alternate source of water was available which could meet those downstream demands, assuming an exchange arrangement could be made with the affected rights holders. These flows, designated as estimated "exchangeable" amounts, represent approximate monthly flows which are estimated to be available assuming the existing water rights demands could be satisfied by releases from an existing storage reservoir. All "exchange" water would have to be purchased by the sponsors of a new project and have been included in the cost estimates. This exchange concept was considered for Onion Creek at the Dripping Springs reservoir site (possible exchange with Lake Travis water) and for the Blanco River near Wimberley (possible exchange with Canyon Lake water).

Potential streams and reservoirs which were evaluated as potential sources of supply in the alternative plans are shown on Figure 2.3-2, and include the following:

Existing Reservoirs:

- Lake Travis; and
- Canyon Lake.

Future Reservoirs:

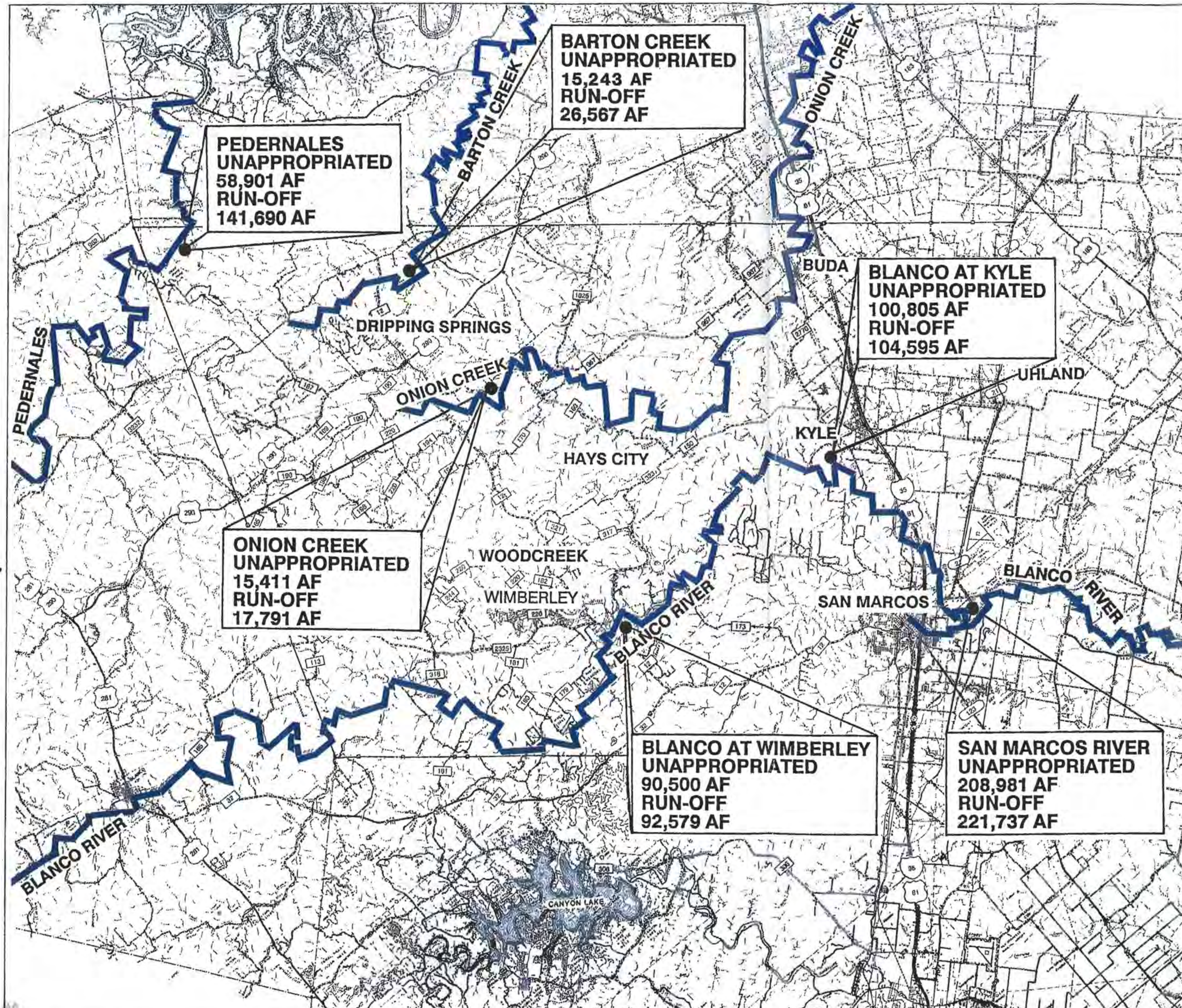
- Lockhart;
- Cloptin Crossing; and
- Dripping Springs.

Stream flow data used in the study included information for the following sites:

- Onion Creek near Dripping Springs;
- Blanco River near Wimberley;
- Blanco River near Kyle;
- San Marcos River near San Marcos; and
- Guadalupe River near New Braunsfels.

2.3.2 Conservation

Conservation, as used in this report, is defined as the efficient use of water for the purpose of reducing unnecessary or wasteful uses. A conservation plan, which includes



NOTE: SEE APPENDIX FOR MONTHLY FLOWS.

FIGURE 2.3-1

HISTORICAL AVERAGE ANNUAL WATER AVAILABILITY IN LOCAL RIVERS AND CREEKS

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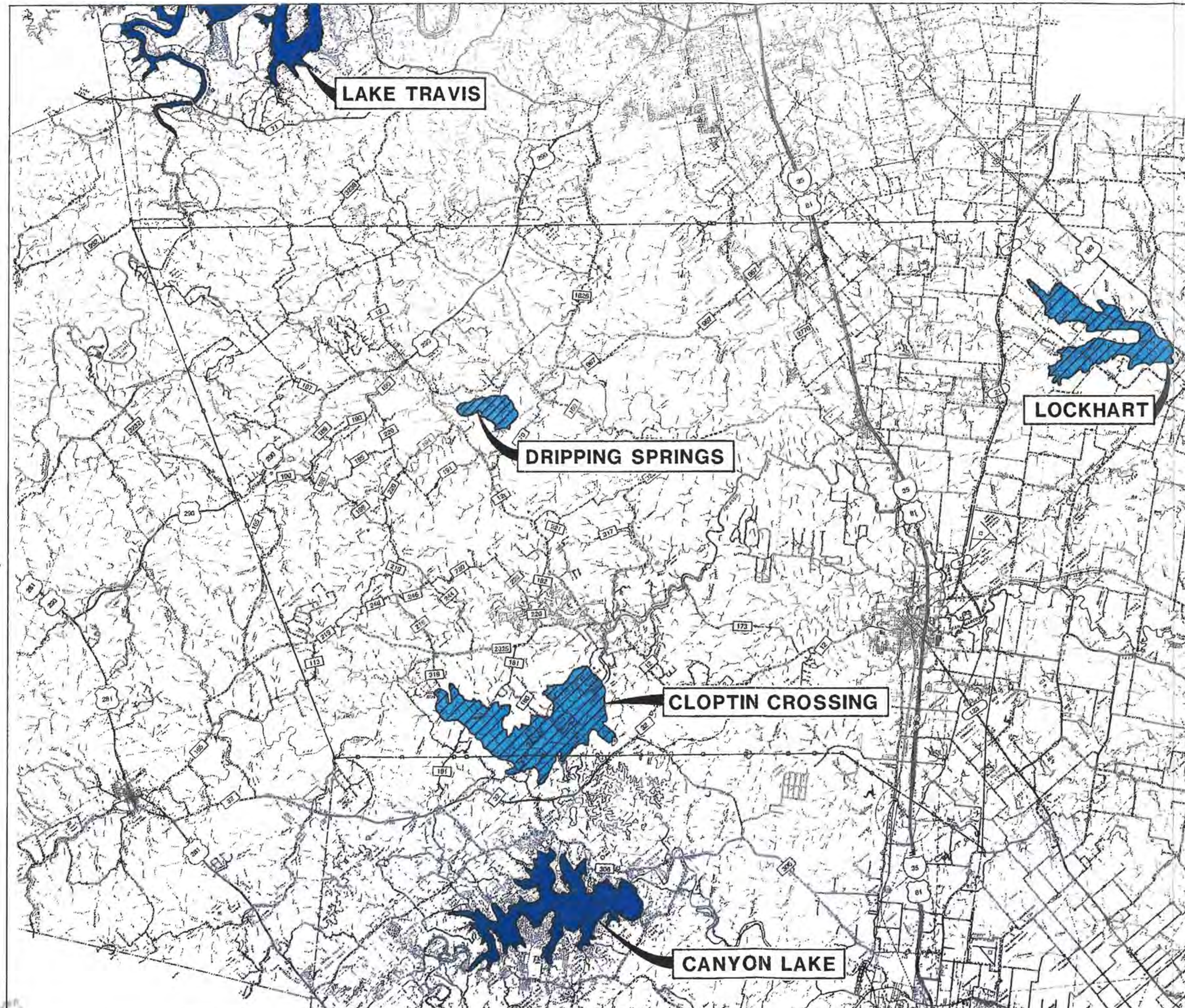

FIGURE 2.3-2

POTENTIAL RESERVOIR SOURCES

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FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

everyday actions to promote conservation of water and special actions to be taken during defined drought periods, has been prepared and is included in the Appendix. The plan is summarized in Section 6, which also includes target goals corresponding to future dates in terms of reduced usage.

As previously discussed, ground water supplies in Hays County are limited. If growth projections occur and present water use per capita continues, new water supplies will be needed in most areas of the county by 1995. Reduction in the amount of water used per person through conservation can benefit the citizens of Hays County by making existing water supplies go farther and by reducing the capacity required for new facilities. In effect, conservation is a source of supply.

2.4 Existing Water Systems

Information concerning the existing water systems in Hays county was obtained from a survey performed by HDR Engineering and from data furnished by the Texas Department of Health (TDH). Based on this information, the existing water systems in Hays County may be categorized as either community or non-community type systems. For purposes of this study, a non-community system is one which indicated no plan to serve 15 or more connections. These include registered commercial systems and unregistered systems, such as individual wells. Many of these systems are located within the existing ETJ's delineated in Figure 1.1-2. It was assumed that alternative systems would eventually augment the water supplies of these systems. Non-community systems located outside of existing ETJ boundaries were assumed to remain rural and dependent on ground water.

Community systems are those which plan to serve or currently serve 15 or more connections. Therefore proposed systems, such as the Woods of Bear Creek, which plan to serve more than 15 connections, were also considered community systems. Figure 2.4-1 shows the current or planned boundary limits of many of the County's community water purveyors.

The community systems with service boundaries which are wholly within the County are listed in Table 2.4-1. Most of these systems serve their customers from sources located within their service area . However, County Line, Plum Creek, and Goforth Water Supply Corporations pump from the Edwards Aquifer just west of Interstate Highway 35 near Kyle, which is outside their service area.

A number of community systems located outside the County, pump ground water in Hays County and transfer it outside for use. The larger of these systems are listed in Table 2.4-2. It should be noted that the County boundary in no way indicates ownership of water. Rather, these systems are important because the communities they serve are also dependent on the same ground water sources as Hays County residents.

Since ground water is the primary water source in the County, treatment is often limited to chlorination. This is true for systems utilizing the Edwards Aquifer. However, systems which utilize the Trinity Group Aquifer, which includes the Glen Rose formation, frequently provide softening or even demineralization in addition to chlorination of the water because of the high content of dissolved solids. Customers of systems on the Trinity Aquifer which do not provide any additional treatment often provide their own softening or demineralization treatment at a significant expense.

The survey of Hays County water suppliers also investigated water rates. Each water supplier sets its own rates. The rates of the Counties' larger suppliers are listed in Table 2.4-3. The water rate for the City of Austin is also provided for reference. It is apparent that Hays County citizens are accustomed to paying relatively low rates for their water in relation to rates paid in other areas. This is possible since ground water is much less expensive to provide than surface water since surface water systems involve the costs of raw water storage, water treatment, and usually the added cost for conveyance from the point(s) of storage to the major water using centers.

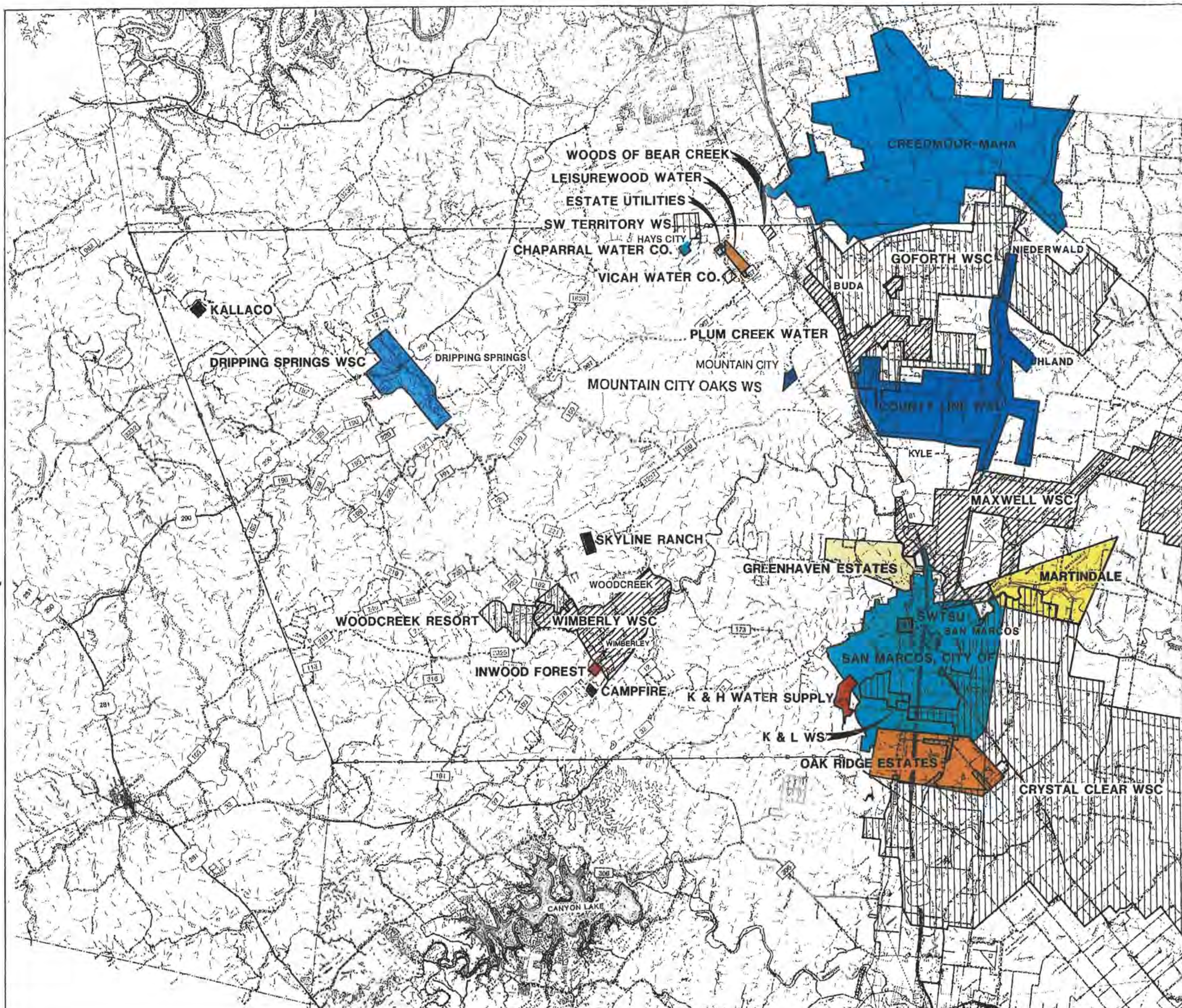

FIGURE 2.4-1

WATER SUPPLY CORPORATIONS AREA BOUNDARY MAP

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FOR
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TABLE 2.4-1

COMMUNITY WATER SYSTEMS IN HAYS COUNTY				
SYSTEM	SOURCE	NUMBER (#) OF CONNECTIONS	POTENTIAL # OF CONNECTIONS	TYPE
Aztec Village	Edwards	93	133	Mobile Home
County Line WSC	Edwards	328	400	Residential
Dripping Springs	Glen Rose/Trinity	630	—	Residential
Cimarron Park WS	Edwards	131	—	Residential
Chaparral Park WS	Edwards	50	—	Residential
Blanco River Cross. WS	Edwards	15	—	Residential
Buda, City of	Edwards	517	—	Residential
Goforth WSC	Edwards	1161	—	Residential
Greenhaven Estates (Elim WSC)	Edwards	295	338	Residential
Kemp Hills	Trinity	15	70	Residential
Kyle, City of	Edwards	870	—	Residential
Leisurewoods W.C.	Edwards	398	—	Residential
Meadow Woods	Edwards	81	—	Residential
Mountain City Oaks	Edwards	133	240	Residential
Oakridge Estates (Elim WSC)	Edwards	392	413	Residential
Plum Creek WSC	Edwards	948	—	Residential
Radiance WSC	Edwards	30	—	Residential
SWTSU	Edwards	[A]400	—	School
San Marcos, City of	Edwards	5953	—	Residential
Wimberly WSC	Glen Rose	1088	—	Residential
Woodcreek Utility Co. #2	Glen Rose	141	4000	Residential
Woodcreek Utility Co. #1	Glen Rose	457	1200	Residential
Estates Utilities WSC	Edwards	82	90	Residential
Inwood Forest	Glen Rose/Pearsal	21	—	Residential
K & L Water Supply	Edwards	64	—	Residential
Kallaco Water System	Alluvial	25	177	Residential
Mockingbird Mobile Home Park	Edwards	38	40	Residential
Regal Oaks Water Co.	Trinity	17	—	Residential
San Marcos Baptist Acad.	Edwards	[B]41	—	School
Signal Hills No. 24 Coop	Edwards	15	—	Residential
Southwest Terr.	Edwards	100	113	Residential
Sunny Acres Mobile Home Park	Alluvial	34	—	Mobile Homes
Camp Fire Wimberley	Trinity	120	—	Residential
Cielo Azul Ranch	Edwards	26	—	Residential
Cypress Creek Acres	Glen Rose	19	—	Residential
Golden Wood West Water System	Glen Rose/Trinity	52	—	Residential
Woods of Bear Creek	Edwards	0	312	Residential
Hays Co. Water Inc. (Dobie Lane)	Glen Rose	15	31	Residential
Skyline Ranch	Glen Rose	2	87	Residential
Shule Mobile Home Park	Edwards	14	17	Mobile Homes

[A]400 connections serve 2500 staff & 19,000 students, 5000 of which live on campus.

[B]41 connections serve 35 staff and 375 students.

TABLE 2.4-2

COMMUNITY WATER SYSTEMS OUTSIDE OF HAYS COUNTY				
SYSTEM	SOURCE	# OF CONNECTIONS	POTENTIAL # OF CONNECTIONS	TYPE
Creedmore-Maha	Edwards	1280	1356	Residential
Crystal Clear WSC	Edwards	2568	—	Residential
Martindale	Alluvial	492	—	Residential
Maxwell	Edwards	985	—	Residential

TABLE 2.4-3

SUMMARY OF WATER RATES 1988

	Minimum Monthly Rate	Water included in minimum (gallons)	Cost per 1,000 gallons after minimum
City of San Marcos	$5.05	1st 2,000 gal	$1.03
City of Kyle	$6.32	1st 1,000 gal	$1.32
outside city limits	$9.48	1st 1,000 gal	$1.98
City of Buda in city limits	$5.25	1st 1,000 gal	$1.40
outside city limits	$10.50	1st 1,000 gal	$2.65
City of Woodcreek	$14.05	1st 3,000 gal	$0.85
Phase II	$12.94	1st 3,000 gal	$1.20
Dripping Springs WSC	$12.50	1st 3,000 gal	$1.50
Wimberley WSC	$13.00	1st 3,000 gal	$1.50
Goforth WSC	$12.00	1st 2,000 gal (after 10,000 gal)	$1.00 $2.00
Plum Creek WSC	$20.00	1st 3,000 gal	$1.50
County Line WSC	$15.00	1st 2,000 gal	$1.00
City of Austin in city limits 5/8" meter	$5.46	1st 2,000 gal	$2.14
outside city limits (MUD) 5/8" meter	$8.19	1st 2,000 gal	$2.68
outside city limits MUD 8" meter	$188.72	1st 2,000 gal	$2.68

SECTION 3
WATER ALTERNATIVES

3.0 WATER ALTERNATIVES

3.1 Introduction to Alternatives

Twenty-one alternative water systems to meet the water needs of Hays County were developed for review by the Hays County Water Development Board. These alternatives ranged from large systems, which would serve the entire County, to small systems which would service only local areas. Table 3.1-1 contains a summary of these alternatives, their service areas, and their supply sources. The methodology used in developing these alternatives in terms of sizing criteria, phasing of components, and estimating costs was the same for each alternative, thereby helping to ensure an accurate comparison. Estimates of total project costs, 20-year water contract costs, and monthly cost increases per connection were made for each alternative to provide a basis of comparison.

Each alternative was sized to be operated as a peaking system. This means that ground water would continue to be used to meet base water demands at the 1984 rate of use of each respective system, while the supplementary system would provide for demands in excess of ground water availability. The assumption that 1984 water use is to be the maximum allowable ground water use is discussed in Sections 1.3 and 1.4. The alternatives provide for delivery of water to each of the target growth areas in the County, however, in addition to having water delivered to them, County Line and Goforth Water Supply Corporations (WSC) would have the additional option of taking delivery of water at Kyle near their well fields. In this case, the cost of water per 1,000 gallons for those two WSC's would be the same as for the City of Kyle.

Alternatives were formulated with consistent phasing of system components. Intakes and pump stations are sized to meet the demands at the end of the study period

Table 3.1-1

SUMMARY OF ALTERNATIVES																					
	ALTERNATIVES																				
	1	2	3	4	5	5a	5b	6	7	8	9	10	10a	10b	11	12	12a	13	14	14a	15
REGION																					
Dripping Springs	X	X	X	X	X		X			X	X				X	X	X				
Hays City	X	X	X	X	X				X	X	X										
Buda	X	X	X	X	X				X	X	X								X		
San Marcos	X	X	X	X	X					X		X	X	X					X	X	
Kyle	X	X	X	X	X					X				X						X	
Mountain City	X	X	X	X	X					X				X							
Wimberley	X	X	X	X	X	X	X			X							X	X			X
Woodcreek	X	X	X	X	X	X	X			X							X	X			X
Goforth	X	X	X	X	X			X		X				X					X	X	
Plum Creek	X	X	X	X	X			X		X				X					X	X	
Uhland	X	X	X	X	X			X		X				X					X	X	
County Line	X	X	X	X	X			X		X				X					X	X	
SOURCE																					
City of Austin									X												
Lake Travis	X		X								X					X	X				
Onion Creek															X						
Plum Creek								X													
Blanco River										X											X
San Marcos River																			X	X	
Canyon Lake	X	X			X	X	X					X	X	X				X	X	X	
Edwards Aquifer	X	X	X	X	X			X	X	X	X	X	X	X			X				
Trinity Aquifer	X	X	X	X	X	X	X			X	X				X	X	X	X			X

Example: Alternative #10 serves San Marcos using Canyon Lake and Edwards Aquifer as the supply source.

(year 2040), pipelines are sized to supply either 20 years or 25 years of forecasted demand, and treatment plants are sized to supply 10 years of demand.

Estimates of total project costs, which are summarized in Table 3.1-2, were calculated with a water cost estimating computer model developed by HDR Engineering, Inc. Project costs include estimates for the construction of all of the system components required to treat (where applicable) and transfer the water supply to a selected point of use for each area served. The project cost estimates include 25% for engineering and contingencies. Land costs for reservoirs included costs of land up to the probable maximum flood plain level based on estimates of land costs in the area provided by the HCWDB.

Total project cost estimates do not include estimates for pipeline right-of-way or land costs for treatment plants and pump stations, but these costs are generally minor when compared to total project cost. Estimates for termination storage and local distribution system improvements were also not included because of the uncertainties in predicting the configurations of future systems and because some distribution systems with adequate storage are already in place.

Estimates of raw water charges were obtained from the Lower Colorado River Authority (LCRA) and the Guadalupe Blanco River Authority (GBRA). Treated water charges were obtained from the City of Austin. These charges are tabulated in Table 3.1-3.

The estimated construction costs are not site specific, but they are based on information obtained from data on actual similar projects which have recently been constructed. However, detailed studies and cost estimates will be required to refine the costs prior to financing and implementation of the selected projects. The cost estimates prepared for this report are considered to be preliminary, appropriate for comparing alternatives, and subject to change as more detailed information becomes available.

TABLE 3.1-2

WATER ALTERNATIVE COST ESTIMATE COMPARISON

ALTERNATIVE	DESCRIPTION	START DATE	SOURCE LIFE	TOTAL PROJECT COST	20 YEAR WATER CONTRACT*
#1	HAYS COUNTY SUPPLIED FROM RESPECTIVE BASINS	1995/2005	2040	$60,510,000	$ 5,850,000
#2	HAYS COUNTY SUPPLIED FROM CANYON LAKE	1995/2005	2040	$65,330,000	$ 5,060,000
#3	HAYS COUNTY SUPPLIED FROM LAKE TRAVIS	1995/2005	2040	$77,970,000	$ 8,120,000
#4	SAN ANTONIO AGREEMENT TO LIMIT PUMPAGE	1995	2040	$26,470,000	$64,590,000
#5	HAYS COUNTY SUPPLIED FROM CANYON LAKE UTILIZING THE BLANCO RIVER	1995/2005	2040	$58,630,000	$ 5,560,000
#5a	**WIMBERLEY & WOODCREEK SUPPLIED FROM BLANCO RIVER WITH CANYON LAKE BACKUP**	**1995**	**2040**	**$ 5,790,000**	**$ 230,000**
#5b	WEST HAYS COUNTY SUPPLIED FROM CANYON LAKE UTILIZING THE BLANCO RIVER	1995	2040	$26,490,000	$ 1,500,000
#6	NORTHEAST HAYS COUNTY SUPPLIED FROM THE LOCKHART RESERVOIR	2005	2040	$ 5,770,000	$ 1,140,000
#7	**BUDA AND HAYS CITY SUPPLIED FROM THE CITY OF AUSTIN**	**1995**	**2040**	**$ 1,580,000**	**$ 550,000**
#8	HAYS COUNTY SUPPLIED FROM THE CLOPTIN CROSSING RESERVOIR	1995/2005	2040	$50,940,000	$40,230,000
#9	COLORADO RIVER BASIN SUPPLIED FROM LAKE TRAVIS UTILIZING ONION CREEK	1995/2005	2040	$20,500,000	$ 2,080,000
#10	SAN MARCOS SUPPLIED FROM GUADALUPE RIVER BY RELEASES FROM CANYON LAKE - EAST	1995	2040	$17,060,000	$ 2,710,000
#10a	SAN MARCOS SUPPLIED FROM GUADALUPE RIVER BY RELEASES FROM CANYON LAKE - WEST	1995	2040	$13,860,000	$ 2,710,000
#10b	**EAST HAYS COUNTY SUPPLIED FROM GUADALUPE BY RELEASES FROM CANYON LAKE**	**1995/2005**	**2040**	**$25,890,000**	**$ 3,540,000**
#11	**DRIPPING SPRINGS SUPPLIED FROM LAKE DRIPPING SPRINGS**	**1995**	**2020**	**$21,350,000**	**$ 390,000**
#12	**DRIPPING SPRINGS SUPPLIED FROM LAKE TRAVIS**	**1995**	**2040**	**$19,470,000**	**$ 2,030,000**
#12a	DRIPPING SPRINGS, WIMBERLEY, AND WOODCREEK SUPPLIED FROM LAKE TRAVIS	1995	2040	$27,530,000	$ 2,400,000
#13	WIMBERLEY AND WOODCREEK SUPPLIED FROM CANYON LAKE	1995	2040	$ 6,870,000	$ 230,000
#14	EAST HAYS COUNTY SUPPLIED FROM THE SAN MARCOS RIVER FIRMED FROM CANYON LAKE	1995/2005	2040	$28,260,000	$ 3,510,000
#14a	NORTHEAST HAYS COUNTY, KYLE, & MOUNTAIN CITY SUPPLIED FROM THE SAN MARCOS RIVER	1995/2005	2040	$10,540,000	$ 830,000
#15	WIMBERLEY AND WOODCREEK SUPPLIED FROM BLANCO RIVER AND OFF-CHANNEL STORAGE	1995	2040	$21,180,000	$ 0

*Present worth @ 8% discount rate.

Using the appropriate water charges, a 20-year water contract cost was calculated for each alternative. The cost was calculated by applying the rates in Table 3.1-3 to the estimated average annual amount of water required for the period and then converting the annual calculated amount to present worth using an 8% interest rate over the 20-year period. Based on discussions with LCRA and GBRA, it is assumed that water contracts would be on a take-or-pay basis, thereby requiring that the contracted water volume would be paid for whether or not it is actually used. Therefore, if a contract is executed to secure annual water requirements for the future, annual payments for the water would begin immediately, regardless of whether or not the water is actually used.

Table 3.1-3

Estimates of Water Charges

Agency	Basis for Estimate	Charge per 1000 gallons
LCRA	current conditions	$0.220
GBRA	current conditions	$0.137
GBRA	with Lockhart reservoir	$0.470
GBRA	with Cloptin Crossing Reservoir	$1.090
Austin	treated water	*$2.680
San Antonio	treated water from Cuero I	$1.750

* An additional capital recovery charge is also applicable

To compare alternatives on a relative economic basis, the estimated cost increase per connection per month was determined. These estimates include operation and maintenance cost, water cost, and the annual cost to finance the new facilities for each alternative, at an interest rate of 8% for 20 years. This is the rate currently being offered by the Texas Water Development Board.

The estimates of expected cost increase per connection are presented in Table 3.1-4. The costs are distributed among entities listed in proportion to each entity's use of the water which will be provided by each alternative project. Therefore, the cost of system components which are common to two or more entities would be shared, however, the cost of a component such as a pipeline or pump station which only serves a single entity is the

TABLE 3.1-4

WATER ALTERNATIVE COST ESTIMATE COMPARISON
INCREASE PER CONNECTION PER MONTH (1988 DOLLARS)

REGION	ALTERNATIVES																				
	#1	#2	#3	#4	#5	#5a	#5b	#6	#7	#8	#9	#10	#10a	#10b	#11	#12	#12a	#13	#14	#14a	#15
Dripping Springs ETJ	$35	$39	$23	$46	$36		$42			$51	$41				$43	$45	$33				
Hays City ETJ	$59	$50	$31	$57	$45				$11	$59	$22										
Buda ETJ	$56	$36	$25	$43	$31				$17	$35	$22										
San Marcos ETJ	$24	$26	$44	$16	$29					$37		$19	$16	$16					$20		
Kyle ETJ	$24	$24	$36	$21	$21					$36				$25					$26	$28	
Mountain City ETJ	$72	$29	$51	$39	$29					$43				$55						$64	
Wimberley WSC	$19	$17	$21	$29	$13	$24	$20			$19							$44	$28			$79
Woodcreek ETJ	$26	$25	$28	$33	$22	$32	$28			$25							$52	$36			$89
Goforth WSC	$28	$29	$36	$44	$24			$16		$38				$28					$22	$25	
Plum Creek WSC	$26	$26	$35	$43	$21			$21		$36				$26					$20	$23	
Uhland ETJ	$24	$25	$34	$41	$20			$20		$34				$25					$19	$22	
County Line WSC	$30	$31	$41	$50	$25			$25		$42				$31					$23	$26	

NOTES:
1. Estimates do not include right-of-way costs, land costs for facilities other than reservoirs, local termination storage, or local distribution piping.
2. Estimates do include engineering, legal, and financial costs.
3. Facility costs are based on a design life of 10 years for water treatment plants, 20 years for pipelines, and 45 years for pump stations and lake intakes.

responsibility of that entity. This approach of distributing a system's cost is judged to be the most approriate and hence is presented in the table.

Based on these economic comparisons and the expected reliability of the alternatives, a set of recommended alternatives was determined. Alternative 5a, Wimberley and Woodcreek supplied from the Blanco River and Canyon Lake, is recommended to serve the community of Wimberley and the City of Woodcreek and its ETJ. Alternative 7, Buda and Hays supplied from the City of Austin, is recommended for the cities and ETJ's of Buda and Hays City. Based on estimates of cost, Alternatives 11, Dripping Springs supplied from Lake Dripping Springs, and 12, Dripping Springs supplied from Lake Travis, are considered equal for serving Dripping Springs and deserve further consideration. A more detailed study, beyond the scope of this report, would be required to make a final selection between these alternatives. San Marcos, Kyle, Mountain City, Uhland, and the Goforth, Plum Creek, and County Line Water Supply Corporations, are recommended to be served by Alternative 10b, supply from Canyon Lake pumped from the Guadalupe River.

3.2 Description of Water Alternatives

Following are descriptions of all of the water supply alternatives investigated in this study. A total of 21 alternatives were considered.

3.2.1 Alternative 1 - Hays County Supplied From Respective Basins

The first alternative is a large scale project which would supply the entire County with surface water from the two existing sources, Lake Travis and Canyon Lake. Areas served are supplied by the source located within the service area basin, so that no water is pumped outside of the basin of origin.

This alternative would require new intakes to be constructed in both lakes, pump stations and treatment plants in both basins, and a substantial pipeline network as illustrated in Figure 3.2-1. It is assumed in the cost calculations that each community in the County participates in the system starting in year 1995, except the communities supplied by Uhland, Goforth WSC, Plum Creek WSC, and County Line WSC which would come on line in 2005.

The total project costs (first phase) for this alternative would be $37.78 million for the system in the Guadalupe River Basin and $22.73 million for the system in the Lower Colorado River Basin. The 20-year raw water contracts cost $3.70 million for Canyon Lake water and $2.15 million for Lake Travis water. The cost presented in Table 3.1-2 is the sum of these estimates.

3.2.2 Alternative 2 - Hays County Supplied from Canyon Lake

This second alternative looks at supplying the entire County with water from Canyon Lake. Again, this alternative involves a major pipe network linking all of the population centers in the County to one central treatment facility located near the lake. This alternative would require an Interbasin Transfer Permit from the Texas Water Commission (TWC) to allow the transport of water from the Guadalupe River Basin to the Lower Colorado River Basin.

The total project cost (first phase) for this alternative is $65.33 million, which is 8% higher than Alternative 1 due primarily to the additional piping required. The 20-year raw water cost of $5.06 million is less than the cost for the previous alternative due to the use of lower cost GBRA water in the northern portion of the county. A map of this alternative is presented in Figure 3.2-2.

3.2.3 Alternative 3 - Hays County Supplied from Lake Travis

Continuing with the county-wide concept, the third alternative provides the entire County with water from Lake Travis as shown in Figure 3.2-3. This system requires even more piping than the preceding alternatives and, hence, is more expensive with a total

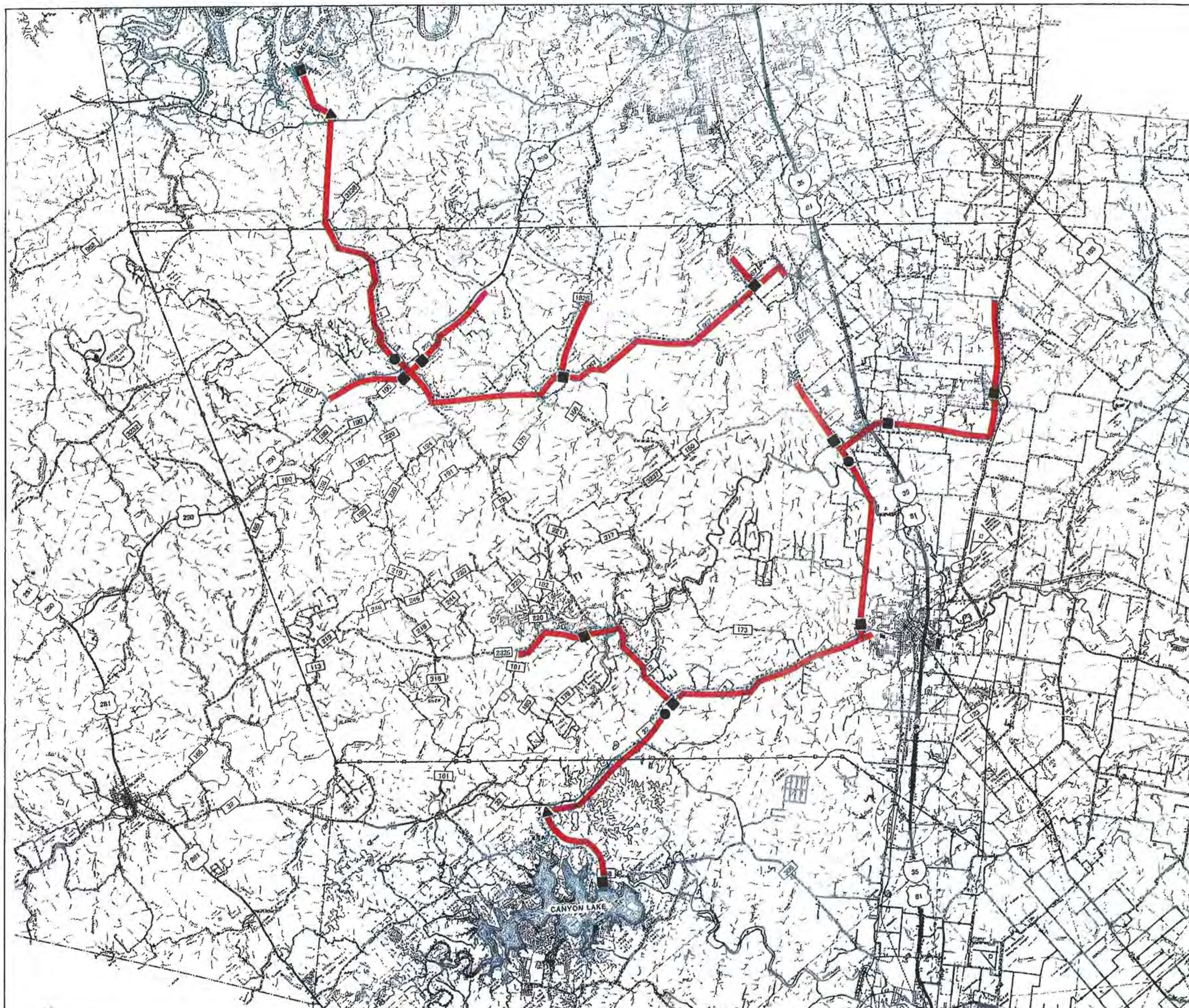

FIGURE 3.2-1

ALTERNATIVE #1
HAYS COUNTY SUPPLIED FROM RESPECTIVE BASINS

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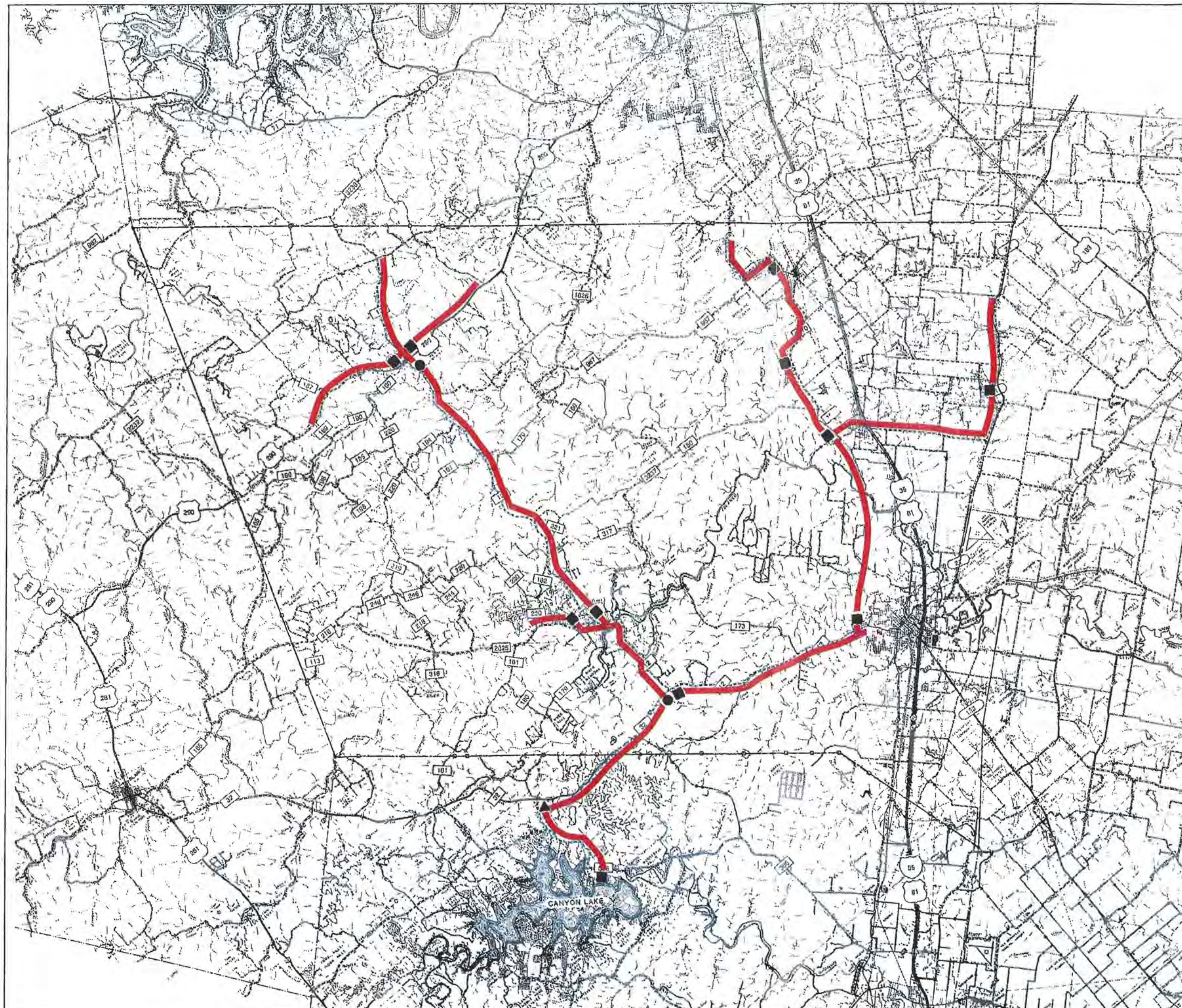

FIGURE 3.2-2

ALTERNATIVE #2
HAYS COUNTY SUPPLIED FROM CANYON LAKE

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FOR
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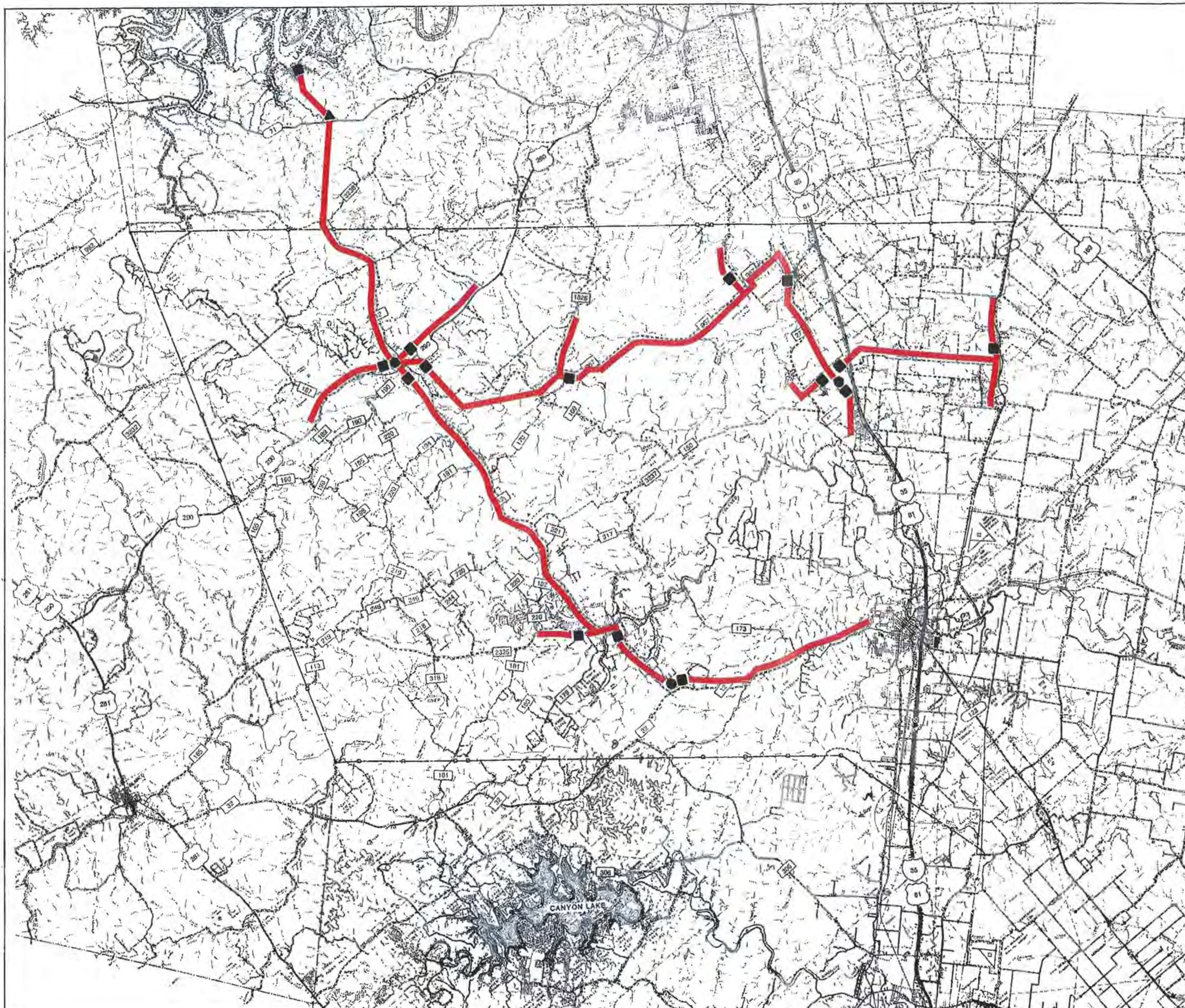

0 2 4 8 MILES

LEGEND:

- ▲ WATER TREATMENT PLANT
- ■ PUMP STATION
- ● STORAGE TANK
- PIPELINE ROUTE

FIGURE 3.2-3

ALTERNATIVE #3

HAYS COUNTY SUPPLIED FROM LAKE TRAVIS

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project cost (first phase) of $77.97 million, making it the most expensive alternative investigated. The 20-year water contract cost is estimated to be $8.12 million. Once again, this alternative would require TWC approval and a TWC permit to transfer water across the river basin boundary.

3.2.4 Alternative 4 - San Antonio Agreement to Limit Pumpage

Alternative 4, as illustrated in Figure 3.2-4, is based on utilizing the Edwards Aquifer to serve the entire County and making an agreement with the City of San Antonio to limit their withdrawal from the aquifer. In return, the County would pay San Antonio for their cost to obtain a comparable amount of water from Cuero I Reservoir to offset reduced pumpage from the Edwards. Since only minimal disinfection treatment is required for Edwards Aquifer water, the reservoir water used for exchange must be treated. It was determined, based on previous studies, that the cost of treating and pumping water from Cuero I to San Antonio would be $1.75 per 1000 gallons.

The actual system for this alternative would require a well field in the Edwards Aquifer and a distribution network to supply communities which are not located on this aquifer. The Cities of San Marcos and Kyle would not require a link to this network since they currently utilize this source. Their cost would simply be their portion of the agreement payment.

The cost of new facilities (first phase) for this alternative, estimated at $26.47 million, is significantly less than the other county-wide alternatives. However, the high cost of water, estimated at $64.6 million, is significantly greater than the construction savings. Also, before such an alternative could be considered, it would be necessary for some type of ground water regulation to be in effect to guarantee that the water purchased by Hays County is not removed from the Edwards aquifer by an entity other than Hays County. This type of regulation would require legislative action and there would be no guarantee of the outcome. Also, artificial recharge would alter flow patterns in the Edwards Aquifer and would increase the volume of flow through the aquifer. Investigations into potential affects on the aquifer and spring flows would be required and could show that this type of recharge and pumping may produce intolerable conditions for other water users.

3.2.5 Alternative 5 - Hays County Supplied From Canyon Lake Utilizing the Blanco River

This alternative is similar to Alternative 2 in that it serves the entire County from Canyon Lake. However, in Alternative 5, the Blanco River is used to transport water across the County in lieu of constructing pipelines. This would involve placing an intake in Canyon Lake and pumping water to the Blanco or one of its tributaries. The intake and pipeline were sized 10% in excess of design requirements to cover anticipated channel losses. Small, low head dams would be placed on the Blanco in Wimberley and near Kyle so that the water could be recovered from the river and pumped to treatment facilities.

Using the river, rather than piping the water, cut $6.7 million from the total project cost (first phase) as compared to Alternative 2, while the water contract cost rose $0.5 million to cover losses in the Blanco River. The significant disadvantage of this plan is the inefficient use of the Canyon Lake water which would be partially lost in transit, and two treatment plants are required. The layout for this alternative is shown in Figure 3.2-5.

3.2.6 Alternative 5a - Wimberley and Woodcreek supplied from the Blanco River with Canyon Lake Backup

In Alternative 5a, Wimberley and Woodcreek are supplied from both the Blanco River and Canyon Lake. This would allow water to be used from the Blanco River when flows were sufficient to meet the demand of the communities without reducing the base flow in the river or the recharge to the Edwards Aquifer which occurs downstream of

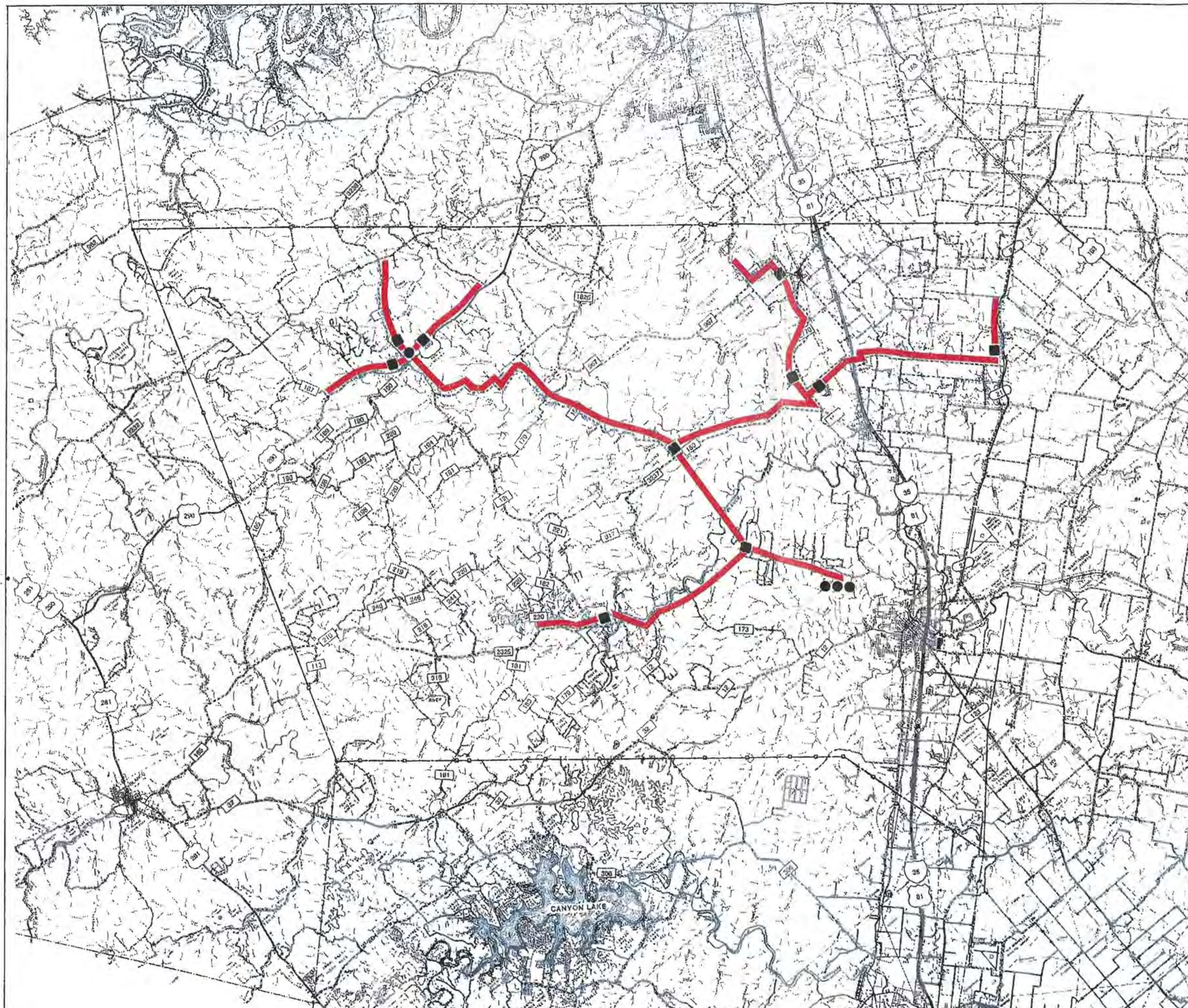

FIGURE 3.2-4

ALTERNATIVE #4

SAN ANTONIO AGREEMENT TO LIMIT PUMPAGE

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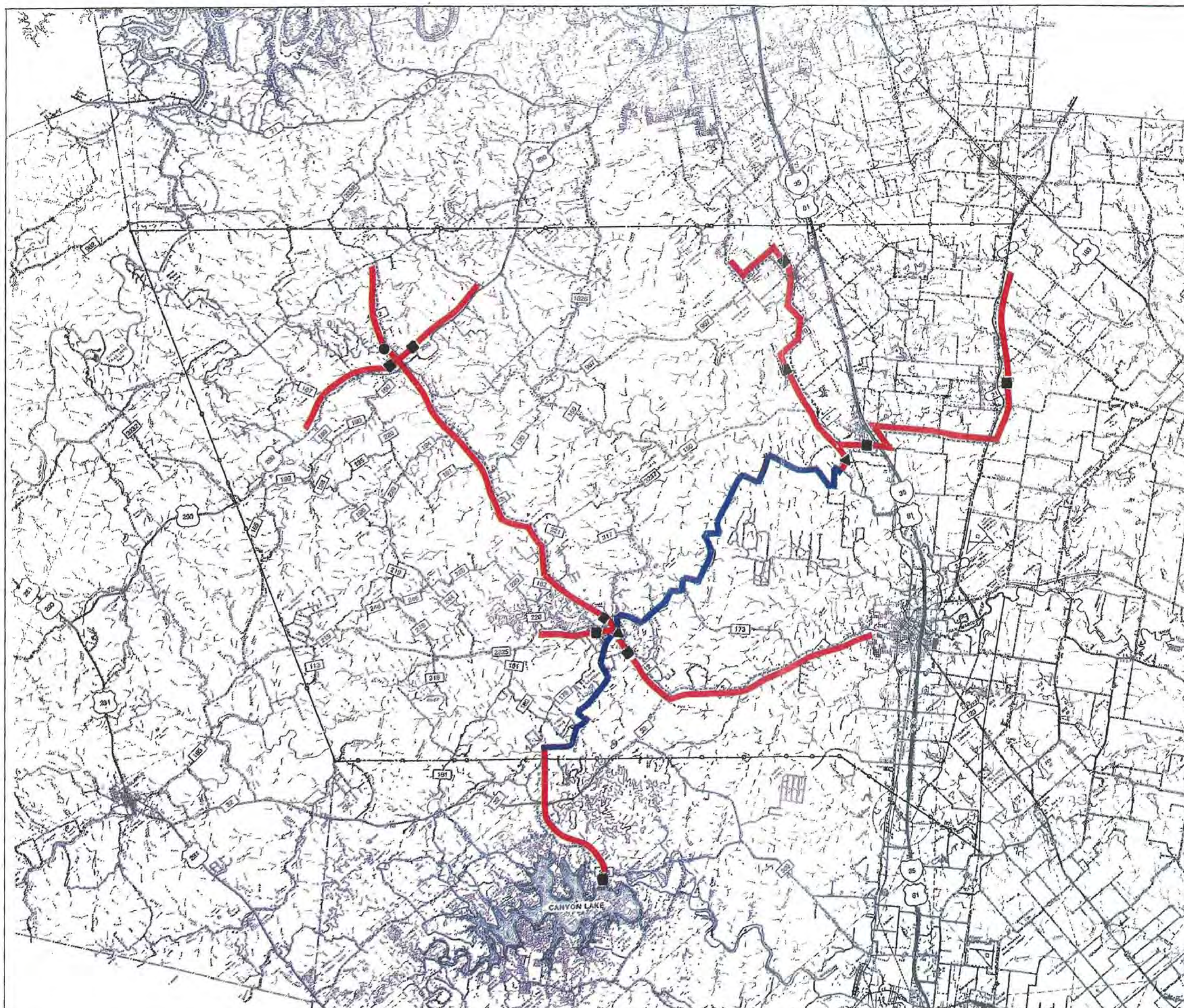

FIGURE 3.2-5

ALTERNATIVE #5

HAYS COUNTY SUPPLIED FROM CANYON LAKE UTILIZING THE BLANCO RIVER

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Wimberley. A computation of available monthly flow in the Blanco River at Wimberley can be found in the Appendix. When sufficient water is not available in the Blanco River, supplementary raw water would be pumped from Canyon Lake to the Blanco River. An additional feature of the plan is the potential to exchange water purchased in Canyon Lake for out-of-priority diversions from the Blanco River. This type of operation would apply to existing water rights on the Guadalupe River downstream of the confluence of the Blanco/San Marcos Rivers with the Guadalupe River. The exchange could work as long as demand for all affected water rights and base flows are met. More detailed studies would be required to fully develop this concept.

