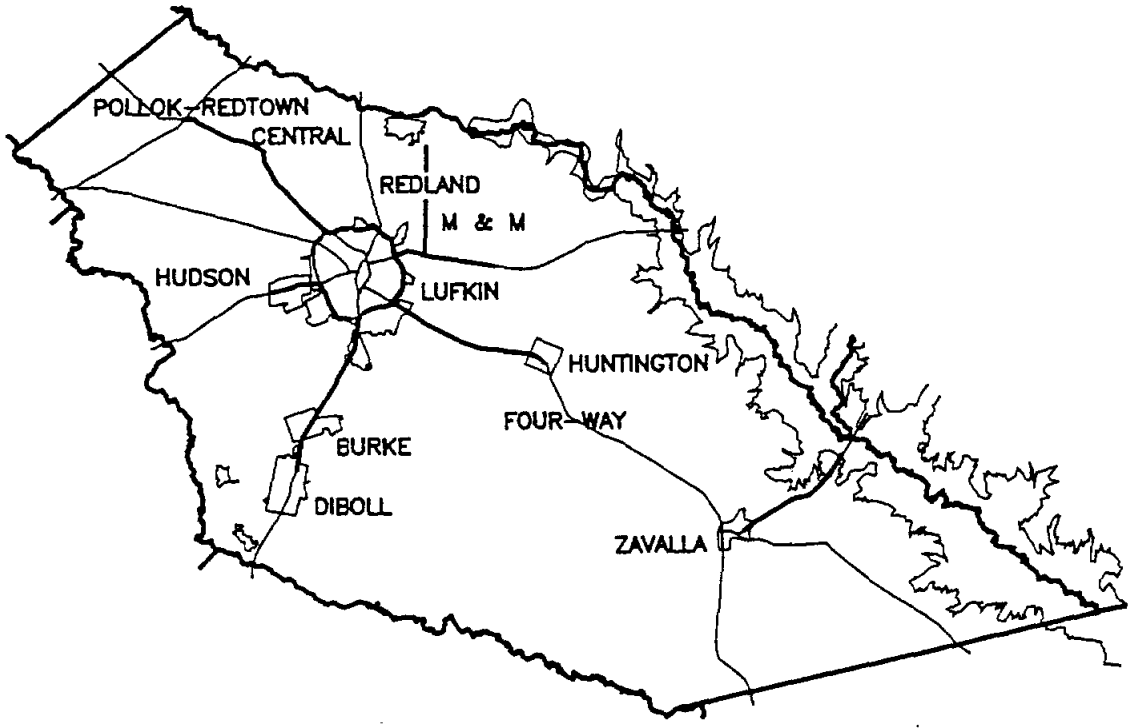
ANGELINA COUNTY REGIONAL WATER STUDY

APRIL 1991



Prepared for:

CITY OF LUFKIN, Lead Agency
AND PARTICIPATING ENTITIES

Prepared by:

Everett Griffith, Jr. & Associates Inc.
ENGINEERS · · SURVEYORS

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ANGELINA COUNTY WATER STUDY
EXECUTIVE SUMMARY

This study was precipitated by the growing need for additional sources of water for the public purveyors of water of Angelina County. The Carrizo Aquifer was being pumped heavily such that in the 1970's "mining" of the aquifer was occurring. The Yegua Formation was a poor quality, often unreliable source of water.

Increasingly, eyes turned toward Sam Rayburn Reservoir. The City of Huntington, in negotiations with the Lower Neches Valley Authority and the Corps of Engineers, began efforts to obtain surface water rights. Lufkin has been paying for water rights since 1965.

A concerted effort of entities in Angelina County began in 1987 to obtain a planning grant from the Texas Water Development Board. That grant was obtained in the early part of 1988, and planning efforts began in earnest in the Summer, 1988.

The following summarizes the findings of that planning effort which is described in the attached report.

WATER ENTITIES OF THE COUNTY

Sixteen public entities and several private water corporations are providing water to the County population. The public entities include three cities, two water control and improvement districts, ten water supply corporations, and one fresh water district.

Service areas of these entities are outlined in Figure 4-7.

Twelve of these entities, which use over 95% of the public-supplied water of the County, were joined by two industries in making this study.

WATER SUPPLY NEEDS

In wet cycle conditions, total county water usage is expected to climb from approximately 9 million gallons per day(MGD) to nearly 15 MGD in the Year 2010. Expected consumption for the Year 2040 is 21 MGD. These projected water demands reflect some anticipated water demand reductions due to water conservation efforts.

Three entities who are currently short of water supply capacity will be joined by the remaining entities who will experience a lack of water supply by the Year 2000. In that Year an additional water source capacity of 3,138 gallons per minute will be required. This equates to approximately 4.4 MGD if the source is surface water, or about 3.5 MGD if the source is groundwater.

These figures grow to 7.4 MGD for the Year 2010 with a surface water supply, or 6.3 MGD with a groundwater source.

POTENTIAL WATER SOURCES

Several surface water sources were identified by this study. These include the following sources with a quantity in MGD available from that source.

Sam Rayburn Reservoir	24.995	Owned by the City of Lufkin
Sam Rayburn Reservoir	8.409	Potentially available through LNVA and the Corps of Engineers
Lake Eastex	9.015	Currently being held by Angelina County public entities

Other sources are possibly available, but these represent the most favorable potential supplies of surface water.

Probably the most important development during this study was the recognition by Champion Paper Mill of significant decreases in groundwater consumption through a combination of conservation and greater usage of surface water. Champion has tentatively committed to hold their groundwater production to a maximum of 12.0 MGD.

This commitment has freed up approximately 8.0 MGD in the Carrizo Aquifer. The Carrizo Aquifer generally provides a less expensive source of water with higher quality than surface water, and is probably a more acceptable public source of water.

A key factor to the best and complete use of the Carrizo depends upon the proper development of the aquifer through best placement of wells with appropriate pumping rates. This factor coupled with the relatively expensive costs to develop the source and pump that water back to the users points toward a regional effort, just as did the surface water options.

PROPOSED ALTERNATIVE

The proposed alternative of this plan is to meet the immediate needs of the regional system through groundwater acquired in the Champion Well Field. This will require some negotiations with Champion Paper Mill related to the trade of surface water rights for groundwater and the possible acquisitions of some Champion wells and supply lines.

In addition, a collection and pumping station would be constructed in the vicinity of Kurth Lake. This station would provide initial aeration, chlorination, and fluoridation, and pump the water through a transmission line parallel to the existing Champion supply lines. The line would continue along Highway 103 into the Lufkin system lying along Loop 287.

Separate lines would radiate out from the Lufkin system to convey water to ground storage tanks in each participating system. Metering facilities would meter water into and out of the Lufkin system, and into each entity supplied.

The beauty of this approach is that it provides a win/win situation for the City of Lufkin and the other County entities. In sharing the Loop lines rather than operating in a parallel situation, the County system saves approximately $700 thousand, while the City of Lufkin recognizes a savings of approximately $900 thousand in construction costs.

The collection and transmission pipelines would be located and sized to provide for their use by the future surface water system as well.

Water supply needs can be met with this available 8 MGD until about the Year 2015. At that time either more groundwater would be required from the Champion field, or the regional system would have to look to a surface water plant.

It is the recommendation of this report that the County entities consider the following approach in regards to a "triggering device" for beginning the use of surface water in addition to ground water:

1. Efforts should be made <u>now</u> to identify and contract for additional surface water rights to provide for the area's future water needs.

2. At the time that pumpage from the Carrizo Aquifer in this area reaches 28 MGD, efforts should begin for the planning and evaluation for conversion to supplementing groundwater supplies with a surface water delivery system, particularly in deciding which surface water supply is to be used initially.

3. At the time that pumpage increases to 30 MGD, efforts should begin to actually treat and distribute surface water.

This process will allow for approximately 4 - 5 years for planning and evaluating the conversion to surface water and for approximately another 4 - 5 years for actual construction of the surface water system.

In developing the cost factors, the report concludes that the southern part of the County including Zavalla WCID probably cannot be cost-effectively served with the groundwater option selected. Therefore, either the regional system could construct surface water facilities in the Highway 147 bridge area to serve that entire area, or Zavalla WCID or other entities might prefer to embark upon such an effort themselves.

PROJECTED COSTS

Total construction costs for the region are estimated at approximately $11,170,000 including surface water for the southern part of the County and interest during construction. This would provide for the water needs of the next 10 years. An additional estimated cost of $975,000 would be required in ten years to provide for the decade of the years 2000-2010.

The initial cost of water to be sold by the regional system is outlined below for each entity. These costs are based upon the considerations outlined in the report, and are, of course, subject to some change dependent upon such factors as who the ultimate participants are and what actual construction costs are incurred.

The chart reflects full operation and maintenance costs as well as the costs incurred to purchase additional surface water for the future. In each case the assumption is made that a regional system will treat and deliver the water to the entity.

Costs are shown in a total annual cost along with the quantity to be purchased in the Year 2000 Phase. Costs in later phases would be less per unit of water purchased due to the greater quantity of water being delivered.

	SUGGESTED PURCHASE QUANTITY (MGD)	ANNUAL COST	PROBABLE INCREASE IN BUDGET
Burke WSC	0.24	$ 148,434	$ 84,574
Central WCID	0.14	$ 91,232	$ 69,055
City of Diboll	0.47	$ 295,788	$ 205,038
Fourway WSC	0.25	$ 150,444	$ 102,173
Hudson WSC	0.19	$ 117,131	$ 83,774
City of Huntington	0.24	$ 144,808	$ 98,468
City of Lufkin	1.40	$ 729,752	$ 531,484
M & M WSC	0.14	$ 87,374	$ 65,197
Pollok-Redtown WSC	0.10	$ 59,688	$ 40,379
Redland WSC	0.08	$ 50,300	$ 37,627
Zavalla WCID	0.13*	$ 87,432*	$ 62,331

*Assumes the construction of a surface water facility in the area of the Highway 147 bridge for the southern area of the County. Some lower costs might be encountered due to sizing down some of the structures.

Some of the costs seem surprisingly high on a per thousand basis, but generally those that seem high are at that level due to a relatively small quantity of water projected to be purchased from the regional entity. This is the case for M & M WSC, Pollok-Redtown, Redland WSC, Central WCID, and Zavalla WCID--whose costs are particularly sensitive to the fact that the combined purchase of delivered water and surface water rights is being spread over a small purchase base. If entities choose to purchase more water, then unit costs would drop.

Generally, cost factors used are conservative--that is, prices indicated should be on the high side. In any case, however, variations of more than about 15% are not expected other than in the case of an entity that decides to vary dramatically the amount of water to be purchased.

CONCLUSION

The conclusion of the study is that the Angelina & Neches River Authority be selected as the regional entity to negotiate water rights and to construct the necessary facilities to provide a regional treatment and supply system. A.N.R.A. would probably contract with the City of Lufkin to operate the regional system.

The regional option ensures that all water systems of the County will have an adequate supply of water both now and in the future. In addition, it will probably provide water service to at least a portion of the estimated nearly 8,000 people not currently served by community systems.

In addition, sufficient water sources would be developed to ensure that all present and future industries would have an adequate available supply of water.

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ANGELINA COUNTY WATER STUDY
MAY, 1990

1.0 INTRODUCTION

Over the last ten years the water purveying entities of Angelina County have become increasingly aware of the need for a long range plan of action to address future water supply needs. In the last five years the City of Huntington and Four Way Water Supply Corporation approached the Lower Neches Valley Authority about the potential of any possible water rights in Sam Rayburn Reservoir. Ensuing discussions with the L.N.V.A. and the Corps of Engineers established the possibility of water being available in the Rayburn Reservoir.

As several Angelina County entities began to pursue the possibility of obtaining a planning grant from the Texas Water Development Board, other entities realized that this effort needed to encompass the needs of the entire County of Angelina. A cooperative effort spearheaded by the City of Lufkin has evolved.

1.1 SCOPE OF WORK

The scope of work can be followed in the Table of Contents. Essentially it is the logical step-by-step approach to formulating the water supply needs of each entity of the County and determining the best practicable option to supplying those needs. Since the systems must not only have enough water for their users, but must also be able to provide this water at pressure even at periods of high demand, we have also analyzed on a general basis the storage, pressure, and delivery systems of each entity. The best option for supplying water to these entities may also address some storage, pressure, or distribution problems within the systems. Additionally, since costs are a very important part of the decision-making process, each entity must be aware if any additional costs will be incurred in order to tie into the regional system.

The various water supply alternatives have been considered along with the probable water quality. Costs of treatment and delivery have been determined using various options and phasing plans. Organizational options hinge upon the willingness of various entities to cooperate and the ability to borrow the necessary money to carry out the plan of action. Other considerations such as permits and agency interaction, environmental analysis, archaeological and historical reviews, and a water conservation plan have been addressed generally, as well.

1.2 APPROACH

A group of entities determined to make application to the Texas Department of Water Resource for a planning grant. This group, spearheaded by the City of Lufkin, determined to look at the long range planning for water supply, treatment, and delivery for the entire County. Generally there was a recognition of the difficulty of a number of different

entities working together in such an effort, but the feeling was that the potential economies and relative ability to accomplish the final product of the regional entity might more than offset some loss of independence and flexibility of options.

All sources of water were considered including the Carrizo, Yegua and Sparta Aquifers, Lake Sam Rayburn, and the future Lake Eastex, as well as any other water that might be accessible. The availability of these sources was considered on a time-line against the needs of the County users.

Various alternatives of water treatment and supply were considered, particularly in light of their impact of cost of delivery of treated water to each customer. Other potential customers were also considered including non-participating entities and industries.

2.0 PROJECT AREA AND PARTICIPANTS IN STUDY

2.1 LISTING OF PARTICIPANTS

The following entities have participated in the study.

City of Lufkin
City of Diboll
City of Huntington
County of Angelina
Central Water Control and Improvement District
Zavalla Water Control and Improvement District
Burke Water Supply Corporation
Four Way Water Supply Corporation
Hudson Water Supply Corporation
M & M Water Supply Corporation
Pollok-Redtown Water Supply Corporation
Redland Water Supply Corporation
Lufkin Industries
Champion Paper Mill

2.2 COMMITTEE COMPOSITION

Three boards were formed to guide the development of this study. These included:

Executive Board
Advisory Board
Water Economic Development Board

The composition of the Boards is as follows:

2.2.1 EXECUTIVE COMMITTEE

ENTITY REPRESENTED	INDIVIDUAL REPRESENTATIVE
City of Lufkin	Hon. Louis Bronaugh, Mayor
City of Lufkin	Harvey Westerholm, City Manager
City of Diboll	Carl Pavlic, Councilman
City of Diboll	Vernon Cupit, City Manager
City of Huntington	Frank Williams, Councilman
Fourway W.S.C.(WSC's)	Morgan Flournoy, Board President
Central W.C.I.D.(WCID's)	Wes Boothe, Board President
A.N.R.A.	Joe Rich, Board Member
A.N.R.A.	Gary Neighbors, Executive Director
Angelina County	Hon. Dan Jones, County Judge

2.2.2 ADVISORY BOARD

Due to changes in board membership, etc., over the time of the study some entities have been represented by different members. The entities represented on this board are indicated. This is a continuing board and may be called on to meet infrequently again in the future.

ENTITY REPRESENTED
City of Lufkin
City of Diboll
City of Huntington
Central W.C.I.D.
Zavalla W.C.I.D.
Burke W.S.C.
Four Way W.S.C.
Hudson W.S.C.
M & M W.S.C.
Pollok-Redtown W.S.C.
Redland W.S.C.
Champion Paper Mill
Lufkin Industries
A.N.R.A.
Angelina Chamber of Commerce
D.E.T.C.O.G.
Lufkin State School

2.2.3 WATER ECONOMIC DEVELOPMENT COMMITTEE

ENTITY REPRESENTED	INDIVIDUAL REPRESENTATIVE
Angelina Chamber of Commerce	Jerry Huffman, President
A.N.R.A.	Gary Neighbors, Executive Director
Angelina Hardwood	George Henderson, Jr.
Bob Bowman & Associates	Bob Bowman
Champion Paper Mill	Jeff Thompson
Lufkin Industries	Morgan Flournoy
Pilgrim's Pride	Bob Palm
Temple-Inland	Mike Harbordt
Texas Foundries	Ed Wareing

2.3 MAP OF STUDY AREA

The study area corresponds generally with the boundaries of Angelina County. Figure 2-1 shows the study area along with approximate service areas of each entity.

3.0 PLANNING PROJECTIONS

3.1 GENERAL METHODOLOGY

Population, often identified by meter connections, and per capita water usage are the primary components in determining future water needs. The planning horizon for this project was 2010 with intermediate projections for 1990 and 2000, and with a longer range look at the years 2040 and 2090. This study considers both normal weather and drought weather conditions. A combination of geometric projections and data included in the Texas Water Plan were incorporated to determine future growth and future water usage.

3.2 DATA GATHERING AND EVALUATION

Population and water demand projections were derived from data gathered from the following sources:

Questionnaires sent to the various water distributing entities

Census of Population and Housing

Past water studies for the City of Lufkin, Champion International, and other entities

Water for Texas, the water planning document for the State of Texas produced in November 1984

Updated information currently being developed by the Texas Water Development Board for updates of the Water Plan

Information already contained in the files of Everett Griffith, Jr. & Associates, Inc. from past work with many of the entities involved in the study

All participating water purveyors filled out questionnaires. In addition, other water using entities provided information on questionnaires even though not participating directly in the study.

Individual interviews were conducted in some cases in order to confirm information and to gain additional data. These questionnaires and interviews helped establish the goals and needs of each entity and how they might be addressed through a common effort.

3.3 POPULATION PROJECTIONS

Historical census data is available for the municipalities of Angelina County, but a large segment of the population lies in unincorporated areas. Much of this area is served by non-profit water supply corporations and two water control and improvement districts. Water for Texas also contained projections for five entities of Angelina including Lufkin, Diboll, Huntington, Fuller Springs, and Hudson. Fuller Springs is no longer incorporated with the Fuller Springs Water Supply District having been absorbed by the City of Lufkin. Hudson is an incorporated City, but water service is by the Hudson Water Supply Corporation.

In most instances the historical number of meter connections was more available than the population--particularly in rural areas. Additionally, most of the guidelines of the Texas State Department of Health are based on meter connections. Therefore most of the projections and accompanying tables are based on metered water connections.

An assumption is made that if there are dramatic changes in the capita per residence in the future, there will also be corresponding changes in regulatory requirements for water supply and other facility requirements. Additionally, there is some slight skewing of the numbers due to past changes in the average number of people per household, but these are not considered to have a significant effect upon the projections.

3.3.1 HISTORICAL TRENDS

For purposes of analyzing growth data in the County we have grouped the population as follows:

Northern Region	Central Region	Southern Region
Hudson W.S.C.	**Burke W.S.C.**	**City of Huntington**
Woodlawn W.S.C.	**City of Diboll**	**Fourway W.S.C.**
Central W.C.I.D.	**Prairie Grove W.S.C.**	**Zavalla W.C.I.D.**
Redland W.S.C.	**Beulah W.S.C.**	
M & M W.S.C.	**Angelina W.S.C.**	

Since the City of Lufkin is so large compared to the other entities, it is treated as an individual grouping. The northern region includes those entities with existing wells in the Carrizo Aquifer. The Central and Southern Region both get their water from the Yegua Aquifer.

Distribution of the population being served by organized water systems is illustrated in Figure 3-1 and Figure 3-2 for the years 1970 and 1988. As can be noted the northern region grew at the greatest rate. However, both the central and southern groups increased their percentage as well. A drop in the percentage of the County's population living in the City of Lufkin was probably keyed to an increase in the percent of the number of people living in the County who were served by community systems. This coupled with growth in the County outside of Lufkin dropped Lufkin's percentage of population to near fifty percent.

Another interesting aspect of the growth in the County is that most of the new service among previously unserved areas has been by the Water Supply Corporations. This would be expected since they generally represent the fringe areas of growth in the County. Figures 3-3 and 3-4 illustrate the percentage of population falling in each category.

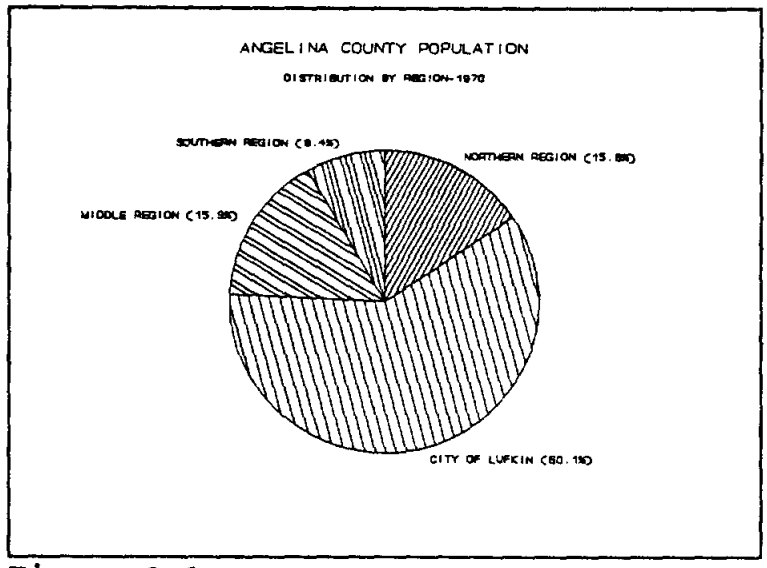


Figure 3-1

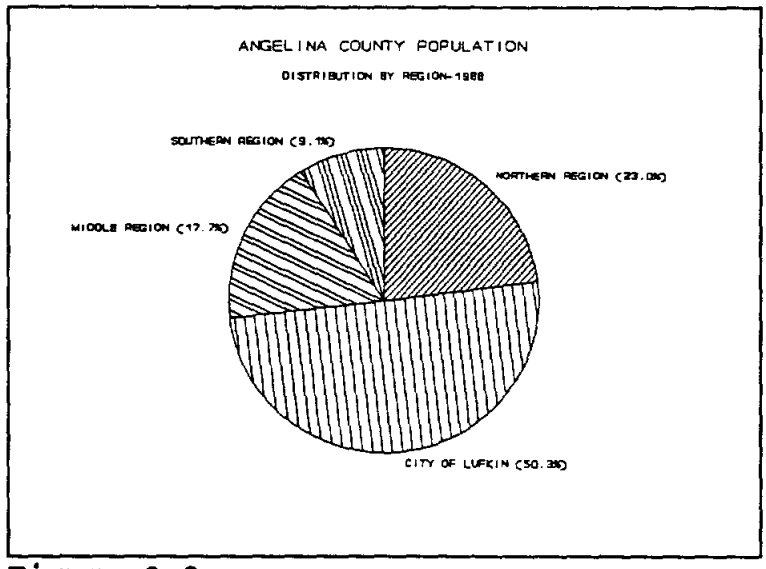


Figure 3-2

3.3.1.1 CITIES

The City of Lufkin has been by far the dominant entity of the County. As can be noted in Table 3-1, the growth has been consistently upward even during the turbulent 80's when the oil industry downturn and other economic factors wreaked havoc with the dominant industries of the City.

The City of Diboll has a very high factor for capita per connection. This is predominately due to the large number of housing units in the City.

The City of Huntington had levelled off in population growth through the 1950's and most of the 60's, but has started an upward climb in the last two decades. Numbers of meters can be very misleading for the City of Huntington since a large percentage of connections are outside the City. The number of outside connections has declined in recent years seemingly indicating a drop in population, which is not correct.

3.3.1.2 WATER CONTROL & IMPROVEMENT DISTRICTS

There are now only two active water districts distributing water to domestic users in Angelina County. These include Central WCID in the northern part of the County, and Zavalla WCID which encompasses the City of Zavalla and surrounding areas near Lake Sam Rayburn. (Note: By late 1990, however, Zavalla WCID was absorbed by the City of Zavalla,

though the service area did not change.)

Central WCID has grown rapidly since its creation in 1964. At this time it has the second largest number of connections of any entity in the County, although Diboll has a greater number of meter equivalents. Central WCID serves the Central community which centers around Central ISD school, although there is no incorporated city involved.

Zavalla WCID developed far more slowly, being located further from Lufkin and the other population centers. Additionally, nearby growth on the Lake was segmented and normally served by small individual subdivision water systems or individual wells. In recent years, the growth rate has picked up for the WCID as it apparently has become more aggressive in servicing its area.

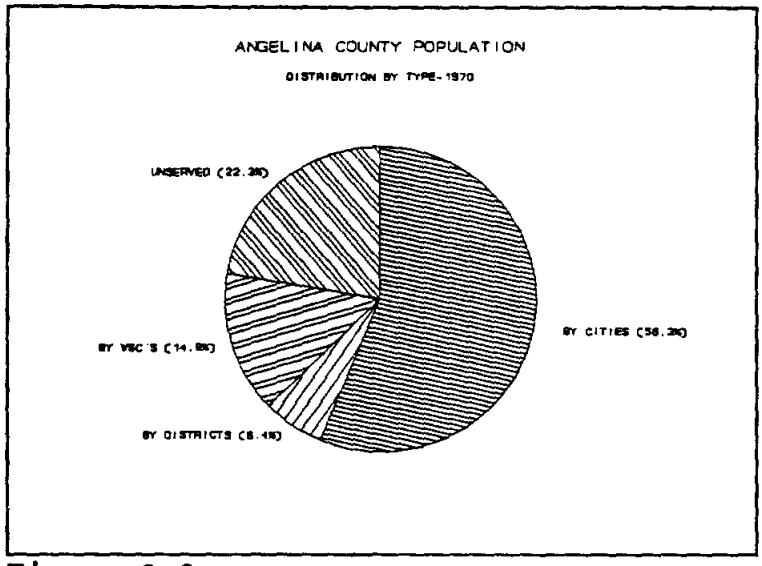


Figure 3-3

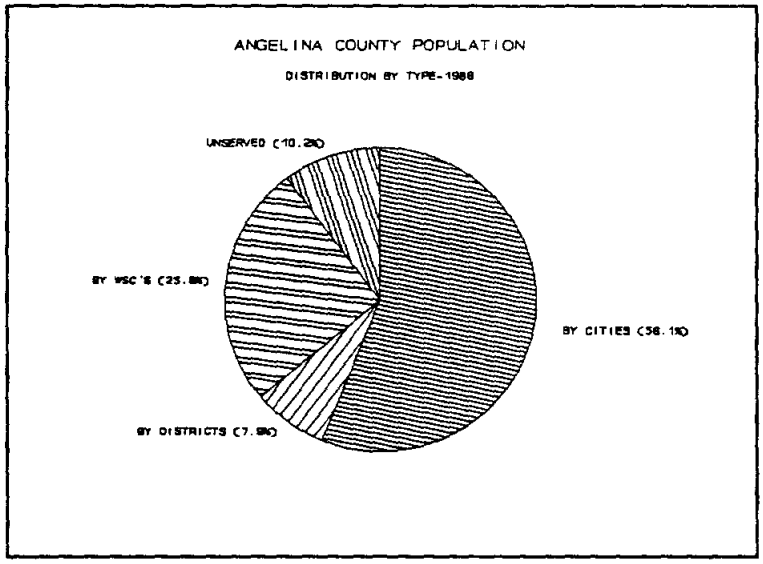


Figure 3-4

3.3.1.3 WATER SUPPLY CORPORATIONS

The impact of water supply corporations is often underestimated. These non-profit entities which were generally first funded under long-term, low-interest loans from Farmers Home Administration have grown to represent over twenty-five percent of the County's population.

Hudson WSC, which includes the City of Hudson serves over 4,000 people, Four Way serves nearly 3,000, and three others provide water to over 2,000 people each. Nearly 20,000 people in Angelina County get their water from Water Supply corporations.

Growth has been very rapid for the water supply corporations with those entities picking up new connections at the rate of 8.1% per year through the 1970's. That has stabilized downward to 5.6% in the early 80's, and 4.6% since 1985. Much of the early growth was involved in serving areas not previously served by an organized system. As the numbers of those not served declined, so did the growth rate of the corporations. However, these groups still maintain a healthy growth rate.

Since the City of Hudson has a sewer system and the Hudson area continues to grow rapidly, this area will probably experience the largest growth of the corporations. However, available land makes most of the corporations likely candidates for sound continued growth.

Table 3-1 tracks the growth of the different entities since 1960.

3.3.2 PROJECTIONS

Table 3-2 indicates projected water connections by entity for 100 years. Certainly, projections will be more accurate for the next 10 years than for more distant years. The table does give some idea of probable growth rates.

Connection projections were made on a modified geometric coefficient basis. This modification attempts to take into account the fact that some of the meter growth has not been based on new population in Angelina County, but instead on providing first-time service to a number of people. Projected growth factors after the year 2000 were buffered to more closely track expected growth for the entire state.

We estimate that over 8000 people in the County are not currently served by an organized water system. Within the next ten years probably 50%-75% of this population will be served by the water purveyors of the County.

Although the projections for water facilities are generally based on number of connections and connection growth to comply with health department requirements, Table 3-3 illustrates projected populations for each of the entities. In order to project these populations, the 1990 Census data was used for the Cities of Lufkin, Diboll, and Huntington.

Current connections were adjusted for Diboll to reflect a large number of living units located on three meters serving housing projects, and for Huntington since about 75 of their connections are located outside the City limits. This adjusted capita per connection for Diboll was 2.894, while that for Huntington was 2.596. Lufkin's capita per connection was 2.674, while the average for the three cities was 2.721. This factor was multiplied by the projected connections to obtain population projections. This approach assumes the same number of capita per connection in the future, which may not be true. However, in light of the fact that generally the only information about historical growth outside the Cities is in connections, this is probably the best projection that can be made. These projections would indicate that about 61,200 people were served by the entities being studied. If approximately 8,000 people are not now served by community water systems, then this number compares favorably with the 1990 Census of just over 69,000 for the County.

TABLE 3-1
TOTAL NUMBER OF WATER CONNECTIONS

WATER AGENCY	ACTUAL NUMBER OF CONNECTIONS								
	1960	1970	1980	1983	1984	1985	1986	1987	1988
1. Angelina W.S.C.	202(64)	364(72)	586	631					859
2. Beulah W.S.C.	45					120	130	140	155
3. Burke W.S.C.	217	368	599	694	727	760	786	816	837
4. Central W.C. & I.D.	280 (64)	472(66)		1,400	1,400				1,635
5. City of Diboll			1,134				1,152	1,375	1,375
6. Four-Way W.S.C	300 (67)	400	600	800	860	900	920	970	990
7. Hudson W.S.C.	225 (63)	795(74)	1,052						1,472
8. City of Huntington		629(75)	731	834			763	760	766
9. City of Lufkin	5,960	7,787	9,642	10,341	10,494	10,662	10,846	11,071	11,555
10. Lufkin Industries									
11. Lufkin State School								150	
12. M & M W.S.C.		276	448	521	543	587	623	658	677
13. Pollok-Redtown WSC			150	166	180	215	250	275	300
14. Prairie Grove W.S.C.		38(68)	79(78)						
15. Rayburn Water Inc.								78	78
16. Redland W.S.C.	125 (61)	190(75)	485			550			607
17. Woodlawn W.S.C.	89 (64)	184(69)	400	450	500	500	515	525	550
18. Zavalla W.C. & I.D.	200 (64)	280	280	300	315	325	335	360	368
19. Other Public Water Entities								205	

NOTE: Numbers in parentheses indicate the year used, if population data was not available for the years shown in the table.
Number of connections as of March, 1989.

TABLE 3-2
PROJECTED WATER CONNECTIONS

WATER AGENCY	CURRENT CONNECT	CURRENT POPULATION	GEOMETRIC COEFF.	PROJECTED CONNECTIONS					
				1990	1995	2000	2010	2040	2090
1. ANGELINA WSC	859	2535	0.047806141	945	1200	1525	1759	2553	4476
2. BEULAH WSC	155	468	0.044170093	169	211	263	304	441	773
3. BURKE WSC	837	2400	0.037470422	902	1088	1312	1514	2198	3853
4. CENTRAL WC&ID	1635	4494	0.031034113	1740	2032	2373	2737	3974	6967
5. DIBOLL	1375	5227	0.033748334	1471	1741	2061	2378	3453	6053
6. FOUR-WAY WSC	990	2820	0.035193138	1062	1267	1510	1742	2529	4434
7. HUDSON WSC	1472	4920	0.041991113	1601	1975	2436	2810	4080	7154
8. HUNTINGTON	766	2259	0.014075065	788	845	907	1046	1519	2663
9. LUFKIN	11296	34203	0.017666420	11702	12783	13963	16107	23386	41000
10. LUFKIN INDUSTRIES									
11. LUFKIN STATE SCHOOL	150	1500							
12. M&M WSC	677	1905	0.051609755	751	972	1258	1451	2106	3693
13. POLLOK-REDTOWN WSC	300	900	0.043321698	327	406	505	582	845	1481
14. PRAIRIE GROVE WSC	120	360							
15. RAYBURN WATER INC	78	258							
16. REDLAND WSC	607	1689	0.028047487	642	739	850	980	1423	2495
17. WOODLAWN WSC	550	1548	0.040134139	596	728	890	1027	1491	2614
18. ZAVALLA WC&ID	368	1101	0.034161666	394	467	554	640	929	1628
19. OTHER PUBLIC ENTITIES	205	615							
TOTALS	21581	69202		23090	26455	30408	35075	50927	89286

TABLE 3-3
POPULATION PROJECTIONS

	WATER AGENCY	CURRENT CONNECT.	1990 POPU-LATION	GEOMETRIC COEFF.	1995	2000	2005	2010	2040	2090
1.	ANGELINA WSC	859	2338	0.0378	2824	3412	4122	4754	6903	12102
2.	BEULAH WSC	155	422	0.0342	500	594	704	812	1179	2068
3.	BURKE WSC	837	2278	0.0375	2747	3313	3996	4609	6692	11733
4.	CENTRAL WC&ID	1635	4450	0.0310	5196	6069	7087	8175	11870	20810
5.	DIBOLL	1375	4341	0.0237	4888	5505	6199	7150	10381	18201
6.	FOUR-WAY WSC	990	2694	0.0302	3133	3644	4238	4888	7097	12443
7.	HUDSON WSC	1472	4006	0.0370	4820	5799	6977	8048	11685	20487
8.	HUNTINGTON	766	1794	0.0141	1925	2065	2216	2556	3711	6506
9.	LUFKIN	11296	30206	0.0177	32996	36043	39371	45414	65938	115604
10.	LUFKIN INDUS-TRIES									
11.	LUFKIN STATE SCHOOL	150	1500		1500	1500				
12.	M&M WSC	677	1842	0.0416	2269	2793	3439	3967	5760	10098
13.	POLLOK-RED-TOWN W.S.C.	300	816	0.0333	964	1139	1346	1552	2254	3952
14.	PRAIRE GROVE W.S.C.	120	327	0.0170	356	387				
15.	RAYBURN WATER	78	212	0.0140	228	244				
16.	REDLAND WSC	607	1652	0.0280	1901	2187	2516	2902	4214	7387
17.	WOODLAWN WSC	550	1497	0.0301	1740	2023	2352	2713	3939	6907
18.	ZAVALLA WC&ID	368	1001	0.0242	1130	1275	1439	1660	2410	4225
19.	OTHER PUBLIC ENTITIES	205	558	0.0150	601	648				
	TOTALS	21581	61934		69718	78640	86002	99201	144033	252522

3.4 WATER DEMAND PROJECTIONS

Water demands include both water used by domestic consumption as well as industrial and commercial usage. Normally the domestic usage is subject to much greater fluctuation both on a daily and seasonal basis. Industrial usage could be influenced by the location of one very large water user, but such an occurrence would be extremely difficult to predict. Since the Chamber of Commerce and Angelina Countians are pursuing the locating of a State Prison within the County, a water supply to the proposed site has been generally addressed.