This system would require an intake in Canyon Lake with a pipeline to the Blanco River. To pump water from the Blanco River, a low head dam approximately 4 feet high would be required. Additionally, a treatment plant would be located near Wimberley with a pump station and pipeline to service Woodcreek.

The favorable costs of this system make it one of the recommended alternatives. The use of unappropriated flows from the Blanco River reduced the 20-year raw water cost to $230,000. The project construction cost (first phase) is estimated at just under $6 million. Alternative 5a is displayed in Figure 3.2-6.

3.2.7 Alternative 5b - West Hays County Supplied form Canyon Lake Utilizing the Blanco River

Alternative 5b is identical to the previous alternative except that Dripping Springs is included in the system as illustrated in Figure 3.2-7. This would require a pump station and pipeline from Wimberley to Dripping Springs in addition to a larger treatment plant and raw water line from Canyon Lake.

The estimated costs per connection for this alternative are slightly lower than the costs for selected Alternatives 5a and 11 or 12 for the three areas to be serviced, primarily because of the relatively low cost of Canyon Lake water. However, the plan requires transporting Guadalupe River Basin water into the Colorado River Basin. This plan must be approved by the Texas Water Commission and approval is contingent on the applicant showing that the water will not be needed in the basin of origin for a 50-year period. It is very unlikely that this could be proven in light of the growth projected for the Guadalupe River Basin. For this reason, this plan is not recommended.

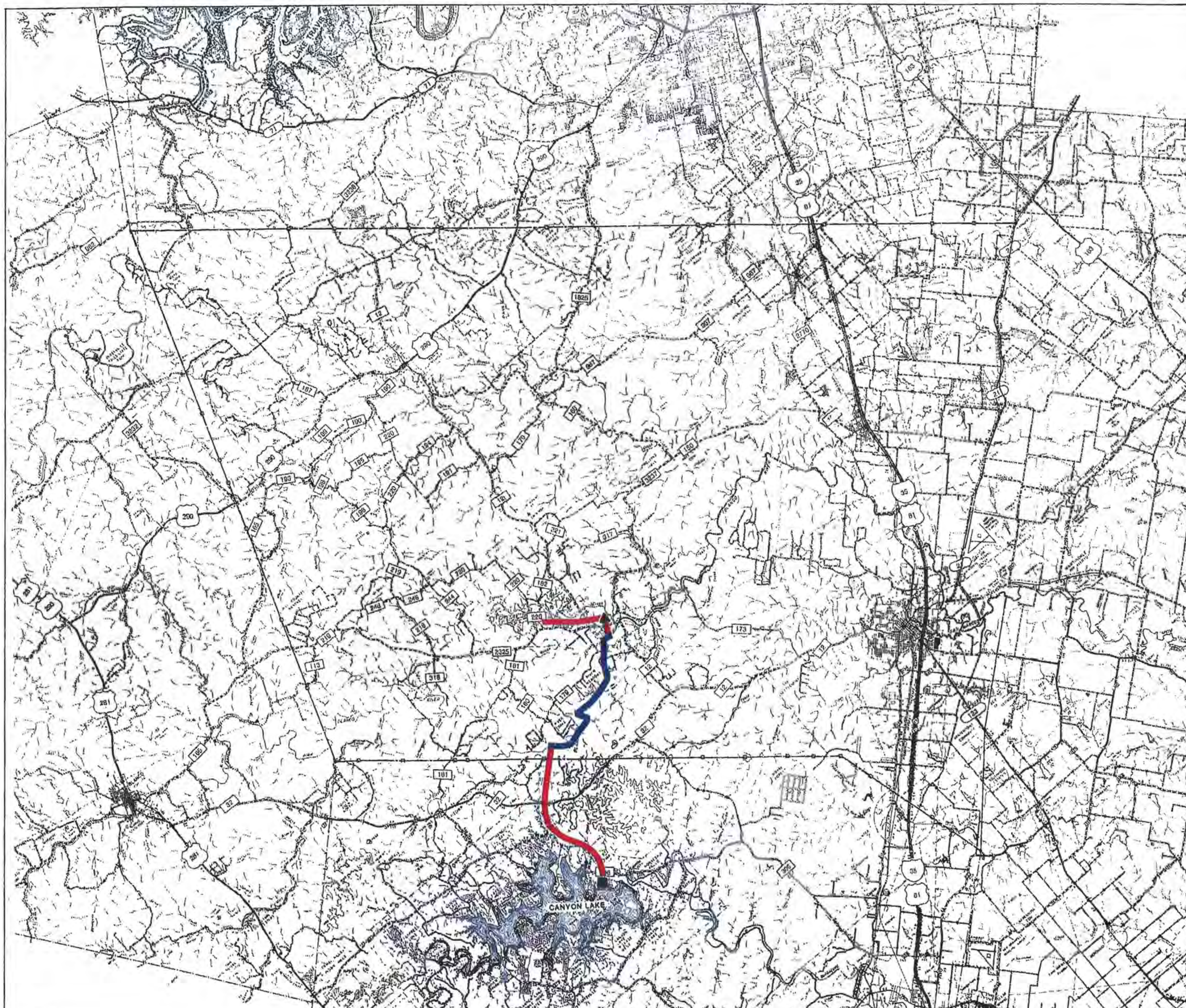
The 20-year raw water contract cost for this alternative is nearly seven times the cost for Alternative 5a due to adding the demand of Dripping Springs. The total estimated project cost (first phase) for the three areas to be served is a little less than the combined cost of the recommended Alternatives 5a and 11 or 12, but the differences are not considered significant for the level of detail associated with these cost estimates.

3.2.8 Alternative 6 - Northeast Hays County Supplied From The Lockhart Reservoir

Lockhart Reservoir is a proposed water supply project on Plum Creek sponsored by GBRA. This reservoir is ideally located for servicing the northeastern portion of the County which includes City of Uhland and Goforth, County Line, and Plum Creek Water Supply Corporations. The actual forecasted need for this portion of the County in 2040 would only require 15% of the reservoir's estimated firm yield. The schedule for construction and the amount and time of need for the other 85% of the reservoir yield is not known.

The project would require construction of an intake in the reservoir and a centralized treatment facility located near the lake. Pipelines would transport the water to the various communities as illustrated in Figure 3.2-7.

This alternative appears to be the least expensive of those supplying this area, but this assumes that other entities outside of Hays County will pay the cost of the remaining portion of the reservoir. Therefore, the total estimated project cost (first phase) of $5.77 million is very uncertain and is contingent on substantial participation by others. Because of this uncertainty this alternative was not recommended. Since the demands in this



0 2 4 8 MILES

LEGEND:

- ▲ WATER TREATMENT PLANT
- ■ PUMP STATION
- PIPELINE ROUTE
- RIVER

FIGURE 3.2-6

ALTERNATIVE #5a

WIMBERLEY AND WOODCREEK SUPPLIED FROM THE BLANCO RIVER WITH CANYON LAKE BACKUP

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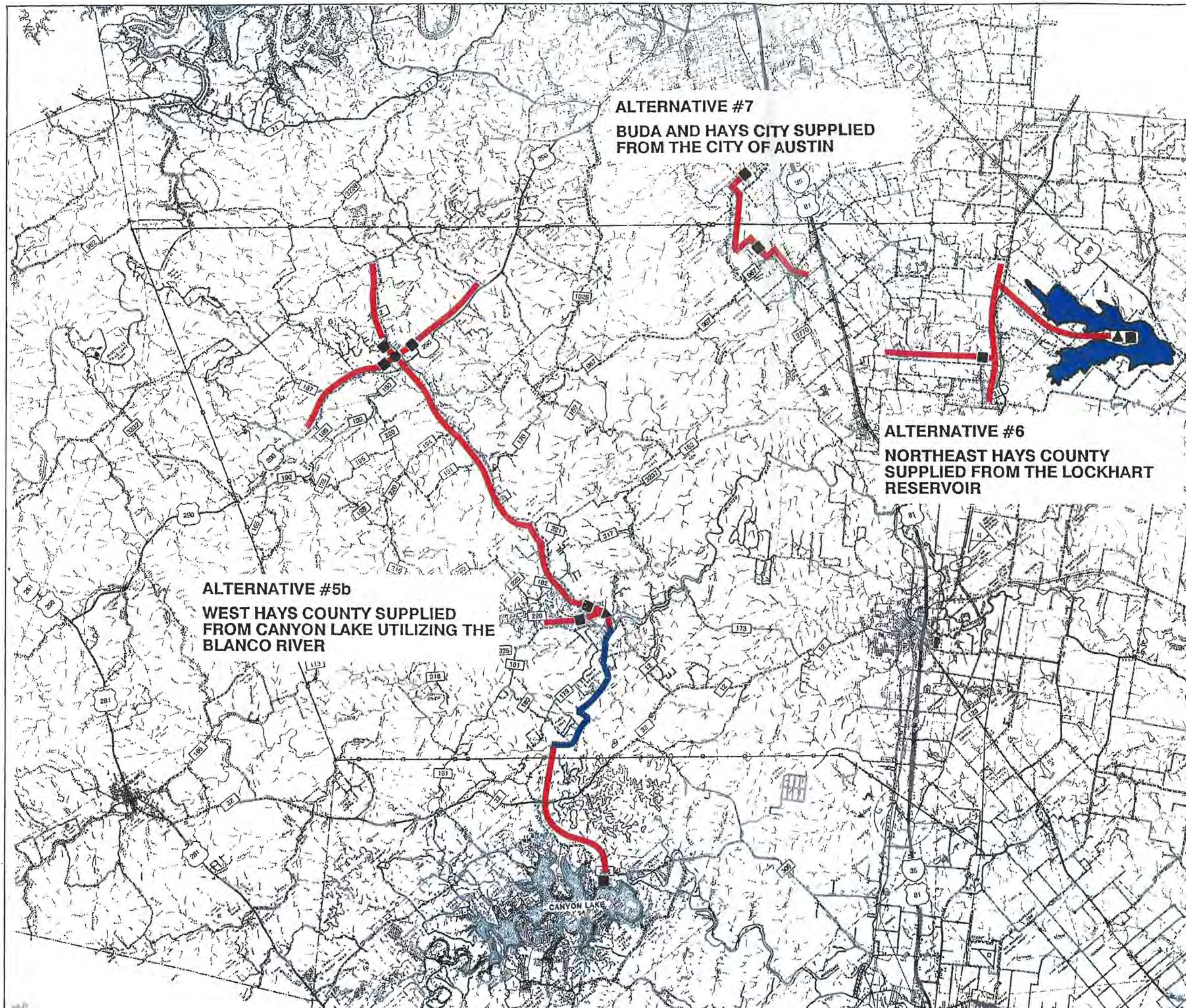

FIGURE 3.2-7

ALTERNATIVE #5b, ALTERNATIVE #6 & ALTERNATIVE #7

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portion of the County alone are not likely to be adequate justification for the reservoir construction. However, this alternative should be considered further if future conditions warrant a strong interest in the project by others.

3.2.9 Alternative 7 - Buda and Hays City Supplied from the City of Austin

Alternative 7 supplies the cities of Buda and Hays City from their nearest supply source, the City of Austin. Although the cost of water is relatively high, the low cost of transporting the water makes this a recommended alternative. Implementation would involve connecting to an existing 36-inch pipeline on Manchaca Road near the intersection of FM 1626 and pumping the water to Hays City. From that point, another pump station and pipeline would transport water to the City of Buda. This is illustrated in Figure 3.2-7. The project cost (first phase) for this alternative is approximately $1.58 million. Water would not have to be purchased on a take or pay basis for this alternative. Rather, the water cost would involve a capital recovery fee and treated water charges based on approximately $189 per month for the first 2,000 gallons used by the total system and then $2.68 for each 1,000 gallons thereafter. For comparison purposes, a twenty year treated water contract would cost $550,000. The effect of spreading these charges over the total connections in each system is included in the cost increase per connection per month shown in Table 3.1-4.

3.2.10 Alternative 8 - Hays County Supplied from the Cloptin Crossing Reservoir

This alternative uses the proposed Cloptin Crossing Reservoir to serve the entire County as was discussed in Section 2.2 and as shown in Figure 3.2-8. Since this reservoir would be located in the County, it naturally requires less of a pipe network than similar alternatives using Lake Travis and Canyon Lake. Alternative 8 consists of an intake located in the reservoir and a corresponding treatment facility to service the communities of Wimberley, Woodcreek, Dripping Springs, and San Marcos. Water would be released from the reservoir to provide recharge to the aquifer through the Blanco River as well as to supply various communities in the County. A low head dam structure would be constructed on the Blanco River near Kyle where another treatment facility would be located. This facility would service Kyle, Buda, Hays City, and the northeastern portion of the County.

Although the total project construction cost (first phase) is lower than the other county-wide projects, it is still high at nearly $51 million. The 20-year raw water contract would cost approximately $40.2 million due to the relatively high cost of the reservoir water. Only Alternative 4 has a higher water cost. An additional drawback would be the potential of severe public opposition to the proposed reservoir. This alternative was not considered cost effective nor politically favorable.

3.2.11 Alternative 9 - Colorado River Basin Portion of Hays County Supplied from Lake Travis Utilizing Onion Creek

Alternative 9 explores the cost savings of utilizing the Onion Creek's recharge to the Barton portion of the Edward's Aquifer to supply the communities of Buda and Hays City. It involves placing an intake in Lake Travis and pumping raw water to a point near Onion Creek. At that point, some of the water would be treated for use by Dripping Springs, while the remaining water would flow into Onion Creek as shown in Figure 3.2-9. The water would only be pumped into Onion Creek to maintain the maximum recharge rate during times of low flow. Hays City and Buda would then continue to use their existing well fields. An uncertainty involved in this alternative is that the plan depends on water being available when the aquifer is being pumped at substantial rates by water users over which Hays City and Buda have no control.

Although this alternative is attractive for Hays City and Buda from a cost view-

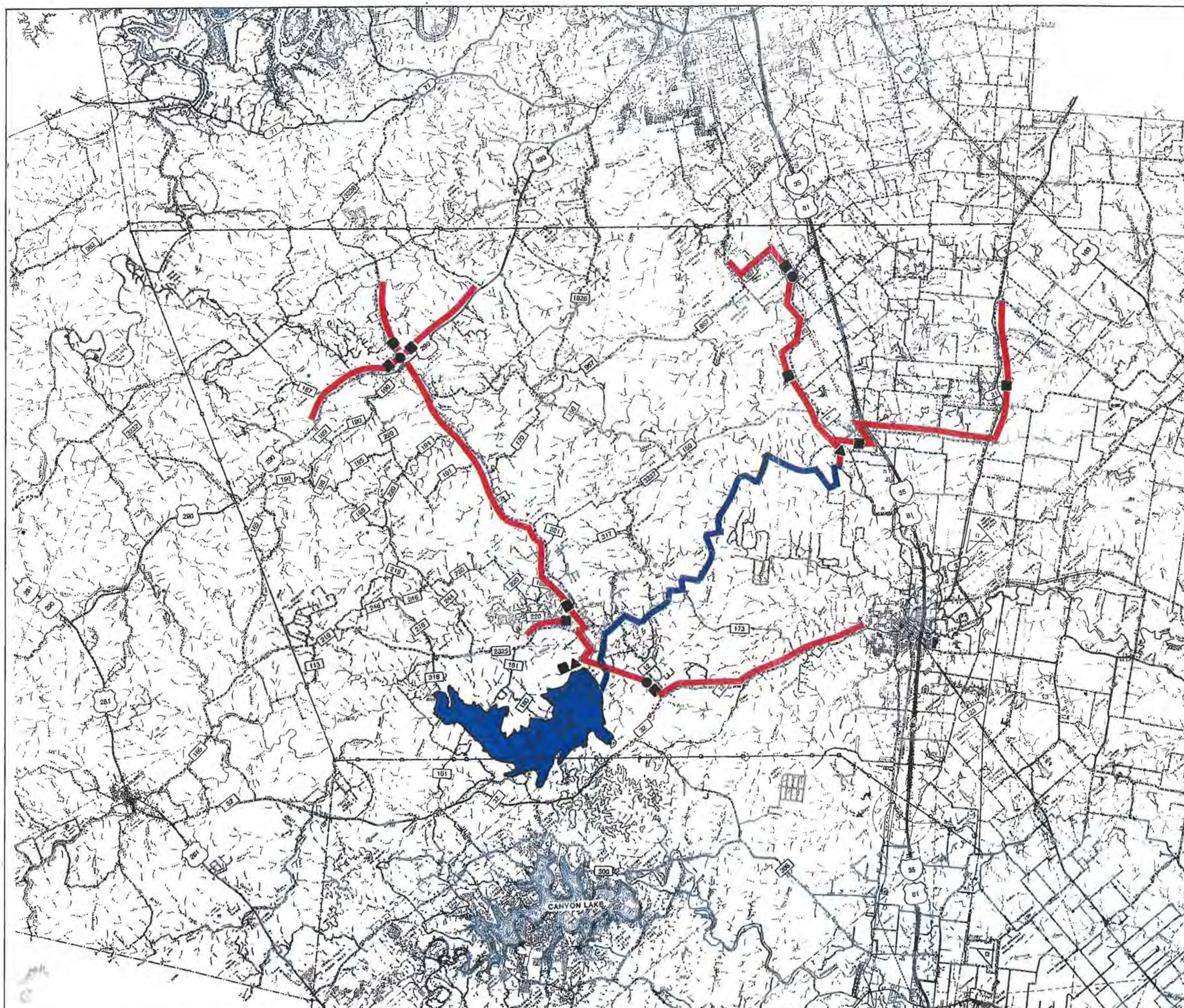

FIGURE 3.2-8

ALTERNATIVE #8

HAYS COUNTY SUPPLIED FROM THE CLOPTIN CROSSING RESERVOIR

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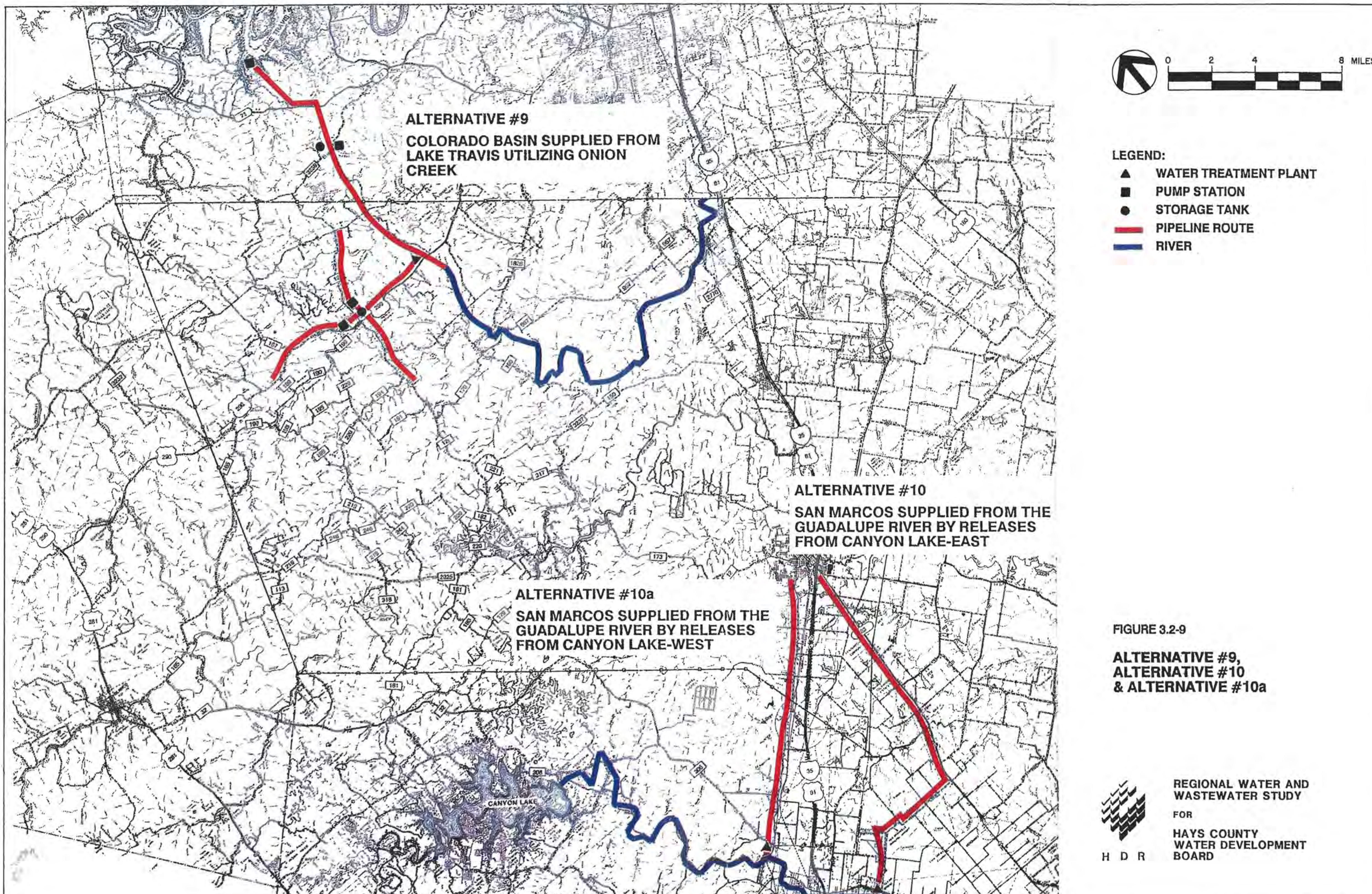

FIGURE 3.2-9

ALTERNATIVE #9, ALTERNATIVE #10 & ALTERNATIVE #10a

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

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point, it would require legislation insuring the right to pump the recharge-enhanced ground water. This alternative is not recommended due to the uncertainty of being able to pump the water from the aquifer and problems and risks associated with attempting to change state law, as well as the fact that it provides no advantages to its major participant, Dripping Springs.

3.2.12 Alternative 10 - San Marcos Supplied from the Guadalupe River by Releases From Canyon Lake -East

This alternative serves only San Marcos and is based on releasing Canyon Lake water to the Guadalupe River and diverting the water at a point east of Interstate Highway 35 with a low head dam. Allowing Canyon Lake releases to pass through Canyon Lake Dam will preserve GBRA hydropower generation and would support recreation interests in that stretch of the Guadalupe River from Canyon Lake to the diversion point. The water would be treated at a facility located near the river and pumped to San Marcos as shown in Figure 3.2-9. The total project cost (first phase) of this system is estimated to be $17 million with a $2.71 million raw water contract.

3.2.13 Alternative 10a - San Marcos Supplied from the Guadalupe River by Releases From Canyon Lake - West

This alternative is similar to one being evaluated by the City of San Marcos and is similar to the previous alternative, but utilizes a river intake site near the community of Gruene, west of Interstate Highway 35. As with Alternative 10, the water would be treated at the river site and pumped to San Marcos. This alternative is less expensive than Alternative 10 due to shorter pipeline lengths and lower pumping head. The total project cost estimate (first phase) is $13.8 million. The raw water cost is the same for Alternative 10: $2.71 million. This alternative is illustrated in Figure 3.2-9.

3.2.14 Alternative 10b - Eastern Hays County (San Marcos, Kyle, Mountain City, and Northeast Hays County) Supplied from the Guadalupe River by Releases from Canyon Lake

Alternative 10b, which is an extension of Alternative 10a, involves the same pipeline system presented in Alternative 10a, except that the pipeline and treatment facility would be enlarged to provide capacity to serve Kyle, Mountain City, and the northeast portions of the County as well as San Marcos. A pipeline would extend from San Marcos to Kyle, and then another pump station and pipeline would be added to service Mountain City. In 2005, a second pump station and a pipeline extension would be constructed to serve the demands in the northeast portion of the County. This system is illustrated in Figure 3.2-10.

The total project cost (first phase) for this alternative would be about $25.89 million and the raw water contract would cost about $3.54 million which is higher than the total cost of Alternative 10a. However, the cost of this alternative to San Marcos would be the same or slightly lower than Alternative 10a. This alternative is recommended for implementation because of the relatively low costs to all the areas served and because purchasing stored water which is currently available within the basin assures that this alternative is reliable and implementable.

3.2.15 Alternative 11 - Dripping Springs Supplied From Lake Dripping Springs

Alternative 11 investigated the construction of a water supply reservoir on Onion Creek to serve the initial water needs of Dripping Springs and its surrounding ETJ. A reservoir site was identified, which, based on a preliminary optimization and yield analysis, is estimated to provide a firm yield (the maximum annual withdrawal of water which can be taken without shortage during the worst drought of record) of 2.8 mgd if only unappropriated flows were retained. A table of storable flows for the period 1940 through 1972 is shown in the Appendix.

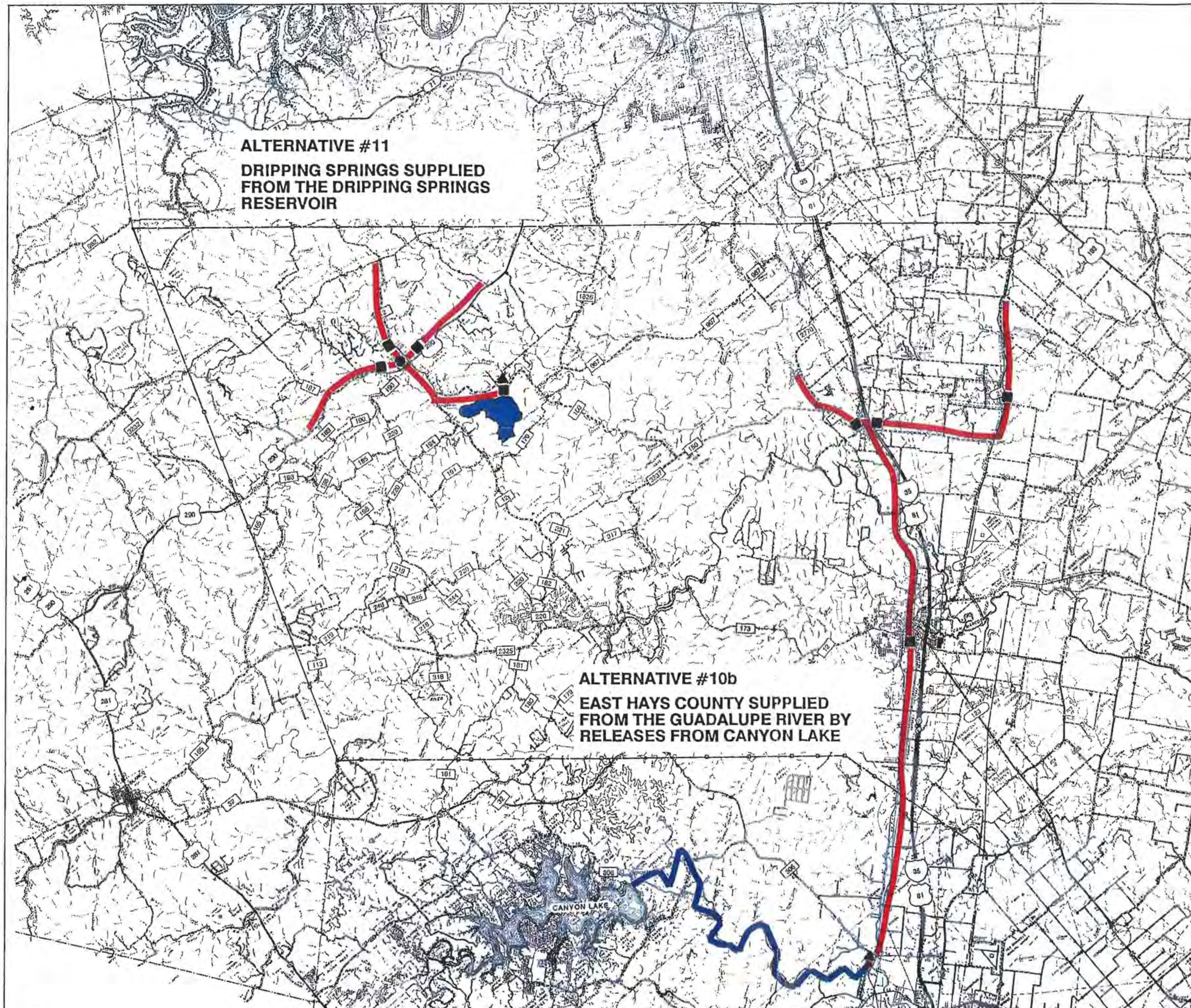


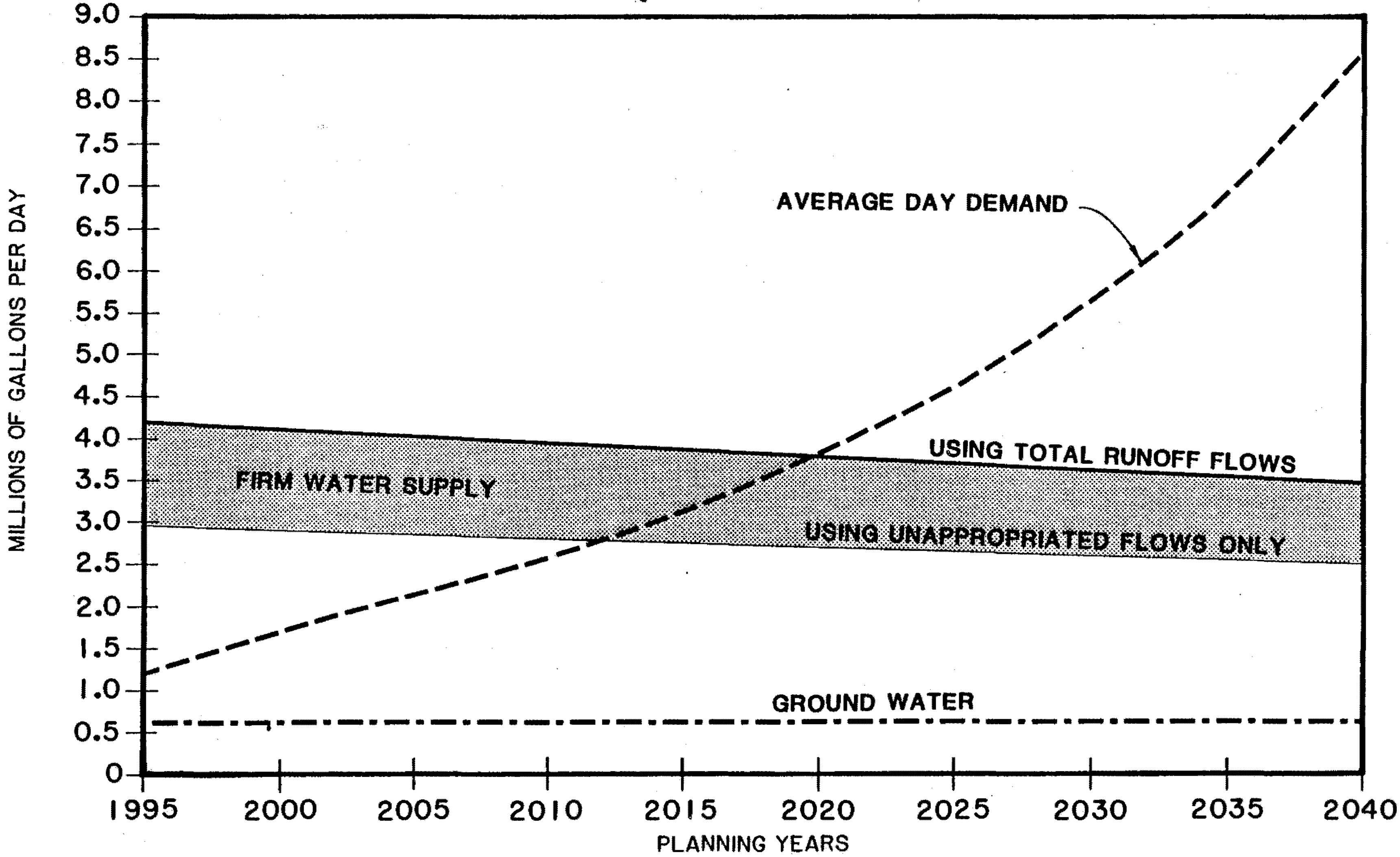
FIGURE 3.2-10

ALTERNATIVE #10b & ALTERNATIVE #11

The yield of the reservoir, named Lake Dripping Springs, using only unappropriated flows would meet Dripping Springs projected demands to the year 2012. If water rights along the Colorado River downstream of the confluence of Onion Creek and the Colorado River that are now being met by Onion Creek flows could be met by releases from the Highland Lakes system, then the reservoir could continue to meet demands until about the year 2020. Figure 3.2-11 illustrates the supplies available from this reservoir and expected demands which would be placed on the reservoir.

The major costs for this alternative are the dam and associated land costs. The estimated cost for the project (first phase) is $21.35 million and the present worth of the water contract cost is estimated to be $390,000. Various types of dams were investigated for cost effectiveness and an earthfill type dam estimated at $4.5 million was selected as being most economical. The land costs are estimated to be $5.25 million, and it is important to note that the cost of this alternative is highly sensitive to the cost of land. If land costs were to return to the level experienced in 1984, the cost of this alternative would escalate significantly.

As shown in Figure 3.2-10 a short raw water pipeline would be constructed from the dam site, where the intake would likely be integrated into the dam, to a nearby treatment facility. Treated water would then be piped to Dripping Springs for distribution. Between the years 2012 to 2020, when the demand on the system reaches the firm yield of the reservoir, it would be necessary to build a raw water line from Lake Travis to the reservoir, tie the north end of the system into a treated water system, or obtain another water supply source. The relative costs for this alternative and the concept of storing available flows for use as needed are the major factors involved in selecting it for further comparison to Alternative 12 to serve the Dripping Springs ETJ.



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WATER USE PROJECTIONS & AVAILABLE SUPPLY FROM PROPOSED DRIPPING SPRINGS RESERVOIR

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.2-11

This alternative would require detailed studies of the potential environmental impacts of the project. A plan for mitigating adverse impacts would be required depending on the impacts found in the studies.

3.2.16 Alternative 12 - Dripping Springs Supplied from Lake Travis

Alternative 12 would supply Dripping Springs directly from Lake Travis. This would involve constructing an intake in the lake and pumping raw water to a treatment site near FM 71. The treated water would then be pumped over relatively rugged terrain to Ranch Road 12 and then into Dripping Springs for distribution. Figure 3.2-12 illustrates this system.

The project cost (first phase) for this alternative is estimated to be $19.47 million, which is slightly less than Alternative 11, however, the raw water cost is higher and, therefore the monthly cost increase per connection would be higher.

Because Alternatives 11 and 12 are practically the same cost and considering the level of detail in this study, it is recommended that both alternatives be chosen as recommended alternatives. The selection of one of these two alternatives should be made following more detailed studies.

3.2.17 Alternative 12a - Dripping Springs, Wimberley, and Woodcreek Supplied From Lake Travis

This system is a variation of Alternative 12 which involves constructing a pipeline along Ranch Road 12 from Dripping Springs to Wimberley as shown in Figure 3.2-13. A pump station would boost the water pressure to the higher level required in Woodcreek and pump it the added distance.

Although this concept would reduce the cost to Dripping Springs, it is not cost effective for Wimberley or Woodcreek. The pipeline crosses the Guadalupe River Basin boundary and, with the water originating in the Colorado River Basin, an Interbasin

Transfer Permit from the Texas Water Commission would be required. Because of the higher costs to Wimberley and Woodcreek and the uncertainty of obtaining the required permit, this alternative is not recommended.

3.2.18 Alternative 13 - Wimberley and Woodcreek Supplied From Canyon Lake

Alternative 13 involves pumping water from Canyon Lake to the communities of Wimberley and Woodcreek. Unlike Alternative 5a, water from the Blanco River would not be used and all demands would be met from Canyon Lake. The intake would be located near the dam as shown in Figure 3.2-14 to gain access to the storage pool of Canyon Lake. Raw water would be piped to a treatment facility located near the lake and then treated water would be piped to Wimberley. Subsequently the treated water would be pumped to Woodcreek through a pipeline along FM 2325.

The total project cost (first phase) of this alternative is $6.87 million and a 20-year raw water contract would add about $230,000 to this total cost. As shown in Table 3.1-4, this alternative would cost about $4 more per month per connection than Alternative 5a, and, therefore, Alternative 13 is not the recommended alternative.

3.2.19 Alternative 14 - East Hays County Supplied From the San Marcos River Firmed From Canyon Lake

This alternative would involve constructing a river intake and placing a low head dam or possibly constructing an alluvial collector in the Guadalupe River to divert releases which would be purchased from Canyon Lake. Raw water would be pumped to a treatment plant located in San Marcos adjacent to the San Marcos River as shown in Figure 3.2-14. This would allow water to be taken from the San Marcos River when it is available and thereby reduce the cost of constantly pumping from the Guadalupe River. From the treatment plant, treated water would be supplied to San Marcos while another series of pipelines would transport water to Kyle and the northeastern communities. The

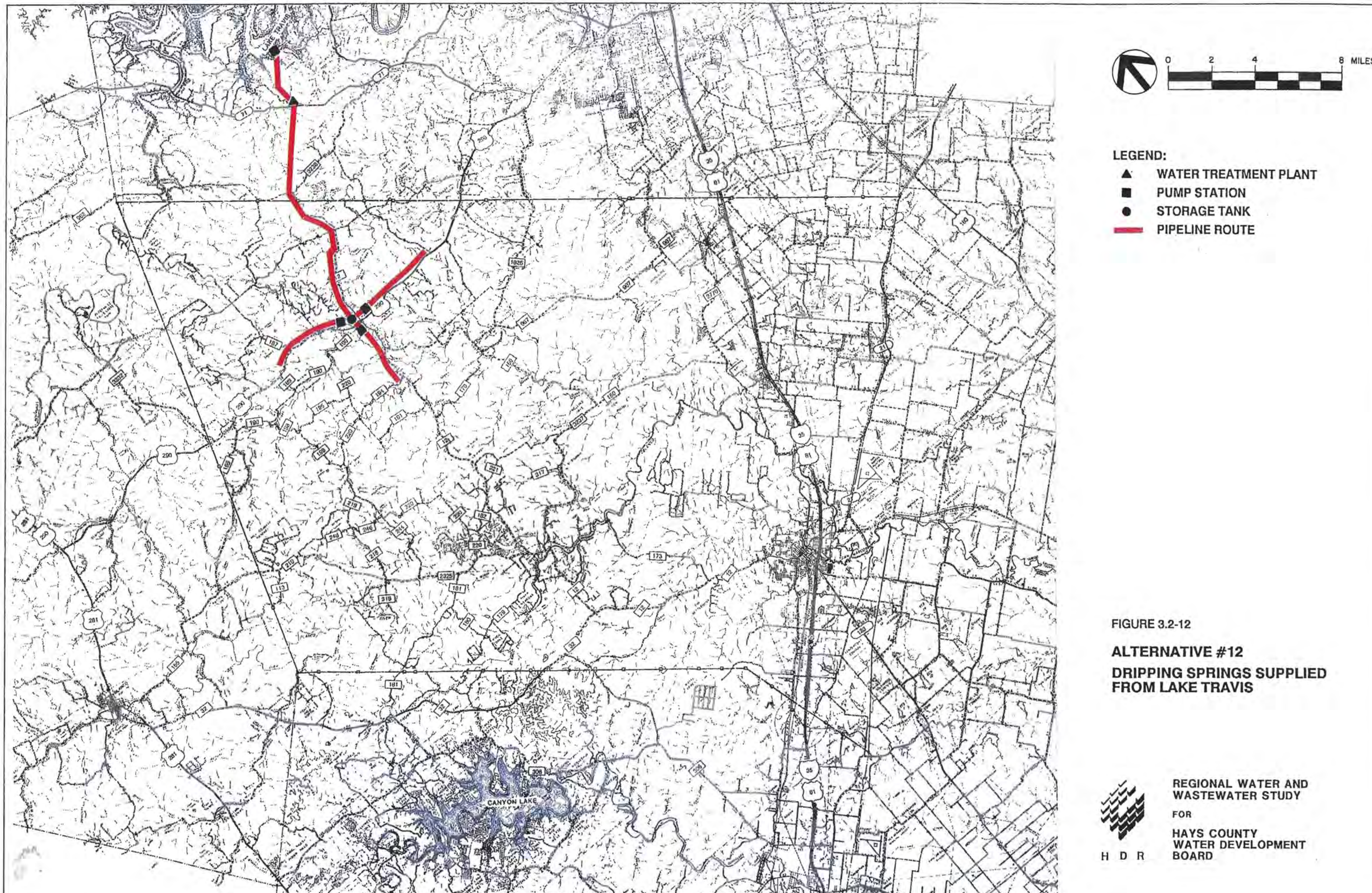

FIGURE 3.2-12

ALTERNATIVE #12

DRIPPING SPRINGS SUPPLIED FROM LAKE TRAVIS

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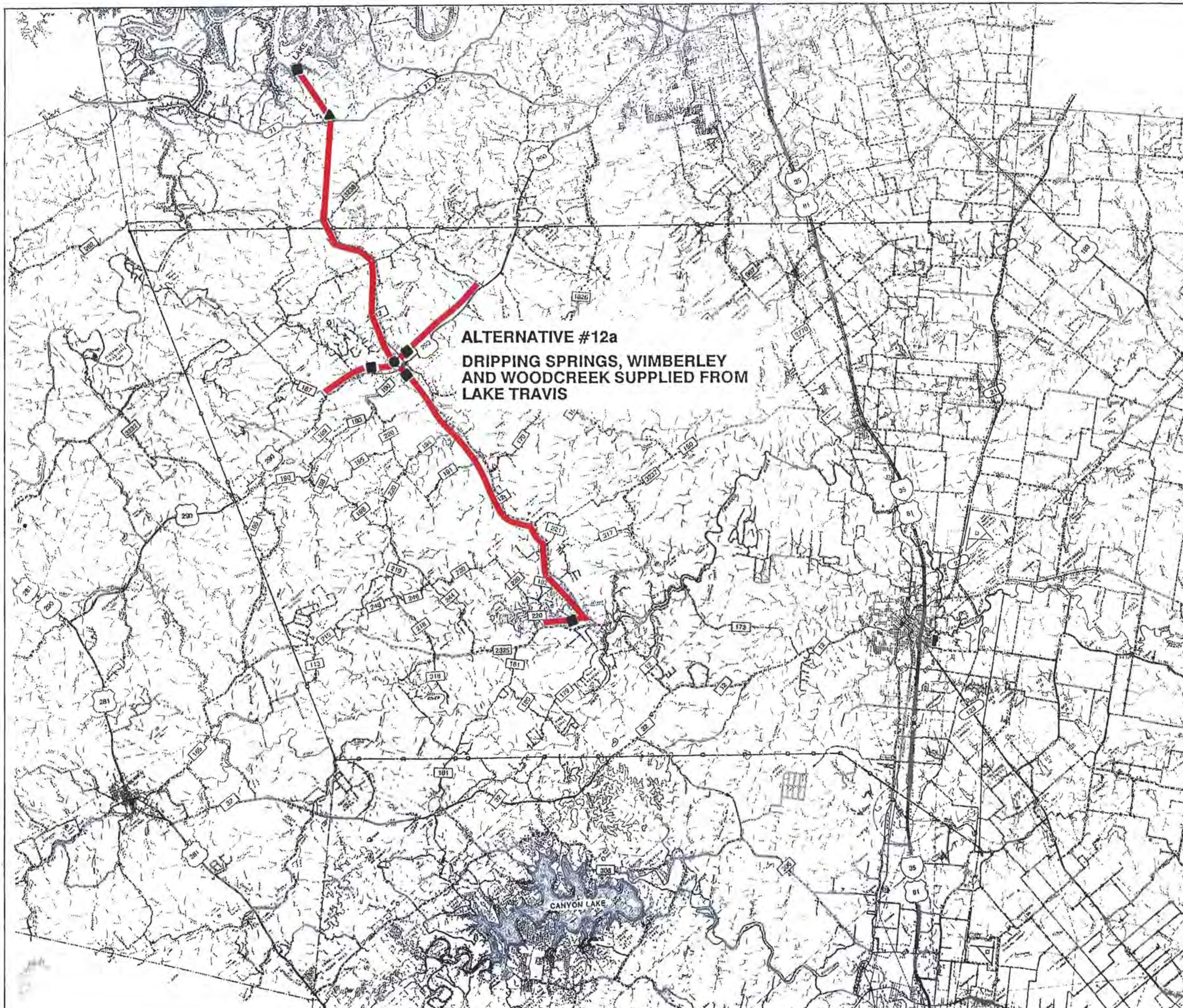

FIGURE 3.2-13

ALTERNATIVE #12a

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REGIONAL WATER AND WASTEWATER STUDY
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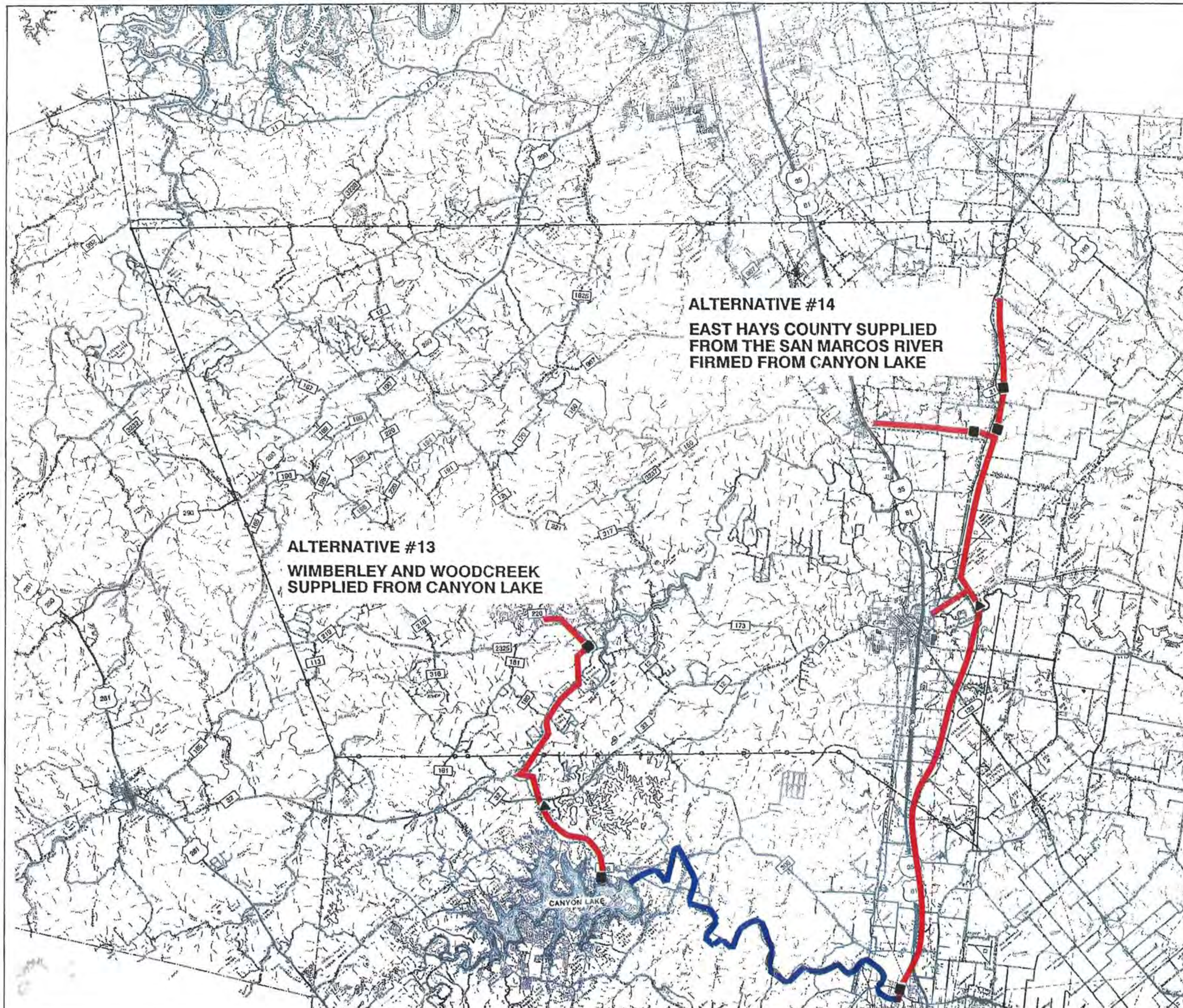
HAYS COUNTY WATER DEVELOPMENT BOARD



LEGEND:
▲ WATER TREATMENT PLANT
■ PUMP STATION
PIPELINE ROUTE
RIVER

FIGURE 3.2-14

ALTERNATIVE #13 & ALTERNATIVE #14

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FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

scheduling of this alternative would require initial delivery of water to San Marcos in 1995, with the northeast communities deferring use of the system until 2005.

The total project cost (first phase) for this system would be $28.3 million which is approximately $3 million more than Alternative 10b which is similar. The increase is due in part to the longer piping distances required to reach the plant site east of the Interstate and the greater head loss associated with the longer pipe line. The raw water cost of $3.5 million is about the same as Alternative 10b. One negative associated with this alternative is that water might not be available in the San Marcos River as previously discussed, thereby eliminating the anticipated benefit of locating the treatment plant on the San Marcos River. In addition to higher costs, this was one of the factors that prevented this alternative from being recommended.

3.2.20 Alternative 14 a - Northeast Hays County, Kyle, and Mountain City Supplied From the San Marcos River

Alternative 14a is a variation of Alternative 14 which eliminates the direct use of Canyon Lake water and supplies the northeast part of the county with raw water from the San Marcos River (see Figure 3.2-15). Based on historical flows in the San Marcos River (discussed in Section 2.2), there is sufficient flow available to meet the needs of the communities of Kyle, Mountain City, and the northeast area. However, using the San Marcos River would require the purchase of releases from Canyon Lake to meet downstream water rights along the Guadalupe River that are currently being satisfied from the San Marcos River, and despite the historical availability of water in the San Marcos River, there is some uncertainty about its future availability due to pumping of the Edwards Aquifer which would reduce the flow of the San Marcos Springs and San Marcos River.

In terms of cost, this is an attractive alternative with cost increases varying from $19 to $26 per month per connection. The low cost of water and close proximity of the supply are the major factors in the low cost, however, this alternative would depend on the San Marcos Springs continuing to flow as they have historically. This uncertainty resulted in Alternative 14a not being recommended for further study.

3.2.21 Alternative 15 - Wimberley and Woodcreek supplied from the Blanco River and Off-Channel Storage

In an attempt to identify a nearby water supply for Wimberley and Woodcreek, reservoir sites were investigated along the Blanco River. Because of spillway costs and sedimentation considerations, an off-channel site, in Smith Hollow rather than a dam on the river was selected for evaluation.

The alternative would consist of an off-channel reservoir and river intake located upstream from Wimberley and a low head dam and river intake which would be used to divert water to a treatment plant located adjacent to the river. A single pipeline and pump station would be required to supply Woodcreek as indicated in Figure 3.2-15.

A computer simulation of the system's operation was performed to verify the technical feasibility of the alternative. The Blanco River was simulated so that only those unappropriated flows which exceed a base unappropriated flow of 18 cubic feet per second were eligible for diversion. When unappropriated water was available and the base flow was satisfied, then the water could be utilized by the treatment plant in Wimberley. Further, if flows exceeded the demand at the water treatment plant, then the excess water could be pumped into the off-channel storage reservoir. Similarly, if water was not available to meet the need at the plant, then water would be released from the off-channel reservoir and diverted at the plant intake.

The estimated cost for this alternative is high. The off-channel storage site would require a high dam with estimated construction costs of approximately $13 million and total project cost (first phase) estimated at $21.18 million. The estimated costs per connection per month would be $79 and $89 for Wimberley and Woodcreek, respectively.

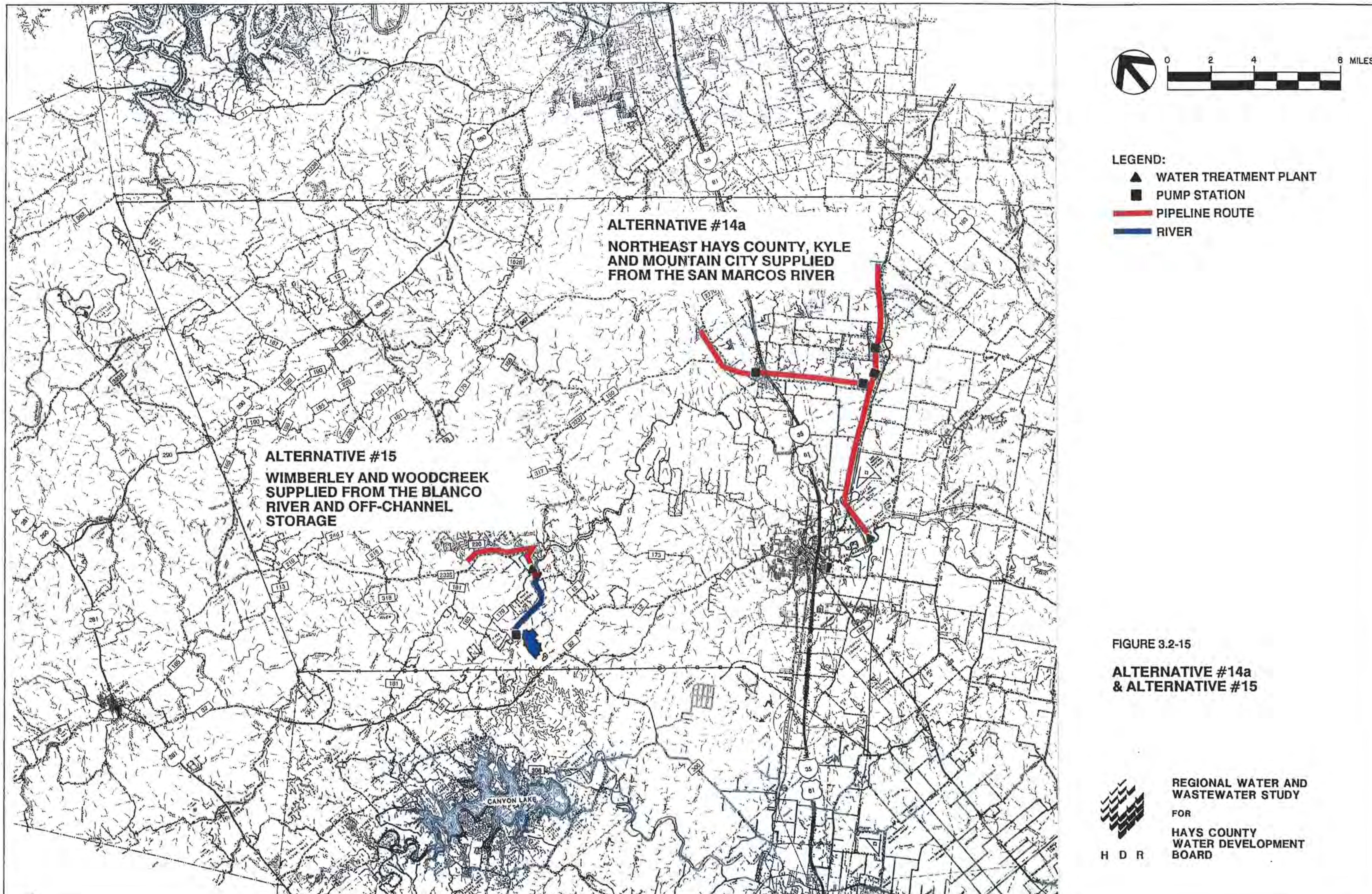

FIGURE 3.2-15

ALTERNATIVE #14a & ALTERNATIVE #15

REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

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Because of the high costs, this alternative is not recommended for implementation.

3.3 Recommended Alternatives and Plans of Implementation

Of the many alternatives which were presented in Section 3.2, several have been selected and are recommended for implementation to provide the water which will be needed for the growth of Hays County.

The five recommended alternatives are all different and each will have unique opportunities for cost savings. The following discussion further analyses each of the alternatives and rather than looking only at the 20 year cost, which was used in Section 3.2 to compare alternatives, seeks a more cost effective implementation program for each of the recommended alternatives.

The following alternatives have been selected for implementation and will be discussed in the following sections:

Alternative	Areas Served
5a	Wimberley/Woodcreek
7	Buda/Hays City
10b	San Marcos, Kyle, Mountain City, Uhland, Plum Creek, County Line, and Goforth WSC's
11 or 12	Dripping Springs

Each plan will be discussed with regard to construction phasing, construction costs, operating and maintenance costs, and other pertinent issues.

It is important to note that conservation effects have not been included in determining the schedule of implementation presented in the following section. Conservation may delay the schedules and/or reduce the costs. Conservation is considered to be a very important part of Hays County's water plan, and will be discussed in Section 6. The estimates of costs for the selected alternatives, assuming the target reductions in demand developed in Section 6 are met, are shown in Section 3.4.

3.3.1 Plan for Wimberley/Woodcreek Area

Alternative	Areas Served	Brief Description
5a	Wimberley/Woodcreek	Supply from Blanco River with Canyon Lake Backup

Estimates of the supply of water available in the Blanco River, according to the Texas Water Commission's (TWC) model, show that the Blanco River could meet the demands for Wimberley and Woodcreek with unappropriated flows except during a drought as severe as the worst drought on record. The sum of these unmet demands in the year 2015 are estimated to be 460 acre-feet and in the year 2040 are estimated to be 1,480 acre-feet, assuming ground water usage is maintained at 770 acre-feet per year.

The first phase of this project would require the construction of a diversion pump station on the Blanco River, a low head dam to provide pump submergence and storage, a water treatment plant, and a treated water transmission pipeline. As growth dictates, the yield of the Blanco River would have to be supplemented by adding an intake in Canyon Lake and a transmission pipeline from Canyon Lake to the Blanco River. It is estimated that the transmission pipeline from Canyon Lake could be delayed until the year 2000, but some risk would be incurred. In the year 2000, the projected average daily demand is 0.79 mgd and the maximum day demand is 1.71 mgd. In order to meet these demands, it is estimated that ground water will supply 0.69 mgd, leaving 0.10 mgd average day demand and 1.02 mgd maximum day to be supplied by the surface water system.