TABLE 3-4
AGENCY WATER PRODUCTIONS AND SALES
APRIL 1987 TO MARCH 1988

WATER AGENCY	PRODUCTION, (gallons)	SALES, (gallons)	PERCENT UNACCOUNTED FOR	PER CONNECT. CONSUMP. DAILY (GALLONS)
1. City of Diboll	310,839,400	257,284,900	17	488.9
2. City of Lufkin	1,983,174,400	1,937,423,000	2	470.2
3. City of Huntington	86,720,667	55,460,900	36	329.1
4. Hudson W.S.C.	116,553,000	101,812,884	13	286.9
5. Angelina W.S.C.	20,754,000	17,696,900	15	271.5
6. Burke W.S.C.	82,069,900	59,292,643	28	268.6
7. Woodlawn W.S.C.	52,420,708	*Unknown*	*Unknown*	261.1
8. Central W.C. & I.D.	152,223,100	*Unknown*	*Unknown*	255.1
9. Pollok - Redtown W.S.C.	27,353,300	24,080,499	12	249.8
10. Redland W.S.C	50,539,000	51,272,000	-1	228.1
11. Beulah W.S.C.	12,482,904	*Unknown*	*Unknown*	220.6
12. Zavalla W.C. & I.D.	28,929,000	19,734,260	32	215.4
13. Four-way W.S.C.	77,700,000	*Unknown*	*Unknown*	215.0
14. M & M W.S.C	52,149,520	44,775,830	14	211.0
15. Rayburn Water Inc.	*Unknown*	*Unknown*	*Unknown*	
16. Prairie Grove W.S.C.	*Unknown*	*Unknown*	*Unknown*	
17. Lufkin Industries			0	

3.4.1 PER CAPITA CONSUMPTION

Per connection consumption records are indicated in Table 3-4. These have been correlated with the records of the planning document Water For Texas. The average water usage for Huntington and Hudson was projected at 106.5 gpcd for 1990, and 109.7 gpcd in the Year 2000. These usages were used as baseline projections for the other entities, with a correction factor based upon historical per connection usage.

In order to reflect the probable impact of implementation of Water Conservation Plans, we used the same methodology as that being used by the Texas Water Development Board in Water for Texas. Historical increases in per capita usage were projected through the Year 2000. After that date, however, per capita usage continued flat rather than increasing. This should reflect the probable impact of water conservation in that though it will not probably result in a decrease in water usage, it should be able to level off the natural and historical trend for increased per capita usage.

Per connection projections for the Cities of Lufkin and Diboll reflected a more substantial impact from commercial and industrial usage. Again, these numbers have been correlated with projections from Water for Texas.

TABLE 3-5
ANGELINA COUNTY WATER SUPPLY STUDY
TEXAS WATER PLAN PROJECTED PER CAPITA CONSUMPTION
WET CYCLE USAGE

ENTITY/YEAR	1980 REPORTED		1990 PROJECTED				2000 PROJECTED				PER CAPITA CONSUMPTION					
			LOW		HIGH		LOW		HIGH		1980	1990		2000		
	POPLN.	AC-FT	POPLN.	AC-FT	POPLN.	AC-FT	POPLN.	AC-FT	POPLN.	AC-FT	REPORTED	LOW	HIGH	LOW	HIGH	
DIBOLL	5227	652	10087	1299	10481	2031	12933	1724	13494	2675	111.4	115.0	173.1	119.1	177.1	
FULLER SPRINGS	1470	221	1742	211	1810	337	1936	239	2020	380	134.3	108.2	166.3	110.3	168.0	
HUDSON	1659	387	1966	240	2043	382	2185	272	2280	432	208.3	109.0	167.0	111.2	169.2	
HUNTINGTON	1672	183	1969	229	2046	371	2204	267	2299	427	97.8	103.9	162.0	108.2	165.9	
LUFKIN	28562	4861	34511	5489	35859	8033	38398	6366	40065	9245	152.0	142.1	200.1	148.1	206.1	

3.4.2 INDUSTRIAL AND COMMERCIAL NEEDS

Some allowance has been made for growth in industrial and commercial demands. However, with current trends toward conservation, the growth in per connection industrial and commercial water demands should be slight. No allowance is made directly for the inclusion of a large industrial user since a location would not be known, and since often large users locate their own source of water. The possibility of a future prison which has been sought by the County is generally addressed later in the report. In that case, delivery of water would be directly to the site which would be near the groundwater source in the Carrizo.

Champion Paper Mill is the largest single user of water in the County with their own supplies of ground water and surface water. However, as is addressed later, there is a possibility of some trade-offs of ground water for surface water which might be delivered by a regional system.

Any increases in the amount of industrial land-use area within the County will be affected by general economic conditions, the accessibility to good land transportation (both road and rail), the availability of an adequate work force/labor pool, and the ability to provide adequate water supplies.

A study of existing major industrial water users in the County has determined that the existing industrial water demand is approximately 25.5 MGD (combined ground and surface water sources).

Discussions with these existing major industries about their projected water needs have shown that their anticipated growth in water demand will be slight, estimated at approximately 1.0 to 1.5% per year over the next 20 years, due to their own water conservation efforts, improvements in manufacturing/industrial techniques, and reuse of water.

Interviews with representatives of the Chamber of Commerce and the municipalities indicate that there is some anticipated growth in industrial relocations and start-ups within the County. These interviews revealed that an available reliable water supply is a key factor in inducing industry to locate in an area. The key word in the foregoing statement is "available" since it takes a minimum of 4 to 6 years to develop a surface water supply. Consequently, industry will choose areas that have an abundant and available supply of groundwater or surface water. If the County is to be in a position to induce industry to locate here, then there should be an additional water supply available for that purpose. An accurate estimate of an amount for this purpose is difficult to project, but based on the existing industry water demands one can speculatively project an amount for future additional industrial users. The anticipated growth is estimated to increase the industrial water demand by another 1.5% per year over the next 20 years.

The current and anticipated industrial water demands are depicted in the following table.

TABLE 3-6
INDUSTRIAL WATER DEMANDS

Year	Ground	Surface	Total
1989	15.9 MGD	9.3 MGD	25.2 MGD
2000	16.4 MGD	13.0 MGD	29.4 MGD
2010	16.9 MGD	17.1 MGD	34.0 MGD

The industrial and commercial water needs have been included in the overall water demand projections for the county and in the analysis of available water supplies. The assumption is made that the industrial entities currently providing their own water source will continue to do so unless otherwise noted in the report.

3.4.3 TOTAL WATER DEMAND

Table 3-7 outlines the combined County needs for the various years. These indicate a 1990 average daily usage of 9.0 MGD with 12.77 MGD being required in 2000 and 14.73 needed in 2010. Table 3-8 identifies water needs under dry cycle conditions. These generally represent the greater water usage which occurs under a dry weather cycle of several years. Since they are not the norm, the design of this report is to address wet weather demands. The higher demands of the dry weather cycle will require either greater efforts in water conservation, or the adoption of different strategies as discussed in Chapter 6.

TABLE 3-7
PROJECTED WATER CONSUMPTION
WET CYCLE

WATER AGENCY	PER CONNECTION CONSUMPTION AND PROJECTED WATER CONSUMPTION					
	1990	1995	2000	2010	2040	2090
1. ANGELINA WSC	315 297751	318 381700	324 494235	324 570087	324 827729	324 1451196
2. BEULAH WSC	256 43362	259 54586	264 69406	264 80058	264 116239	264 203793
3. BURKE WSC	311 283439	314 352639	321 443144	321 511154	321 742163	321 1301179
4. CENTRAL WC&ID	296 541957	299 725528	305 981041	305 1131605	305 1643017	305 2880578
5. DIBOLL	502 739007	510 888082	518 1066991	518 1230746	518 1786963	518 3132948
6. FOUR-WAY WSC	249 272943	252 354371	257 464714	257 536036	257 778289	257 1364516
7. HUDSON WSC	333 533246	336 664002	343 835129	343 963300	343 1398648	343 2452146
8. HUNTINGTON	289 219467	295 253527	300 292498	300 337389	300 489867	300 858846
9. LUFKIN	443 5343958	451 6075482	459 6904781	459 7964482	459 11563910	459 20274138
10. LUFKIN INDUSTRIES	0	0				
11. LUFKIN STATE SCHOOL	0	0				
12. M&M WSC	245 183788	247 240129	252 316895	252 365530	252 530726	252 930482
13. POLLOK-REDTOWN WSC	290 103408	293 160975	298 253107	298 291952	298 423896	298 743185
14. PRAIRIE GROVE WSC	296 0	299 0	305 0	305 0	305 0	305 0
15. RAYBURN WATER INC	0	0				
16. REDLAND WSC	265 169935	267 197354	272 231501	272 267030	272 387710	272 679743
17. WOODLAWN WSC	303 180565	306 222398	312 276676	312 319139	312 463369	312 812390
18. ZAVALLA WC&ID	250 98459	252 117895	257 142587	257 164470	257 238800	257 418671
19. OTHER PUBLIC ENTITIES	0	0				
TOTALS	9011285	10688667	12772706	14732977	21391326	37503810
	10,094		15,583	17,974	26,097	45,755

TABLE 3-8
PROJECTED WATER CONSUMPTION
DRY CYCLE

WATER AGENCY	PER CONNECTION CONSUMPTION AND PROJECTED WATER CONSUMPTION					
	1990	1995	2000	2010	2040	2090
1. ANGELINA WSC	487 459906	490 587640	496 755783	496 871775	496 1265761	496 2219164
2. BEULAH WSC	396 66977	398 84037	403 106135	403 122424	403 177752	403 311640
3. BURKE WSC	481 437801	484 542901	490 677654	490 781656	490 1134913	490 1989759
4. CENTRAL WC&ID	457 837107	460 1116976	466 1500205	466 1730447	466 2512496	466 4404971
5. DIBOLL	723 1063218	730 1271887	738 1521346	738 1754832	738 2547902	738 4467045
6. FOUR-WAY WSC	385 421588	387 545566	392 710640	392 819704	392 1190157	392 2086614
7. HUDSON WSC	514 823653	518 1022254	524 1277077	524 1473075	524 2138809	524 3749814
8. HUNTINGTON	450 341862	456 392249	461 449726	461 518747	461 753187	461 1320506
9. LUFKIN	604 7290605	612 8247674	621 9328651	621 10760351	621 15623331	621 27391217
10. LUFKIN INDUSTRIES	0	0				
11. LUFKIN STATE SCHOOL	0	0				
12. M&M WSC	378 283879	380 369687	385 484595	385 558967	385 811585	385 1422890
13. POLLOK-REDTOWN WSC	448 159725	450 247827	456 387051	456 446453	456 648220	456 1136476
14. PRAIRIE GROVE WSC	457 0	460 0	466 0	466 0	466 0	466 0
15. RAYBURN WATER INC	0	0				
16. REDLAND WSC	409 262481	411 303833	417 354010	417 408341	417 592885	417 1039460
17. WOODLAWN WSC	468 278900	471 342389	477 423093	477 488026	477 708582	477 1242304
18. ZAVALLA WC&ID	386 152080	388 181504	393 218044	393 251508	393 365173	393 640230
19. OTHER PUBLIC ENTITIES	0	0				
TOTALS	12879781	15256424	18194009	20986306	30470753	53422091
	15,713		22,199	25,603	37,514	65,195

A strong distinction should be drawn between a required average daily demand, as opposed to the Health Department requirements that each system have a minimum water supply of .6 gpm per connection. The average daily demand indicates the demand upon a water source over a year-long basis. The .6 gpm per connection guideline is intended to address instantaneous demands which might exist within a system on a 24 hour basis, or in dry spells. The water source requirements are addressed in Chapter 5.

4.0 INVENTORY OF EXISTING FACILITIES

The following summaries and tables outline existing facilities being used by the entities participating in this study as well as other water purveyors in Angelina County. This assessment of existing capabilities is made for comparison to current and projected needs in order to establish the future improvements needed by the entities.

4.1 WATER SOURCES

Currently, all water production is out of groundwater sources with the exception of surface water being used by Champion and some small systems on the southern end of Sam Rayburn Reservoir. The groundwater is from the Carrizo, Yegua, and Sparta aquifers. Champion draws water from run-of-the-river and from releases from Lake Striker.

Table 4-1 lists the wells in use for those entities who responded to questionnaires, as well as for those for whom other data was available.

TABLE 4-1
EXISTING WELL DATA

WATER AGENCY	NO. OF WELLS	AGE OF WELLS (YRS.)	DEPTH TO TOP OF SCREEN (FT.)	TOTAL SCREEN (FT.)	RANGE OF PRODUCTION RATES (GPM)	TOTAL PRODUCTION RATE (GPM)	STATIC WATER LEVEL (FT.)	PUMPING WATER LEVEL (FT.)	NAME OF FORMATION
CENTRAL WCID	3	9-24	1125-1210	90-140	250-450	1150	428-560	451-618	CARRIZO
CITY OF LUFKIN	8	8-49	920-1160	92-130	550-1450	8900	463-520	562-651	CARRIZO
HUDSON WSC	1	5	1312	112	600	600	398	453	CARRIZO
M & M WSC	2	6-16	1085	80	300-325	625	4616-457	486-523	CARRIZO
POLLOK-REDTOWN	1	7	935	84	125	125	355	395	CARRIZO
REDLAND WSC	2	8-26	1050-1079	60-120	150-275	425	555	580	CARRIZO
WOODLAWN WSC	2	10-24	1302	85	120-250	370	409-570	439	CARRIZO
ANGELINA WSC	3	4-22	180-210	605					YEGUA
BEULAH WSC	1	23	517	43	130	130	41	84	YEGUA
BURKE WSC	4	5-21	270-820	40-60	60-375	695	100-165	206-235	YEGUA
CITY OF DIBOLL	4	4-40	304-440	68-90	175-300	1030	155-255	240-287	YEGUA
CITY OF HUNTINGTON	2	12-29	505-652	64-100	142-160	302	250-275	360-413	YEGUA
FOUR-WAY WSC	4	2-21	320-660	50-70	70-280	680	210-268	320-535	YEGUA
HUDSON WSC	3	12-19	273-372	64-77	150-200	500	100-275	173-281	YEGUA
LUFKIN INDUSTRIES	1	7	521	50	300	300	235	268	YEGUA
PRAIRIE GROVE WSC	2	367-512	40-60	35-47	82				YEGUA
RAYBURN WATER, INC.	5	3-23	232						YEGUA
ZAVALLA WCID	2	16-23	754	70	92-93	185	175-250	240-272	YEGUA

Table 4-2 provides an analysis of maximum daily pumping capacities (based on 16 hours of pumping) compared against current average daily demands. Additionally, this table shows the 16-hour pumping capacity with the largest well out. Although, certainly most of the wells will pump for 24 hours per day for at least a number of days, this procedure would certainly not be advisable on a sustained basis. Additionally, some areas of the Yegua do not recharge adequately to maintain pumping for more than 16 hours per day, and even less in some instances.

TABLE 4-2
WELL USE SUMMARY

WATER AGENCY	NO. OF WELLS	TOTAL PRODUCTION RATE (GPM)	AVERAGE DAILY PRODUCTION (1987-88) (MGD)	MAXIMUM DAILY PRODUCTION (16 HRS) (MGD)	TOTAL PRODUCTION RATE WITH LARGEST WELL OUT (GPM)	MAXIMUM DAILY PRODUCTION LARGEST WELL OUT (MGD)	REGION	NAME OF FORMATION
ANGELINA WSC	3	605	0.231	0.581	390	0.374	CENTRAL	YEGUA
BEULAH WSC	1	130	0.034	0.125	0	0.000	CENTRAL	YEGUA
BURKE WSC	4	695	0.225	0.667	320	0.307	CENTRAL	YEGUA
CITY OF DIBOLL	4	1030	0.852	0.989	730	0.701	CENTRAL	YEGUA
PRAIRIE GROVE WSC *	2	82	0.026	0.079	35	0.034	CENTRAL	YEGUA
CITY OF LUFKIN	8	8900	5.433	8.544	7450	7.152	LUFKIN	CARRIZO
CENTRAL WCID	3	1150	0.417	1.104	700	0.672	NORTHERN	CARRIZO
HUDSON WSC	4	1100	0.424	1.056	500	0.480	NORTHERN	CARR,YEG
M & M WSC	2	625	0.143	0.600	175	0.168	NORTHERN	CARRIZO
POLLOK-REDTOWN WSC	1	125	0.075	0.120	0	0.000	NORTHERN	CARRIZO
REDLAND WSC	2	425	0.138	0.408	150	0.144	NORTHERN	CARRIZO
WOODLAWN WSC	2	370	0.144	0.355	120	0.115	NORTHERN	CARRIZO
CITY OF HUNTINGTON	2	302	0.238	0.290	142	0.136	SOUTHERN	YEGUA
FOUR-WAY WSC	4	680	0.213	0.653	400	0.384	SOUTHERN	YEGUA
RAYBURN WATER, INC. *	5	232	0.134	0.223	132	0.127	SOUTHERN	YEGUA
ZAVALLA WCID	2	185	0.079	0.178	92	0.088	SOUTHERN	YEGUA
LUFKIN INDUSTRIES	1	300	INCLUDED IN FOURWAY FIGURES			0.000	SOUTHERN	YEGUA
CARRIZO TOTAL	19	12195	6.581	11.707	8595	8.251		
YEGUA TOTAL	30	4441	2.225	4.263	2741	2.631		

4.1.1 CARRIZO AQUIFER

The total supply available from the Carrizo Sand is 32 MGD as established by the Texas Water Development Board, Report 110, Ground-water Conditions in Angelina and Nacogdoches Counties, Texas. This correlates with studies accomplished by Guyton & Associates for Champion International.

Current and projected well use from the Carrizo is shown in the following Table 4-3. As can be noted in the table, 6.6 MGD is being used by the public entities of Angelina County. Champion reports that their usage has dropped from 18.1 MGD as recorded in the TWDB report to 12 MGD today. This has been accomplished through a combination of reuse of water, conservation, and a greater use of surface water combined with the ground-water. City of Nacogdoches usage is 4.8 MGD, while other systems in Nacogdoches County are estimated to be using 0.6 MGD.

Under wet cycle conditions there appears to be an additional 8.0 MGD of water available. However, under dry cycle usage this figure drops to 2.0 MGD.

Figure 4-1 shows the favorable areas of development for the Carrizo Aquifer. This figure must be correlated with the positions of existing wells. Generally, according to Report 110 "it is not believed that the Carrizo Sand should be developed much more in Angelina and Nacogdoches Counties." However, since Champion has cut back in production there appears to be some availability of water. Any development should consider either the use or retirement of existing Champion wells.

Table 4-3

TABLE 4-3
ANGELINA COUNTY WATER STUDY
USE OF CARRIZO AQUIFER GROUNDWATER

ENTITY	PRESENT USAGE WET CYCLE	PRESENT USAGE DRY CYCLE
CHAMPION	12.0	12.0
CITY OF LUFKIN	5.4	8.1
CITY OF NACOGDOCHES	4.8	7.2
ANGELINA CO. SYSTEMS*	1.2	1.8
NACOGDOCHES CO. SYSTEMS	0.6	0.9
TOTAL USAGE	24.0	30.0
TOTAL AQUIFER CAPACITY	32.0	32.0
TOTAL AVAILABLE	8.0	2.0

* PRESENT USAGE BASED ONLY ON THOSE SYSTEMS CURRENTLY USING CARRIZO WELLS.

An important issue in the efficient use of the Carrizo Sand is the uniform placement of wells. To some degree entities which have produced wells have attempted to maintain proper spacing. However, some wells have been developed to the maximum capacity of the Sand at that location, while others have been sized only to address a particular entity's needs. Figure 4-2 shows existing Carrizo wells with their pumping rate.

Figures 4-3,4-4,4-5,and 4-6 are bar charts illustrating current pumpage rates along with existing well capacities. Figure 4-3, which addresses the northern region, shows the usage from the Carrizo Sand with the exception that Lufkin is not included, and that Hudson WSC also gets water out of the Yegua.

Existing wells allow for the extraction of 11.7 MGD from the Carrizo by public entities in Angelina County. This figure coupled with the 18.0 MGD currently drawn by the City of Nacogdoches, other Nacogdoches County systems, and Champion Paper Mill yields a total current potential pumpage of 29.1 MGD. Certainly, none of these systems produces their wells at absolute potential at this time.

These totals are an indicator that including the Champion wells(pumping at a greater rate), there appear to be enough existing wells to fully pump the Carrizo to its highest potential.

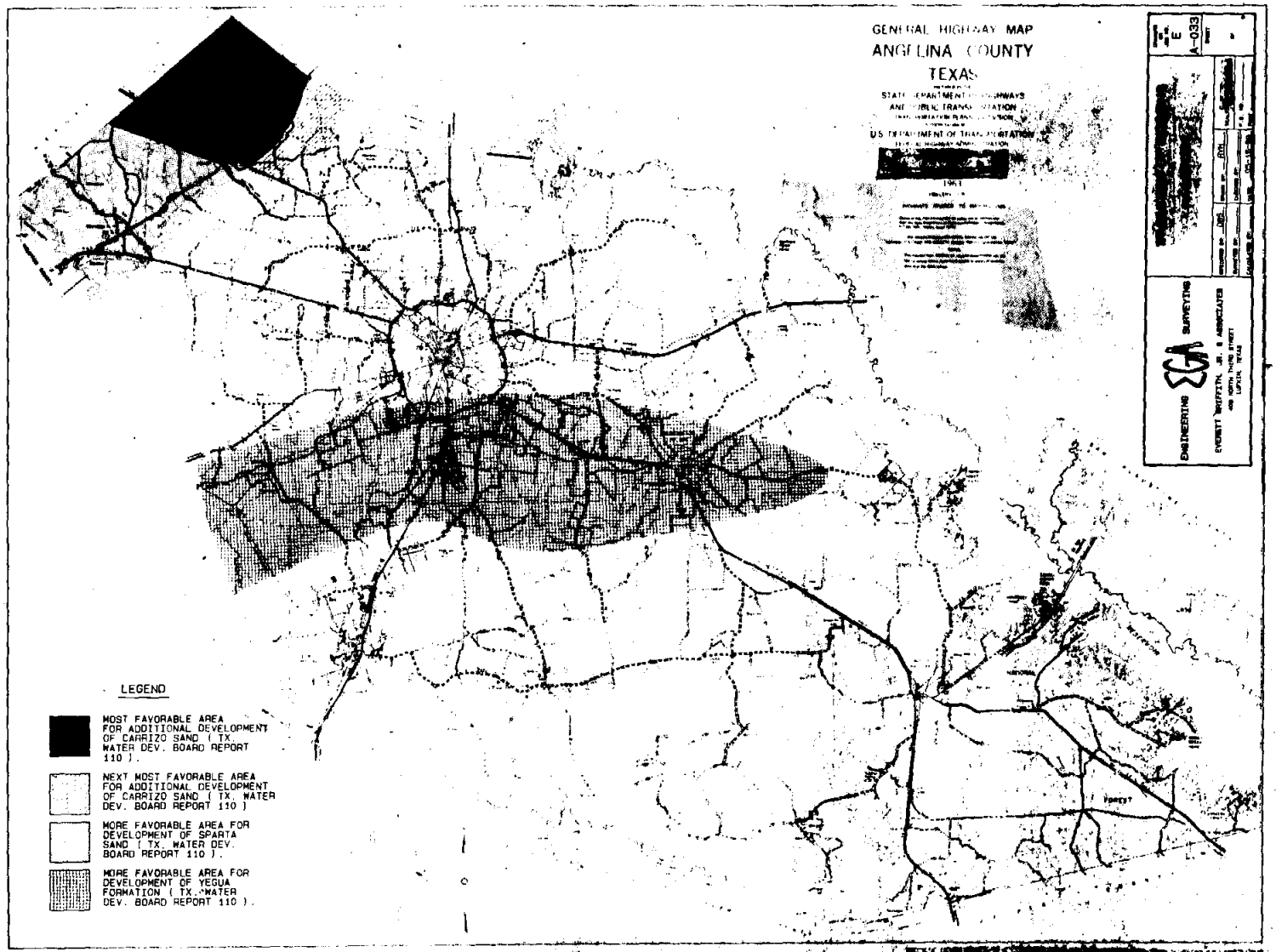
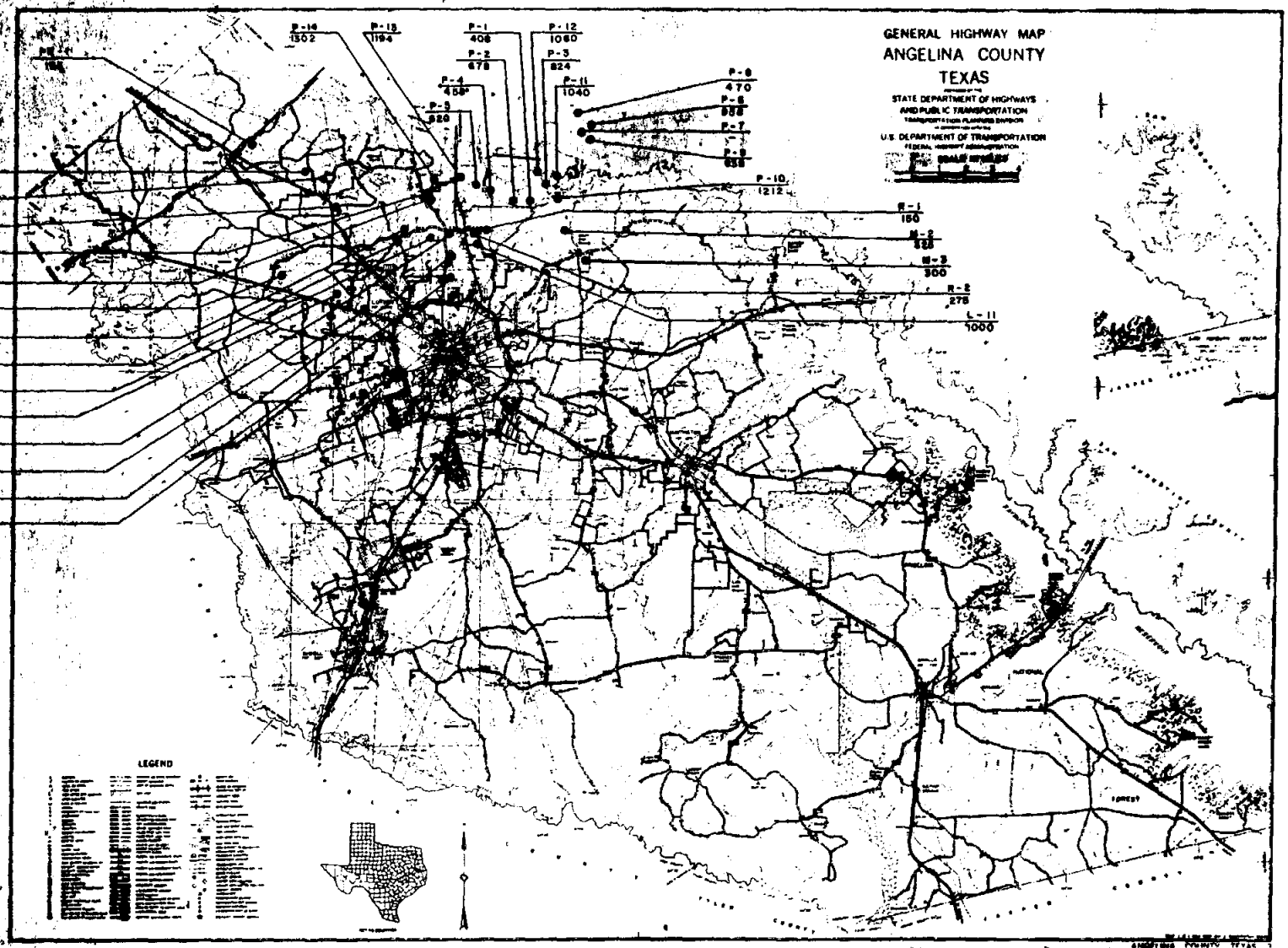

GENERAL HIGHWAY MAP
ANGELINA COUNTY
TEXAS
LEGEND
MOST FAVORABLE AREA FOR ADDITIONAL DEVELOPMENT OF CARRIZO SAND (TX. WATER DEV. BOARD REPORT 110).
NEXT MOST FAVORABLE AREA FOR ADDITIONAL DEVELOPMENT OF CARRIZO SAND (TX. WATER DEV. BOARD REPORT 110)
MORE FAVORABLE AREA FOR DEVELOPMENT OF SPARTA SAND (TX. WATER DEV. BOARD REPORT 110).
MORE FAVORABLE AREA FOR DEVELOPMENT OF YEGUA FORMATION (TX. WATER DEV. BOARD REPORT 110).
A-033
ENGINEERING
SURVEYING

Figure 4-1



CHAMPION, LUFKIN AND OTHER ANGELINA COUNTY WATER WELLS IN THE CARRIZO SAND

ENGINEERING SURVEYING

EVERETT GRIFFITH, JR. & ASSOCIATES
408 NORTH THIRD STREET
LUFKIN, TEXAS

Drawing No. E A-033

LEGEND

P-1 / 408 = OWNER'S WELL NUMBER / PRODUCTION RATE, GPM

- P = CHAMPION
- L = LUFKIN
- M = M&M WSC
- R = REDLAND WSC
- PR = POLLOK-REDTOWN WSC
- C = CENTRAL WCID
- LS = LUFKIN STATE SCHOOL
- H = HUDSON WSC
- W = WOODLAWN WSC

Figure 4-2

However, the placement of these wells is not necessarily ideal. Therefore, some agreements may be needed so that in the future replacement wells will be drilled in a more ideal location with a maximum capacity for that location.

An area of concern is that the cone of depression in the piezometric surface of the Carrizo Sand could cause some brackish water to move updip toward the larger well fields. This movement has not been registered to-date in any of the well qualities, but this point should be continuously noted. The wells nearest the fault line are those of Hudson WSC and Woodlawn WSC but other wells could be affected first depending on the degree of pumpage in any given area.

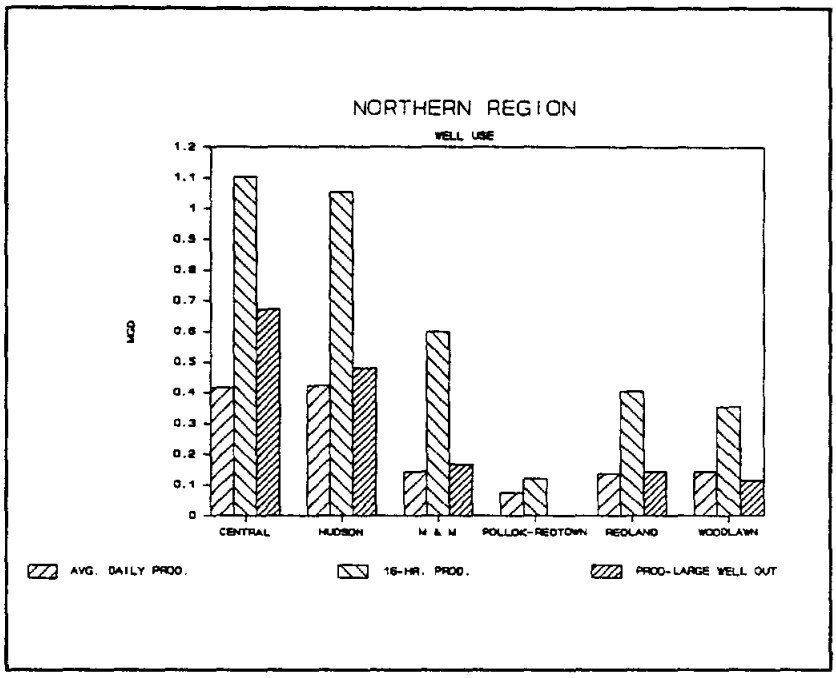


Figure 4-3

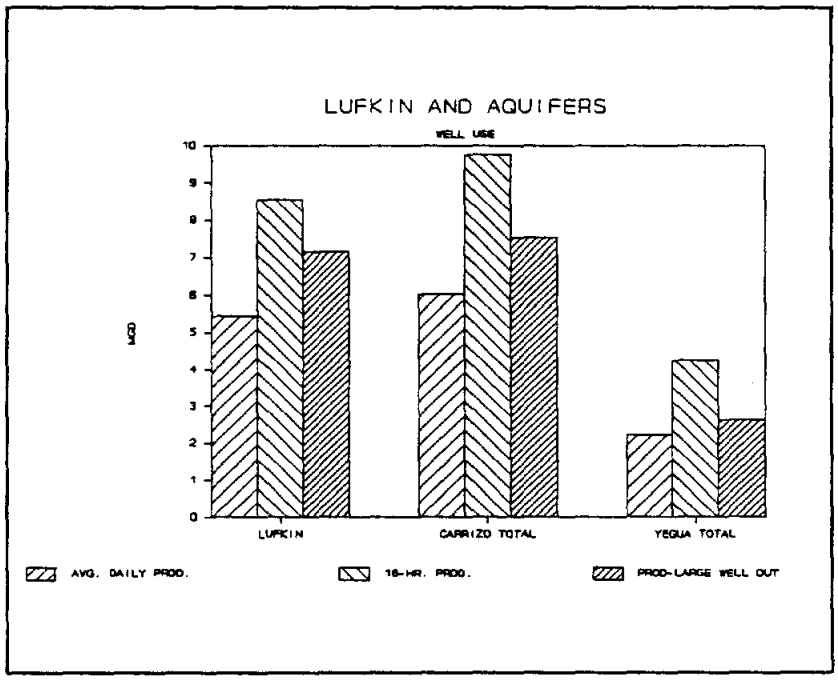


Figure 4-4

4.1.2 YEGUA AQUIFER

The Yegua Formation is far more broken than the Carrizo. Sands are often not continuous, and at times wells indicate a far greater capacity in an initial pumping test than can actually be sustained under continuous operating conditions. Additionally, many of the Yegua Wells have shown a degradation of water quality under years of pumping.

This worsening water quality generally has been in the amount of color, iron, or hydrogen sulfide, or a combination of those qualities.

The best Yegua wells are located in the Fuller Springs and Homer area, and in the Diboll area. However, test holes between those two areas either did not find good water availability, or found high color in the water. Burke's wells require ozonation in order to adequately deal with the color, which appears to be attributable to organic leachates.

Figure 4-7 locates the wells and plants of systems in Angelina County. Those lying south of Highway 103 are Yegua wells.

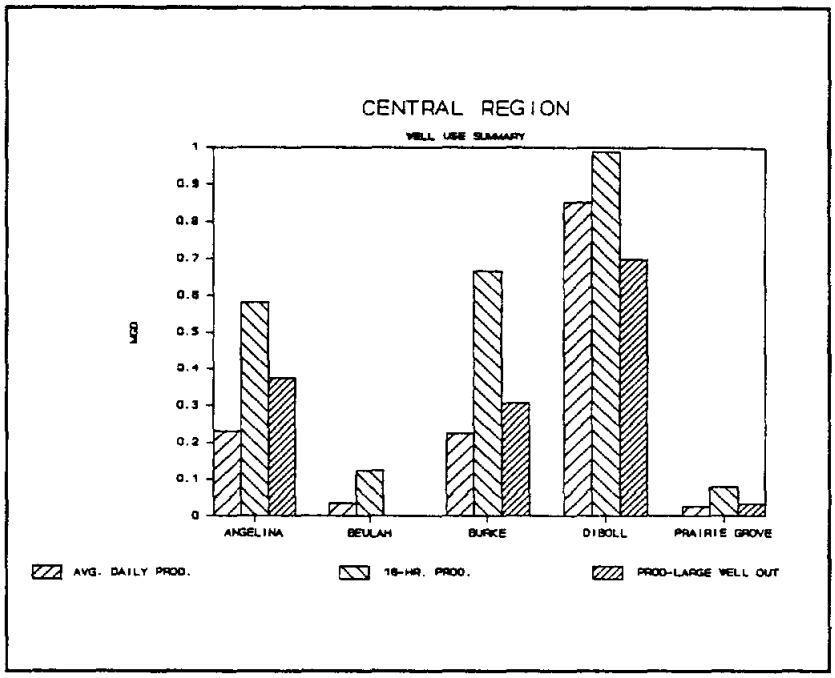


Figure 4-5

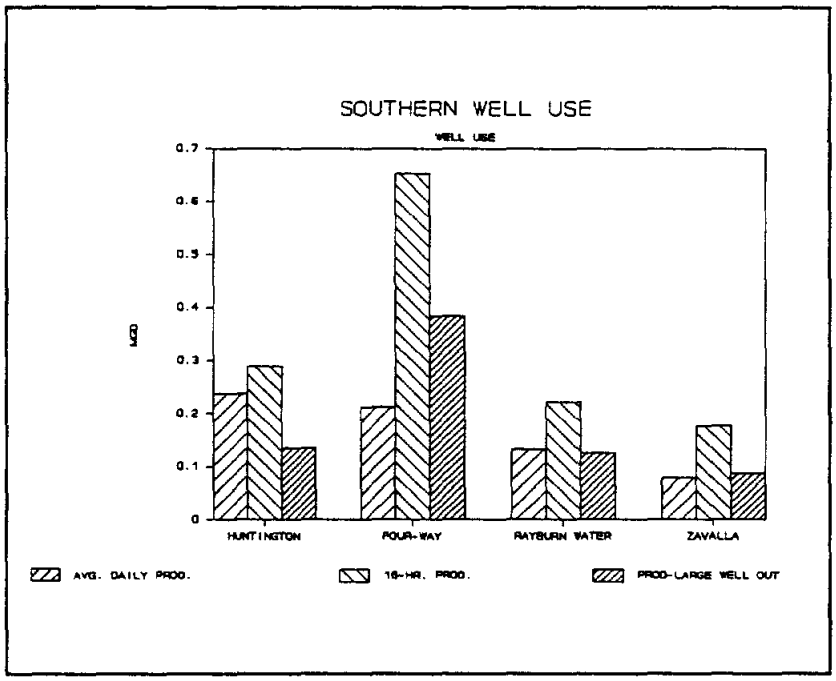


Figure 4-6

The estimated yield of the Yegua Formation according to Report 110 is 7 MGD.

The estimated 1988 pumpage by Angelina County entities is 2.23 MGD. Current wells have the capacity of producing 4.26 MGD. We do not recommend further development of the Yegua due to the broken nature of the sands, the difficulty in locating good sands and of proving them out, the relatively poor recharge which generally exists, and the worsening water quality which seems to be pervasive in most of the formation.

In some of the better areas where proper well spacing can be attained, some further development might take place. This area should probably be generally confined to the region between Lufkin and Huntington.

4.1.3 SAM RAYBURN RESERVOIR

Table 4-4 charts the potentially available water in Sam Rayburn Reservoir. The City of Lufkin is currently paying for storage and O & M Costs for 43,000 acre-feet of water storage to the Corps of Engineers. The storage payments will continue through the Year 2017. In addition, the City is on a take-or-pay contract with the Lower Neches Valley Authority for 28,000 acre-feet per annum of water from Sam Rayburn which will be paid out in the year 2014.

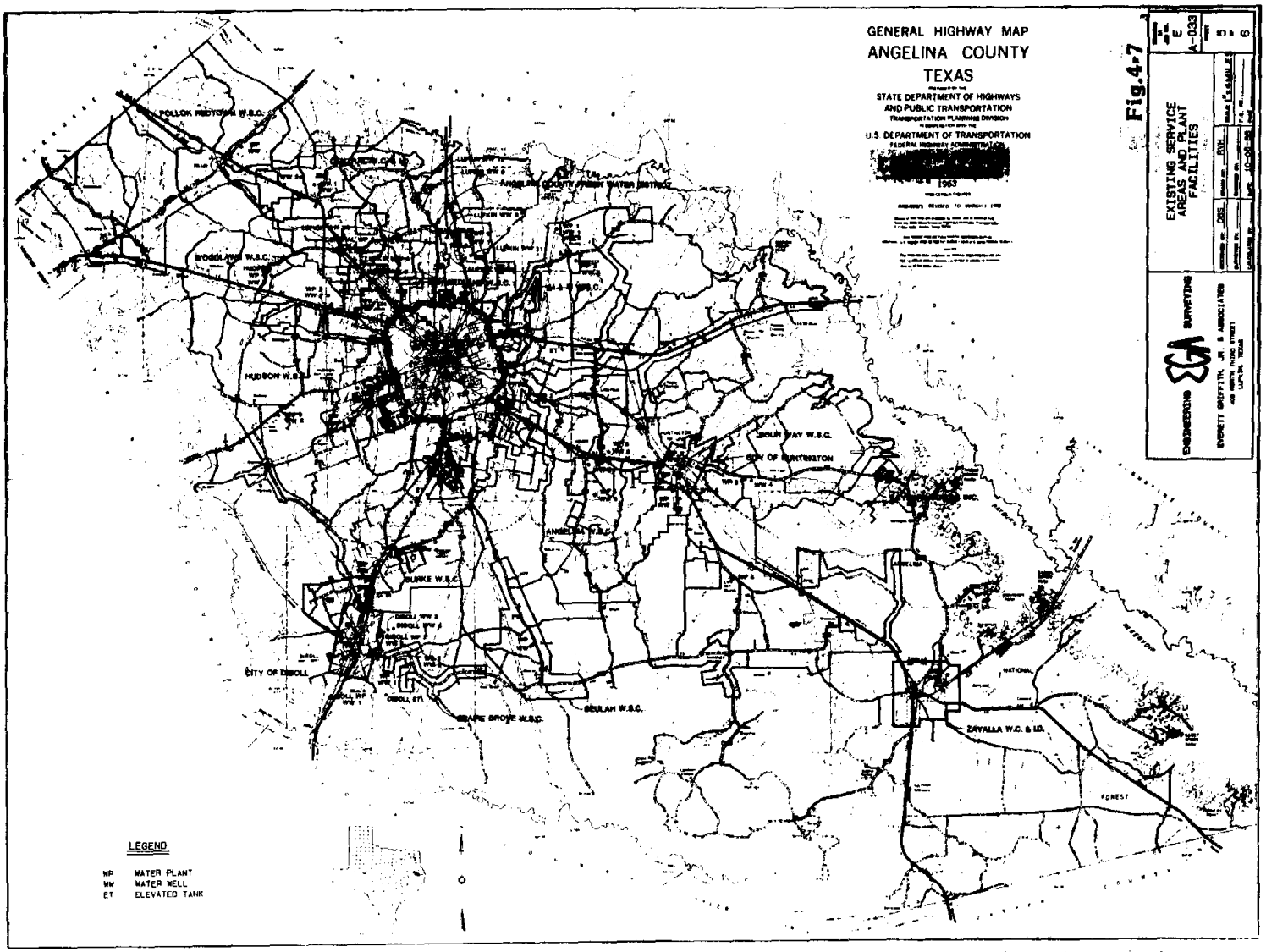
TABLE 4-4
POTENTIAL WATER AVAILABILITY
SAM RAYBURN RESERVOIR

CURRENT OR PROPOSED PURCHASER	QUANTITY (AC-FT)	QUANTITY (MGD)	COST ITEM	PAYEE	ANNUAL COST	COST/1000 GALS
CITY OF LUFKIN	43000	24.997,	STORAGE	CORPS OF ENGINEERS	$ 19,748	$0.0021
	43000	24.997,	O & M	CORPS OF ENGINEERS	$ 31,000	$0.0034
	28000	24.997	TAKE OR PAY	LNVA	$ 16,190	$0.0018
COUNTY ENTITIES	14467	8.409,	STORAGE,O&M	CORPS OF ENGINEERS	$ 91,903	$0.0338
	9420	8.409	TAKE OR PAY	LNVA	$ 43,804	$0.0117

, Quantities for MGD shown on actual yield and not on storage amounts.

Talks with the Lower Neches Valley Authority and the Corps of Engineers have established that there is 3000 acre-feet of water that is currently available subject to working out contracts with the Corps and LNVA and getting permitted with the State of Texas. Additionally, a preliminary contract (shown in Appendix F) has been prepared for a take-or-pay of another 11,467 acre-feet of water which involves a study by the Corps of Engineers. A preliminary study has been made and has concluded that a variation in conservation pool elevation of .1 foot would provide the additional water.

Assuming that these contracts could be consummated and permits obtained, there should be up to 14,467 acre-feet of water available in Sam Rayburn Reservoir not including that already owned by the City of Lufkin.


GENERAL HIGHWAY MAP
ANGELINA COUNTY
TEXAS
STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION
TRANSPORTATION PLANNING DIVISION
U.S. DEPARTMENT OF TRANSPORTATION
1963
Fig.4-7
EXISTING SERVICE AREAS AND PLANT FACILITIES
ENGINEERING SURVEYING
EVERETT GRIFFITH, JR. & ASSOCIATES
LUFKIN, TEXAS
POLLOK RURAL W.S.C.
HUDSON W.S.C.
BRUN WAY W.S.C.
CITY OF HUNTINGTON
BURKE W.S.C.
CITY OF DIBOLL
BEULAH W.S.C.
ZAVALLA W.C. & I.D.
FOREST
LEGEND
WP WATER PLANT
WW WATER WELL
ET ELEVATED TANK

4.1.4 LAKE EASTEX

The following Angelina County entities have maintained a right to purchase water in Lake Eastex.

City of Lufkin
Redland WSC
Woodlawn WSC
Angelina WSC
Temple-Inland

Table 6-1 fully lists all participants with water reserved.

There is, of course, much work remaining before Lake Eastex becomes a reality. Estimates are that the Lake will probably be constructed in 10 years. This lake, which will be upstream on the Angelina River, could serve entities through releases which could either be picked up out of the river, possibly out of some existing off-river reservoir such as Kurth Lake, or out of Sam Rayburn Reservoir.

There is a general assumption that, although all the water in Lake Eastex is tied up at this time, that by the time construction begins and true take-or-pay costs are established, there will be some water available. Therefore, this possibility is addressed in this report.

A detailed report on cost to deliver to the entities above is being prepared for the Angelina and Neches River Authority by Lockwood, Andrews, & Newnam, Inc.

4.2 ELEVATED, STORAGE, AND PUMPING FACILITIES

In the overall assessment of needs of the systems of the County, the elevated, storage, and pumping facilities must be considered. These affect the ability of an entity to provide water. They also control to some degree how water from a regional entity can be delivered to the system. The following Table 4-5 indicates the various system capacities in the County.

These capacities will be further analyzed in Chapter 5. Generally, Burke WSC, Central WCID, the City of Diboll, Hudson WSC, the City of Huntington, M & M WSC, Redland WSC, the City of Lufkin, and Zavalla WCID are operating off of Elevated Storage type systems. The other systems have pressure maintained by hydro-pneumatic pressure tanks.

Plant locations are shown in Figure 4-7.

TABLE 4-5
TOTAL CONNECTIONS AND CAPACITIES

SYSTEM	GROUND STORAGE CAPACITY (GAL.)	BOOSTER PUMPS CAPACITY (GPM)	WELL CAPACITY (GPM)	PRESSURE TANK CAPACITY (GAL.)	ELEVATED STORAGE CAPACITY (GAL.)	NUMBER OF PLANTS	NUMBER OF CURRENT CONNECTIONS
ANGELINA WSC	280000	1700	605	22500	0	3	859
BEULAH WSC	80000	270	130	6500	0	1	155
BURKE WSC	200000	600	695	0	150000	3	837
CENTRAL WCID	200000	1400	1150	0	250000	2	1635
CITY OF DIBOLL	750000	1100	1030	0	500000	4	1375
FOUR-WAY WSC	330000	2690	640	22000	0	6	990
HUDSON WSC	315000	1200	1100	10000	250000	4	1472
CITY OF HUNTINGTON	191000	1200	302	8000	50000	2	766
CITY OF LUFKIN	4000000	8000	9000	0	2400000	4	11555
M & M WSC	165000	1150	625	0	75000	3	677
POLLOK-REDTOWN WSC	60000	580	125	6000	0	1	300
PRAIRIE GROVE WSC*	26000	150	72	3500	0	2	120
RAYBURN WATER, INC.	46600	350	237	5830	0	2	78
REDLAND WSC	113500	1400	425	7500	50000	2	607
WOODLAWN WSC	130000	960	370	15000	0	2	550
ZAVALLA WCID	25000	240	185	0	75000	2	368

4.3 SUPPLY AND DISTRIBUTION LINES

The scope of this report does not allow for a full mapping of all systems in the County. However, as a general rule most of the improvements in the Water Supply Corporations consist of thin wall PVC pipe. Normally, pipe of 4" diameter and below is of a Class 200 pipe, and sizes above are generally Class 160 (SDR 26). The improvements in the cities have normally been of Asbestos Cement, C900 PVC pipe, Concrete Cylinder Pipe, or Ductile Iron. Lines in Central WCID are primarily Asbestos Cement with some steel and some SDR 21 and SDR 26 PVC pipe.

None of the rural systems have been able to fully design for fire flows, although some have attempted to provide such flows in critical areas and to provide fire hydrants in some locations. The larger pipe sizes(6" and above) have generally been confined to the larger systems and areas with greater densities. The preponderance of pipe in the rural areas is 4" diameter or smaller.

The systems with some potential for transporting water through to other areas include:

City of Lufkin
Central WCID
Burke WSC
Four-Way WSC
City of Huntington
Zavalla WCID

Of these, only the City of Lufkin and Central WCID appear to have lines large enough accommodate such pass-through flows. Probably the City of Lufkin will need improvements which can be shared with the regional system, while Central's ability to transport through to Pollok-Redtown is marginal and will depend upon the amount of water needed.

5.0 DETERMINATION OF NEEDS

The primary purpose of this report is to determine the extent of needs of sources for water supply, and what solutions would provide the most cost-efficient benefits. However, as a secondary concern, the study also addresses needs in pressure, storage, and somewhat in supply and distribution.

The design parameters used to determine needs are in most instances drawn from Rules & Regulations for Public Water Systems as adopted in 1988 by the Texas Department of Health, Water Hygiene Division. Additional considerations include rules by the State Fire Insurance Board.

Relevant excerpts are listed below.

For more than 250 connections, the system must meet the following requirements.

(i) Total storage capacity of 200 gallons per connection must be provided.

(ii) Pressure maintenance facilities must either have elevated storage based on 100 gallons per connection or pressure tank capacity of 20 gallons per connection with a maximum of 30,000 gallons for systems with less than 2,500 connections. Elevated storage in the amount of 100 gallons per connection is required for systems with over 2,500 connections.

(iii) Well capacity must be such that two or more wells having a total capacity of 0.6 gallons per minute per connection are provided. Where an interconnection is provided with another acceptable water system capable of supplying at least 0.35 gallons per minute for each connection in the combined system under emergency conditions, an additional well will not be required as long as the 0.6 gallons per minute per connection requirement is met for each system on an individual basis.

(iv) Service pump capacity must be such that each pump station or pressure plane shall have two or more pumps having a total capacity of 2.0 gallons per minute per connection or total capacity of 1000 gallons per minute and be able to meet peak demands, whichever is less.

5.1 NEEDS IN SOURCES OF WATER

The needs for sources of water is examined both in the perspective of the individual entities, and as a regional group. Estimates of alternatives are also based in this way so that each entity can compare cost factors for individual courses of action as opposed to group effort.

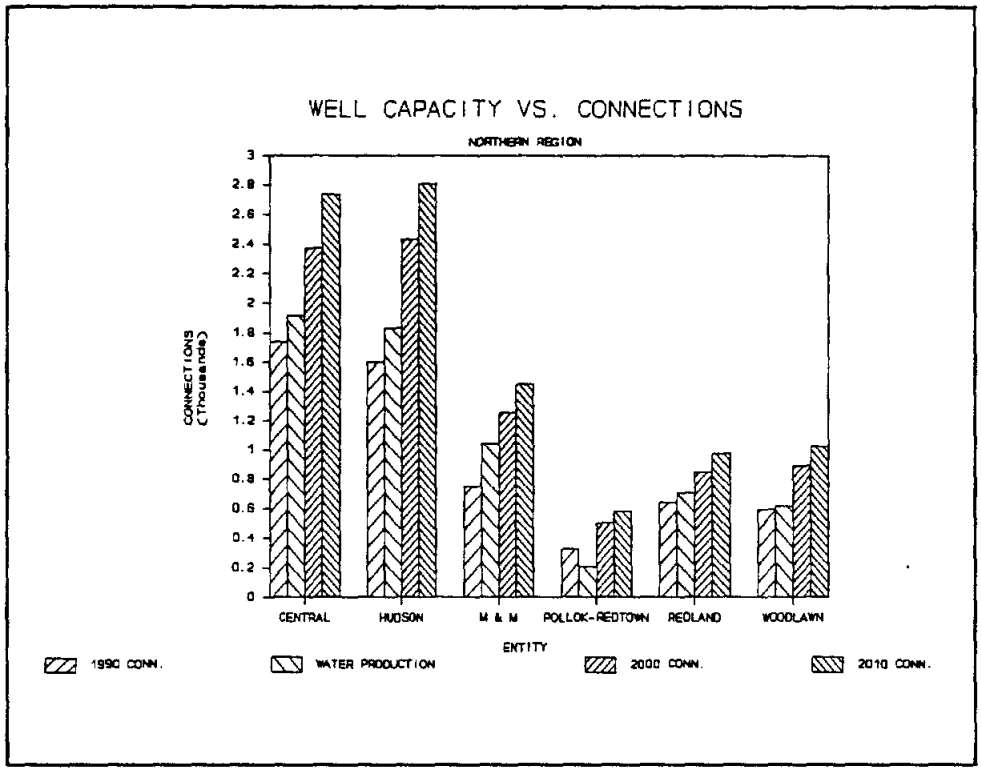


Figure 5-1

5.1.1 INDIVIDUAL ENTITIES

Generally, the design parameters for sources of water are identified in the excerpt from the Rules & Regulations for Public Water Systems quoted above. The general rule is that each system must have 0.6 gpm capacity per connection.

Water production needs are illustrated in Figures 5-1, 5-2, 5-3, and 5-4. These bar graphs show current water production capacities in connections (based on 0.6 gpm per connection) against 1990, 2000, and 2010 projected number of connections. All entities will be short of water production capabilities by the Year 2010. Table 5-1 shows entities by the year they will require more water production.

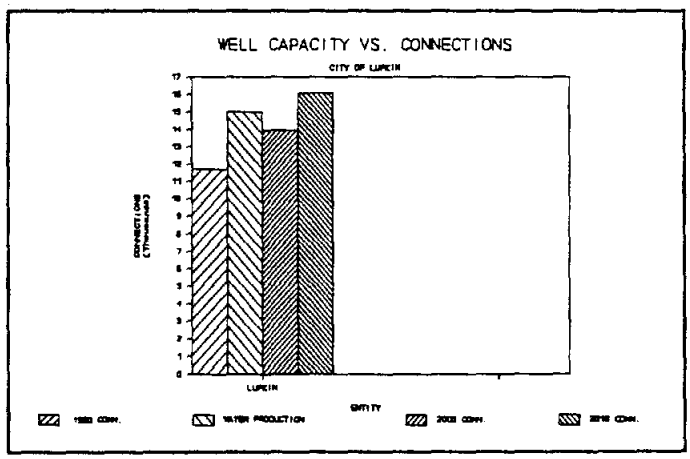


Figure 5-2

Four entities need to address immediate water production shortage needs. These include the Cities of Diboll and Huntington, Pollok Redtown WSC, and Zavalla WCID. Diboll's shortage is based on equivalent water connections. When considering that a large part of their consumption is commercial or industrial with lesser peaking factors, the shortfall at Diboll may not be of as serious nature.

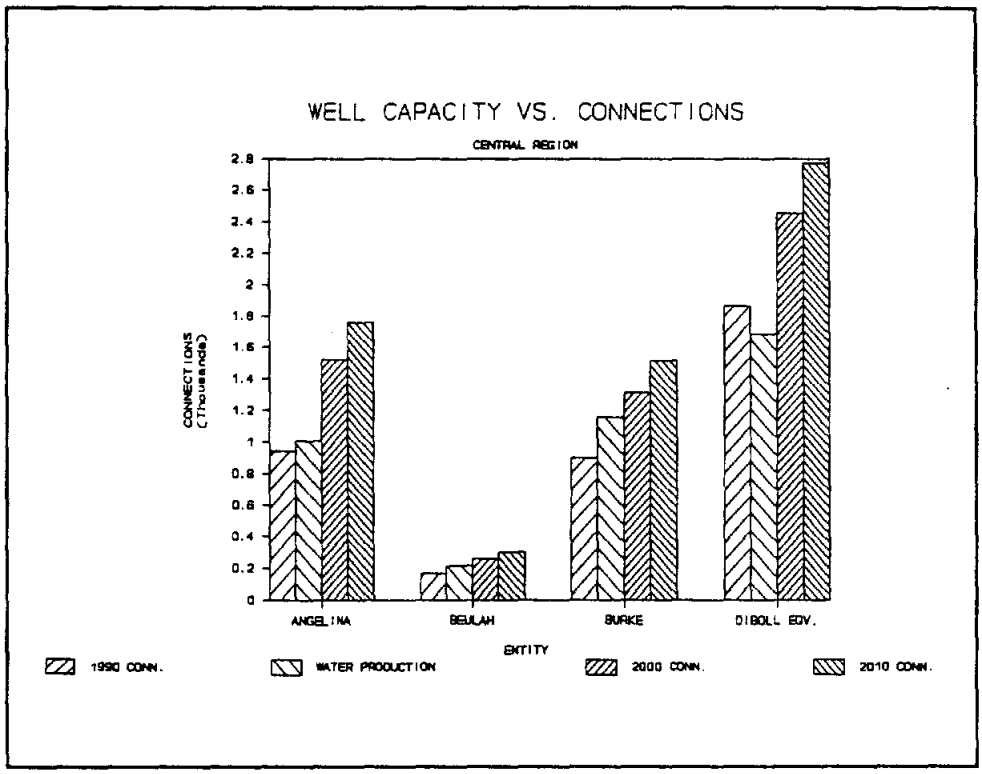


Figure 5-3

All other entities besides the City of Lufkin will need greater water production capacities by the Year 2000. Surface water alternatives, at best, would require several years for implementation. Even a regional well supply system might require at least two years to bring to fruition. This indicates that efforts should begin imme-

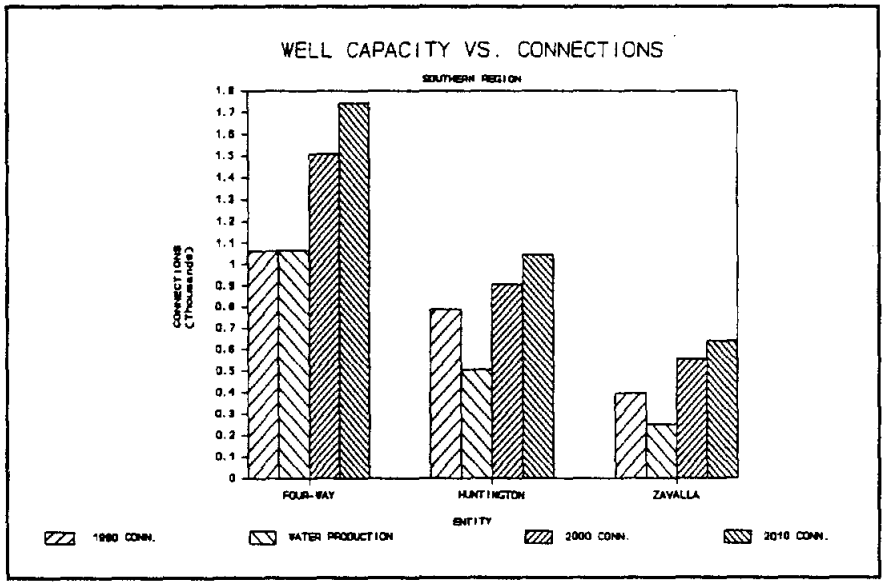


Figure 5-4

diately to meet the needs of the short-term future. This shorter-term plan should be compatible with an overall plan that best addresses all the needs of the County entities.

5.1.2 REGIONAL ENTITY

A regional entity would be required to best address the water production needs in the most economical and beneficial manner. If surface water becomes the option, then minimum cost-effective sizes of treatment plants becomes a major consideration. Additionally, great lengths of pipe would be required to bring water from a surface water source. Significant economies of scale can be recognized by a regionally operated system.

If a groundwater alternative is selected, an orderly development of the well field would be absolutely required. With proper spacing and sizing, aquifers such as the Carrizo could be fully developed. Additionally, lines coming in from the well field could be shared in order to minimize costs of transporting the water back to the users.

Financing has become a major consideration, especially for non-tax base entities such as non-profit water supply corporations. Savings of as much as 2-3% in interest can be accomplished by either cities or properly organized districts.

Operation and maintenance is becoming increasingly complex, even for basic operations such as production of water from water wells. A regional entity might well have advantages in being able to address the ever-changing nature of federal and state regulations.

Although the supply of water probably accommodates well the idea of regionalization, the other operations of the systems seems to best be handled on an individual basis by the respective boards.

The needs of the regional system would essentially be the compilation of the needs of all of the entities. Some savings might be recognized if the Health Department is willing to consider a relaxation of its 0.6 gpm minimum well capacity in light of the expected overall lower peaking factors of a larger entity.

5.2 NEEDS IN ELEVATED STORAGE, GROUND STORAGE, AND PUMPING FACILITIES

The Health Department has general guidelines as outlined above in Section 5.0. These parameters must be considered in conjunction with a consideration of fire flows, actual flow conditions, and computer modelling of systems. However, they do serve a valid function of providing a rule against which each system's existing capacities can be measured.

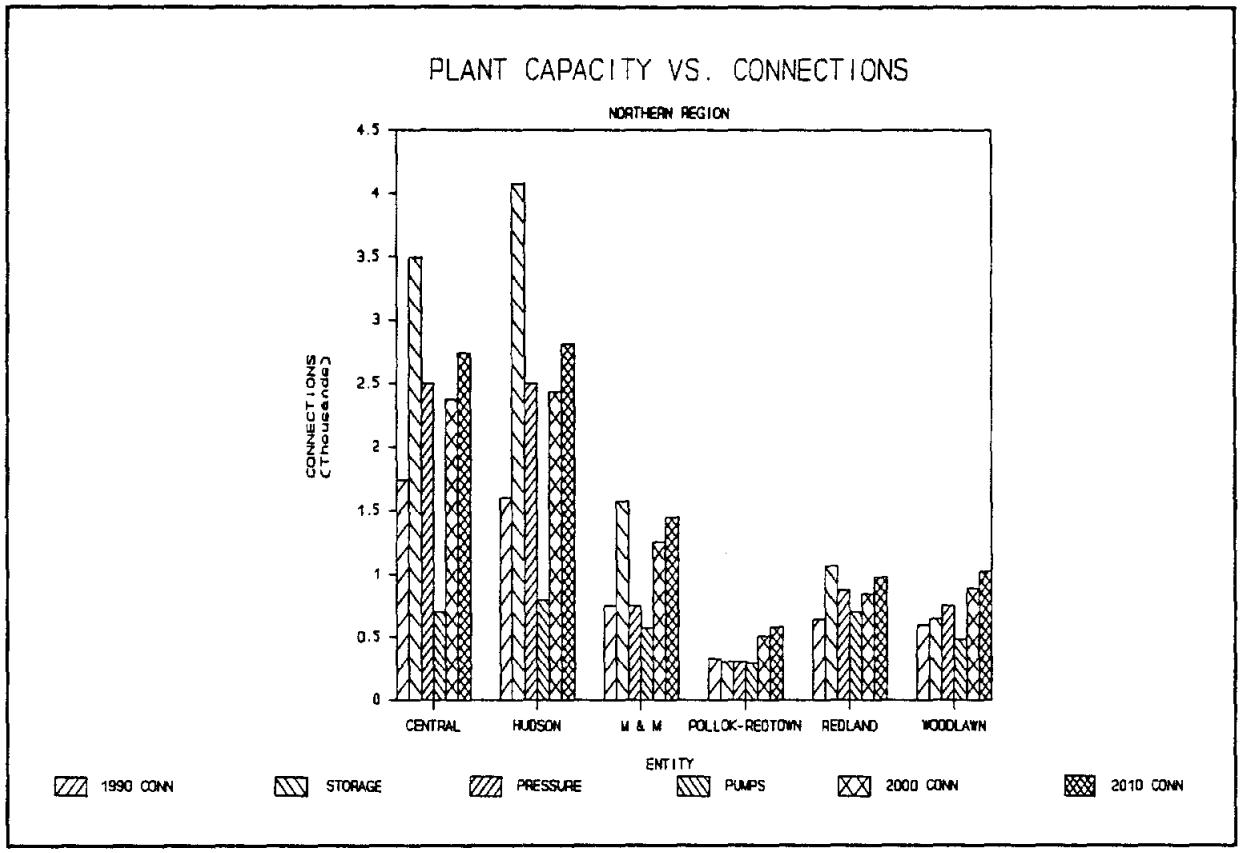


Figure 5-5

The needs of each system may be met either through facilities constructed by individual entities or possibly through those constructed by the regional system. Because of this dual possibility, this report looks at both the individual needs as well as the overall requirements for the regional system.

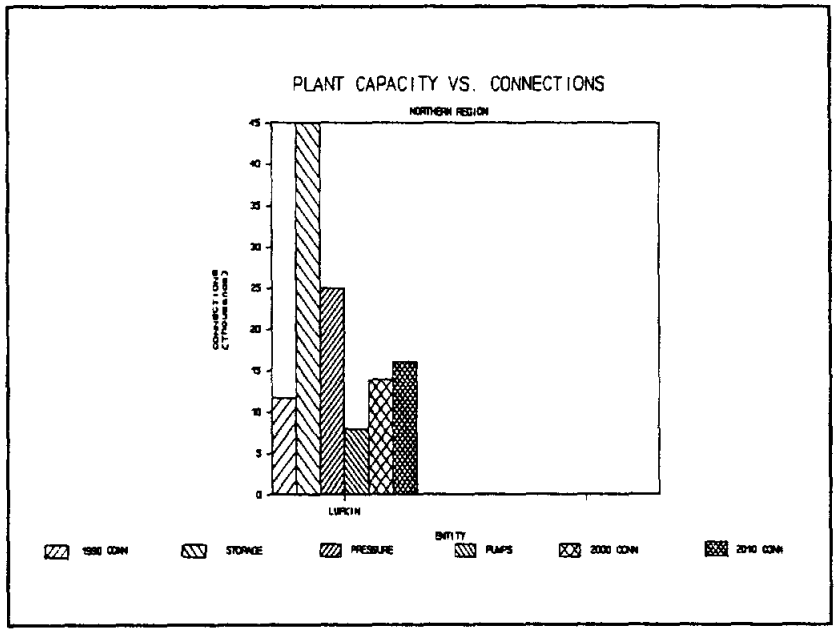


Figure 5-6

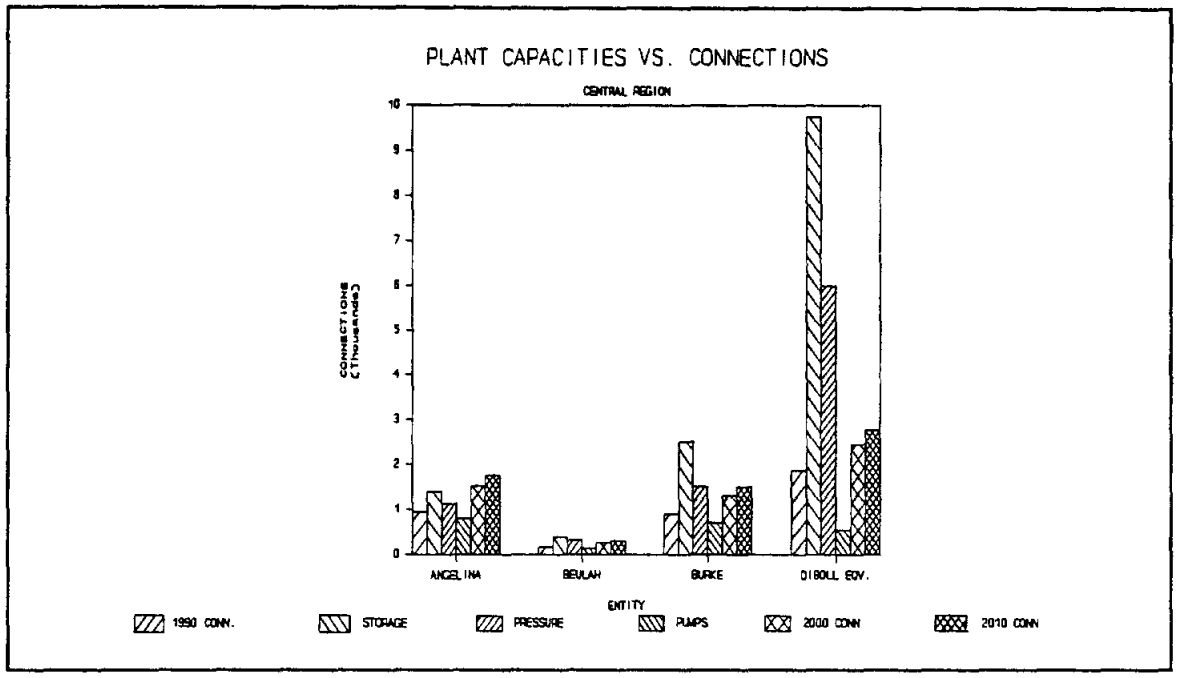


Figure 5-7

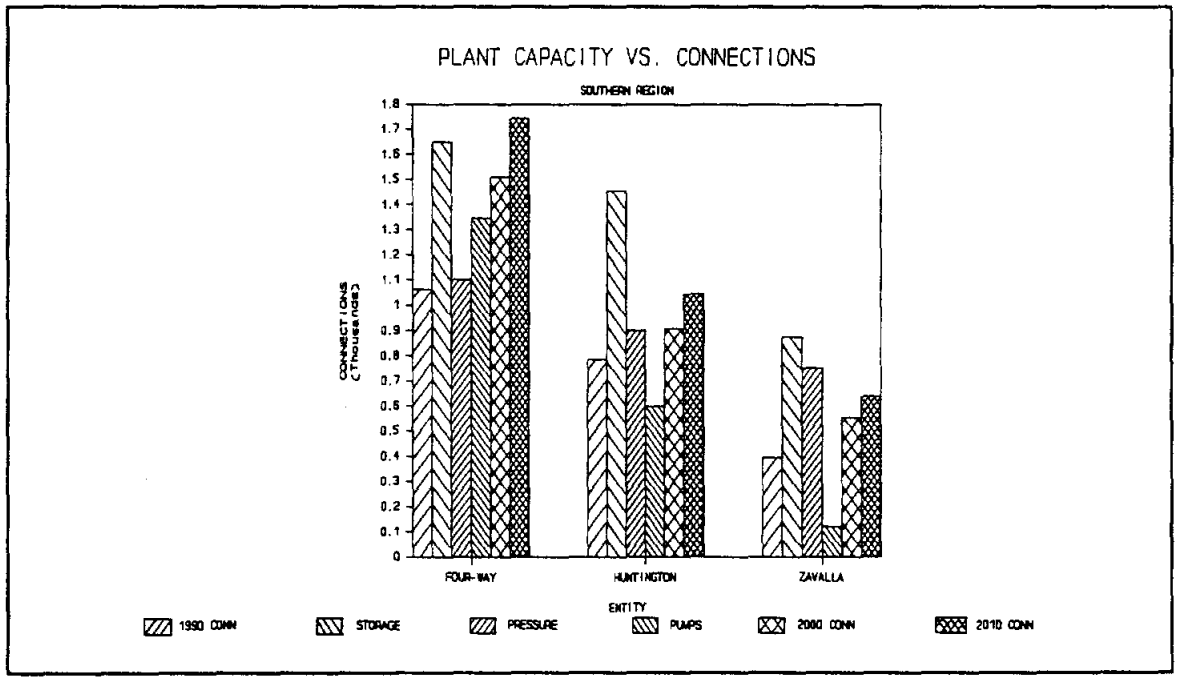


Figure 5-8

5.2.1 INDIVIDUAL ENTITIES

Figures 5-5, 5-6, 5-7, and 5-8 illustrate through bar graphs the capacities of the individual systems in storage, pressure, and pumping capacity in connection capacities. These calculations are compared to connections expected in the years 1990, 2000, and 2010. The

water purveyors have been grouped by regions as discussed previously. The charts should be self-explanatory.

Table 5-1 lists those entities deficient at the given year in the listed parameter.

TABLE 5-1
WATER PLANT NEEDS

YEAR	STORAGE	PRESSURE	WATER PRODUCTION	PUMPING
1990	Pollok-Redtown	M & M WSC Pollok-Redtown	Diboll Huntington Pollok-Redtown Zavalla WCID	Beulah WSC Pollok-Redtown Woodlawn WSC Zavalla WCID
2000	Angelina WSC Four-Way WSC M & M WSC Woodlawn WSC	Angelina WSC Four-Way WSC Huntington Woodlawn WSC	Angelina WSC Beulah WSC Burke WSC Central WCID Four-Way WSC Hudson WSC M & M WSC Redland WSC Woodlawn WSC	
2010		Burke WSC Central WCID	City of Lufkin	Hudson WSC

The most immediate problems include water supply and booster pump capacity. Most of the water production shortfall occurs in the central and southern part of the County which is drawing from the Yegua Formation.