If the drought of record did occur before the year 2000, it is possible that the supply from the Blanco River would be insufficient to meet demands without the construction of the Canyon Lake intake and supply pipeline. However, the relatively low demand projected during this period could probably be met by additional ground water pumping and the implementation of a mandatory water conservation plan.

As shown in Table 3.3-1 the estimated average cost per connection during the first phase is $22 per month. This includes engineering, construction, and operation and maintenance costs. The estimated average cost per connection during the second phase, five to ten years following construction of initial facilities, is $31 per month. Construction of the second phase facilities initially in order to guarantee meeting all demands during a severe drought would increase the initial monthly cost to $33.

The monthly cost estimate includes water which would be required to provide supplemental supply during drought periods. This would require a water contract with the Guadalupe Blanco River Authority for water stored in Canyon Lake. The estimated volume to be contracted is 1,480 acre-feet per year to cover the system's needs through the year 2040. The estimated annual cost of the water is $66,000 based on a selling price of $0.137 per 1000 gallons. Figure 3.3-1 shows a plan of the required facilities. Cost of each phase, its scheduled implementation and water demands are shown on Figure 3.3-2.

3.3.2 Recommended Plan for Hays City and Buda

Alternative	Area Served	Brief Description
7	Buda/Hays City	Supply from City of Austin

Of the alternatives evaluated, Alternative 7 is the most feasible for Hays City and Buda, considering reliability of water sources, overall costs, and environmental impacts. The City of Austin has indicated a willingness to supply the Buda and Hays City areas from an existing 36-inch pipeline which is part of a reliable municipal system providing treated surface water from Lake Austin and Town Lake.

Obtaining this water would require the construction of approximately seven miles of transmission pipeline and two booster pump stations. The connection would be made to the City of Austin's pipeline at a site near Manchaca Road, about 0.7 miles north of Manchaca. Then, the route of the pipeline would pass through Hays City and terminate

Table 3.3-1

ALTERNATIVE #5a - PHASING SCHEDULE						
PHASE	Ia	Ib	II	III	IV	V
PERIOD	1995-2000	2000-2005	2005-2015	2015-2025	2025-2035	2035-2040
Population*						
- Wimberley	3951	4476	5376	6600	8100	8775
- Woodcreek	1256	1457	1813	2436	3274	4098
Total	5207	5933	7189	9036	11374	12873
Estimated Connections*						
- Wimberley	1320	1490	1790	2200	2700	2925
- Woodcreek	800	930	1170	1550	2090	2610
Total	2120	2420	2960	3750	4790	5535
Surface Demands (mgd)*						
Average day	.04	.14	.33	.61	.96	1.22
Maximum day	.93	1.15	1.55	2.16	2.94	3.31
Construction Costs (millions)						
River Intake	$.60					
Treatment Plant	1.47		$.84	$.98	$1.05	$1.09
Raw Water Line		$2.92		1.93		
TW Line to Woodcreek	.67	—	—	.68	—	—
Total	$2.74	$2.92	$.84	$3.59	$1.05	$1.09
Annual Costs (millions)						
New Debt Service	$0.28	$0.30	$0.09	$0.37	$0.11	$0.11
Old Debt Service		.28	.58	.09	.37	.48
O&M	.20	.24	.36	.52	.66	.76
Raw Water	.07	.07	.07	.07	.07	.07
Total	$0.55	$0.89	$1.10	$1.05	$1.21	$1.42
Monthly Cost/Connection*						
Wimberley	$19	$28	$29	$22	$20	$21
Woodcreek	$26	$34	$34	$26	$23	$22
Overall	$22	$31	$31	$23	$21	$21

*Figures shown are for the mid-point of the period.

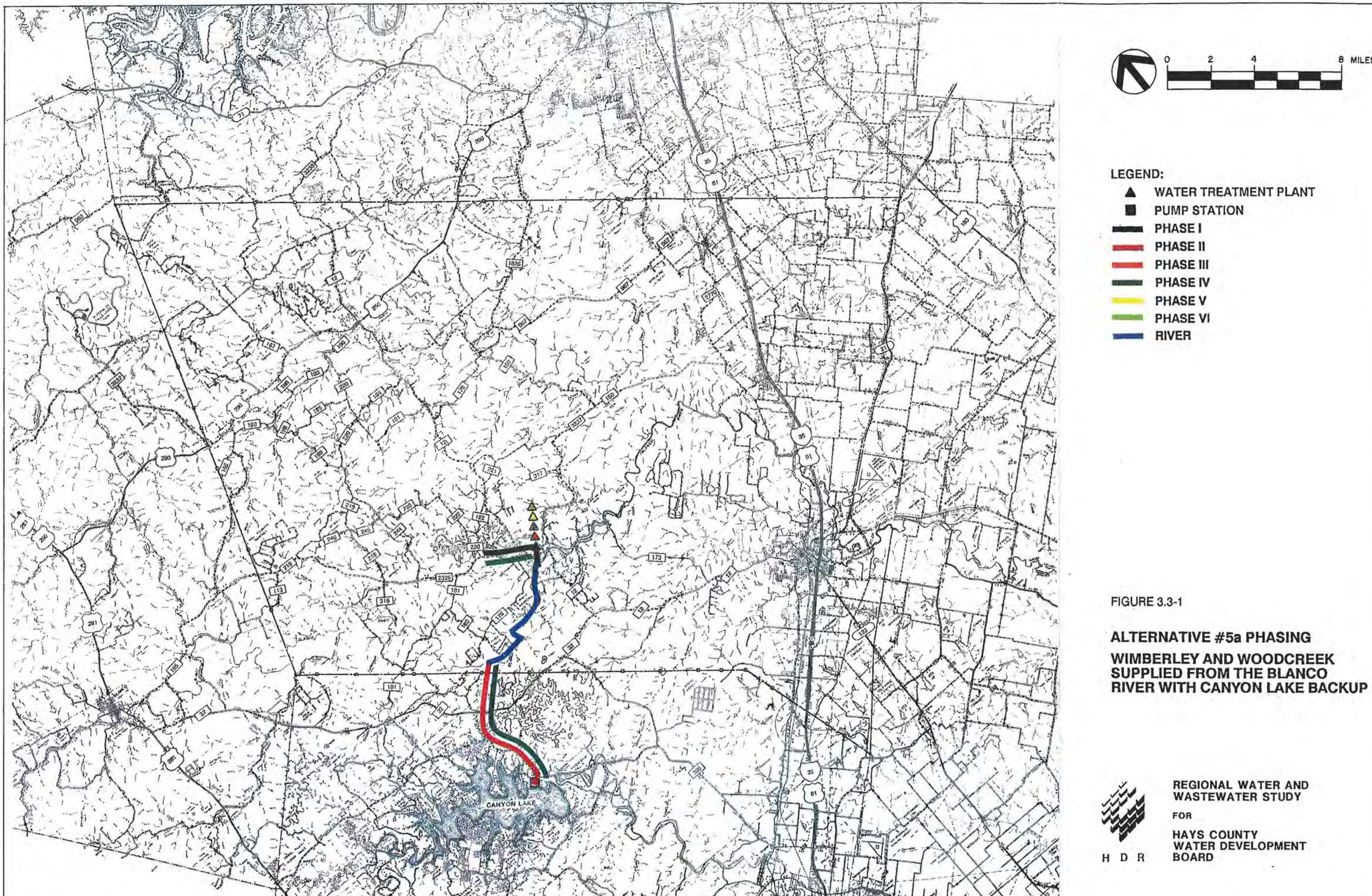

FIGURE 3.3-1

ALTERNATIVE #5a PHASING

WIMBERLEY AND WOODCREEK SUPPLIED FROM THE BLANCO RIVER WITH CANYON LAKE BACKUP

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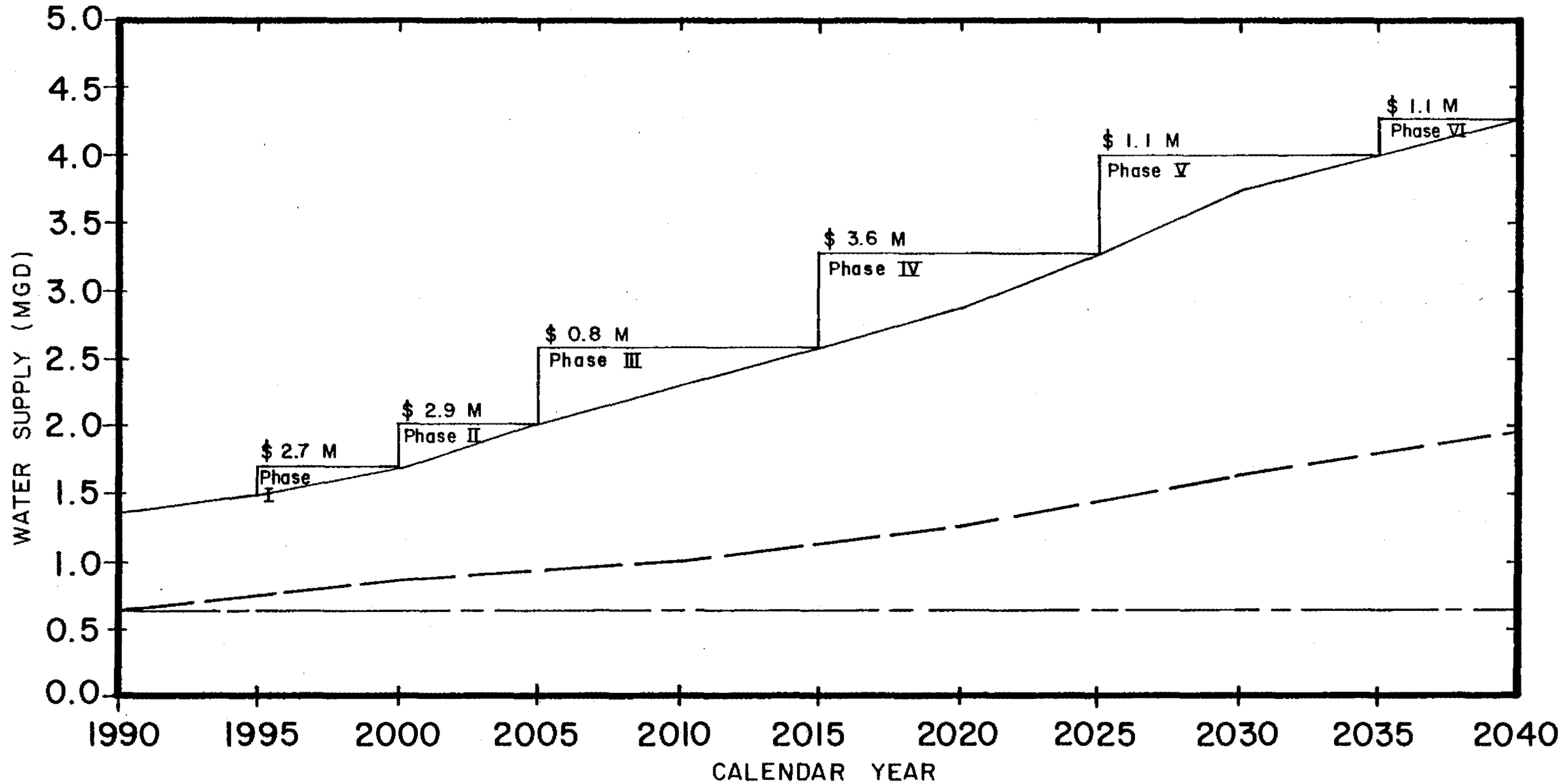

LEGEND:

- —— MAXIMUM DAY DEMAND
- — — AVERAGE DAY DEMAND
- - - - GROUND WATER

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ALTERNATIVE 5a
PHASING SCHEDULE FOR WIMBERLEY WSC AND WOODCREEK, TEXAS

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.3-2

in the Buda area. The system would be sized to deliver maximum daily demands over and above the amount which will continue to be supplied from ground water sources. One pump station and a storage tank would be located near the connection to the City of Austin's pipeline while the other pump station would be located in the Hays City area and would be an in-line booster which would pump the required flow to Buda.

A phased construction program as shown in Figure 3.3-3 is recommended so as to tailor facilities to demand. The first phase would include the two pump stations, the storage tank, and transmission pipelines sized for 20 years of growth. The second phase would include additional pumps and the construction of pipelines parallel to the first phase lines for the following 25 years of growth.

Annual costs include debt service on engineering, construction, and related costs, operation and maintenance costs, and costs for water. Water charges were estimated assuming current City of Austin charges which are $2.68 per 1,000 gallons plus a one time capital recovery charge.

The recommended construction phasing program is shown graphically in Figure 3.3-4 along with the projected water supply. Estimated construction costs for the first 20 years of operation include $750,000 for the pipeline, storage tank and pump station from the City of Austin connection to Hays City and $600,000 for the pump station and pipeline to Buda. Estimates of construction costs for the second 25 years of operation are also shown in Table 3.3-2. The estimated costs per connection per month for the first 10 years are $12 for Hays City and $19 for Buda. These costs increase somewhat as shown in Table 3.3-2.

3.3.3 Recommended Plan for Eastern Hays County

Alternative	Areas Served	Brief Description
10b	San Marcos, Kyle, Mountain City, Plum Creek WSC, Uhland, County Line WSC, & Goforth WSC	Supply by pipeline from Canyon Lake

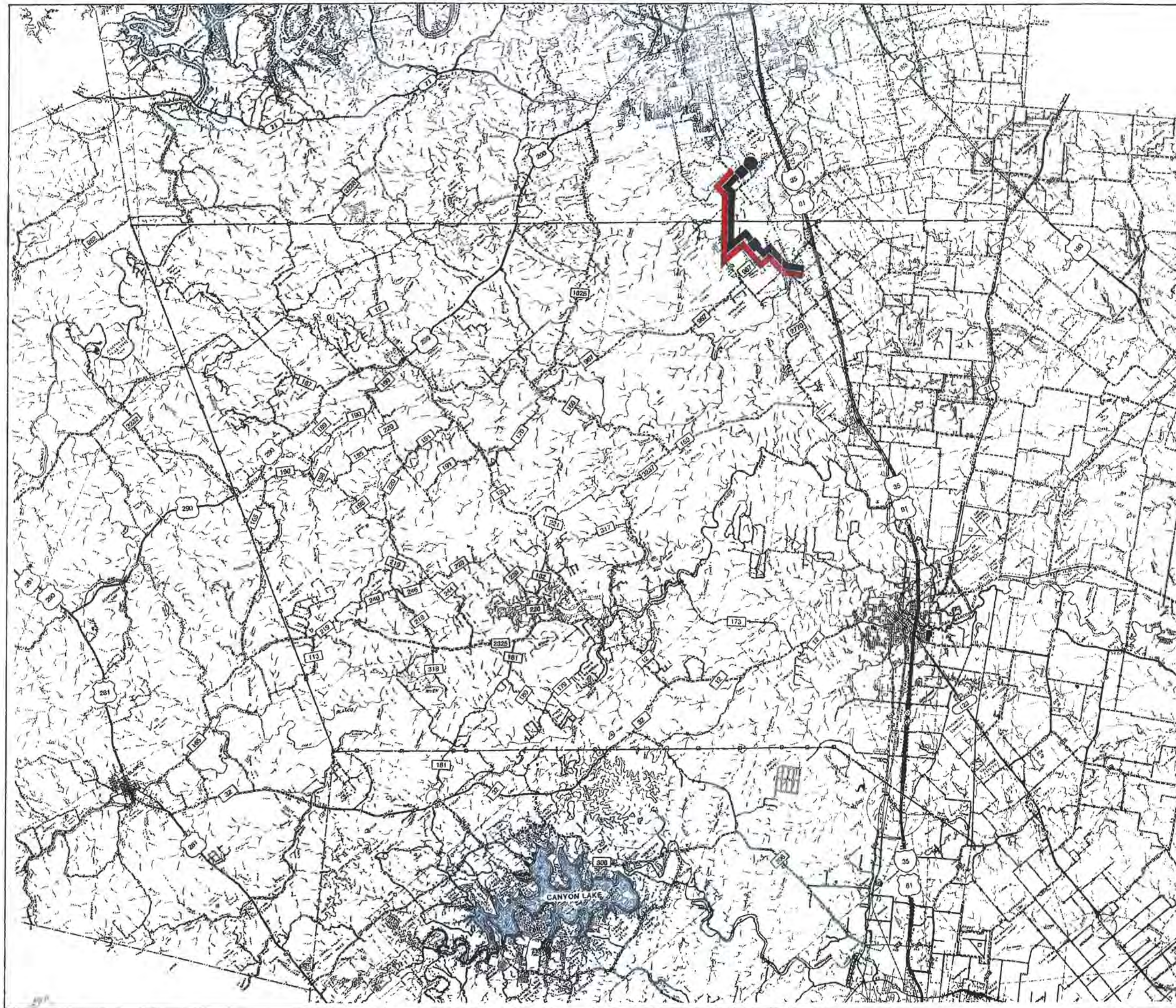

FIGURE 3.3-3

ALTERNATIVE #7 PHASING

BUDA AND HAYS CITY SUPPLIED FROM THE CITY OF AUSTIN

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FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

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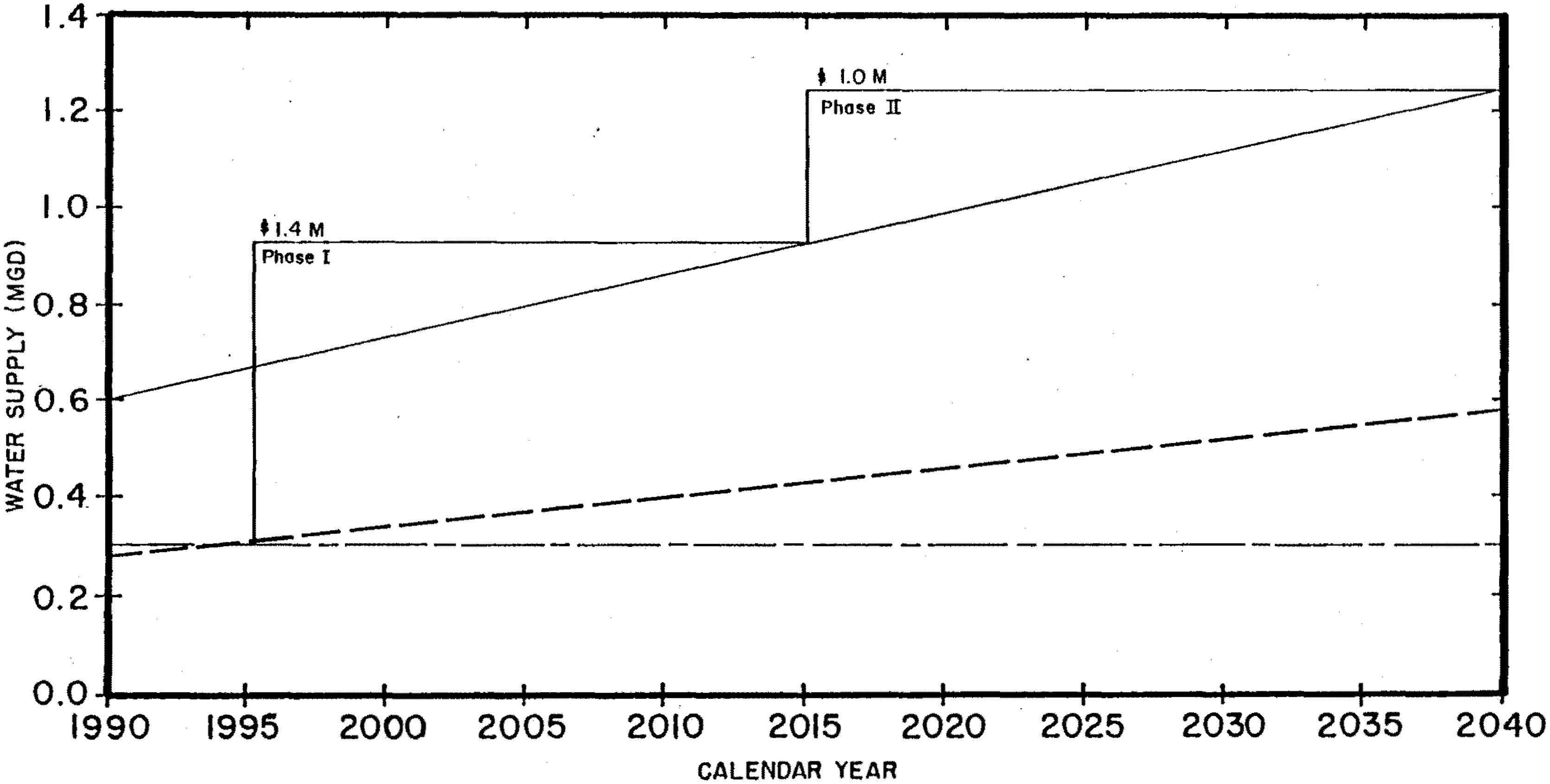


LEGEND:

- ——— MAXIMUM DAY DEMAND
- — — AVERAGE DAY DEMAND
- —·— GROUND WATER

HDR

ALTERNATIVE #7 PHASING SCHEDULE FOR HAYS CITY AND BUDA, TEXAS

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.3-4

TABLE 3.3-2

ALTERNATIVE #7 - PHASING SCHEDULE

PHASE	Ia	Ib	IIa	IIb	IIc
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
- Hays	860	1080	1300	1530	1690
- Buda	2260	2580	2910	3240	3480
Total	3120	3660	4210	4770	5170
Estimated Connections*					
- Hays	300	370	450	530	590
- Buda	780	890	1000	1100	1180
Total	1080	1260	1450	1650	1770
Surface Demands (mgd)*					
Average day	.03	.09	.14	.21	.25
Maximum day	.43	.55	.68	.81	.91
Construction Costs (millions)					
Delivery Storage	.07				
Pump station & Pipelines					
- to Hays	.68		.53		
- to Buda	.60		.47		
	$1.35		$1.00		
Annual Costs (millions of $)					
Debt Service	$.14	$.14	$.10	$.10	
O&M	.01	.01	.02	.02	$.03
Treated Water	.07	.12	.15	.22	.25
Total	$0.22	$0.27	$0.27	$0.34	$.28
Monthly Cost/Connect					
- Hays	$12	$14	$12	$15	$13
- Buda	$19	$19	$16	$18	$13
- Overall	$17	$18	$16	$17	$13

*Figures shown are for the mid-point of the period

Considering estimated costs, implementation, reliability of water supply, and environmental impacts, the alternatives evaluation concluded that a supply from Canyon Lake would provide the most feasible plan for serving the San Marcos, Kyle, Mountain City, and Northeast County areas. The projected year 2040 requirement from surface water sources to supply all these communities is 16.75 mgd as shown in 10-year increments in Table 3.3-3. At present, sufficient water is available from the Canyon Lake to supply this projected requirement.

A phased construction program tailored to meet the water supply requirements as growth occurs is presented in Figure 3.3-5. A graph of water demands and costs of water supply phases are shown in Figure 3.3-6. This type of plan allows those being served to pay the costs of the construction, thus minimizing the cost per connection to the water users. The projected total construction costs and total costs per connection (excluding right-of-way), for 10 year increments, are shown for each entity in Table 3.3-3.

The phasing plan is based on the population and water use estimates which show that San Marcos, Kyle, and Mountain City will require additional water in 1995, and that Plum Creek WSC, Uhland, County Line WSC, and Goforth WSC will require service in 2005. To contain costs, treatment plants will be expanded at 10 year intervals and pipelines will be constructed initially to supply 20 year's of growth and then, subsequently to supply 25 years through year 2040.

It is assumed that Uhland and Plum Creek, County Line, and Goforth WSC's (NE County Area), would utilize the 1995 transmission lines from 2005 to the time for the first transmission pipeline expansion. The charge for this use has been included in the annual costs for the NE County area in Phase 2. The Phase 2 charges for the NE County also include prorata cost sharing of the intake pump station and raw water supply with accrued interest.

TABLE 3.3-3

ALTERNATIVE #10b - PHASING SCHEDULE					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
- San Marcos	50,700	63,350	76,000	88,650	98,140
- Kyle	7,592	11,238	16,634	24,623	33,200
- Mountain City	490	590	720	860	1,000
- Plum Creek WSC	3,861	4,624	5,537	6,630	7,600
- Uhland	320	446	584	766	940
- County Line WSC	997	1,192	1,425	1,703	1,949
- GoForth WSC	4,500	6,000	7,000	8,000	8,750
Total	68,460	87,440	107,900	131,233	147,579
Estimated Connections*					
- San Marcos	9,770	12,210	14,640	17,080	18,910
- Kyle	2,260	3,340	4,550	7,330	9,880
- Mountain City	150	180	220	270	310
- Plum Creek WSC	1,220	1,460	1,750	2,100	2,410
- Uhland	110	150	170	260	310
- County Line WSC	270	320	390	460	530
- GoForth WSC	1,480	1,970	2,300	2,630	2,880
Total	15,260	19,630	24,440	30,130	35,230
Surface Demands (mgd)*					
Average day	2.45	5.57	8.85	12.52	15.66
Maximum day	8.22	14.40	19.82	25.99	31.38
Construction Costs (millions)					
Intake & Dam	$1.20				
Treatment Plant	9.83	$6.45	$5.76	$6.41	$6.96
Treated Water Line	7.24		7.30		
Line to Kyle	3.74		3.56		
Line to Mountain City	.60		.49		
Line to Uhland & County Line WSC		1.34		.95	
Line to Goforth WSC		.73		.45	
Total	$22.61	$8.52	$17.11	$7.81	$6.96
Annual Costs (millions of $)					
New Debt Service	$2.30	$.87	$1.74	$.80	$.71
Old Debt Service		2.30	.87	1.79	.80
O & M	.34	.63	.94	1.19	1.45
Raw Water	.84	.84	.84	.84	.84
Total	$3.48	$4.64	$4.39	$4.62	$3.80
Monthly Cost/Connection ($)					
San Marcos	$19	$17	$13	$11	$9
Kyle	33	21	16	13	9
Mountain City	67	50	35	29	9
Plum Creek		35	18	15	10
Uhland		35	18	15	10
County Line		35	18	15	10
Goforth WSC		39	21	16	11
Overall	19	20	15	13	9

*Figures shown are for the mid-point of the period.

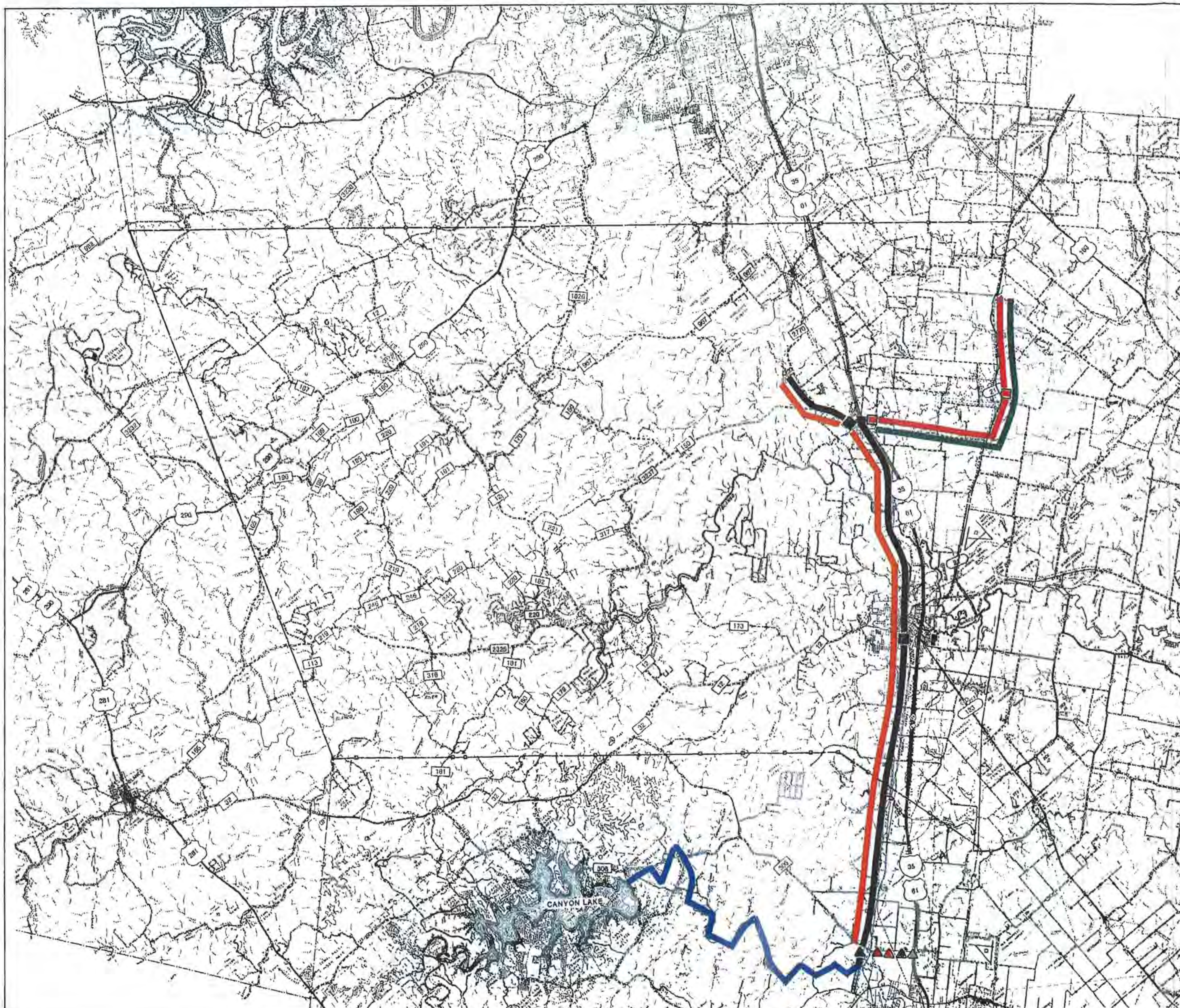


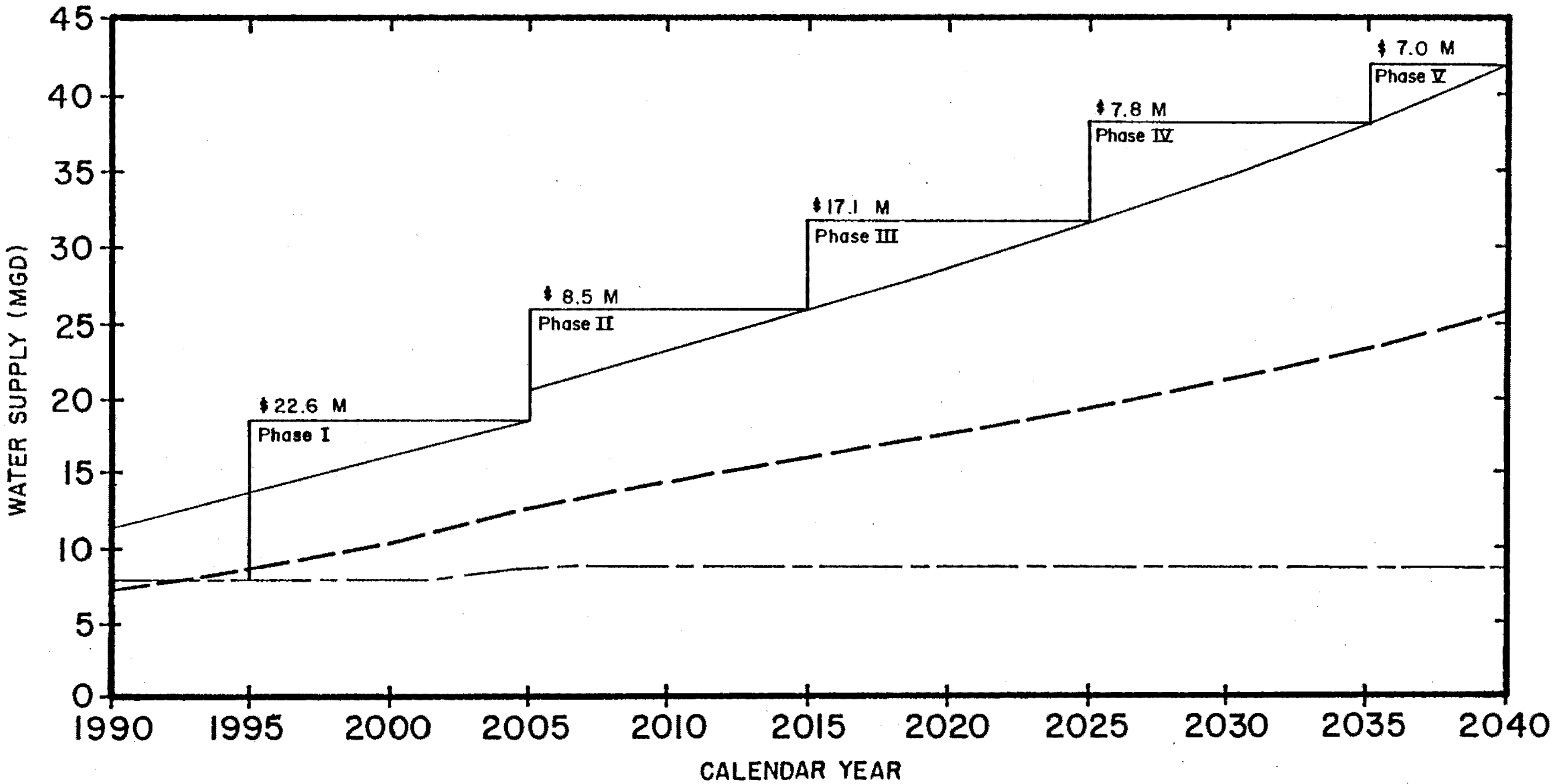
FIGURE 3.3-5

ALTERNATIVE #10b PHASING

EAST HAYS COUNTY SUPPLIED FROM THE GUADALUPE RIVER BY RELEASES FROM CANYON LAKE

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD



*UHLAND, PLUM CREEK WSC, GOFORTH WSC, AND COUNTY LINE WSC COME ON LINE IN THE YEAR 2005.

LEGEND:
- ——— MAXIMUM DAY DEMAND
- — — AVERAGE DAY DEMAND
- - - - GROUND WATER

H D R

ALTERNATIVE #10b
PHASING SCHEDULE FOR SAN MARCOS, KYLE, MOUNTAIN CITY & *NE COUNTY

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.3-6

A raw water contract with GBRA to supply the requirements of all entities served through year 2040 is included. This contract will provide 18,760 acre-feet per year. The estimated annual cost of the raw water is $840,000 based on a price of $0.137 per 1000 gallons.

The estimated initial construction cost for Phase I is $22.61 million. In Phase II, expansion and construction costs would be $8.52 million. However, debt service would still be required for Phase I based on a 20-year bond issue, increasing annual costs during Phase 2 from $3.48 to $4.64 million, but the population increase reduces the effect of the higher annual cost. In the subsequent phases, increased population and lower expansion costs reduces the cost per month for the system.

3.3.4 Plan A for Dripping Springs

Alternative	Area Served	Brief Description
11	Dripping Springs	Supply from Lake Dripping Springs located on Onion Creek

Comparative studies using the HDR cost estimating model and the TWC model for water availability showed that Dripping Springs could be supplied from a new reservoir located on Onion Creek at approximately the same cost as purchasing and delivering water from Lake Travis to Dripping Springs. Preliminary studies indicate the yield of the new reservoir will meet the surface water requirements of Dripping Springs until about 2015, assuming that growth and demand occur as projected. Following year 2015, a supplemental supply would be required from Lake Travis, but it is possible that Lake Dripping Springs could be used as a balancing reservoir to receive raw water deliveries from Lake Travis at average demand rates, thereby reducing the size of the pipeline to Lake Travis.

The reservoir project has some distinct advantages to the Dripping Springs area, including:

* The reservoir would store unappropriated water for which there is no charge;

* The reservoir is located relatively close to the area of service;

* The reservoir would be a community project with recreational benefits to the area;

* The reservoir could be further utilized as a balancing facility in the future should the full yield from Onion Creek be exhausted. Used in this capacity, water could be pumped at average day demand rate from Lake Travis, and the reservoir storage could be relied on to supply daily peak demands; and

* An economical intake could be constructed in conjunction with construction of the dam, possibly incorporating it within the spillway.

The reservoir has some disadvantages also, including potential environmental impacts, land purchasing uncertainties, and the potentially lengthy time to obtain water rights and construction permits. A detailed study of potential environmental impacts and plans to mitigate adverve effects of the project would be required. Another factor which must be considered is the potential effect on recharge to the Barton Springs-Edwards Aquifer, but if well planned, this could be an enhancement to the area rather than a detriment, since recharge to the aquifer could be improved. Also, the improvements to Onion Creek created by extending the periods when flows occur in the stream could significantly improve water quality in the stream.

If this alternative is selected, a phased plan as shown in Figure 3.3-7 is recommended. The first phase of the plan would require the construction of the reservoir, an intake, a water treatment plant, a pump station, and a pipeline. The pipeline would connect the treatment plant to the central part of Dripping Springs with branches extending out into the ETJ. Assuming utilization of the total runoff available, it is estimated that the reservoir coupled with ground water could supply a population of approximately 27,200 people, which is estimated to occur in 2020. Beyond this a supplemental source of water will be required. It is also estimated that the reservoir and ground water will supply the 2012 demand using unappropriated flows.

A reasonable estimate of the yield of the reservoir lies between the yield using unappropriated flow and the yield using runoff flow, if supplemental water could be made available from Lake Travis to meet demands of downstream water rights on the Colorado River. Accordingly, it is felt the reservoir yield and supplemental water from Lake Travis could meet the demand at year 2017, when the total demand is approximately 3.6 mgd. Allowing 0.6 mgd from ground water, leaves 3.0 mgd to be met from the yield of Lake Dripping Springs. This could be accomplished by Lake Dripping Springs being supplemented by the purchase of 1,000 acre-feet from Lake Travis which would be released to downstream water rights in exchange for diversion of available runoff at Lake Dripping Springs.

The first phase annual cost is estimated to be $2.40 million including debt service, operation and maintenance, and raw water from Lake Travis, resulting in an average cost per connection of $49 per month. Table 3.3-4 shows the projected costs of the five phases through the year 2040. If population projections are accurate, the cost per connection should go down with each phase.

A recommended phasing plan of system components is illustrated in Figure 3.3-7. The timing of the phases is controlled by water demand as shown in Figure 3.3-8. If demand is less than or greater than projected, then the phasing would be accelerated or delayed appropriately.

3.3.5 Plan B for Dripping Springs

Alternative	Area Served	Brief Description
12	Dripping Springs	Supply from Lake Travis, Purchase Water from LCRA

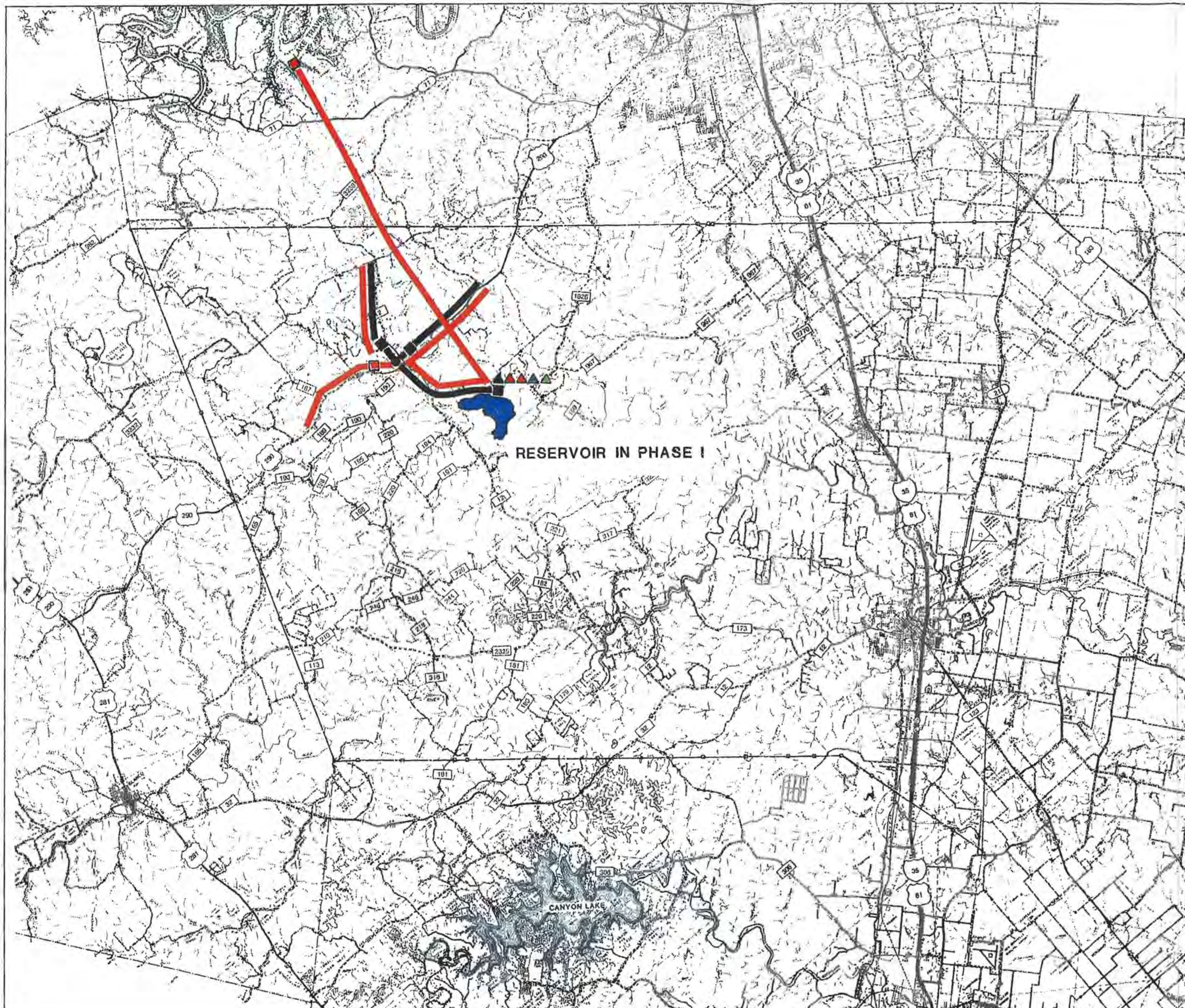


FIGURE 3.3-7

ALTERNATIVE #11 PHASING

DRIPPINGS SPRINGS SUPPLIED FROM LAKE DRIPPING SPRINGS

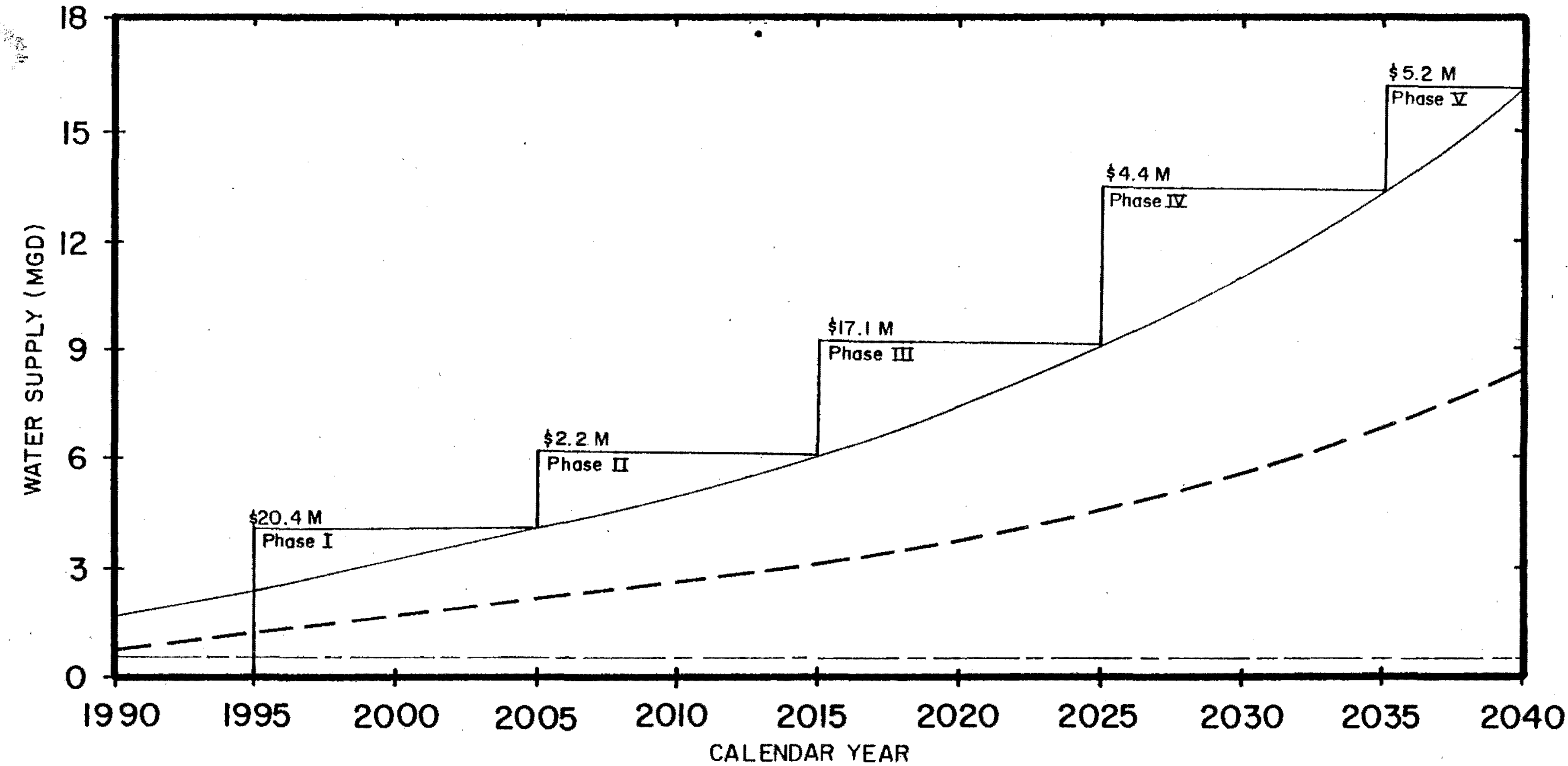
REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

H D R

TABLE 3.3-4

ALTERNATIVE #11 - PHASING SCHEDULE					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
Dripping Springs	12,120	18,385	27,215	40,284	54,321
Estimated Connections*					
Dripping Springs	4,110	6,230	9,230	13,660	18,410
Surface Demands (mgd)*					
Average day	1.09	1.96	3.20	5.03	7.00
Maximum day	2.66	4.36	6.74	10.27	14.07
Construction Costs (millions)					
Reservoir	$10.87				
Treatment Plant	3.57	$2.23	$3.07	$4.36	$5.18
Raw Water Line	.81		.44		
Treated Water Line	1.49		1.75		
Storage & Pump Station	1.58				
East Branch	1.03		1.03		
North Branch	1.03		1.03		
West Branch			1.03		
Raw Water Line from Travis	—	—	8.60	—	—
	$20.38	$2.23	$16.95	$4.36	$5.18
Annual Costs (millions)					
New Debt Service	$2.08	$ .22	$1.73	$ .44	$ .53
Old Debt Serve		2.08	.22	1.68	.44
O&M	.27	.43	.70	.90	1.08
Raw Water	0.07	0.07	.43	.43	.43
Total	$2.42	$2.80	$3.08	$3.45	$2.48
Monthly Cost/Connect ($)	$49	$37	$28	$21	$11

*Figures shown are for the mid-point of the period.



LEGEND:

- ——— MAXIMUM DAY DEMAND
- — — AVERAGE DAY DEMAND
- - - - GROUND WATER

H D R

ALTERNATIVE #11
PHASING SCHEDULE FOR DRIPPING SPRINGS, TEXAS

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.3-8

As stated in the discussion for Alternative 11, the report produced two alternatives for Dripping Springs which compared favorably, considering the level of detail involved. Alternative 12 would include construction of an intake and pump station on Lake Travis as shown on Figure 3.3-9, a water treatment plant, and pipeline to serve the Dripping Springs ETJ, all to be constructed by 1995. Subsequent facilities would include water treatment plant expansions at 10-year intervals, branch pipelines, and parallel pipelines projected for the needs shown in Table 3.3-5. The water demand and estimated incremental construction costs and estimated annual costs are also shown in Table 3.3-5 and Figure 3.3-10.

Annual charges for raw water to meet year 2040 requirements are included in Phase I and subsequent phases. These charges are approximately $600,000 and provide 8,700 acre-feet per year.

The first phase construction is estimated to cost $15.7 million, providing an annual cost of $2.50 million including debt service, operations and maintenance costs, and raw water charges. This annual cost results initially in a $51 cost per connection per month, which is the maximum monthly cost projected for Dripping Springs throughout the planning period.

Several factors should be considered when comparing Alternative 12 and Alternative 11, including:

* This alternative uses stored water of good quality which is currently available;

* The overall environmental impacts should not be great, however, the Lake Travis intake will require special attention;

* The construction phasing for the alternative is flexible and can easily be adjusted if needed;

TABLE 3.3-5

ALTERNATIVE #12 - PHASING SCHEDULE					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
Dripping Springs	12,120	18,385	27,215	40,284	54,321
Estimated Connections*					
Dripping Springs	4,110	6,230	9,230	13,660	18,410
Surface Demands (mgd)*					
Average day	1.09	1.96	3.20	5.03	7.00
Maximum day	2.66	4.36	6.74	10.27	14.07
Construction Costs (millions)					
Intake & Pump Station	$2.98				
Raw Water Line	.98		1.29		
Treated Water Line	5.60		7.33		
Treatment Plant	3.57	2.23	3.07	4.36	5.18
Storage & P.S.	1.58				
Branch East	1.03		1.03		
Branch South		1.03		1.03	
Branch West	—	—	1.03	—	1.03
Total	$15.74	$3.26	$13.75	$5.39	$6.21
Annual Costs (millions)					
New Debt Service	1.60	0.33	1.40	0.55	0.63
Old Debt Service		1.60	0.33	1.40	0.55
O&M	.30	.56	1.00	1.23	1.43
Raw Water	.60	.60	.60	.60	.60
Total	$2.50	$3.09	$3.33	$3.78	$3.21
Monthly Cost/Connection ($)	$51	$40	$30	$23	$15

*Figures shown are for the mid-point of the period.

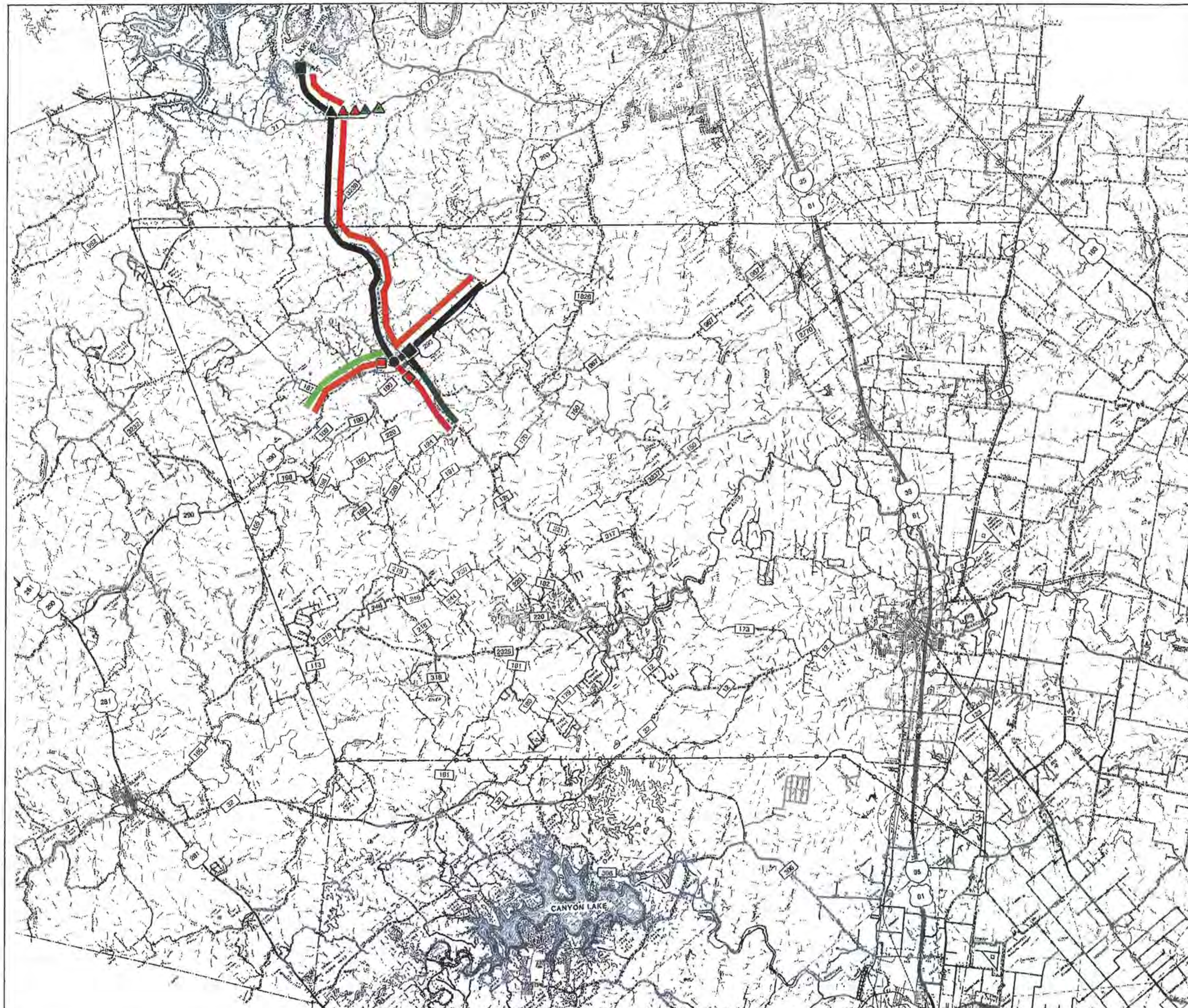


FIGURE 3.3-9

ALTERNATIVE #12 PHASING

DRIPPING SPRINGS SUPPLIED FROM LAKE TRAVIS

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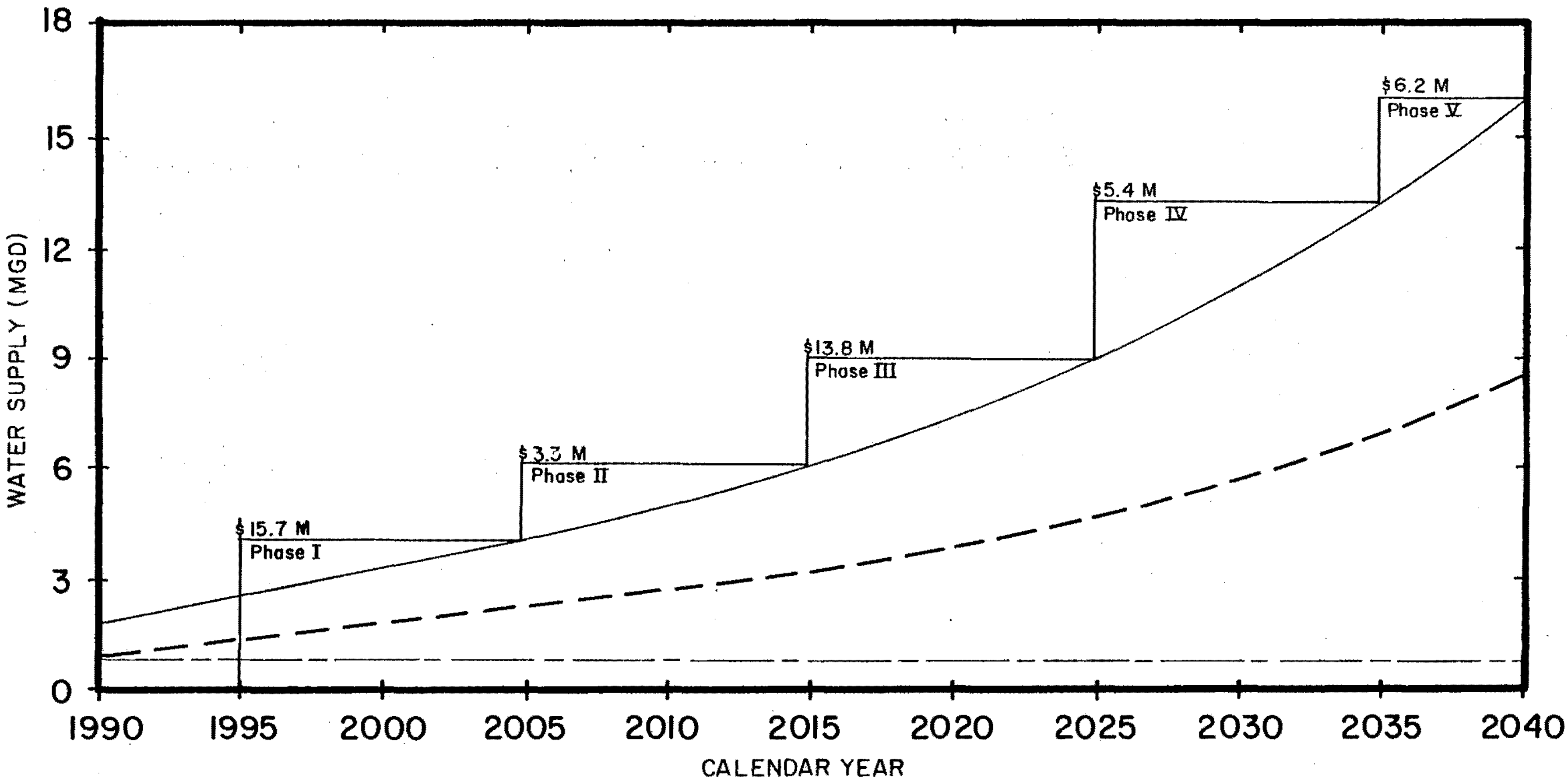
REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY
WATER DEVELOPMENT BOARD



LEGEND:

- ——— MAXIMUM DAY DEMAND
- — — AVERAGE DAY DEMAND
- – – – GROUND WATER

H D R

ALTERNATIVE #12
PHASING SCHEDULE FOR DRIPPING SPRINGS, TEXAS

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 3.3-10

* The alternative should be acceptable to the public;

* The time required to get the project on line from planning to finished facilities is minimal; and

* Preliminary estimated average costs per connection may be slightly higher for Alternative 12, but in general, the facilities required for Alternative 12 can probably be more accurately estimated than can a dam as in Alternative 11, considering the preliminary level of this report.