Four systems are currently short of water production capabilities, and will be joined within ten years by eight others. The remaining two systems will be short by 2010.

Due to changes in Health Department regulations which now allow Elevated Storage tank capacities to count in the overall storage capacity, most of the systems with elevated tanks are in good condition relevant to storage. The only system with elevated storage tanks that will fall short in storage capacity in the next twenty years is M & M WSC. Those systems which are currently on Hydro-pneumatic systems would be well advised to consider, where possible, the construction of elevated storage in the future to address both pressure and storage requirements. The only system with immediate needs in storage is the Pollok-Redtown WSC, which has grown rapidly since its inception a few years ago.

The systems needing immediate attention to pressure capacities include Pollok-Redtown, a hydro-pneumatic type system, and M & M WSC, which operates with an elevated tank. Three more water supply corporations and the City of Huntington will be short of pressure facilities by the Year 2000.

Tables 5-2, 5-3 and 5-4 describe in detail the projected needs of the County systems for the years 1990, 2000 and 2010.

TABLE 5-2
YEAR 1990
ANGELINA COUNTY
WATER SYSTEM NEEDS-PLANTS AND WATER SUPPLY
TEXAS STATE DEPARTMENT OF HEALTH REQUIREMENTS
FOR DRINKING WATER ONLY
8-3-88

WATER AGENCY	STORAGE			ELEVATED STORAGE				WATER PRODUCTION			BOOSTER PUMP		
	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE	NEEDS	TYPE *	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE) **
1. ANGELINA WSC	189000	280000	91000	18900	PT	22500	3600	567	605	38	1890	1600	-290
2. BEULAH WSC	33800	80000	46200	3380	PT	6500	3120	101	130	29	338	270	-68
3. BURKE WSC	180400	350000	169600	90200	ET	150000	59800	541	695	154	1804	1400	-404
4. CENTRAL WCID	348000	450000	102000	174000	ET	250000	76000	1044	1150	106	3480	1400	-2080
5. DIBOLL	294200	1350000	1055800	147100	ET	600000	452900	883	1010	127	2942	1100	-1842
CONNECTION EQUIV.	372796	1350000	977204	186398	ET	600000	413602	1118	1010	-108	3728	1100	-2628
6. FOUR-WAY WSC	212400	330000	117600	21240	PT	22000	760	637	640	3	2124	2690	566
7. HUDSON WSC	320200	565000	244800	160100	ET	250000	89900	961	1100	139	3202	1600	-1602
8. HUNTINGTON	157600	241000	83400	78800	ET	50000	11200	473	302	-171	1576	1200	-376
					PT	8000							
9. LUFKIN	2340400	6500000	4159600	1170200	ET	2500000	1329800	7021	9000	1979	23404	8000	-15404
12. M & M WSC	150200	240000	89800	75100	PT	75000	-100	451	625	174	1502	1150	-352
13. POLLOK-REDTOWN WSC	65400	60000	-5400	6540	PT	6000	-540	196	125	-71	654	580	-74
14. PRAIRIE GROVE WSC													
15. RAYBURN WATER, INC													
16. REDLAND WSC	128400	163500	35100	64200	ET	50000	23300	385	425	40	1284	1400	116
					PT	7500							
17. WOODLAWN WSC	119200	130000	10800	11920	PT	15000	3080	358	370	12	1192	960	-232
18. ZAVALLA WCID	78800	100000	21200	39400	ET	75000	35600	236	150	-86	788	240	-548

*PT=Pressure Tank,
ET=Elevated Storage Tank
**Over 1000 gpm must be analyzed on individual basis

TABLE 5-3
YEAR 2000
ANGELINA COUNTY
WATER SYSTEM NEEDS-PLANTS AND WATER SUPPLY
TEXAS STATE DEPARTMENT OF HEALTH REQUIREMENTS
FOR DRINKING WATER ONLY
8-3-88

WATER AGENCY	STORAGE			ELEVATED STORAGE				WATER PRODUCTION			BOOSTER PUMP		
	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	TYPE	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE) **
1. ANGELINA WSC	305000	280000	-25000	30500	PT	22500	-8000	915	605	-310	3050	1600	-1450
2. BEULAH WSC	52600	80000	27400	5260	PT	6500	1240	158	130	-28	526	270	-256
3. BURKE WSC	262400	350000	87600	131200	ET	150000	18800	787	1400	613	2624	1400	-1224
4. CENTRAL WCID	474600	450000	-24600	237300	ET	250000	12700	1424	1150	-274	4746	1400	-3346
5. DIBOLL	412200	1350000	937800	206100	ET	600000	393900	1237	1010	-227	4122	1100	-3022
CONNECTION EQUIV.	490796	1350000	859204	245398	ET	600000	354602	1472	1010	-462	4908	1100	-3808
6. FOUR-WAY WSC	302000	330000	28000	30200	PT	22000	-8200	906	640	-266	3020	2690	-330
7. HUDSON WSC	487200	565000	77800	243600	ET	250000	6400	1462	1100	-362	4872	1600	-3272
8. HUNTINGTON	181400	241000	59600	90700	ET	50000	-700	544	302	-242	1814	1200	-614
					PT	8000							
9. LUFKIN	2792600	6500000	3707400	1396300	ET	2500000	1103700	8378	9000	622	27926	8000	-19926
12. M & M WSC	251600	240000	-11600	125800	ET	75000	-50800	755	625	-130	2516	1150	-1366
13. POLLOK-REDTOWN WSC	101000	60000	-41000	10100	PT	6000	-4100	303	125	-178	1010	580	-430
14. PRAIRIE GROVE WSC													
15. RAYBURN WATER, INC													
16. REDLAND WSC	170000	163500	-6500	85000	ET	50000	2500	510	425	-85	1700	1400	-300
					PT	7500							
17. WOODLAWN WSC	178000	130000	-48000	17800	PT	15000	-2800	534	370	-164	1780	960	-820
18. ZAVALLA WCID	110800	100000	-10800	55400	ET	75000	19600	332	150	-182	1108	240	-868

*PT=Pressure Tank,
ET=Elevated Storage Tank
**Over 1000 gpm must be analyzed on individual basis

TABLE 5-4
YEAR 2010
ANGELINA COUNTY
WATER SYSTEM NEEDS-PLANTS AND WATER SUPPLY
TEXAS STATE DEPARTMENT OF HEALTH REQUIREMENTS
FOR DRINKING WATER ONLY
8-3-88

WATER AGENCY	STORAGE			ELEVATED STORAGE				WATER PRODUCTION			BOOSTER PUMP		
	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	TYPE	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE)	NEEDS	PRESENT CAPACITY	OVERAGE (SHORTAGE) **
1. ANGELINA WSC	351800	280000	-71800	35180	PT	22500	-12680	1055	605	-450	0	1600	1600
2. BEULAH WSC	60800	80000	19200	6080	PT	6500	420	182	130	-52	608	270	-338
3. BURKE WSC	302800	350000	47200	151400	ET	150000	-1400	908	1400	492	3028	1400	-1628
4. CENTRAL WCID	547400	450000	-97400	273700	ET	250000	-23700	1642	1150	-492	5474	1400	-4074
5. DIBOLL	475600	1350000	874400	237800	ET	600000	362200	1427	1010	-417	4756	1100	-3656
CONNECTION EQUIV.	554196	1350000	795804	277098	ET	600000	322902	1663	1010	-653	5542	1100	-4442
6. FOUR-WAY WSC	348400	330000	-18400	34840	PT	22000	-12840	1045	640	-405	3484	2690	-794
7. HUDSON WSC	562000	565000	3000	281000	ET	250000	-31000	1686	1100	-586	5620	1600	-4020
8. HUNTINGTON	209200	241000	31800	104600	ET	50000	-14600	628	302	-326	2092	1200	-892
					PT	8000							
9. LUFKIN	3221400	6500000	3278600	1610700	ET	2500000	889300	9664	9000	-664	32214	8000	-24214
12. M & M WSC	290200	240000	-50200	145100	ET	75000	-70100	871	625	-246		0	0
13. POLLOK-REDTOWN WSC	116400	60000	-56400	11640	PT	6000	-5640	349	125	-224		0	0
14. PRAIRIE GROVE WSC													
15. RAYBURN WATER, INC													
16. REDLAND WSC	196000	163500	-32500	98000	ET	50000	-10500	588	425	-163	1960	1400	-560
					PT	7500							
17. WOODLAWN WSC	205400	130000	-75400	20540	PT	15000	-5540	616	370	-246	2054	960	-1094
18. ZAVALLA WCID	128000	100000	-28000	64000	ET	75000	11000	384	150	-234	1280	240	-1040

*PT=Pressure Tank,
ET=Elevated Storage Tank
**Over 1000 gpm must be analyzed on individual basis

5.2.2 REGIONAL SYSTEM

The water plant and supply line requirements of a regional system will depend upon the source of water. The requirements of the Health Department of a supply of 0.6 gpm per connection must be met. In the case of a surface water solution, a plant is normally operated 24 hours per day. However, the 0.6 gpm parameter is such that a water well supplying the required minimum 0.6 gpm will operate only about 7 hours per day to meet normal daily demands.

On the other hand, a surface water plant should normally be operated on a 24-hour per day basis. Therefore, if it is sized to meet the 0.6 gpm requirement but is operated on a 24-hour basis, the participating entities will be required to purchase a much greater quantity than they might otherwise. With this larger sized plant, some of the other plant improvements will be increased as well.

Tables 5-5 and 5-6 illustrate this difference in required takes for each entity with the surface water and water well alternatives. Total design demands for the surface water alternatives would be 4.4 MGD in the Year 2000 and 7.4 MGD in 2010. For the water well option those same year demands would be only 3.2 MGD and 6.3 MGD respectively.

Water plants, storage, pumping stations, and supply lines must be sized accordingly.

TABLE 5-5
SURFACE WATER OPTION
PROJECTED WATER TAKE QUANTITIES
WET WEATHER DEMANDS

WATER AGENCY	1987-88 AVERAGE DAILY USAGE	CURRENT WELL CAPACITIES (GPM)	1990 SUPPLY SHORTAGE (OVERAGE) GPM)	LIKELY WELL CAPACITIES 2000 (GPM)	PROJECTED SUPPLY SHORTAGE (OVERAGE) 2000 (GPM)	LIKELY WELL CAPACITIES 2010 (GPM)	PROJECTED SUPPLY SHORTAGE (OVERAGE) 2010 (GPM)	2000 WATER SUPPLY		2010 WATER SUPPLY	
								GROUND WATER (DAILY)	SURFACE WATER (DAILY)	GROUND WATER (DAILY)	SURFACE WATER (DAILY)
ANGELINA WSC	230,600	605	(38)	605	310	425	630	195,418	298,817	0	570,087
BEULAH WSC	34,200	130	(28)	130	28	130	52	42,385	27,021	29,640	50,418
BURKE WSC	224,849	695	(154)	375	412	375	533	22,847	397,691	0	485,285
CENTRAL WC&ID	417,050	1,150	(106)	1,150	274	1,150	492	458,862	264,162	359,056	474,875
DIBOLL	851,614	1,030	73	1,030	516	730	1,053	569,034	497,957	214,412	1,016,334
FOUR-WAY WSC	212,877	680	(43)	500	406	430	615	0	387,386	0	446,905
HUDSON WSC	423,829	1,100	(139)	1,100	362	950	736	486,035	349,095	253,030	710,270
HUNTINGTON	237,591	302	171	160	384	0	628	0	272,066	0	313,760
LUFKIN	5,433,355	8,900	(123)	8,350	2,122	7,350	4,730	4,365,910	2,047,547	2,834,490	4,563,745
M&M WSC	142,875	625	(175)	625	130	300	570	191,875	125,020	0	365,530
POLLOK-REDTOWN WSC	74,941	125	71	125	178	125	224	0	150,636	0	173,605
PRAIRIE GROVE WSC		100		40		40					
REDLAND WSC	138,463	425	(40)	425	85	300	288	0	231,532	0	266,943
WOODLAWN WSC	143,618	370	(13)	370	164	370	246	119,453	158,227	82,891	237,534
ZAVALLA WC&ID	79,258	150	86	92	241	92	292	0	142,587	0	164,470
OTHER PUBLIC ENTITIES		0	0	0	432	0	504		283,135		330,324
TOTALS	8,236,700	15,182	402	13,932	5,542	11,802	10,667	6,094,564	5,148,814	3,660,998	9,312,046
TOTAL OF ALL	8,645,118	16,387	402	15,077	6,043	12,767	11,595	6,451,820	5,632,880	3,773,520	10,170,085
NON-PARTICIP. TOTAL	408,418	1,205	(0)	1,145	502	965	929	357,256	484,066	112,531	858,038

TABLE 5-6
WATER WELL OPTION
PROJECTED WATER TAKE QUANTITIES
WET WEATHER DEMAND

WATER AGENCY	1987-88 AVERAGE DAILY USAGE	CURRENT WELL CAPACITIES (GPM)	1990 SUPPLY SHORTAGE (OVERAGE) (GPM)	LIKELY WELL CAPACITIES 2000 (GPM)	PROJECTED SUPPLY SHORTAGE (OVERAGE) 2000 (GPM)	LIKELY WELL CAPACITIES 2010 (GPM)	PROJECTED SUPPLY SHORTAGE (OVERAGE) 2010 (GPM)	2000 WATER SUPPLY GROUND WAT. FROM EXIST. WELLS (DAILY)	2000 WATER SUPPLY GROUND WAT. FROM NEW WELLS (DAILY)	2010 WATER SUPPLY GROUND WAT. FROM EXIST. WELLS (DAILY)	2010 WATER SUPPLY GROUND WAT. FROM NEW WELLS (DAILY)
ANGELINA WSC	230,600	605	(38)	605	310	425	630	336,278	157,957	248,734	321,353
BEULAH WSC	34,200	130	(28)	130	28	130	52	55,122	14,284	53,407	26,651
BURKE WSC	224,849	695	(154)	375	412	375	533	210,316	210,222	213,251	272,034
CENTRAL WC&ID	417,050	1,150	(106)	1,150	274	1,150	492	583,387	139,638	582,909	251,022
DIBOLL	851,614	1,030	73	1,030	516	730	1,053	726,349	340,642	535,493	695,253
FOUR-WAY WSC	212,877	680	(43)	500	406	430	615	180,326	207,060	133,153	313,752
HUDSON WSC	423,829	1,100	(139)	1,100	362	950	736	650,596	184,534	587,846	375,453
HUNTINGTON	237,591	302	171	160	384	0	628	76,124	195,942	0	313,760
LUFKIN	5,433,355	8,900	(123)	8,350	2,122	7,350	4,730	5,012,772	1,400,685	4,276,270	3,121,965
M&M WSC	142,875	625	(175)	625	130	300	570	250,809	66,086	74,632	290,898
POLLOK-REDTOWN	74,941	125	71	125	178	125	224	59,856	90,780	59,263	114,342
PRAIRE GROVE		100		40		40					
REDLAND WSC	138,463	425	(40)	425	85	300	288	188,182	43,350	120,063	146,880
WOODLAWN WSC	143,618	370	(13)	370	164	370	246	194,040	83,640	194,863	125,562
ZAVALLA WC&ID	79,258	150	86	92	241	92	292	19,838	122,750	15,681	148,789
OTHER PUBLIC ENTITIES		0	0	0	432	0	504		220,320		257,040
TOTALS	8,236,700	15,182	402	13,932	5,542	11,802	10,667	7,958,554	3,222,009	6,598,561	6,301,190
TOTAL	8,645,118	16,387	402	15,077	6,043	12,767	11,595	8,543,995	3,477,889	7,095,564	6,774,756
NON-PARTIC. TOTAL	408,418	1,205	0	1,145	502	965	929	585,441	255,880	497,003	473,566

6.0 WATER SUPPLY ALTERNATIVES

6.1 GENERAL

This study is not intended to be an exhaustive survey of every water supply alternative. It is intended to address the more significant and viable options. Those are outlined below. Reference is made to Chapter 4 where current water sources are identified and current usage is summarized.

6.2 GROUNDWATER SUPPLY SOURCES

A report prepared in 1981 by Temple Associates, Inc. in conjunction with Turner Collie & Braden, Inc. summarized an "Analysis Of Groundwater Availability in the Lufkin-Diboll Area" with the following statements. The St. Regis plant referred to is now the Champion Paper Mill.

> "1. The three major users of groundwater in the two counties are the St. Regis Paper Company and the cities of Lufkin and Nacogdoches. The average pumping rates from the Carrizo in Angelina and Nacogdoches counties in 1980 were 23.0 and 7.1 million gallons per day (mgd), respectively for a total average pumping rate in 1980 of approximately 30.1 mgd.
>
> In 1977, the average pumping rate of the counties was approximately 34.5 mgd. The reduction in pumping rate from 1977 to 1980 resulted from reductions in pumpage at the St. Regis plant and the City of Nacogdoches.
>
> 2. Water levels in observation wells of the Carrizo in northern Angelina County declined at a rate of 4 feet per year between 1971 and 1978. Since 1978, the levels in these observation wells have stabilized.
>
> The stability of the water levels is a result of water level recovery caused by reductions in pumpage by the City of Nacogdoches and St. Regis. All of the drawdown to be caused by previous increases in pumpage is not believed to have occurred. It is estimated that water levels will decline an additional 5 to 20 feet throughout the area. Wells in the St. Regis "Old Field" indicate the most critical conditions in the area.
>
> 3. Static water levels in public wells in northwest Angelina County indicate that the potential for additional drawdown exists, and that if future wells are to be developed, this area of the county appears most favorable.

4. Chemical analyses in recent years (1975-1980) do not reveal any recognizable deterioration of the chemical quality of groundwater north of a line extending across Angelina County north of Lufkin. South of this line, dissolved solids are higher than 1,000 milligrams per liter (mg/l). The probability of brackish water encroachment increases significantly with increases in the rate of groundwater withdrawal.

5. System wide groundwater withdrawal is in excess of annual effective recharge. Additional pumpage from the Carrizo will be satisfied by the existing storage of water in the aquifer. While the exact amount of recoverable storage is unknown, static water levels in existing wells indicate that a reliable quantity of groundwater storage exists for the immediate future; however, this source of water should not be relied upon on a sustained basis.

6. Projected average-day demands for the Angelina-Nacogdoches area are expected to exceed 50 mgd by the year 2011. Based on current relationships of groundwater withdrawal and draw-down, it is expected that resources of the Carrizo aquifer could be substantially depleted within the next 15 to 20 years if major additional well fields are constructed to meet area demands.

7. Alternative sources of groundwater such as the Sparta aquifer can offset, to a limited degree, the future demands for water in Angelina County. The northwest area of the county is a favorable location for future pumpage from the Sparta aquifer."

6.2.1 CARRIZO AQUIFER

With the decrease in production of water by the Champion Paper Mill, there appears to be about 8 MGD of water available in wet cycle conditions. Under a dry cycle situation the available quantity decreases to 2 MGD. This aquifer generally yields good quality water in Angelina County with a relatively high pH and significant amounts of Hydrogen Sulfide. The hydrogen sulfide can generally be removed through aeration. The major well field areas are readily accessible to the larger population centers of Angelina County.

6.2.2 SPARTA AQUIFER

There is an estimated 8 MGD of water available in Angelina County from the Sparta Aquifer. Though not currently developed, this sand could be considered for future development by those systems nearest to the favorable areas for development shown in Figure 4-1. This would probably include the Pollok-Redtown W.S.C. and Central W.C.I.D. It is conceivable that Woodlawn W.S.C. and Hudson W.S.C. might also draw from this source.

Normally wells would be limited to 200 to 500 gpm and total development costs to bring water back to the other population areas would be higher than that of surface water. Since this source is limited it is not considered further in this report but is noted for information for areas in the northwestern part of the County.

6.2.3 YEGUA AQUIFER

As noted in Item 4.1.2 of this report the Yegua Aquifer does not appear to offer a prospect for any future significant development although some well located wells might be placed in the area between Lufkin and Huntington, and possibly east of Diboll. Additionally, Temple-Inland has located a well field known as the Eason Lake Field which shows some promise for development. That field is located on Temple-Inland land and is not available for municipal development.

Generally, due to the broken nature of the formation and the erratic water quality which often includes color, iron, and hydrogen sulfide, this aquifer is not considered a good source for future development.

6.3 SURFACE WATER SUPPLY SOURCES

Although some run-of-the-river sources might be available in the Neches River, the surface water sources considered by this report included Lake Sam Rayburn and Lake Eastex. Lake Striker is also mentioned although essentially all the water from that reservoir is accounted for. Lake Striker does provide surface water for the Champion Mill.

6.3.1 LAKE SAM RAYBURN

As discussed in Item 4.1.3, Lufkin has approximately 43,000 acre-feet of storage available in Lake Sam Rayburn with a yield of approximately 28,000 acre-feet per annum. An additional 14,467 acre-feet of storage is evidently available according to a Corps of Engineers' study conducted at the request of the Lower Neches Valley Authority.

6.3.2 LAKE EASTEX

Although all water of the future Lake Eastex is currently tied up in the planning phase, it is assumed that some water will probably become available as the construction process begins and each entity reconsiders its position and the take-or-pay cost it will incur. The entities with current water rights in Lake Eastex are listed in Table 6-1.

TABLE 6-1
LAKE EASTEX PROJECT
PRELIMINARY LIST OF PARTICIPANTS AND RESERVED WATER RIGHTS

PARTICIPANT	RESERVED DEPENDABLE YIELD (MGD)	(%)
1. Angelina WSC	2.290	3.00
2. Arp, City of	1.145	1.50
3. Blackjack WSC	0.596	0.78
4. Cherokee County	5.000	6.55
5. Childs, Leo F.	0.076	0.10
6. Craft-Turney WSC	1.000	1.31
7. Henderson, City of	11.451	15.00
8. Jacksonville, City of	11.451	15.00
9. Jackson WSC	0.500	0.66
10. Lufkin, City of	5.725	7.50
11. Nacogdoches, City of	7.634	10.00
12. New London, City of	1.908	2.50
13. New Summerfield WSC	1.000	1.31
14. Overton, City of	2.290	3.00
15. Redland WSC	0.500	0.66
16. Reklaw WSC	0.382	0.50
17. Rusk, City of	4.412	5.78
18. Star Mountain WSC	1.000	1.31
19. Temple-Eastex, Inc.	9.186	12.03
20. Troup, City of	2.290	3.00
21. Walnut Grove WSC	5.000	6.55
22. Woodlawn WSC	0.500	0.66
23. Wright City WSC	1.000	1.31
TOTAL	76.336	100.00

7.0 RAW WATER QUALITY AND TREATMENT

7.1 RAW WATER QUALITY - SAM RAYBURN RESERVOIR

Extensive testing of raw water from the Angelina River and Sam Rayburn Reservoir was performed by the United States Geological Survey during the years 1974-1979. A summary of those test results at four separate locations is presented in Tables 7-1 through 7-4.

A separate more recent raw water testing program was conducted by the City of Lufkin at the location of a planned intake structure north of Stanley Creek on the west side of Sam Rayburn Reservoir. This testing program began in May of 1988 and is continuing at this time. Results of these tests are shown in Table 7-5.

7.2 RAW WATER QUALITY - CARRIZO SAND AQUIFER

From information included in "Report 110", prepared by the Texas Water Development Board in 1970, it can be concluded that "The Carrizo Sand contains water of excellent chemical quality throughout most of Nacogdoches County and the northernmost 8 miles of Angelina County. The formation tends to be a continuous, massively embedded sand, and the quality of water is very consistent from one place to the next, as well as from top to bottom in the formation." Some existing wells in the aquifer show evidence of water containing greater than 1,000 ppm dissolved solids, some have high iron concentrations and some contain hydrogen sulfide. All of these characteristics are relatively minor and treatable and are not common to all wells in this sand.

In the "Report on Pumpage and Water Levels in the Lufkin -Nacogdoches Area" prepared by William F. Guyton Associates, Inc. for Champion International Corporation in 1988, chemical analysis of Carrizo wells is presented for the period 1939-87. The report concludes that "no appreciable increase in dissolved solids has occurred over the last 23 years of pumpage."

7.3 WATER TREATMENT

The surface water quality is such that it should be treatable with conventional methods discussed in Chapter 8 of this report. However, a detailed study of the raw water quality and specific treatment requirements has not been performed since the recommended initial phase water supply alternative is groundwater.

As discussed in paragraph 7.2, the quality of the groundwater in the Carrizo Sand is generally excellent. Experience with the City of Lufkin's Carrizo wells indicates that aeration will be required for hydrogen sulfide removal. Other than that, chlorination and fluoridation are the only treatments considered for this water.

TABLE 7-1
WATER QUALITY SUMMARY
ANGELINA RIVER BELOW
PAPER MILL CREEK
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
1. Calcium	mg/l	12	18	14	31	13	14	18 My	13	14	16	14	20	18	11	11	19	15	11	14	21	13	13	10	13
2. Magnesium	mg/l	5.1	4.9	5.2	4.1	3.3	5.3	4.4 My	4.1	3.2	5	5.1	4.4	4	4.3	4.6	4.7	3.2	5.3	5.9	5.6	3.2	4.2	3.8	3.9
3. Sodium	mg/l			52	120	40	46	110 My	57	39	38	37	110	54	28	37	110	110	37	80	210	45	31	30	78
4. Carbonate	mg/l	0	0	0	0	0	0	0 My	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Bicarbonate	mg/l	46	62	40	112	46	36	76 My	57	31	40	43	78	59	21	29	72	50	21	47	94	31	16	30	73
6. Sulfate	mg/l	40	43	49	90	43	43	70 My	41	47	51	43	58	39	42	39	76	77	53	59	130	45	39	33	51
7. Chloride	mg/l	37	60	62	130	44	57	120 My	64	51	48	44	140	69	35	49	130	130	42	95	230	58	49	35	87
8. Fluoride	mg/l	0	0.1				0.1	0.1 My	0.2	0.2	0.3	0.3	0.8	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
9. Nitrate (as N)	mg/l	0.09	0.04	0.26	0.35	0.01	0.01	.04 My	0.06	0.02	0.13	0.15	0.21	0.2	0.04	0.03	0.03	0.58	0.11			0.26	0.01	0.02	0.42
10. Dissolved Solids	mg/l	165	223	218	450																				
11. Phenolphthalein Alkalinity as CaCO3	mg/l																								
12. Total Alkalinity as CaCO3	mg/l																								
13. Total Hardness CaCO3	mg/l	51	65	56	94	46	57	63 My	49	48	61	56	68	61	45	46	67	51	49	59	76	46	50	41	49
14. pH		6.3	6.5	6.2	6.7	6.8	6.5	6.6 My	6.8	6.3	6.2	6.4	6.5	7	6.7	6.8	6.7	6.9	6.7	6.8	7	6.7	6.4	6.9	6.8
15. Diluted Conductance	umhos																								
16. Arsenic	mg/l																								
17. Barium	mg/l																								
18. Cadmium	mg/l																								
19. Chromium	mg/l																								
20. Copper	mg/l																								
21. Iron	ug/l	700	800 Mr		470 Sp	560	970 Mr	1000 M		630	520 Mr	800 My	650 Sp	630	430 Mr	740 My									
22. Lead	mg/l																								
23. Manganese	ug/l	0			190 Sp	0	70 Mr	830 My		140	110 Mr	140 My	300 Sp	170	60 Mr	460 My									
24. Mercury	ug/l																								

TABLE 7-1
WATER QUALITY SUMMARY
ANGELINA RIVER BELOW
PAPER MILL CREEK
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
25. Selenium	ug/l																								
26. Silver	ug/l																								
27. Zinc	ug/l																								
28. Potential THM																									
29. Volatile Organic Compounds	mg/l																								
30. Radon	pCi/l																								
31. Radium 226	pCi/l																								
32. Radium 228	pCi/l																								
33. Gross Alpha	pCi/l																								
34. Gross Beta	pCi/l																								
35. Tritium	pCi/l																								
36. Strontium 90	pCi/l																								
37. Corrosivity																									
38. Foaming Agents																									
39. Odor																									
40. Asbestos Fiber Count																									
41. Semi-Volatiles																									
42. Organochlorine Pesticides																									
43. Chlorinated Herbicides																									
44. Carbamate Pesticides																									
45. Nitrite	mg/l	0	0	0.02	0.06	0.01	0.01	.04 My	0.06	0.01	0.01	0.01	0.02	0	0.01	0.01		0.04	0.01			0.01	0.12	0	0.08
46. Color																									
47. Hydrogen Sulfide	mg/l																								

TABLE 7-1
WATER QUALITY SUMMARY
ANGELINA RIVER BELOW
PAPER MILL CREEK
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
48. Turbidity	NTU																								
49. Total Coliform Bacteria	mg/l																								
50. Dissolved Oxygen	mg/l	8.6	7.6	7.3	7	6.8	7.8	6.4 My	4	7.1	7.5	7.4	3.8	8.5	9.6	8	1.8	6.3	11.6	6.2	4.2	6.9	9	7.7	2.3
51. Temperature	deg. C	12	14	22	30	15	15	22 My	27.5	19.5	15.1	20.5	27	12	9.6	19	28	14.5	7.5	22.5	29	14	9.5	18.5	29
52. Total Dissolved Solids	mg/l																								

NOTES

1) Data for period 1973 thru 1979 from reports "Water Resources Data for Texas" published by the U.S. Department of the Interior Geological Survey.

2) Where dates for testing differ from column headings the actual date of the test is designated by abbreviation of the month and shown next to the test result.

TABLE 7-2
WATER QUALITY SUMMARY
ANGELINA RIVER AT SH
103 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
1. Calcium	mg/l	10	6.5	11	13	6.8	7.2	8.8																	
2. Magnesium	mg/l	5.1	3.4	5.3	5.3	3	3.2	4.7																	
3. Sodium	mg/l			25	44	17	15	19																	
4. Carbonate	mg/l	0	0	0	0	0	0	0																	
5. Bicarbonate	mg/l	30	16	36	64	10	16	28																	
6. Sulfate	mg/l	29	21	28	29	28	25	28																	
7. Chloride	mg/l	28	17	32	51	21	22	28																	
8. Fluoride	mg/l	0	0				0.1	0.1																	
9. Nitrate (as N)	mg/l	0.07	0.09	0	0	0.01	0.07	0.12																	
10. Dissolved Solids	mg/l																								
11. Phenolphthalein Alkalinity as CaCO3	mg/l																								
12. Total Alkalinity as CaCO3	mg/l																								
13. Total Hardness CaCO3	mg/l	46	30	49	54	29	31	41																	
14. pH		6.4	6.4	6.1	6.8	6.5	6.8	6.9																	
15. Diluted Conductance	umhos																								
16. Arsenic	mg/l																								
17. Barium	mg/l																								
18. Cadmium	mg/l																								
19. Chromium	mg/l																								
20. Copper	mg/l																								
21. Iron	ug/l	990	400 Mr	300 Ju	380 Sp	540	660 Mr	690 My																	
22. Lead	mg/l																								
23. Manganese	ug/l	0	40 Mr	210 My	150 Sp	10	20 Mr	50 My																	
24. Mercury	ug/l																								
25. Selenium	ug/l																								

TABLE 7-2
WATER QUALITY SUMMARY
ANGELINA RIVER AT SH
103 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
26. Silver	ug/l																								
27. Zinc	ug/l																								
28. Potential THM																									
29. Volatile Organic Compounds	mg/l																								
30. Radon	pCi/l																								
31. Radium 226	pCi/l																								
32. Radium 228	pCi/l																								
33. Gross Alpha	pCi/l																								
34. Gross Beta	pCi/l																								
35. Tritium	pCi/l																								
36. Strontium 90	pCi/l																								
37. Corrosivity																									
38. Foaming Agents																									
39. Odor																									
40. Asbestos Fiber Count																									
41. Semi-Volatiles																									
42. Organochlorine Pesticides																									
43. Chlorinated Herbicides																									
44. Carbamate Pesticides																									
45. Nitrite	mg/l	0	0	0.01		0	0	0	0.01																
46. Color																									
47. Hydrogen Sulfide	mg/l																								
48. Turbidity	NTU																								
49. Total Coliform	mg/l																								

TABLE 7-2
WATER QUALITY SUMMARY
ANGELINA RIVER AT SH
103 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
Bacteria																									
50. Dissolved Oxygen	mg/l		8	6	6.4	6.4	7.6	7																	
51. Temperature	deg. C	11.5	14	21.5	27.5	15.5	10.5	17																	
52. Total Dissolved Solids	mg/l																								

NOTES

1) Data for period 1973 thru 1979 from reports "Water Resources Data for Texas" published by the U.S. Department of the Interior Geological Survey.

2) Where dates for testing differ from column headings the actual date of the test is designated by abbreviation of the month and shown next to the test result.

TABLE 7-3
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
AT SH 147 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
1. Calcium	mg/l		6.5	7 My																					
2. Magnesium	mg/l		4.8	3.1 My																					
3. Sodium	mg/l			15 Ju																					
4. Carbonate	mg/l	0	0	0	0	0	0	0																	
5. Bicarbonate	mg/l	29	15	20	28	28	16	16																	
6. Sulfate	mg/l		23	17 Ju																					
7. Chloride	mg/l	19	16	15	20	15	25	21																	
8. Fluoride	mg/l		0																						
9. Nitrate (as N)	mg/l	0.2	0.2	0.03	0.01	0.08	0.1	0.1																	
10. Dissolved Solids	mg/l																								
11. Phenolphthalein Alkalinity as CaCO3	mg/l																								
12. Total Alkalinity as CaCO3	mg/l																								
13. Total Hardness CaCO3	mg/l	38	36	30 My																					
14. pH		6.5	6.4	6.3	6.3	6.7	6.7	7.1																	
15. Diluted Conductance	umhos																								
16. Arsenic	mg/l																								
17. Barium	mg/l																								
18. Cadmium	mg/l																								
19. Chromium	mg/l																								
20. Copper	mg/l																								
21. Iron	ug/l	180	200 Mr	1700 J	50 Sp	10	370 Mr	640 My																	
22. Lead	mg/l																								
23. Manganese	ug/l	5	0 Mr	170 My	10 Sp	0	0 Mr	150 My																	
24. Mercury	ug/l																								

TABLE 7-3
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
AT SH 147 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
25. Selenium	ug/l																								
26. Silver	ug/l																								
27. Zinc	ug/l																								
28. Potential THM																									
29. Volatile Organic Compounds	mg/l																								
30. Radon	pCi/l																								
31. Radium 226	pCi/l																								
32. Radium 228	pCi/l																								
33. Gross Alpha	pCi/l																								
34. Gross Beta	pCi/l																								
35. Tritium	pCi/l																								
36. Strontium 90	pCi/l																								
37. Corrosivity																									
38. Foaming Agents																									
39. Odor																									
40. Asbestos Fiber Count																									
41. Semi-Volatiles																									
42. Organochlorine Pesticides																									
43. Chlorinated Herbicides																									
44. Carbamate Pesticides																									
45. Nitrite	mg/l	0	0	0.01	0	0	0.01	0.01																	
46. Color																									
47. Hydrogen Sulfide	mg/l																								

TABLE 7-3
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
AT SH 147 BRIDGE
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
48. Turbidity	NTU																								
49. Total Coliform Bacteria	mg/l																								
50. Dissolved Oxygen	mg/l	9 Dc	6.4	6	7.8	7.8	9.1	6.4																	
51. Temperature	deg. C	17.5	12.5	19.5	28.5	17.5	14	16																	
52. Total Dissolved Solids	mg/l																								

NOTES

1) Data for period 1973 thru 1979 from reports "Water Resources Data for Texas" published by the U.S. Department of the Interior Geological Survey.

2) Where dates for testing differ from column headings the actual date of the test is designated by abbreviation of the month and shown next to the test result.