3.4 Estimated Cost of Selected Alternatives with Conservation

The estimated potential water savings derived from implementation of the recommended water conservation plan are presented in Section 6.4. Also, Table 6.4-1 shows estimated savings in water demand as a percent of projected demands. The recommended plan for implementation of all of the alternatives is to develop each alternative in phases corresponding to need and the ability of the customer to pay for the projects. Further, it is recommended that prior to design of each phase of an alternative that population projections and water use data be reanalyzed. By following this procedure, each phase of all the alternatives will be constructed to meet the requirements consistent with the most up-to-date population projections and water demand data.

To determine the potential effects of conservation on the costs of the recommended alternatives, the water demands for each of the selected alternatives was re-calculated using the savings in water shown in Table 6.4.1. Then, using these reduced demands, the estimated cost for each phase was calculated assuming identical population projections. The estimated costs for the five selected alternatives with conservation are shown in Table Nos. 3.4-1 through 3.4-5.

The criteria used in calculating the costs with conservation was the same as previously used in Section 3.3. Intakes and pump stations were sized to meet year 2040 demands, pipelines were sized to supply 20 or 25 years of demand, and treatment plants

Table 3.4-1

ALTERNATIVE #5a - PHASING SCHEDULE WITH CONSERVATION						
PHASE	Ia	Ib	II	III	IV	V
PERIOD	1995-2000	2000-2005	2005-2015	2015-2025	2025-2035	2035-2040
Population*						
- Wimberley	3951	4476	5376	6600	8100	8775
- Woodcreek	1256	1457	1813	2436	3274	4098
Total	5207	5933	7189	9036	11374	12873
Estimated Connections*						
- Wimberley	1320	1490	1790	2200	2700	2925
- Woodcreek	800	930	1170	1550	2090	2610
Total	2120	2420	2960	3750	4790	5535
Surface Demands (mgd)*						
Average day	.03	.07	.19	.39	.64	.82
Maximum day	.70	.93	1.22	1.68	2.21	2.62
Construction Costs (millions)						
River Intake	$.60					
Treatment Plant	1.31		$.67	$.78	$.83	$.81
Raw Water Line		$2.82		1.82		
TW Line to Woodcreek	.62	—	—	.65	—	—
Total	$2.53	$2.82	$.67	$3.25	$.83	$.81
Annual Costs (millions)						
New Debt Service	$0.26	$0.29	$0.07	$0.33	$.08	$0.08
Old Debt Service		.26	.55	.07	.33	.41
O&M	.13	.24	.36	.50	.64	.76
Raw Water	.03	.03	.03	.03	.03	.03
Total	$0.42	$0.82	$1.01	$.93	$1.08	$1.28
Monthly Cost/Connection*						
Wimberley	$14	$26	$26	$19	$18	$19
Woodcreek	$21	$32	$31	$23	$20	$20
Overall	$17	$28	$28	$21	$19	$19

*Figures shown are for the mid-point of the period.

TABLE 3.4-2

ALTERNATIVE #7 - PHASING SCHEDULE WITH CONSERVATION					
PHASE	Ia	Ib	IIa	IIb	IIc
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
- Hays	860	1080	1300	1530	1690
- Buda	2260	2580	2910	3240	3480
Total	3120	3660	4210	4770	5170
Estimated Connections*					
- Hays	300	370	450	530	590
- Buda	780	890	1000	1100	1180
Total	1080	1260	1450	1650	1770
Surface Demands (mgd)*					
Average day	.00	.03	.07	.11	.14
Maximum day	.37	.41	.50	.59	.65
Construction Costs (millions)					
Delivery Storage	.07				
Pump Station & Pipelines					
- to Hays	.66				
- to Buda	.60				
	$1.33				
Annual Costs (millions of $)					
Debt Service	$.14	$.14	$.00	$.00	
O&M	.01	.01	.01	.02	$.02
Treated Water	.04	.06	.07	.11	.14
Total	$0.19	$0.21	$0.08	$0.13	$.16
Monthly Cost/Connect					
- Hays	$10	$10	$5	$7	$8
- Buda	$16	$15	$5	$7	$8
- Overall	$15	$14	$5	$7	$8

*Figures shown are for the mid-point of the period

TABLE 3.4-3

ALTERNATIVE #10b - PHASING SCHEDULE WITH CONSERVATION					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
- San Marcos	50,700	63,350	76,000	88,650	98,140
- Kyle	7,592	11,238	16,634	24,623	33,200
- Mountain City	490	590	720	860	1,000
- Plum Creek WSC	3,861	4,624	5,537	6,630	7,600
- Uhland	320	446	584	766	940
- County Line WSC	997	1,192	1,425	1,703	1,949
- GoForth WSC	4,500	6,000	7,000	8,000	8,750
Total	68,460	87,440	107,900	131,233	147,579
Estimated Connections*					
- San Marcos	9,770	12,210	14,640	17,080	18,910
- Kyle	2,260	3,340	4,550	7,330	9,880
- Mountain City	150	180	220	270	310
- Plum Creek WSC	1,220	1,460	1,750	2,100	2,410
- Uhland	110	150	170	260	310
- County Line WSC	270	320	390	460	530
- GoForth WSC	1,480	1,970	2,300	2,630	2,880
Total	15,260	19,630	24,440	30,130	35,230
Surface Demands (mgd)*					
Average day	1.33	3.28	5.70	8.27	10.45
Maximum day	6.47	10.70	14.67	19.06	22.72
Construction Costs (millions)					
Intake & Dam	$1.20				
Treatment Plant	7.51	$4.73	$4.19	$4.58	$4.83
Treated Water Line	5.59		6.26		
Line to Kyle	2.94		3.56		
Line to Mountain City	.54		.47		
Line to Uhland & County Line WSC		1.26		.89	
Line to Goforth WSC		.69		.42	
Total	$17.78	$6.68	$14.48	$5.89	$4.83
Annual Costs (millions of $)					
New Debt Service	$1.81	$.68	$1.47	$.60	$.49
Old Debt Service		1.81	.68	1.47	.60
O & M	.24	.45	.70	.95	1.19
Raw Water	.59	.59	.59	.59	.59
Total	$2.64	$3.53	$3.44	$3.61	$2.87
Monthly Cost/Connection ($)					
San Marcos	$15	$13	$10	$8	$6
Kyle	25	16	13	11	6
Mountain City	56	41	31	26	6
Plum Creek		27	15	12	8
Uhland		27	15	12	8
County Line		27	15	12	8
Goforth WSC		30	18	14	9
Overall	18	15	12	10	7

*Figures shown are for the mid-point of the period.

TABLE 3.4-4

ALTERNATIVE #11 - PHASING SCHEDULE WITH CONSERVATION					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
Dripping Springs	12,120	18,385	27,215	40,284	54,321
Estimated Connections*					
Dripping Springs	4,110	6,230	9,230	13,660	18,410
Surface Demands (mgd)*					
Average day	.91	1.56	2.51	3.89	5.40
Maximum day	2.31	3.56	5.42	8.09	10.98
Construction Costs (millions)					
Reservoir	$10.87				
Raw Water Line	.62		.32		
Treatment Plant	3.04	$1.80	$2.43	$3.36	$3.86
Treated Water Line	1.36		1.56		
Elev. Storage & Dist. Pump Station	1.50				
East Branch	1.00		1.00		
North Branch	1.00		1.00		
West Branch			1.00		
Raw Water Line from Travis	—	—	7.46	—	—
	$19.39	$1.80	$14.77	$3.36	$3.86
Annual Costs (millions)					
New Debt Service	$1.97	$ .18	$1.50	$ .34	$ .39
Old Debt Serve		1.97	.18	1.50	.34
O&M	.20	.39	.62	.80	.99
Raw Water	0.07	0.07	.28	.28	.28
Total	$2.24	$2.61	$2.58	$2.92	$2.00
Monthly Cost/Connect ($)	$45	$35	$23	$18	$9

*Figures shown are for the mid-point of the period.

TABLE 3.4-5

ALTERNATIVE #12 - PHASING SCHEDULE WITH CONSERVATION					
PHASE	I	II	III	IV	V
PERIOD	1995-2005	2005-2015	2015-2025	2025-2035	2035-2040
Estimated Population*					
Dripping Springs	12,120	18,385	27,215	40,284	54,321
Estimated Connections*					
Dripping Springs	4,110	6,230	9,230	13,660	18,410
Surface Demands (mgd)*					
Average day	0.91	1.56	2.51	3.89	5.40
Maximum day	2.31	3.56	5.42	8.09	10.98
Construction Costs (millions)					
Intake & Pump Station	$1.82				
Raw Water Line	.89		1.13		
Elev. Storage and Dist. Pump Station	1.50				
Treated Water Line	5.60		6.44		
Treatment Plant	3.04	1.79	2.43	3.36	3.86
Branch East	1.00		1.00		
Branch South		1.00		1.00	
Branch West	—	—	1.00	—	1.00
Total	$13.85	$2.79	$12.00	$4.36	$4.86
Annual Costs (millions)					
New Debt Service	1.41	0.28	1.22	0.44	0.50
Old Debt Service		1.41	0.28	1.22	0.44
O&M	.23	.38	.54	.72	.90
Raw Water	.60	.60	.60	.60	.60
Total	$2.24	$2.67	$2.64	$2.98	$2.44
Monthly Cost/Connection ($)	$45	$36	$24	$18	$11

*Figures shown are for the mid-point of the period.

sized for 10 years of demand. Costs for water were obtained from Table 3.1-3. Annual costs were estimated for the mid-point of each phase assuming all capital costs are financed at 8% for 20 year terms. The cost per connection shown represents the additional average cost per connection required to deliver the water supply. Costs do not include the distribution system.

Estimating the cost by this method results in a reduced cost per connection for each phase, since the water demand is less but the population remains the same as was used for previous calculations. Also, the lower demand results in generally smaller facilities. However, the costs of the conservation program are not shown in the tables.

The estimated costs and savings in water and energy per home for key items of the conservation program are presented in Tables 6.3-1 and 6.3-2. The cost estimates show a net overall savings would occur by implementation of the conservation program.

3.5 Water Requirements of Selected Alternatives

Water contracts will be required for each of the selected alternatives. To assist in planning for purchase of water, estimates of water required are shown in Table 3.5-1 for 10-year intervals through year 2040. The table shows the requirements without a change in per capita demand and, also the requirements assuming the projected savings due to conservation (see Table 6.4-1) are achieved.

TABLE 3.5-1

***WATER REQUIREMENTS FOR SELECTED ALTERNATIVES**
(in Acre-Feet Per Year)

	1990		2000		2010		2020		2030		2040	
	A	B(9%)	A	B(11%)	A	B(16%)	A	B(18%)	A	B(20%)	A	B(22%)
Guadalupe River Basin												
Alternative 10b												
San Marcos	0.00	0.00	2363.20	1237.15	4905.60	2860.93	7448.00	4690.11	9990.40	6417.60	12555.20	8060.86
Kyle	0.00	0.00	369.60	237.78	929.60	648.26	1780.80	1311.07	3035.20	2262.40	4883.20	3626.56
Mountain City	11.20	5.15	33.60	23.74	44.80	28.67	78.40	54.21	100.80	69.44	134.40	92.51
Plum Creek WSC	0.00	0.00	22.40	0.00	100.80	25.54	190.40	89.60	302.40	168.00	425.60	250.66
Uhland	0.00	0.00	0.00	0.00	11.20	4.03	33.60	21.50	56.00	38.08	78.40	53.76
County Line WSC	0.00	0.00	0.00	0.00	22.40	0.90	44.80	16.58	78.40	40.32	112.00	62.72
Goforth WSC	0.00	0.00	44.80	0.00	224.00	111.10	347.20	198.02	459.20	271.04	582.40	348.32
Total (Alt. 10b)	11.20	5.15	2833.60	1498.67	6238.40	3679.42	9923.20	6381.09	14022.40	9266.88	18771.20	12495.39
Alternative 5a												
Wimberley WSC	0.00	0.00	89.60	30.46	246.40	135.30	403.20	249.98	593.60	385.28	716.80	460.54
Woodcreek	0.00	0.00	11.20	0.00	123.20	51.52	280.00	171.14	481.60	320.32	761.60	522.59
Total (Alt. 5a)	0.00	0.00	100.80	30.46	369.60	186.82	683.20	421.12	1075.20	705.60	1478.40	983.14
Colorado River Basin												
Alternative 7												
Hays City	0.00	0.00	22.40	11.31	56.00	34.50	78.40	50.18	112.00	73.92	134.40	87.58
Buda	0.00	0.00	11.20	0.00	44.80	0.00	89.60	25.09	134.40	53.76	168.00	71.90
Total (Alt. 7)	0.00	0.00	33.60	11.31	100.80	34.50	168.00	75.26	246.40	127.68	302.40	159.49
Alternative 11 & 12												
Dripping Springs	291.20	203.50	1232.00	1021.33	2206.40	1744.06	3584.00	2815.90	5622.40	4361.28	8668.80	6611.36
Total (Alt. 11 & 12)	291.20	203.50	1232.00	1021.33	2206.40	1744.06	3584.00	2815.90	5622.40	4361.28	8668.80	6611.36

Notes:

* Water Requirements = Total Water Demand Less Ground Water Supply
A Without Conservation
B With Conservation, percent savings due to conservation are shown in parenthesis.

SECTION 4
EXISTING WASTEWATER TREATMENT PLANTS

4.0 EXISTING WASTEWATER TREATMENT PLANTS

4.1 County Drainage Characteristics

Hays County is hydrologically divided along an east-west line with the north half of the county lying in the Colorado River Basin and the south half in the Guadalupe River Basin. For wastewater planning each of these basins is divided into sub-basins or stream segments.

The Hays County portion of the Colorado River Basin includes Segment No. 1414 of the Pedernales River, Segment No. 1430, Barton Creek, and Segment No. 1427, Onion Creek Basin. The Pedernales River, which is a no discharge segment, covers the northern portion of Hays County and drains into Lake Travis. Barton Creek, which is also a no discharge segment, is immediately south of the Pedernales River and flows into Barton Springs and thence into Town Lake. Onion Creek, which is the largest segment in the county, has permitted wastewater discharges and drains into the Colorado River below Town Lake.

The Guadalupe River Basin in Hays County includes Cypress Creek, Segment No. 1815; the Upper Blanco River, Segment No. 1813; the Lower Blanco River, Segment No. 1809; the Upper San Marcos River, Segment No. 1814; the Lower San Marcos River, Segement No. 1808; and Plum Creek, Segment No. 1810. Cypress Creek discharges into the Upper Blanco River near Wimberley, and because Blue Hole, a swimming and recreation area is located on Cypress Creek, wastewater discharges are not allowed in the creek. The Upper Blanco River drainage flows over the Edwards Aquifer Recharge Zone and provides 6% of that aquifer's total recharge. Any wastewater discharge in this segment will require advanced treatment or, as an alternative, land application, if suitable irrigation sites are available. The Lower Blanco River is southwest of Kyle and flows into the San Marcos River at a point four miles east of IH 35. The Upper San Marcos River is located in the City of San Marcos and includes Sink Creek and Purgatory Creek, but stream flow is predominantly from San Marcos Springs. The Lower San Marcos River, which includes Cottonwood Creek and York Creek, begins east of San Marcos and continues beyond the County line. Additionally, the San Marcos WWTP secondary effluent discharges into the lower San Marcos River. Plum Creek Basin covers the eastern portion of the County, including Brushy Creek, Elm Creek, and Clear Fork Creek drainage areas. Wastewater discharges from Kyle and Buda enter the Plum Creek, after receiving advanced secondary treatment.

4.2 Current and Anticipated Future Stream Standards

Figures 4.2-1 and 4.2-2 show existing and anticipated future stream standards in Hays County, and the tables shown on Figure 4.2-1 indicate stream uses and criteria established by the Texas Surface Water Quality Standards. Further studies are being conducted by the TWC to determine levels of treatment required to protect the stream environment, but most of the tributaries receiving wastewater discharge are water quality limited and, therefore, will require higher levels of treatment. Each segment is being considered individually to determine proper levels of treatment to insure protection of that particular stream.

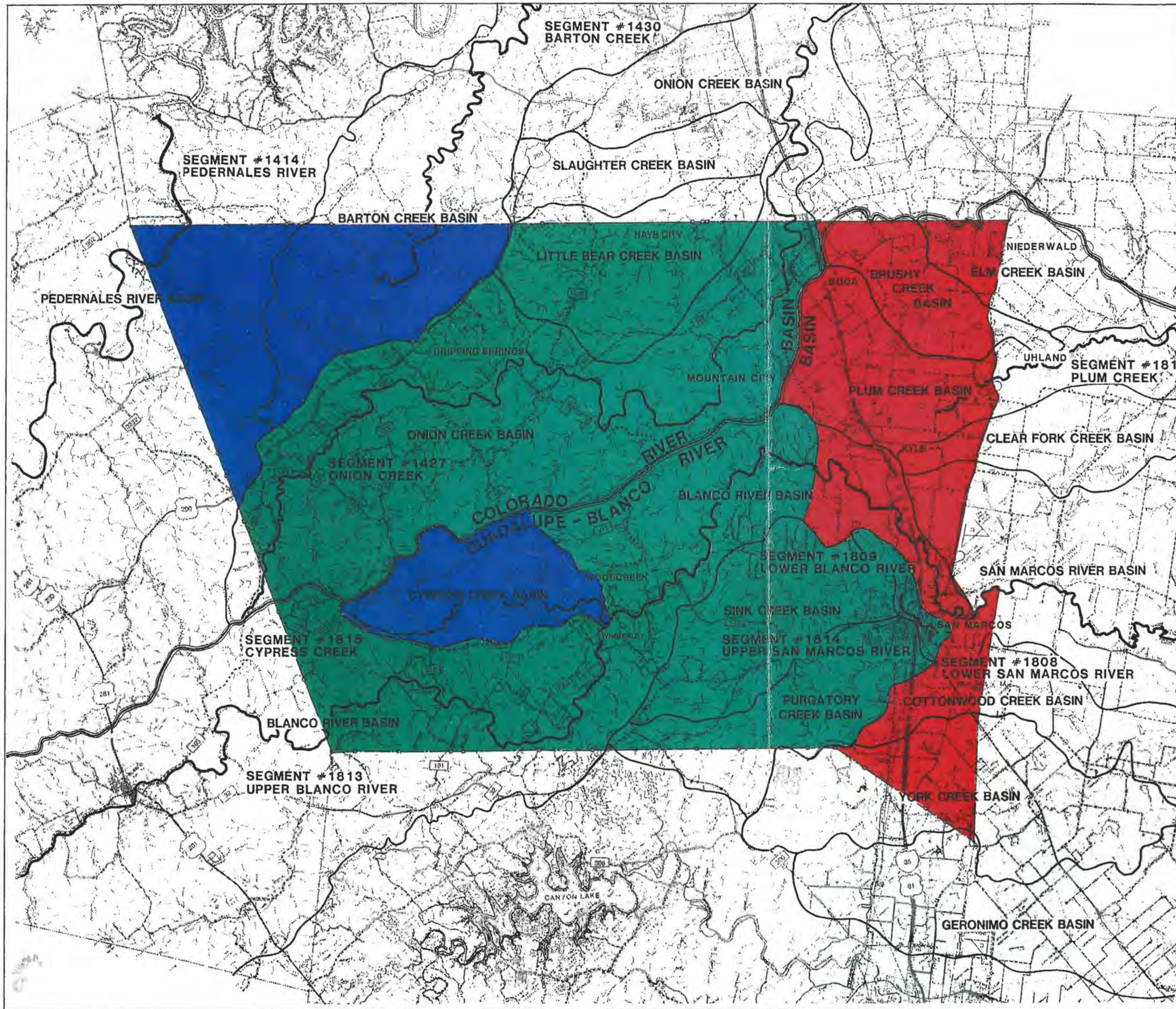
As research continues on the aquifers, there may be future regulations that prohibit discharge over the recharge zones of either the Edwards or the Barton Springs-Edwards Aquifers. Also, it is anticipated that effluent requirements for both San Marcos and Kyle will require higher degrees of treatment when future permits are requested.

4.3 Existing Wastewater Treatment Plants

The few existing municipal and commercial treatment plants in Hays County are described below. These plants are located mostly in the eastern portion of the County.

San Marcos Wastewater Treatment Plant

The City of San Marcos operates a contact stabilization wastewater treatment plant which includes diffused aeration, secondary clarification, chlorination, aerobic digestion, and a combination of sludge drying and land disposal of sludge. The dried sludge is disposed of



0 2 4 8 MILES

Segment Number	COLORADO RIVER BASIN — Segment Name	USES: RECREATION	USES: AQUATIC LIFE	USES: DOMESTIC WATER SUPPLY	CRITERIA: CHLORIDE (mg/L) Annual Average not to exceed	CRITERIA: SULFATE (mg/L) Annual average not to exceed	CRITERIA: TOTAL DISSOLVED SOLIDS (mg/L) Annual average not to exceed	CRITERIA: DISSOLVED OXYGEN (mg/L)	CRITERIA: pH RANGE	CRITERIA: FECAL COLIFORM (#/100 mL) Thirty-day geometric mean not to exceed	CRITERIA: TEMPERATURE (F) not to exceed
1414	Pedernales River	CR	H	PS	110	50	500	5.0	6.5-9.0	200	91
1427	Onion Creek	CR	H	PS/AP	50	50	300	5.0	6.5-9.0	200	90
1428	Colorado River Below Town Lake	CR	H	PS	105	65	425	5.0	6.5-9.0	200	95
1429	Town Lake*	CR	H	PS	70	50	410	5.0	6.5-9.0	200	90
1430	Barton Creek	CR	H	AP	40	40	500	5.0	6.5-9.0	200	90

Segment Number	GUADALUPE RIVER BASIN — Segment Name	USES: RECREATION	USES: AQUATIC LIFE	USES: DOMESTIC WATER SUPPLY	CRITERIA: CHLORIDE (mg/L) Annual Average not to exceed	CRITERIA: SULFATE (mg/L) Annual average not to exceed	CRITERIA: TOTAL DISSOLVED SOLIDS (mg/L) Annual average not to exceed	CRITERIA: DISSOLVED OXYGEN (mg/L)	CRITERIA: pH RANGE	CRITERIA: FECAL COLIFORM (#/100 mL) Thirty-day geometric mean not to exceed	CRITERIA: TEMPERATURE (F) not to exceed
1808	Lower San Marcos	CR	H	PS	60	50	400	5.0	6.5-9.0	200	90
1809	Lower Blanco River	CR	H	PS/AP	40	50	400	5.0	6.5-9.0	200	92
1810	Plum Creek	CR	H			350	150	5.0	6.5-9.0	200	90
1813	Upper Blanco River	CR	E	PS/AP	30	50	410	6.0	6.5-9.0	200	92
1814	Upper San Marcos River	CR	E		25	25	380	6.0	6.5-9.0	200	90
1815	Cypress Creek	CR	E	PS	20	20	350	6.0	6.5-9.0	200	88

NO DISCHARGE
BARTON CREEK
CYPRESS CREEK
*PEDERNALES RIVER

SECONDARY TREATMENT
*PLUM CREEK
*LOWER BLANCO RIVER
*LOWER SAN MARCOS RIVER

ADVANCED TREATMENT
ONION CREEK
UPPER BLANCO RIVER
UPPER SAN MARCOS RIVER

*STREAM STANDARDS UNDER STUDY BY THE TEXAS WATER COMMISSION.

LEGEND:
- NO DISCHARGE
- ADVANCED TREATMENT
- SECONDARY TREATMENT

FIGURE 4.2-1

EXISTING WASTEWATER DISCHARGE REQUIREMENTS

H D R

REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY
WATER DEVELOPMENT BOARD

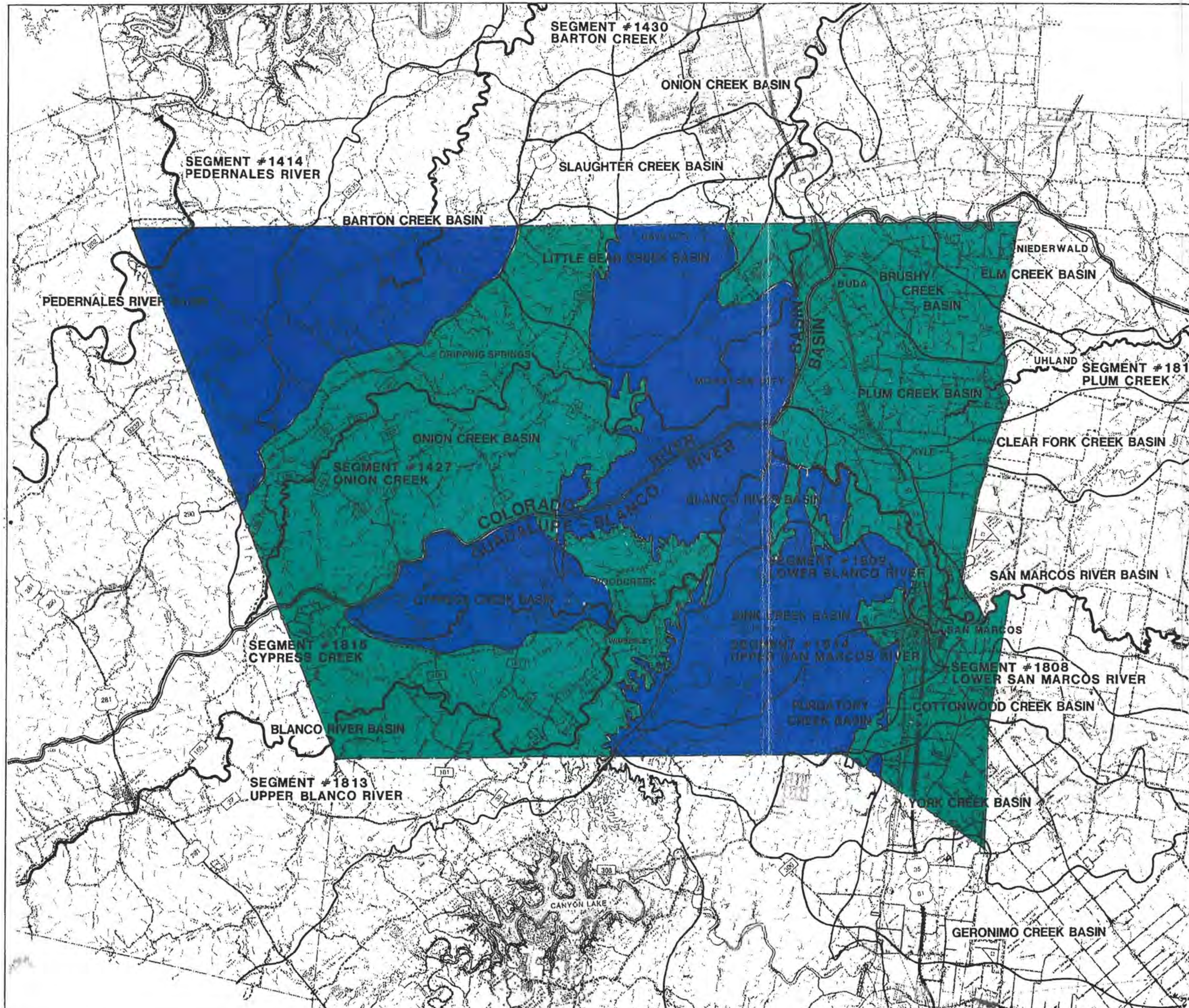


FIGURE 4.2-2

FUTURE WASTEWATER DISCHARGE REQUIREMENTS

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

by land application. The current average daily flow is approximately 4.0 mgd, and the effluent requirements are 20 mg/l BOD5 and 20 mg/l TSS. The waste discharge permit (No. 10273) was recently renewed to continue allowing an averaging daily discharge of 6.25 mgd and a maximum discharge of 10.0 mgd into the San Marcos River (Segment No. 1808) east of IH-35, which is above its confluence with the Blanco River.

Kyle Wastewater Treatment Plant

The City of Kyle operates a series of aerated lagoons, with an effluent discharge requirement of 30 mg/l BOD5 and 90 mg/l TSS, and a current average daily flow of approximately 0.3 mgd. The permit (No. 11041) which allows an average daily flow of 0.89 mgd and a maximum flow rate of 1.35 mgd will be up for renewal in 1991. The plant is located east of IH 35 and south of FM 150, and the effluent discharges into a tributary of Plum Creek (Segment No. 1810) and thence is impounded in a downstream reservoir located north of FM 150.

Buda Wastewater Treatment Plant

The City of Buda operates an extended aeration wastewater treatment plant with a current average daily flow of approximately 0.10 mgd. The plant includes an oxidation ditch, secondary clarification, chlorination, and sludge drying with dried sludge disposal into a landfill. The waste discharge permit (No. 11060) was issued in 1986 and expires in 1991. The permitted effluent requirements are 10 mg/l BOD5 and 15 mg/l TSS for an average daily flow of 0.15 mgd and a maximum flow of 0.30 mgd, as long as the flow continues to be pumped from the Onion Creek basin to a tributary of Porter Creek in the Plum Creek watershed (Segment No. 1810). Ultimately it is planned that the plant will discharge into Onion Creek, and for that discharge, the already permitted effluent limits are 5 mg/l BOD5, 5 mg/l TSS, 2 mg/l ammonia nitrogen, and 1 mg/l total phosphorus with an average daily flow of 0.7 mgd and 1.4 mgd maximum daily flow.. An addition to the plant has been constructed but not placed in service because of the limited flow now being received.

Woodcreek Utilities, Inc. Wastewater Treatment Plants

Woodcreek Utilities, Inc. operates two extended aeration package plants with secondary clarification and chlorination. The plants are located in the Woodcreek Subdivision which drains to the Cypress Creek basin (Segment No. 1815). The permitted effluent requirements are 20 mg/l BOD5 and 20 mg/l TSS for average daily flows of 0.05 mgd and maximum daily flows of 0.10 mgd. The sludge is disposed of by land application and the effluent is used for irrigation of the Woodcreek golf course and/or pasture land as required by the no-discharge permits (Nos. 11431 and 11790) which expire in 1999. Effluent storage ponds are used when they are not able to irrigate.

The current flows at the two plants are not known since operating records are not available. Woodcreek Uilities, Inc. is under an enforcement order by the Texas Water Commission because of a number of violations. Corrective action has not been taken to date.

Texas Lehigh Cement Company Wastewater Treatment Plant

Texas Lehigh operates an extended air package wastewater treatment plant on Texas Lehigh property south of Buda. Facilities include an aeration basin, clarification, chlorination, sludge holding facilities, and a lined evaporation pond. The facility has a no discharge permit (No. 11976) which allows an average flow of .0027 mgd. Excess effluent at a permitted quality of 30 mg/l BOD5 is irrigated on 40 acres of farmland on the plant site. Sludge is removed by vacuum truck and disposed of elsewhere.

There are no current flow records for the facility.

Longhorn Machine Works Wastewater Treatment Plant

Longhorn Machine Works operates two evaporative ponds with retention terraces downslope of the two ponds, all located on the Longhorn Machine Works 16 acre site approximately one mile north of Kyle between the Missouri Pacific Railroad and Interstate Highway 35. The ponds contain process wastewater and waste cutting oil, with the oil periodically skimmed from pond No. 1 and hauled off by truck.

The permit (No. 00315) does not allow a discharge and the permitted average flow is 300 gallons per day with a maximum amount of oil and grease of 10 mg/l. The maximum permitted flow is 550 gallons per day. Excess flow above the evaporation rate flows over a weir in Pond No. 2 and is impounded by the terraces.

Hughson Meat Co., Inc. Wastewater Treatment Plant

Hughson Meat operates three holding ponds located two miles northwest of the Hays County courthouse and one half mile north of RR 12. The permitted flow is for process water from the slaughterhouse and no discharge is allowed. The permit (No. 01647) provides for an average flow of 4,500 gallons per day and a maximum flow of 6,000 gallons per day. Sludge accumulates in the ponds and has to be removed and hauled to a disposal site by truck. The plant also has a tailwater pond which has been discontinued from service.

4.3.1 Wastewater Discharge Permits

There are a number of wastewater discharge permit holders in Hays County that have not yet constructed facilities. Some have delayed construction because of the slowdown in the Texas economy and some have just recently received approval of their permits so construction has not been completed. The following describes the permitted facilities.

Blue Hole Management, LTD

The permit (No. 13321) for Blue Hole Management, LTD was issued in April, 1988 for interim facilities which will consist of primary clarification and eleven absorption beds with a total area of 94,500 square feet to treat a flow of 0.015 mgd. Final facilities to treat 0.05 mgd will consist of an extended aeration package plant, secondary clarification, chlorination, and aerobic digestion with sludge disposal on site. Permitted facilities also include a 21.8 acre foot storage pond and 19 acres of coastal bermuda or rye grass land for irrigation.

The flow will be from a nursing home, doctors clinic, emergency clinic, apartments, and campground with interim operations expected to begin around January, 1989. The plant will be located one mile northeast of the intersection of RR 12 and FM 2325.

Goforth Utility Company

A permit (No. 13293) has been issued to Goforth Utility Company for an extended aeration package plant permitted to discharge 0.0424 mgd at a quality of 10 mg/l BOD5, 15 mg/l TSS, and 3 mg/l NH3-N into an unnamed tributary of Brushy Creek and then to Plum Creek (Segment No. 1810).

The plant will be located four miles southeast of the intersection of IH 35 and FM 2001.

Cottonwood Creek Park

Austin Partners, Inc. have a permit (No. 02800) to discharge into Cottonwood Creek, thence to York Creek, and thence to the lower San Marcos River (Segment No. 1808). The plant is to be located 2.5 miles south of San Marcos on Cottonwood Creek. Permit parameters are 0.35 mgd average daily flow, 10 mg/l BOD5, 10 mg/l TSS, 2 mg/l NH3-H, and 1 mg/l phosphorus.

Lowman Ranch, LTD

Lowman Ranch, LTD has two permits (Nos. 13024 and 13128). Permitted facilities include septic tanks, rock reed filters, intermittent sand filters, a five acre storage pond, and 15 acres of pasture which will be irrigated. The site is located 3,500 feet west of the intersection of Centerpoint Road and FM 2439 in the lower San Marcos River (Segment No. 1808).

Permitted daily flows provide for an average of 0.035 mgd and a maximum flow of 0.070 mgd.

SVS Utilities, Inc.

SVS Utilities, Inc. has a permit (No. 13269) to irrigate 180 acres of a 1,344 acre development north of San Marcos. The permit provides for an average daily flow of 0.43 mgd treated to 10 mg/l BOD5, with the system to consist of an activated sludge plant with secondary clarification, chlorination, aerobic digestion, and a 5.9 acre lined pond for storage. The site is located 3/4 miles west of the IH 35 crossing over the Blanco River (Segment No. 1809).

Future plans are to connect the development to the City of San Marcos and only treat the flow needed to irrigate a golf course which is planned for the development.

David M. Zuniga

David Zuniga holds a permit (No. 13250) to dispose of domestic wastewater. His plant will consist of an oxidation ditch, secondary clarification, and chlorination to meet interim permit parameters of 0.5 mgd average daily flow, 10 mg/l BOD5, 15 mg/l TSS, and 3 mg/l NH3-N. Final permitted average daily flow is 1.0 mgd. The site is 2.5 miles east of the intersection of IH-35 and FM 150, and discharges to Plum Creek (Segment No. 1810).

Cypress One, LTD

Cypress One, LTD has a permit (No. 13369) for a flow of 0.0056 mgd average daily flow and 20 mg/l BOD5. The facility will be an extended air package plant with secondary clarification and two absorption beds covering 11,700 square feet. The plant will be located on Bluebird Lane and Cypress Creek Lane northwest of Wimberley and will discharge to Cypress Creek (Segment 1815).

4.4 Projected Wastewater Flows

Projected wastewater flows which will be treated at wastewater treatment plants are shown by decade in Table 4.4-1, and Table 4.4-2 presents the decennial flows that are expected to be treated using on-site disposal systems.. These projections reflect that 37% of the County population will use on-site treatment by 1990, and in 2040, 31% will be using on-site systems. If any of the communities shown do not develop centralized wastewater systems, then there will be a correspondingly larger percentage of on-site systems. These flow projections will be used in costing and evaluating the various wastewater treatment alternatives presented in the following section.

Table 4.4-1

Projected Wastewater Flows (mgd), Centralized Systems						
Area	1990	2000	2010	2020	2030	2040
San Marcos ETJ	3.54	5.07	6.33	7.60	8.87	10.13
Kyle ETJ	0.51	0.76	1.12	1.66	2.46	3.64
Dripping Springs ETJ	0.17	0.25	0.34	0.45	0.54	0.62
Buda ETJ	0.19	0.22	0.26	0.29	0.32	0.35
Hays City ETJ		0.09	0.11	0.13	0.15	0.18
Woodcreek ETJ	0.10	0.13	0.18	0.24	0.33	0.44
Wimberley		0.12	0.14	0.16	0.18	0.19
Austin ETJ	___	0.10	0.23	0.34	0.44	0.55
Total	4.51	6.74	8.71	10.42	12.75	16.10

Table 4.4-2

Areas Affected by Projected Wastewater Flows (mgd), On-Site Disposal Systems						
Area	1990	2000	2010	2020	2030	2040
Edwards Aquifer	1.69	2.22	2.98	3.72	4.86	6.41
Other	0.97	.92	1.09	1.81	2.43	2.56
Total	2.66	3.14	4.07	5.53	7.29	8.97

SECTION 5
ALTERNATIVES FOR WASTEWATER DISPOSAL

5.0 ALTERNATIVES FOR WASTEWATER DISPOSAL

5.1 Description of Alternatives

Because its geology and topography complicate the collection and centralized treatment of wastewater, the current and future residents of Hays County will need to continually assess the requirements and costs of providing proper disposal of wastewater. This study evaluates various alternative methods of wastewater disposal which are felt to be currently feasible, presents assumptions about the level of treatment which may be required in the future, and provides a Summary/Recommendations section which may be used as a basis for future wastewater disposal management decisions.

This report evaluates the following disposal alternatives:

* On-site wastewater systems;
* Individual community wastewater collection and treatment systems;
* Regionalization of wastewater systems;
* The potential for reuse of wastewater; and
* Alternatives for disposing of solids.

5.2 On-Site Wastewater Disposal System Alternatives

5.2.1 Introduction

Approximately 37% of the existing population in Hays County is not served by centralized collection and treatment systems but, rather, by some type of on-site disposal system. In nearly all cases, these systems are conventional septic tanks having unlined, trenched drain fields. By the end of the 50 year planning period, it is estimated that approximately 31% of the population will still have on-site systems; and therefore, a significant portion of the future population will be utilizing a wastewater treatment technology that cannot be controlled as easily as can the treatment provided by a centralized treatment plant. As a result, the current pollution problems thought to be associated with on-site systems will continue unless a management system is put in place which will require individual homeowners to use the most appropriate system, not just the cheapest alternative, and to replace on-site systems which are not performing satisfactorily.

The following section addresses on-site systems as a continued method of wastewater disposal. It does not assume that all on-site disposal should be eliminated or even reduced. It does, however, treat on-site systems as a group of disposal options which will require management in order to prevent wide-spread pollution of ground and surface water resources.

5.2.2 Characteristics of On-site Disposal in Hays County

With respect to suitability for drain fields, more than 95% of the County's geology is classified as "severe" by the Soil Conservation Service, and the 5% which is not classified as "severe" is nearly all classified as "moderate". Limitations, such as depth to impervious strata, impervious clays, and excessive permeability contribute to making truly effective disposal using drain fields difficult to attain in the County. In order for a drain field to be effective, a certain degree of treatment, or reduction in the pollution-causing materials, must be accomplished by filtering the wastewaters through pervious materials before they enter the groundwater system. Generally, treatment occurs both by filtration and by biological activity caused by bacteria in the soil. The widespread impervious soils or soils which are too permeable and steep topography in the County cause many septic systems to function improperly or totally fail, thereby polluting the ground or surface waters into which improperly treated wastewaters flow.

Regulation of on-site systems is based on the County's jurisdiction as a local agency with authority in this area granted by the Texas Water Commission and supported by the State standards for on-site disposal. The County Sanitarian is charged with the enforcement of County regulations, which basically defer to the State standards. Whether this management system currently protects the County's ground and surface waters is subject to debate, however, there is no doubt that there will be a need for improved management of on-site systems in the future.

5.2.3 Costs of On-site Systems

Historically, people have tended to prefer to be connected to centralized systems, when it is economically feasible to do so. The ease of maintenance, the opportunity to use the area of their property which would have otherwise been taken by a drain field, and the perceived ability to spread out capital costs over time through property taxes, rather than paying a first cost and interest to construct an on-site system, are some of the reasons for this preference.

Centralized systems typically amortize their debt over a 20 year period, while a homeowner may amortize his over as much as 30 years, and in today's financial market, tax exempt bonds typically yield or pay 8% interest, while homeowner loans are at about 10% interest. Comparing 8% for 20 years and 10% for 30 years, one finds that the monthly cost to finance the same amount of debt is essentially the same. However, the life of on-site systems is estimated to be 20 years, and therefore, throughout this report, monthly costs for on-site systems will be calculated assuming the homeowner's debt is financed for 20 years at 10% interest.

The current cost of an approved conventional septic system in Hays County ranges from about $2,000 to as much as $5,000. This range of capital costs is equivalent to monthly costs of $19.40 to $48.50, if the capital costs are amortized over 20 years at an interest rate of 10 percent. Engineered systems, such as evapotranspiration beds and low pressure dosing systems, typically cost $4,000 to $10,000 in Hays County. At the $10,000 cost, the amortized monthly cost would be $97 per connection at 10% interest for 20 years. Therefore, when comparing the cost of on-site systems with centralized systems, the monthly cost for on-site systems can be expected to range from a low of $19.40 to a high of $97, with the average being about $48 per month.

When the above monthly amortization costs are compared to the year 2000 regional centralized wastewater collection and treatment costs presented in Section 5.4, it becomes clear that, in terms of 1988 dollars, a totally new community locating near one of the four regional facilities would realize savings over even a moderately priced on-site system. For existing communities which will continue to be comprised of both centralized systems and on-site systems, the cost comparison may not favor centralized systems, unless the replacement cost of on-site systems, amortized over the life of the existing system, are included.

All currently approvable on-site systems eventually fail to perform in the manner they are intended and, therefore, require replacement. Therefore, on-site wastewater disposal must be treated as a continuing cost because the systems must be periodically replaced.

5.2.4 Recommendations for On-Site Disposal

To be viable as an alternative for wastewater disposal, on-site systems must be treated with the same degree of seriousness as are centralized treatment systems. For instance, there should be proper planning and inspection of such systems so the proposed system is appropriate for the location and is constructed and maintained to successfully accomplish the intended functions. Also, there should be a mechanism to provide for the upgrading of systems periodically as improved technologies become avaliable and are accepted by the industry. Additionally, the regulator (whether the County or some other entity) should have the authority to limit the use of certain systems or specify specific systems, when such action is in the interest of protecting the water supply or public health.

Therefore, the following policies should be adopted:

* Hays County, acting through its Commissioners Court, should have the responsibility to ensure that on-site systems are properly planned, designed, constructed, inspected, and maintained.

* The County should develop a mechanism whereby out-dated and failed on-site systems are detected and replaced with new systems which use accepted state-of-the-art disposal technology. Such a mechanism might involve a requirement for inspection of the existing system prior to transferring title to the property and/or a periodic inspection of such systems. Also, at the time of title transfer, the County should consider giving the new property owner an incentive, such as a 5-year reduction in property taxes, to upgrade to an up-to-date system rather than delaying until an older system fails and contributes to or creates a pollution problem.

* The County should delineate critical water quality zones, such as the entire area located over the Edwards Aquifer and the Barton Springs-Edwards Aquifer Recharge Zone, and prohibit and/or require specific systems in these areas in order to maintain ground and surface water quality. In these areas of the County, systems which would result in pollution of the Aquifer should not be installed.

5.3 Individual Community Wastewater Collection and Treatment Systems

5.3.1 Introduction

An obvious plan for development of wastewater systems in the County would be for each community to develop and construct its own individual system. In Hays County there are several communities which will be forced by their relative isolation into this alternative, however, some areas may be able to share facilities and thereby, reduce their costs. As a basis for comparing independent plants with regional systems, this section develops the costs for each community to plan, finance, develop, and operate its own system independent of the other communities in the County.

5.3.2 Non-Economic Issues

There are advantages and disadvantages to a community having its own system, outside of the fiscal consequences. There is the potential for relatively greater citizen involvement and control when decision-making is at the local, rather than the regional level. For a smaller community, there may be the opportunity to develop the type of facility, within regulatory constraints, that more nearly meets the needs and desires of the community.

The disadvantages are equally obvious. With individual plants, each community will have 100% of the responsibility of operations and, they will be solely responsible for modifying their systems as treatment standards become more stringent. Also, individually, the smaller communities will have relatively less influence on new pollution abatement regulations than a major regional entity might.

5.3.3 Costs

Table 5.3.3-1 demonstrates the relative costs anticipated for individual community systems, which might exist in the year 2010. In order to provide a "worst-case" view of the financial impact on communities, it has been assumed that only relatively high levels of treatment will be allowed in the County. A comparison is developed later in the study showing how these costs relate to equivalent costs for regional and on-site systems. But, from this table, it can be clearly seen why people tend to prefer centralized systems, since none of the communities would have a total monthly cost as great as the $97 maximum cost for an on-site system.

Table 5.3.3-1

Individual Community Treatment Plant Costs, Year 2000-2020		
Community	2010 Population	Average Total Cost Per Connection Per Month
San Marcos	63,350	$ 9.10
Kyle	11,238	$22.32
Dripping Spring	4,950	$18.78
Buda	2,580	$31.48
Hays City	1,080	$53.63
Wimberley/Woodcreek	3,300	$38.07
Uhland	500	$74.17
Mountain City	590	$70.97

5.4 Alternatives for Regional Wastewater Collection and Treatment Systems

5.4.1 Introduction

The feasibility of regionalization of wastewater systems depends on several factors. One of the leading factors is density of population, since, clearly, the denser the population in a region, the more likely that a centralized regional system will be the most economical for the area. Another factor that impacts the feasibility of regional systems, and all centralized systems, is the strict enforcement of alternatives to centralized treatment and disposal. For instance, an area-wide authority such as the Texas Department of Health or the Edwards Underground Water District might prohibit the use of conventional septic tank drain fields over the recharge zone of aquifers. Since engineered on-site systems are more expensive than conventional on-site systems, the resulting cost for constructing new and replacement systems could result in regionalization becoming economically feasible.

Much of the area of the County has no apparent driving force for either an increase in population density sufficient for regionalization or an apparent need for regulatory prohibition of conventional septic tank drain fields. Therefore, for a large part of the County, this study assumes that regionalization of wastewater collection and treatment will not be feasible during the study planning period. The portion of the County west of the recharge zone which will not be served by Dripping Springs or the Woodcreek/Wimberley system is considered to be an area where regionalization is not feasible.

Other factors which affect the regionalization of wastewater include whether or not an interbasin transfer of water might occur by pumping wastewater into another basin, whether discharge of wastewaters are allowed into the stream or if land application of effluent is necessary, the economies or necessity to reuse water, and the impact that water conservation might have in reducing or delaying regional wastewater treatment plants. The City of Buda currently has a permit for interim discharge into the Guadalupe River Basin even though they are located in the Lower Colorado Basin, however, the regional systems presented in the following section are based on the assumption that additional interbasin transfer of wastewater will not be allowed. Subsequent sections present the estimated costs of treatment systems which will produce reclaimable water from a secondary wastewater treatment plant suitable for injection into the Edwards Aquifer and discusses the options for disposing of wastewater sludges.

5.4.2 Assumptions

The development of alternatives for regionalization of wastewater systems requires that certain assumptions be made. The five principal assumptions made for this study are as follows:

Population in the County will increase in accordance with the projections developed earlier in this study;

Transfer of treated effluent between river basins will not be allowed (i.e., between the Colorado River Basin and the Guadalupe River Basin);

All wastewaters discharged will require treatment to achieve an effluent quality equal to 5-5-2-1 (phosphorus);

Regulations will prohibit on-site wastewater disposal systems which allow pollutants to enter the Edwards Aquifer. Both new and replacement systems will be required to meet stringent requirements; and

Acceptable on-site systems will be evapotranspiration beds (ET beds) and low pressure dosing systems (LPD systems).

The history of pollution abatement in Texas reflects that the permitted quality of wastewater treatment plant effluent has improved over time. However, it is not possible to know many years in advance what the effluent limitations may be. Our choice of a target effluent quality of 5 milligrams per liter (mg/l) of BOD (biochemical oxygen demand), 5 mg/l TSS (total suspended solids), 2 mg/l ammonia nitrogen and 1 mg/l phosphorus is based on the presumption that a low-oxygen-consuming discharge containing low concentrations of phosphorus will be most likely for the more sensitive (and most populated) areas of Hays County.

ET beds and LPD systems are currently approved as on-site systems in Texas and a considerable amount of information regarding their cost and effectiveness is available. Other systems currently under consideration, such as upflow anaerobic filters and rock-reed filters, may come into general acceptance and even provide improved reliability and cost savings in the future. However, for the purpose of comparing the feasibility of regional wastewater collection and treatment systems, only on-site systems with established design criteria and adequate cost information have been used.

5.4.3. Description of Alternatives

The potential alternatives for regionalization have been grouped into the largest regions which could be economically served by individual systems without crossing river basin boundaries. This would provide four regional systems, which would include the North County, South County, Dripping Springs, and Woodcreek/Wimberley Regional Systems as shown in Figure 5.4.3-1. The Dripping Springs and Woodcreek/Wimberley areas have been treated as separate regions due to their relative isolation from the other populated areas of the County. Since its planning is fairly recent, the Dripping Springs' Facility Plan for their proposed collection and treatment system has been used in this report.

The North County System would serve the cities of Buda and Hays City, the rural area within the Austin ETJ, and the Mountain City area. Its treatment plant would be the current City of Buda treatment plant, expanded as necessary to serve the area, with new interceptors and pump stations to collect and transfer raw wastewater to the plant. The plant would be required to treat to the assumed level of quality and for planning purposes, it was assumed it would utilize activated sludge treatment with nitrification, filtration, carbon adsorption, and solids handling with aerobic digestion, drying beds, and ultimate disposal by landfilling.

The South County System would serve San Marcos and Kyle, and it would consist of periodic expansions of the San Marcos treatment plant and transfer pipelines and pump stations to deliver raw wastewater from the the Kyle ETJ to the plant. The San Marcos plant is currently permitted for an average flow of 6.25 million gallons per day and discharge quality parameters of 20/20. To convert this plant to a regional plant, it is anticipated that further improvement of this facility will be required, which would include the addition of nitrification, carbon adsorption, and new sludge handling facilities.

At Dripping Springs, the recommended treatment regime is a 20/20 activated sludge plant with land application of the effluent. This plant will serve only the Dripping Springs area, and, in fact, it is not anticipated that all of the area in the current ETJ of the city will be served or even developed during the planning period.

The Woodcreek/Wimberley System will serve the areas around these two communities which could feasibly be sewered. It would be a new treatment facility which would be periodically expanded as required. The secondary effluent would be land applied so there would not be a discharge to area streams.

5.4.4 Cost Comparison - On-Site, Regionalization, and Individual Treatment Plants

In order to simplify the comparison of the alternative methods of wastewater disposal, only two planning sub-periods have been selected for evaluation of treatment plants, the period from the year 2000 to 2020 and the period from 2020 to 2040. The decade from 1990 to 2000 was excluded since a significant amount of detailed planning has recently occurred in Dripping Springs and San Marcos and both have found that growth rates do not justify a more aggressive development schedule than beginning new facilities around the year 2000. For this comparison, it was assumed that the same would hold true for the two other regional systems. For each of the sub-planning periods, it was assumed that facilities adequate for the entire 20 year period would be constructed at one time and then an average monthly cost per connection was calculated for the planning period mid-points, i.e. 2010 and 2030. It should be noted that these years are different than the planning target years used for water supply planning.

As noted earlier, the average monthly cost of on-site treatment systems in Hays County is approximately $48. This equates to a capital cost of $5,000 amortized for 20 years at an interest rate of 10%. This average cost will be used for comparison with centralized treatment systems, since it is a compromise between the least expensive and most expensive

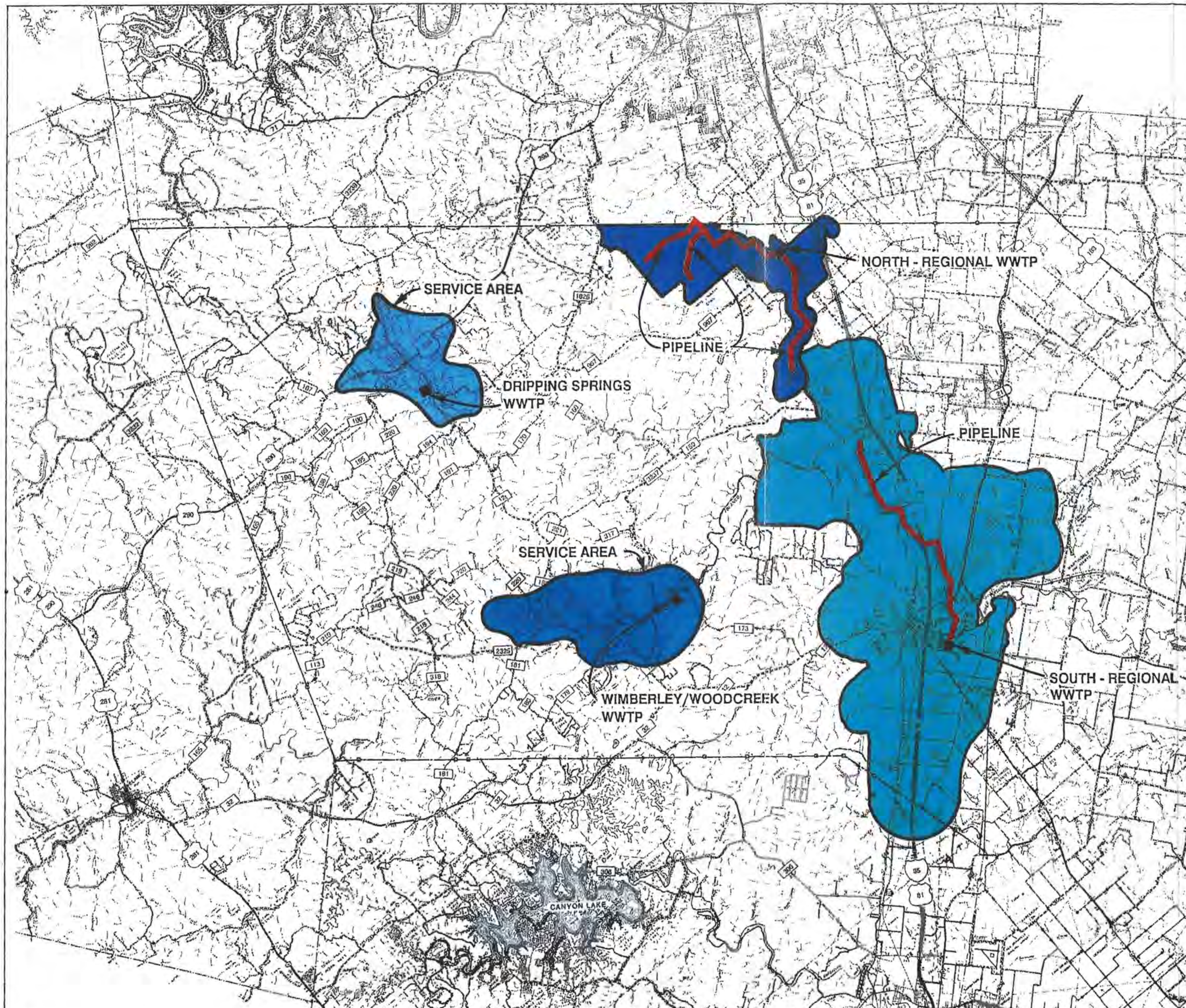


FIGURE 5.4.3-1

REGIONAL WASTEWATER TREATMENT PLANT ALTERNATIVES

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systems described in the section on on-site systems. It should be noted that this monthly cost assumes there is no cost for maintenance of on-site systems.

Year 2000 Facilities

Tables 5.4.4-1 and 5.4.4-2 present the anticipated costs for individual community and regional treatment facilities in 1988 dollars. The costs include the collectors for individual residences, interceptors and pump stations, and the treatment plants, all of which are assumed to treat to a level of 5-5-2-1.

From Table 5.4.4-1 it can be seen that several of the communities would have system costs much greater than the $48 per month per house for an on-site system. Table 5.4.4-2 shows more favorable economics when the individual systems are grouped to form regional systems.

Year 2020 Facilities

Tables 5.4.4-3 and Table 5.4.4-4 present costs for the 2020-2040 planning period in 1988 dollars. The assumptions regarding system components are the same as for the facilities presented in the previous section. It can be seen that economies of scale significantly impact the cost of facilities, as evidenced by cost for an individual treatment plant to serve Kyle, which is projected to double in population while the monthly wastewater cost is reduced by about 18%.

Table 5.4.4-1

Individual Collection and Treatment System Plant Costs, 2000-2020

Community	2010 Pop.	Capital Cost	Uniform Ann. Pmts.	O & M Cost	Total Annual Cost	Cost/ month/ conn
San Marcos	63,350	$39,000	$3,972	$2,400	$6,372	$20.96
Kyle	11,238	13,861	1,412	580	1,992	36.93
Dripping Spgs	4,950	4,770	486	260	746	31.40
Buda	2,580	2,224	227	224	451	36.42
Hays City	1,080	2,614	266	144	410	79.09
Wimberley/ Woodcreek	3,300	4,870	496	278	774	48.87
Uhland	500	1,362	139	94	233	97.08
Mountain City	590	1,656	169	104	273	96.40

(All figures in $1000's except first and last columns.)

Table 5.4.4-2

Regional System Costs, 2000-2020

Community	2010 Pop.	Capital Cost	Uniform Ann. Pmts.	O & M Cost	Total Annual Cost	Cost/ month/ conn
North	6,600	$9,076	$924	$407	$1,331	$42.01
South	74,600	57,501	5,856	2,690	8,546	23.87

(All figures are $1000's except first and last columns.)

Table 5.4.4-3

Individual Collection and Treatment System Costs, 2020-2040						
Community	(1) 2030 Pop.	(2) Capital Cost	(3) Uniform Annual Payments	(4) O & M Cost	(5) Total Annual Cost	(6) Cost/ month/ conn
San Marcos	88,650	$38,119	$3,882	$2,790	$6,672	$15.68
Kyle	24,623	23,152	2,358	1,205	3,563	30.15
Buda	3,240	2,040	208	257	465	29.89
Hays City	1,527	1,204	123	178	301	41.02
Wimberley/ Woodcreek	6,500	5,671	578	357	935	29.95
Uhland	766	910	93	144	237	64.37
Mountain City	860	812	83	144	227	54.92

(All costs in $1,000's except columns (1) and (6).)

Table 5.4.4-4

Regional System Costs, 2020-2040						
Community	(1) 2030 Pop.	(2) Capital Cost	(3) Uniform Annual Payments	(4) O & M Cost	(5) Total Annual Cost	(6) Cost/ month/ conn
North	10,000	$5,980	$609	$354	$963	$20.06
South	113,273	58,557	5,964	3,640	9,604	17.66

(All costs in $1,000's except columns (1) and (6).)

5.5 Cost Comparison - Wastewater Treatment Plants Sized for the Effects of Water Conservation

Table 5.5-1 compares wastewater treatment plant costs for individual communities when water conservation is not instituted (Table 5.3.3-1) and after water conservation is instituted. The percentage of water use conserved was assumed to be about 11% by year 2000 and 22% by year 2040. Return flows were adjusted by the same percentages to reflect the effect of water conservation on treatment plant costs.

The figures in Table 5.5-1 show the reduction in monthly per connection costs for treatment facilities when water conservation is practiced. The savings is, overall, about the same for both planning periods. This might suggest that, within the range of conservation assumed herein, there is no great benefit in wastewater treatment plant costs as a result of conservation beyond about 11%. However, our conclusion is that the costs are less than they would be otherwise (i.e., without water conservation). Therefore, the benefit of water conservation related to wastewater treatment plants will be down-sizing or postponement of plant installations and expansions.

Table 5.5-1

Effect of Water Conservation on Wastewater Treatment Plant Monthly Per Connection Costs

	Years 2000-2020		Years 2020-2040	
	Without Conservation	With Conservation	Without Conservation	With Conservation
San Marcos	$ 9.10	$ 6.16	$ 7.31	$5.76
Kyle	22.32	20.06	14.47	11.33
Dripping Springs	18.78	16.92	19.17	16.58
Buda	31.48	26.65	22.51	14.91
Hays City	53.63	49.58	30.02	23.31
Wimberley/Woodcreek	38.07	29.42	16.02	14.16
Uhland	74.17	65.83	25.53	18.00
Mountain City	70.97	61.44	43.60	35.68
North Regional	21.41	18.06	10.90	10.29
South Regional	10.40	8.02	8.97	7.08

5.6 Wastewater Reuse

Wastewater can be reused either directly or indirectly. An example of direct reuse would be the use of treated wastewater for closed cycle cooling water in an industry. An example of indirect reuse would be the injection of highly treated wastewater into an underground aquifer which serves as a water supply. Most reuse applications can be grouped into the following general classifications:

* municipal;
* industrial;
* agricultural;
* recreational; and
* recharge.

Since San Marcos has a high quality surface water source at hand, in the form of San Marcos River flows, municipal reuse of wastewater might become feasible for San Marcos at some time in the future. Assuming water rights were available in the San Marcos River and spring flows in the river could be protected, a possible reuse scenario would be to blend highly treated wastewater with the normal flow in the San Marcos River, then subsequently diverting and treating the blended water supply at a downstream surface water treatment plant. The high volume of water normally flowing in the San Marcos River, relative to the needs of San Marcos, should lessen the stigma the public normally associates with reuse. It does not seem likely that this form of reuse would be as acceptable in other parts of the County because of the limited availability of dilution water and the high cost associated if the reuse water becomes a significant part of the water supply.

Industrial reuse could be feasible at any of the communities in the County which will have at least secondary treatment levels. However, there would need to be a demand from an industry or a group of industries for the treated water. At present there is no such demand.

Agricultural reuse is currently being planned for the Dripping Springs facility and it is envisioned that this will be the method of disposal if the Wimberly/Woodcreek system is constructed. Irrigation with treated wastewater is practiced in many areas of Texas and the nation. The use of raw wastewater for irrigation has been discouraged nationally and is not allowed in Texas, and as a result, some treatment, normally to at least secondary level requirements, is required prior to irrigation.

Recreational reuse is also being practiced in many areas. Many golf courses in Texas are irrigated with treated wastewater as their primary source of water or as an irrigation supplement. One other recreational reuse of water might be to create a lake using highly treated wastewaters, but it does not appear likely that a lake for boating and fishing in Hays County could be created because of the relatively small quantity of wastewater involved.

The recharging of a water supply aquifer is being practiced in El Paso, among a few other places. In El Paso, wastewater from the city is treated to a high level and then injected into the aquifer which serves as the city's drinking water supply. Therefore, the ground water which is withdrawn and used as potable water is not totally recycled wastewater, and in fact, the injected portion, relative to the total available supply is fairly small, but this approach has enabled El Paso to improve the dependability of its water supply. The following section discusses recharge of treated wastewater as a disposal option for Hays County.

5.6.1 Potential Cost of Edwards Aquifer Recharge Using Treated Wastewater

It is estimated that the long term annual average recharge to the Edwards Aquifer which enters from Hays County is about 6% of the aquifer's total recharge, or about 36,500 acre-feet. Assuming that all the communities which are listed in Section 5.4 participate in a regional system, except Dripping Springs and the Wimberley/Woodcreek areas, and that about 50% of the water used by these communities actually returned to the wastewater system, there wastewater system, there could be about 5,000 acre-feet per year recharged into the aquifer. This recycling of water would reduce the net withdrawal from the aquifer by that amount.

The treatment processes required following secondary treatment would typically be as follows:

* chemical coagulation and clarification;
* air stripping of ammonia;
* recarbonation;
* filtration;
* activated carbon absorption;
* reverse osmosis;
* disinfection;
* blending of water streams; and
* injection or pumping.

If the plant were located at San Marcos, for example, the entire wastewater flow from the areas of Buda, Hays City, Austin's ETJ, and Mountain City could be transferred to the Kyle collection system which would then flow to the San Marcos plant for treatment. The cost of this transfer plus the costs for the treatment and injection would increase the average total monthly cost per connection for the "north" areas from $40.63 to $59.75 for the year 2010. The equivalent cost for San Marcos and Kyle would increase from $22.53 to $30.13 per connection per month for the same year. Since these costs are nearly double the costs for regional treatment and discharge, forces other than wastewater treatment economics will have to create a need before aquifer recharge becomes a reality .

5.6.2 Reuse at the Source

Under the appropriate conditions, allowable by public health authorities, there could be advantages to wastewater reuse methods at the source, i.e. at the home or business. In Hays County the most promising form of reuse would be the recycling of "greywater" for specific limited uses approved by the regulators.

The use of "greywater" for toilet flushing and irrigation would reduce the quantity of wastewater transferred to either an on-site or centralized system. The construction of new facilities for either type system, if recycling greywater becomes widely used, could be delayed and possibly facilities could be downsized.

However, the HCWDB can only be supportive of the concept at this time. Several major obstacles must be overcome before such practices could even be encouraged by the Board. These include, but are probably not limited to, the following:

1. Research must be done on the short-term and long-term effects of such recycling in order to establish water quality standards for each recycling option.

2. The questions of the liability of government, utilities, contractors and manufacturers with regard to recycling will have to be satisfactorily resolved.

3. The State Department of Health and/or the Texas Water Commission will have to promulgate standards and rules for recycling wastewater.

5.7 Solids Handling Alternatives

5.7.1 Introduction

In the types of wastewater treatment alternatives anticipated in Hays County, the removal of pollutants from the water results in the creation of various types of solids being either directly removed or being added and subsequently removed during the treatment processes. These solids must then be handled and disposed of in a manner which will not result in their being a source of pollution.

The sources of these solids are the wastewater itself, which normally contains grit and other non-biodegradeable materials, wasted biological matter known as sludge, and other solids such as spent activated carbon in plants which require high levels of treatment. Some of the solids can be reused, such as the thermal regeneration of activated carbon, but other solids, such as primary sludge, have no reuse value unless they are further treated through biological or chemical means. Generally, there are two ways of dealing with these produced materials: by conversion processes such as incineration or composting where an entirely different material is created; or land disposal which can take the form of land spreading or landfilling.

Ideally, the best method of disposal of these materials is through the creation of new usable materials which are enhanced by the very chemicals and nutrients which must be removed from the wastewater. Treated (or, digested) sludge generally contains nutrients and metals in a concentrated form which can benefit soil and crops. The City of Milwaukee has processed its solids and marketed the soil conditioner Milorganite for many years, however, the creation of a marketable product is not necessary in order to benefit from the sludge. In most cases, land spreading of digested sludge provides an economical solution benefiting the land but not requiring large quantities of production in order to make it viable.

5.7.2 Limitations of Solids Handling Alternatives

Every option for handling solids from wastewater treatment plants has limitations. Site conditions and economics must play important roles in the determination of the appropriate option selected. Some of the limitations of the more likely alternatives for this planning area are discussed below.

Incineration is not generally considered economically feasible for plants having less than 1 million gallons per day flow unless the community already uses incineration for another reason, such as disposal of other solid wastes, (garbage and refuse). Also, incineration converts one type of pollution, solid waste, into another, air pollution, which can be controlled, but even after the air pollution problem is solved there is a final residue (ash) which must be removed periodically from the incinerator and disposed of in a safe manner.

None of these problems are insurmountable, but they will generally not be cost effective for facilities the size of those anticipated in Hays County.

Composting is an ideal solution for disposing of solid wastes from wastewater plants because it is an effective form of recycling of nutrients and organic material which can benefit soil greatly. However, composting is relatively labor intensive and there must be a market for the final product to offset this labor cost.

Land application is the second most commonly practiced method of disposing of wastewater sludges in this area. However, Texas Department of Health regulations state that: "Ultimate sludge disposal shall be accomplished in such a manner that sludges will not enter the waters of the State." This requirement results in a permanent modification having to be made to the disposal site, thereby, effectively requiring that a long term arrangement for use of the land must be in place and eliminating the possibility of using a large number of sites for disposal of digested sludge. Generally, limiting the number of sites also limits the utilization of this method of disposal to a site owned by the plant operator, and it forces the operator to have another method of sludge disposal available when his site is not useable.

Landfilling is the most widely practiced method of sludge disposal in this area because it is generally the most economical method and the most reliable. The only additional cost created by disposing of sludge in this manner is that it must be well-dried, normally in sludge drying beds in this area, before hauling to the landfill. The biggest negative to this type of disposal, other than the possibity that the landfill may not be adequately constructed, is that this method of wastewater sludge disposal does not allow the reuse of the valuable materials which it contains.

5.7.3 Recommendations for Solids Handling

For existing or proposed treatment plants in the planning area, it is generally recommended that land application continue to be utilized as the primary disposal method for San Marcos. Landfilling is recommended for systems which do not have access to San Marcos.

There may be future conditions, now unseen, which will make land application an unattractive solution, however, it currently appears that there will be adequate land available in Hays County for land disposal throughout the planning period.

The Hays County Water Development Board, or its successor(s), should encourage the development of reuse alternatives such as land application and, if a market or citizen interest can be developed, the use of composting.

5.8 Summary/Recommendations

The increase in population in Hays County during the planning period will increase the requirements to effectively utilize and manage the various options for wastewater disposal. While it is generally recognized that centralized wastewater collection and treatment systems will expand during the planning period, it is anticipated that the portion of the County which will continue to utilize on-site disposal will be 31% by year 2040, compared to 37% at the present.

Obviously the continued major role for on-site disposal will necessitate the treatment of on-site disposal methods in the same manner as treated wastewater discharges. There will be the need for a management structure which insures that the on-site systems are appropriate for the site, designed properly, constructed according to approved plans, and operated to prevent pollutants from entering surface and ground water resources.

There will be continued advantages toward creating and operating regional collection and treatment systems. The movement toward more and more advanced levels of treatment prior to discharge will make the joining of financial and political resources more likely because of the economies involved. Based on the analysis presented in this study, the following are recommended regarding wastewater disposal:

1. Hays County, acting through its Commissioners Court, should have the responsibility to ensure that on-site systems are properly planned, designed, constructed, inspected, and maintained.

2. The County should develop a mechanism whereby out-dated and failed on-site systems are detected and replaced with new systems which use accepted state-of-the-art disposal technology. Such a mechanism might involve a requirement for inspection of the existing system prior to transferring title to the property and/or a periodic inspection of such systems. Also, at the time of title transfer, the County might give the new property owner an incentive, such as a 5-year reduction in property taxes, to upgrade to an up-to-date system rather than delaying until an older system fails and contributes to or creates a pollution problem.

3. The County should delineate critical water quality zones, such as the entire area located over the Edwards Aquifer and the Barton Springs-Edwards Aquifer Recharge Zone, and prohibit and/or require specific systems in these areas in order to maintain ground and surface water quality. In these areas of the County, systems which would result in pollution of the Aquifer could not be installed.

4. The County should encourage and support the development of regional wastewater collection and disposal systems in the part of the County over the Aquifer, in the Kyle and San Marcos area, in the Dripping Springs area, and in the Wimberley/Woodcreek area.

SECTION 6
WATER CONSERVATION AND DROUGHT CONTINGENCY

6.0 WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

6.1 Water Conservation Plan

In 1985, the Texas Constitution was amended to require water suppliers to develop and adopt a water conservation and drought contingency plan in order to be eligible for financial assistance from the Texas Water Development Fund. This plan was developed by a special committee appointed by the HCWDB. The required water conservation plan must identify feasible aspects of conservation for the particular entity and must include one or more of the following methods:

- Education and Information;
- Plumbing Codes;
- Retrofit Programs;
- Water Rate Structures;
- Universal Metering;
- Water Conservation Landscaping;
- Leak Detection;
- Recycling and Reuse; and
- Implementation and Enforcement;

The drought contingency plan must include the following six elements:

- Trigger Conditions;
- Drought Contingency Measures;
- Information and Education;
- Initiation and Procedures;

* Termination Notification; and
* Implementation Procedures.

This section is a summary of the HCWDB's water conservation and drought contingency plan. The complete document is included in the Appendix. In addition to a smmary of the plan, discussions on the potential impacts of the conservation plan are included.

Purpose and Objectives

Projected population and economic growth in Hays County have raised public awareness and concern about the adequacy of available water supplies to satisfy future needs. Based on the population and water demands for Hays County, it appears that the risk of future water shortages will increase over time. Water conservation and reuse can help reduce this risk as well as reduce the cost of water to individual consumers. By practicing water conservation, individual consumers can benefit directly from less expensive water and wastewater facilities and reduce the operation and maintenance costs of these facilities. Consumers also benefit by deferring expansion of existing systems to a later date. Many water conservation actions provide direct economic benefits to the water user as will be demonstrated in this section of the report.

Specific water conservation goals were adopted by the HCWDB in formulating this plan are as follows:

1) To reduce future water demands on limited freshwater supply sources;

2) To reduce the magnitude of seasonal peak water demands;

3) To reduce the magnitude of wastewater flows requiring treatment and disposal; and

4) To fully integrate water conservation and reuse into long-range water resources planning and management and land use planning and development.

Conservation Measures

The water conservation plan addresses nine aspects of water conservation, including public information and education, water conserving plumbing codes, water conservation retrofit programs, water conservation-oriented rate structures, universal metering and meter repair and replacement, water conserving landscaping, leak detection and water audits, and wastewater reuse and recycling. Following is a summary of the requirements and implementation plan for each of these items.

6.1.1 Public Information and Education

A committee composed of dedicated, committed, and respected citizens will be appointed to engage in an ongoing education program. The committee will be responsible for the following:

* Provide qualified individuals to speak at institutions, organizations, and groups throughout the County at regular intervals;

* Conduct or sponsor exhibits on conservation, water saving devices, and other methods to promote water conservation and efficiency;

* Provide and distribute brochures and other materials to the citizens of Hays County. These materials are frequently available from an assortment of agencies such as the Texas Agricultural Extension Service and the Texas Water Development Board;

* Work in cooperation with builders, developers, and governmental agencies to provide exhibits of xeriscape landscaping on new homes in highly visible locations;

* Work in cooperation with schools and Southwest Texas State University to establish an education program within these institutions and to provide them with landscape videos, brochures, and other training aids; and

* Develop welcome packages for new citizens to educate them in the benefits of conservation and inform them of water efficient plants, trees, shrubs, and grasses best suited to this area.

6.1.2 Water Conserving Plumbing Codes

The following plumbing code was established to mandate the use of water conserving plumbing fixtures.

Requirements For All New Residential and Commercial Construction

(a) Toilets: Toilets shall be designed, manufactured, and installed so the maximum flush will not exceed 1.6 gallons of water.

(b) Urinals: Urinals shall be designed, manufactured, and installed so the maximum flush will not exceed 1.5 gallons of water. Adjustable type flushometer valves may be used provided they are adjusted so the maximum flush will not exceed 1.5 gallons of water.

(c) Showerheads: Showerheads, except where provided for safety reasons, shall be designed, manufactured, and installed with a flow limitation device which will not allow a water flow rate in excess of 3.0 gallons per minute. The flow limitation device must be a permanent and integral part of the showerhead and must not be removable to allow flow rates in excess of 3 gallons per minute.

(d) Faucets: All lavatory, kitchen, and bar sink faucets shall be designed, manufactured, installed and equipped with a flow contol device or aerator which will not allow a water flow rate in excess of 2 gallons per minute. In addition, all lavatory faucets located in restrooms intended for use by the general public shall be of the metering or self-closing type.

(c) Hot Water Piping: All hot water lines not in or under a concrete slab shall be insulated.

(f) Automatic Dishwashers: All automatic dishwashers installed in residential dwellings shall be of a design that uses a maximum of 13 gallons per cycle.

Requirements For Replacement or Renovation of Plumbing Fixtures

All new plumbing fixtures that replace or renovate existing plumbing fixtures shall follow the requirements for new residential and commercial construction.

6.1.3 Water Conservation Retrofit Program

Retrofit of existing plumbing fixtures would be accomplished through the voluntary efforts of individual consumers for their homes and businesses. Adoption of the water conservation plumbing code will provide a gradual up-grading of plumbing fixtures in existing structures.

6.1.4 Water Conservation - Oriented Rate Structure

The HCWDB recommends the establishment of an increasing block rate structure.

6.1.5 Universal Metering and Meter Repair and Replacement

The HCWDB recommends universal metering by all water suppliers along with the development and implementation of a meter replacement/testing schedule.

6.1.6 Water Conserving Landscaping

Water conserving landscaping will be initiated through public information and education. Well designed and properly maintained demonstration landscapes located in highly visible areas within Hays County will be created to promote the water conserving landscape concept. Incentives are also recommended for builders and developers who install or require water conserving landscapes.

6.1.7 Leak Detection and Water Audits

Leak detection and water audits will be accomplished through the voluntary efforts of each water supplier.

6.1.8 Wastewater Reuse and Recycling

The HCWDB recommends that reuse be encouraged by all available means whenever it is found to be fiscally, environmentally, and institutionally practical and prudent.

6.1.9 Means of Implementation and Enforcement

The HCWDB will act as the administrator of the Water Conservation Program. The Board will oversee the implementation of the program. The HCWDB will be responsible for the submission of an annual report to the Texas Water Development Board on the Water Conservation Plan. The annual report will address progress made, response by the public, and quantitative effectiveness of the program.

The HCWDB will require, upon disbursement of any funds for water supply projects, that each water supply entity being served by the water supply projects adopt this water conservation plan by ordinance or by-laws. Each entity will be responsible for enforcement of the Water Conservation Plan and each entity will be also responsible for furnishing all information requested by the HCWDB.

6.2 Drought Contingency Plan

The Board's Drought Contingency Plan will be a recommendation for the water suppliers within Hays County to follow. During a drought condition, the Board will serve to coordinate the consumption of water resources within the County to ensure fair and equitable use among consumers.

The drought contingency plan is divided into parts according to the particular areas served by the Edwards Aquifer (San Antonio), the Barton Springs - Edwards Aquifer, and the Trinity Group Aquifer. These areas are defined as:

* Edwards Underground Water District within Hays County;

* Barton Springs-Edwards Aquifer Conservation District within Hays County; and

* Trinity Group Aquifer area defined as the area west of the EUWD boundary and west of the Barton Springs-Edwards Aquifer Conservation District boundary within Hays County.

The EUWD has a drought management plan which will apply to the Edwards Aquifer (San Antonio) region in Hays County. The Barton Springs-Edwards Aquifer Conservation District has not developed a drought contingency plan to date, however a plan is expected in the near future. The Trinity Group Aquifer region is closely correlated with the Edwards Aquifer (San Antonio), therefore the Trinity Group Aquifer region and the EUWD should be subject to the same trigger conditions in Hays County.

The drought contingency plan is described in the Appendix. The plan is divided into three stages: mild condition, moderate condition, and severe condition. Trigger conditions are defined for each of these stages for each of the three areas defined earlier. Drought contingency measures were also given for each of the three drought stages, and these measures are the same for each area.

Information and education are an integral part of the drought contingency plan. The purpose and desired effects of the drought contingency plan will be communicated to the public through articles in local newspapers and supplemented by pamphlets and notices. When trigger conditions are approaching, articles will be published to notify the public. Newspapers will also publish articles concerning the implementation of drought measures and will notify the public when drought measures may be abated.

The HCWDB will implement the drought contingency plan in a manner similar to that stated for the water conservation plan. Upon disbursement of any funds by the HCWDB for water supply projects, each entity being served by the water supply projects will be required to adopt the drought contingency plan by ordinance or by-laws.

6.3 Benefits of the Water Conservation Plan

Individual consumers would benefit in many ways through the adoption of the water conservation plan. Numerous studies have shown that water conservation devices and practices are cost effective and pay for themselves in a relatively short period of time. Tables 6.3-1 and 6.3-2 give estimates of savings that could be achieved through the adoption of the HCWDB's Water Conservation Plan. The items addressed are only those that are recommended by the HCWDB, however additional savings could be achieved by individual consumers voluntarily implementing other programs discussed in the plan. For example, while no specific actions were included in the water conservation plan for outdoor watering, significant savings could be achieved through the adoption of some of the recommended alternatives. Table 6.3-1 shows that by implementing the water conservation plan, new construction could attain a $28.74 annual savings in their water bill and a $70.80 savings in their electric bill for a combined total annual savings of $99.54. The annual cost of the program is estimated to be $16.90, resulting in a net savings of $82.64 per year per home. The annual cost of the program was computed by taking the additional cost to implement the program and amoritizing it over an assumed 15 year service life at a 10% interest rate.

The 1.6 gallon/flush toilets cost an additional $100 over the standard 3.5 gallon/flush toilet. Pipe insulation is estimated to have an additional cost of $25 per home resulting in an initial investment of $125. Savings that could be achieved in the first year would amount to almost 80% of the initial investment. Retrofitting existing homes and businesses is also cost effective for individual consumers. Table 6.3-2 shows that by replacing a 3.5 gallon/flush

Table 6.3-1

Water Conservation Savings for New Construction					
Program	Water Savings (gpcd)	Energy Savings Electric Water Heater KW-HR/YR/Home	Water Savings $/YR/Home	Energy Savings $/YR/Home	Additional Cost for Program $/Yr/Home
Public Information and Education	1.0	---	$1.14	---	$0.50
Water Conserving Plumbing Code					
Toilets (1.6 gal/flush max.)	9.5	---	$10.84	---	$13.15
Showerheads (3 gpm max.)	6.7	541	$7.64	$32.40	$0.00
Faucets (2 gpm max.)	0.5	---	$0.57	---	$0.00
Pipe Insulation	2.0	320	$2.28	$19.20	$3.25
Water Efficient Dishwasher (13 gal/cycle max.)	2.0	320	$2.28	$19.20	$0.00
Water Conserving Rate Structure					
Increasing Block Rate	3.5	---	$3.99	---	$0.00
Total	25.2	1181	$28.74	$70.80	$16.90

Notes: Water savings based on county average of $1.25/1000 gal.
Energy savings based on electric cost of $0.06/Kw-Hr
Cost per home based on 2.5 persons per home.
Program cost assumes a 15 yr. service life with the capital cost amoritized over 15 yrs. at 10% interest.

Table 6.3-2

Water Conservation Savings for Existing Structures					
Program	Water Savings (gpcd)	Energy Savings Electric Water Heater KW-HR/YR/Home	Water Savings $/YR/Home	Energy Savings $/YR/Home	Additional Cost for Program $/Yr/Home
Public Information and Education	1.0	---	$1.14	---	$0.50
Water Conserving Plumbing Code					
Toilets (1.6 gal/flush max.)	9.5	---	$10.84	---	$36.80
Showerheads (3 gpm max.)	6.7	541	$7.64	$32.40	$3.15
Faucets (2 gpm max.)	0.5	---	$0.57	---	$0.40
Water Conserving Rate Structure					
Increasing Block Rate	3.5	---	$3.99	---	$0.00
Total	21.2	541	$24.18	$32.40	$40.85

Notes: Water savings based on county average of $1.25/1000 gal.
Energy savings based on electric cost of $0.06/Kw-Hr
Cost per home based on 2.5 persons per home.
Program cost assumes a 15 yr. service life with the capital cost amoritized over 15 yrs. at 10% interest.

toilet with a 1.6 gallon/flush toilet, and by replacing inefficient showerheads and faucets, individual consumers could achieve a $24.18 annual savings in their water bill and a $32.40 savings in their electric bill for a total annual savings of $56.58. The annual cost of the program is estimated to be $40.85 resulting in a net annual savings of $15.73.

Benefits of water conservation other than savings in water and energy can also be identified. For example, a reduction in the volume of wastewater would be expected due to the reduction in water use. This reduction in wastewater would reduce the load on individual on-site wastewater treatment systems which would improve performance and reduce operation and maintenance. For organized wastewater treatment systems, a reduction in wastewater flow through the combined water conservation efforts of all consumers could result in a reduction in operation and maintenance expenses and could defer future expansion costs.

Water conservation offers numerous direct benefits to the residents of Hays County as well as many indirect benefits. The wide-spread implementation of the plan could have far reaching positive impacts on the future water supply needs of Hays County.

6.4 Possible Impacts of Conservation

6.4.1 Savings in Water

The impact of the conservation plan outlined is not known, however, it is possible to calculate potential savings in water demand by assuming the degree of participation in the various conservation programs and the amount of water saved by the actions described in the plan. Calculations to estimate potential impacts of the proposed conservation plan were made, using the following assumptions:

a. Savings in gpcd were taken from Tables 6.3-1 and 6.3-2;

b. The sum of projected populations for all ETJ's and WSC's listed in Table 2.1-2 of this report were used in the calculations;

c. 75% of all the population included in item b are expected to save water due to the public education programs;

d. 100% of all the population included in item b are expected to save water due to the increasing block rate structures, and 100% of new homes serving the population included in item b would be equipped with water saving plumbing;

e. A retrofit program would begin in 1990 and existing homes in the County would be retrofitted, with 25% of the homes completed by 1995, 30% of homes by 2000, 40% of the homes by 2010, 50% of the homes by 2020, 70% by 2030, and 90% by 2040;

f. Retrofitting would include replacing all toilets with the 1.5 gallon type and installing low-flow shower heads and faucets; and

g. To account for other conservation savings, including more efficient irrigation and landscape watering, water saving washers, leak detection, metering, and reuse for non-potable purposes, a percentage of the savings obtained by all of the preceeding (items a through f, above) was assumed. It was assumed that savings from these additional items would be 25% of items a through f through the year 2000 and then the savings would increase to 40% by year 2010 and beyond.

Based on these assumptions, the estimated savings due to conservation were calculated and are presented in Table 6.4-1.

Table 6.4-1

Estimated Savings by Conservation

Year	Estimated Savings as Percent of Projected Water Demand
1995	9
2000	11
2010	16
2020	18
2030	20
2040	22

6.4.2 Cost of the Conservation Program

The education program and plumbing codes are clearly cost effective as demonstrated in Section 6.3. To achieve the savings in water shown in Table 6.4-1, additional costs beyond those shown in Tables 6.3-1 and 6.3-2 will be required. Since the exact conservation measures to be used are not known, no attempt at estimating the cost is presented, however, it is believed that the use of water conserving landscaping and efficient irrigation practices will be the most cost effective conservation practices of those listed in g above.

6.4.3 Possible Effects of Conservation on Water and Wastewater Alternatives

The alternatives evaluated in earlier sections were reviewed to determine if reduced demands due to conservation would affect the selection and/or implementation of water and wastewater alternatives. It was concluded that conservation would not change the selection of alternatives but could result in postponement of construction and/or reduction in cost of the projects. The folowing sections discuss the impacts on water and wastewater alternatives.

6.4.3.1 Water Supply Alternatives

Those entities with the lowest projected rates of growth will benefit the most by conservation. The estimated time selected projects could be postponed is shown in Table 6.4-2.

Table 6.4-2

Alternative	Estimated Time of Postponement of Construction in Years Caused by Conservation
Alternative 5a, Wimberley & Woodcreek supplied by Blanco River	4
Alternative 7, Buda and Hays supply by City of Austin	4
Alternative 10b, San Marcos and NE County supplied by Canyon Reservoir	3
Alternative 11 and 12, Dripping Springs	2

The project cost by phases and cost per connection were calculated for each selected alternative assuming the projected demands were reduced by conservation as shown in Table

6.4-1. These costs are shown in Section 3.4, Table 3.4-1 through 3.4-5. An analysis of the cost tables shows significant savings in the cost per connection as a result of the reduced demand due to conservation. Typical savings for the first phase of water supply alternatives range from 5% for Alternative 10b to 22% for Alternative 5a. The greatest savings in cost noted occurs after year 2015 for Alternative 7, since only one pipeline will be required for the study period because of the relatively low projected population increase.

6.4.3.2 Wastewater Alternatives

Conservation could also provide savings because of reduced wastewater treatment. The benefits of water conservation are down-sizing or postponement of plant installation and expansions and reduced operations and maintenance costs. For comparison purposes, the estimated cost of wastewater treatment plants, with and without conservation, were made for the individual communities included in the study. These cost estimates, converted to cost per connection per month, are shown in Table 5.5-1. The savings in cost per connection typically range from 10% to 20%.

6.5 The Role of Conservation

Conservation is necessary, but it does not take the place of a new water supply in meeting future demands. It is recommended that both conservation and development of new water supplies be included in future planning for the County.

Because of the uncertainties concerning the effectiveness of conservation measures on population and demand projections and other factors, it is not recommended that specific monetary savings be relied upon in establishing initial project budgets. It is recommended that the HCWDB adopt a goal to achieve the percentages of reductions in the amount of water use shown in Table 6.4-1. This will require adoption of the plan outlined and substantial effort and expenditures.

At the time of design of the projects, reviews of per capita consumption rates and population projections should be made and the capacity requirements adjusted accordingly. This procedure will provide a method to incorporate conservation effects. The estimates of cost shown in Tables 3.4-1 through 3.4-5 provide targets which reflect significant savings in cost but the conservation program must be effective to achieve these savings.

SECTION 7
ENVIRONMENTAL CONSIDERATIONS

7.0 ENVIRONMENTAL CONSIDERATIONS

Construction of water and wastewater systems can impact virtually all facets of our environment. Prior to design and construction, each facility should be analyzed to identify potential site-specific impacts which might affect ground water quality, surface water quantity and quality, air quality, wetlands, vegetation, fish, wildlife, cultural resources, noise, geology, topography, and land uses. For a number of these factors, the impacts can be either positive or negative, but for some, only negative impacts will occur. When negative impacts are anticipated, protective actions should be identified, and if the negative impact cannot be avoided, then mitigative actions should be taken.

The following sections present a very preliminary analysis of impacts anticipated due to the five recommended water supply alternatives and a general discussion of the impacts expected from on-site wastewater systems and regional collection and treatment systems.

7.1 Alternative 5a - Wimberley and Woodcreek supplied from Blanco River and Canyon Reservoir.

This plan requires construction of an intake in Canyon Reservoir and a low dam and diversion structure on the Blanco River. Section 404 permits will be required for these structures, and the permits will require environmental studies to assess the impacts of the structures and provide protection or mitigation for affected environmental factors. The intake in Canyon Reservoir should not be considered as a significant impact and will probably be approved under the Corps of Engineers Regional General Permit. The low dam will be considered as a significant impact, with the magnitude dependent upon the storage volume of the impoundment. Also, if the volume exceeds 200 acre-feet, Texas Water Commission permits will also be required.

Pipelines from the reservoir to the river and treated water transmission lines will generally be buried within public rights-of-way and will not cross the Edwards Aquifer recharge zone, so any impacts should be temporary. However, each pipeline route should be reviewed to ensure that there will be no permanent impact to the environment.

7.2 Alternative 7 - Buda and Hays supplied by the City of Austin.

This plan requires a storage tank and pump station near the connection to the City of Austin pipeline, a pipeline extending through Hays to the City of Buda, and a booster pump station near Hays. All of these facilities will be constructed within or adjacent to public rights of way so virtually all of the land will have been previously disturbed. Also, the pipeline route generally traverses east of the outcrop zone of the Barton Springs-Edwards aquifer, so there should be no impact to aquifers. However, the line will cross Onion Creek north of Buda, and the crossing could be through an environmentally sensitive area. Environmental studies will be required to identify potential impacts at Onion Creek and should be performed for the remainder of the proposed facilities and to sensitive areas which have not been disturbed.

7.3 Alternative 10b - San Marcos, Kyle, Mountain City and the Northeast County supplied by water released from Canyon Reservoir.

This plan requires construction of a low dam and diversion structure on the Guadalupe River, a water treatment plant near the river, and pipelines from the Guadalupe River through San Marcos to Kyle and Mountain City. A pipeline extending east and northeast of Kyle to serve Uhland and the County Line, Plum Creek, and Goforth WSC's will also be required.

As with the previously discussed dam on the Guadalupe River, this low dam and diversion structure will require Section 404 permits, environmental studies, and mitigative and protective treatment. It also would also require a TWC permit.

Other sensitive areas include the pipeline crossings of the San Marcos and Blanco Rivers. In general, the pipeline routes do not cross the Edwards nor Barton Springs-Edwards Aquifer outcrop zones, however, the specific locations of the pipelines relative to the aquifer outcrop zones should be considered in more detail during design and appropriate action taken when the system is designed.

7.4 Alternatives 11 and 12 - Dripping Springs supplied by Lake Dripping Springs and by Lake Travis.

Lake Dripping Springs will definitely be environmentally sensitive and will require its own environmental assessment report and mitigation plan. Some of the major items to be addressed will include the potential effects on recharge to the Barton Springs-Edwards Aquifer, land use modifications, minimum stream flows, water quality, flooding, fish and wildlife, vegetation, and recreation.

Both plans for Dripping Springs will eventually include intake structures in Lake Travis, water treatment plants, and pipelines within the Onion Creek and Barton Creek basins. The Lake Travis intake and pipelines within the Barton Creek Basin will be especially environmentally sensitive and will require detailed studies to determine mitigative and protective measures during the construction of the required facilities, and to determine if mitigation is required for the permanent facilities.

7.5 Wastewater Alternatives

Since Hays County falls within two river basins (the Colorado and the Guadalupe) and overlies three ground water aquifers (the Edwards, Barton Springs-Edwards, and

Trinity Group) any form of wastewater treatment and disposal would have negative impacts. Obviously, discharges to surface waters in the County must be of a quality that will not degrade the receiving stream and the TWC permitting process ensures that stream quality will be maintained.

Less obvious, though, is the fact that on-site treatment and disposal systems have a potential to pollute the ground water of the County. As discussed in Section 5 of this report, on-site systems will continue to be used throughout the County, and it is imperative that mechanisms to detect and replace failing systems be adopted. This is especially important in the recharge areas of the aquifers where only reliable systems capable of returning high quality effluent or zero-discharge systems should be permitted. The only regulatory agency currently overseeing on-site systems is the Health Department and their process does not currently address environmental aspects of such systems. Therefore, in order to protect its environment, specifically its ground water quality, Hays County should aggressively become involved in the regulation of on-site systems.

SECTION 8
LEGAL INSTITUTIONAL ALTERNATIVES

8.0 LEGAL INSTITUTIONAL ALTERNATIVES

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8.1. Institutional and Financial Structure for Water and Wastewater Projects

8.1.1. General Overview. Table 8.1.1-1 lists the various types of legal entities (existing or potential) with the power to construct, own and operate water and wastewater systems, and describes the basic financial sources (taxes or system revenues) available to each type of entity.

8.1.2. Existing Entities. There are a number of existing water and wastewater utility systems in Hays County owned by cities, water districts and private water supply corporations. See Table 2.4-1. These entities are the most likely ones to construct and finance additional water and wastewater projects. Additionally, the Lower Colorado River Authority ("LCRA") and the Guadalupe Blanco River Authority ("GBRA") own large reservoirs with potential raw water supplies for the County. GBRA has experience in constructing and operating wastewater treatment systems. LCRA has recently expressed interest in owning wholesale water supply and wastewater treatment systems. Also, the Barton Springs-Edwards Aquifer Conservation District ("BSEACD") has the authority to construct water facilities utilizing both surface water and ground water. It has no power to construct wastewater facilities.

All of the existing entities may use system revenues to finance projects. Cities and water districts also have taxing authority to support water and wastewater projects. However, neither LCRA, GBRA nor the BSEACD have taxing authority.

Table 8.1.1-1

Hays County Water Development Board Water and Wastewater Project Ownership, Construction and Operation						
			Finance Construction Debt with		Finance Maintenance with	
Type of Entity	Own Water System	Own Sewer System	Taxes	Revenue	Taxes	Revenue
1. Texas Water Development Board	X	X		X		X
2. Hays County[1]	X		X	X	X	X
3. General Law City	X	X	X	X	X	X
4. Home Rule City	X	X	X	X	X	X
5. River Authority						
A. LCRA	X	X		X		X
B. GBRA	X	X		X		X
6. Public Utility Agent		X		X		
7. Water Control and Improvement District	X	X	X	X	X	X
8. Underground Water Conservation District						
A. BSEAUWCD	X			X		X
B. Chapter 52, Water Code	X		X	X	X	X
9. Fresh Water Supply District	X	X	X	X	X	X
10. Municipal Utility District	X	X	X	X	X	X
11. Water Improvement District	X		X	X		X
12. Special Utility District	X	X		X		X
13. Article 1434A Water Supply Corporation	X	X		X		X
14. For Profit Corporation	X	X		X		X

[1] If, prior to September 1, 1963, a county has adopted the provisions of Article 2352e, V.T.C.S., it may construct a water project up to a maximum amount of $250,000 per project "for county purposes."

8.1.3. Other Potential Entities to Own and Operate Water and Wastewater Projects. In addition to the existing water and wastewater providers in Hays County, state law allows for the creation of a number of other types of entities to provide such services.

8.1.3.A. Water Districts.

8.1.3.A.(1) General. Article XVI, Section 59 of the Texas Constitution authorizes the creation of water districts with authority to construct, own and operate water and wastewater systems. Districts may be created either under the general law provisions of the Texas Water Code or by special legislative act.

8.1.3.A.(2) General Law Districts. The more flexible and useful of the general law districts are the water control and improvement district ("WCID"), authorized under Chapter 51, Texas Water Code, and the municipal utility district ("MUD"), authorized under Chapter 54, Texas Water Code. A WCID may be created by the county commissioners court if it is located solely within one county and is only to have water, not wastewater powers. Otherwise, WCIDs must be created at the Texas Water Commission (the "Commission"). MUDs are created at the Commission.

Each of these districts is created by the commissioners court or Commission upon a petition signed by landowners within the district filed with the creating governmental body. If created, voters in the district are required to confirm the creation at an election called and held for that purpose.

Either type of district is governed by a board of five (5) directors elected by residents within the district.

Taxes may only be levied within any such district if approved by the voters. Taxes levied within any such district must be levied on an equal and uniform basis. MUDs authorize taxes only on the ad valorem basis. WCIDs may tax on either the ad valorem or benefits basis.

WCIDs are specifically authorized to designate defined areas within the district which may receive special benefits from a particular project. Upon voter approval within the entire district and within the defined area, debt supported by a tax levied only within the defined area, and not within the entire district, may be issued for a project benefitting the defined area. This mechanism provides flexibility for financing projects benefitting particular areas of any district without taxing the entire district.

8.1.3.A.(3) Legislatively Created Districts. In addition to creating districts under the general laws contained in the Texas Water Code, the Legislature often creates districts by special act. LCRA, GBRA, the BSEACD and the Edwards Underground Water District ("EUWD") are special act districts.

Creating a district by special act provides broad flexibility to tailor the district's powers, financing and authority to meet the particular needs of any area. The Legislature typically requires a confirmation election to approve the creation of any such district. Elections to approve any tax by such a district are required by the Texas Constitution.

8.1.3.B. Combinations of Political Subdivisions. Many water and wastewater projects jointly serve two or more political subdivisions. Such projects are usually owned by one entity who agrees to provide water or wastewater services to the other. However, joint ownership or operation is also authorized under state law.

8.1.3.B.(1) Interlocal Cooperation Act. The Interlocal Cooperation Act, Article 4413(32c), Vernon's Texas Civil Statutes, is the most commonly used statute for jointly owned or operated projects. It offers flexibility for the existing cities in Hays County, particularly those situated along the I-35 growth corridor, to create an agency to perform the administrative functions associated with any such jointly owned project. However, financing of any such project is usually borne separately by each individual entity for its pro rata share of the cost of constructing and maintaining the facilities.

8.1.3.B.(2) Public Utility Agencies. Article 1110f, Vernon's Texas Civil Statutes, authorizes existing political subdivisions to create a public utility agency to construct, own and operate wastewater facilities. Similarly to the Interlocal Cooperation Act, this act authorizes the creation of a public utility agency by contract between the existing political subdivisions. However, the public utility agency is declared to be a separate governmental entity, governed by a board of directors appointed by any method agreed upon by the member political subdivisions. Public utility agencies may only finance projects through system revenues; they do not have taxing authority.

8.1.3.C. Underground Water Conservation Districts. In addition to the BSEACD, the Commission is presently conducting studies, as provided by Chapter 52, Texas Water Code, to determine the boundaries of a subdivision of the Trinity Aquifer including a portion of western Hays County. If any district is created pursuant to these studies, it would be empowered to construct water, but not wastewater, projects, and would have taxing power.

8.1.4. Recommended Institutional and Financial Framework for Specific Projects. Sections 3.1 and 5.4.3 have previously identified specific projects recommended for further study to meet the future water and wastewater needs of Hays County. Tables 8.1.4-1 and 8.1.4-2 identify the recommended institutional and financial structure for each of these specific water and wastewater projects. Not listed on Tables 8.1.4-1 or 8.1.4-2, however, is the obvious possibility that any of these potential projects could be constructed and financed by existing water or wastewater utilities either individually or jointly.

8.2. Required Approvals For Project Construction and Operation

8.2.1. General. Table 8.2.1-1 provides a broad overview of the regulatory approvals typically required to construct any particular water or wastewater project. Table 8.2.1-1 should be considered only as a starting point.

Any particular project must be reviewed in detail to determine whether or not any other permits or approvals might be required. Tables 8.1.4-1 and 8.1.4-2 list for each specific recommended project listed in Sections 3.1 and 5.4.3 the particular approvals which clearly apply. Again, Tables 8.1.4-1 and 8.1.4-2 should be considered only as starting points.

Table 8.1.4-1			
HAYS COUNTY WATER DEVELOPMENT BOARD POTENTIAL WATER PROJECTS			
Project Alternative[1]	Ownership and Operation[2] of Wholesale Systems[5]	Financing[3] of Wholesale Systems[5]	Potentially Required Permits[4]
5a-Wimberly, Woodcreek from Blanco w/ Canyon backup	GBRA, HCWDA	Contract revenue debt	II.A.1, II.B.1
7-Buda & Hays City from Austin	Austin, HCWDA	Wholesale water contract with Austin; contract revenue debt for HCWDA	II.A.1, II.B.1
10b-East Hays County from Guadalupe via Canyon Lake	GBRA, HCWDA	Contract revenue debt	II.A.1, II.B.1
11-Dripping Springs from Dripping Springs Reservoir	Dripping Springs	Tax and/or revenue debt	II.A.1, II.B.1
12-Dripping Springs from Lake Travis	LCRA, GBRA, HCWDA	Contract revenue debt	II.A.1, II.B.1

(1) Numbers or names correspond to projects recommended in Sections 3.1 and 5.4.3.

(2) Obviously, any project to serve more than one political subdivision could be jointly owned and operated by those two entities, or one entity could own the project and agree by contract to serve the other entity. This obvious possibility is not included in the table, unless no other reasonable alternative for ownership and operation exists. Abbreviations for ownership entities should be evident; HCWDA stands for the proposed Hays County Water Development Authority.

(3) Contract revenue debt indicates a specific form of debt where the wholesale entity pledges the revenues from specific contracts entered into with its wholesale customers to pay principal of and interest on any debt issued to construct the project.

(4) Numbers listed correspond to numbers in Table 8.2.1-1, below, for potentially required approvals.

(5) The term wholesale system is used loosely to try to discern between those parts of any project which would be owned by a regional entity as opposed to the retail systems of the particular utility systems being provided with wholesale service. The specific facilities included within the wholesale system would have to be determined on a project-by-project basis.

Table 8.1.4-2

HAYS COUNTY WATER DEVELOPMENT BOARD
POTENTIAL WASTEWATER PROJECTS

Project Alternative[1]	Ownership and Operation[2] of Wholesale Systems[5]	Financing[3] of Wholesale Systems[5]	Potentially Required Permits[4]
North	Buda	Tax and/or revenue debt	I.A.1, II.A.7, II.B.2
South	San Marcos	Tax and/or revenue debt	I.A.1, II.A.7, II.B.2
Dripping Springs	Dripping Springs	Tax and/or revenue debt	I.A.1, II.A.7, II.B.2
Wimberly/ Woodcreek	GBRA,HCWDA	Contract revenue debt	I.A.1, II.A.7, II.B.2

(1) Numbers or names correspond to projects recommended in Sections 3.1 and 5.4.3.

(2) Obviously, any project to serve more than one political subdivision could be jointly owned and operated by those two entities, or one entity could own the project and agree by contract to serve the other entity. This obvious possibility is not included in the table, unless no other reasonable alternative for ownership and operation exists. Abbreviations for ownership entities should be evident; HCWDA stands for the proposed Hays County Water Development Authority.

(3) Contract revenue debt indicates a specific form of debt where the wholesale entity pledges the revenues from specific contracts entered into with its wholesale customers to pay principal of and interest on any debt issued to construct the project.

(4) Numbers listed correspond to numbers in Table 8.2.1-1, below, for potentially required approvals.

(5) The term wholesale system is used loosely to try to discern between those parts of any project which would be owned by a regional entity as opposed to the retail systems of the particular utility systems being provided with wholesale service. The specific facilities included within the wholesale system would have to be determined on a project-by-project basis.

Table 8.2.1-1

HAYS COUNTY WATER DEVELOPMENT BOARD

Potentially Required Approvals
for Water and Wastewater Projects

I. FEDERAL

A. Environmental Protection Agency
1. Section 402, Clean Water Act (NPDES Permitting)
2. Sole Source Aquifer Review of Use of Federal Funds

B. Corps of Engineers
1. Section 404, Clean Water Act, (Dredge & Fill Permitting)

II. STATE

A. Texas Water Commission
1. Surface Water Permitting (31 TAC Ch. 295, 297)
2. Transwatershed Permit (Section 11.085, Water Code)
3. Bed and Banks Permit (Section 11.042, Water Code)
4. Designation of Underground Water Management Areas and Creation of Underground Water Conservation Districts (31 TAC Ch. 294)
5. Water Well Drilling Regulation (31 TAC Ch. 287)
6. CCN Service Area Regulation (31 TAC Ch. 291)
7. Wastewater Discharge Regulation (31 TAC Ch. 305, 311, 315, 317, 319)
8. Septic Tank Regulation (31 TAC Ch. 311)
9. Edwards Aquifer Recharge Zone - Approval of Water Pollution Abatement Plan (31 TAC Ch. 313)
10. Designated Regional Sewer Authority (31 TAC Ch. 323)

B. Texas Department of Health
1. Water System Plans and Specifications Approval
2. Wastewater System Plans and Specifications Approval
3. Septic Tank Approval

III. LOCAL

A. County
1. Subdivision Approval
2. Septic System Regulation
3. Nuisance
4. Public Health and Welfare

B. Cities
1. Zoning
2. Subdivision Approval
3. Septic System Regulation
4. Watershed/Water Supply Protection
5. Nuisance Prohibition and Abatement
6. Public Health and Welfare

C. Underground Water Conservation Districts
   1. Edwards Underground Water District
      a. Ground water Export Regulation
      b. Ground water Quality Protection

   2. Barton Springs-Edwards Aquifer Conservation District
      a. Ground water Pumping Controls
      b. Ground water Quality Protection

D. Water Districts
   1. Plumbing Codes
   2. Septic System Regulation

8.2.2. Texas Water Rights Permitting. Figure 2.3-1 describes the water availability analysis provided by representatives of the Commission for the various streams in Hays County. This figure shows on an average annual basis the amount of water which has not already been appropriated at specific points within each stream. This analysis is based on the Commission's best available hydrologic model. However, data used in the Colorado River model have not been updated since 1979. Since that time the Commission has completed its adjudication of water rights into the Colorado River Basin.

8.2.3. Texas Water Quality Point Source Discharge Permitting. Figure 4.2-1 describes the applicability of the Commission's discharge requirements for streams in Hays County. Although each permit request would be judged on its own merits, Figure 4.2-1 reflects the fact that wastewater systems discharging over or upstream of the Edwards Aquifer Recharge Zone will normally require either no discharge or tertiary treatment. Discharges downstream of the Edwards Aquifer Recharge Zone generally require secondary treatment.

8.2.4. Transwatershed Diversion of Surface Water. Hays County lies within the watersheds of both the Colorado and Guadalupe River Basins. Section 11.085, Texas Water Code, requires a permit for diversion and use of surface water from one watershed to the other. Thus, for use of LCRA water from Lake Travis in those portions of Hays County outside the Colorado River Basin, the Commission would have to authorize the diversion under Section 11.085, Texas Water Code. Any project utilizing surface water from the Guadalupe River Watershed (Canyon Reservoir or otherwise) to serve that portion of Hays County in the Colorado River watershed, would have to be similarly permitted. In authorizing any such diversion, the Commission will generally look at the future availability of and demand for water within the basin of origin and satisfy itself that such waters will be available for future projected needs within the river basin of origin. It should be noted that the City of Austin's water rights authorize transwatershed diversion of treated water from the Colorado River Basin already.

8.2.5. Use of Texas Water Development Fund Moneys to Finance Projects Contemplating Transwatershed Diversion. Article XVI, Section 49d of the Texas Constitution prohibits the use of moneys in the Texas Water Development Fund or any other State fund created for water development to finance any project contemplating a transwatershed diversion if the water being so diverted will be needed within the basin of origin within the next 50 years, except on a temporary, interim basis. In making such determination, the Texas Water Development Board traditionally considers not only the future water demands within the basin of origin, but also the future water supplies from projected water development projects. This constitutional provision could restrict the accessibility of State funds for certain projects in Hays County.

8.3. Regulating Water and Wastewater use in Hays County

8.3.1. Regulatory Framework. Table 8.3.1-1 provides an overview of the regulatory framework in Texas and Hays County governing water use and wastewater treatment and disposal.

8.3.1.A. Water Use Regulation.

8.3.1.A.(1) Surface Water Use. The Texas Legislature in 1917 delegated authority to the Commission to regulate the use of surface waters in the State. Now

Table 8.3.1-1

Hays County Water Development Board - Overview of Water and Wastewater Regulation					
	Regulatory Powers				
	Water Use			Wastewater	
Type of Entity	Surface(1)	Groundwater	Non-Point Source(2)	Point Source(3)	Septic(4)
1. Texas Water Development Board					
2. A. Texas Water Commission	X		X	X	X
B. Texas Dept. of Health					X
3. Hays County			X		
4. General Law City			X		X
5. Home Rule City			X		X
6. River Authority					
A. LCRA			X		X
B. GBRA			X		X
7. Water Control and Improvement District			X		X
8. Underground Water Conservation District			X		X
A. EUWD			X		X
B. BSEAUWCD		X	X		X
C. Chapter 52, Water Code		X	X		X
9. Fresh Water Supply District					
10. Municipal Utility District			X		X
11. Water Improvement District					
12. Special Utility District			X		X

1. The Texas Water Commission has general power to control surface water use in the state; additionally, each water supplier has the right to regulate water use from its system.
2. Chapter 26, Texas Water Code generally delegates authority to the Commission to regulate non-point source pollution. However, Section 26.177, Texas Water Code, grants authority to cities to regulate urban stormwater runoff within the city limits and extra- territorial jurisdiction. Further, laws governing certain river authorities and local districts grant these districts authority to prevent pollution. To date, the Commission generally has not exercised its authority to regulate storm water runoff. The Commission is presently studying the adoption of any such regulations. Section 26.175, Texas Water Code, provides that the Commission may agree to delegate its management, inspection and enforcement authority to local governments, including cities, counties and districts.
3. Although it is arguable that cities and certain districts may regulate point-source wastewater discharges, the Texas Water Commission has probably preempted local regulation for all practical purposes. Note, however, under Sections 26.081, et seq, Texas Water Code, a local government may acquire a certain amount of regulatory control as a designated regional provider. Also, local governments have certain rights to bring enforcement actions for violations of the Texas Water Code and, upon agreement with the Commission, may perform management, inspection and enforcement functions, including any delegated by the Commission.
4. The Texas Water Commission may regulate septic tanks by rule. The Commission may also delegate the licensing function to a city, county, river authority or water district. Counties may separately adopt rules regulating septic tanks, with Commission approval. See Sections 26.031 and 26.032, Texas Water Code. HB 1788, 70th Legislature (1987) repeals Sections 26.031 and 26.032, Texas Water Code, effective September 1, 1989. In the meantime, that Act authorizes the Texas Department of Health to assume the responsibilities of the Texas Water Commission in regulating septic tanks and delegating regulatory functions to a local government entity. The Texas Department of Health has not yet adopted regulations implementing its program.

codified as Chapter 11, Texas Water Code, this program was supplemented by the Water Rights Adjudication Act of 1967 (now, Sections 11.301, et seq., Texas Water Code) whereby riparian users were brought under the state permitting program. Chapter 11, Texas Water Code, establishes a permitting program administered by the Commission to control all uses of surface water in the State's rivers and streams, except certain domestic and livestock uses.

8.3.1.A.(2) Ground Water Use. The Legislature has not delegated to the Commission authority to regulate ground water use. However, it has authorized creation of districts under Article XVI, Section 59, Texas Constitution, by both special act and general law, to control use of ground water in certain instances.

In Hays County, the EUWD, created by special act of the Legislature in 1957, encompasses within its limits a portion of the Edwards Aquifer in the southern part of Hays County. However, the EUWD has no authority to regulate ground water use other than to require a permit for exportation of ground water from within to outside of its boundaries.

Pursuant to Chapter 52, Texas Water Code, the Commission has created the BSEACD. That district includes part of the Edwards Aquifer in the northern part of Hays County. The district has power to regulate water use from the Edwards Aquifer within its boundaries except for certain exempted wells.

As mentioned previously, the Commission is presently studying the boundaries of a subdivision of the Trinity Aquifer which would include a portion of western Hays County. These studies could lead to creation of another Chapter 52 district to regulate ground water use in that area.

8.3.1.A.(3) Regulation of Water Use by Utilities. In addition to these regulatory authorities, it should be noted that each water utility in the State has authority to regulate water use from its system, including the power to adopt water use restrictions during times of emergency or other shortage of water supply. For those entities requiring certificates of convenience and necessity from the Commission, Section 13.136, Texas Water Code, authorizes the Commission to review and approve such restrictions.

Further, where surface water is used, the Commission has the power to prevent waste of such water through "negligent operation" and could probably use that power to regulate conservation efforts by utilities should it desire. See Sections 11.092-11.095, Texas Water Code. Chapter 52 underground water districts have similar authority regarding ground water within their jurisdiction. See Section 52.151, Texas Water Code. Finally, the Commission has general supervisory power over all water districts in the State and might be able to regulate their conservation efforts under that authority. See Section 12.081, Texas Water Code.

8.3.1.B. Water Quality Regulation. Table 8.3.1-1 analyzes the existing regulatory framework for wastewater treatment and disposal by dividing the subject into three categories: (1) non-point source pollution; (2) point source pollution; and (3) septic tanks.

8.3.1.B.(1) Non-Point Source Pollution. The Legislature has delegated to the Commission broad authority to regulate non-point source pollution (primarily stormwater runoff). Section 26.175, Texas Water Code, also provides that the Commission may delegate its management, inspection and enforcement authority over non-point source pollution to local governments, including cities, counties and water districts. Section 26.177, Texas Water Code, grants specific authority to cities to regulate non-point source pollution within the city limits and extraterritorial jurisdiction, subject to the right of appeal to the Commission.