TABLE 7-4
WATER QUALITY SUMMARY
ANGELINA RIVER JUST DOWNSTREAM
OF SAM RAYBURN RESERVOIR DAM
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
1. Calcium	mg/l	8.5	7.5	6.7	8.5	7.5	6.5	6.2 My	6.4	6.9	6.4	6.4	7.2	6.4	5.1	5.6	6.8	6.2	6.3	6.2	11	8.3	6.6 Mr	5.8	6.5
2. Magnesium	mg/l	3.6	4.7	2.8	2.1	2.9	2.9	2.4 My	3.5	2.9	2.5	3.2	3.1	3.3	3.8	3.5	3.7	4.1	3.9	3.9	3.9	5.9	3.9 Mr	3.5	3.3
3. Sodium	mg/l			12	18	18	13	13 My	13	19	19	14	18	18	18	20	19	25	25	23	24	26	22 Mr	21	15
4. Carbonate	mg/l	0	0	0	0	0	0	0 My	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 Mr	0	0
5. Bicarbonate	mg/l	30	24	20	36	32	23	18 My	16	30	24	20	33	23	19	23	25	31	25	20	30	27	22 Mr	13	22
6. Sulfate	mg/l	16	16	16	16	16	20	22 My	19	19	21	15	21	21	22	21	27	25	30	31	30	34	23 Mr	25	18
7. Chloride	mg/l	19	17	16	18	22	18	17 My	17	22	23	19	21	23	23	24	25	30	31	31	30	34	23 Mr	25	18
8. Fluoride	mg/l	0	0			.1 Dc	0.1	.1 My	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	.1 Mr	0.1	0.1
9. Nitrate (as N)	mg/l	0.2	0.2	0.1	0	0.13	0.08	0.08	0.02	0.04	0.08	0.07	0.02	0.06	0.06	0.08	0.02	0.05	0.12			0.04	.09 Mr	0.15	0.03
10. Dissolved Solids	mg/l																								
11. Phenolphthalein Alkalinity as CaCO3	mg/l																								
12. Total Alkalinity as CaCO3	mg/l																								
13. Total Hardness CaCO3	mg/l	36	38	28	30	31	28	25 My	30	29	26	29	31	30	28	28	32	32	32	32	44	45	33 Mr	29	30
14. pH		6.2	6.5	6.7	7.2	6.6	7	7	6.6	6.5	6.7	6.2	5.8	6.9	6.9	6.7	7	7.1	7	6.6	6.5	6.7	7.1 Mr	6.5	6.9
15. Diluted Conductance	umhos																								
16. Arsenic	mg/l	1	0 Mr	1	0 Sp	2	4 Mr	1 Ju	10 Sp	1		1 Ju	2 Sp	1	1 Mr	1 Ju		1 Ja	1 Mr			1			
17. Barium	mg/l			50	80 Sp	90	40 Mr	0 Ju	50 Sp	90		40 Ju	30 Sp	100	0 Mr	200 Ju		0 Ja	100 Mr			100			
18. Cadmium	mg/l	0	0 Mr	0		1	0 Mr	1 Ju	0 Sp	0		0 Ju	0 Sp	0	0 Mr	0 Ju		1 Ja	1 Mr			0			
19. Chromium	mg/l	0	0 Mr	20		0	0 Mr	0 Ju	0 Sp	0		0 Ju	0 Sp	4	9 Mr	0 Ju		0 Ja	0 Mr			0			
20. Copper	mg/l	0	2 Mr	9		1	3 Mr	2 Ju	1 Sp	1		2 Ju	1 Sp	0	2 Mr	1 Ju		0 Ja	1 Mr			1			
21. Iron	ug/l	90	190 Mr	800		40	50 Mr	240 My	50 Sp	10	10 Mr	30 My	30 Sp	30	40 Mr	80 My		20	30 Mr	20 My	160 Sp	40		160	
22. Lead	mg/l	0	0 Mr	5		3	1 Mr	1 Ju	0 Sp	0		0 Ju	2 Sp	0	0 Mr	0 Ju		1 Ja	0 Mr			1			
23. Manganese	ug/l	240	0 Mr	50		0	10 Mr	5 My	390 Sp	70	0 Mr	10 My	130 Sp	0	0 Mr	10 Ju		240	10 Mr	0 My	1400 S	220		0	
24. Mercury	ug/l	0.6	.2 Mr	0		0	0 Mr	0 Ju	0 Sp	0		.3 Ju	.2 Sp	0.2	0 Mr	0 Ju		0 Ja	0 Mr			0			

TABLE 7-4
WATER QUALITY SUMMARY
ANGELINA RIVER JUST DOWNSTREAM
OF SAM RAYBURN RESERVOIR DAM
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
25. Selenium	ug/l													0	0 Mr	2 Ju		0 Ja	0 Mr			0			
26. Silver	ug/l													0	0 Mr	0 Ju		0 Ja	0 Mr			0			
27. Zinc	ug/l	10	0 Mr	20		30	90 Mr	40 Ju	20 Sp	20		10 Ju	20 Sp	10	10 Mr	10 Ju		20 Ja	10 Mr			10			
28. Potential THM																									
29. Volatile Organic Compounds	mg/l																								
30. Radon	pCi/l																								
31. Radium 226	pCi/l																								
32. Radium 228	pCi/l																								
33. Gross Alpha	pCi/l																								
34. Gross Beta	pCi/l																								
35. Tritium	pCi/l																								
36. Strontium 90	pCi/l	70	60 Mr	100		90	80 Mr	40 Ju	110 sp	160		110 Ju	100 Sp												
37. Corrosivity																									
38. Foaming Agents																									
39. Odor																									
40. Asbestos Fiber Count																									
41. Semi-Volatiles																									
42. Organochlorine Pesticides																									
43. Chlorinated Herbicides																									
44. Carbamate Pesticides																									
45. Nitrite	mg/l	0	0	0	0	0	0.01	0.01	0.01	0	0	0.01	0	0	0	0.01	0.01	0	0			0.01	0 Mr	0	0.02
46. Color		40	60 Mr	30 My	60	20	30	50 My	20	20	40 Mr	20 M	30 Sp	30	30 Mr	20 My	20 Sp	20	10 Mr			40	40 Mr	30	30
47. Hydrogen Sulfide	mg/l																								

TABLE 7-4
WATER QUALITY SUMMARY
ANGELINA RIVER JUST DOWNSTREAM
OF SAM RAYBURN RESERVOIR DAM
8-3-88

PARAMETER	UNITS	1973-74				1974-75				1975-76				1976-77				1977-78				1978-79			
		Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.	Nov.	Feb.	Apr.	Aug.
48. Turbidity	NTU	5	15 Mr	8 My	10	6	6	10 My	6	7	10 Mr	4 My	4 Sp	2	5 Mr	6 My	6 Sp	6	5 Mr			5	10 Mr	4.6	1.4
49. Total Coliform Bacteria	mg/l																								
50. Dissolved Oxygen	mg/l	7.4 Dc	10.2	9.2	2.8	10.8	9.4	8.4	4.4	8.2	10.6	9.8	5	10	12	9.8	4.8	8.2	13.6	9	2	6.8	10.4 M	8.9	5.3
51. Temperature	deg. C	19	14	20.5	20	18.5	13	19.5	27	20	17.5	17.5	23	14	10	17	27.5	19.5	8	14	20	16.5	10.5 M	17	26.5
52. Total Dissolved Solids	mg/l																								

NOTES

1) Data for period 1973 thru 1979 from reports "Water Resources Data for Texas" published by the U.S. Department of the Interior Geological Survey.

2) Where dates for testing differ from column headings the actual date of the test is designated by abbreviation of the month and shown next to the test result.

TABLE 7-5
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
NORTH OF STANLEY CREEK
1988-1989
8-16-89

PARAMETER	UNITS	MAY 88					AUG. 88				NOV. 88				FEB.89		
		SAMPLE ELEV.,MSL					SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL		
		163.93	160.00	155.00	150.00	145.00	157.74	155.00	150.00	145.00	151.90	150.00	147.22	145.00	155.00	150.00	145.00
1. Calcium	mg/l	9.000						10.000						11.000		8.000	
2. Magnesium	mg/l	4.000						4.000						5.000		4.000	
3. Sodium	mg/l	24.000						41.000						73.000		20.000	
4. Carbonate	mg/l	0.000						0.000						0.000		0.000	
5. Bicarbonate	mg/l	20.000						50.000						45.000		11.000	
6. Sulfate	mg/l	36.000						25.000						54.000		34.000	
7. Chloride	mg/l	29.000						47.000						82.000		25.000	
8. Fluoride	mg/l	0.100						0.100						0.100		0.100	
9. Nitrate (as N)	mg/l	0.010						0.011						0.010		0.090	
10. Dissolved Solids	mg/l	115.000						155.000						251.000		99.000	
11. Phenolphthalein Alkalinity as CaCO3		0.000						0.000						0.000		0.000	
12. Total Alkalinity as CaCO3		16.000						41.000						37.000		9.000	
13. Total Hardness CaCO3	mg/l	40.000						41.000						46.000		34.000	
14. pH		7.500	7.400	7.600	7.500	7.200	7.300	7.400	7.300	7.200	7.100	7.200		7.200	7.400	6.900	6.900
15. Diluted Conductance	umhos	222.000						320.000						494.000		192.000	
16. Arsenic	mg/l	0.010						0.010						0.010		0.010	
17. Barium	mg/l	0.500						0.500						0.050		0.050	
18. Cadmium	mg/l	0.005						0.005						0.010		0.010	
19. Chromium	mg/l	0.020						0.020						0.020		0.020	
20. Copper	mg/l	0.020						0.020						0.020		0.020	
21. Iron	mg/l	0.430						0.370						1.040		1.690	
22. Lead	mg/l	0.020						0.020						0.050		0.050	
23. Manganese	mg/l	0.030						0.160						0.120		0.110	

TABLE 7-5
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
NORTH OF STANLEY CREEK
1988-1989
8-16-89

PARAMETER	UNITS	MAY 88					AUG. 88				NOV. 88				FEB.89		
		SAMPLE ELEV.,MSL					SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL		
		163.93	160.00	155.00	150.00	145.00	157.74	155.00	150.00	145.00	151.90	150.00	147.22	145.00	155.00	150.00	145.00
24. Mercury	mg/l	0.0002						0.0002						0.0002		0.0002	
25. Selenium	mg/l	0.002						0.002						0.002		0.002	
26. Silver	mg/l	0.010						0.010						0.010		0.010	
27. Zinc	mg/l	0.020						0.020						0.020		0.020	
28. Potential THM	ug/l	1081.000						1231.000								1492.000	
29. Volatile Organic Compounds	mg/l																
30. Radon	ug/L							5.000						5+/-4		23+/-9	
31. Radium 226	pCi/L							0.600						0.600		0.600	
32. Radium 228	pCi/L							1.000						1.000		1.000	
33. Gross Alpha	pCi/L							2.000						3.000		2.000	
34. Gross Beta	pCi/L							3.000						0.600		3+/-2	
35. Tritium	pCi/L							500.000						0.500		1522+/-544	
36. Strontium 90	ug/L							0.500						500.000		0.500	
37. Corrosivity																	
38. Foaming Agents																	
39. Odor	TO							2.500						1.000		1.000	
40. Asbestos Fiber Count																	
41. Semi-Volatiles																	
42. Organochlorine Pesticides																	
43. Chlorinated Herbicide																	
44. Carbamate Pesticides																	
45. Nitrite	mg/l		0.120					0.011						0.028			

TABLE 7-5
WATER QUALITY SUMMARY
SAM RAYBURN RESERVOIR
NORTH OF STANLEY CREEK
1988-1989
8-16-89

PARAMETER	UNITS	MAY 88					AUG. 88				NOV. 88				FEB.89		
		SAMPLE ELEV.,MSL					SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL				SAMPLE ELEV.,MSL		
		163.93	160.00	155.00	150.00	145.00	157.74	155.00	150.00	145.00	151.90	150.00	147.22	145.00	155.00	150.00	145.00
46. Color			35.000					38.000					10.000	20.000		16.000	
47. Hydrogen Sulfide	mg/l		0.230					0.290						0.340		0.220	
48. Turbidity	NTU		0.290					0.320						0.570		0.290	
49. Total Coliform Bacteria	mg/l																
50. Dissolved Oxygen	mg/l		10.100	10.600	9.500	5.900	9.100	8.100	9.200	7.700	9.600	9.800		11.000	10.800	10.100	10.400
51. Temperature	deg. F		75.200	75.200	72.500	70.700	83.300	82.400	83.300	80.600	55.400	56.300		57.200	56.300	50.000	50.000
52. Total Dissolved Solids	mg/l		152.000	166.000	136.000	151.000	173.000	158.000	165.000	178.000	142.000	148.000		172.000	168.000	170.000	174.000
53. Color Spectrophotometric													16.000	67.000		31.500	

NOTES

1) Data from testing program performed by Angelina Neches River Authority for the City of Lufkin.

2) Sample depth based on normal pool elevation of 164 feet above MSL.
Elevation of bottom of reservoir is approximately 140.

8.0 SURFACE WATER TREATMENT AND TRANSPORTATION SYSTEM ALTERNATIVE

When this study began the primary alternative for new sources of water appeared to be surface water. Therefore, the primary initial effort was directed toward this option. As the study progressed, it became evident that there was probably an option of going to the Carrizo Aquifer.

In order to allow for a comparison of the costs involved in constructing and operating the facilities, we have developed fully both the option of surface water from Sam Rayburn Reservoir and the use of well water from the Carrizo Aquifer. Initially the study was intended to look at several different options regarding the location of an intake structure. However, since the well water proved to be the more economical approach, this effort of comparing the different locations was not fully developed.

8.1 INTAKE STRUCTURE AND PUMP STATION

8.1.1 LOCATION

The City of Lufkin selected a potential site for an intake structure about two years ago based upon the depth of the water in Sam Rayburn Reservoir in a near proximity to the shore. This site is indicated on Figure 8-3. This site is located at a point thought to be far enough downstream in the Lake to avoid significant impact from both point and non-point dischargers upstream, and yet at a point that is not too distant from the main population of the County located in the vicinity of Lufkin.

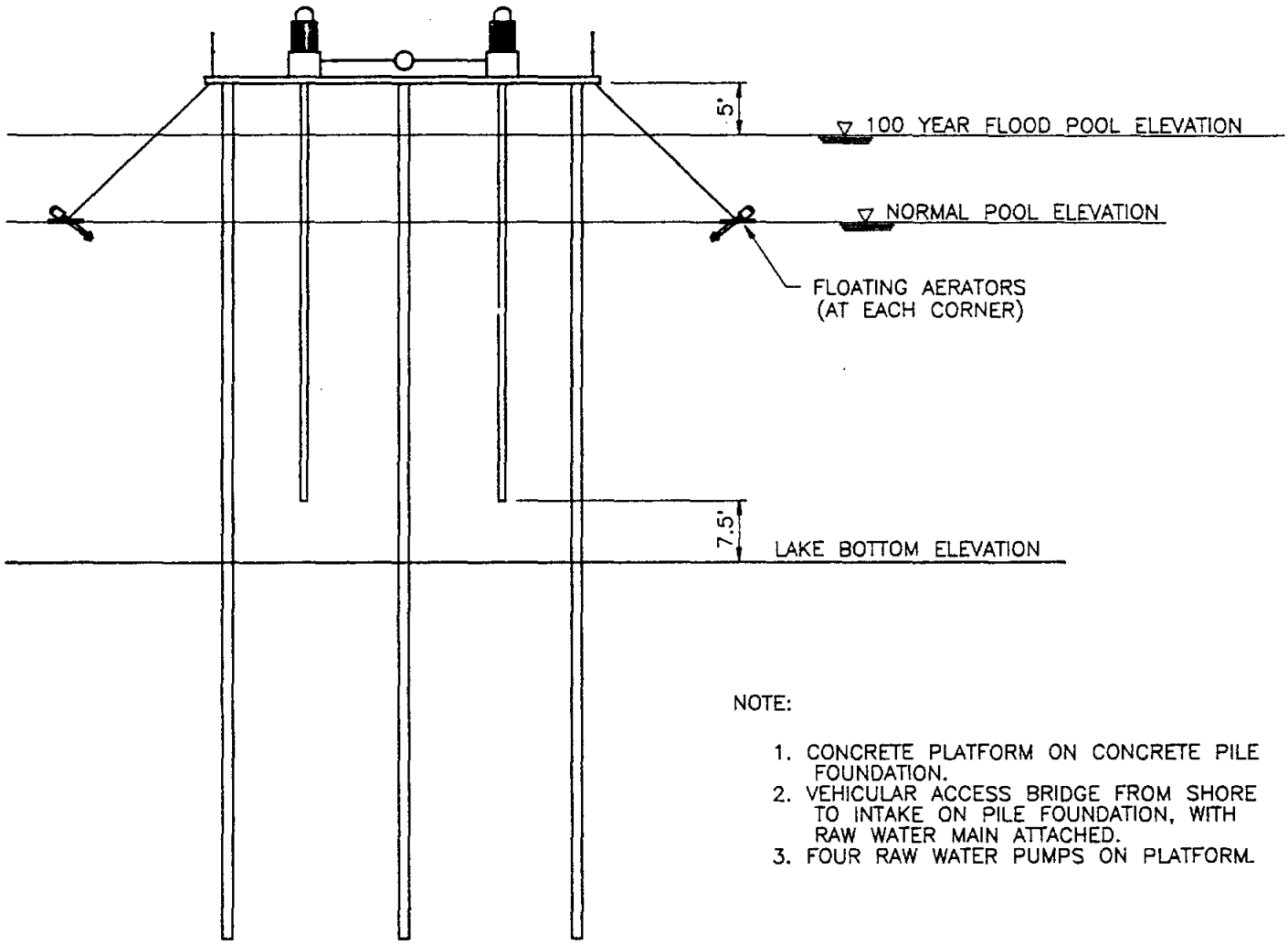
A water testing program with sampling at this location was on-going for about one year, with the testing being conducted by the Angelina and Neches River Authority. A discussion of this program and its results is included in Chapter 7.

Approximately 25 acres would be needed for the surface water plant if sludge is disposed of on-site. Additionally, easements for the raw water and treated lines would be needed.

8.1.2 INTAKE STRUCTURE

Figure 8-1 illustrates in schematic form the proposed intake structure. The intake structure envisioned is one capable of taking water at three different levels. It would be constructed so that four intake pumps could be mounted on top of the intake structure. A vehicular access bridge would be constructed from the shore to the intake structure and a raw water pipeline would be attached. This approach would require an approval process with the Corps of Engineers.

FIGURE 8.1
INTAKE STRUCTURE
(IN-LAKE FACILITY)



NOTE:

1. CONCRETE PLATFORM ON CONCRETE PILE FOUNDATION.
2. VEHICULAR ACCESS BRIDGE FROM SHORE TO INTAKE ON PILE FOUNDATION, WITH RAW WATER MAIN ATTACHED.
3. FOUR RAW WATER PUMPS ON PLATFORM.

8.1.3 PUMP STATION

The pump station would consist of an intake piping and manifold arrangement anchored on the top slab of the intake structure. Three pumps with a capacity of 5 MGD with the largest unit out would be located on the intake structure.

If difficulties are encountered with the Corps of Engineers in the approval process, then the option would be to locate a pump station on the shore with a suction line running back out to the intake structure. The pumps would be of the same capacity but would require a greater suction lift capacity or the construction of a wet-well/dry-well structure.

Table 8-1 provides a cost estimate for the Intake Structure, Raw Water Pump Station, and Raw Water Pipeline.

TABLE 8-1
COST ESTIMATE
INTAKE STRUCTURE AND RAW WATER PUMPS AND RAW WATER PIPELINE

Facility	Cost
Intake Structure (10 MGD capacity, access gangway)	$ 600,000.00
Pumps and Controls (5 MGD capacity)	300,000.00
Raw Water Main (24"ϕ, 1 mile)	350,000.00
Geotechnical	50,000.00
Legal & Administrative	25,000.00
Engineering	150,000.00
Contingency	125,000.00
Total	$1,600,000.00

8.2 SURFACE WATER TREATMENT PLANT

8.2.1 TREATMENT PLANT FACILITIES

The overall regional plan is based on a regional treatment facility. The cost estimates for construction and operations are included in the discussion below in Item 8.2.1.1. For purposes of comparison of costs and for distribution of cost factors for determining treated and delivered water costs to each entity, a section is included under Item 8.2.1.2. Individual plants or efforts are not envisioned under this plan, however.

WATER TREATMENT PLANT
FLOW DIAGRAM

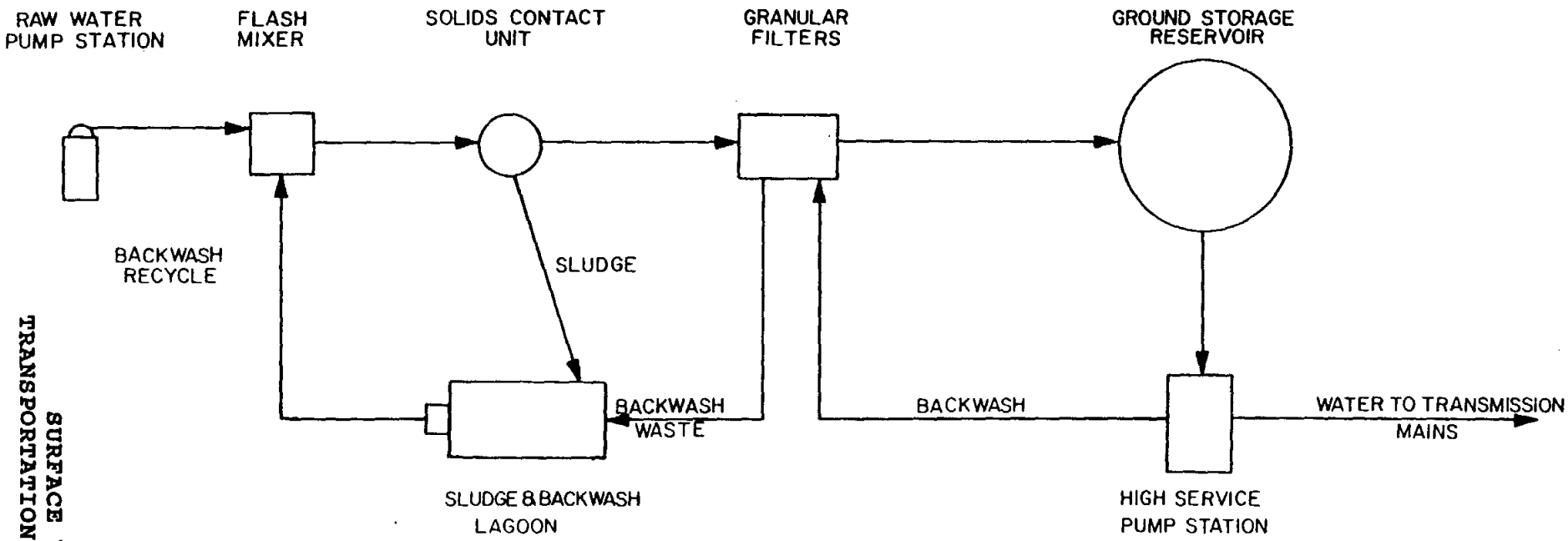


FIGURE 8-2

ENGINEERING EGA SURVEYING

EVERETT GRIFFITH, JR. & ASSOCIATES

409 NORTH THIRD STREET

LUFKIN, TEXAS

These costs were used to establish the cost factors shown in Chapter 11 where individual system costs are developed in order to apportion out capital costs.

TABLE 8-3
METHODOLOGY ON COST ESTIMATES

1. Intake Structure and Raw Water Pipeline

   (Plant Capacity, MGD)$^{0.6}$ * $402,000 = $ cost

2. Water Treatment Plant

   (Plant Capacity, MGD)$^{0.71}$ * $2,000,000 = $ cost

8.2.2 OPERATIONAL CONSIDERATIONS

As discussed in Chapter 7, generally the raw water quality is very good. There is some slight turbidity but most of the parameters of concern are at a reasonable level. Organics can often be high and as such there is cause for concern for the formation of trihalomethanes with prechlorination. We have considered utilizing Ozonation in lieu of prechlorination. This pretreatment process would be aided by location of the treatment plant as close as possible to the intake structure to limit the length of raw water line.

An important operational consideration is the remote location of the plant site. If operators and staff live in the larger population centers then they will have nearly a twenty mile trip from Lufkin to the plant. This needs to be considered in the proper provision of facilities such as office space, showers and lockers, storage room for equipment, etc.

A sludge and backwash lagoon will be constructed at the plant site. Sufficient land should be acquired in order to provide enough volume for this element of the facility to allow for the elapse of a long period prior to any removal of sludge being required.

Table 8-4 includes first year operation and maintenance costs for the Phase I construction.

TABLE 8-4
COST ESTIMATE
O&M COSTS AT WATER TREATMENT PLANT

Facility	9.56 MGD Cost	5.00 MGD Cost
Labor (1)	$ 290,000.00	$ 290,000.00
Energy (2)	821,250.00	400,000.00
Chemicals		
1. Alum or Polymers	90,000.00	45,000.00
2. Caustic or Polymers	70,000.00	35,000.00
3. Chlorine & Ammonia	40,000.00	20,000.00
Maintenance and Repair	75,000.00	50,000.00
Miscellaneous Supplies	35,000.00	25,000.00
Total	$1,421,250.00	$ 750,000.00
	Approximately $0.41/1,000 gallons	$0.47/1,000 gallons

(1) 3 person day shift
2 person evening shift
1 person night shift
1 person fill-in
7 persons
14,560 man-hours

(2) 3,000 kWh per MGD
@ $0.075/kWh
Includes Pumping Costs

8.3 TRANSMISSION LINES

8.3.1 PUMPING STATION

The pumping station would be constructed to operate initially with four pumps each with a capacity of 3800 g.p.m. at 410 feet of Total Dynamic Head. Normal operation would have two pumps operating essentially 24 hours per day. The other two pumps could come on during peak conditions but total production with all four pumps would drop to about 2500 gpm per pump, or a total of 10,000 gpm.

The manifold and building would be arranged to allow for the installation of larger pumps in place of the initial pumps, and for the inclusion of additional pumps as well.

Yard piping would be sized and constructed to allow for the easy tie-in of an additional future supply line.

8.3.2 ROUTE AND SIZING

Figure 8-3 depicts the proposed water transmission system and the possible take point on Lake Sam Rayburn for the surface water alternative. As can be noted, the main trunk line takes a cross-country route to County Roads 192 and 196, which it then follows to F.M. Highway 2109. A smaller 8" line goes south to the Zavalla area, while the main 24" line proceeds up F.M. Highway 2109 to Huntington. After offsetting on F.M. Highway 1669, a 21" line continues up Highway 69 to Lufkin.

A significant point of this study includes the concept of using the distribution system of the City of Lufkin to transmit the water around Loop 287 and the surrounding area of Lufkin. This is feasible in that the City of Lufkin currently is in need of some improvements to its overall distribution system, and those needed improvements can be correlated with the needs of the regional system. In this way, the efficiency of size can be used to give both the City of Lufkin and the regional system the advantage of the needed pipe capacity at a lower cost per unit of water conveyed.

This is further discussed in Chapter 11, PROPOSED PHASING.

Additional smaller lines branch off of the Lufkin System to serve M & M WSC, Redland WSC, Central WCID and Pollok-Redtown WSC, Hudson WSC, and Burke WSC and the City of Diboll. The main 21" line coming up Highway 69 will be metered into the Lufkin System, and each of these branch lines will be then be metered back out to the surrounding systems.

8.4 PHASING

The following is intended only as a general discussion of the potential for phasing for this project. Certainly, as much as practicable, only work required now should be constructed initially. However, sometimes the economics are such that it's less expensive, even when considering the cost of interest, to build a larger facility now. Generally, in comparing the various phasing options, the component was amortized over its life at 8% interest to compare the feasibility of building a larger facility initially.

8.4.1 INTAKE AND RAW WATER PUMPING STRUCTURE

Since the intake structure requires a major undertaking in an inundated area, the effort to construct the structure should include making it large enough for a fifty year time frame. The pumping station itself can be designed such that additional pumps could be added or the existing pumps upsized. This would include the provision of a proper foundation(the top of the intake structure) and good sizing and design of the manifolding and other piping and controls.

The raw water line should be sized sufficiently for forty years capacity since it would be accessible(being mounted on the access bridge) but could be upsized only with great difficulty. The access bridge would be essentially the same for today's needs as well as those for tomorrow.

8.4.2 SURFACE WATER TREATMENT PLANT

8.4.2.1 WATER TREATMENT PLANT SIZING

As discussed in Chapter 5 and illustrated in Table 5-5, surface water demands must be based on the capacity to meet overall demands of the regional system. Since one of the Health Department requirements is that each system have at least the ability to provide a source of water with a capacity of .6 gpm per connection, this parameter becomes the controlling factor in sizing a surface water treatment plant.

With a water well supply, an entity can simply go out and flip on the well when additional water is needed, then cut it off when demand is met. In this way the systems might operate a well only four hours a day or up to twenty-four hours per day. Thus the impact of the 0.6 gpm, which requires enough well capacity that effectively the average well only operates about seven hours per day, is not significant.

However, in the case of the surface water plant, which cannot be readily turned on and off, this parameter becomes critical. In fact, with a surface water option, the regional entities will be required to commit for more water from the regional system than they would if the supply is from wells since the surface water plant must be sized to meet(in conjunction with available well capacity) the 0.6 gpm parameter.

8.4.2.2 OTHER PHASING CONSIDERATIONS

Certain elements of the plant cannot be efficiently phased for construction purposes. These include the chemical building and facilities, flash mix facility, the administration/laboratory building, and most of the site work, piping, and electrical.

Since the plant needs to have stand-by units in certain areas, these areas will begin with two units each sized to handle the initial phase loads. Expansion which would include adding one more unit of that size would effectively double capacity since only one stand-by unit is required. For example, initially two solids contact units, each with a capacity of 5 MGD, would be constructed. Later, the addition of another 5 MGD unit would double the capacity to 10 MGD with one of the 5 MGD units serving as a back-up. Included in this category are the solids contact units and granular filters.

Ground storage facilities can also be easily duplicated although close attention must be paid to the economics of various sized tanks. The pump station would be constructed with the capacity for expansion both by the addition of additional pumps and/or the replacement of the initial pumps with larger pumps.

8.4.3 TRANSMISSION LINES

Table 8-5, which follows, compares the cost-effectiveness of constructing the main part of the supply lines in two phases. Essentially, this would involve constructing a line sized to handle about 10 years of growth initially. In about 10 years an additional line could be constructed to accommodate additional needs.

Cost estimating factors for pipeline costs are outlined in CHAPTER 10, on Page 90 in Table 2.

In reality, since most parts of a water supply system have a life of over 40 years, the needs of forty years could have been properly considered. However, as can be noted, the only instance in which a lesser sized line might be cost-effective was for the 24-inch line. Due to the much greater capacity of the 24-inch over the option of an 18-inch line and a 15-inch line built later, the decision was made that in terms of overall cost-effectiveness the 24-inch design was the wiser choice. The other realistic option would be construction of a 21" line instead of the 24"-inch line.

Another item that should be noted is that in the methodology for estimating construction costs for the linework different factors were used to address differences in cost for laying in a city type environment as opposed to placing line in the more rural areas. Additionally, in some cases in this report, cost factors for C-900, Class 100 P.V.C. pipe were used since that pipe will do the job and is superior to the S.D.R. 26, Class 160 Thin Wall P.V.C. pipe often used for transmission lines for the rural water supply corporations.

TABLE 8-5
ANGELINA COUNTY WATER STUDY
TRANSMISSION LINE PHASING
ECONOMIC FEASIBILITY

	:OPTION 1-20 YR. CAPACITY :INITIALLY				:OPTION 2-10 YEAR CAPACITY :INITIALLY				:ADDITIONAL PIPE NEEDED FOR :OPTION 2 AT YEAR 10				:OPTION 2 +:CAPACITY :ADDITIONAL:OPTION 1		
	: CARRYING FRICTION COST				: CARRYING FRICTION COST				: CARRYING FRICTION COST				:OPTION 1: PRESENT:	PIPE : PRESENT :	VERSUS :OPTION 2
LINE SEGMENT	: LINE LENGTH	CAPACITY SIZE	LOSS/ (MGD)	PER 1000 FT.	FOOT	: LINE CAPACITY SIZE	LOSS/ (MGD)	PER 1000 FT.	FOOT	: LINE CAPACITY SIZE	LOSS/ (MGD)	PER 1000 FT.	FOOT	: WORTH :(PER FT.)	WORTH : (PER FT.):	PLUS (MGD)
A1	5280	24	12.00	3.00	$63.20	18	5.10	3.00	$39.99	16	3.75	3.00	$32.60	$63.20	$55.09	3.15
B1	33264	24	12.00	3.00	$63.20	18	5.10	3.00	$39.99	16	3.75	3.00	$32.60	$63.20	$55.09	3.15
B2	11616	24	12.00	3.00	$63.20	18	5.10	3.00	$39.99	16	3.75	3.00	$32.60	$63.20	$55.09	3.15
B3	4224	24	12.00	3.00	$63.20	18	5.10	3.00	$39.99	16	3.75	3.00	$32.60	$63.20	$55.09	3.15
B4	37488	20	7.07	3.00	$46.36	18	5.10	3.00	$39.99	16	3.75	3.00	$32.60	$46.36	$55.09	-1.78
D1	8976	8	0.62	3.00	$14.14	6	0.30	3.00	$9.53	6	0.30	3.00	$9.53	$14.14	$13.94	0.02
E1	13728	18	5.10	3.00	$52.92	12	1.80	3.00	$34.52	16	3.75	3.00	$44.15	$52.92	$54.97	-0.45
E2	3696	12	1.80	3.00	$22.52	8	0.62	3.00	$14.14	10	1.10	3.00	$16.98	$22.52	$22.01	0.08
E3	12144	12	1.80	3.00	$22.52	8	0.62	3.00	$14.14	10	1.10	3.00	$16.98	$22.52	$22.01	0.08
E4	4752	12	1.80	3.00	$22.52	8	0.62	3.00	$14.14	10	1.10	3.00	$16.98	$22.52	$22.01	0.08
E5	13728	8	0.62	3.00	$14.14	6	0.30	3.00	$9.53	6	0.30	3.00	$9.53	$14.14	$13.94	0.02
H1	4224	8	0.62	3.00	$14.14	6	0.30	3.00	$9.53	6	0.30	3.00	$9.53	$14.14	$13.94	0.02

9.0 WATER WELL SOURCE SUPPLY SYSTEM

Champion Paper Mill, upon realizing the increasing water needs of the county, opened up a whole new option with an offer to consider the transfer of some of their current well capacity either through actually conveying some of the water wells or by backing off of current and past production rates from their wells located in the Carrizo Aquifer. All of the entities currently use groundwater, and most of that is from the Carrizo Aquifer, a source that the entities are very comfortable with. Additionally, since water wells allow for better addressing of Health Department regulations and peak flow demands(which generally are greater for residential needs), wells are better suited to the needs of the predominately domestic usage of the County.

A number of questions remain for this option and should be explored with Champion Paper. These include the following items:

1. Would Champion be interested in selling or gifting some of their wells to the regional system? If these would be sold, what would be the methodology for placing a value on the facilities?

2. Could a new transmission line be constructed parallel to the Champion supply lines on the present Champion right-of-way?

3. Would Champion be interested in a trade of water rights which would include them gaining surface water rights in exchange for their loss of groundwater?

Another major consideration is the fact that in Texas there are no "groundwater rights" similar to surface water rights. Champion, then cannot, convey any groundwater rights. Instead, Champion can negotiate with the Regional entity on an agreement under which they would limit groundwater pumpage to a fixed amount, probably based on a daily average over a year of time. In turn, Champion might either sell facilities and/or acquire surface water rights in exchange. Unless such an agreement is made, Champion could increase pumpage at a later time frame, thus eliminating the availability of groundwater.

Additionally, there is no guarantee that another entity won't come into the area and begin pumping from groundwater. Such an occurrence is unlikely for a major industry since they would immediately be moving into conflict with public entities in the area. However, the City of Nacogdoches or other Nacogdoches County entities could increase pumpage, or other public entities might choose to begin drawing water from the Carrizo. Each of these possibilities must be carefully considered and appropriate alternatives should be available.

9.1 WATER WELLS

For purposes of analysis and cost estimating, we have assumed two options as follows.

Case 1) Champion would convey their western-most wells to the regional system. We further assume that this transfer would include the collection lines for these wells. These wells include the Champion wells shown in Table 9-1.

Case 2) The Regional Entity would construct new wells and a collections system while Champion would agree to a maximum pumpage rate out of the Carrizo Aquifer for their wells.

Table 9-1 outlines those wells that would be the easiest to incorporate into a regional system. These may well not be the wells that Champion might be willing to negotiate on.

TABLE 9-1
CHAMPION WELLS CONSIDERED FOR REGIONAL USE

WELL NO.	CURRENT PRODUCTION RATE (GPM)	POSSIBLE PRODUCTION RATE* (GPM)
P-2	678	1,200
P-4	458	1,200
P-5	620	1,200
P-13	1,194	1,194
P-14	1,302	1,302
TOTAL	4,252	6,096

*Has not been confirmed, but this rate is indicated by pumping curves.