Several bills have been introduced into the current session of the Texas Legislature which could potentially affect the regulation of water pollution in the State. HB 1546 would amend Section 26.177, Texas Water code, by requiring that a water pollution control and abatement program adopted by a city under Section 26.177 be submitted to the Commission for review and approval. HB 1458 would add a new subchapter J to Chapter 26, Texas Water Code, to establish a ground water protection committee, led by the Texas Water Commission, to coordinate ground water protection activities of the agencies represented on the committee, to develop and update a comprehensive ground water protection strategy for the State, to study and recommend to the Legislature ground water protection programs for each area in which ground water is not protected by current regulation, and to file a report with various state offices concerning ground water monitoring and contamination. HB 533 would add a new Chapter 202 to the Natural Resources Code to require any person who desired to fill in, close, destroy, or impede the flow of water into a cave, sinkhole or significant cave recharge area located wholly or partially within an underground water conservation district to fist obtain a permit from the district and would provide for criminal penalties and injunctive relief for violations of the Act.

Section 319 of the Federal Water Quality Act of 1987 amended the Federal Water Pollution Control Act at 33 U.S.C. 1329 to require the governor of each state, after notice and opportunity for public comment, to prepare and submit to the Administrator for EPA a report which identifies waters in the state which, without additional action to control non-point sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards; identifies those categories of non-point sources which add significant pollution; describes the process for identifying the best management practices and measures to control non-point sources of pollution; and identifies and describes the state and local programs for controlling pollution. The governor of each state is also to prepare and submit to the Administrator for approval a management program which the state proposes to implement in the first four fiscal years beginning after the date of submission of the management program for controlling pollution from non-point sources. Each report and management program is to be submitted to the Administrator during the 18-month period beginning on February 4, 1987.

Section 402 of the Federal Water Quality Act of 1987, amended the Federal Water Pollution Control Act at 33 U.S.C. 1342 (p) to provide that prior to October 1, 1992, EPA would not require a permit for discharges composed entirely of stormwater, with certain exceptions, the most significant of which are discharges from a municipal storm sewer system serving a population of 250,000 or more, a discharge from a municipal separate storm sewer system serving a population of 100,000 or more but less than 250,000, or a discharge which the EPA Administrator determines contributes to a violation of water quality standard or is a significant contributor of pollutants. The Act provides that the Administrator will work with states to provide regulations governing storm water discharges by October 1, 1992, and that within one year thereafter, cities must apply for permits for storm water discharges from their storm water sewer systems and must obtain permits within the next year after the filing period.

The Commission has adopted regulations governing non-point source pollution over most of the Edwards Aquifer Recharge Zone, including that part in Hays County, and delegating certain powers regarding septic tank regulation. See 31 TAC Chapter 313, subchapter (A). Chapter 313 of the Commission's rules requires approval of water pollution abatement plans for certain regulated developments over the Edwards Aquifer Recharge Zone prior to construction within the development. Generally, any development within the recharge zone, except for residential subdivisions with lots larger than five acres, is regulated. Prior to undertaking such development, the pollution control abatement plan must be filed with and approved by the Commission, showing the proposed methods for disposing of both point source and non-point source pollution. Approval is required of the specific plans and specifications for wastewater collection and treatment systems. The Hays County Commissioners Court is designated as the licensing authority for inspecting and testing the design and construction of septic systems over the Edwards Aquifer Recharge Zone in Hays County.

8.3.1.B.(2) Point Source Pollution. The Commission has been delegated, and has exercised, broad jurisdiction over point source pollution in the State. See, Chapter 26, Texas Water Code, and 31 TAC Chapters 307-325. Although it is arguable that cities and certain water districts may regulate point source wastewater discharges, the Commission, in all probability, has pre-empted local regulation for all practical purposes. Note, however, that under Sections 26.081, et seq., Texas Water Code, a local government may acquire a degree of regulatory control as a designated regional wastewater provider, subject to TWC approval. Also, local governments have certain rights to bring enforcement actions for violations of Chapter 26, Texas Water Code, and, upon agreement with the Commission, may perform management, inspection and enforcement functions delegated by the Commission.

8.3.1.B.(3) Septic Tank Regulation. Sections 26.031 and 26.032, Texas Water Code, constitute a grant by the Legislature of power to regulate septic tanks to the Commission. Those statutes also authorize the Commission to delegate its authority to regulate septic tanks to local political subdivisions. As mentioned previously, 31 TAC Chapter 313 constitutes a delegation by the Commission of certain of such functions to the Hays County Commissioners Court. These powers are implemented by the San Marcos-Hays County Health Department, operating under the supervision of the Hays County Commissioners Court. The Commission has also approved rules of the San Marcos-Hays County Health Department for the entire County.

In 1987 the Legislature adopted HB 1788 (now, Article 4477-7e, Vernon's Texas Civil Statutes), delegating to the Texas Department of Health power to regulate septic tanks. HB 1788 authorizes the Department of Health to replace the Commission in this role effective September 1, 1989, by repealing Sections 26.031 and 26.032, effective on that date. The Department of Health has adopted construction standards for septic tanks but has not yet adopted regulations implementing its authority to approve local regulations.

8.4. Proposed Hays County Water Development Authority

8.4.1. General. As a result of the study, it was determined that only one local government entity had jurisdiction over the entire county: the Hays County Commissioners Court. However, the Commissioners Court's powers are so restricted in regard to implementing water and wastewater projects that it was not considered to be a practical alternative for developing and coordinating the County's water and wastewater resources.

However, the County's boundaries do serve as a recognizable governmental boundary to citizens. This geographical unit has a history of cooperation among the various political subdivisions and persons within its boundaries. Thus, it was felt that a countywide water district created pursuant to the provisions of Article XVI, Section 59, Texas Constitution, should be created to enhance and coordinate development of water and wastewater projects and regulation of septic tanks in the County. Although such a district could be created as a WCID by petition to the Commissioners Court or as a MUD by petition to the Texas Water Commission, creating the district by adoption of a special act in the Texas Legislature would provide more flexibility. Any such district would be subject to confirmation by the voters of the County at an election called and held for that purpose. The district would be called the Hays County Water Development Authority ("HCWDA").

8.4.2. Powers. The HCWDA should have broad authority to construct, own, operate and finance water and wastewater projects. The HCWDA could own and operate regional facilities designed to serve more than one retail water or wastewater system. As discussed below, the HCWDA could also assist by owning "over-sized" portions of projects to optimize their development. Because of the likelihood that significant portions of Hays County will continue to be served by septic tanks in soils not well suited for conventional septic tank systems, the HCWDA should have broad authority to own and operate such facilities and to regulate their construction and use by others.

8.4.3. Finance. The HCWDA should obviously be given power to pledge the revenues from any water and wastewater systems constructed by it for payment of debt service or operation and maintenance expenses associated with such systems. Additionally, the HCWDA should be authorized to define specific areas of the County which will be benefitted by certain projects and to finance projects benefitting such areas by issuing defined area ad valorem tax bonds similar to those in Chapter 51, Texas Water Code, for WCIDs. The HCWDA could also be authorized to pledge the proceeds of any such tax to payment of debt service on bonds issued by any other political subdivision. Any such tax would be authorized only upon a majority vote of all affected persons and only with the consent of any city overlapping the defined area.

The HCWDA should also be authorized, subject to voter approval, to levy a limited tax on the entire county to support debt service on bonds issued to pay for projects, including oversizing portions of projects which otherwise might not be optimally developed. In this way, facilities which might be constructed and paid for by other local political subdivisions but which might not be sized for ultimate needs of the County or any portion of the county because of lack of local funds, could be oversized for ultimate development and the cost of the oversizing paid for by bonds supported by a limited tax on the entire County. At a later time when the oversize capacity was needed by a local political subdivision, the excess capacity could be sold to the local political subdivision by the HCWDA for its cost, plus all accrued interest.

8.4.4. Governing Body. The governing body of the HCWDA should reflect the unique political mix of Hays County.

8.4.5. MUD Chapter Adopted. To the extent not otherwise specifically provided for, the powers, duties and responsibilities of the HCWDA would be governed by Chapter 54, Texas Water Code.

REFERENCES

REFERENCES

1. Ashworth, John B., "Ground Water Availability of the Lower Cretacious Foundations in the Hill Country of South-Central Texas", Texas Dept. of Water Resources, Report 273, January 1983.

2. Reeves, R.D., and G. B. Ozuna, "Compilation of Hydrologic Data for the Edwards Aquifer, San Antonio Area, Texas, 1982, with 1934-82 Summary", Bulletin 42, Edwards Underground Water District, March 1985.

3. Ogden, Albert E., Anthony J. Spinelli; and Jack Horton, "Hydrologic and Hydrochemical Data for the Edwards Aquifer in Hays and Comal Counties", October 1983 to June 1985, Edwards Aquifer Research and Data Center, Southwest Texas State University, San Marcos, Texas.

4. Baker, E. T., Jr., R. M. Slade, Jr., M. E. Dorsey, and L. M. Duffin, "Geohydrology of the Edwards Aquifer in the Austin Area, Texas", Report 293, Texas Water Development Board, March, 1986.

5. Dougherty, John P., "Streamflow and Reservoir-Content Records in Texas", Compilation Report, January 1889 to December 1975, Report 244, Texas Department of Water Resources, Volume 3, April, 1980.

6. Baulch, Clay, "Growth Trends Report No. 5", Capital Area Planning Council, 1988.

7. "San Antonio Regional Water Resources Study", City of San Antonio and the Edwards Underground Water District, April, 1986.

8. Gordon, J. D., D. L. Pate, and M. E. Dorsey, "Hydrologic Data for Urban Studies in the Austin Metropolitan Area, Texas, 1984", U. S. Geological Survey, Open File Report 85-676, 1986.

9. Gordon, J. D., D. L. Pate, and M. E. Dorsey, "Hydrologic Data for Urban Studies in the Austin Metropolitan Area, Texas, 1983", U. S. Geological Survey, Open File Report 85-172, 1985.

10. Slade, R. M., Jr., J. E. Veenhuis, M. E. Dorsey, S. L Stewart, and L. M. Ruiz, "Hydrologic Data for Urban Studies in the Austin Metropolitan Area, Texas, 1983", U. S. Geological Survey, Open File Report 85-172, 1985.

11. Muller, D. A., and Price, R. D., Texas Dept. of Water Resources, "Groundwater Availability in Texas", March, 1983.

12. Muller, D. A., and McCory, Wesley, "Ground Water Conditions of the Trinity Group Aquifer in Western Hays County", Texas Water Development Board, LP-205, January, 1987.

13. Slade, R. M., Dorsey, M. E., Sheree, S. L., "Hydrology and Water Quality of the Edwards Aquifer associated with Barton Springs in the Austin Area, Texas", U. S. Geological Survey, Water-Resources Investigation Report 86-4036, 1986.

14. Guyton, William F., & Associations, "Geohydrology of Comal, San Marcos, and Hueco Springs", Texas Department of Water Resources, Report 234, June, 1979.

15. "Soil Survey of Comal and Hays Counties, Texas", USDA-SCS, June, 1984.

16. "Draft Regional Water Resources Plan", Joint Committee on Water Resources of the San Antonio City Council and the Edwards Underground Water District Board of Directors, July, 1988.

17. "The Edwards Aquifer Underground River of Texas", Guadalupe-Blanco River Authority, April 1988.

18. "Water and Wastewater Master Plan for the City of Dripping Springs and Surrounding Area", Engineering-Science, November, 1985.

19. "Alternative Source Water Supply Study", February, 1987, Guadalupe Blanco River Authority.

20. "Lake Travis West Water Supply Project", Technical Memorandum, August, 1988, Water Resources Department Office of Conservation and Natural Resources.

21. Senger, Rainer K., Kreitler, Charles W., "Hydrogeology of the Edwards Aguifer, Austin Area, Central Texas", Bureau of Economic Geology, University of Texas, 1984.

22. Slade, R.M., Jr., Ruiz, Linda, and Slagle, Diana, "Simulation of the Flow System of Barton Springs and Associated Edwards Aquifer in the Austin Area, Texas." U.S. Geological Survey, Water Resources Investigations Report 85-4299 prepared in cooperation with the City of Austin, 1985.

APPENDIX 1
WATER CONSERVATION AND DROUGHT CONTINGENCY PLAN

TABLE OF CONTENTS

PREFACE

In 1985, the Texas Constitution was amended requiring a water supplier to develop and adopt a water conservation and drought contingency plan in order to be eligible for financial assistance from the Texas Water Development Fund. The water conservation plan should address all feasible aspects of conservation for the particular entity including one or more of the following methods:

- Education and Information
- Plumbing Codes
- Retrofit Programs
- Water Rate Structures
- Universal Metering
- Water Conservation Landscaping
- Leak Detection
- Recycling and Reuse
- Implementation and Enforcement

The drought contingency plan must include the following six elements:

- Trigger Conditions
- Drought Contingency Measures
- Information and Education
- Initiation and Procedures
- Termination Notification
- Implementation Procedures

This document is a summary of the Hays County Water Development Board's policies which will meet the requirements of the law and are implementable within the board's powers and scope of operation.

HAYS COUNTY WATER DEVELOPMENT BOARD

WATER CONSERVATION PLAN

INTRODUCTION

Projected population and economic growth within Hays County has raised public awareness and concern about the adequacy of available water supplies to satisfy future needs. A particular concern relates to the adequacy of ground and surface water supplies to meet both current and projected demands during drought conditions. Based on the population and water demand projections for Hays County, it appears certain that the risk of disruptive costly water shortages will increase over time. Moreover, a portion of the cost of projects can be deferred by conservation of resources. Consequently, prudence dictates that the conservation and reuse of available water supplies must become a key element of Hays County's long-range water management strategy.

While perhaps not a complete solution, water conservation and reuse can provide a large and relatively inexpensive source of water "supply" for Hays County. At a minimum, water conservation can help mitigate the impacts of future population and economic growth on limited water supplies and minimize the risk of disruptive shortages. Water conservation can also favorably effect the timing and amount of future capital investments in water and wastewater facilities and reduce utility operating costs. Individual consumers also benefit directly from more affordable water and wastewater utility services and from reduced expenditures of time and money. Importantly, water conservation can also help mitigate the environmental impacts of population growth by preventing the harmful overuse of limited water supplies and by minimizing both point and non-point sources of water pollution.

PURPOSE AND OBJECTIVES

Recognizing the importance of a "balanced" water budget to the future of Hays County, the Hays County Water Development Board (WDB) established, in March of 1988, a Water Conservation Committee composed of WDB members and interested residents of Hays County. The Committee's assignment was to identify and evaluate various water conservation and reuse measures and implementation strategies and recommend a water conservation "plan" for adoption by the Hays County WDB. In part, the water conservation plan presented herein is intended to satisfy requirements for participation in the Texas Water Development Board's Planning and Research Grant Program. More importantly, however, the Water Conservation Committee viewed its task as being to formulate a workable and cost-effective water conservation plan that will be implemented throughout Hays County.

The specific water conservation goals adopted by the Committee are:

(1) To reduce future demands on limited freshwater supply sources;

(2) To reduce the magnitude of seasonal peak water demands;

(3) To reduce the magnitude of wastewater flows requiring treatment and disposal; and

(4) To fully integrate water conservation and reuse into long-range water resources planning and management and land use planning and development.

GUIDING PRINCIPLES

During the meetings and deliberations of the Water Conservation Committee, several underlying themes and principles emerged that would serve to guide the Committee's work and recommendations. Paramount among these is that water conservation and reuse strategies must become an integral part of the daily activities of Hays County residents, businesses, and institutions. Similarly, recommended water conservation and reuse strategies, and their effects, must be fully integrated into water resources management and planning at all levels - both in the near-term and the long-term. The actual implementation of the Committee's recommendations was therefore an overriding concern and priority.

The Committee's concern about the implementation of its recommendations arises from the fact that the Hays County WDB serves in an advisory capacity and does not itself possess the authority or the resources to enact legislation, set policies, or implement programs. Rather, the Hays County WDB is limited to providing guidance and assistance to those entities that have the legal authority and financial resources to implement water conservation and reuse policies and programs. These entities include the State Legislature and relevant state agencies, Hays County, municipalities, school districts and universities, special purpose districts, water supply corporations, and private businesses. The water conservation plan proposed is intended for the use of all entities possessing capabilities to implement or facilitate the implementation of recommended water conservation and reuse strategies.

Other themes and principles that guided the Water Conservation Committee include:

(1) Generally, water conservation is defined as those measures that are intended to improve water use efficiency, increase beneficial reuse and recycling, and minimize waste. This definition focuses on the technical methods of reducing water demands through efficiency and reuse and should not be equated with sacrifice on the part of the end user. As such, the Committee chose to focus on strategies that will induce permanent reductions in water demand rather than temporary, emergency measures to be implemented only during drought conditions.

(2) The Committee recognized that its primary task was to identify and recommend appropriate strategies for encouraging or inducing the application of "technical" measures to improve water use efficiency, minimize waste and increase reuse.

(3) The Committee resolved that its recommendations should not be constrained by real or perceived institutional barriers to the implementation of particular conservation or reuse strategies. Rather, where such barriers are identified, the Committee would seek to identify and recommend such actions as are necessary to overcome or remedy implementation problems.

(4) Recognizing that future population growth within the county is of primary concern as it relates to the adequacy of water supplies, it was generally agreed that the overall water conservation strategy recommended for Hays County should focus particularly on conservation and reuse measures for new development. In part, a focus on future growth stems from the belief that the best opportunities to reduce future water demands will be realized, at the least cost, by incorporating efficiency and reuse into the planning, design, construction, and ultimate habitation of new developments. The focus on new development should not, however, be taken to imply that conservation opportunities in existing developments have not been pursued or recommended.

(5) The Committee also recognized that the most appropriate level at which to implement many water conservation strategies is locally through utility-supported programs. As such, local water conservation programs should be developed in consideration of local conditions, resources, and priorities. Nonetheless, the Water Conservation Committee strongly agreed that certain minimum standards, particularly for new development, should be applied throughout the county.

(6) Finally, the Committee recognized that private markets would naturally tend to compensate or adjust to future water supply conditions within Hays County. On one hand, inadequate water supplies would likely become a limiting factor on future population and economic growth. On the other hand, the increasing scarcity and "value" of water will tend to direct private markets towards improved water use efficiency and reuse. Recognizing such economic forces, the Committee resolved to recommend an "aggressive" water conservation and reuse strategy that will guide private markets towards efficiencies that otherwise may not be achieved by market forces alone. In other words, the role and functions of private markets should be fully marshalled in support of public efforts to achieve long-range conservation and reuse goals.

DESCRIPTION OF PLANNING AREA

The planning area for the report is shown in Figure 1. The area consists of Hays County, located in south-central Texas, and adjacent areas. Hays County is bordered by Travis County on the north, Comal County on the south, Caldwell and Guadalupe County on the east, and Blanco County on the west.

The location and physical characteristics of the County make it attractive for curent and future development. The county covers 428,800 acres, most of which is within 30 miles of Austin. The Balcones

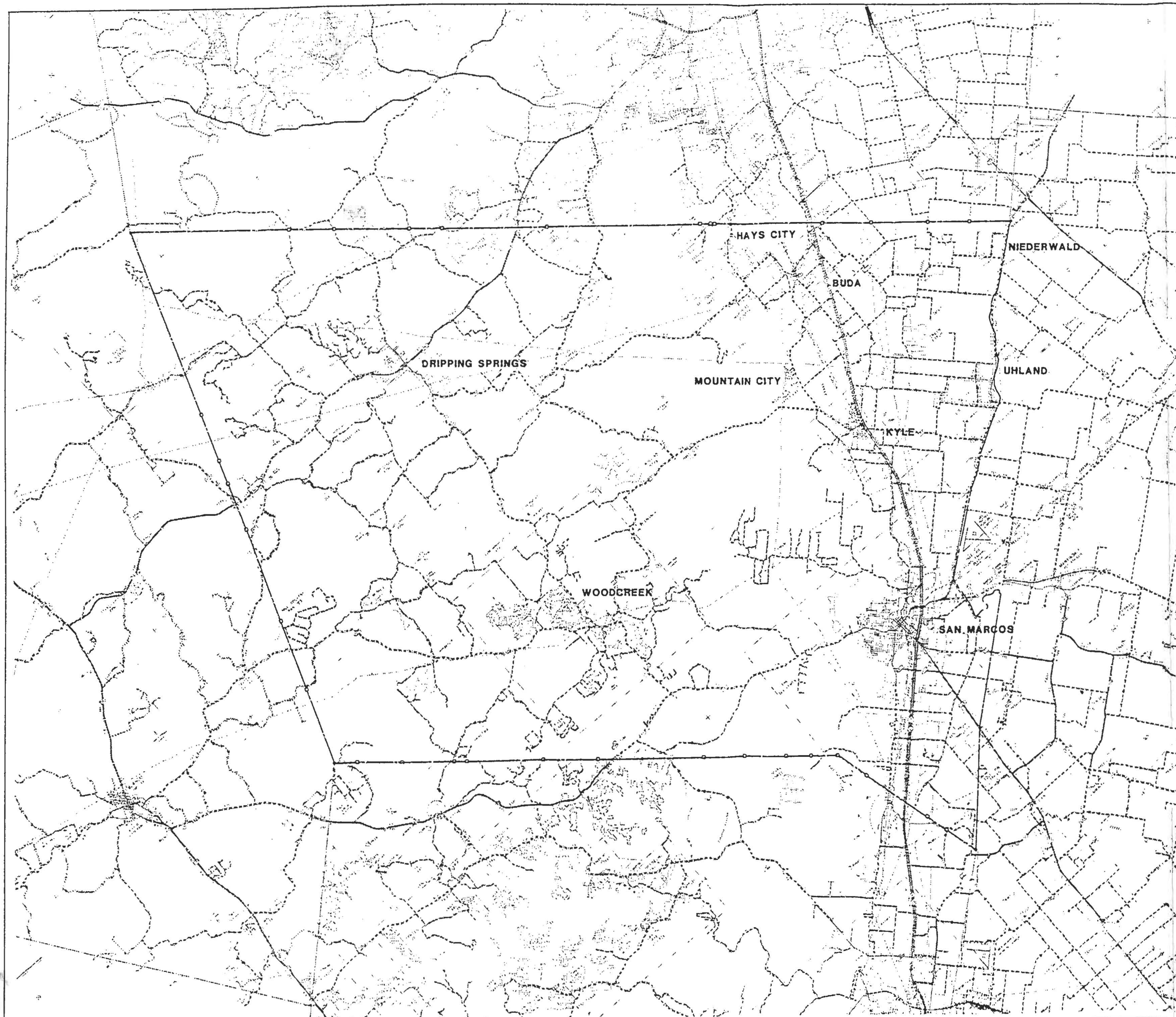
Escarpment extends through eastern Hays county, separating the Blackland Prairie (east) and the Edwards Plateau (west). The Blackland Prairie is characterized by rich farm land and gently sloping, deep clay soils. The Edwards Plateau, locally known as the "Hill Country", is characterized by shallow, stony clay and gravelly clay loam soils. The county straddles two major river basins, the Colarado River Basin and the Guadalupe-Blanco River Basin as shown in Figure 2. In Hays County, the Colorado River Basin includes the Pedernales River, Onion Creek, Barton Creek, and Bear Creek. The Guadalupe-Blanco River Basin includes the Blanco River and San Marcos River in southern Hays County.

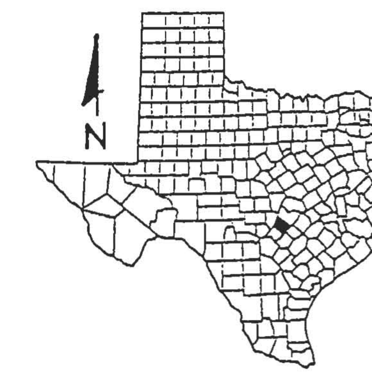
Land use has changed rapidly in recent years. Land once used for agricultural purposes has since been converted to urban uses. This rapid change is associated with an increase in residential development in the county, primarily due to the expansion of nearby Austin and San Antonio. The growth of smaller urban areas around San Marcos, Kyle, Dripping Springs, and Buda, along with the growth of retirement communities near Wimberley and Woodcreek has also contributed to this rapid change in land use.

WATER RESOURCES

Water is an important natural resource for Hays County. There are no major surface water reservoirs in the county to date. The primary source of water in the County is groundwater. Groundwater resources in the County lie in three major aquifer systems, The Edwards Aquifer (San Antonio Region), the Barton Springs Edwards Aquifer, and the Trinity Group Aquifer. Figure 3 shows the location of the aquifers within Hays County and Figure 4 shows the location of the aquifers within the region.

The Edwards Aquifer provides a steady supply of good quality water to part of Hays County and to a large region of south central Texas. The Edwards Aquifer covers eastern Hays County and supplies approximately 80% of the total County demand. It is the primary source of water for San Marcos, Kyle and numerous water supply corporations in eastern Hays County. The aquifer is a major source of water for a six county region including Hays, Comal, Bexar, Medina, Uvalde, and Kinney. Bexar County, which includes San Antonio, exercises the highest demand on the aquifer followed by Uvalde and Medina Counties. A summary of estimated withdrawals from the Edwards Aquifer by county for 1986 is presented in Table 1. As seen in the table, the total pumpage in Hays County from the Edwards Aquifer amounts to less than 4% of the total aquifer pumpage. Also, over 90% of the Edwards discharge in Hays County is through springs. Municipal flows account for approximately 6% of the total, and domestic flows account for just over 1% of the total pumpage from the Edwards Aquifer.





LOCATION MAP

FIGURE 1

PLANNING AREA

REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

H D R

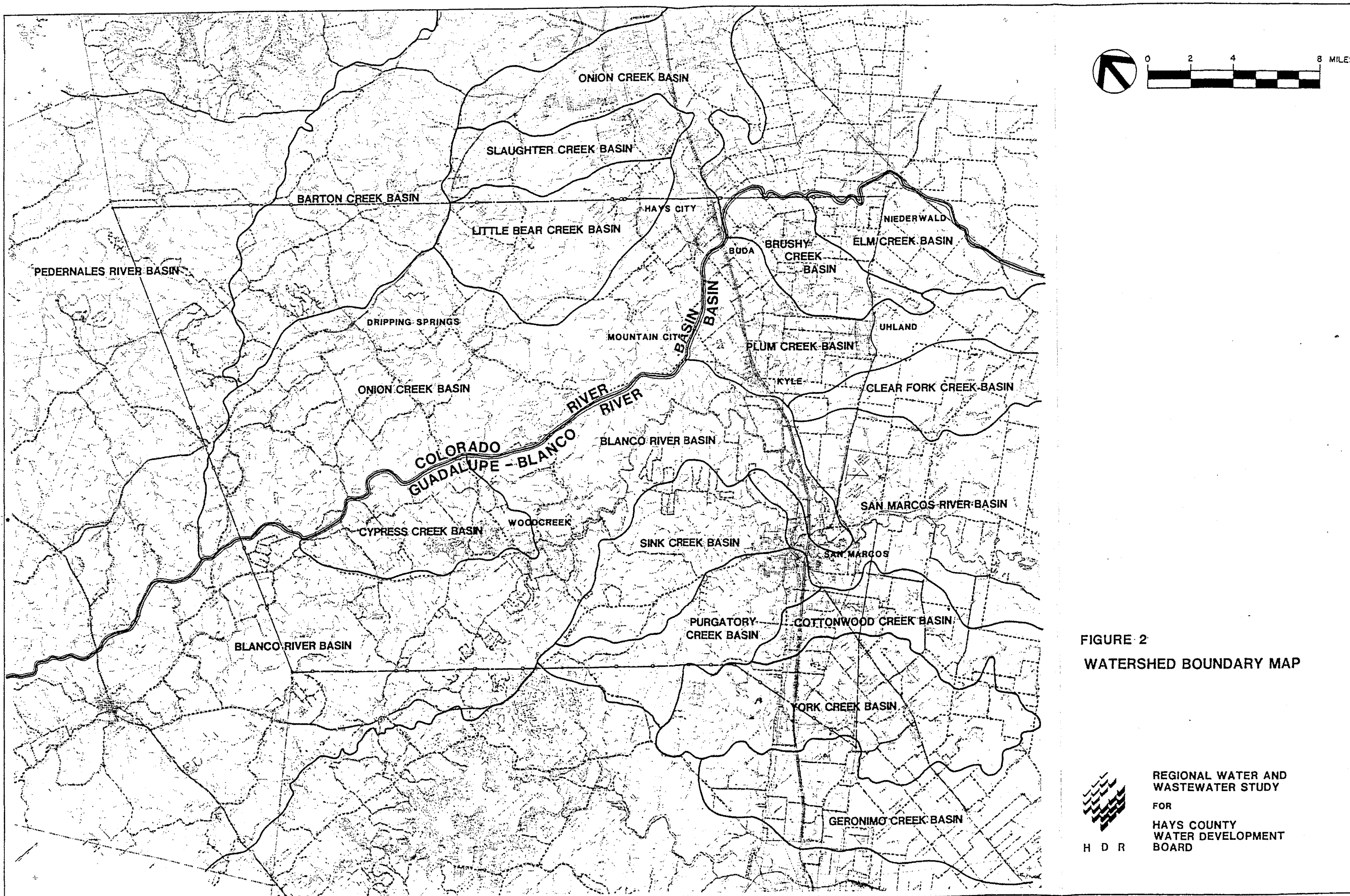


FIGURE 2

WATERSHED BOUNDARY MAP

H D R

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

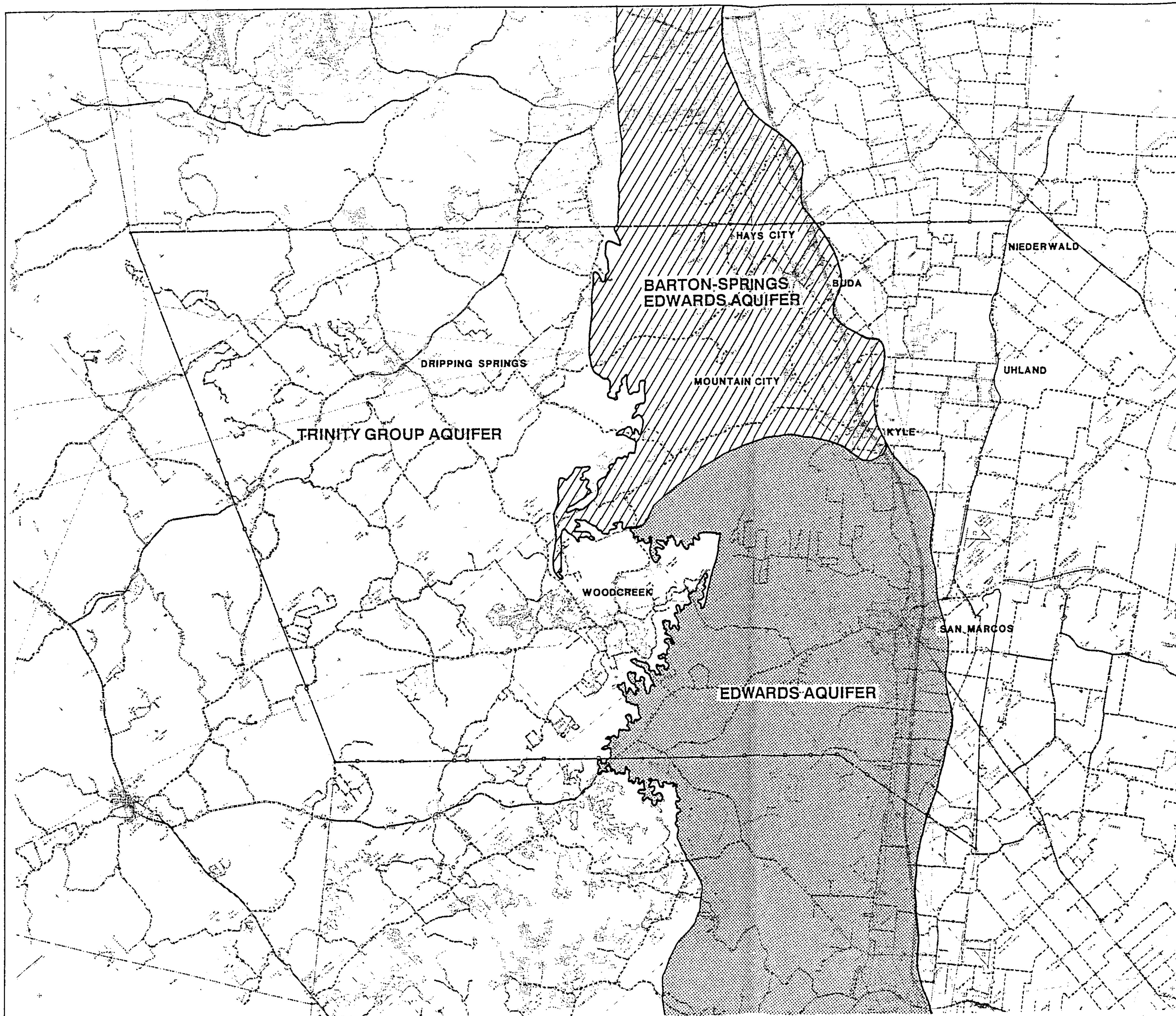


FIGURE 3

AQUIFER BOUNDARY MAP

HDR

REGIONAL WATER AND WASTEWATER STUDY
FOR
HAYS COUNTY WATER DEVELOPMENT BOARD

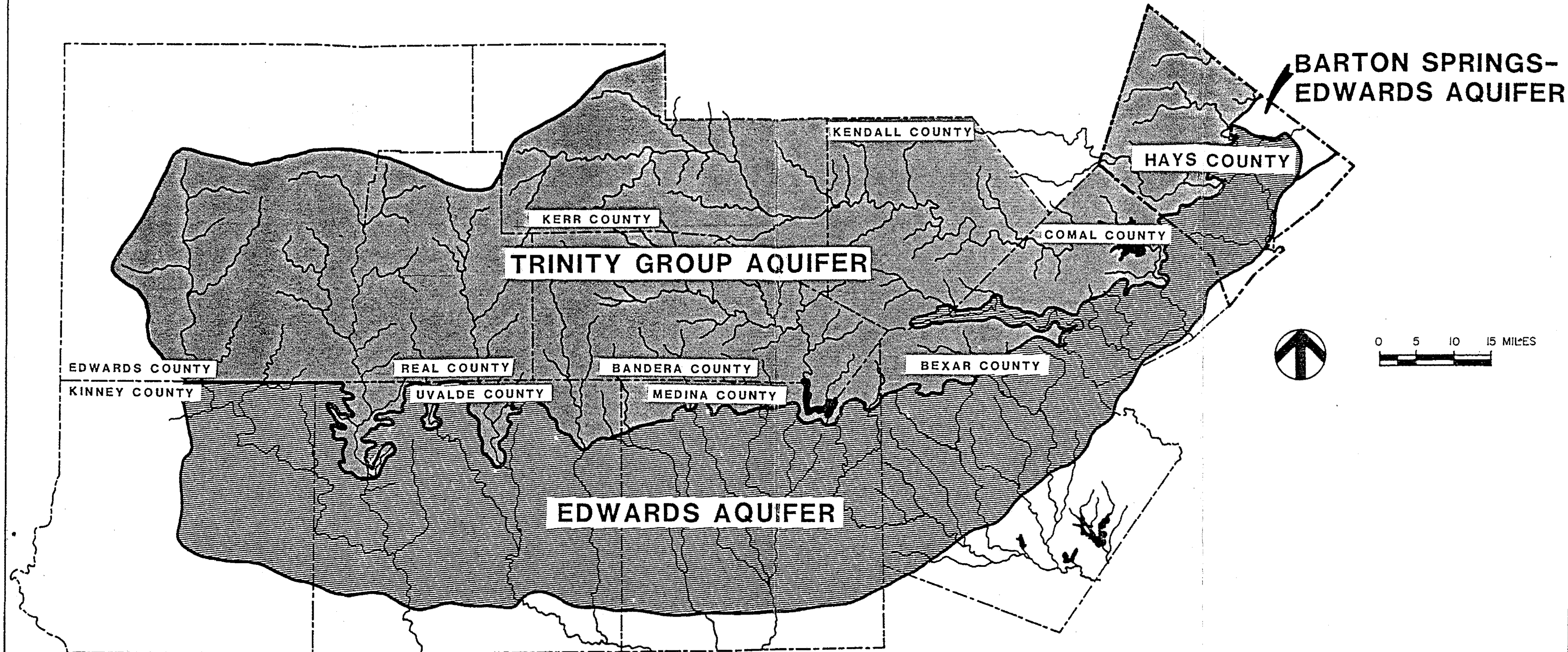


FIGURE 4

REGIONAL AQUIFER MAP

HDR

REGIONAL WATER AND WASTEWATER STUDY

FOR

HAYS COUNTY
WATER DEVELOPMENT BOARD

Table 1

Calculated discharge from the Edwards Aquifer by county and by water use, 1986

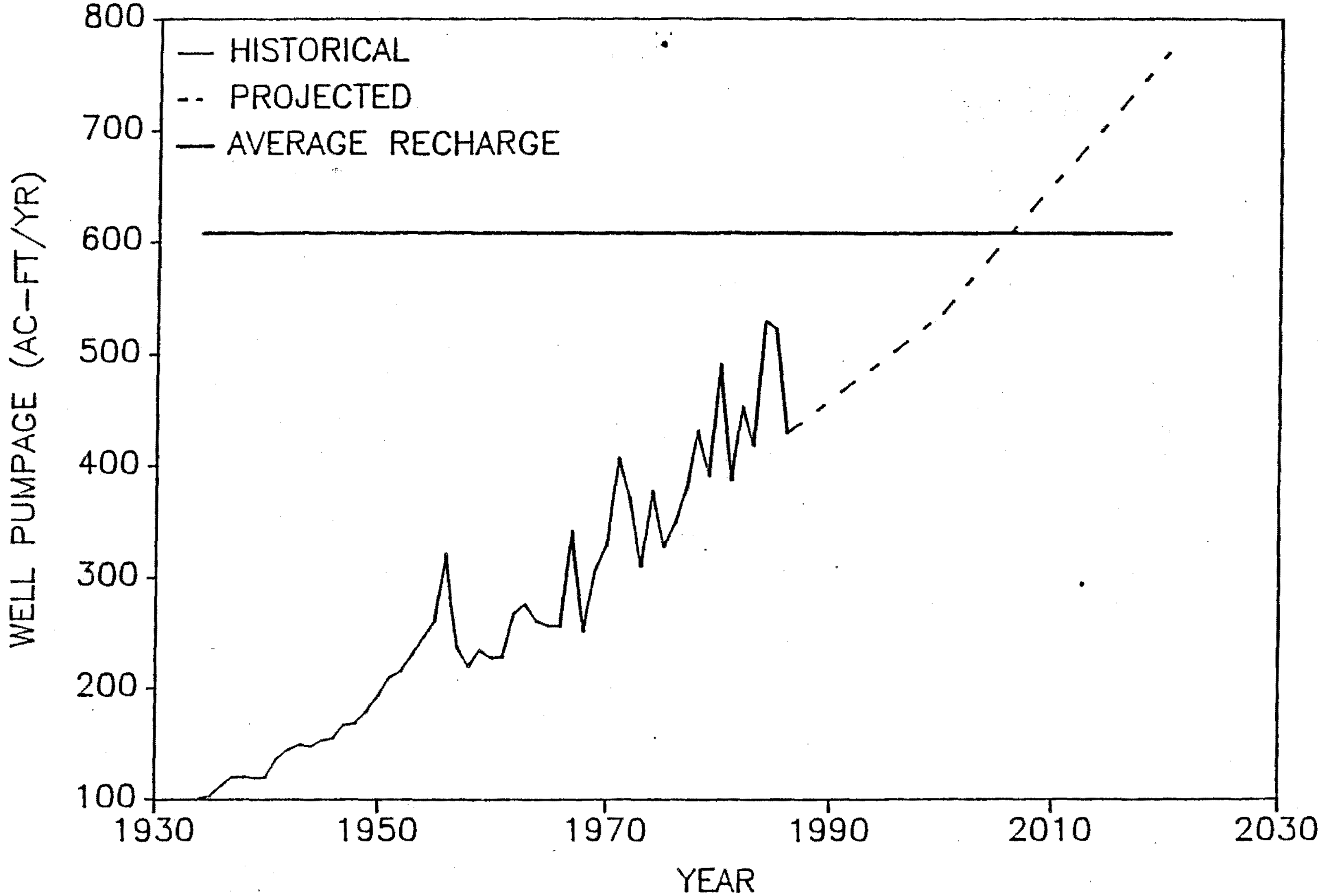
County	Springs (mgd)	Municipal (mgd)	Irrigation (mgd)	Industrial (mgd)	Domestic (mgd)	Total (mgd)
Kinney			0.2		0.2	0.4
Uvalde	36.1	4.2	53.0	0.6	2.9	96.8
Medina		4.3	32.5		0.6	37.4
Bexar	6.3	208.3	6.8	9.7	31.4	262.5
Comal	188.7	12.1	0.3	3.0	0.6	204.7
Hays	130.7	8.8	0.2	1.7	1.8	143.2
Total	361.8	237.7	93.0	15.0	37.5	745.0

Source: Edwards Underground Water District.

Current projections for the Edwards Aquifer region show that unless other sources of water are utilized in the future, the demand will exceed the safe yield of the Edwards Aquifer by the year 2015 (Figure 5). If this occurs, the groundwater supply would decrease, average water levels would drop, pumping costs would increase, spring flow would be reduced, and the quality of water could deteriorate. Springs, such as San Marcos springs which now produce an average of 107 million gallons per day, would gradually decrease and could eventually cease to flow. These conditions may not affect all users in the region at the same time, but eventually all areas would be adversely affected.

The Barton Springs Edwards Aquifer is located in northeast Hays County and extends into the southern part of Travis County. The aquifer covers 155 square miles of which 151 square miles discharge to Barton Springs, currently the fourth largest spring in Texas. Recent studies show that the surface recharge and the groundwater discharge (springflow and pumpage) are reasonably balanced. In 1982, the estimated total groundwater pumpage of about 3,800 ac-ft/yr represented approximately 11% of the average annual discharge of 36,000 ac-ft to Barton Springs. Increased pumpage associated with future groundwater development could result in a reduction in the discharge at Barton Springs, reduce groundwater availability, and possibly allow migration of "bad water" into the aquifer.

The Trinity Group Aquifer is another major water supply which covers most of western Hays County. It is the primary source of water for the Dripping Springs area, Wimberley, Woodcreek, and the surrounding rural area. The Trinity Group Aquifer extends across several counties and supplies several cities in south-central Texas. This aquifer is estimated to receive recharge at a rate of 200,000 ac-ft/yr. However, much of this recharge is believed to re-emerge as natural stream and springflow in area streams which in turn recharge the Edwards Aquifer. These complex interactions of the aquifer make it difficult to quantify the amount of water available from the aquifer. Additional pumpage of the Trinity Group Aquifer may result in a decrease in the baseflow of area streams, with a corresponding decrease in recharge to the Edwards Aquifer.



Source: Edwards Underground Water Dist.

EDWARDS AQUIFER HISTORICAL AND PROJECTED WELL PUMPAGE

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 5

WATER QUALITY

The quality of water in the Edwards Aquifer and the Barton Springs-Edwards Aquifer is generally very good. Although relatively high concentrations for a few contaminants have been detected at various sites, no regional contamination problems have occurred. Water quality in the Trinity Group Aquifer varies throughout the county. Groundwater from the Trinity Group can vary from fresh, as low as 236 mg/l total dissolved solids (TDS), to slightly saline, as high as 2273 mg/l TDS. The aquifer yields characteristicly very hard water and some of the wells have exhibited excessive sulfate and flouride contents. Historically, several wells located in the Trinity Group Aquifer within Hays County have displayed an increase in sulfate, TDS, and hardness since the late 1930's.

The aquifers in Hays County are generally producing good quality water, however future water quality is a concern for Hays County. The Edwards Aquifer, Barton Springs-Edwards Aquifer, and the Trinity Group Aquifer are threatened by contamination. Septic tanks are the most commonly used method of wastewater treatment in the county, even though soil conditions are generally poor for this type of treatment. As the population of Hays County expands, contamination in by septic tanks will become more of a threat. Another threat to water quality in the aquifer is an increase in groundwater pumpage. Additional pumpage of the aquifers could lower water levels, with the potential for causing an increase in subsurface flow into the aquifers in the form of "bad water" encroachment and leakage from underlying aquifers.

POPULATION AND WATER DEMAND PROJECTIONS

Projections for Hays County indicate that water consumption will increase rapidly due to residential development within the County. The current population of Hays County is estimated to be approximately 66,000. By the year 2000, the population should reach approximately 99,000 and by the year 2040 the population is projected to be about 251,000. Figure 6 shows historical growth along with projected growth for Hays County. Table 2 lists the population projections for Hays County along with a breakdown by area and city.

Water demand projections are presented in Table 3. Water demand projections were based on individual area statistics and their corresponding population projections. The average per capita water usage in Hays County is about 150 gallons per day with most of the water demand being almost entirely residential consumption with a small amount of industrial usage.

CITY OR REGION	HAYS COUNTY POPULATION PROJECTIONS 1990	2000	2010	2020	2030	2040
Hays County	70,427	98,790	126,831	159,586	200,051	250,801
Colorado R. Basin	13,523	20,417	27,816	37,871	52,232	72,965
Guadalupe-Blanco R. Basin	56,904	78,374	99,016	121,715	147,820	177,837
Edwards Aquifer	52,341	72,869	92,115	113,236	137,238	165,449
Trinity Group Aquifer	18,086	25,921	34,716	46,350	62,813	85,352
San Marcos ETJ	35,400	50,700	63,350	76,000	88,650	101,300
Kyle ETJ	5,129	7,592	11,238	16,634	24,623	36,448
Dripping Springs ETJ	6,314	12,120	18,385	27,215	40,284	59,630
Buda ETJ	1,930	2,260	2,580	2,910	3,240	3,562
Hays City ETJ	633	857	1,080	1,303	1,527	1,750
Woodcreek ETJ	1,004	1,349	1,813	2,436	3,274	4,400
Uhland ETJ	213	320	446	584	766	1,004
Mountain City ETJ	400	490	590	720	860	1,040
Wimberley WSC	3,276	4,176	5,376	6,600	8,100	9,000
Goforth WSC	3,746	4,873	6,000	7,000	8,000	9,000
Plum Creek WSC	3,224	3,861	4,624	5,537	6,630	7,940
County Line WSC	834	997	1,192	1,425	1,703	2,036
Rural Areal, Other WSC	8,325	9,196	10,158	11,221	12,395	13,691
Outside Hays Co.	17,227	23,006	30,918	41,778	56,715	77,297
Hays Co. including Outside	87,564	121,796	157,749	201,364	256,766	328,098

TABLE 2
HAYS COUNTY POPULATION PROJECTIONS

	HAYS COUNTY WATER DEMAND PROJECTIONS (MGD)											
	1990		2000		2010		2020		2030		2040	
CITY OR REGION	Avg. Day	Peak Day	Avg. Day	Peak Day	Avg. Day	Peak Day	Avg. Day	Peak Day	Avg. Day	Peak Day	Avg. Day	Peak Day
Hays County	12.85	21.86	17.85	30.26	22.78	38.58	28.21	48.20	34.80	59.92	42.86	74.47
Colorado R. Basin	1.86	3.84	2.83	5.73	3.85	7.76	5.25	10.52	7.25	14.45	10.15	20.12
Guadalupe-Blanco R. Basin	10.99	18.01	15.03	24.52	18.85	30.81	22.96	37.67	27.55	45.47	32.71	54.35
Edwards Aquifer	10.25	16.59	14.14	22.79	17.74	28.63	21.59	34.96	25.84	42.05	30.66	50.26
Trinity Group Aquifer	2.61	5.27	3.72	7.47	4.96	9.95	6.62	13.23	8.96	17.87	12.20	24.22
San Marcos ETJ	6.36	9.55	9.14	13.70	11.41	17.09	13.68	20.51	15.95	23.93	18.24	27.35
Kyle ETJ	0.71	1.37	1.07	2.05	1.57	3.02	2.33	4.47	3.45	6.62	5.10	9.80
Dripping Springs ETJ	0.87	1.70	1.71	3.28	2.58	4.97	3.81	7.35	5.63	10.88	8.35	16.11
Buda ETJ	0.21	0.46	0.25	0.56	0.28	0.62	0.32	0.70	0.36	0.78	0.39	0.86
Hays City ETJ	0.07	0.13	0.09	0.20	0.12	0.24	0.14	0.29	0.17	0.34	0.19	0.39
Woodcreek ETJ	0.22	0.49	0.30	0.65	0.40	0.88	0.54	1.18	0.72	1.58	0.97	2.13
Uhland ETJ	0.02	0.03	0.03	0.06	0.04	0.08	0.06	0.11	0.08	0.14	0.10	0.18
Mountain City ETJ	0.06	0.25	0.08	0.31	0.09	0.38	0.12	0.46	0.14	0.55	0.17	0.67
Wimberley WSC	0.38	0.82	0.48	1.07	0.62	1.36	0.76	1.67	0.93	2.05	1.04	2.28
Goforth WSC	0.43	1.07	0.47	1.17	0.63	1.55	0.74	1.81	0.84	2.07	0.95	2.32
Plum Creek WSC	0.29	0.52	0.35	0.65	0.42	0.77	0.50	0.92	0.60	1.10	0.71	1.31
County Line WSC	0.08	0.14	0.10	0.18	0.12	0.22	0.14	0.26	0.17	0.30	0.20	0.36
Rural Area, other WSC	1.25	2.49	1.39	2.77	1.52	3.05	1.68	3.37	1.86	3.72	2.05	4.11
Industrial	1.90	2.85	2.40	3.60	2.90	4.35	3.40	5.10	3.90	5.85	4.40	6.60
Outside Hays Co.	1.77	3.54	2.36	4.71	3.16	6.31	4.25	8.50	5.75	11.50	7.82	15.64
Hays Co. including Outside	14.62	25.40	20.21	34.98	25.86	44.90	32.46	56.70	40.55	71.42	50.68	90.11

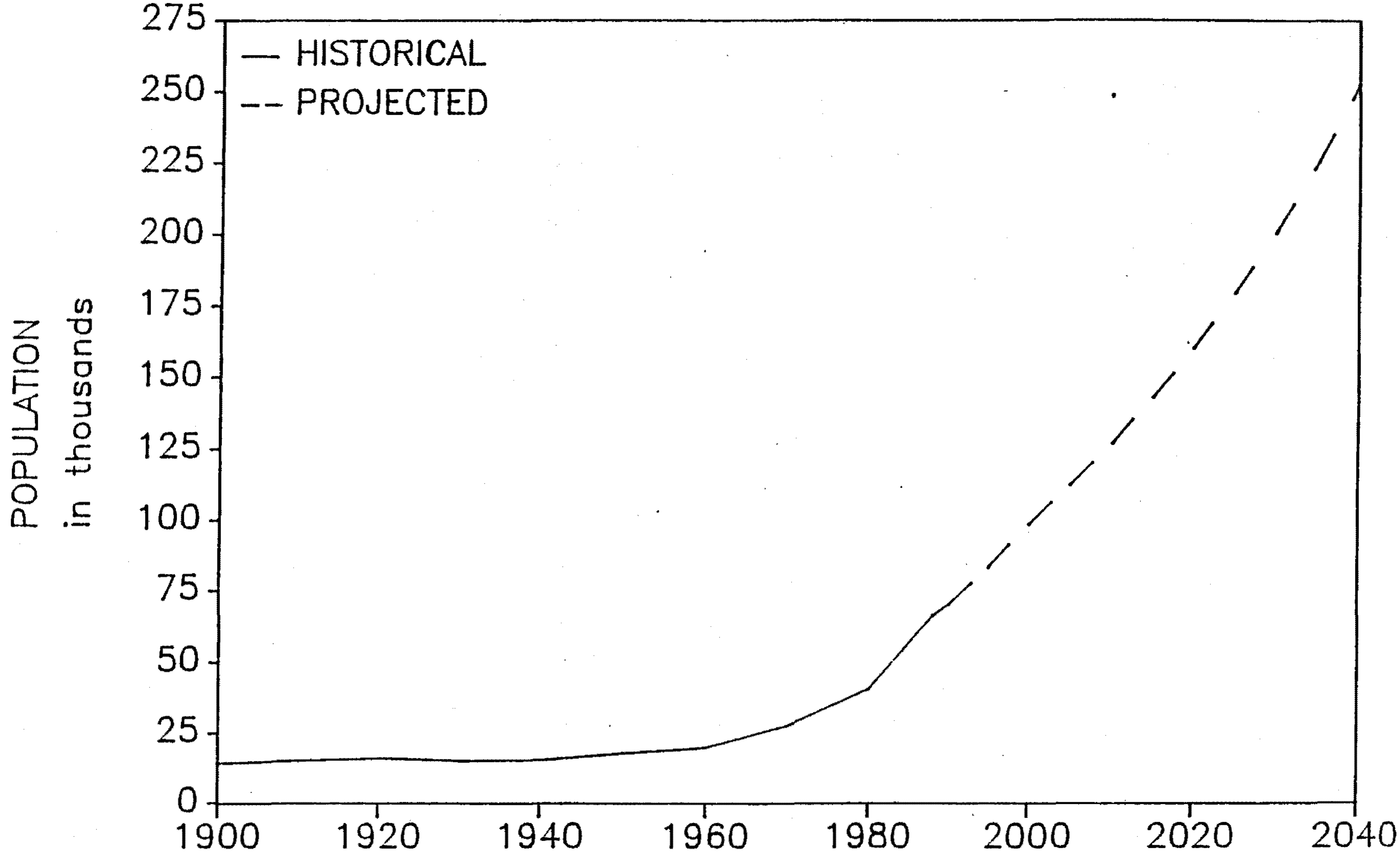
Note: Water demand projections do not include water conservation.

TABLE 3
HAYS COUNTY WATER DEMAND PROJECTIONS

TABLES 2 & 3

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR
HAYS COUNTY WATER DEVELOPMENT BOARD



HAYS COUNTY HISTORICAL AND PROJECTED POPULATION GROWTH

HDR

REGIONAL WATER AND WASTEWATER STUDY FOR HAYS COUNTY WATER DEVELOPMENT BOARD

FIGURE 6

PUBLIC INFORMATION AND EDUCATION

Public acceptance of this conservation plan is based upon information and education. Informed and supportive citizens are necessary to implement the conservation plan. The primary goals of the education program are to:

a. Create an awareness of local water problems and issues.

b. Inform the citizens of the benefits of water conservation which include:

1. Reduced risk of severe water supply shortages.
2. Optimize use and efficiency of available water supplies.
3. Cost savings in reducing, delaying or eliminating utility system expansion.
4. Reduction of utility costs to customer.
5. Protection of the economic viability of the area.

c. Educate the citizens on water conservation techniques, low water use landscaping (Xeriscape), low water use fixtures and reuse/recycling benefits.

d. Educate the citizens on the benefits and opportunities of reuse and recycling of water.

To accomplish the necessary education of the citizens of Hays County requires identification of the target groups for education. These groups are diverse and served by a variety of media, local organizations and institutions. The following target groups include most citizens and water users of Hays County.

- Governments (town, county, subdivision approval authority, planning & zoning, architectural control)
- Water suppliers
- News Media
- Property owners associations. (These associations include some with little authority and control to very active associations with considerable control and influence over the residents)
- Farmers/ranchers
- Industry
- Students/teachers (public schools, private schools, university)
- Community leaders/influential citizens
- Professionals/tradesmen (landscape architects, architects, builders, nursery owners, etc.)
- Other golf course operators, launderies, high water use businesses, motels, hotels, restaurants

To educate and inform the citizens of Hays County will require developing a plan tailored to the resources available in Hays County. The effectiveness of the plan will depend on how well each institution, organization, and group is utilized.

Following is a list of suggested Public Education "Forums":

- Government meetings
- Media (newspaper-radio-TV-property owners associations newsletters, etc.)
- Regional authorities, districts, organizations, (LCRA, EUWD, GBRA)
- Billings (telephone, gas, electric, water)
- Property owners association meetings
- Agricultural agencies (publications, meetings, etc.)
- Classroom grades (3-12 and university)
- Professional publications (farmers, ranchers, builders, architects)
- Service and social clubs (Lions, Rotarians, womens clubs, senior citizens, etc.)
- Garden club meetings

Implementation

For the Hays County education program to be effective, the following actions are necessary.

1. Designate responsibility for establishing an ongoing education program. Since this is a county endeavor, the County Judge should appoint a committee composed of dedicated, committed and respected citizens. Each community or geographical area must be represented on such a committee. The committee would be responsible for the following:

    - Provide qualified individuals to speak at institutions, organizations and groups throughout the county at regular intervals.

    - Conduct or sponsor exhibits on conservation, water saving devices and other methods to promote water conservation and efficiency.

    - Provide and distribute brochures and other materials to the citizens of Hays County. These materials are frequently available from an assortment of agencies such as the Texas Agricultural Extension Services and Texas Water Development Board.

- Work in cooperation with builders, developers, and governmental agencies to provide exhibits of Xeriscape Landscaping on new homes in highly visible locations.

- Work in cooperation with schools and Southwest Texas State University (SWTSU) to establish an education program within these institutions and provide these institutions with landscape videos, brochures and other training aids.

- Develop welcome packages for new citizens to educate them on the benefits of conservation and the plants, trees, shrubs and grasses best suited to the area which are water efficient.

2. The effectiveness of the education program must be measured at regular intervals. This measurement must first determine what public awareness and knowledge existed at the start of the education program and then at regular intervals. One proven method to accomplish this is as follows:

   - Commission a statistically valid public opinion survey to establish a "baseline" of public awareness/attitudes and knowledge about water problems, conservation, efficiency and retrofits.

   - Conduct periodic surveys to develop "time series" data to evaluate and measure education effects.

   - Utilize SWTSU to accomplish the surveys and evaluate the data.

3. Adequate funding of the education program is vital. An education program should be cost effective and funded by both state and local agencies. Use of existing resources will substantially reduce expenditures. Conservation education must have the same priority for funding as other services which are considered necessary for the health, safety and general welfare of our citizens.

WATER CONSERVING PLUMBING CODE

INTERIOR WATER USE EFFICIENCY

Interior water use in both residential and commercial settings is largely "technology based" that is, the amount of water required to accomplish a function is determined in great measure by the water use rates of fixtures and appliances. As a result, enhancing the efficiency of these devices can produce significant reductions in water demand. For example, and old toilet installed under codes prevailing before about 1980 would draw about 5.5 gallons per flush. Currently, toilets using 1.5 gallons per flush or less are becoming available. So the same function can be accomplished using about a quarter of the water. End use efficiency enhancement of interior water demands is therefore one of the major means of conserving water supplies.

This section examines the various methods of increasing interior water use efficiency. Two basic categories into which these efforts can be classified are retrofitting of existing structures and code standards for new construction. The ultimate water savings potential per structure in each category is similar, since either depends upon similar hardware substitutions to achieve these savings. However, they differ in the institutional/regulatory issues important to each and their impact upon water savings actually realized. Hardware options are discussed first, noting their apparent water saving potential, the category to which they are relevant, and the cost effectiveness of each. Benefits other than direct fiscal advantages to the end users are also discussed.

TECHNOLOGIES FOR EFFICIENCY ENHANCEMENT

As an aid to surveying the hardware options and their water savings potential, five generic scenarios are presented:

1) The "non-conserving" scenario, reflecting the type of hardware prevalent prior to the institution of current plumbing codes, generally meaning the structures were built before 1980.

2) The "low-cost retrofit" scenario, in which the residential hardware assumed in the first scenario is retrofit as follows: toilet dams in toilet tanks, toilet tank leakage is minimized, and low-flow showerheads are substituted for "non-conserving" ones. Commercial fixtures remain unchanged in this scenario.

3) The "current practice" scenario, which reflects just that--a structure with plumbing fixtures simply conforming to currently prevalent construction practices, which in some cases are more water conserving than present codes strictly require.

4) A "moderate conservation" option. which could be viewed alternatively as "high-cost retrofit" scenario. This assumes an "advanced" plumbing code, mainly relating to toilet fixtures, with a 1.5

gallon per flush unit being assumed for both residential and commercial fixtures. A more efficient washing machine and a high efficiency dishwasher are also assumed.

5) A "high conservation" option, incorporating the most advanced, maximum water saving fixtures which are currently commercially available. For residences, these include a 0.5 gallon per flush air assisted toilet with zero toilet leakage, a 0.5 gallon per minute specialty showerhead, and a high efficiency washing machine. Commercial sector usage is assumed to be the same as the "moderate conservation" scenario.

The water demands per capita implied by each of these scenarios are displayed in Table 4. This shows the "base" use per capita in old construction to be 80.4 gallons for residences and 20.0 gallons in commercial settings.

The low-cost retrofit gains a savings in the residential sector of about 13 gallons per capita per day (gpcd), or a 16% savings. The current practice scenario results in a demand of 61.8 gpcd in the residential sector and 10.3 gpcd in the commercial sector. This can be considered the "base" demand for all recent and new construction. Moderate conservation measures in new construction result in a demand of 50.4 gpcd in the residential sector and 5.8 gpcd in commercial buildings. This represents an 18% decrease in residential demand and a 44% decrease in commercial demand from the current practice base. If these measures were pursued as retrofits to old construction, a 37% decrease in residential demand and a 71% decrease in commercial demand would be realized. The high conservation option yields a residential demand of 29.4 gpcd--a 52% decrease from current practice--and a commercial demand of 1.3 gpcd--an 87% decrease.

This analysis, though admittedly simplistic and based upon "global" usage rates, etc., indicates a very large potential for enhancing the end use efficiency of interior water uses in the residential and commercial sectors. The impacts of these savings go well beyond the savings in water rates to the end users, as the following discussion outlines.

BENEFITS OF INCREASED INTERIOR WATER USE EFFICIENCY

As noted, end use efficiency enhancements would save money for the user through reduced water bills. Certain actions would also result in savings in energy bills due to a reduced demand for hot water. One result of decreased demand for interior water uses is reduced wastewater flow. This imparts a general environmental benefit due to lower volumes of effluent to be assimilated. It also provides direct tangible benefits to the wastewater system. An on-site system would operate better with lower flows, and in many cases the disposal field could be safely downsized in recognition of the lower volume of flow. A collective system could benefit through smaller component sizes throughout the collection and treatment system.

Likewise, lower demands upon the water system might allow downsizing components of that system as well. Attaining a practical benefit would undoubtably require some regulatory changes, however, since "stock" line sizes are usually stipulated.

Perhaps the greatest potential benefit of increasing efficiency of end uses is that this may forestall the need to expand the capacity of water supply and/or wastewater treatment systems. Note that decreasing wastewater flow per capita 30%, for example, is equivalent to decreasing the contributing population 30%, allowing that much more capacity to accommode growth before a plant expansion would be required. This benefit appears to be particularly valuable in terms of water supply expansion, since it appears that any new sources of supply for Hays County would be quite costly relative to current water rates.

Implementation

Improved technology has made it possible to accomplish considerable water savings through the use of more efficient plumbing fixtures. Among these fixtures are improved low flow shower heads, low volume toilets, water saving washing and dishwashing machines, and flow controlled or aerated faucets. Use or specification of these plumbing fixtures would fall under the "moderate conservation option". Under the "moderate conservation option", an 11.4 gpcd decrease in residential demand and a 4.5 gpcd decrease in commercial demand from the current practice can be realized.

Due to the potential water savings available through the use of more efficient plumbing fixtures and the fact that these fixtures are commonly available at most plumbing supply centers in the area, the following plumbing code and standard should be established.

REQUIREMENTS FOR ALL NEW RESIDENTIAL AND COMMERCIAL CONSTRUCTION

(a) Toilets: Toilets shall be designed, manufactured, and installed so the maximum flush will not exceed 1.6 gallons of water.

(b) Urinals: Urinals shall be designed, manufactured, and installed so the maximum flush will not exceed 1.5 gallons of water. Adjustable type flushometer valves may be used provided they are adjusted so the maximum flush will not exceed 1.5 gallons of water.

(c) Showerheads: Showerheads, except where provided for safety reasons, shall be designed, manufactured, and installed with a flow limitation device which will not allow a water flow rate in excess of 3.0 gallons per minute. The flow limitation device must be a permanent and integral part of the showerhead and must not be removable to allow flow rates in excess of 3 gallons per minute.

(d) Faucets: All lavatory, kitchen, and bar sink faucets shall be designed, manufactured, installed and equipped with a flow control device or aerator which will not allow a water flow rate in excess of 2 gallons per minute. In addition, all lavatory faucets located in restrooms intended for use by the general public shall be of the metering or self-closing type.

(e) Hot Water Piping: All hot water lines not in or underneath a concrete slab shall be insulated.

(f) Automatic Dishwashers: All automatic dishwashers installed in residential dwellings shall be of a design that uses a maximum of 13 gallons per cycle.

REQUIREMENTS FOR REPLACEMENT OR RENOVATION OF PLUMBING FIXTURES

All new plumbing fixtures that replace or renovate existing plumbing fixtures shall follow the requirements for new residential and commercial construction.

WATER CONSERVATION RETROFIT PROGRAM

APPLICATIONS

Water conservation retrofit programs are generally targeted at up-grading the efficiency of plumbing fixtures in structures whose construction pre-dates the adoption of prevailing national plumbing code standards for water conservation (approximately 1980). Most utility-sponsored retrofit programs have been implemented to achieve "wastewater flow reduction" objectives rather than water conservation per se. The most common situation has involved a hydraulically over-loaded wastewater collection and/or treatment system. Water conservation retrofits are intended to provide some near-term relief or perhaps enable a delay in wastewater system improvements. Retrofit programs have also been implemented to reduce water use during a water supply shortage or other emergency (e.g., contamination of a well). Retrofitting existing structures served by private sewage facilities (i.e., septic systems) is another possible application. Research has shown significant improvements in the overall performance of septic systems when hydraulic loadings are reduced through water conservation retrofits.

IMPLEMENTATION ALTERNATIVES

As with the technologies for water conservation retrofits, a wide-range of options exist for implementing retrofit programs. A few "generic" implementation alternatives are identified below:

I) <u>Voluntary Retrofit Programs</u>:

Utility (or other public agency) encourages and promotes retrofitting of existing structures by the property owners at property owners expense. Requires educational and promotional effort regarding the need for and benefits of retrofits. Overall program effectiveness likely to be low.

II) <u>Manadatory Retrofit Programs</u>

Appropriate governmental entity mandates, by ordinance, the retrofit of all existing structure according to prescribed standards. Options include retrofit by a prescribed date or at point-of-sale. Requires inspections to insure compliance. Overall program effectiveness likely to be high if public resistance can be overcome.

III) <u>Utility Sponsored Retrofit Programs</u>

Water and/or wastewater utility is directly involved in the procurement and distribution of retrofit "kits." Most utility-sponsored programs entail free distribution to all utility customers and installation by the customer. Distribution methods include; direct mail, depot and door-to-door. Some programs have included assistance with device installation to some or all customers. In a few examples, retrofit kits are sold to the utility customer at or below cost. Overall program effectiveness will vary according to types of devices provided and distribution method.

Recommendations

Upgrading the water use efficiency of existing residential and commercial developments through water conservation retrofits can provide significant benefits to the citizens of Hays County. However, utility or other publicly-sponsored retrofit programs are not recommended for implementation county-wide. Rather, publicly-sponsored retrofit programs should be implemented on a case-by-case basis in response to local water and wastewater utility service problems. In particular, publicly-sponsored water conservation retrofit programs should be considered as a method of achieving reductions in wastewater flows to wastewater systems that are at or near hydraulic overload. Assistance with the design and implementation of local water conservation retrofit programs should be available from the Texas Water Development Board and appropriate regional water management agencies.

Not withstanding the above recommendation, it is strongly recommended that the benefits of and technologies for water conservation retrofits be included in public education and information programs. The objective would be to motivate individual consumers to undertake voluntary retrofits of their homes and businesses. The educational effort should focus on low and moderate cost "do-it-yourself" retrofits and underscore the favorable cost payback of such retrofits. Information regarding the improved performance of on-site wastewater treatment and disposal systems (i.e., septic tank systems) should also be included. Additionally, adoption and enforcement of plumbing code standards for new construction and rehabilitation will provide a gradual up-grading of plumbing fixtures in existing structures.

WATER CONSERVATION-ORIENTED RATE STRUCTURE

Water rates and water pricing as tools in an aggressive program of water conservation for Hays County will be effective to the extent that cities and other water purveyors initiate and carry out simultaneous programs of rate setting and customer education designed to deal with local site specific circumstances. For county-wide water demand reduction to reflect these local initiatives, the County can take actions and provide incentives for compliance with goals of demand reduction and improving the effectiveness of management of the limited water resources available.

The key issues that must be addressed to achieve the County's objectives of demand reduction are conservation pricing and marginal cost pricing. These are described below, followed by recommendations for actions by the County and by individual water purveyors. Some of these actions may require new legislation, but they deserve consideration in a county wide approach to the problem.

<u>Conservation Pricing</u>

The success of price as a method to achieve conservation depends largely on the specific water use and the conditions of water supply. Price elasticity, which measures the change in demand that occurs for every one percent change in price, is a tool which measures the sensitivity of consumption to changes in price. Most studies have found consumption somewhat responsive to price changes, although the change in consumption tends to be proportionally less than the associated price change. As might be expected, essential water uses are generally less responsive to price changes than nonessential uses. For example, water use within the home is less responsive than exterior water use to changes in price.

Estimates of price elasticity from other areas are a useful way to examine the potential effectiveness of pricing measures. These estimates vary widely as shown in the following table. Estimates range from -.01 to -.60 for residential use up to -.27 to -.70 for sprinkler use. A price elasticity of -.02 means that water use should decrease 2 percent with a 100 percent increase in price.

PRICE ELASTICITY OF WATER

Water Use	Elasticity	Location
Municipal	-.27	Phoenix
Municipal	-.41	Tucson
Municipal	-.35	Southwest U.S.
Residential in-house	-.20 to -.38	Colorado
Sprinkling	-.27 to -.53	Colorado
Municipal	-.335	Las Vegas
Residential	-.225	dispersed
Residential	-.03 to -.29	Mississippi
Residential	-.10	dispersed
Residential	-.15 to -.24	Minnesota
Industrial cooling	-.894	New Jersey
processing	-.745	New Jersey
steam generation	-.741	New Jersey
Sprinkling	-.703	dispersed
Municipal	-.6	Midwest
Municipal	-.37	Massachusetts
Municipal	-.02 to -.28	Illinois

These elasticity measurements are point estimates, meaning they reflect the charge for a given price-quantity relationship. In fact, as prices rise, elasticity estimates tend to increase as excessive water use is cut back, then decrease as the minimum water use requirements are approached.

Elasticity estimates for semi-arid areas indicate relatively low price elasticities, most likely in the magnitude of -.10 to -.20. Water is relatively inexpensive compared to other household purchases. This tends to limit the reduction in water use when price increases.

These studies over the long-term indicate that consumer behavior can be modified with price but that permanent behavioral adjustment may take several years to occur.

Marginal Cost Pricing

Historically, water rates have been set to reflect the average cost of water. That is, the total cost for the water is divided among the users, without regard to how different users influence the costs for expanding the water system. Some utilities have recognized that the addition of new users results in the expansion of facilities and the acquisition of new, and usually more expensive water. To more fairly assess the cost of obtaining new water, utilities charge new customers substantial fees for a connection to the system. These fees provide the utility with income that can be used for expansion. However, developers and community boosters sometimes oppose high connection charges on the grounds that they inhibit growth and development. Conservationists sometimes argue on behalf of such fees because they do tend to limit growth and protect the investment of present customers.

Economists have argued that water rates should reflect not the average cost of water today but the cost of the next unit of water to be obtained by the utility, or the marginal cost. Marginal cost is usually defined as the cost of water from the most recently constructed or next increment of plant capacity and supply. Thus, the charge for water from a new and expensive supply source should reflect that additional cost even if it is greater than the average cost. If rates were based on marginal costs, then, they would increase to reflect the increasing scarcity and delivery cost of new water. As a tool in rate setting, marginal cost pricing may be very useful as Hays County looks at its options for the future.

Specific Measures

Governmental agencies and water supply corporations should, after evaluation of their particular environment, establish rates and incentives to encourage water conservation. Each entity should set conservation goals and then tailor their program to attain the set goals.

1. Rates: There are several different rate structures that each entity should consider when setting rates to encourage water conservation.

*Increasing block rates

*Rate rachet for peak demands

*Seasonal rates - flat rate with higher monthly charges during high use months

1) Increasing block rates, e.g., less than 2,000 gal./mo., 2,000-10,000 gal./mo.

2) Customer determined increasing block rates, e.g., anything above average usage by customer during December, January and February -- time of least consumptive use--is charged at higher rate.

3) Seasonal rates, e.g., flat rate regardless of gallonage but higher in summer--time of higher peak demand--than in winter, when demand is lower.

4) Demand charge, as is done with electric customers, e.g., month with highest sets a demand charge for the next 12 months.

5) For water providers, a pumpage fee or surcharge--could be somehow worked in as "value added" tax--to be passed on to customers to encourage individual conservation efforts. Fee could be "modulated" based upon loss rate of system.

2. Incentives: A variety of incentives are available to governmental entities and water supply corporations to encourage and promote water conservation.

*Lower permit fees and hook up fees for new homes equipped with plumbing fixtures which meet the requirements of an "advanced" plumbing code.

*Rebate of a portion of permit fees and hook up fees for new single or multi-family homes and commercial developments when approved Xeriscape landscaping is installed.

3. Incentives to Homeowners, Builders & Developers

1) Cash rebate program for installation of ultra-low volume toilet. Might be in form of reduction in "capital recovery" fees for development, direct rebate to homeowner, unless sufficient rate structure incentives instituted.

2) For developments not within area served by existing "organized" wastewater system, grant increased density or decreases in development fees (increase county platting fees to make this incentive meaningful) for water reusing wastewater management. Might include:

*"Improved" on-site systems, e.g., pressure-dosed designed to obtain some irrigation benefit or true drip irrigation.

*Collective systems with irrigation disposal in some manner which displaces what would have been supplied with potable supply.

3) For developments within area served by existing "organized" wastewater system, grant some form of development credit--definitely a decree in "capital recovery" fee, perhaps density increase, setback relaxation, impervious coverage waiver, etc.-- for separately plumbing greywater, treating it on-site and using it for irrigation of grounds and/or toilet flush supply.

4) Rebate or decrease in fees for installation of xeriscape on common areas of multi-family, P.D.D./P.U.D.'s, or on commercial/industrial grounds.

5) Reduction or rebate of fees for implementation of commercial or industrial reuse/recycle operations.

6) Some sort of revolving loan program to finance water saving appliances and fixtures or water reuse programs, e.g., greywater irrigation system. System operator would split savings with purchaser until loan is repaid.

7) Allow decrease in size of water supply pipes relevant to expected decrease in demand from conservation measures, but require proof of reduction effectiveness.

8) Reduction or rebate of fees for commercial or industrial users who install reuse/recycle equipment.

9) Penalties for water systems whose water sales consistently falls below 85% of pumpage.

Implementation

Water conservation-oriented rate structures have been shown to reduce water use. The HCWDB recommends that each water supplier establish an increasing block rate structure. The HCWDB also encourages any of the other water conservation incentives listed above.

UNIVERSAL METERING AND METER REPAIR AND REPLACEMENT

Universal metering of all accounts is becoming routine practice among most water suppliers in this area. In order to enforce a stand of system integrity, this would have to be mandatory, of course. It would also be of practical benefit in terms of water conservation in two ways. First, studies show that metering results in lower water use, since the customer becomes "sensitized" to the amount of water used through the effect it has on the water bill. Second, metering is an aid to detecting leaks--on both sides of the meter. For the system side, the difference between water production and metered use is, by definition, the amount of system losses. On the customer side, an unexpected increase in metered demand may indicate a break in the customer's line.

Maintenance programs for water meters are essential to assuring that an accurate measure of system integrity is being obtained. A common approach is to change out a given percentage of total meters in the system every year, running the meters that are "pulled" through a preventative maintenance program, then using them for replacements. Another benefit of this strategy to the water provider is that under-registration by meters may result in significant loss of revenue.

<u>Implementation</u>

- The following actions are necessary:

    - Universal metering is required by all water suppliers.
    - A meter replacement/testing schedule be developed and implemented by each water supplier.

WATER CONSERVING LANDSCAPING

EXTERIOR WATER USE EFFICIENCY

Exterior water use for landscape irrigation represents the largest single water use in residential developments. Analysis of water utility billing data for residential developments in Central Texas indicates that the average annual water use for landscape purposes is approximately 35 to 40 percent for single family residences.

SEASONAL WATER DEMAND

Landscape irrigation creates seasonal peak water demands. Seasonal water demands represent the incremental demand above base (interior only) levels, primarily for landscape irrigation during the summer months. For residential developments, peak demands during the summer months are sometimes four times greater than normal (interior only) demands. Commercial uses typically show lower peak water demand factors than residential developments. Because landscape irrigation use is largely dependent on weather conditions, large variations in peak demand occur between wet, normal and dry years. Drought conditions typically result in an overall increase in total water use and peak water demands.

Communities often rely on water supply sources which are highly dependent on favorable climatic conditions. Typically there is reduced inflow to or recharge of the supply source during the low rainfall periods accompanied by an increase in overall water demand due to increased water use for landscape irrigation. The requirement to size the water supply system to meet peak water demands with adequate reserve for fire fighting purposes means that facilities are oversized with respect to normal demands and are underutilized most of the year. The costs for oversized facilities must be borne by the rate payers. Reducing the magnitude of seasonal peak water demands through water-conserving landscaping offers the greatest potential for optimal sizing of water treatment and distribution facilities.

FUNDAMENTALS OF WATER CONSERVING LANDSCAPING

The key elements of low-water demand landscaping are contained in a program called Xeriscape developed in Denver, Colorado. The Xeriscape program is based on seven fundamentals of water conserving landscaping. The seven fundamentals are:

- Planning and Design

Perhaps the most important fundamental is a good design which will ensure both the resident's long term satisfaction and water conservation. Key considerations include the functions (recreation, shading, aesthetics, etc.); maintenance requirements; priorities and budget. Planning also allows installation of landscaping in phases which minimizes initial expenses.

- Limiting Turf Areas

Turf areas are the most long term water-consumptive component of a landscape. Depending on soil conditions, climate and grass type, turf areas normally require large amounts of water to supplement natural rainfall during the summer months. It is essential in a low-water demand landscape plan to reduce the size of the irrigated turf areas. Substitutes for irrigated turf areas include native grasses, ground covers, low-water demand plants or mulches, decks, patios, walkways and rock gardens.

- Soil Improvement

Prior to the installation of vegetation or an irrigation system, the existing soil must be analyzed to determine the necessary improvements. County extension agents can provide assistance in taking soil samples and determining the soil improvements required to ensure water holding capacity, absorption properties and nutrients for plant growth.

- Larger Mulch Areas

Mulches cover and cool the soil, reduce weed growth, minimize evaporation and slow erosion. Organic mulches are typically bark chips, wood grindings, composted leaves or pole peelings. Inorganic mulches include rock and various gravel products.

- Low-Water Use Plants

The use of native and other adapted low-water use plants is essential in any low-water demand landscaping strategy. Such plants normally do not require supplemental irrigation except during the initial establishment period or during severe drought conditions. Native plants are normally more resistant to disease and insects and more likely to survive temperature extremes.

- Efficient Irrigation

Water efficiency in irrigation requires knowing when to water, how much to water and how to water. Knowing when to water is essential to both healthy plant growth and water conservation. Most professionals agree that people tend to over-water, rather than under-water their landscapes. A general rule of thumb is to irrigate when plants first begin to show signs of drought stress. The most optimal time for landscape irrigation is during early morning hours and late evening when temperatures are the lowest and winds are normally calm.

How much to water is dependent upon the type, age and size of plant, soil characteristics, the season and weather. Most plants, including turf grasses, can survive with an application of water every five to seven days. A general rule-of-thumb is to apply 1.0 to 1.5 inches of water per application. To avoid over-watering or under-watering plants with similar water requirements should be grouped together.

The question of how to water relates mostly to the type of systems used to apply water to a landscape. These include three commonly used: end-of-hose sprinklers, drip irrigation systems and permanently installed automatic systems. End-of-hose sprinklers are commonly used in residential settings and efficiency varies with product design. Sprinklers that spray large droplets close to the ground are more efficient than those which spray a fine mist or stream high into the air. End-of-hose sprinklers require constant monitoring and control to ensure uniform water distribution.

Drip irrigation systems apply water at a low constant rate directly to or beneath soil surface. High water efficiency is attained by reducing evaporating losses and wasteful runoff. Drip irrigation systems are most suitable for the irrigation of trees, shrubs, bedding plants and vegetable gardens.

Permanently installed automatic systems have become increasingly common in both residential and commercial settings. Higher water use efficiency can be achieved with automatic sprinkler systems by automatically regulating the amount and timing of water application and can be tailored to water requirements of different plants and turf.

- Landscape Maintenance

Low-water demand landscaping generally requires less maintenance than the more traditional landscape. Proper maintenance is required and preserves the intended beauty of the landscape. Poor and improper maintenance practices can undermine much of the effectiveness of a well planned and installed Xeriscape.

Periodic fertilizing is essential to a healthy landscape. Because fertilizer requirements vary with plant type, season and soil type, professional advice should be sought.

Turf areas should be mowed frequently, cutting only the top one-third of the grass at a time. The clippings should be allowed to remain as mulch and soil conditioner.

Periodic aeration of turf areas is recommended. Aeration reduces compaction allowing water and fertilizer to penetrate the soil to the root zones.

Undesirable weeds should be removed as soon as they become visible. In addition to being unsightly, weeds use water intended for desired plants.

Trees and shrubs should be pruned periodically. Pruning reduces the amount of leaf surface on a plant which reduces plant transpiration.

Implementation

To achieve widespread use of the fundamentals of XERISCAPE, the following actions are required:

- Use all available educational resources as recommended in the Public Information and Education section of this document. Emphasis must be placed on the education of government officials as they have the authority to enact ordinances necessary to ensure use of Xeriscape fundamentals. Public awareness and knowledge of the long term benefits and cost effectiveness of the Xeriscape concept is essential to obtaining desired water conservation.

- Well-designed and properly maintained demonstration landscapes located in highly visible areas within Hays County.

- Incentives to include reduction in subdivision fees and building permit fees for builders or developers installing or requiring landscaping using the Xeriscape fundamentals.

The acceptance of the Xeriscape concept by the majority of Hays County residents is essential for the long term success of the Conservation Plan.

LEAK DETECTION AND WATER AUDITS

SYSTEM LOSS CONTROL

a. Leak Prevention, Detection and Repair

The surest way to minimize leaks is use high quality materials to construct the system, assure that they are properly installed, and then to maintain all components in good operating condition. Therefore, good water system construction standards and a program of water main replacement in areas where leaks are recurrent should result in a low level of leaks from water systems.

Many water systems are not following these practices, however, due partly to the cost of raw water currently being so low that low system integrity is generally affordable relative to the costs of higher construction standards and pipe replacement programs. Also, there is not universal agreement on what construction standards should be considered adequate.

A solution to this problem is to make it more costly to allow a low system integrity than to take the measures to raise it to an "acceptable" level. For this to happen, some authority must establish standards for system integrity, along with meaningful sanctions against the system operator for falling below that standard.

Specific actions can be taken to prevent leaks and to locate those that do occur so they can be repaired quickly. Corrosion can be prevented in tanks and metal pipes through proper coatings and cathodic protection. Valves can be inspected and operated periodically. Visual inspection and leak detection equipment can be employed to actively seek out system leaks. Records of leak frequency can be used as a guide to determining the cost effectiveness of line replacement. Through these activities, even a decrepit system could eventually be brought up to a high standard of integrity.

b. System Pressure Control

In general, pressure control is best executed at service laterals, since pressure reduction in the distribution system might compromise fire fighting capabilities. Any areas of the system where pressures become excessive, usually taken to mean over 100 psi static pressure, are candidates for system pressure control. Reduction of system pressure would minimize the losses from any leaks which go undetected for long periods. The actual static pressure to be maintained would depend upon the characteristics of the area and system, especially the pressure drop caused by peak demands.

CUSTOMER LOSS CONTROL

a. Pressure Control at Point-of-Use

Many water uses which require a specific amount of water--such as filling a bathtub, toilet tank or a washing machine--are not affected by pressure. However, others are "time dependent"--like taking a shower or watering a lawn--and reducing line pressure can reduce the total quantity of water flow from an outlet. For the same reason, pressure reduction would also reduce the waste per unit time from any leaks or faulty fixtures left unattended by the customer.

It is generally preferable to control pressure at the customer's service line. Many plumbing codes already require pressure regulators where the static pressure exceeds 80 psi. Uniform enforcement of this requirement would be a minimum step in this direction. A static pressure of 40 psi is generally more than adequate for household purposes.

b. Water Audits

A water audit offers a vehicle for helping to eliminate waste on the customer side of the meter. "Waste" might be defined broadly as water used in excess of the amount required to perform the desired function. Thus, water audits could not only help the homeowner to identify and fix leaks, but also could be used to purvey information about the cost effectiveness of retrofitting water conserving fixtures and about improved landscape irrigation practices.

Implementation

The HCWDB recommends that each water supplier voluntarily implement a leak prevention, detection, and repair program. The HCWB also recommends that each water supplier consider system pressure control as a means of reducing the potential for leaks.

WASTEWATER REUSE AND RECYCLING AS A CONSERVATION MEASURE

The planned reuse of treated wastewater effluent is one of the two major means of reducing demand upon aquifers and reservoirs. It is noted that when treated effluent is discharged into a receiving stream, that water often ends up being used again by downstream communities. There is no specific intent to reuse wastewater under this management strategy, so the extent of reuse is unknown, as is the cost effectiveness of any reuse which does occur. In contrast, the term "reuse" here refers to a deliberate strategy of directly using wastewater effluent--treated to a degree appropriate for the intended reuse--to satisfy various non-potable demands.

This general strategy of wastewater management is termed "beneficial reuse." In practice, satisfaction of irrigation demand will often be the reuse to which wastewater effluent is applied. It is important to distinguish between "beneficial reuse" and the conventional wastewater disposal practice of "land application." The latter is quite often what may be termed a "contrived" reuse--that is, an area of land is irrigated for the sole purpose of disposing of wastewater. This land would not be irrigated in the absence of this need, and economic benefits from irrigation are usually not a factor. Under a "land application" management strategy, wastewater literally lives up to its name.

In contrast, under a "beneficial reuse" strategy, effluent is used to supply irrigation demands which would exist regardless of the need to dispose of wastewater. Treated wastewater is used to displace an equivalent amount of demand upon the potable water supply system. Therefore, this effluent has a value, as opposed to effluent under a "land application" strategy, which is generally viewed as a liability. In Hays County, a large part of that value would be forestalling the need to bring new sources of supply on line.

"Reuse" is the general term applied to any process in which a wastewater stream is employed for any beneficial purpose. A common example is treated effluent being used for golf course irrigation. "Recycling" is a subclass of reuse in which the same water is used over and over to satisfy the same demand. An example would be the recycling of toilet flush water in an office building. For convenience, the general term "reuse" is used here to cover both reuse and recycling. The context of usage will indicate those situations were "recycling" is the appropriate action.

Reuse activities can be executed at varying levels of aggregation of wastewater flow. The lowest level at which reuse is expected to be viable is at the "building" scale. Obviously, the greatest level of aggregation is reusing conventional, centralized wastewater treatment plant effluent. This is denoted the "utility" scale. Between these extremes, two other levels are identified--the "neighborhood/campus" scale and the "development" scale. Reuse opportunities at each scale and their expected costs and benefits are discussed separately herein.

I. BUILDING SCALE

a. Prototypes and Examples

Part or all of the wastewater flow from a single building may be intercepted, treated and reused at the site of generation. A prototype for this scale of reuse is the old rural practice of using clothes wash water to irrigate lawns and gardens. Though the direct dumping of untreated wash water is now outlawed, the basic idea may still be executed. Appropriately treated residential greywater can displace an equivalent amount of demand upon the potable water system for landscape irrigation. If these individual lot systems are controlled by the residents, it is probably in the best interests of public health that they be limited to low density developments.

Another example of this scale of reuse is the recycling of toilet flush water after treatment in office buildings. Since approximately 90% of the water demand in such buildings is for toilet flush water, most of the demand upon the potable water supply system can be displaced by this practice. It is also possible that the residual 10% of the flow could be reused, for irrigation around the building or to supply cooling towers for the building's space conditioning system.

b. Potential and Limitations

The water savings potential from implementation of reuse at this scale will depend on the portion of total water use demanded by development in which on-site reuse is a viable option. Therefore, future development patterns would dictate total savings county-wide. As noted above, 90% savings in demand is expected in each office building for which toilet flush water recycling is practiced. A cursory analysis of irrigation demands versus greywater flows indicates that, subject to several assumptions, on-lot reuse of treated greywater for landscape irrigation might save about 30% of total water demand annually, with about 25% savings being realized in the peak month. If toilet flush water were also supplied by treated greywater, saving should be 40% annually and 30% in the peak month.

Reuse is expected to be more cost effective at the building scale than at greater levels of wastewater aggregation in those situations in which on-site reuse is otherwise viable. For isolated homes or developments of low density, collection and redistribution system costs would most likely make collective reuse systems far more costly. Building scale toilet flush water recycling is generally considered appropriate for isolated office buildings, where again collective systems would be far more costly.

A great deal of existing development may be difficult to retrofit for reuse at this scale, effectively limiting potential savings to new development. The ability to retrofit new development in the future would be enhanced by assuring that proper provisions are built into all new structures. As present Hays County population is less than one-third of that projected for 2040, new development alone offers a very significant potential for savings in water demand.

First cost inertia is perhaps the greatest obstacle to reuse at the building scale. Effective on-site reuse of greywater for landscape irrigation or recycling of toilet flush water would require a substantial investment in treatment facilities. Also, dual piping--for greywater/blackwater separation or a separate supply line to toilets--would increase first costs, the degree varying from negligible to considerable, depending upon the situation. Regardless of the general benefit of helping to forestall costly water supply projects, the microeconomics of the project are often favorable, however. In many cases, paybacks from savings in water costs are fairly attractive. But in general, the people building a project are far more sensitive to first cost than to operating cost. Therefore, some mechanism of financing these types of projects would help to proliferate them.

II. NEIGHBORHOOD/CAMPUS SCALE

a. Prototypes and Examples

This scale is appropriate to a neighborhood with higher residential density where a block of homes could have their greywater treated at a collective facility, then routed back to the lots on which it was generated to serve irrigation demands and to supply toilet flush water. These facilities would probably be installed by and under the control of some wastewater service authority.

Another example would be reuse within a commercial/industrial campus. Renovated wastewater could be used for cooling tower supply, irrigation, toilet flush water, or other non-potable demands. Cooling tower blowdown could also be utilized to serve other non-potable demands. Process water might also be amenable to reuse or to direct recycling.

b. Potential and Limitations

The total savings potentially available county-wide from broad implementation of reuse at this scale would be highly dependent upon the portion of total water demand routed to development in which reuse at this scale would be viable. A cursory analysis similar to that conducted for a single home indicates that neighborhood greywater reuse might result in a 46% savings in water demand, the greater savings being due to the ability to cost effectively include long-term storage in a collective system. In addition, an 84% decrease in wastewater flow--other than to the greywater treatment facilities--could be realized.

Savings from reuse within a commercial/industrial campus would depend upon the water use characteristics of the activities being carried on there. A toilet flush water recycle system for an office building complex would exhibit savings similar to that for a single building. Cooling towers are a significant point of demand for air conditioned buildings. Cooling tower blowdown is a lightly polluted stream with potential for reuse. A study recently completed for Southwest Texas State University indicates that cooling tower demands constitute about a quarter of total water demands on campus, and that cooling tower blowdown might supply almost all irrigation needs. A cascading reuse system, with renovated greywater supplying cooling towers and cooling tower blowdown supplying irrigation demands and toilet flush water, might cut total water demand in half.

This scale of reuse might prove to be the most cost effective. Collective systems at a neighborhood or campus scale are likely to exhibit the maximum economy, considering the collection and redistribution systems as well as the treatment facilities.

Barriers to reuse at this scale again include the difficulty of retrofitting existing development and various regulatory/code problems. Public acceptance of neighborhood greywater reuse systems may be more of a barrier than with on-lot systems, since a assurance of proper operation is beyond the control of the residents receiving the renovated water. Objections may be blunted by choosing to use treatment systems appropriate to use at this scale, in terms of the operating reliability and maintenance liabilities--that is, using treatment schemes which are inherently more "fail-safe."

Neighborhood greywater systems would presumably be sponsored by a water and wastewater authority rather than directly by the residents, so first cost inertia might not be as great. The water savings potential and long-term cost advantages are likely to be more important than quick payback to such entities. Campus scale reuse systems which are sponsored by the business entities involved are likely to be subject to considerable first cost inertia, since such investments would be governed by typical business microeconomics, stressing fast payback on capital investments. The expectation of increased water rates would, of course, help to spur such investments. Still, the people who build the structures--both residential and commercial/industrial--must be given some incentive or provided with some financial assistance to justify incurring the increased first cost required to build in the provisions for reuse, such as dual piping.

III. DEVELOPMENT SCALE

a. Prototype and Examples

In a mixed use development there may be many opportunities for non-potable reuse. If such a development were served by a conventional, centralized wastewater system, then dual piping might be installed throughout to route treated effluent to a variety of demands, such as irrigation, toilet flush supply, cooling tower supply, or commercial/industrial process water supply. In a new development, the building scale and neighborhood/campus scale facilities could be incorporated into the development's wastewater management plan. In any case, the ability to "connect" between water usage sectors at the development scale offers the possibility of maximizing reuse opportunities. An example of such a synergism is the use of wastewater from a housing development to irrigate a golf course, which serves as a major amenity of the development.

b. Potential and Limitations

This ability to maximize reuse indicates that total savings development-wide would exceed that available at the neighborhood scale. A greater variety of reuse opportunities would be available, perhaps allowing a better spatial and temporal match of supply and demand. Long-term storage may be more cost effective in a development-wide reuse system as well. It may be possible to integrate long-term storage into "water amenities." Since the neighborhood/campus scale of reuse exhibited a residential sector savings potential of 46% and a commercial office sector savings potential of 90%, it is likely that in excess of 50% of potable water demand could be displaced in a residential/office/retail development if all opportunities for reuse were implemented.

Relative cost effectiveness of reuse at the development scale would be somewhat site specific. If, for example, treatment were executed at a high level of wastewater flow aggregation but reuse opportunities were widely distributed, cost per gallon of water made available for reuse might be higher than if reuse were executed at a neighborhood scale. As a general rule, however, however, the ability to more cost effectively incorporate long-term storage and to connect among different sectors of water demand would tend to make development scale reuse the most cost effective level.

Again, it may be difficult to retrofit much of the existing development for reuse at this scale, since the actual reuse activities are simply multiples of the lower levels of reuse. Nevertheless, with over two-thirds of the County population projected for 2040 yet to be accommodated, new development still offers vast potential for reuse. Planning entire developments to incorporate reuse would maximize the opportunities for savings in potable water demand, so it is imperative that new projects be guided in this direction at the earliest possible stage.

Reuse projects instituted at this scale would definitely be under the sponsorship of a utility provider. Regulatory/code problems may still be a barrier at this scale, but perhaps less so than at lower scales, where reuse activities might be privately executed. Likewise, public acceptance of reuse activities which are "institutionalized" as an integral facet of development design would probably be more readily given. Concerns may arise as to whether treatment facilities can be made continuously reliable, which may be minimized by choosing to use relatively "fail-safe" treatment schemes.

First cost inertia would be a significant obstacle to gaining support of the developer of a project. Some form of incentives or some mechanism of financial assistance would probably be necessary to spur planning for reuse at the development scale. The public entities created to purvey the utility service to the users of the development are likely to have access to financing sources with greater latitude to make capital improvements now in the expectation that future savings would make them a wise investment. Allowing the developer to transfer some of the first cost burden of reuse facilities to these entities may be a viable form of assistance.

IV. UTILITY SCALE

a. Prototypes and Examples

This is the scale encountered when wastewater flows aggregate at a conventional, centralized treatment plant before being treated to a level allowing reuse. Reuse opportunities at this scale include routing of effluent to a single point of large demand, such as agricultural operations or industrial processes, routing effluent to several points of lesser but still sizable demands, like parkland irrigation, or installation of extensive dual pipe systems to route effluent to many points of small demand, such as lawn watering or toilet flush supply. A prototype of this scale of reuse is provided by the Irvine Ranch Water District in California, which has used centralized treatment plant effluent for irrigation since the mid-60's.

b. Potential and Limitations

A utility scale reuse system could theoretically result in the reuse of the entire flow into the treatment plant. Therefore, the potential for water savings by this strategy would be governed by the percent of total water use resulting in return flow to the wastewater system. Again, total savings countywide would depend upon the amount of total development served by treatment plants where this scale of reuse was found to be viable.

Unless there is available a large point of demand near the treatment plant, this scale of reuse is likely to be somewhat more expensive than reuse at lower levels of wastewater flow aggregation. Both an extensive wastewater collection system and an extensive water redistribution system would have to be paid for, in addition to the treatment facilities.

Since economics favors the targeting of large volume demands, it is probable that reuse at this scale could be more readily retrofitted into existing development. The problem of retrofitting the facilities--such as an office building using effluent for flush water supply--at the end use might still constitute a formidable barrier, however.

Unless reuse is targeted to specific demands with uniform potential for human contact and similar constraints, the entire volume of wastewater would have to be treated to the quality required by the most restrictive use. It is reasonable to assume that beneficial reuse regulations would allow lesser treatment for effluent used to irrigate access controlled areas, like agriculture operations, golf courses or roadway medians, than for effluent with higher potential for human contact, like lawn irrigation or toilet flush supply.

Public acceptance of utility scale reuse has not been found to be a problem in areas where it has been practiced. Some degree of education would probably be required, and the public would have to be convinced that the utility operator can assure continuously reliable operation of its treatment facilities. As almost every existing wastewater service provider in Hays County has some history of non-compliance, this may be a considerable obstacle to public acceptance. It is possible, however, that the proper choice of treatment facilities--favoring those which are more inherently "fail-safe"--might relieve such problems.

Recommendations

In view of the potential for reuse of treated wastewater effluent to greatly decrease per capita water demands without comprising the ability to accomplish the desired purposes of water use, the Hays County Water Development Board recommends that reuse be encouraged by all available means wherever it is found to be fiscally, environmentally and institutionally practical and prudent.

MEANS OF IMPLEMENTATION AND ENFORCEMENT

The Hays County Water Development Board will act as the administrator of the Water Conservation Program. The Board will oversee the execution and implementation of the program.

The HCWDB will be responsible for the submission of an annual report to the Texas Water Development Board on the Water Conservation Plan. This report will include the following elements:

1) Progress made in the implementation of the program.
2) Response to program by the public.
3) Quantitative effectiveness of the program.

The HCWDB will require, upon disbursement of any funds for water supply projects, that each water supply entity (city, public or private water supply corporation) being served by the water supply projects adopt this water conservation plan by ordinance or by-laws. Each entity will be responsible for enforcement of the Water Conservation Plan and each entity will also be responsible for furnishing all information requested by the HCWDB.

HAYS COUNTY WATER DEVELOPMENT BOARD
DROUGHT CONTINGENCY PLAN

INTRODUCTION

The Hays County Water Development Board's Drought Contingency Plan will include the following:

- Trigger Conditions
- Drought Contingency Measures
- Information and Education
- Termination Notification
- Implementation Procedure

The Board's Drought Contingency Plan will be a recommendation for the water suppliers within Hays County to follow. During a drought condition, the Board will serve to coordinate the consumption of water resources within the county to insure fair and equitable use among consumers.

Groundwater is the primary source of water for Hays County, however surface water is expected to provide a large percentage of water in future years. Several agencies or governmental authorities have jurisdiction over these water supplies including the Edwards Underground Water District (EUWD), Barton Springs-Edwards Aquifer Conservation District, Lower Colorado River Authority, and the Guadalupe-Blanco River Authority.

Hays County is served by three major aquifer systems: the Edwards Aquifer (San Antonio Region), the Barton Springs-Edwards Aquifer, and the Trinity Group Aquifer. Therefore, the drought contingency plan is divided into parts according to the particular area served by each of the above mentioned aquifers. These areas are defined as:

- Edwards Underground Water District within Hays County
- Barton Springs-Edwards Aquifer Conservation District within Hays County
- Trinity Group Aquifer area defined as the area west of the EUWD boundary and west of the Barton Springs-Edwards Aquifer Conservation District boundary within Hays County.

The EUWD has a drought management plan which will apply to the Edwards Aquifer (San Antonio Region) in Hays County. The Barton Springs-Edwards Aquifer Conservation District has not developed a drought contingency plan to date, however a plan is expected in the near future. The plan presented herein for the Barton Springs-Edwards Aquifer Conservation District is intended to be only a guide and subject to change as dictated by the detailed plan being prepared by the District. The Trinity Group Aquifer serves most of western Hays County. The Trinity Group Aquifer serves most of Hays County. Due to the complex interactions with the Trinity Group Aquifer and the Edwards Aquifer (San Antonio Region), and the fact that a large portion of the spring discharge from the Trinity Group Aquifer recharges portions of the Edwards Aquifer, the two areas were combined so that both areas are subject to the same trigger conditions. The Trinity Group Aquifer plan is considered to be a general guide subject to change as other governing bodies develop detailed drought contingency plans.

TRIGGER CONDITIONS

1. <u>Mild Condition</u>

Barton Springs-Edwards Aquifer Conservation District area

(a) Elevation of water level in well #58-57-903 at Mountain City Ranch less than 580 ft MSL for a period of 90 consecutive days or,

(b) Barton Springs discharge is less than 30 cfs for 90 consecutive days.

EUWD and the Trinity Group Aquifer area

(a) Stage I (Mild Condition) is reached according to the EUWD Drought Management Plan.

2. <u>Moderate Condition</u>

Barton Springs-Edwards Aquifer Conservation District area

(a) Elevation of water level in well #58-57-903 at Mountain City Ranch is less than 575 ft for 60 consecutive days or,

(b) Barton Springs discharge is less than 20 cfs for a period of 60 consecutive days.

EUWD and the Trinity Group Aquifer area

(a) Stage II (Moderate Condition) is reached according to the EUWD Drought Management Plan.

3. <u>Severe Condition</u>

Barton Springs-Edwards Aquifer Conservation District area

(a) Elevation of water level in well #58-57-903 at Mountain City Ranch is less than 570 ft MSL for 30 consecutive days or,

(b) Barton Springs discharge is less than 15 cfs for a period of 30 consecutive days.

EUWD and the Trinity Group Aquifer area

a. Stage III (Severe Condition) is reached according to the EUWD Drought Management Plan.

DROUGHT CONTINGENCY MEASURES

The following actions shall be taken by the Hays County Water Development Board when trigger conditions are met for any of the areas mentioned previously. These measures will apply only to the particular area in which a trigger condition is reached

1. Mild Condition

(a) Inform the public through the news media that a trigger condition has been reached and that they should look for ways to voluntarily reduce water use. Specific steps which can be taken will be provided through the news media.

(b) Publicize a voluntary lawn watering schedule.

(c) During winter months, request water users to insulate pipes rather than running water to prevent freezing.

2. Moderate Condition

(a) Continue implementation of all sections in preceeding phase.

(b) Car washing, window washing, and pavement washing is prohibited, except when a bucket is used.

(c) The following mandatory lawn watering schedule will be implemented:

Consumers with even numbered street addresses may water on even days of the month. Consumers with odd numbered street addresses may water on odd days of the month. Watering shall occur only between the hours of 6-10 a.m. and 8-10 p.m.

(d) Public water uses, not essential to public health or safety, are prohibited.

3. Severe Condition

(a) Continue implementation of all relevant actions in preceeding phase.

(b) All outdoor water use not essential to public health or safety is prohibited. Watering of livestock would not be prohibited.

INFORMATION AND EDUCATION

The purpose and desired effects of the Drought Contingency Plan will be communicated to the public through articles in local newspapers and supplemented by pamphlets and notices. When trigger conditons appear to be approaching, the public will be notified through publications of articles in local newspapers, with information on water conserving methods.

Newspapers will publish notifications that drought contingency measures are abated for a given condition, and will outline measures necessary for the reduced condition.

Throughout the duration of drought contingency measure implementation, regular articles will appear to explain and educate the public on the purpose, cause, and methods of conservation for that condition.

INITIATION PROCEDURE

Prior to formal notification of a drought condition, the Board will release a statement to all media sources warning that a potential drought condition is approaching. Once a trigger condition is reached, the Board will make formal notification that a particular drought condition is in effect.

TERMINATION NOTIFICATION

The Board will acknowledge through the news media that the emergency condition has passed. The Board will also recommend to each water supply utility to notify the customers that the emergency has passed and any temporary restrictions that are being relieved.

IMPLEMENTATION PROCEDURE

The Hays County Water Development Board cannot implement ordinances, codes, etc., however the HCWDB will require, upon disbursement of any funds for water supply projects, that each water supply entity (city, public or private water supply corporation) being served by the water supply projects adopt this drought contingency plan by ordinance or by-laws. Each entity will be responsible for enforcement of the plan and will also be responsible for furnishing all information requested by the HCWDB.

REFERENCES

1. Baker, E. T., Slade, R.M., Dorsey, M.E., Ruiz, L.M., and Duffin, G. L., "Geohydrology of the Edwards Aquifer in the Austin area, Texas", Report 293, Texas Water Development Board, March, 1986.

2. Muller, D. A., and McCory, Wesley, "Ground-Water Conditions of the Trinity Group Aquifer in Western Hays County", Texas Water Development Board, LP-205, January, 1987.

3. Muller, D. A., and Price, R.D., Texas Dept. of Water Resources, "Groundwater Availability in Texas", March, 1983.

4. Reeves, R.D., Maclay, R.W., and Ozuna, G. B., "Compilation of Hydrologic Data for the Edwards Aquifer, San Antonio area, Texas, 1981 with 1934-81 Summary", Bulletin 41, Edwards Underground Water District, February, 1984.

5. "San Antonio Regional Water Resource Study", City of San Antonio and the Edwards Underground Water District, April, 1986.

6. Slade, R.M., Dorsey, M.E., Sheree, S.L., "Hydrology and Water Quality of the Edward Aquifer associated with Barton Springs in the Austin area, Texas", U.S. Geological Survey, Water-Resources Investigation Report 86-4036, 1986.

7. "Soil Survey of Comal and Hays Counties, Texas", USDA-SCS, June, 1984.

8. "Water, Water Conservation, and the Edwards Aquifer", Edwards Underground Water District, August, 1981.

APPENDIX 2
TWC LETTERS

TEXAS WATER COMMISSION

Paul Hopkins, Chairman
John O. Houchins, Commissioner
B. J. Wynne, III, Commissioner

J. D. Head, General Counsel
Michael E. Field, Chief Examiner
Karen A. Phillips, Chief Clerk

Allen Beinke, Executive Director

June 24, 1988

Mr. Ronald Anderson
HDR Engineering, Inc.
3000 South I-35, Suite 400
Austin, Texas 78704-2618

Dear Mr. Anderson:

In response to request contained in your letter of June 2, 1988 addressed to Executive Director Allen Beinke, we are herewith transmitting the following data of water availability based on the Commission's water availability computer models.

1. Colorado River Basin

The latest water availability model for this basin was developed in October 1979 which includes the Stacy Project. The water rights and claims existing in April 1978 were considered in the model. Therefore, adjustments must be made for changes in the water rights after that date, including the agreement reached recently between the Lower Colorado River Authority and the City of Austin. The following tables of data are enclosed:

Table 1: Estimated unappropriated water on the Pedernales River shown at location 1 on your map which has been determined to be in subwatershed (24,3) with an incremental drainage area of 7.62 square miles in subwatershed (24,3) and a total drainage area of 1177.42 square miles.

Table 2: Estimated runoff at location (1) in subwatershed (24,3) after satisfying the upstream water rights included in the model.

Table 3: Unappropriated water on the Barton Creek shown at location 2 on your map which has been determined to be in subwatershed (25,6) of the Colorado River Basin with a drainage area of 41.07 square miles.

Table 4: Estimated runoff at location 2 in subwatershed (25,6) prorated for a drainage area of 41.07 square miles after satisfying the upstream water rights included in the model.

Table 5: Estimated unappropriated water at location 3 on your map which has been determined to be subwatershed (26,10) of the Colorado River Basin with a total drainage area of 84.87 square miles.

TEXAS WATER COMMISSION

RECEIVED JUL 11 1988

Paul Hopkins, Chairman
John O. Houchins, Commissioner
B. J. Wynne, III, Commissioner

J. D. Head, General Counsel
Michael E. Field, Chief Examiner
Karen A. Phillips, Chief Clerk

Allen Beinke, Executive Director

July 8, 1988

Mr. Ronald Anderson
HDR Engineering, Inc.
3000 South I-35, Suite 400
Austin, Texas 78704-2618

Dear Mr. Anderson:

As requested in your letter of June 29, 1988, we are herewith enclosing two tables of additional data showing the estimated unappropriated water and runoff downstream from the confluence of Blanco River with the San Marcos River in subwatershed (11,7) of the Guadalupe River Basin model. A diskett containing this data also is enclosed.

The same assumptions and restrictions apply to these data as indicated in our letter of June 24, 1988. In that letter also the drainage area for your location 5 in subwatershed (11,3) is shown as 46.66 square miles. This is not the total upstream drainage area, it is the incremental drainage area in watershed (11). The total drainage area would be 401.66 square miles including drainage area of 355 square miles for watershed 10.

The cost of extracting the data enclosed and diskett preparation is $47.00. Please arrange to pay this amount before obtaining these data.

Sincerely,

Jerry G. Boyd

Jerry G. Boyd, P.E,
Chief, Water Use Section
Texas Water Commission

VRKM:pf
Enclosures a/s

APPENDIX 3
WATER AVAILABILITY TABLES
COLORADO RIVER BASIN
TABLES 1-6

(Pedernales River)

TABLE 1
COLORADO RIVER BASIN (RUN III)
ESTIMATE OF UNAPPROPRIATED WATER
CUMULATIVE AMOUNT IN ACRE-FEET IN SW (22,01) THRU (23,24) + (24,03) * .0165

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	0.	2769.	0.	0.	0.	18602.	21549.	0.	0.	0.	25675.	70554.	139149.
1941	16068.	48297.	57643.	69022.	75836.	23020.	9032.	0.	0.	6382.	2676.	1621.	309597.
1942	1966.	708.	480.	9149.	1994.	0.	0.	0.	0.	55346.	8096.	3130.	80869.
1943	33.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	33.
1944	0.	0.	2510.	0.	55946.	0.	0.	0.	0.	0.	655.	21139.	80250.
1945	26416.	24288.	44808.	41938.	0.	0.	0.	0.	0.	0.	0.	0.	137450.
1946	2038.	9449.	3590.	4205.	19199.	0.	0.	0.	0.	0.	0.	0.	38481.
1947	44273.	9791.	9080.	0.	0.	0.	0.	0.	0.	0.	0.	0.	63144.
1948	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1949	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1950	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1951	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1952	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1953	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1954	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1955	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1956	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1957	0.	0.	0.	0.	0.	5364.	0.	0.	0.	27343.	21790.	8747.	63244.
1958	12818.	46311.	29632.	1366.	25450.	25876.	0.	0.	0.	15656.	10466.	4374.	171949.
1959	2125.	4359.	1722.	9652.	0.	4224.	0.	0.	0.	134509.	5100.	22900.	184591.
1960	22866.	31083.	13181.	2547.	0.	0.	0.	0.	0.	6552.	5237.	27925.	109391.
1961	20041.	56012.	13807.	0.	0.	13701.	2322.	0.	0.	0.	0.	0.	105883.
1962	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1963	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1964	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1965	0.	0.	0.	0.	0.	0.	0.	0.	0.	5723.	4495.	20534.	30752.
1966	4590.	5253.	3804.	2421.	5359.	0.	0.	0.	0.	0.	0.	0.	21427.
1967	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1968	62618.	15918.	35388.	11903.	28267.	6780.	0.	0.	0.	0.	0.	0.	160874.
1969	0.	0.	0.	10828.	7363.	0.	0.	0.	0.	28199.	9210.	14984.	70584.
1970	7524.	11829.	43829.	928.	59862.	0.	0.	0.	0.	0.	0.	0.	123972.
1971	0.	0.	0.	0.	0.	0.	0.	0.	0.	24139.	2871.	6718.	33728.
1972	3558.	1386.	0.	0.	13414.	0.	0.	0.	0.	0.	0.	0.	18358.
AVERAGE	6877.	8105.	7863.	4968.	8869.	2957.	997.	0.	0.	9208.	2917.	6140.	58901.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM COLORADO RIVER BASIN WATER AVAILABILITY COMPUTER MODEL RUN III OF OCTOBER 1979 WHICH INCLUDED STACY PROJECT.
2. PLEASE REFER TO THE INTEROFFICE MEMORANDUM OF NOVEMBER 15, 1979 FOR THE ASSUMPTIONS AND CHANGES MADE IN THIS RUN.
3. A HIGH PRIORITY LCRA IRRIGATION WATER RIGHT OF 400,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FROM LAKE TRAVIS AND ANOTHER LCRA IRRIGATION WATER RIGHT FOR 362,000 ACRE-FEET PER YEAR WITH THE LOWEST PRIORITY HAS BEEN ASSUMED IN THE LAST SUBWATERSHED AT THE EXTREME DOWNSTREAM END OF BASIN.
4. A RELEASE OF 100,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FOR HYDROELECTRIC PURPOSE FROM LAKE TRAVIS DURING THE FOUR NON-IRRIGATION MONTHS OF JANUARY, FEBRUARY, NOVEMBER, AND DECEMBER AT A MONTHLY RATE OF 25,000 ACRE-FEET WITH 100 PERCENT RETURN FLOW.
5. PERMIT*UNAPP.C03$24-03CF
6. HDR INC.