Actually, as can be noted in Table 5-6, the needs of the regional system for the Year 2000 would include a production rate increase of 5,542 gpm. The needs for the Year 2010 would be 10,667 gpm. Champion's total current production is only 11,060 gpm, but by pumping up to 20 hours per day(which is generally acceptable on a Carrizo well), these Champion wells can actually produce over 13 MGD. Additionally, many of these wells are throttled back at this time.

The seeming shortage of capacity involves the fact that in providing 0.6 gpm per connection, a well need only be pumped about 7 hours per day in order to provide normal daily demands.

In the case of the regional system, if Champion is willing to initially convey some of its wells, then they can be used to meet immediate demands. However, the 4,252 gpm noted above will cover about the next 8 years. At that time, either a waiver of the 0.6 gpm rule can be requested(wells producing 4,252 gpm pumped 20 hours per day would provide 5.1 MGD) or new wells could be constructed. In either case the water would be available in the Carrizo Aquifer due to Champion cutting back on their production rate.

For purposes of this study for either Case 1 or 2 noted above, the assumption is made that approximately 5-6 additional wells would be constructed beginning at Year 2000. These wells would be about 1200 gpm each, and could be constructed as necessary. Collection lines and plant would be designed to allow for this expansion.

9.2 WATER WELL COLLECTION SYSTEM

Although well pumps can be designed to pump several miles to a central collecting plant and pump station(such as is the case for the City of Lufkin system), the current Champion system is designed for wells to pump to a central station located in the vicinity of the wells near Kurth Lake. Therefore, if any of the Champion wells are to be used with present well pumps, that type of logic would have to be continued.

Additionally, present well collection lines were designed to convey quantities of water only the shorter distances to the collecting station. An effort to use existing collection lines will involve placement of a new collecting and pumping station somewhere in the well field vicinity.

Figure 9-1 shows the general layout of the proposed well field, collection system, pumping station, and two options for transmission of the water back to the loop of the Lufkin system.

A pumping station would consist of a 2 million gallon ground storage tank(or possibly 2-1MG tanks), pumps with a firm capacity of 8,500 gpm, aeration facilities, fluoridation and chlorination equipment, and buildings and piping constructed to allow for further expansion.

Additionally, a radio control system would be needed to be able to properly utilize all of the wells in both the existing Lufkin well field, and those available in the Champion well field. A radio control system linked with a PC would be placed at the existing Lufkin Water Plant. Cost of this system could vary depending on a number of parameters and the degree of sophistication, but preliminary estimates would be that a good system might cost $120,000. This would allow for full control and monitoring of the entire well field systems.

9.3 WATER TRANSMISSION LINES

Figure 9-1 shows two different routes for construction of a new pipeline facility to bring water from the Champion well field back to the Lufkin system. Generally, Option 1 would be somewhat preferable if the right-of-way is available from Champion. The tie-in to the Lufkin system would ease the demand in the northeastern quadrant of the Loop by supplying water to the south of that area. The present water supply could then be used predominately to supply to the west and to the central part of the City.

Other distribution lines would be in about the same locations as for the surface water option, providing no impediment to future conversion to a surface water system. Line sizes on U.S. Highway 69 would vary due to the fact that they would be supplying water out to the City of

Huntington, Four Way WSC, and Zavalla WCID, as well as to other users in the southern part of the County. Some consideration has been given to upsizing this line to provide the potential for ultimately bringing in water from Lake Sam Rayburn. However, this does not appear to be economical. The acquisition of sufficient easements/rights-of-way for the future surface water transmission main should be included with the initial acquisitions.

The overall transmission and distribution systems for the water well source of supply system is very compatible with the anticipated future surface water supply system from either Lake Sam Rayburn or the Angelina River (from Lake Eastex).

9.4 CONSTRUCTION COST ESTIMATES AND OPERATING COSTS

9.4.1 CONSTRUCTION COSTS

Table 9-2 lists expected construction costs for the water plant and collection system for the well field option. Variations of these cost estimates have been used for Table 11-3 to estimate the cost of individual entities providing their own facilities.

TABLE 9-2
COST ESTIMATE FOR WATER WELL OPTION
WATER COLLECTION AND PUMPING STATION

ITEM	COST ESTIMATE	COMMENTS
LAND(3 ACRES)	$9,000	PROVIDES FOR EXPANSION
SITE IMPROVEMENTS	$50,000	SUFFICIENT FOR EXPANSION
2 MG GROUND STORAGE TANK	$400,000	
BUILDING, PUMPS, PIPING, ETC.	$330,000	
AERATORS AND TOWER	$200,000	TOWER SIZED FOR EXPANSION
CHLORINATION AND FLUORIDATION	$120,000	
TIE-IN-WELL FIELD COLLECTION	$100,000	
RADIO CONTROL SYSTEM	$120,000	
TOTAL ESTIMATED CONSTRUCTION	$1,329,000	
ENGR., SURVEYING, INSPECTION	$125,000	
LEGAL AND ADMINISTRATIVE	$60,980	
CONTINGENCIES	$120,000	
TOTAL ESTIMATED PROJECT COSTS	$1,514,000	

9.4.2 OPERATING COSTS

The following Table 9-3 shows estimated construction and operating expenses for a typical small and larger Carrizo well as well as for a Yegua well. These have been compiled from the files and records of Everett Griffith, Jr. & Associates, Inc. and from those of several of the water systems of the area. Though not precisely correct for each system, they are generally representative.

These figures have been used to compare costs of surface water to well water, avoided costs that systems might incur by buying from the regional system(either surface or ground water), and for the operating costs for the regional system if the well field option is selected.

TABLE 9-3
ANGELINA COUNTY WATER STUDY
TYPICAL WELL OPERATIONAL COSTS

ITEM	YEGUA WELL	SMALLER CARRIZO WELL	LARGER CARRIZO WELL
TYPICAL DEPTH(FT.)	700	1200	1200
TYPICAL CONSTRUCTION COST*	$196,800	$331,320	$579,120
TYPICAL PRODUCTION RATE(GPM)	225	600	1150
TYPICAL OPERATING DAY(HRS)	8.5	8.5	8.5
HORSEPOWER OF PUMP	40	150	300
ELECTRICAL COST(PER TYP. YEAR)	$6,943	$26,038	$52,075
MAINTENANCE COST	$4,500	$7,500	$10,000
LABOR COST	$8,213	$8,213	$8,213
CHLORINATION,AERATION,FLUORID.,ETC	$2,513	$6,701	$12,844
DEPRECIATION	$9,761	$20,213	$35,725
INTEREST COSTS	$10,748	$18,095	$31,629
TOTAL ANNUAL PUMPAGE(1000 GAL)	41883.75	111690	214072.5
O & M COST/1000 GAL	$0.529	$0.434	$0.388
DEPR. & INT. COST/1000 GAL	$0.490	$0.343	$0.315
TOTAL COST/1000 GAL	$1.019	$0.777	$0.703
AVOIDED COST FOR EXIST. FACILITIES	$0.529	$0.434	$0.388

*INCLUDES ONE MILE OF SUPPLY LINE

10.0 DETAILED DESCRIPTION OF RECOMMENDED FACILITIES

The following chapter is intended to summarize and explain the recommended alternative for the regional system to provide water to the various county entities. Since the selected option is groundwater from the Carrizo Aquifer based on its cost-effectiveness, this chapter will of necessity duplicate somewhat the previous Chapter 9.

Table 10-1 summarizes the major cost components for the two water source alternatives considered and clearly demonstrates the relative cost benefits of the groundwater wells. Although the cost per thousand exclusive of surface water is only $ 0.11 difference, the annual costs are much higher for surface water and each entity would be required to have a much higher take-or-pay quantity.

TABLE 10-1
COMPARATIVE COST SUMMARY
YEAR 2010 FACILITIES

	SURFACE WATER OPTION	GROUND WATER OPTION
CONSTRUCTION COSTS		
Wells and Wellfield Collection	$ -0-	$ 1,025,000
Intake Structure	1,561,585	
Water Treatment and Pumping Plant	9,936,183	2,039,000
Surface Water System-South County	-0-	1,540,000
Transmission Lines	8,516,150	6,786,959
TOTAL CONSTRUCTION COSTS	$20,013,919	$11,390,959
ANNUAL COSTS		
Construction Amortization	$ 2,038,416	$ 1,160,168
O&M	$ 1,779,719	$ 1,103,397
Raw Water	$ 187,183	-0-
TOTAL ANNUAL COSTS	$ 4,005,318	$ 2,263,565
COSTS PER 1,000 GALLONS		
Construction Amortization	$ 0.584	$ 0.505
O&M	$ 0.51	$ 0.48
Raw Water	$ 0.054	-0-
TOTAL COST PER 1,000 GALS.	$ 1.148	$ 0.985

10.1 WATER WELLS

Initially it is anticipated that the five western wells of Champion will be acquired. Since an agreement has not been made, this assumption may not end up being the actual alternative. However, for overall planning and cost-estimating this assumption will probably be close enough to the actual final agreement to allow for valid cost-estimating and planning.

These wells are described as Well Nos. 2,4,5,13, and 14. According to the report entitled "Pumpage and Water Levels in the Lufkin-Nacogdoches Area" by Guyton & Associates, these wells should produce about 6000 gpm total, although they are currently throttled back to 4,252 gpm.

This report anticipates that if a further agreement is reached with Champion Paper pertaining to further ground water(in the case that Champion would convert wholly to surface water), future needs from about Year 2010 would be met either with the acquisition of other Champion wells or the drilling of new wells in the area of the Champion well field.

10.2 WELL COLLECTION FIELD

This report envisions that if an accord is reached for Well Nos. 2,4,5,13, and 14, then the collecting system for these wells can also be conveyed to the regional system. In this way only a short stretch of line would be required to tie in the existing collection line to the proposed plant site. The current wells, existing collection system, and two different possible water plant sites are illustrated in Figure 9-1.

If future acquisition of other Champion wells occurred, then probably the collection system for those wells could also be obtained. If new wells were drilled, then new collection lines would be required as well.

10.3 PUMPING STATION

Figure 10-1 shows a typical layout with probable dimensions of land needed for a pump station. Cost estimates for this facility were included in Table 9-2. The pump station should be designed to be flexible enough to be expanded from 2 million gallons of storage and a pumping capacity of 3.37 MGD to up to 8 million gallons of storage and a pumping capacity of 14 MGD.

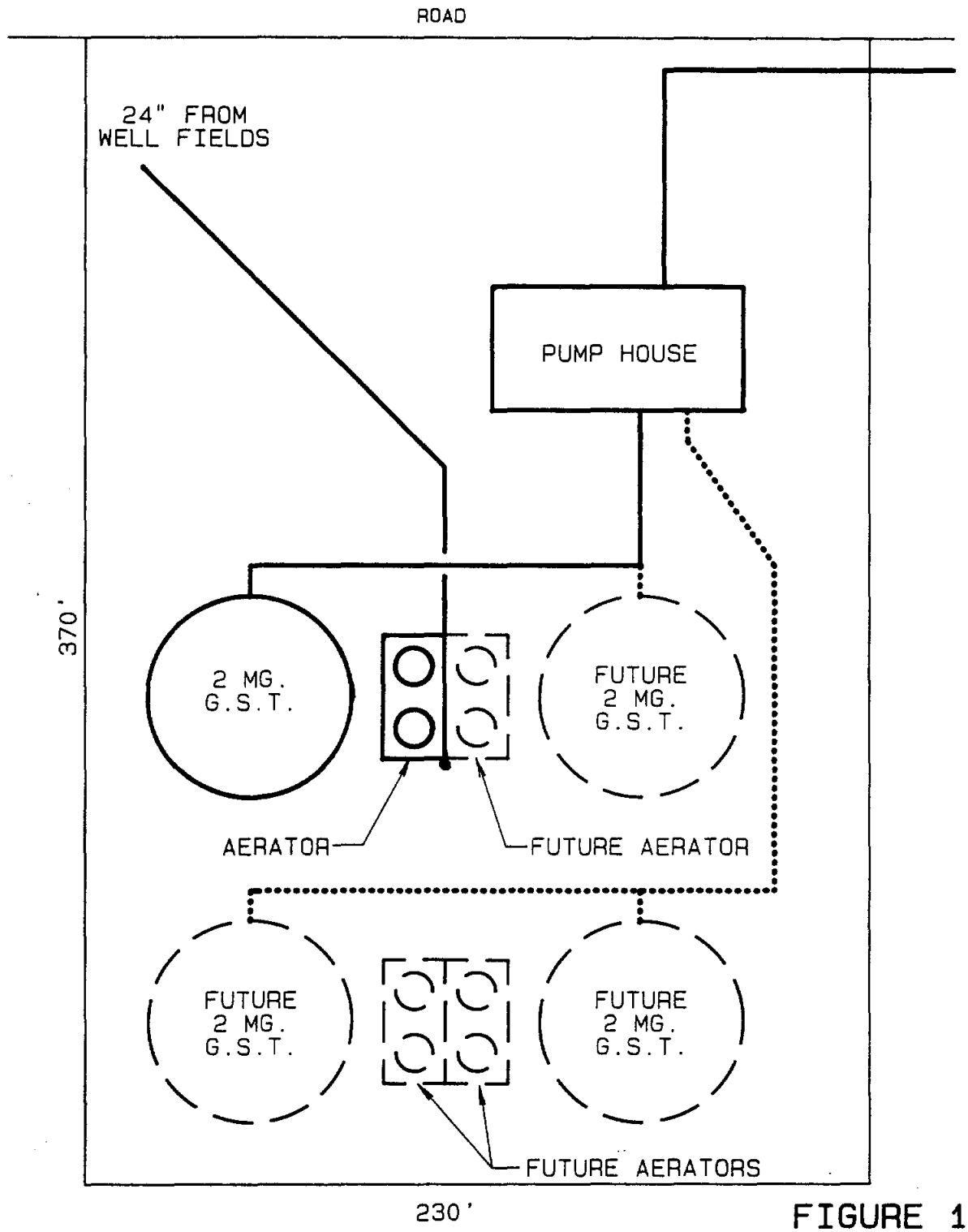


FIGURE 10-1

PROPOSED WATER PLANT
WELL FIELD ALTERNATE

ENGINEERING SGA SURVEYING
EVERETT GRIFFITH, JR. & ASSOCIATES
408 NORTH THIRD STREET
P.O. BOX 1748
LUFKIN, TEXAS

DESIGNED BY: JWG	CHECKED BY: JWG	SCALE: 1" = 50'
DRAWN BY: RVH	APPROVED BY: JWG	DATE: 07-03-89

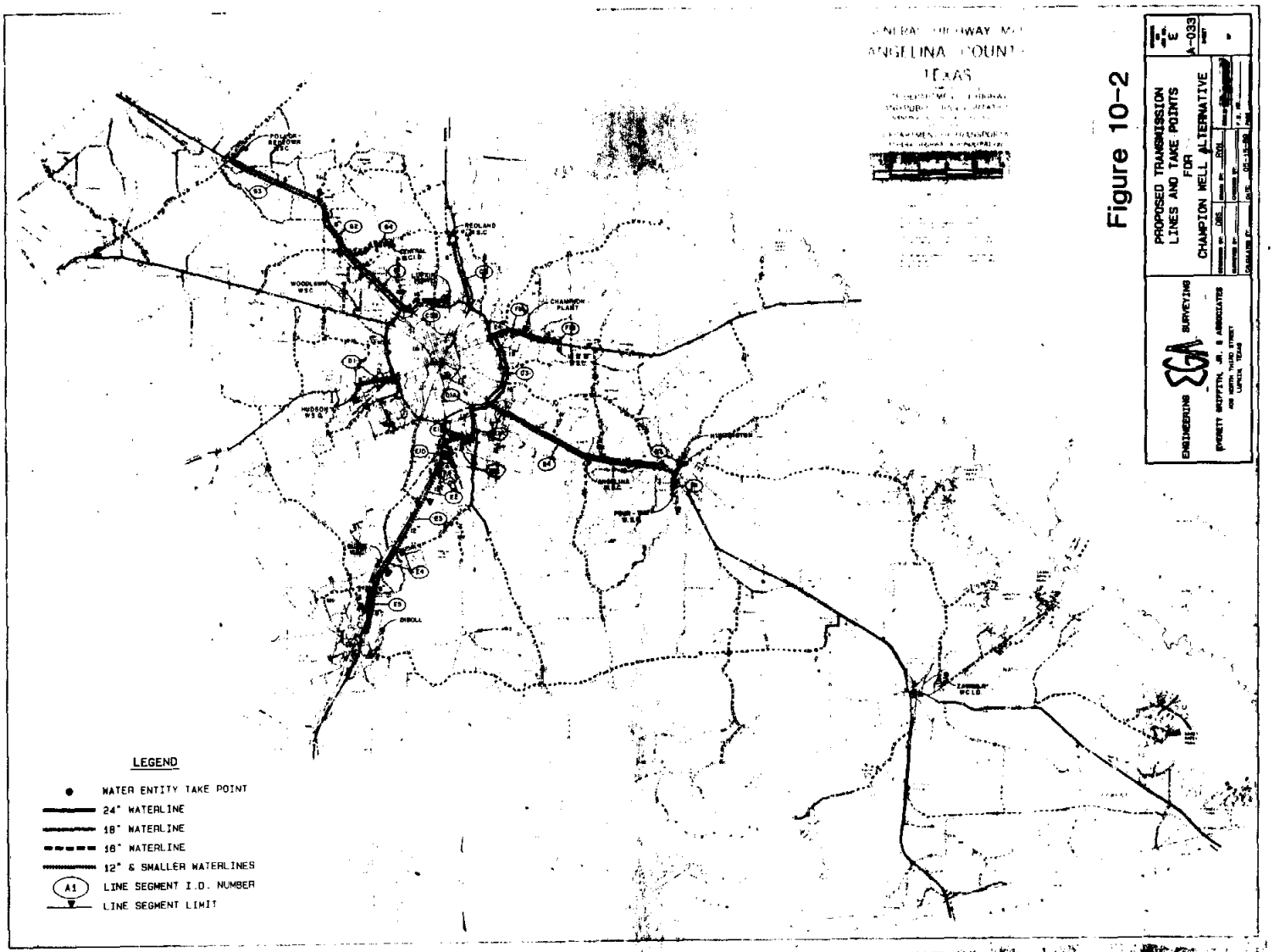

LEGEND
WATER ENTITY TAKE POINT
24" WATERLINE
18" WATERLINE
16" WATERLINE
12" & SMALLER WATERLINES
A1
LINE SEGMENT I.D. NUMBER
LINE SEGMENT LIMIT
PROPOSED TRANSMISSION LINES AND TAKE POINTS FOR CHAMPION WELL ALTERNATIVE
ENGINEERING SURVEYING

Figure 10-2

10.4 TRANSMISSION LINES

Figure 10-2 presents the proposed regional layout with the water well supply alternative. The numbering system is the same as that for the surface water alternative in order to allow for comparison of the two options. A line is not shown to Zavalla since that line does not appear to be cost-effective at this time.

10.4.1 REGIONAL LINES

The proposed system assumes Option 1 in Figure 9-1 is used for the routing of the supply line in from the pumping station. This supply line would intersect the State Highway 103 right-of-way and continue west along that right-of-way to Loop 287, where it would tie in to the transmission lines of the City of Lufkin. The mutual conveyance of water is discussed in Item 10.4.2 below.

The regional lines would radiate out from the Lufkin transmission system with an 8" and 6" line following Highway 69 north to Central and Pollok-Redtown, a 6" conveying water to Redland's water plant, a 12" line carrying water to Huntington and Four-Way WSC, a 12" and 8" line carrying water to Burke and Diboll, and an 8" line following Highway 94 to the Hudson Water Plant No. 1.

Table 10-2 shows line types and sizes with estimates of costs for each line type and size. These cost factors can be correlated with the various charts and tables to determine the type that was envisioned.

The pipe laying costs include material, labor cost of installation, valves, fittings, fire hydrants in city and some open areas, bores and pavement repairs, air release valves, trench safety system, embedment, and right-of-way costs. Engineering, surveying, inspection, administration, and contingencies are also included in the unit cost factors. Normally, the first cost shown for a line size in open conditions does not include fire hydrants.

Generally, pipe material of smaller size pipe is for C-900 PVC, Class 100 pipe (DR 25). In some city installations regular C-900 PVC pipe (DR 18) is estimated. In sizes 12" to 24" C-905 PVC pipe is estimated. In the larger sizes concrete lined steel cylinder pipe is estimated.

TABLE 10-2
ANGELINA COUNTY WATER STUDY
FULL COST OF STANDARD LINE INSTALLATION
REVISED: AUGUST 28, 1989

LINE SIZE	AREA	QUANT.	PIPE MATERIAL	PIPE LAYING COST	ENGR., ADMIN., ETC.	CONTING.	TOTAL UNIT COST
6	OPEN	1000	C900,DR25	$7.20	$1.08	$1.24	$9.53
6	CITY	1000	C900,DR25	$11.99	$1.80	$2.07	$15.85
8	OPEN	1000	C900,DR25	$10.70	$1.60	$1.84	$14.14
8	CITY	1000	C900,DR25	$17.57	$2.64	$3.03	$23.24
10	CITY	1000	C900,DR18	$21.91	$3.29	$3.78	$28.98
12	OPEN	1000	C900,DR25	$17.03	$2.55	$2.94	$22.52
12	OPEN	1000	C900,DR25	$18.49	$2.77	$3.19	$24.46
12	OPEN	1000	C900,DR18	$21.09	$3.16	$3.64	$27.89
12	CITY	1000	C900,DR18	$26.10	$3.92	$4.50	$34.52
16	OPEN	1000	C905	$24.65	$3.70	$4.25	$32.60
16	OPEN	1000	C905	$26.52	$3.98	$4.57	$35.07
16	CITY	1000	C905	$33.38	$5.01	$5.76	$44.15
18	OPEN	1000	C905	$30.24	$4.54	$5.22	$39.99
18	OPEN	1000	C905	$32.37	$4.86	$5.58	$42.81
18	CITY	1000	C905	$40.01	$6.00	$6.90	$52.92
20	OPEN	1000	C905	$35.05	$5.26	$6.05	$46.36
20	OPEN	1000	C905	$37.72	$5.66	$6.51	$49.89
20	CITY	1000	C905	$46.63	$6.99	$8.04	$61.67
24	OPEN	1000	C905	$47.79	$7.17	$8.24	$63.20
24	OPEN	1000	C905	$50.45	$7.57	$8.70	$66.73
24	CITY	1000	C905	$61.49	$9.22	$10.61	$81.33
30	OPEN	1000	RCCP	$83.84	$12.58	$14.46	$110.87
30	OPEN	1000	RCCP	$87.17	$13.08	$15.04	$115.28
30	CITY	1000	RCCP	$102.34	$15.35	$17.65	$135.34
36	OPEN	1000	RCCP	$104.72	$15.71	$18.06	$138.49
36	OPEN	1000	RCCP	$108.05	$16.21	$18.64	$142.89
36	CITY	1000	RCCP	$128.11	$19.22	$22.10	$169.43

10.4.2 USE OF LUFKIN TRANSMISSION SYSTEM

The regional plan rests on the concept of use of the City of Lufkin's transmission system around Loop 287. This is due to the economies recognized in not paralleling existing or planned lines of the City of Lufkin.

An important consideration is that accurate metering is absolutely necessary in that a meter will measure flow into the Lufkin system, and five meters will measure flows out. Any inaccuracies could result in Lufkin being charged more than the actual quantity used by the City(due to the normal tendency of meters to measure low if they are inaccurate, though in this type of larger meter that assumption is not always valid).

Table 10-3 tabulates the regional system needs exclusive of those of Lufkin to establish what size of lines would be required for a system on Loop 287 parallel to the lines of Lufkin. This parallel system would also follow a route down F.M. Highway 58 to avoid the Highway 59-Loop 287 intersection.

TABLE 10-3
ANGELINA COUNTY WATER STUDY
LINE FLOW REQUIREMENTS
COMBINATION SYSTEM WITH CITY OF LUFKIN

SYSTEM	YEAR 2000 FLOW (MGD)	YEAR 2010 FLOW (MGD)	LINE C-1A	LINE C-3	LINE C-4	LINE C-5A	LINE C-5B	LINE C-6A	LINE C-6B	LINE E-1A	LINE E-1B	LINE E-1C	LINE E-1D	LINE F-1
BURKE WSC	0.210	0.272	0.272	0.272						0.272	0.272	0.272	0.272	0.27
CENTRAL WCID	0.140	0.251			0.251	0.251	0.251							0.25
CITY OF DIBOLL	0.341	0.695	0.695	0.695						0.695	0.695	0.695	0.695	0.69
FOUR-WAY WSC	0.207	0.314		0.314										0.31
HUDSON WSC	0.185	0.375			0.375	0.375	0.375	0.375	0.375					0.37
CITY OF HUNTINGTON	0.196	0.320		0.320										0.32
LUFKIN INDUSTRIES	0.100	0.200		0.200										0.20
M & M WSC	0.067	0.291												0.29
POLLOK-REDTOWN WSC	0.091	0.114			0.114	0.114	0.114							0.11
REDLAND WSC	0.043	0.147			0.147									0.14
ZAVALLA WSC	0.123	0.149		0.149										0.14
OTHER ENTITIES	0.220	0.257		0.257										0.25
TOTAL FLOW W/O LUFKIN	1.923	3.385	0.967	2.207	0.887	0.740	0.740	0.375	0.375	0.967	0.967	0.967	0.967	3.38
CITY OF LUFKIN	1.400	3.122												
TOTAL-ALL ENTITIES	3.323	6.507												
LINE SIZE NEEDED			12	16	12	12	12	8	8	12	12	12	12	16
OTHER POSSIBLE ENTITIES														
ANGELINA WSC	0.158	0.321		0.321										0.32
BEULAH WSC	0.014	0.027	0.027	0.027						0.027	0.027	0.027	0.027	0.02
PRAIRIE GROVE WSC														
WOODLAWN WSC	0.084	0.126			0.126	0.126	0.126	0.126						0.12
SUBTOTAL	0.256	0.474	0.027	0.348	0.126	0.126	0.126	0.126	0.000	0.027	0.027	0.027	0.027	0.47
TOTAL-ALL POSSIBLE	3.579	6.981	0.994	2.555	1.013	0.866	0.866	0.501	0.375	0.994	0.994	0.994	0.994	3.85
LINE SIZE NEEDED			12	16	12	12	12	12	8	12	12	12	12	18

Table 10-4 shows in a combined chart the required size of line for the county regional system, the line for the City of Lufkin, and the required line size for joint use. As can be noted, significant savings are accomplished on the part of both the regional system and the City of Lufkin. This win/win situation is due to the economies of larger line sizes, and due to the fact that the City of Lufkin will need to build some new lines either now or in the near future. These new lines can be constructed to provide for the regional system needs as well as for those of the City of Lufkin.

Table 10-4 shows on a line by line basis the proposed split of costs to be borne by the City of Lufkin and the regional system. In some cases an existing line is sufficiently sized to handle the proposed regional flows. In that instance, the cost of a new similarly sized line is calculated, and distributed just as in the case of a new line. The City's share of that cost is deducted back out in the line that is entitled "Actual New Construction".

As can be noted on that same line, the regional system realizes a savings of $714,623($2,169,811 less $1,455,188) while the City of Lufkin has a savings of $896,398($2,0-63,837 less $1,167,439). These figures are carried forward in the calculations shown in Tables 12-1 through 12-6.

TABLE 10-4
ANGELINA COUNTY WATER STUDY
FLOW THROUGH CITY OF LUFKIN DISTRIBUTION SYSTEM
IMPROVEMENTS AND COST SHARING
REVISED: MAY, 1990

LINE SEGMENT	LENGTH	SIZE REQUIRED BY COUNTY SYSTEM	ESTIMATED COST	SIZE REQUIRED BY CITY SYSTEM	ESTIMATED COST	SIZE REQUIRED FOR JOINT USE	ESTIMATED COST	PCT. PAID BY COUNTY SYSTEM	COST BORN COUNTY SYSTEM	COST BORN CITY OF LUFKIN	NEW OR EXISTING LINE
C-1A	3,370	12	$77,510	16	$148,280	18	$178,610	36.00%	$64,300	$114,310	NEW
C-2	13,860	NA	$0	NA	$0	NA	$0				
C-3	13,390	16	$589,160	16	$589,160	18	$709,670	50.00%	$354,835	$354,835	NEW
C-4	8,448	12	$194,304	12	$194,304	12	$194,304	50.00%	$97,152	$97,152	EXISTING
C-5A	5,016	12	$115,368	12	$115,368	12	$115,368	50.00%	$57,684	$57,684	EXISTING
C-5B	9,768	12	$224,664	16	$429,792	16	$429,792	36.00%	$154,725	$275,067	NEW
C-6A	3,160	8	$44,240	12	$72,680	12	$72,680	30.77%	$22,363	$50,317	EXISTING
C-6B	11,310	8	$158,340	12	$260,130	12	$260,130	30.77%	$80,040	$180,090	EXISTING
E-1A	6,800	12	$156,400	16	$299,200	18	$360,400	36.00%	$129,744	$230,656	NEW
E-1B	2,900	12	$66,700	12	$66,700	18	$153,700	50.00%	$76,850	$76,850	NEW
E-1C	3,700	12	$85,100	16	$162,800	16	$162,800	36.00%	$58,608	$104,192	EXISTING
E-1D	5,800	12	$133,400	12	$133,400	18	$307,400	50.00%	$153,700	$153,700	NEW
F-1	6,125	18	$324,625	18	$324,625	24	$410,375	50.00%	$205,188	$205,188	NEW
TOTALS	93,647		$2,169,811		$2,796,439		$3,355,229		$1,455,188	$1,900,041	
ACTUAL NEW CONSTRUCTION			$2,169,811		$2,063,837		$2,622,627		$1,455,188	$1,167,439	

NOTE: NEW ESTIMATES OF CONSTRUCTION COST ARE USED FOR BOTH NEW LINES AND EXISTING LINES WHICH WILL BE SHARED. COSTS ARE PRO-RATED BASED ON PERCENTAGE OF VOLUME OF THE NEW LINE.

10.5 SERVICE FOR THE SOUTHERN PART OF THE COUNTY

Since the water well alternative does not appear to be a cost-effective one for the southern part of the County, this plan proposes that the regional system consider constructing a smaller intake structure and water treatment plant in the vicinity of the Highway 147 bridge.

A fairly substantial number of people live in the area along Highway 147 east of Zavalla, and along Highways 63 and 69 south of Zavalla. For the most part these people are not served by a community system. Additionally, quality of the ground water is very poor, and the Yegua Aquifer, which is the only source, generally has wells with very limited output.

Some of the systems lying south of Zavalla off of Highway 63 have either non-approved surface water treatment systems, or plants which are at best marginal.

Either the Zavalla W.C.I.D. could extend lines to serve these areas if its Board so chose, or the regional entity could construct lines and plants to serve these people.

Cost estimates for this option are outlined below.

TABLE 10-5
ESTIMATED COSTS FOR SEPARATE
SURFACE WATER SYSTEM TO SERVE
ZAVALLA W.C.I.D. AND HIGHWAY 147 AREA

CONSTRUCTION COSTS	
Intake Structure	$ 290,000
Treatment and Pumping Plant (0.34 MGD)	950,000
Transmission Line	300,000
TOTAL CONSTRUCTION COSTS	$1,540,000
ANNUAL COSTS	
Construction Amortization	$ 156,800
O&M	58,000
Raw Water	7,600
TOTAL ANNUAL COSTS	$ 222,400
COSTS PER 1,000 GALLONS	
Construction Amortization	$ 1.26
O&M	0.47
Raw Water	0.06
TOTAL COST PER 1,000 GALLONS	$ 1.79

10.6 TERMINATION FACILITIES

In laying out the proposed regional system, the lines radiating out from Lufkin would carry water to one or more plants of the entities being served. Some strong consideration was given to serving the systems on a floating basis whereby the tie-in was made directly into their system.

However, when the complexities of the various operating pressure planes of each system were considered along with the requirements of the Health Department pertaining to maintaining some type of air gap between approved and non-approved systems, the determination was made that the best option was to deliver water to one or more ground storage tanks of each entity.

10.6.1 REGIONAL IMPROVEMENTS

The proposed regional system includes the costs of the line and tie-in necessary to deliver water to each system. In this way responsibilities remain well-defined. The system buys water delivered to its plant. The system maintains its independence fully in the operation of its delivery system.

One area requiring further consideration is the advisability of constructing fire hydrants along the regional transmission lines. Since most of the rural areas do not have true fire protection lines that are based on U.L. fire-approved water line, construction of a regional system would be an opportunity to provide true fire protection in at least the areas along the lines. Additionally, this would provide locations for refilling fire trucks for fighting fires in other rural areas.

Generally, pipe of 12" and smaller was estimated as being C-900, Class 100, which has the capacity to serve as pipe for fire protection in accordance with U.L. regulations.

10.6.2 IMPROVEMENTS REQUIRED BY INDIVIDUAL SYSTEMS

Generally, no further improvements are required of individual entities in order to make the tie-in to the regional system. Certainly, the individual needs of the system must continue to be met by that system. The regional system can be used, however, to some degree to meet requirements for storage, pressure, and service pump capacity, depending on the particular layout of the system and approval by the Texas State Department of Health. This would be an additional plus tacked on to the provision for meeting water supply requirements.

11.0 PROPOSED PHASING

11.1 WATER SUPPLY

The best alternative at this time is to use the groundwater available in the Carrizo Aquifer. This should be accompanied by an effort to iron out an agreement with Champion Paper in regards to their continued lower usage of water from that source. The 8 MGD now available is based on wet cycle usage. If a dry cycle develops, or if new users or changes in growth demand more water than projected, then the second phase of going to surface water will be moved up in time. The alternative to that rests on the possibility that Champion might consider converting entirely to surface water at some stage. In that case, surface water rights would probably be traded with Champion.

One of the dangers of planning is that it is often too short-sighted. This is particularly true when future water supplies are being determined. If a larger water line than that originally constructed is needed, then it is a relatively simple matter to construct another. However, if it is determined in the future that more water supply is needed, there may or may not be any available water at that time.

Therefore it is critical for all the entities involved in this study to think seriously about not only shorter term needs of twenty years, but also about needs over the next fifty and even one hundred years. Certainly, changes in water usage may have dramatic effects. Very possibly we will be reusing wastewater that has been satisfactorily purified for even human consumption. But in fifty years most of the water now available will be owned by some other entities. Any one not owning sufficient water rights at that time will be in very bad shape.

As can be noted in Figure III-6-4 taken from Water For Texas, Technical Appendix, Volume 2, shown on Page 95, there is a total of 973.1 thousand acre-feet projected to be available in Zone 2 of the Neches River Basin in 1990. In-zone demand is only expected to be 285.1 thousand acre-feet. However, export demand is projected at 320.7 thousand acre-feet.

In the Year 2030, water supply is projected to be 1645.4 thousand acre-feet, and in-zone demand is expected to be 540.1 thousand acre-feet. In that year 1226.8 thousand acre-feet is projected to be transferred to another river basin because by then demand will have outstripped available water supply in every river basin in Texas with the exception of the Neches and Sabine River Basins.

Water is currently plentiful in East Texas, but that will probably not always be the case. With these thoughts in mind, the following needs are addressed along with recommendations about the acquisition of needed water rights.

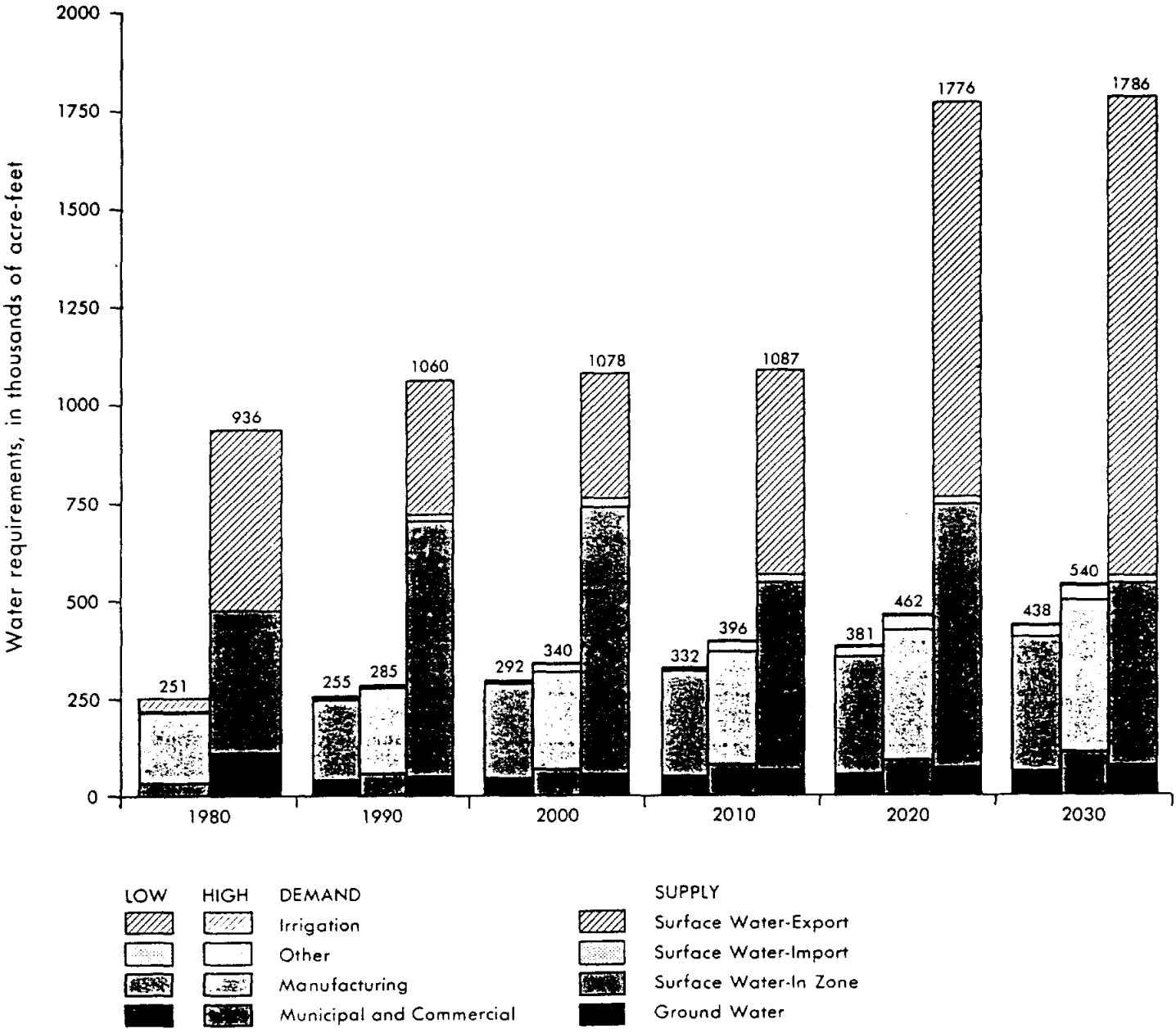


Figure III-6-4. Reported Use and Supply Source, With Projected Water Supplies and Demands, Neches River Basin, Zone 2, 1980-2030

11.1.1 WATER NEEDS BY SYSTEMS

Table 11-1 summarizes water system needs(in addition to existing supplies) for the County including those entities not participating in this study.

TABLE 11-1
WATER NEEDS BY SYSTEM WITH PROPOSED PHASING

	WATER NEEDED FROM REGIONAL SYSTEM (In Million Gallons Per Day)			
WATER AGENCY	2000	2010	2040	2090
BURKE WSC	0.210	0.272	0.503	1.062
CENTRAL WCID	0.140	0.251	0.762	2.000
DIBOLL	0.341	0.695	1.251	2.597
FOUR-WAY WSC	0.208	0.314	0.556	1.143
HUDSON WSC	0.185	0.375	0.811	1.864
HUNTINGTON	0.196	0.320	0.473	0.842
LUFKIN	1.401	3.122	6.722	15.432
M & M WSC	0.066	0.291	0.456	0.855
POLLOK-REDTOWN WSC	0.091	0.114	0.246	0.565
REDLAND WSC	0.043	0.147	0.268	0.560
ZAVALLA WCID	0.123	0.149	0.224	0.404
OTHER PUBLIC ENTITIES	0.220	0.257	0.488	1.047
TOTAL OF PARTICIPATING ENTITIES	3.224	6.307	12.760	28.371
ANGELINA WSC	0.158	0.321	0.579	1.202
BEULAH WSC	0.014	0.027	0.063	0.151
PRAIRIE GROVE WSC	0.030	0.040	0.080	0.160
WOODLAWN WSC	0.084	0.126	0.270	0.619
NEW INDUSTRIES	0.150	0.200	0.400	0.800
TOTAL OF NON-PARTICIPATING ENTITIES	0.436	0.714	1.392	2.932
COUNTY TOTAL	3.660	7.021	14.152	31.303
CITY OF LUFKIN TOTAL	1.401	3.122	6.722	15.432
OTHER PARTICIPATING ENTITIES	1.823	3.185	6.038	12.939
NON-PARTICIPATING ENTITIES	0.436	0.714	1.392	2.932
AVAILABLE WATER SOURCES				
AVAILABLE GROUNDWATER[1]	8.000	8.000	8.000	8.000
LUFKIN SURFACE WATER	24.995	24.995	24.995	24.995
OTHER RAYBURN WATER	8.409	8.409	8.409	8.409
LAKE EASTEX WATER[2]	9.015	9.015	9.015	9.015

1 AMOUNT CURRENTLY AVAILABLE WITH CHAMPION USAGE AT 12.0 MGD. CHAMPION HAS INDICATED A WILLINGNESS TO CONSIDER FURTHER REDUCTION IN USAGE IF NECESSARY. THIS WOULD PROBABLY REQUIRE A TRADE-OFF OF SURFACE WATER RIGHTS.

2 OWNED BY PUBLIC ENTITIES OF ANGELINA COUNTY.

The totals shown are grouped in three amounts including the City of Lufkin, participating entities, and non-participating entities. This reflects the fact that the City of Lufkin has had its own source of surface water for over twenty years and that the participating entities will probably want to consider the purchase of some of the water available in Sam Rayburn for future use.

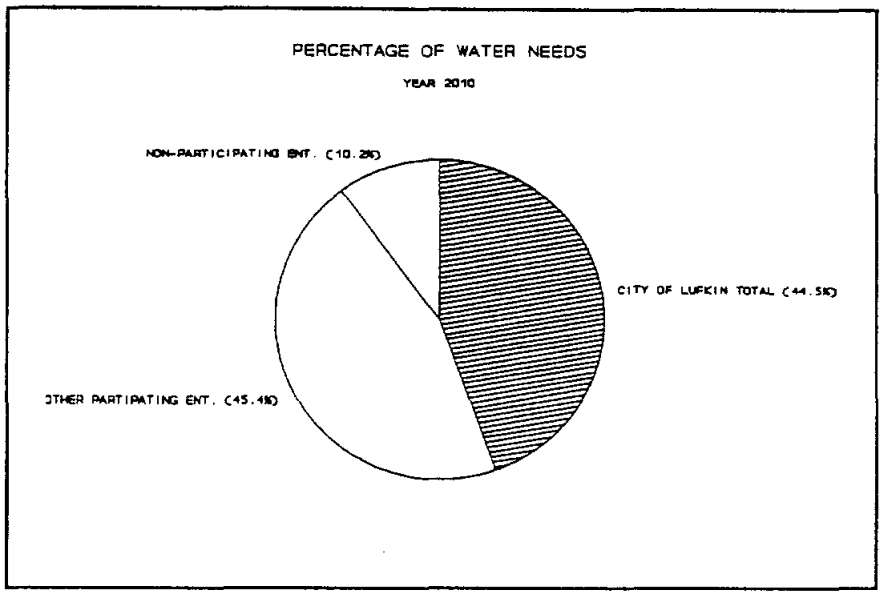


Figure 11-1

The non-participating entities, if they wanted to ultimately participate in the county-wide study, could line up their own water rights. This is already the case for Angelina WSC and Woodlawn WSC who are holding rights in Lake Eastex.

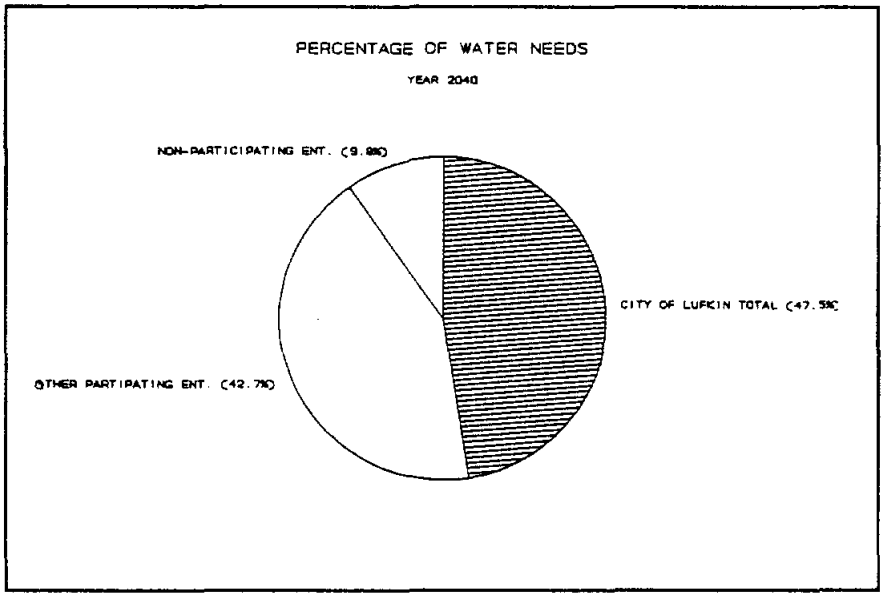


Figure 11-2

The available well water would be split between the City of Lufkin and the participating entities initially. As that source was no longer able to fully meet demands, either further water might be made available from Champion's well field, or the regional system could proceed with plans for a surface water plant. If Champion made more ground water available, then they would probably need to arrange for some trade of surface water for ground water. In either case, the entities should plan on acquiring necessary surface water rights.

Figures 11-1, 11-2, and 11-3 indicate in pie chart form the water needs of the County in the three groupings described above. In each case the City of Lufkin will need nearly 50% of the additional water.

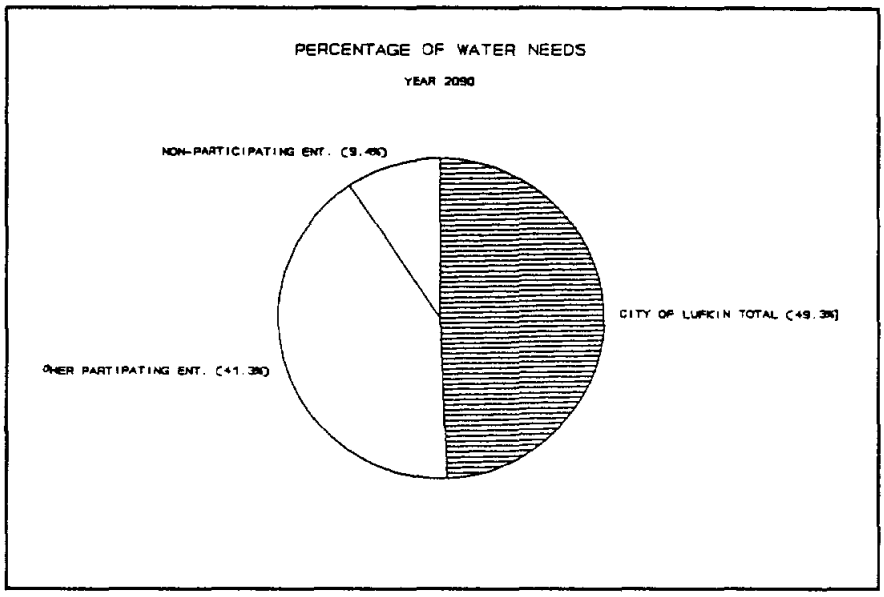


Figure 11-3

Figure 11-4 shows in stacked bar-graph format the overall county needs for the next 100 years.

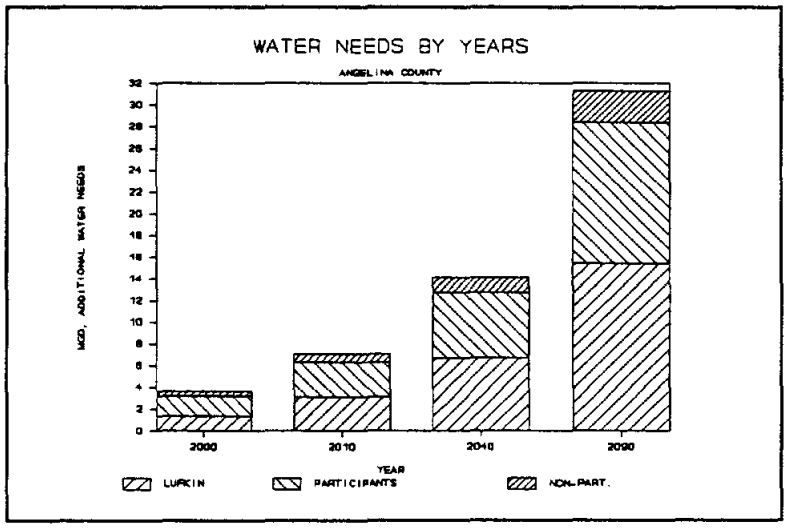


Figure 11-4

Figure 11-5 illustrates the additional water needs of the City of Lufkin as compared to the additional ground water available and the sum of that ground water and the available water that Lufkin has in Sam Rayburn Reservoir.

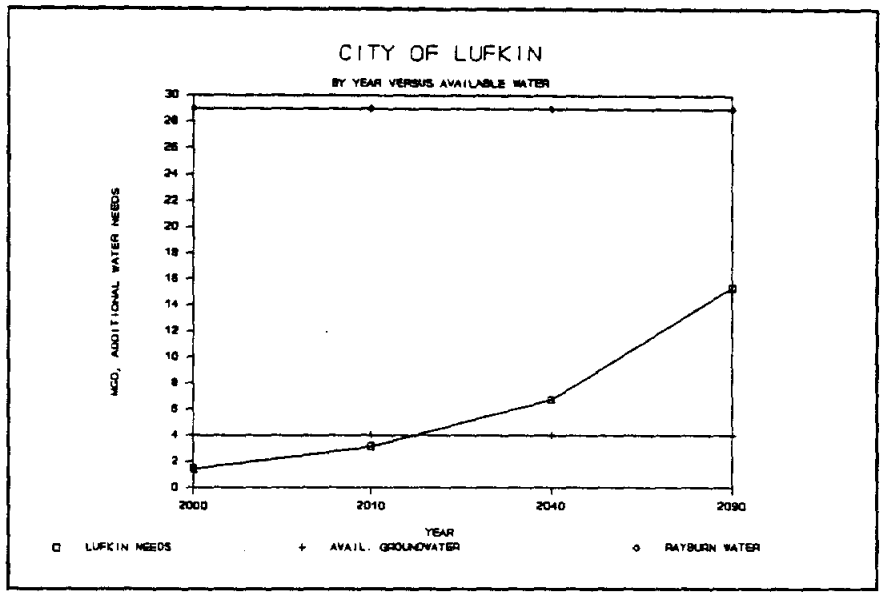


Figure 11-5

As can be noted, the addition of 4 MGD of ground water (half of the 8 MGD identified) would provide Lufkin's needs until about the Year 2015. The large amount of water available at Sam Rayburn would provide for needs throughout the twenty-first century.

Additionally, Figure 11-6 displays the needs versus the available ground water and against the total of the well water and the maximum available water from Sam Rayburn (exclusive of that owned by the City of Lufkin.

Like Lufkin's supply, the additional ground water would provide needs through about the Year 2015, and the additional surface water would provide fully the needs throughout most of the twenty-first century.

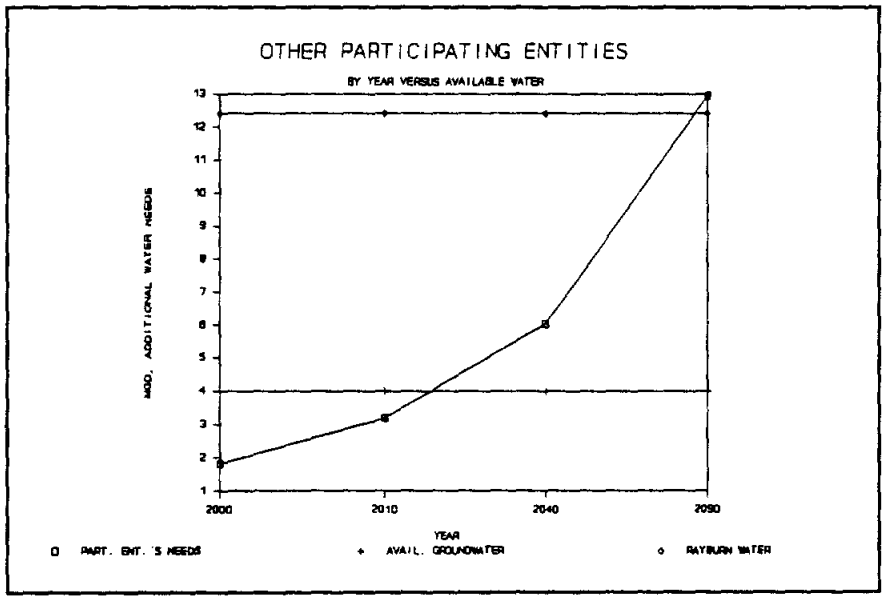


Figure 11-6

These quantities should also provide for dry cycle conditions as well as for large users who might move into the area, and for unexpected increases in population or per capita usage rates.

11.4 ANNUAL O & M COSTS BY PHASING

Annual operation and maintenance costs are estimated in Table 11-2 below. These costs include all operation and maintenance costs including power, chemicals, and labor and annual costs for the purchase of surface water.

TABLE 11-2
TOTAL SYSTEM O & M COSTS

/OPTION ITEM/YEAR	SURFACE WATER 2000	SURFACE WATER 2010	GROUND WATER 2000	GROUND WATER 2010
TREATMENT & PUMPING COSTS	$926,370	$1,430,654	$481,873	$850,815
LINE MAINTENANCE COSTS	$90,000	$120,000	$65,000	$85,000
MANAGEMENT & PLANNING COSTS	$175,637	$229,065	$128,687	$167,582
TOTAL COSTS	$1,192,007	$1,779,719	$675,560	$1,103,397
PRODUCTION RATE(MGD)	5.4	9.56	3.22	6.3
O & M COSTS/1000 GALS.	$0.60	$0.51	$0.57	$0.48

11.5 CAPITAL COST BY PHASING

Tables 11-3 and 11-4 show the proposed phasing of the overall project for the next twenty years. Costs shown for 1990 are for the initial phase of construction and are intended to address needs through the Year 2000. In the case of transmission lines the first phase would be satisfactory through at least the Year 2010. Table 11-3 envisions the purchase of wells from Champion while Table 11-4 includes wells being donated by Champion or being traded for surface water rights.

TABLE 11-3
ESTIMATED CONSTRUCTION COST OF WATER SERVICE PLAN

ITEM	2000	2010
ADDITIONAL WATER NEEDED	3.220	6.300
WATER NEEDS TO BE MET BY:		
GROUNDWATER	3.220	6.300
WATER PLANT	$ 1,414,000	$ 400,000
WATER WELLS	$ 450,000	$ 450,000
WELL COLLECTION SYSTEM	$ 100,000	$ 125,000
WELL TRANSMISSION LINE	$ 1,489,410	
OTHER TRANSMISSION LINES	$ 2,674,922	
LOOP SYSTEM IMPROVEMENTS	$ 2,622,627	
SURFACE WATER-SOUTH COUNTY	$ 1,540,000	
ELEVATED STORAGE TANK-REGIONAL	$ 400,000	
TOTAL SYSTEM COSTS	$10,690,959	$ 975,000
AMORTIZATION COSTS @ 8%, 20 YEARS	$ 1,088,873	$ 1,188,177
ANNUAL O & M COSTS	$ 675,560	$ 1,103,397
RAW WATER COSTS-SURFACE WATER	$ 186,660	$ 186,660
TOTAL ANNUAL COST	$ 1,951,093	$ 2,478,234
AVERAGE O & M COST/1000 GALS	$0.57	$0.48
AVERAGE AMORTIZATON COST/1000 GALS	$0.93	$0.52
AVERAGE RAW WATER COSTS/1000 GALS*	$0.16	$0.08
AVERAGE COST PER 1000 GALLONS	$1.66	$1.08

*Raw surface water costs distributed on total gallonage of well water sold, and not on actual per thousand cost of raw surface water.

As can be noted, total construction costs including those involving the transmission system of the City of Lufkin would total $10,690,959. This would also include paying $ 900,000 for six wells and paying $ 400,000 for the regional share of a 2 million gallon elevated storage tank.

Other figures indicate the cost to operate these facilities as well as the cost to purchase available water in Sam Rayburn Reservoir.

Table 11-4 shows similar costs as Table 11-3 but is intended to show the lower side of cost estimates by including no additional costs for the purchase of wells(they would be traded for surface water), and a southern county surface water system would not be included.

TABLE 11-4
ESTIMATED CONSTRUCTION COST OF WATER SERVICE PLAN
(NO PAYMENT FOR WELLS, NO SOUTH SURFACE WATER)

ITEM	2000	2010
ADDITIONAL WATER NEEDED	2.877	5.894
WATER NEEDS TO BE MET BY:		
GROUNDWATER	2.877	5.894
WATER PLANT	$ 1,414,000	$ 400,000
WATER WELLS	$ 0	$ 0
WELL COLLECTION SYSTEM	$ 100,000	$ 125,000
WELL TRANSMISSION LINE	$ 1,489,410	
OTHER TRANSMISSION LINES	$ 2,674,922	
LOOP SYSTEM IMPROVEMENTS*	$ 2,622,627	
ELEVATED STORAGE TANK-REGIONAL	$ 400,000	
TOTAL SYSTEM COSTS	$ 8,700,959	$ 525,000
AMORTIZATION COSTS @ 8%, 20 YEARS	$ 886,192	$ 919,663
ANNUAL O & M COSTS	$ 598,560	$ 1,032,629
RAW WATER COSTS-SURFACE WATER	$ 186,660	$ 186,660
TOTAL ANNUAL COST	$ 1,671,412	$ 2,138,952
O & M COST/1000 GALS	$0.57	$0.48
AMORTIZATION COSTS/1000 GALS	$0.82	$0.43
RAW WATER COSTS/1000 GALS PURCHASED*	$0.18	$0.09
AVERAGE COST PER 1000 GALLONS	$1.57	$1.00

*Raw surface water costs distributed on total gallonage of well water sold, and not on actual per thousand costs of raw surface water.

11.6 FUTURE PHASING TO SURFACE WATER

The Carrizo Aquifer, according to studies by Guyton & Associates, is capable of safely yielding approximately 32 MGD. However, it has been overproduced during the 1960's and 1970's at rates of up to 40 MGD. Some mining did occur in this time frame with pumping levels dropping significantly. There does not appear to be any serious damage to the aquifer due to this overpumping which continued for a period in excess of ten years.

The regional entity should consider 32 MGD as the maximum safe yield of the Carrizo with the realization that some slight overpumping may be permissible for a couple of years. With this in mind, this report recommends the following approach in regards to a "triggering device" for beginning the use of surface water in addition to ground water.

1. Sufficient surface water should be identified and contracted for at this time to provide for the water needs for the next 100 years.

2. When the pumpage rate from the Carrizo Aquifer in Angelina and Nacogdoches Counties reaches 28 MGD, the regional entity should begin the planning and evaluation for conversion to supplementing groundwater supplies with a surface water delivery system. The decision of which surface water supply to use should be made during this process.

3. When the pumpage rate reaches 30 MGD, the regional entity should begin the actual conversion to supplementing groundwater supplies with a surface water delivery system.

4. This process should allow for approximately 4-5 years for planning and evaluating the conversion to surface water and should allow for approximately 2-4 years for the actual implementation of a surface water delivery system.

Figure H-1, a map in Appendix H, exhibits the ability of this plan to expand the proposed groundwater delivery system to allow for the use of water from either Lake Sam Rayburn or from the future Lake Eastex (via Kurth Lake or some other off-river reservoir). In either case, proposed lines will tie in well with the surface water concept.

11.7 SURFACE WATER AVAILABILITY BY PHASING

The groundwater supply would be sufficient for about another twenty years of growth. At that time, surface water would be needed. Tables 11-5, 11-6, and 11-7 show different options that were originally proposed by the Corps of Engineers and the Lower Neches Valley Authority for the possible purchase of raw water rights in Sam Rayburn Reservoir. Although at this time it appears that a regional entity will probably purchase the water with a lump sum payment with bond proceeds, the tables are included for informational purposes. Additionally, the Lower Neches Valley Authority has asked the Corps of Engineers to reconsider the cost factors assigned to this water since they do reflect a much higher cost than that originally incurred in the construction of Sam Rayburn Reservoir.

The initial investigation by the Corps was for a total of 11,467 acre-feet. Subsequently the Corps discovered that about 3,000 acre-feet had never been allotted in addition to the 11,467 acre-feet. No dollar figures were ever received on that amount. Additionally, these discussions were taking place in 1987 and 1988, and current interest rates are considerably lower, so annual capital costs will probably be lower.

TABLE 11-5
DETERMINATION OF WATER RATES FOR RAW WATER
OUT OF SAM RAYBURN RESERVOIR
SEGMENT 1 - 6000 ac. ft.

Charges Due 01-01-88 to 01-01-2016

1.	Fixed cost: Annual capital cost and O&M cost payable to U.S. Government annually.	
	6000 ac. ft. x $8.185 per ac. ft. =	$49,110.00
2.	Water cost payable to LNVA	
	6000 ac. ft. x $3.82 per ac. ft. =	$22,920.00
	Total cost per year for 6,000 ac. ft. =	$72,029.50
	Cost per ac. ft. =	$12.00
	Cost per 1,000 gals. =	$ .057

based upon an anticipated yield of 3910 acre-feet per annum

Table 11-5 provides for the initial purchase of 6000 acre-feet of storage of water and approximately 3910 acre-feet per annum yield. This water would be paid out over a 28 year period. In the Year 2016 the water would be fully paid for. Payments would continue for maintenance costs of the reservoir.

A preliminary contract for form is included in Appendix F.

Table 11-6 shows calculations for the remaining 5,467 acre-feet which is inflated due to payment not beginning until 1995. Payments would be completed in 21 years.

TABLE 11-6
DETERMINATION OF WATER RATES FOR RAW WATER
OUT OF SAM RAYBURN RESERVOIR
SEGMENT 2 - 5467 ac. ft.

Charges Due 01-01-95 to 01-01-2016

1. Fixed cost: Annual capital cost and O&M cost payable to U.S. Government annually.
   5467 ac. ft. x $18.00 per ac. ft. = $ 98,422.00

2. Water cost payable to LNVA
   5467 ac. ft. x $3.82 per ac. ft. = $ 20,884.00
   Total cost per year for 5,467 ac. ft. = $119,306.00
   Cost per ac. ft. = $ 21.82
   Cost per 1,000 gals. = $ .103
   based upon an anticipated yield of 3560 acre-feet per annum

Table 11-7 includes calculations if all 11,467 acre-feet of water were purchased at one time with payments continuing for 28 years. If the purchase of that water were made outright with money borrowed at 8.0% with a twenty year payback, annual costs would be $91,903 and total costs would be $135,707. Per thousand costs would be $.0558 per thousand gallons of raw water. After twenty years the only costs would be about $.0012 per thousand to the LNVA.

TABLE 11-7
DETERMINATION OF WATER RATES FOR RAW WATER
OUT OF SAM RAYBURN RESERVOIR
ONE SEGMENT- 11,467 ac. ft.

Charges Due 01-01-88 to 01-01-2016

1. Fixed cost: Annual capital cost and O&M cost payable to U.S. Government annually.
   11467 ac. ft. x $9.15 per ac. ft. = $104,903.00

2. Water cost payable to LNVA
   11467 ac. ft. x $3.82 per ac. ft. = $ 43,804.00
   Total cost per year for 11,467 ac. ft.= $148,707.00
   Cost per ac. ft. = $ 12.97
   Cost per 1,000 gals. = $ .061
   based upon an anticipated yield of 7467 acre-feet per annum

12.0 FINANCIAL FEASIBILITY

The question asked repeatedly when different systems are asked if they wish to participate in a regional system is what will the costs be? One of the primary thrusts of this report was to establish the possible water sources, and then estimate the cost factors involved in delivering treated water to each system.

The assumption was made that the regional system would actually deliver treated water to an existing take point in each system, so that the system could begin accepting water with no other construction costs required. Certainly, if the system already has shortages, these would have to be addressed on an individual basis although to some degree service pumps, storage, and pressure facilities might be addressed by the regional system.

12.1 ESTIMATED COSTS AND COST DISTRIBUTION

The following tables, which have been reduced in order to accommodate the format of this report, provide in spreadsheet format the estimated individual costs of delivering treated water as well as the cost on a regional basis. The regional costs are listed under the column Year 2000 and Year 2010 Total System.

Table 12-1	Year 2000 Surface Water Option
Table 12-2	Year 2010 Surface Water Option
Table 12-3	Year 2000 Groundwater Option
Table 12-4	Year 2010 Groundwater Option
Table 12-5	Year 2000 Groundwater (Surface Water in Southern Part of County)
Table 12-6	Year 2010 Groundwater (Surface Water in Southern Part of County)

12.1.1 ESTIMATED COSTS

Total system costs are outlined below.

Year 2000 Surface Water Option	$ 14,803,302
	$ 2,296,886 (Reserve Capacity)
Year 2010 Surface Water Option	$20,413,919
Year 2000 Groundwater Option	$ 9,150,959 (without South County)
Year 2010 Groundwater Option	$10,125,959 (without South County)

Essentially the groundwater option is from 30-50% less expensive than the surface water alternative.

In Tables 12-1 through 12-6, the format shows line segments in the left column, the length of the line segment next, and the following columns yield cost estimates for that particular segment for each system. There is a figure on that line under a particular system only if that system would use that line segment in deriving its own water source.

Additionally, a water plant size is given along with supply line costs, intake structures, and water plant costs. These columns are useful in determining what the individual system costs would be to develop the same source of water.

12.1.2 COST DISTRIBUTION METHODOLOGY

By determining what each system would spend to obtain its own water source, a total of all systems added together is derived. By dividing each system's individual total by the aggregate, a percentage of the regional costs is obtained. This percentage is then multiplied by the total regional cost(not the aggregate of the individual system costs) for each entity's share of the regional costs.

However, it was determined during the study that this method might not be wholly fair in that the systems closest to the source would not only have the least expensive water, but that it would be far less expensive than if the more distant systems were not participating in the regional effort. If the systems further away chose not to participate, then the costs of the closer systems would go up substantially. Therefore, a damping factor was used which essentially distributed a portion of the cost on a straight cost per thousand gallons capacity basis.

This factor tended to bring the per thousand costs for each system closer to the median.

TABLE 12-1
YEAR 2000 SURFACE WATER OPTION
WATER SUPPLY SYSTEM ESTIMATED COSTS
INDIVIDUAL SYSTEMS ANALYSIS AND REGIONAL COSTS

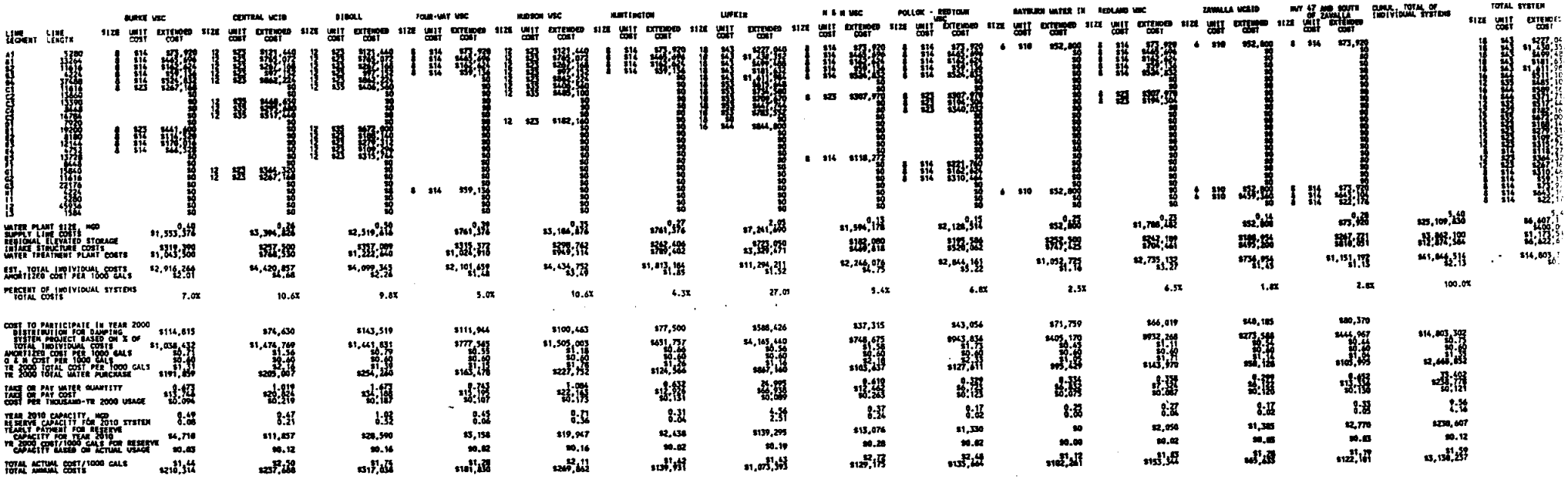


TABLE 12-2
WATER SUPPLY SYSTEM ESTIMATED COSTS
INDIVIDUAL SYSTEMS ANALYSIS
YEAR 2010 MAINS AND WATER TREATMENT COSTS
SURFACE WATER OPTION

LINE SEGMENT	LINE LENGTH	BURKE WSC SIZE	BURKE WSC UNIT COST	BURKE WSC EXTENDED COST	CENTRAL WCID SIZE	CENTRAL WCID UNIT COST	CENTRAL WCID EXTENDED COST	DIBOLL SIZE	DIBOLL UNIT COST	DIBOLL EXTENDED COST	FOUR-WAY WSC SIZE	FOUR-WAY WSC UNIT COST	FOUR-WAY WSC EXTENDED COST	HUDSON WSC SIZE	HUDSON WSC UNIT COST	HUDSON WSC EXTENDED COST
A1	5280	8	$14	$73,920	12	$23	$121,440	12	$23	$121,440	8	$14	$73,920	12	$23	$121,440
B1	33264	8	$14	$465,696	12	$23	$765,072	12	$23	$765,072	8	$14	$465,696	12	$23	$765,072
B2	11616	8	$14	$162,624	12	$23	$267,168	12	$23	$267,168	8	$14	$162,624	12	$23	$267,168
B3	4224	8	$14	$59,136	12	$23	$97,152	12	$23	$97,152	8	$14	$59,136	12	$23	$97,152
B4	37488	8	$14	$524,832	12	$23	$862,224	12	$23	$862,224			$0	12	$23	$862,224
C1	11616	6	$23	$267,168			$0	12	$35	$406,560			$0	12	$35	$406,560
C2	13860			$0			$0			$0			$0	12	$35	$485,100
C3	13390			$0	12	$35	$468,650			$0			$0			$0
C4	8448			$0	12	$35	$295,680			$0			$0			$0
C5	14784			$0	12	$35	$517,440			$0			$0			$0
D1	7920			$0			$0			$0			$0	12	$23	$182,160
E1	19200	8	$23	$441,600			$0	12	$35	$672,000			$0			$0
E2	8180	8	$14	$114,520			$0	12	$23	$188,140			$0			$0
E3	12144	8	$14	$170,016			$0	12	$23	$279,312			$0			$0
E4	4752	8	$14	$66,528			$0	12	$23	$109,296			$0			$0
E5	13728			$0			$0	12	$23	$315,744			$0			$0
F1	8448			$0			$0			$0			$0			$0
G1	15840			$0	12	$23	$364,320			$0			$0			$0
G2	11616			$0	12	$23	$267,168			$0			$0			$0
G3	22176			$0			$0			$0			$0			$0
H1	4224			$0			$0			$0	8	$14	$59,136			$0
I1	5280			$0			$0			$0			$0			$0
I2	45936			$0			$0			$0			$0			$0
I3	1584			$0			$0			$0			$0			$0