[illegible signature] 6/11/84

FORM: 11LINE

(Pedernales River)

TABLE 2
COLORADO RIVER BASIN (RUN III)
ESTIMATE OF TOTAL RUNOFF
OUTFLOWS FROM (23,24) + STORM RUNOFF IN (24,03) * .0165

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	703.	8061.	8165.	22472.	11286.	43797.	28785.	1937.	2134.	6449.	36762.	70931.	241482.
1941	18304.	48667.	58020.	75167.	79926.	29039.	19264.	3762.	4873.	19335.	5720.	4522.	366599.
1942	4695.	3534.	4238.	13067.	5179.	5889.	3686.	16954.	11220.	55781.	10170.	5839.	140252.
1943	2320.	1635.	4825.	3945.	3712.	7307.	6578.	0.	768.	133.	312.	742.	32277.
1944	5520.	6004.	12309.	3291.	79026.	12829.	1739.	63491.	21138.	5085.	5110.	24499.	240041.
1945	28714.	26411.	48226.	49204.	15142.	8647.	2004.	1967.	25030.	13457.	4317.	6685.	229804.
1946	11784.	12514.	7968.	20523.	30905.	9080.	993.	935.	3350.	7909.	25503.	20818.	152282.
1947	45441.	15341.	14683.	12224.	8782.	6511.	626.	1668.	19.	44.	585.	1836.	107760.
1948	1019.	1598.	1188.	11054.	5771.	774.	3377.	837.	130.	446.	176.	471.	26841.
1949	798.	4563.	4796.	14124.	3797.	5487.	1736.	61.	1378.	391.	120.	1878.	39129.
1950	761.	2017.	157.	1170.	3585.	2850.	56.	338.	327.	0.	0.	15.	11276.
1951	43.	604.	2203.	156.	1627.	6819.	2351.	0.	406.	961.	742.	142.	16054.
1952	583.	0.	98.	5279.	16917.	5828.	5325.	3359.	394430.	1561.	2626.	26838.	462844.
1953	8294.	3085.	4954.	5810.	6517.	0.	0.	3551.	3084.	6158.	799.	754.	43006.
1954	1155.	190.	21.	2419.	1092.	0.	0.	0.	461.	2346.	74.	150.	7908.
1955	1531.	5424.	0.	0.	18976.	3078.	5076.	4645.	11084.	170.	207.	26.	50217.
1956	609.	285.	0.	0.	0.	0.	0.	73.	0.	933.	3218.	314.	5432.
1957	0.	0.	7568.	119579.	44262.	50600.	2740.	0.	13454.	31241.	22926.	12148.	304518.
1958	15524.	46666.	30647.	14022.	36538.	72490.	7612.	3691.	25957.	22414.	16496.	9595.	301652.
1959	7006.	8224.	7080.	25499.	10039.	36087.	4117.	1517.	3165.	154220.	10661.	25864.	293479.
1960	24703.	33933.	19333.	12358.	5764.	1753.	5593.	4614.	623.	30793.	9580.	29474.	178521.
1961	22610.	56385.	18133.	8159.	4001.	23841.	6937.	2310.	3319.	2850.	3766.	3647.	155958.
1962	2172.	4033.	1237.	4753.	7669.	14875.	55.	0.	1096.	3143.	894.	1171.	41098.
1963	1565.	845.	251.	1334.	2714.	240.	0.	0.	1329.	205.	8602.	1359.	18444.
1964	3555.	5581.	12420.	3127.	1006.	128.	0.	0.	8229.	652.	5933.	1098.	41729.
1965	1968.	31718.	4869.	7527.	61490.	27977.	1939.	34.	32708.	10736.	7317.	22581.	210864.
1966	8134.	8441.	7701.	16542.	12272.	2475.	2208.	947.	5869.	756.	727.	658.	66730.
1967	779.	5122.	385.	682.	4888.	61.	74.	0.	7998.	17652.	8301.	4086.	50028.
1968	108784.	17871.	35832.	22262.	37260.	16947.	12688.	1217.	3187.	2313.	2569.	5090.	266020.
1969	2829.	3053.	6978.	20824.	22517.	10566.	3747.	5364.	3714.	55079.	13251.	19201.	167123.
1970	11179.	14345.	44399.	14504.	81602.	18379.	3603.	1620.	18767.	2969.	1627.	1939.	214933.
1971	1685.	1435.	1434.	466.	284.	95.	167.	18435.	1940.	50360.	6590.	9554.	92445.
1972	7468.	4889.	4141.	6190.	38840.	20028.	3450.	3694.	1446.	2800.	3631.	2465.	99042.
AVERAGE	10674.	11590.	11341.	15689.	20102.	13469.	4137.	4455.	18565.	15434.	6646.	9588.	141690.

REMARKS:
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3. A HIGH PRIORITY LCRA IRRIGATION WATER RIGHT OF 400,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FROM LAKE TRAVIS AND ANOTHER LCRA IRRIGATION WATER RIGHT FOR 362,000 ACRE-FEET PER YEAR WITH THE LOWEST PRIORITY HAS BEEN ASSUMED IN THE LAST SUBWATERSHED AT THE EXTREME DOWNSTREAM END OF BASIN.
4. A RELEASE OF 100,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FOR HYDROELECTRIC PURPOSE FROM LAKE TRAVIS DURING THE FOUR NON-IRRIGATION MONTHS OF JANUARY, FEBRUARY, NOVEMBER, AND DECEMBER AT A MONTHLY RATE OF 25,000 ACRE-FEET WITH 100 PERCENT RETURN FLOW.
5. PERMIT*RUNOFF.CO3$24-03CF
6. HDR INC.

6/11/88

FORM: 11LINE

(Barton Creek)

TABLE 3
COLORADO RIVER BASIN (RUN III)
ESTIMATE OF UNAPPROPRIATED WATER
CUMULATIVE AMOUNT IN ACRE-FEET IN SW (25,06) * .46940

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	0.	171.	0.	0.	0.	1659.	4310.	0.	0.	0.	5452.	6770.	18363.
1941	1866.	3727.	4408.	3788.	5677.	2815.	2459.	0.	0.	907.	380.	191.	26218.
1942	356.	188.	145.	1000.	131.	0.	0.	0.	0.	3378.	1330.	499.	7027.
1943	1637.	2296.	2859.	0.	0.	0.	0.	0.	0.	0.	839.	346.	7977.
1944	925.	2972.	3919.	0.	3707.	0.	0.	0.	0.	0.	1180.	3705.	16408.
1945	5134.	3359.	4247.	7775.	0.	0.	0.	0.	0.	806.	313.	1586.	23220.
1946	3274.	4701.	5024.	1672.	6510.	0.	0.	0.	0.	366.	10263.	5427.	37235.
1947	7455.	1569.	1122.	0.	0.	0.	0.	0.	0.	0.	273.	583.	11002.
1948	242.	0.	378.	0.	0.	0.	0.	0.	0.	0.	343.	704.	1667.
1949	358.	455.	0.	0.	0.	0.	0.	0.	0.	0.	600.	860.	2273.
1950	784.	1241.	0.	0.	0.	0.	0.	0.	0.	0.	172.	246.	2442.
1951	100.	315.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	415.
1952	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1451.	555.	2005.
1953	1336.	2434.	0.	0.	0.	0.	0.	0.	0.	0.	474.	1868.	6113.
1954	3632.	688.	0.	0.	0.	0.	0.	0.	0.	0.	58.	0.	4378.
1955	216.	508.	0.	0.	0.	0.	0.	0.	0.	0.	634.	55.	1413.
1956	219.	2648.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2867.
1957	5.	263.	0.	4438.	0.	11359.	0.	0.	0.	12120.	8607.	6369.	43161.
1958	7360.	10601.	3962.	368.	9265.	4070.	0.	0.	0.	4875.	3611.	1717.	45829.
1959	3904.	0.	1243.	4054.	0.	536.	0.	0.	0.	14453.	4486.	3455.	32130.
1960	4460.	6435.	1950.	1634.	0.	0.	0.	0.	0.	7235.	2704.	6035.	30452.
1961	7686.	6463.	4508.	0.	0.	3053.	6068.	0.	0.	312.	2485.	2110.	32684.
1962	3925.	0.	0.	0.	0.	0.	0.	0.	0.	0.	238.	884.	5047.
1963	860.	4110.	0.	0.	0.	0.	0.	0.	0.	0.	20.	89.	5079.
1964	200.	214.	0.	0.	0.	0.	0.	0.	0.	0.	294.	248.	957.
1965	1902.	6628.	1031.	0.	11632.	3636.	0.	0.	0.	1526.	2421.	7431.	36207.
1966	2504.	1229.	2996.	1226.	5694.	0.	0.	0.	0.	0.	117.	108.	13873.
1967	172.	893.	0.	0.	0.	0.	0.	0.	0.	2050.	6502.	2810.	12427.
1968	15808.	5805.	2809.	3341.	4543.	2613.	0.	0.	0.	0.	245.	1857.	37021.
1969	365.	950.	0.	3551.	3221.	0.	0.	0.	0.	0.	511.	2359.	10955.
1970	1428.	7858.	2446.	309.	4561.	0.	0.	0.	0.	0.	208.	205.	17014.
1971	224.	152.	0.	0.	0.	0.	0.	0.	0.	0.	447.	1612.	2436.
1972	2916.	0.	0.	0.	2024.	0.	0.	0.	0.	329.	777.	678.	6726.
AVERAGE	2462.	2390.	1304.	1005.	1726.	901.	389.	0.	0.	1465.	1740.	1859.	15243.

REMARKS:
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2. PLEASE REFER TO THE INTEROFFICE MEMORANDUM OF NOVEMBER 15, 1979 FOR THE ASSUMPTIONS AND CHANGES MADE IN THIS RUN.
3. A HIGH PRIORITY LCRA IRRIGATION WATER RIGHT OF 400,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FROM LAKE TRAVIS AND ANOTHER LCRA IRRIGATION WATER RIGHT FOR 362,000 ACRE-FEET PER YEAR WITH THE LOWEST PRIORITY HAS BEEN ASSUMED IN THE LAST SUBWATERSHED AT THE EXTREME DOWNSTREAM END OF BASIN.
4. A RELEASE OF 100,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FOR HYDROELECTRIC PURPOSE FROM LAKE TRAVIS DURING THE FOUR NON-IRRIGATION MONTHS OF JANUARY, FEBRUARY, NOVEMBER, AND DECEMBER AT A MONTHLY RATE OF 25,000 ACRE-FEET WITH 100 PERCENT RETURN FLOW.
5. PERMIT*UNAPP.C03$25-06F
6. HDR INC.

(Barton Creek)

TABLE 4
COLORADO RIVER BASIN (RUN III)
ESTIMATE OF STORM RUNOFF
CUMULATIVE AMOUNT IN ACRE-FEET IN SW (25,06) * .46940

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	0.	234.	145.	1133.	585.	2044.	4310.	330.	438.	96.	5452.	6770.	21537.
1941	1866.	3727.	4408.	3788.	5677.	2815.	2602.	571.	443.	1084.	569.	338.	27888.
1942	488.	320.	578.	1000.	182.	841.	399.	256.	1348.	3378.	1330.	634.	10754.
1943	2434.	2883.	4290.	2738.	2708.	3073.	2677.	703.	1806.	1775.	2006.	1064.	28157.
1944	1658.	3470.	4315.	2618.	3707.	2934.	642.	2632.	3098.	0.	2139.	3705.	30918.
1945	5134.	3359.	4247.	7775.	4052.	4526.	1745.	1776.	1668.	2973.	1199.	2643.	41096.
1946	3586.	4701.	5106.	3738.	6510.	3146.	1533.	767.	1783.	2463.	10263.	5962.	49558.
1947	7455.	1569.	1154.	2479.	1704.	870.	0.	1582.	1082.	1113.	1082.	1409.	21499.
1948	628.	0.	1987.	1005.	1514.	1530.	1389.	1067.	1048.	1267.	1211.	1570.	14216.
1949	834.	851.	898.	1571.	957.	1408.	0.	908.	594.	692.	1603.	1767.	12083.
1950	1440.	1797.	1046.	2633.	3476.	1566.	1843.	1535.	891.	968.	850.	818.	18863.
1951	320.	629.	817.	1212.	3062.	2722.	2030.	3189.	1397.	319.	431.	363.	16490.
1952	387.	473.	420.	705.	868.	1487.	2138.	1336.	948.	830.	2631.	1339.	13562.
1953	2065.	2935.	0.	1206.	2302.	2417.	1805.	1510.	1900.	1730.	1403.	2854.	22127.
1954	4162.	1131.	0.	493.	944.	574.	1148.	773.	820.	491.	475.	0.	11011.
1955	562.	902.	0.	677.	3242.	2842.	593.	2421.	89.	1527.	1586.	291.	14732.
1956	562.	3090.	0.	544.	1132.	2488.	3051.	1776.	511.	880.	673.	465.	15171.
1957	305.	568.	1043.	6469.	0.	11359.	4926.	2749.	3375.	12120.	8607.	6369.	57890.
1958	7360.	10601.	3962.	1281.	9265.	6299.	1589.	1020.	2762.	4875.	3611.	1953.	54578.
1959	3981.	0.	2057.	4054.	3129.	1842.	2332.	3279.	1592.	14453.	4557.	3455.	44731.
1960	4460.	6435.	1950.	2219.	1647.	1034.	816.	2171.	1098.	7235.	2855.	6035.	37954.
1961	7686.	6463.	4508.	4568.	3112.	3053.	6978.	3489.	3524.	1971.	3590.	3016.	51959.
1962	4278.	0.	488.	849.	983.	2794.	1503.	1070.	1165.	1478.	884.	1682.	17174.
1963	1448.	4270.	0.	1730.	1304.	1240.	906.	681.	1483.	0.	227.	361.	13650.
1964	493.	435.	514.	790.	1333.	1742.	810.	495.	1119.	622.	1007.	743.	10104.
1965	2551.	6628.	2487.	2829.	11998.	9417.	2691.	1695.	2027.	1765.	2529.	7431.	54049.
1966	2504.	1229.	3160.	4466.	5694.	3435.	2297.	2253.	1196.	542.	575.	406.	27756.
1967	432.	1464.	1400.	0.	1508.	927.	731.	921.	2065.	3782.	6818.	3611.	23659.
1968	15808.	5806.	2809.	3358.	4543.	2613.	3223.	2763.	2340.	1133.	814.	3179.	48389.
1969	720.	1337.	0.	3551.	3912.	2495.	1476.	2114.	1359.	0.	511.	2359.	19834.
1970	1428.	7858.	2446.	1628.	4561.	1883.	988.	911.	1546.	1436.	755.	577.	26017.
1971	521.	286.	476.	112.	0.	0.	0.	1345.	639.	0.	604.	1612.	5595.
1972	2919.	0.	62.	0.	2043.	1574.	793.	1001.	593.	1772.	1628.	1319.	13704.
AVERAGE	2742.	2589.	1720.	2219.	2959.	2697.	1817.	1548.	1447.	2266.	2257.	2306.	26567.

REMARKS:
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5. PERMIT*RUNOFF.C03$25-06F
6. HDR INC.

6/15/88

FORM 11LINE

(Onion Creek)

TABLE 5
COLORADO RIVER BASIN (RUN III)
ESTIMATE OF UNAPPROPRIATED WATER
CUMULATIVE AMOUNT IN ACRE-FEET IN SW (26,07) THRU (26,09) + (26,10) * .9700

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	258.	823.	0.	0.	0.	3396.	5505.	0.	0.	206.	4274.	6534.	20996.
1941	1822.	1286.	3181.	2959.	10963.	15454.	3459.	0.	0.	1167.	183.	453.	40928.
1942	0.	322.	0.	1959.	0.	0.	996.	0.	2571.	1043.	332.	442.	7667.
1943	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1944	2171.	1734.	2469.	0.	2685.	0.	0.	0.	0.	851.	1078.	3472.	14458.
1945	3539.	3074.	2180.	2936.	0.	0.	0.	0.	0.	721.	0.	358.	12807.
1946	1422.	1480.	2940.	2714.	3796.	1911.	293.	0.	2038.	0.	7240.	2137.	25970.
1947	4516.	1429.	2694.	0.	0.	0.	0.	0.	0.	23.	274.	113.	9048.
1948	686.	808.	0.	0.	0.	0.	0.	0.	0.	0.	208.	145.	1847.
1949	529.	994.	514.	7103.	0.	0.	0.	0.	0.	3428.	0.	0.	12568.
1950	0.	1492.	141.	2663.	0.	2741.	0.	0.	0.	0.	0.	0.	7036.
1951	0.	665.	0.	0.	0.	0.	0.	0.	0.	0.	199.	98.	962.
1952	103.	46.	0.	0.	300.	0.	0.	0.	0.	7.	1159.	855.	2470.
1953	0.	811.	704.	0.	0.	0.	0.	0.	292.	3551.	432.	3619.	9409.
1954	232.	111.	0.	0.	0.	0.	0.	0.	0.	30.	1.	68.	442.
1955	265.	1044.	0.	0.	0.	0.	0.	0.	0.	846.	0.	496.	2652.
1956	118.	417.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	535.
1957	0.	67.	1494.	12714.	0.	14257.	0.	0.	3719.	11079.	3751.	2121.	49202.
1958	3696.	13152.	5337.	2266.	5311.	1243.	0.	0.	4799.	1798.	1550.	443.	39594.
1959	0.	1570.	327.	2787.	0.	464.	0.	0.	0.	2579.	1498.	543.	9769.
1960	971.	1385.	1284.	3021.	473.	5421.	569.	0.	0.	15013.	4347.	5305.	37789.
1961	5271.	5965.	786.	0.	0.	12187.	7910.	0.	4083.	367.	896.	1680.	39145.
1962	1925.	482.	805.	0.	0.	0.	0.	0.	0.	1142.	247.	1341.	5942.
1963	71.	1901.	85.	0.	0.	0.	0.	0.	0.	452.	207.	209.	2924.
1964	153.	209.	309.	0.	0.	0.	0.	0.	0.	703.	579.	317.	2270.
1965	5972.	7940.	819.	0.	9804.	1871.	371.	0.	0.	439.	2329.	5425.	34970.
1966	1180.	1942.	843.	531.	3622.	0.	0.	0.	0.	406.	376.	341.	9240.
1967	305.	0.	0.	0.	0.	0.	0.	0.	3365.	1298.	2510.	379.	7857.
1968	14617.	3223.	3767.	4357.	7753.	6325.	2165.	0.	1651.	570.	961.	2357.	47746.
1969	1019.	3168.	3409.	3618.	1951.	0.	0.	0.	0.	0.	1939.	2298.	17401.
1970	1792.	3575.	4805.	899.	8392.	0.	0.	0.	269.	1612.	504.	366.	22215.
1971	237.	195.	0.	0.	0.	0.	0.	0.	1212.	184.	1961.	2931.	6721.
1972	1170.	424.	415.	0.	2805.	0.	0.	0.	0.	595.	287.	274.	5970.
AVERAGE	1638.	1871.	1191.	1531.	1753.	1978.	644.	0.	727.	1518.	1192.	1367.	15411.

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5. PERMIT*UNAPP.CO3$26-10CF
6. HDR INC.

6/15/88

FORM: 11LINE

(Onion Creek)

TABLE 6
COLORADO-RIVER BASIN (RUN III)
ESTIMATE OF TOTAL RUNOFF
OUTFLOWS FROM (26,08) + (26,09) + STORM RUNOFF IN (26,10) * .9730

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	262.	823.	0.	1099.	1161.	3397.	5523.	131.	593.	214.	4270.	6532.	24005.
1941	1824.	1286.	3182.	2960.	10966.	15460.	3475.	810.	0.	1185.	189.	454.	41791.
1942	0.	329.	0.	1964.	0.	0.	1025.	0.	3088.	1047.	337.	443.	8233.
1943	0.	0.	0.	0.	381.	0.	0.	0.	204.	0.	0.	0.	585.
1944	2181.	1733.	2470.	123.	2686.	1031.	173.	294.	148.	862.	1074.	3468.	16243.
1945	3538.	3074.	2182.	2938.	15.	1550.	0.	630.	0.	739.	8.	358.	15032.
1946	1420.	1482.	2942.	3036.	3800.	1925.	316.	382.	2058.	0.	7247.	2137.	26745.
1947	4514.	1434.	2697.	1761.	880.	210.	429.	1206.	369.	79.	278.	112.	13969.
1948	687.	808.	0.	0.	46.	0.	0.	65.	166.	3.	225.	148.	2148.
1949	526.	994.	518.	7102.	399.	223.	276.	0.	400.	3435.	0.	0.	13872.
1950	0.	1500.	147.	2836.	447.	2752.	448.	9.	552.	0.	0.	0.	8693.
1951	0.	694.	515.	0.	0.	1796.	0.	0.	231.	224.	204.	149.	3813.
1952	136.	49.	80.	15.	594.	0.	0.	0.	0.	87.	1158.	853.	2972.
1953	0.	818.	708.	4077.	0.	0.	0.	0.	491.	3552.	436.	3618.	13700.
1954	236.	118.	0.	0.	0.	0.	0.	122.	114.	121.	9.	73.	793.
1955	266.	1044.	108.	0.	2345.	0.	143.	0.	0.	887.	0.	507.	5300.
1956	120.	419.	79.	0.	371.	0.	0.	0.	35.	0.	14.	56.	1094.
1957	2.	82.	1496.	12708.	2361.	14266.	1356.	382.	3729.	11079.	3751.	2123.	53334.
1958	3698.	13149.	5340.	3970.	5319.	1256.	2197.	1286.	4803.	1803.	1554.	444.	44819.
1959	0.	1574.	335.	2790.	570.	772.	0.	38.	521.	2587.	1501.	542.	11230.
1960	972.	1386.	1289.	3026.	483.	5433.	1123.	725.	37.	15012.	4349.	5303.	39138.
1961	5271.	5965.	792.	824.	592.	12192.	7925.	1167.	4090.	376.	898.	1681.	41773.
1962	1927.	487.	813.	602.	1081.	2040.	851.	1332.	1913.	1149.	251.	1342.	13788.
1963	74.	1904.	95.	717.	0.	62.	140.	578.	1151.	465.	212.	211.	5609.
1964	155.	211.	314.	0.	0.	1760.	754.	15.	2070.	714.	583.	319.	6895.
1965	5972.	7939.	825.	131.	9804.	2754.	642.	0.	884.	447.	2331.	5422.	37151.
1966	1180.	1942.	849.	964.	3624.	232.	180.	641.	873.	418.	385.	344.	11632.
1967	310.	0.	42.	0.	1183.	1000.	548.	559.	3376.	1305.	2511.	379.	11213.
1968	14611.	3225.	3771.	4361.	7755.	6334.	2184.	0.	1678.	582.	963.	2358.	47822.
1969	1022.	3168.	3410.	3620.	1957.	0.	0.	53.	470.	0.	1949.	2296.	17945.
1970	1794.	3574.	4806.	2475.	8395.	1646.	635.	279.	872.	1615.	513.	371.	26975.
1971	242.	199.	229.	11.	468.	438.	37.	884.	1221.	138.	1964.	2927.	8808.
1972	1172.	430.	426.	1280.	2806.	1045.	474.	418.	778.	600.	288.	276.	9993.
AVERAGE	1640.	1874.	1226.	1981.	3136.	2411.	935.	364.	1119.	1539.	1195.	1371.	17791.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM COLORADO RIVER BASIN WATER AVAILABILITY COMPUTER MODEL RUN III OF OCTOBER 1979 WHICH INCLUDED STACY PROJECT.
2. PLEASE REFER TO THE INTEROFFICE MEMORANDUM OF NOVEMBER 15, 1979 FOR THE ASSUMPTIONS AND CHANGES MADE IN THIS RUN.
3. A HIGH PRIORITY LCRA IRRIGATION WATER RIGHT OF 400,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FROM LAKE TRAVIS AND ANOTHER LCRA IRRIGATION WATER RIGHT FOR 362,000 ACRE-FEET PER YEAR WITH THE LOWEST PRIORITY HAS BEEN ASSUMED IN THE LAST SUBWATERSHED AT THE EXTREME DOWNSTREAM END OF BASIN.
4. A RELEASE OF 100,000 ACRE-FEET PER ANNUM HAS BEEN ASSUMED FOR HYDROELECTRIC PURPOSE FROM LAKE TRAVIS DURING THE FOUR NON-IRRIGATION MONTHS OF JANUARY, FEBRUARY, NOVEMBER, AND DECEMBER AT A MONTHLY RATE OF 25,000 ACRE-FEET WITH 100 PERCENT RETURN FLOW.
5. PERMIT*RUNOFF.CO3126-10CF
6. HDR INC.

6/11/88

APPENDIX 3
WATER AVAILABILITY TABLES
GUADALUPE RIVER BASIN
TABLES 1, 2 AND 7 THROUGH 10

SAN MARCOS

(San Marcos River)

TABLE 1

GUADALUPE RIVER BASIN (RUN I - REVISED 3/83)

ESTIMATE OF UNAPPROPRIATED WATER

CUMULATIVE AMOUNT IN ACRE-FEET IN SW (10.01) THRU (11.07)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	5452.	4850.	4789.	7659.	4407.	16578.	8092.	3747.	2045.	4965.	17236.	42148.	121966.
1941	20478.	39343.	52940.	66216.	72121.	55607.	27460.	15539.	11485.	16097.	10809.	10526.	398622.
1942	9408.	7291.	7456.	19843.	12839.	8594.	24669.	8799.	47075.	37200.	24731.	19462.	227367.
1943	16630.	13132.	14192.	12674.	11348.	10193.	8261.	4866.	7258.	6195.	7076.	7711.	119535.
1944	14843.	24314.	41811.	27040.	39912.	30716.	18921.	16954.	20640.	11551.	13326.	28451.	288478.
1945	36407.	41074.	57590.	39721.	22085.	16412.	9208.	8087.	6991.	10867.	9056.	12243.	269740.
1946	15864.	71823.	33725.	21397.	18907.	16190.	7285.	12074.	18646.	16800.	45096.	39278.	267083.
1947	49099.	34280.	28683.	22603.	18829.	13470.	8046.	14500.	5485.	5369.	6604.	7170.	214138.
1948	7612.	7720.	7159.	3583.	9423.	2438.	3137.	3693.	839.	3887.	2800.	2358.	54647.
1949	4655.	10947.	8380.	39005.	19058.	10631.	6342.	3996.	3060.	19195.	6644.	7154.	139066.
1950	7051.	8358.	6215.	11364.	8015.	13796.	1396.	439.	692.	1932.	2206.	2002.	63467.
1951	3241.	2284.	1607.	547.	3327.	12795.	0.	0.	1095.	982.	1858.	1698.	29435.
1952	2658.	1598.	415.	2940.	12051.	8680.	0.	0.	76416.	9482.	10801.	14271.	139312.
1953	16978.	10645.	7351.	19348.	9301.	0.	0.	4071.	17965.	11598.	10025.	15940.	123224.
1954	10501.	5001.	3129.	2068.	6500.	0.	0.	0.	0.	0.	0.	493.	27692.
1955	1575.	5902.	801.	0.	8180.	4900.	0.	0.	0.	0.	0.	0.	21357.
1956	518.	371.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2206.	3095.
1957	12701.	9526.	25371.	58439.	42343.	44616.	3730.	0.	17186.	54921.	31295.	22223.	322351.
1958	32734.	58228.	50892.	35471.	85002.	31357.	15973.	8646.	21315.	22411.	29287.	21785.	413101.
1959	17425.	17820.	17668.	29022.	20257.	15760.	12174.	9277.	6222.	34473.	14657.	15684.	210439.
1960	21000.	24546.	21280.	28529.	17736.	31147.	16782.	15043.	11550.	65101.	36118.	50755.	339588.
1961	50792.	70646.	38734.	23237.	16925.	39768.	20681.	14468.	11595.	11189.	13905.	11954.	323892.
1962	10903.	8958.	8794.	8390.	6664.	10190.	660.	0.	7087.	8157.	7961.	10115.	87881.
1963	9607.	9262.	7547.	8306.	4976.	0.	0.	0.	0.	0.	5405.	2696.	47796.
1964	4413.	5799.	7991.	4837.	2859.	4650.	0.	628.	6491.	6381.	9413.	4828.	58288.
1965	13144.	38867.	20904.	28988.	68024.	52069.	16281.	9999.	7370.	15343.	13694.	35860.	320543.
1966	23185.	22196.	23994.	24085.	24994.	15164.	8071.	6492.	8908.	10237.	7493.	6868.	181686.
1967	7674.	4908.	5003.	2644.	1375.	140.	0.	82.	13545.	10286.	19490.	12523.	77671.
1968	94378.	34241.	36201.	37293.	36618.	25356.	17152.	11355.	11345.	10692.	11497.	15084.	341212.
1969	11147.	15249.	19164.	25671.	35409.	22110.	10862.	8210.	8350.	12498.	10717.	16996.	196383.
1970	15703.	23297.	39491.	24514.	66371.	39645.	19464.	15444.	12689.	14952.	11348.	10458.	293376.
1971	9387.	7698.	7608.	6434.	4635.	2512.	206.	4553.	7203.	6984.	10129.	22705.	90053.
1972	15155.	11592.	10299.	8454.	57416.	22285.	13670.	11833.	8509.	10497.	12972.	11746.	194429.
1973	16219.	23594.	29574.	34217.	26691.	56154.	60892.	28289.	25213.	94101.	41953.	26062.	462959.
1974	24698.	18002.	16866.	14362.	19101.	13129.	8909.	13849.	28270.	15958.	48204.	33998.	255345.
1975	27774.	58037.	28053.	22873.	81894.	60517.	42244.	25642.	17096.	16533.	14728.	14192.	409583.
1976	12392.	10427.	11410.	42505.	60779.	41138.	37695.	22225.	17205.	40168.	48498.	49033.	393477.
1977	42054.	45601.	33693.	86555.	49212.	27837.	17478.	12520.	10834.	11386.	12644.	10720.	360534.
1978	10556.	10042.	9579.	8095.	7443.	9915.	3650.	6084.	9490.	8022.	13484.	12900.	109259.
1979	35257.	36433.	54944.	62472.	54388.	29494.	21885.	19657.	13920.	11685.	10862.	10158.	361154.
AVERAGE	18532.	20098.	20033.	23035.	26685.	20399.	11782.	8526.	12527.	16202.	15100.	16061.	208981.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM THE REVISED GUADALUPE/SAN ANTONIO RIVER BASIN WATER AVAILABILITY MODEL RUN I OF MARCH, 1983.
2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.
3. PERMIT•UNAPP.RG1$11-07C
4. HDR INC.

FORM: 11LINE

(San Marcos River)

TABLE 2

GUADALUPE RIVER BASIN (RUN I - REVISED 4/83)

ESTIMATE OF TOTAL RUNOFF

OUTFLOWS FROM 11,03 & 11,06 + STORM RUNOFF & BASE FLOW IN 11,07

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	5453.	5503.	6508.	8913.	5993.	16636.	8178.	5935.	5566.	5602.	17237.	42149.	133673.
1941	20478.	39342.	52960.	66257.	72192.	55666.	27546.	15556.	11516.	16115.	10809.	10526.	398963.
1942	9408.	7617.	8134.	19884.	12912.	9079.	24756.	9465.	47106.	37217.	24731.	19461.	229770.
1943	16631.	13132.	14213.	13589.	11631.	10251.	10566.	7306.	9382.	7578.	7767.	8312.	130358.
1944	14842.	24315.	41831.	27081.	39984.	30774.	19007.	21061.	20670.	12038.	13327.	28451.	293381.
1945	36408.	41074.	57610.	39761.	22157.	16637.	13112.	10648.	9238.	10885.	9057.	12875.	279462.
1946	15863.	21823.	33745.	21438.	18978.	16248.	10412.	12091.	18677.	16817.	45096.	39279.	270467.
1947	49099.	34280.	28703.	22645.	18902.	13543.	10456.	14518.	8431.	8165.	7571.	8058.	224371.
1948	7612.	7720.	7624.	6297.	9495.	5658.	5484.	5031.	4778.	7127.	5328.	5457.	77611.
1949	5987.	10947.	8400.	39045.	19131.	10688.	8011.	6390.	5526.	19213.	6644.	7154.	147136.
1950	7051.	8358.	7442.	11405.	9728.	13855.	6195.	5411.	5473.	4944.	4785.	4844.	89491.
1951	4796.	4693.	5037.	4660.	5537.	12853.	4419.	4045.	4934.	4365.	4668.	4876.	64883.
1952	4602.	4195.	4638.	6125.	12124.	9403.	5494.	4772.	86313.	9735.	10802.	14271.	172474.
1953	16977.	11056.	9665.	19389.	9373.	6805.	5184.	7439.	18311.	11615.	11497.	15940.	143251.
1954	11590.	9007.	8725.	7116.	7779.	4651.	3904.	3915.	3653.	4038.	4205.	4675.	73258.
1955	4375.	5902.	5173.	4486.	11081.	6151.	3933.	4222.	3655.	3188.	3282.	4507.	59955.
1956	4535.	4309.	4006.	3336.	4304.	2696.	2862.	3289.	3855.	5616.	5040.	4750.	48598.
1957	12759.	11040.	25392.	62638.	42415.	44674.	5344.	3910.	17218.	54938.	31295.	22223.	333846.
1958	32734.	58228.	50912.	35511.	85074.	31414.	17106.	11789.	21346.	22427.	29287.	21785.	417613.
1959	17426.	17820.	17689.	29063.	20330.	16439.	12259.	11493.	8803.	34491.	14657.	15684.	216154.
1960	21001.	24546.	21300.	28570.	17807.	31205.	16868.	16322.	11626.	65118.	36118.	50756.	341237.
1961	50792.	70645.	38753.	23278.	16998.	39825.	20767.	14484.	11626.	11206.	13905.	11954.	324233.
1962	10903.	8958.	9314.	9085.	8420.	15046.	7903.	5981.	9518.	9847.	8302.	10115.	113392.
1963	9606.	9262.	8445.	12063.	8012.	5667.	4928.	4474.	4361.	4634.	5405.	5638.	82495.
1964	5955.	5799.	8011.	6526.	5803.	6356.	5289.	4513.	6888.	6398.	9413.	7291.	78242.
1965	13143.	38867.	20924.	29029.	68095.	52128.	17465.	12903.	11824.	15360.	13694.	35860.	329292.
1966	23185.	22195.	24015.	24126.	25066.	15222.	11080.	9039.	10488.	10254.	8343.	8222.	191235.
1967	7768.	6614.	7074.	6167.	5901.	4242.	3732.	4090.	13576.	10303.	19491.	12523.	101481.
1968	94378.	34241.	36221.	37334.	36690.	25414.	17238.	12473.	11376.	10709.	11497.	15083.	342654.
1969	11148.	15250.	19184.	25713.	35481.	22169.	13968.	11316.	10509.	12516.	10717.	16996.	204967.
1970	15704.	23297.	39511.	24554.	66444.	39703.	20286.	15461.	12720.	14970.	11348.	10458.	294456.
1971	9387.	7698.	7628.	6476.	6202.	5138.	4369.	7295.	7234.	7266.	10129.	22705.	101527.
1972	15155.	11592.	10319.	8495.	57487.	22343.	13757.	11850.	8541.	10514.	12971.	11746.	194770.
1973	16219.	23593.	29594.	34259.	26763.	56212.	67506.	28306.	25243.	94117.	41952.	26062.	469826.
1974	24697.	18002.	16886.	14404.	19172.	13187.	8996.	13891.	28301.	15975.	48204.	33998.	255713.
1975	27774.	58037.	28073.	22914.	81966.	60575.	42330.	25659.	17126.	16551.	14728.	14192.	409925.
1976	12393.	10426.	11430.	42546.	60851.	41196.	37781.	22242.	17235.	40186.	48499.	49033.	393818.
1977	42053.	45601.	33713.	86596.	49284.	27895.	17565.	12537.	10865.	11403.	12644.	10720.	360876.
1978	10556.	10043.	9598.	8136.	7606.	9989.	5287.	6101.	10039.	8039.	13484.	12899.	111777.
1979	35256.	36433.	54964.	62514.	54460.	29552.	21971.	19673.	13951.	11702.	10863.	11516.	362855.
AVERAGE	18892.	20537.	20834.	24036.	27441.	21430.	14083.	10672.	14187.	17080.	15720.	16826.	221737.

REMARKS: 1. THESE ESTIMATES ARE OBTAINED FROM THE REVISED GUADALUPE/SAN ANTONIO RIVER BASIN WATER AVAILABILITY MODEL RUN I OF MARCH, 1983.

2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.

3. PERMIT+RUNOFF.RG1$11-07C

4. HDR INC.

7/7/1988

FORM: 11LINE

(Blanco River at Wimberley)

TABLE 7
GUADALUPE RIVER BASIN (RUN I - REVISED 3/83)
ESTIMATE OF UNAPPROPRIATED WATER
CUMULATIVE AMOUNT IN ACRE-FEET IN SW (10,01) THRU (10,10)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	539.	759.	1363.	3231.	818.	3953.	2520.	858.	429.	279.	7288.	23720.	45757.
1941	7599.	27350.	33705.	32088.	43230.	34373.	10343.	3355.	2235.	5968.	2505.	2039.	204790.
1942	1751.	1675.	1725.	11899.	4483.	2449.	1576.	3520.	21561.	15169.	9372.	6459.	81639.
1943	5136.	3491.	4282.	5354.	3366.	2542.	3398.	1266.	2701.	1402.	1155.	1123.	35217.
1944	5068.	13222.	21035.	11192.	18270.	12733.	4567.	7698.	10000.	2700.	2962.	14706.	124151.
1945	19861.	21386.	29588.	15856.	7264.	5391.	3034.	1887.	1856.	3027.	1928.	5770.	116849.
1946	6065.	10487.	16075.	8115.	7093.	4811.	2205.	1946.	3271.	4529.	28679.	19264.	112541.
1947	23407.	12903.	9204.	6522.	4821.	3028.	1774.	1564.	1119.	1155.	1150.	1219.	67867.
1948	1126.	1107.	877.	729.	3595.	611.	685.	507.	136.	1397.	598.	510.	11878.
1949	897.	2390.	2806.	16494.	10343.	3084.	1655.	1043.	693.	909.	764.	931.	42009.
1950	847.	1562.	963.	2510.	3459.	2333.	330.	92.	138.	371.	466.	404.	13478.
1951	537.	478.	357.	110.	806.	2907.	0.	0.	244.	140.	331.	302.	6213.
1952	397.	301.	75.	1202.	5711.	4380.	0.	0.	72022.	3566.	2700.	4675.	95030.
1953	7355.	3876.	3196.	4952.	3031.	0.	0.	2014.	12065.	3593.	3666.	4240.	47988.
1954	2718.	1508.	831.	492.	865.	0.	0.	0.	0.	0.	0.	94.	6508.
1955	371.	776.	140.	0.	4840.	835.	0.	0.	0.	0.	0.	0.	6961.
1956	84.	66.	0.	0.	0.	0.	0.	0.	0.	0.	0.	902.	1052.
1957	494.	1304.	11132.	50724.	19349.	20861.	2254.	0.	13449.	27803.	22576.	15012.	184959.
1958	14297.	26634.	27969.	13788.	62481.	17941.	6082.	2953.	9300.	9531.	13662.	6704.	211343.
1959	4998.	6580.	6448.	12462.	7074.	6533.	3510.	3490.	2118.	22081.	4477.	5951.	85724.
1960	9756.	12201.	9362.	8004.	5544.	3682.	5298.	5602.	3033.	44730.	18209.	26177.	151600.
1961	22750.	49261.	19201.	8208.	4939.	22486.	9188.	5083.	4131.	3728.	3363.	3245.	155584.
1962	3035.	2376.	2530.	2614.	2426.	6799.	254.	0.	2382.	1630.	1421.	2713.	28181.
1963	2163.	1851.	1813.	4494.	1798.	0.	0.	0.	0.	0.	673.	606.	13399.
1964	696.	1071.	2525.	1490.	786.	1041.	0.	118.	2150.	1694.	3409.	1375.	16353.
1965	3227.	20141.	7343.	13251.	43831.	32632.	6050.	3834.	3333.	8360.	5925.	21510.	169437.
1966	11025.	10863.	11484.	13566.	13331.	5720.	3275.	2655.	4600.	3116.	2260.	2029.	83921.
1967	1859.	1499.	1465.	832.	451.	42.	0.	17.	2817.	4168.	8307.	4848.	26305.
1968	66257.	18909.	16125.	13708.	18267.	9678.	5395.	3193.	3289.	2840.	2288.	3322.	163272.
1969	2506.	3338.	5485.	9634.	16775.	9422.	4000.	2900.	2730.	5453.	3702.	7470.	73415.
1970	6518.	11530.	24053.	10836.	29807.	16252.	5459.	3389.	2999.	3172.	2178.	2062.	118254.
1971	1672.	1344.	1367.	1227.	1021.	536.	32.	1071.	947.	3686.	4640.	10838.	28382.
1972	5788.	3679.	3025.	2109.	16129.	8519.	4403.	3782.	2295.	3816.	5654.	4607.	63805.
1973	7221.	12095.	13540.	13854.	12296.	33789.	49254.	12205.	7945.	53594.	17629.	8897.	242318.
1974	6904.	5989.	5263.	4183.	4273.	2887.	1889.	4339.	7289.	6208.	13402.	8821.	71447.
1975	10610.	37862.	12366.	9167.	33362.	32665.	17406.	8715.	5933.	6276.	5952.	4521.	184834.
1976	4168.	3418.	4296.	25220.	30224.	15986.	19162.	9598.	5964.	11078.	16168.	16715.	161999.
1977	14524.	16598.	11878.	51035.	20861.	9767.	5543.	3406.	2736.	4041.	3172.	2781.	146342.
1978	2559.	2543.	2345.	2259.	1832.	4151.	920.	2075.	6287.	2738.	3335.	3592.	34635.
1979	16350.	20895.	39164.	37762.	27868.	13577.	9373.	5735.	4462.	3673.	2951.	2752.	184561.
AVERAGE	7578.	9383.	9160.	10779.	12418.	8960.	4771.	2748.	5717.	6941.	5723.	6323.	90500.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM THE REVISED GUADALUPE/SAN ANTONIO RIVER BASIN WATER AVAILABILITY MODEL RUN I OF MARCH, 1983.
2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.
3. PERMIT+UNAPP.RG1$10-10C
4. HDR INC.

6/15/88

FORM: TILINE

(Blanco River at Kyle)

TABLE 10
GUADALUPE RIVER BASIN (RUN I - REVISED 4/83)
ESTIMATE OF TOTAL RUNOFF
OUTFLOWS FROM (11,02) + STORM RUNOFF & BASE FLOW IN (11,03) * .4545

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	851.	1073.	1711.	3788.	1272.	6550.	3147.	1241.	1102.	768.	9010.	26938.	57451.
1941	8612.	28238.	34898.	36870.	46335.	36241.	11800.	4154.	2873.	6875.	3038.	2599.	222533.
1942	2296.	2088.	2188.	12542.	5021.	2880.	6538.	3942.	26949.	18201.	10401.	7355.	100401.
1943	5907.	4120.	4954.	5895.	4055.	3153.	4159.	1697.	3345.	1837.	1649.	1601.	42372.
1944	6014.	13912.	23227.	12186.	20902.	14267.	5484.	8981.	10673.	3290.	4010.	16454.	139400.
1945	21883.	23305.	32277.	18479.	8204.	6107.	4118.	2448.	2329.	3575.	2432.	6215.	131372.
1946	6964.	11341.	17797.	8950.	7882.	5879.	3069.	3150.	5699.	5467.	30497.	20741.	127436.
1947	25327.	14226.	10414.	7860.	5956.	3698.	2348.	3486.	1627.	1613.	1554.	1646.	79755.
1948	1540.	1522.	1307.	1202.	4136.	1436.	1278.	805.	733.	2251.	983.	1018.	18211.
1949	1254.	3754.	3227.	21302.	11154.	3573.	2092.	1517.	1100.	4727.	1151.	1330.	56181.
1950	1238.	2170.	1393.	3705.	4044.	4353.	1538.	1039.	1016.	868.	865.	845.	23074.
1951	810.	838.	1023.	938.	1338.	4692.	531.	403.	974.	561.	702.	729.	13539.
1952	680.	670.	750.	2466.	6577.	4973.	1552.	726.	80718.	3969.	3699.	5661.	112441.
1953	8056.	4340.	3971.	7924.	3700.	1797.	1198.	3564.	12723.	4544.	4234.	5440.	61491.
1954	3275.	2421.	2086.	1582.	1705.	750.	523.	503.	472.	754.	619.	766.	15456.
1955	901.	1345.	791.	676.	6045.	1495.	639.	712.	520.	440.	534.	716.	14814.
1956	610.	646.	513.	480.	1052.	268.	211.	228.	563.	2092.	1817.	1767.	10247.
1957	1817.	2258.	13606.	53937.	22120.	22591.	3409.	1665.	13702.	34437.	24794.	16982.	211318.
1958	16193.	31990.	29610.	15137.	64749.	18789.	6786.	3680.	10814.	10830.	14860.	7638.	231076.
1959	5773.	7476.	7177.	14537.	8056.	7201.	4127.	4011.	2822.	23981.	5512.	6582.	97255.
1960	10659.	12973.	10109.	11275.	6537.	9371.	6126.	6273.	3606.	48375.	20159.	27689.	173152.
1961	24479.	50580.	20415.	9153.	5704.	24964.	10042.	5679.	4636.	4299.	4559.	3788.	168298.
1962	3528.	2792.	2973.	3113.	2931.	9920.	3028.	1738.	3262.	2370.	1853.	3217.	40725.
1963	2633.	2530.	2271.	6343.	2723.	1462.	987.	886.	861.	854.	1065.	1093.	23708.
1964	1042.	1379.	2941.	1934.	1478.	1617.	822.	710.	2659.	2073.	3967.	1847.	22469.
1965	4703.	23771.	8526.	14235.	47243.	35077.	6915.	4550.	4978.	8816.	6583.	23884.	189281.
1966	11832.	11736.	12266.	14228.	14132.	6403.	4392.	3394.	5111.	3815.	2653.	2426.	92388.
1967	2233.	1825.	1878.	1800.	1912.	1242.	809.	736.	4887.	4733.	10173.	5427.	37655.
1968	72065.	20545.	17367.	16245.	19557.	10887.	6147.	3781.	3903.	3360.	3092.	4618.	181567.
1969	3059.	4941.	6920.	11454.	18927.	10397.	4949.	3674.	3245.	5924.	4173.	8323.	85986.
1970	7111.	12399.	25416.	11786.	35204.	17954.	6595.	4198.	3675.	4260.	2785.	2606.	133989.
1971	2161.	1753.	1794.	1571.	1381.	1050.	805.	1524.	1581.	3895.	5002.	11588.	34105.
1972	6370.	4169.	3490.	2522.	24219.	9873.	5073.	4322.	2712.	4256.	6125.	5051.	78182.
1973	7920.	12999.	15102.	15948.	13230.	36028.	56091.	13116.	9718.	59104.	19215.	9955.	268426.
1974	8310.	6734.	5988.	4831.	5900.	3789.	2382.	5094.	10479.	6691.	19286.	10673.	90157.
1975	11658.	39817.	13318.	10143.	41342.	35840.	19041.	9948.	6637.	7100.	6513.	5162.	206519.
1976	4695.	3859.	4782.	28102.	35397.	18616.	20645.	10383.	6684.	15487.	18977.	19092.	186719.
1977	16524.	19043.	13186.	55938.	22798.	10986.	6325.	3996.	3263.	4415.	3808.	3284.	163566.
1978	3071.	3048.	2811.	2646.	2232.	4572.	1432.	2274.	6785.	3087.	4317.	4299.	40574.
1979	18369.	22097.	41027.	41096.	30085.	14665.	10465.	6640.	5079.	4182.	3449.	3337.	200491.
AVERAGE	8561.	10418.	10138.	12370.	14181.	10385.	5940.	3522.	6863.	8204.	6753.	7260.	104595.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM THE REVISED GUADALUPE/SAN ANTONIO RIVER BASIN WATER AVAILABILITY MODEL RUN I OF MARCH, 1983.
2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.
3. PERMIT*RUNOFF.RG1$11-03CF
4. HDR INC.

6/17/88

FORM: 11LINE

(Blanco River at Kyle)

TABLE 9

GUADALUPE RIVER BASIN (RUN I - REVISED 4/83)

ESTIMATE OF UNAPPROPRIATED WATER

CUMULATIVE AMOUNT IN ACRE-FEET IN SW (10.01) THRU (10.10) + (11.01) + (11.02) + (11.03) * .4545

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	803.	976.	1370.	3458.	975.	6426.	2971.	858.	429.	656.	8969.	26896.	54787.
1941	8567.	28195.	34825.	36769.	46187.	36114.	11626.	4074.	2777.	6804.	2987.	2551.	221476.
1942	2249.	2015.	2039.	12441.	4872.	2701.	6372.	3764.	26861.	18132.	10351.	7307.	99104.
1943	5860.	4070.	4877.	5638.	3893.	3018.	3398.	1266.	2901.	1609.	1541.	1510.	39581.
1944	5972.	13868.	23151.	12079.	20757.	14132.	5304.	7698.	10577.	3174.	3968.	16411.	137091.
1945	21838.	23260.	32202.	18376.	8048.	5974.	3034.	2089.	1925.	3503.	2381.	6061.	128691.
1946	6921.	11294.	17721.	8845.	7733.	5748.	2205.	3073.	5612.	5394.	30452.	20694.	125692.
1947	25283.	14177.	10337.	7754.	5805.	3561.	1897.	3408.	1208.	1213.	1418.	1522.	77583.
1948	1493.	1478.	1203.	729.	3986.	611.	685.	628.	136.	1397.	598.	510.	13454.
1949	1077.	3711.	3149.	21204.	11001.	3439.	1655.	1043.	693.	4659.	1099.	1285.	54015.
1950	1191.	2124.	1209.	3601.	3459.	4220.	330.	92.	138.	371.	466.	404.	17605.
1951	633.	478.	357.	110.	806.	4559.	0.	0.	244.	140.	331.	302.	7960.
1952	476.	301.	75.	1202.	6427.	4701.	0.	0.	72022.	3872.	3654.	5617.	98347.
1953	8006.	4247.	3196.	7819.	3548.	0.	0.	2014.	12575.	4474.	3946.	5393.	55218.
1954	3097.	1508.	831.	492.	1418.	0.	0.	0.	0.	0.	0.	94.	7440.
1955	371.	1301.	140.	0.	4840.	1217.	0.	0.	0.	0.	0.	0.	7869.
1956	84.	66.	0.	0.	0.	0.	0.	0.	0.	0.	0.	902.	1052.
1957	1766.	2050.	13532.	50724.	21974.	22459.	2254.	0.	13614.	34367.	24750.	16934.	204424.
1958	16148.	31948.	29533.	15032.	64601.	18656.	6444.	2953.	10727.	10761.	14811.	7589.	229203.
1959	5723.	7433.	7097.	14433.	7904.	6973.	3951.	3490.	2118.	23912.	5463.	6535.	95032.
1960	10611.	12926.	10032.	11170.	6384.	9237.	5951.	5999.	3508.	48312.	20110.	27645.	171885.
1961	24433.	50537.	20337.	9043.	5549.	24837.	9873.	5597.	4544.	4226.	4513.	3740.	167229.
1962	3481.	2744.	2840.	2924.	2426.	6799.	254.	0.	2756.	2098.	1784.	3171.	31277.
1963	2584.	2484.	2094.	4494.	1798.	0.	0.	0.	0.	0.	1017.	606.	15077.
1964	864.	1333.	2864.	1490.	786.	1298.	0.	118.	2528.	1997.	3919.	1375.	18572.
1965	4657.	23729.	8448.	14129.	47100.	34944.	6575.	3941.	3333.	8744.	6535.	23841.	185976.
1966	11786.	11691.	12189.	14124.	13985.	6268.	3275.	2655.	4617.	3739.	2493.	2200.	89022.
1967	2184.	1502.	1465.	832.	451.	42.	0.	17.	4796.	4659.	10125.	5379.	31452.
1968	72023.	20500.	17291.	16141.	19411.	10754.	5972.	3561.	3812.	3285.	3042.	4570.	180362.
1969	3012.	4897.	6843.	11351.	18778.	10263.	4000.	2900.	2800.	5852.	4123.	8276.	83095.
1970	7063.	12354.	25340.	11680.	35056.	17817.	6338.	4115.	3586.	4187.	2733.	2555.	132824.
1971	2111.	1703.	1711.	1462.	1056.	536.	32.	1119.	1489.	3686.	4953.	11543.	31401.
1972	6323.	4121.	3410.	2413.	24071.	9739.	4899.	4246.	2616.	4181.	6078.	5003.	77100.
1973	7875.	12954.	15025.	15845.	13077.	35898.	49254.	13036.	9627.	59034.	19164.	9904.	260693.
1974	8264.	6684.	5909.	4722.	5750.	3651.	2202.	5020.	10387.	6618.	19242.	10627.	89076.
1975	11609.	39771.	13240.	10038.	41193.	35709.	18867.	9870.	6542.	7024.	6462.	5114.	205439.
1976	4645.	3809.	4704.	27999.	35246.	18481.	20474.	10302.	6590.	15415.	18931.	19047.	185643.
1977	16478.	18994.	13108.	55834.	22647.	10851.	6144.	3913.	3164.	4337.	3759.	3233.	162462.
1978	3025.	3003.	2732.	2539.	2080.	4436.	920.	2195.	6287.	3011.	4273.	4253.	38754.
1979	18323.	22053.	40951.	40993.	29934.	14532.	10293.	6561.	4983.	4103.	3400.	3117.	199243.
AVERAGE	8473.	10307.	9934.	11998.	13875.	10015.	5186.	3040.	6313.	7974.	6596.	7093.	100805.

REMARKS:
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2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.
3. PERMIT*UNAPP.RG1$11-03CF
4. HDR INC.

6/15/88

FORM 11LINE

(Blanco River at Kyle)

TABLE 10

GUADALUPE RIVER BASIN (RUN I - REVISED 4/83)

ESTIMATE OF TOTAL RUNOFF

OUTFLOWS FROM (11,02) + STORM RUNOFF & BASE FLOW IN (11,03) * .4545

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1940	851.	1073.	1711.	3788.	1272.	6550.	3147.	1241.	1102.	768.	9010.	26938.	57451.
1941	8612.	28238.	34898.	36870.	46335.	36241.	11800.	4154.	2873.	6875.	3038.	2599.	222533.
1942	2296.	2088.	2188.	12542.	5021.	2880.	6538.	3942.	26949.	18201.	10401.	7355.	100401.
1943	5907.	4120.	4954.	5895.	4055.	3153.	4159.	1697.	3345.	1837.	1649.	1601.	42372.
1944	6014.	13912.	23227.	12186.	20902.	14267.	5484.	8981.	10673.	3290.	4010.	16454.	139400.
1945	21883.	23305.	32277.	18479.	8204.	6107.	4118.	2448.	2329.	3575.	2432.	6215.	131372.
1946	6964.	11341.	17797.	8950.	7882.	5879.	3069.	3150.	5699.	5467.	30497.	20741.	127436.
1947	25327.	14226.	10414.	7860.	5956.	3698.	2348.	3486.	1627.	1613.	1554.	1646.	79755.
1948	1540.	1522.	1307.	1202.	4136.	1436.	1278.	805.	733.	2251.	983.	1018.	18211.
1949	1254.	3754.	3227.	21302.	11154.	3573.	2092.	1517.	1100.	4727.	1151.	1330.	56181.
1950	1238.	2170.	1393.	3705.	4044.	4353.	1538.	1039.	1016.	868.	865.	845.	23074.
1951	810.	838.	1023.	938.	1338.	4692.	531.	403.	974.	561.	702.	729.	13539.
1952	680.	670.	750.	2466.	6577.	4973.	1552.	726.	80718.	3969.	3699.	5661.	112441.
1953	8056.	4340.	3971.	7924.	3700.	1797.	1198.	3564.	12723.	4544.	4234.	5440.	61491.
1954	3275.	2421.	2086.	1582.	1705.	750.	523.	503.	472.	754.	619.	766.	15456.
1955	901.	1345.	791.	676.	6045.	1495.	639.	712.	520.	440.	534.	716.	14814.
1956	610.	646.	513.	480.	1052.	268.	211.	228.	563.	2092.	1817.	1767.	10247.
1957	1817.	2258.	13606.	53937.	22120.	22591.	3409.	1665.	13702.	34437.	24794.	16982.	211318.
1958	16193.	31990.	29610.	15137.	64749.	18789.	6786.	3680.	10814.	10830.	14860.	7638.	231076.
1959	5773.	7476.	7177.	14537.	8056.	7201.	4127.	4011.	2822.	23981.	5512.	6582.	97255.
1960	10659.	12973.	10109.	11275.	6537.	9371.	6126.	6273.	3606.	48375.	20159.	27689.	173152.
1961	24479.	50580.	20415.	9153.	5704.	24964.	10042.	5679.	4636.	4299.	4559.	3788.	168298.
1962	3528.	2792.	2973.	3113.	2931.	9920.	3028.	1738.	3262.	2370.	1853.	3217.	40725.
1963	2633.	2530.	2271.	6343.	2723.	1462.	987.	886.	861.	854.	1065.	1093.	23708.
1964	1042.	1379.	2941.	1934.	1478.	1617.	822.	710.	2659.	2073.	3967.	1847.	22469.
1965	4703.	23771.	8526.	14235.	47243.	35077.	6915.	4550.	4978.	8816.	6583.	23884.	189281.
1966	11832.	11736.	12266.	14228.	14132.	6403.	4392.	3394.	5111.	3815.	2653.	2426.	92388.
1967	2233.	1825.	1878.	1800.	1912.	1242.	809.	736.	4887.	4733.	10173.	5427.	37655.
1968	72065.	20545.	17367.	16245.	19557.	10887.	6147.	3781.	3903.	3360.	3092.	4618.	181567.
1969	3059.	4941.	6920.	11454.	18927.	10397.	4949.	3674.	3245.	5924.	4173.	8323.	85986.
1970	7111.	12399.	25416.	11786.	35204.	17954.	6595.	4198.	3675.	4260.	2785.	2606.	133989.
1971	2161.	1753.	1794.	1571.	1381.	1050.	805.	1524.	1581.	3895.	5002.	11588.	34105.
1972	6370.	4169.	3490.	2522.	24219.	9873.	5073.	4322.	2712.	4256.	6125.	5051.	78182.
1973	7920.	12999.	15102.	15948.	13230.	36028.	56091.	13116.	9718.	59104.	19215.	9955.	268426.
1974	8310.	6734.	5988.	4831.	5900.	3789.	2382.	5094.	10479.	6691.	19286.	10673.	90157.
1975	11658.	39817.	13318.	10143.	41342.	35840.	19041.	9948.	6637.	7100.	6513.	5162.	206519.
1976	4695.	3859.	4782.	28102.	35397.	18616.	20645.	10383.	6684.	15487.	18977.	19092.	186719.
1977	16524.	19043.	13186.	55938.	22798.	10986.	6325.	3996.	3263.	4415.	3808.	3284.	163566.
1978	3071.	3048.	2811.	2646.	2232.	4572.	1432.	2274.	6785.	3087.	4317.	4299.	40574.
1979	18369.	22097.	41027.	41096.	30085.	14665.	10465.	6640.	5079.	4182.	3449.	3337.	200491.
AVERAGE	8561.	10418.	10138.	12370.	14181.	10385.	5940.	3522.	6863.	8204.	6753.	7260.	104595.

REMARKS:
1. THESE ESTIMATES ARE OBTAINED FROM THE REVISED GUADALUPE/SAN ANTONIO RIVER BASIN WATER AVAILABILITY MODEL RUN I OF MARCH, 1983.
2. PLEASE REFER TO THE REPORT OF WATER AVAILABILITY OF MARCH 1983 FOR THE WATER RIGHTS CONSIDERED AND ASSUMPTIONS MADE.
3. PERMIT*RUNOFF.RG1$11-03CF
4. HDR INC.

6/17/88

FORM: 11LINE