LINE SEGMENT	LINE LENGTH	HUNTINGTON SIZE	HUNTINGTON UNIT COST	HUNTINGTON EXTENDED COST	LUFKIN SIZE	LUFKIN UNIT COST	LUFKIN EXTENDED COST	N & N WSC SIZE	N & N WSC UNIT COST	N & N WSC EXTENDED COST	POLLOK - REDTOWN WSC SIZE	POLLOK - REDTOWN WSC UNIT COST	POLLOK - REDTOWN WSC EXTENDED COST	RAYBURN WATER IN SIZE	RAYBURN WATER IN UNIT COST	RAYBURN WATER IN EXTENDED COST
A1	5280	8	$14	$73,920	18	$43	$227,040	8	$14	$73,920	8	$14	$73,920	6	$10	$52,800
B1	33264	8	$14	$465,696	18	$43	$1,430,352	8	$14	$465,696	8	$14	$465,696			$0
B2	11616	8	$14	$162,624	18	$43	$499,488	8	$14	$162,624	8	$14	$162,624			$0
B3	4224	8	$14	$59,136	18	$43	$181,632	8	$14	$59,136	8	$14	$59,136			$0
B4	37488			$0	18	$43	$1,611,984	8	$14	$524,832	8	$14	$524,832			$0
C1	11616			$0	18	$53	$615,648			$0			$0			$0
C2	13860			$0	18	$44	$609,840			$0			$0			$0
C3	13390			$0	18	$53	$709,670	8	$23	$307,970	8	$23	$307,970			$0
C4	8448			$0	18	$53	$447,744			$0	8	$23	$194,304			$0
C5	14784			$0	18	$44	$650,496			$0	8	$23	$340,032			$0
D1	7920			$0	18	$0	$0			$0			$0			$0
E1	19200			$0	18	$44	$844,800			$0			$0			$0
E2	8180			$0			$0			$0			$0			$0
E3	12144			$0			$0			$0			$0			$0
E4	4752			$0			$0			$0			$0			$0
E5	13728			$0			$0			$0			$0			$0
F1	8448			$0			$0	8	$14	$118,272			$0			$0
G1	15840			$0			$0			$0	8	$14	$221,760			$0
G2	11616			$0			$0			$0	8	$14	$162,624			$0
G3	22176			$0			$0			$0	8	$14	$310,464			$0
H1	4224			$0			$0			$0			$0			$0
I1	5280			$0			$0			$0			$0	6	$10	$52,800
I2	45936			$0			$0			$0			$0			$0
I3	1584			$0			$0			$0			$0			$0

LINE SEGMENT	LINE LENGTH	REDLAND WSC SIZE	REDLAND WSC UNIT COST	REDLAND WSC EXTENDED COST	ZAVALLA WCSID SIZE	ZAVALLA WCSID UNIT COST	ZAVALLA WCSID EXTENDED COST	HWY 69 AND SOUTH OF ZAVALLA SIZE	HWY 69 AND SOUTH OF ZAVALLA UNIT COST	HWY 69 AND SOUTH OF ZAVALLA EXTENDED COST	YEAR 2010 TOTAL SYSTEM SIZE	TOTAL SYSTEM UNIT COST	TOTAL SYSTEM EXTENDED COST
A1	5280	8	$14	$73,920	6	$10	$52,800	8	$14	$73,920	24	$63	$332,640
B1	33264	8	$14	$465,696			$0			$0	24	$63	$2,095,632
B2	11616	8	$14	$162,624			$0			$0	24	$63	$731,808
B3	4224	8	$14	$59,136			$0			$0	24	$63	$266,112
B4	37488	8	$14	$524,832			$0			$0	20	$50	$1,874,400
C1	11616			$0			$0			$0	18	$53	$615,648
C2	13860			$0			$0			$0	18	$44	$609,840
C3	13390	8	$23	$307,970			$0			$0	18	$53	$709,670
C4	8448	8	$23	$194,304			$0			$0	18	$53	$447,744
C5	14784			$0			$0			$0	16	$44	$650,496
D1	7920			$0			$0			$0	12	$23	$182,160
E1	19200			$0			$0			$0	18	$53	$1,017,600
E2	8180			$0			$0			$0	12	$23	$188,140
E3	12144			$0			$0			$0	12	$23	$279,312
E4	4752			$0			$0			$0	12	$23	$109,296
E5	13728			$0			$0			$0	12	$23	$315,744
F1	8448			$0			$0			$0	8	$14	$118,272
G1	15840			$0			$0			$0	12	$23	$364,320
G2	11616			$0			$0			$0	12	$23	$267,168
G3	22176			$0			$0			$0	8	$14	$310,464
H1	4224			$0			$0			$0	8	$14	$59,136
I1	5280			$0	6	$10	$52,800	8	$14	$73,920	8	$14	$73,920
I2	45936			$0	6	$10	$459,360	8	$14	$643,104	8	$14	$643,104
I3	1584			$0			$0	8	$14	$22,176	8	$14	$22,176

	BURKE WSC	CENTRAL WCID	DIBOLL	FOUR-WAY WSC	HUDSON WSC	HUNTINGTON	LUFKIN
WATER PLANT SIZE, MGD	0.49	0.67	1.02	0.43	0.71	0.31	4.56
SUPPLY LINE COSTS	$1,553,376	$3,394,826	$2,519,814	$761,376	$3,186,876	$761,376	$7,241,690
ELEVATED STORAGE TANK							
INTAKE STRUCTURE	$351,697	$347,481	$509,026	$337,633	$425,521	$282,980	$1,878,858
WATER PLANT COSTS	$1,196,483	$1,177,152	$2,022,468	$1,129,141	$1,548,279		$5,077,131
ESTIMATED TOTAL COSTS	$3,101,551	$4,919,659	$5,051,308	$2,228,151	$5,160,676	$1,044,356	$14,197,679
AMORTIZED COST PER 1000 GALS	$1.76	$2.85	$1.37	$1.37	$2.01	$0.91	$0.86
PERCENT OF INDIVIDUAL SYSTEMS TOTAL COSTS	6.5%	10.4%	10.6%	4.7%	10.9%	2.2%	29.9%
COST TO PARTICIPATE IN YEAR 2010 DISTRIBUTION FOR DAMPING	$152,271	$148,817	$318,984	$140,340	$222,912	$98,584	$1,432,915
SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS	$1,209,338	$1,952,425	$2,170,856	$957,208	$2,122,212	$481,458	$6,637,961
AMORTIZED COST PER 1000 GALS	$0.73	$1.13	$0.59	$0.59	$0.82	$0.42	$0.40
O & M COST PER 1000 GALS	$0.51	$0.51	$0.51	$0.51	$0.51	$0.51	$0.51
YR 2010 TOTAL COST PER 1000 GALS	$1.24	$1.64	$1.10	$1.10	$1.33	$0.93	$0.91
YR 2010 TOTAL WATER PURCHASE	$219,732	$284,259	$407,062	$179,313	$345,237	$106,789	$1,316,040
TAKE OR PAY WATER QUANTITY	0.473	1.019	1.473	0.763	1.084	0.632	24.995
TAKE OR PAY COST	$13,744	$20,824	$34,188	$15,195	$22,163	$12,936	$46,938
COST PER THOUSAND-YR 2010 USAGE	$0.078	$0.120	$0.092	$0.093	$0.086	$0.113	$0.040
TOTAL ACTUAL COST/1000 GALS	$1.32	$1.76	$1.19	$1.19	$1.42	$1.04	$0.95
TOTAL ANNUAL COSTS	$233,476	$305,083	$441,270	$194,507	$367,400	$119,716	$1,582,978

	N & N WSC	POLLOK - REDTOWN WSC	RAYBURN WATER IN	REDLAND WSC	ZAVALLA WCSID	HWY 69 AND SOUTH OF ZAVALLA	CUMUL. TOTAL OF INDIVIDUAL SYSTEMS	YEAR 2010 TOTAL SYSTEM
WATER PLANT SIZE, MGD	0.37	0.17	0.25	0.27	0.17	0.33	9.56	9.56
SUPPLY LINE COSTS	$1,594,178	$2,128,514	$52,800	$1,788,482	$52,800	$73,920	$25,109,830	$8,516,150
ELEVATED STORAGE TANK								$400,000
INTAKE STRUCTURE	$305,515	$210,482	$252,500	$260,944	$208,132	$290,100	$6,858,231	$1,561,585
WATER PLANT COSTS	$979,719	$577,854	$747,425	$783,164	$550,472	$910,280	$17,525,772	$9,936,183
ESTIMATED TOTAL COSTS	$2,879,412	$2,917,025	$1,052,725	$2,832,590	$814,404	$1,274,300	$47,493,833	$20,413,919
AMORTIZED COST PER 1000 GALS	$2.16	$4.61	$1.16	$2.92	$1.34	$1.06	$1.37	$0.59
PERCENT OF INDIVIDUAL SYSTEMS TOTAL COSTS	6.1%	6.1%	2.2%	6.0%	1.7%	2.7%	100.00%	FOR DAMPING
COST TO PARTICIPATE IN YEAR 2010 DISTRIBUTION FOR DAMPING	$114,909	$54,629	$78,490	$83,827	$51,803	$103,607	$3,002,088	LINES $1,277,423
SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS	$1,170,538	$1,124,046	$444,432	$1,122,290	$350,376	$570,781	$20,413,919	PLANT $1,724,665
AMORTIZED COST PER 1000 GALS	$0.88	$1.78	$0.51	$1.16	$0.58	$0.48	$0.59	
O & M COST PER 1000 GALS	$0.51	$0.51	$0.51	$0.51	$0.51	$0.51	$0.51	
YR 2010 TOTAL COST PER 1000 GALS	$1.39	$2.29	$1.02	$1.67	$1.09	$0.99	$1.10	
YR 2010 TOTAL WATER PURCHASE	$185,653	$145,244	$93,166	$142,580	$65,892	$118,734	$3,829,524	
TAKE OR PAY WATER QUANTITY	0.610	0.329	0.334	0.358	0.299	0.652	33.402	
TAKE OR PAY COST	$12,442	$6,723	$6,832	$7,334	$6,122	$13,336	$238,778	
COST PER THOUSAND-YR 2010 USAGE	$0.093	$0.106	$0.075	$0.075	$0.103	$0.111	$0.068	
TOTAL ACTUAL COST/1000 GALS	$1.48	$2.39	$1.10	$1.74	$1.39	$1.10		
TOTAL ANNUAL COSTS	$198,115	$151,967	$99,999	$149,704	$72,014	$132,072		

TABLE 12-3
ANGELINA COUNTY WATER SUPPLY
WATER SUPPLY SYSTEM ESTIMATED COSTS
INDIVIDUAL SYSTEMS ANALYSIS-BASED ON WELL SUPPLY SOURCE
YEAR 2000 MAINS AND WATER TREATMENT COSTS

LINE SEGMENT	LINE LENGTH	BURKE WSC SIZE	BURKE WSC UNIT COST	BURKE WSC EXTENDED COST	CENTRAL WCID SIZE	CENTRAL WCID UNIT COST	CENTRAL WCID EXTENDED COST	DIBOLL SIZE	DIBOLL UNIT COST	DIBOLL EXTENDED COST
A1	5280									
B1	33264									
B2	11616									
B3	4224									
B4	37488									
C1a	3370	6	$16	$53,920				8	$23	$77,510
C1b	8244									
C2	13460									
C3	13390	6	$16	$214,240				8	$23	$307,970
C4	8448									
C5a	5016									
C5b	9768									
C6a	3160									
C6b	11310									
C8	11880									
D1	7920									
E1a	6800	6	$10	$68,000				8	$23	$156,400
E1b	2900	6	$10	$29,000				8	$23	$66,700
E1c	3700	6	$10	$37,000				8	$14	$51,800
E1d	5800	6	$10	$58,000				8	$14	$81,200
E2	8180	6	$10	$81,800				8	$14	$114,520
E3	12144	6	$10	$121,440				8	$14	$170,016
E4	4752	6	$10	$47,520				8	$14	$66,528
E5	13728									
F1a	6125	6	$10	$61,250				10	$29	$177,625
F1b	2125									
G1	15840									
G2	11616									
G3	22176									
H1	4224									
I1	5280									
I2	45936									
I3	1584									
WF1	22230	6	$10	$222,300	6"	$10	$158,400	10	$29	$644,670

LINE SEGMENT	FOUR-WAY WSC SIZE	FOUR-WAY WSC UNIT COST	FOUR-WAY WSC EXTENDED COST	HUDSON WSC SIZE	HUDSON WSC UNIT COST	HUDSON WSC EXTENDED COST	HUNTINGTON SIZE	HUNTINGTON UNIT COST	HUNTINGTON EXTENDED COST	LUFKIN SIZE	LUFKIN UNIT COST	LUFKIN EXTENDED COST
B3	6	$10	$42,240				6	$10	$42,240			
B4	6	$10	$374,880				6	$10	$374,880			
C3	6	$16	$214,240				6	$16	$214,240			
F1a	6	$10	$61,250				6	$10	$61,250			
H1	6	$10	$42,240									
WF1	6	$10	$222,300	6"	$10	$316,800	6	$10	$222,300	16	$44	$978,120

LINE SEGMENT	H & H WSC SIZE	H & H WSC UNIT COST	H & H WSC EXTENDED COST	POLLOK - REDTOWN WSC SIZE	POLLOK - REDTOWN WSC UNIT COST	POLLOK - REDTOWN WSC EXTENDED COST	RATCLIFF WATER SIZE	RATCLIFF WATER UNIT COST	RATCLIFF WATER EXTENDED COST	REDLAND WSC SIZE	REDLAND WSC UNIT COST	REDLAND WSC EXTENDED COST
WF1	6"	$10	$222,300	6"	$10	$222,300				6"	$10	$52,800

LINE SEGMENT	ZAVALLA WCSID SIZE	ZAVALLA WCSID UNIT COST	ZAVALLA WCSID EXTENDED COST	HWY 47 AND SOUTH OF ZAVALLA SIZE	HWY 47 UNIT COST	HWY 47 EXTENDED COST	CUMUL. TOTAL OF INDIVIDUAL SYSTEMS TOTAL COSTS	CUMUL. TOTAL FLOW (MGD)	YEAR 2000 TOTAL SYSTEM SIZE	YEAR 2000 UNIT COST	YEAR 2000 EXTENDED COST
A1											
B1								0.343	8	$16	$446,496
B2								[illegible]	8	$0	$0
B3								[illegible]	8	$16	$67,584
B4	6	$10	$374,880	6	$10	$374,880		0.495	12	$23	$862,224
C1a								0.677	18	$53	$178,610
C1b								0.736			
C2								0.185			
C3	6	$16	$214,240	6	$16	$214,240		[illegible]	18	$53	$709,670
C4								[illegible]			
C5a								1.877			
C5b								0.231	16	$44	$429,792
C6a									16	$0	$0
C6b											
C8									4	$10	$118,800
D1								0.185	4	$10	$79,200
E1a									18	$53	$360,400
E1b									18	$53	$153,700
E1c									16	$44	$162,800
E1d								0.351	18	$53	$307,400
E2								0.231	12	$23	$188,140
E3								0.481	12	$23	$279,312
E4								0.411	12	$23	$109,296
E5								0.341	12	$23	$315,744
F1a									24	$67	$410,375
F1b								0.066	6	$10	$21,250
G1								0.231	6	$14	$221,760
G2								0.161	6	$10	$116,160
G3								0.091	4	$10	$221,760
H1								0.069	4	$10	$42,240
I1				6	$10	$52,800		0.313	8	$14	$73,920
I2	6"	$10	$712,800	6	$10	$459,360		0.343	8	$14	$643,104
I3								0.100	6	$10	$15,840
WF1	6	$10	$222,300	6	$10	$222,300			24	$67	$1,489,410

	BURKE WSC	CENTRAL WCID	DIBOLL	FOUR-WAY WSC	HUDSON WSC	HUNTINGTON	LUFKIN
WATER PLANT SIZE, MGD	0.21	0.14	0.34	0.21	0.19	0.20	1.40
WATER PLANT COSTS	$106,750	$94,500	$130,550	$106,750	$104,750	$107,000	$262,000
SUPPLY LINE COSTS	$994,470	$158,400	$1,914,939	$957,150	$316,800	$914,910	$3,041,957
ELEVATED STORAGE TANK							
WATER WELL COSTS	$300,000	$250,000	$300,000	$300,000	$300,000	$300,000	$500,000
TOTAL FOR WELLS OPTION	$1,401,220	$502,900	$2,345,489	$1,345,900	$721,550	$1,321,910	$3,803,957
AMORTIZED COST PER 1000 GALS	$1.84	$0.99	$1.89	$1.82	$1.07	$1.86	$0.75
PERCENT OF INDIVIDUAL SYSTEMS							
WELLS AND PLANT	8.72%	7.39%	9.24%	8.77%	8.68%	8.73%	16.34%
LINES EXCLUSIVE OF LUFKIN	10.34%	1.65%	19.99%	9.99%	3.31%	9.55%	10.21%
TOTAL COSTS	8.6%	3.1%	14.4%	8.4%	4.4%	8.1%	23.3%
COST TO PARTICIPATE IN YEAR 2000							
REDISTRIBUTION FOR DAMPING	$156,376	$104,251	$253,925	$154,142	$137,760	$145,951	$1,043,252
SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS	$836,850	$347,152	$1,394,529	$817,336	$486,857	$787,711	$2,975,865
AMORTIZED COST PER 1000 GALS	$1.10	$0.68	$1.12	$1.09	$0.72	$1.11	$0.58
O & M COST PER 1000 GALS	$0.57	$0.57	$0.57	$0.57	$0.57	$0.57	$0.57
YR 2000 TOTAL COST PER 1000 GA	$1.67	$1.25	$1.69	$1.66	$1.29	$1.68	$1.15
YR 2000 TOTAL WATER PURCHASE	$127,705	$43,961	$210,956	$125,127	$87,370	$119,844	$590,253

	H & H WSC	POLLOK - REDTOWN WSC	RATCLIFF WATER	REDLAND WSC	ZAVALLA WCSID	HWY 47 AND SOUTH OF ZAVALLA	CUMUL. TOTAL OF INDIVIDUAL SYSTEMS	YEAR 2000 TOTAL SYSTEM
WATER PLANT SIZE, MGD	0.07	0.09		0.04	0.12	0.22	3.22	3.22
WATER PLANT COSTS	$82,250	$85,750		$77,000	$91,000	$110,500	$1,360,800	$1,516,000
SUPPLY LINE COSTS	$222,300	$222,300		$52,800	$1,524,220	$1,323,580	$11,643,826	$8,037,719
ELEVATED STORAGE TANK								$400,000
WATER WELL COSTS	$180,000	$180,000		$180,000	$180,000	$331,320	$3,301,320	$450,000
TOTAL FOR WELLS OPTION	$484,550	$488,050		$309,800	$1,795,220	$1,765,400	$16,305,966	$10,401,719
AMORTIZED COST PER 1000 GALS	$2.02	$1.48		$1.96	$4.01	$2.21	$1.39	$0.89
PERCENT OF INDIVIDUAL SYSTEMS								
WELLS AND PLANT	5.63%	5.70%		5.51%	5.81%	9.48%	100.00%	
LINES EXCLUSIVE OF LUFKIN	2.32%	2.32%		0.55%	15.91%	13.82%	100.00%	
TOTAL COSTS	3.0%	3.0%		1.9%	11.0%	10.8%	100.00%	
COST TO PARTICIPATE IN YEAR 2000								
REDISTRIBUTION FOR DAMPING	$49,147	$67,763		$32,420	$91,592	$143,823	$2,400,000	$2,200,000
SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS	$283,643	$303,962		$181,350	$966,986	$1,021,557	$10,401,719	$200,000
AMORTIZED COST PER 1000 GALS	$1.18	$0.92		$1.16	$2.16	$1.28	$0.89	
O & M COST PER 1000 GALS	$0.57	$0.57		$0.57	$0.57	$0.57	$0.57	
YR 2000 TOTAL COST PER 1000 GA	$1.75	$1.49		$1.73	$2.73	$1.85	$1.46	
YR 2000 TOTAL WATER PURCHASE	$42,209	$49,448		$27,155	$122,475	$148,335	$1,714,878	

TABLE 12-4
ANGELINA COUNTY WATER SUPPLY
WATER SUPPLY SYSTEM ESTIMATED COSTS
INDIVIDUAL SYSTEMS ANALYSIS-BASED ON WELL SUPPLY SOURCE
YEAR 2010 MAINS AND WATER TREATMENT COSTS

LINE SEGMENT	LINE LENGTH	BURKE WSC SIZE	BURKE WSC UNIT COST	BURKE WSC EXTENDED COST	CENTRAL WCID SIZE	CENTRAL WCID UNIT COST	CENTRAL WCID EXTENDED COST	DIBOLL SIZE	DIBOLL UNIT COST	DIBOLL EXTENDED COST	FOUR-WAY WSC SIZE	FOUR-WAY WSC UNIT COST	FOUR-WAY WSC EXTENDED COST	HUDSON WSC SIZE	HUDSON WSC UNIT COST	HUDSON WSC EXTENDED COST	HUNTINGTON SIZE	HUNTINGTON UNIT COST	HUNTINGTON EXTENDED COST	LUFKIN SIZE	LUFKIN UNIT COST	LUFKIN EXTENDED COST	N & H WSC SIZE	N & H WSC UNIT COST	N & H WSC EXTENDED COST	POLLOCK - REDTOWN MUD SIZE	POLLOCK - REDTOWN MUD UNIT COST	POLLOCK - REDTOWN MUD EXTENDED COST	RAYBURN WATER SIZE	RAYBURN WATER UNIT COST	RAYBURN WATER EXTENDED COST	REDLAND WSC SIZE	REDLAND WSC UNIT COST	REDLAND WSC EXTENDED COST	ZAVALLA WCRID SIZE	ZAVALLA WCRID UNIT COST	ZAVALLA WCRID EXTENDED COST	HWY 67 AND SOUTH OF ZAVALLA SIZE	HWY 67 AND SOUTH OF ZAVALLA UNIT COST	HWY 67 AND SOUTH OF ZAVALLA EXTENDED COST	CUMUL. TOTAL OF INDIVIDUAL SYSTEMS TOTAL COSTS	TOTAL FLOW (MGD)	TOTAL SYSTEM NEEDED BY PARTICIPANTS SIZE	TOTAL SYSTEM NEEDED BY PARTICIPANTS UNIT COST	TOTAL SYSTEM NEEDED BY PARTICIPANTS EXTENDED COST
A1	5280																																								0.406	8	$14	$465,696
B1	15840																																								0.685	8	0	$0
B2	11616																																								0.842	8	$14	$59,136
B3	4224										6	$10	$42,240				6	$10	$42,240																					0.842	8	$14	$59,136
B4	37488										6	$10	$374,880				6	$10	$374,880																6	$10	$374,880	6	$10	$374,880	0.842	12	$23	$883,272
C1a	3370	6	$16	$53,920				8	$23	$77,510																															0.842	18	$53	$178,610
C1b	8246																																								0.378			
C2	13860																																								1.185			
C3	13500	6	$16	$216,240				8	$23	$307,970	6	$16	$214,240				6	$16	$214,240																6	$16	$214,240	6	$16	$214,240	1.470	18	$53	$709,670
C4	8448																																								1.563			
C5a	5016																																								0.364			
C5b	9768																																									16	$44	$429,792
C5c	5280																																								0.273	16	$0	$0
C6b	11310																																								0.967			
C8	11880																																											
D1	7920																																									4	$10	$118,800
E1a	6900	6	$10	$69,000				8	$23	$158,700																															0.967	4	$10	$97,200
E1b	6900	6	$10	$69,000				8	$23	$158,700																															0.976	18	$53	$369,408
E1c	3700	6	$10	$37,000				8	$23	$85,100																															0.788	18	$53	$351,288
E1d	5800	6	$10	$58,000				8	$14	$81,200																															0.499	16	$44	$163,800
E2	8182	6	$10	$81,800				6	$14	$114,548																															0.927	18	$53	$307,692
E3	12164	6	$10	$121,640				6	$14	$170,296																															0.539	18	$53	$179,112
E4	4228	6	$10	$42,520				8	$14	$58,328																															0.114	18	$53	$37,788
E5	11728																																								0.905	24	$53	$300,672
F1a	6156	6	$10	$61,250				10	$29	$177,625	6	$10	$61,250				6	$10	$61,250																					0.406	24	$67	$410,375
F1b	6223																																								0.406	6	$10	$61,920
G1	15840																																								0.100	6	$10	$237,600
G2	11616																																									6	$10	$174,240
G3	22176																																									6	$10	$332,640
H1	4224																																									6	$10	$63,360
I1	5280																																									6	$14	$73,920
I2	45936																																									6	$14	$643,104
I3	1056																																									6	$10	$15,840
WF1	22220	6	$10	$222,300	6"	$10	$158,400	10	$29	$644,670	6	$10	$222,300	6"	$10	$316,800	6	$10	$222,300	16	$44	$978,128	6"	$10	$222,300	6"	$10	$222,300				6"	$10	$52,800	6	$10	$222,300	6	$10	$222,300				24	$67	$1,480,410
WATER PLANT SIZE	MGD			0.27			0.25			0.70			0.31			0.38			0.31			3.12			0.29			0.11			0.15			0.15			0.26	6.30			6.30
WATER PLANT COSTS				$113,550			$111,750			$179,600			$125,400			$136,900			$125,400			$213,345			$122,125			$89,150			$95,000			$95,000			$115,900	$1,326,575			$2,039,000
SUPPLY LINE COSTS				$996,470			$158,400			$1,914,939			$997,150			$316,800			$914,918			$3,041,957			$222,300			$222,300			$52,800			$1,534,220			$1,325,580	$11,243,626			$2,037,719
ELEVATED STORAGE TANK																																											$400,000
WATER WELL COSTS				$331,320			$331,320			$579,120			$331,320			$331,320			$331,320			$1,737,360			$331,320			$250,000			$250,000			$250,000			$331,320	$5,385,720			$900,000
TOTAL FOR WELLS				$1,441,340			$601,470			$2,673,559			$1,453,870			$785,020			$1,371,850			$4,992,562			$675,745			$560,450			$397,800			$1,860,220			$1,771,800	$18,553,871			$11,376,719
AMORTIZED COST PER 1000 GALS				$1.46			$0.86			$1.06			$1.24			$0.58			$1.20			$0.64			$0.64			$1.55			$0.71			$3.45			$1.90	$0.81			$0.50
PERCENT OF INDIVIDUAL SYSTEMS																																											
WELLS AND PLANT				6.47%			6.41%			10.90%			6.63%			4.78%			6.63%			28.23%			4.56%			4.80%			4.00%			4.00%			6.47%	100.00%			
LINES EXCLUSIVE OF LUFKIN				10.56%			1.65%			19.99%			9.09%			5.51%			9.53%			10.21%			2.32%			2.32%			0.55%			13.91%			13.82%	100.00%			
TOTAL COSTS				7.8%			3.2%			14.4%			7.6%			4.2%			7.4%			26.9%			3.6%			3.0%			2.1%			10.1%			9.5%	100.00%			
COST TO PARTICIPATE IN YEAR 2010 DISTRIBUTION FOR DAMPING SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS				$103,619			$95,238			$264,762			$119,619			$142,857			$119,619			$1,189,333			$110,857			$43,629			$56,000			$56,762			$997,905	$2,400,000			ADJUSTMENT DAMPING $2,200,000 $200,000
				$801,599			$383,818			$1,560,188			$806,199			$520,455			$783,687			$3,604,791			$433,538			$313,110			$244,317			$956,481			$956,496	$11,376,719			
AMORTIZED COST PER 1000 GALS				$0.81			$0.62			$0.62			$0.70			$0.58			$0.69			$0.54			$0.61			$0.78			$0.48			$1.78			$1.02	$0.56			
Q & M COST PER 1000 GALS				$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48	$0.48			
YR 2010 TOTAL COST PER 1000 GA				$1.29			$0.90			$1.10			$1.18			$0.86			$1.17			$0.80			$0.89			$1.26			$0.96			$2.26			$1.50	$0.98			
YR 2010 TOTAL WATER PURCHASE				$128,155			$82,135			$278,407			$135,754			$117,974			$133,687			$909,098			$94,711			$51,409			$50,483			$122,951			$141,058	$2,243,983			

TABLE 12-5
ANGELINA COUNTY WATER SUPPLY
WATER SUPPLY SYSTEM ESTIMATED COSTS-WITHOUT SOUTH ANGELINA COUNTY
INDIVIDUAL SYSTEMS ANALYSIS-BASED ON WELL SUPPLY SOURCE
YEAR 2000 MAINS AND WATER TREATMENT COSTS

LINE SEGMENT	LINE LENGTH	BURKE WSC SIZE	BURKE WSC UNIT COST	BURKE WSC EXTENDED COST	CENTRAL WCID SIZE	CENTRAL WCID UNIT COST	CENTRAL WCID EXTENDED COST	DIBOLL SIZE	DIBOLL UNIT COST	DIBOLL EXTENDED COST	FOUR-WAY WSC SIZE	FOUR-WAY WSC UNIT COST	FOUR-WAY WSC EXTENDED COST	HUDSON WSC SIZE	HUDSON WSC UNIT COST	HUDSON WSC EXTENDED COST	HUNTINGTON SIZE	HUNTINGTON UNIT COST	HUNTINGTON EXTENDED COST	LUFKIN SIZE	LUFKIN UNIT COST	LUFKIN EXTENDED COST	N & M WSC SIZE	N & M WSC UNIT COST	N & M WSC EXTENDED COST	POLLOK - REDTOWN WSC SIZE	POLLOK - REDTOWN WSC UNIT COST	POLLOK - REDTOWN WSC EXTENDED COST	BARBERS WATER SIZE	BARBERS WATER UNIT COST	BARBERS WATER EXTENDED COST	REDLAND WSC SIZE	REDLAND WSC UNIT COST	REDLAND WSC EXTENDED COST	ZAVALLA WCSUD SIZE	ZAVALLA WCSUD UNIT COST	ZAVALLA WCSUD EXTENDED COST	HWY 47 AND SOUTH OF ZAVALLA SIZE	HWY 47 AND SOUTH OF ZAVALLA UNIT COST	HWY 47 AND SOUTH OF ZAVALLA EXTENDED COST	CUMUL. TOTAL OF INDIVIDUAL SYSTEMS TOTAL COSTS	YEAR 2000 TOTAL SYSTEM TOTAL FLOW (MGD)	YEAR 2000 TOTAL SYSTEM SIZE	YEAR 2000 TOTAL SYSTEM UNIT COST	YEAR 2000 TOTAL SYSTEM EXTENDED COST
A1	5280																																										
B1	31264																																									0.000	8	$0	$0
B2	11616																																								0.000	8	$0	$0
B3	4224																																								0.158	8	$16	$68,134
B4	37488										6	$10	$62,240				6	$10	$62,240																						0.335	12	$553	$662,224
C1a	3370	6	$16	$53,920				8	$23	$77,510	6	$10	$374,880				6	$10	$374,880																						1.748	18	$53	$178,810
C1b	8344																																								0.734			
C1c	19800																																								1.585			
C1d	13200																																								1.748	18	$53	$709,670
C1e	8340	6	$16	$214,240				8	$23	$307,970	6	$16	$214,240				6	$16	$214,240																						1.748			
C2a	5016																																								0.000			
C2b	9768																																								0.000			
C2c	3168																																								0.231	16	$44	$429,792
C2d	3168																																									16	$0	$0
C3	11520																																											
C4	11880																																											
D1	7920																																								0.185	6	$10	$118,800
E1a	6600	6	$10	$66,000				8	$23	$156,600																																8	$53	$349,800
E1b	5000	6	$10	$50,000				8	$23	$90,700																																16	$53	$265,000
E1c	17000	6	$10	$170,000				8	$23	$391,000																																16	$53	$901,000
E1d	5900	6	$10	$59,000				8	$14	$82,600																																16	$53	$312,700
E1e	8100	6	$10	$81,000				8	$14	$113,400																																16	$53	$429,300
E2a	12124	6	$10	$121,240				8	$14	$169,736																																16	$53	$642,572
E2b	4752	6	$10	$47,520				6	$14	$66,528																																16	$53	$251,856
E3	13728																																								0.341	16	$53	$1,809,984
F1a	6336	6	$10	$63,360				10	$29	$183,744																																0.341	24	$67	$1,809,984
F1b	6125	6	$10	$61,250				10	$29	$177,625	6	$10	$61,250				6	$10	$61,250																						0.866	24	$67	$4,599,744
G1	15840																																								0.866	8	$10	$137,280
G2	11616																																								0.220	8	$16	$85,536
G3	22176																																								0.420	8	$16	$162,624
H1	4224																																								0.080	8	$10	$33,792
I1	3520																																								0.080	8	$16	$45,056
I2	45936																																								0.000	8	$0	$0
I3	1584																																								0.000	8	$0	$0
W1	22250	6	$10	$222,300	6"	$10	$158,400	10	$29	$644,670	6	$10	$222,300	6"	$10	$316,800	6	$10	$222,300	16	$44	$978,120	6"	$10	$222,300	6"	$10	$222,300				6"	$10	$52,800	6	$0	$0	4	$0	$0	0.100	24	$67	$1,489,410

WATER PLANT SIZE	MGD		0.21			0.16			0.34			0.21			0.19			0.28			1.48			0.07			0.09			0.04			0.00			0.00	2.88			2.88	
WATER PLANT COSTS			$100,320			$94,500			$130,350			$109,150			$104,500			$107,000			$265,000			$88,000			$77,000			$52,800			$0			$0	$1,129,800			$1,514,800	
SUPPLY LINE COSTS			$904,470			$158,400			$1,914,959			$957,150			$316,800			$914,910			$3,041,957			$222,500			$222,500			$552,800			$0			$0	$8,746,026			$1,784,968	
ELEVATED STORAGE TANK																																										$450,000	
WATER WELL COSTS			$300,000			$250,000			$300,000			$300,000			$300,000			$300,000			$500,000			$180,000			$180,000			$180,000			$0			$0	$2,790,000			$450,000	
TOTAL FOR WELLS OPTION			$1,401,220			$502,900			$2,345,489			$1,365,900			$721,550			$1,321,910			$3,805,957			$488,500			$488,050			$309,800			$0			$0	$12,745,326			$99,150,959	
AMORTIZED COST PER 1000 GALS			$1.84			$0.99			$1.89			$1.81			$1.07			$1.86			$0.75			$1.48			$1.48			$1.98			ERR			ERR	$1.22			$0.87	
PERCENT OF INDIVIDUAL SYSTEMS WELLS AND PLANT			10.30%			8.72%			10.90%			10.35%			10.25%			10.31%			10.29%			6.44%			6.33%			6.78%			0.00%			0.00%	100.00%				
LINES EXCLUSIVE OF LUFKIN			14.77%			2.35%			28.44%			14.22%			4.71%			13.57%			14.53%			3.30%			3.30%			2.30%			0.00%			0.00%	100.00%				
TOTAL COSTS			11.0%			3.9%			18.4%			10.7%			5.7%			10.4%			29.8%			3.8%			3.8%			2.4%			0.0%			0.0%	100.00%				
COST TO PARTICIPATE IN YEAR 2000 REDISTRIBUTION FOR DAMPING SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS			$174,939			$116,626			$286,068			$173,273			$154,113			$163,277			$1,167,095			$54,981			$75,807			$35,821			$0			$0	$2,400,000			$2,200,000	
			$912,772			$394,182			$1,503,077			$893,314			$544,609			$860,861			$3,171,772			$317,944			$348,773			$209,488			$0			$0						$300,000	
AMORTIZED COST PER 1000 GALS			$1.48			$0.63			$1.51			$1.18			$0.91			$1.21			$0.84			$1.23			$1.35			$1.35			ERR			ERR	$59,150,959				
O & M COST PER 1000 GALS			$0.47			$0.17			$0.51			$0.37			$0.37			$0.37			$0.37			$0.37			$0.37			$0.37			ERR			ERR	$0.87				
YR 2000 TOTAL COST PER 1000 GA			$1.72			$0.72			$1.78			$1.38			$1.12			$1.39			$1.20			$1.40			$1.40			$1.40			ERR			ERR	$1.12				
YR 2000 TOTAL WATER PURCHASE			$135,335			$68,704			$221,854			$132,963			$93,509			$127,208			$609,918			$45,653			$53,144			$29,999			$0			$0	$1,518,148				

TABLE 12-6
ANGELINA COUNTY WATER SUPPLY
WATER SUPPLY SYSTEM ESTIMATED COSTS-WITHOUT SOUTH ANGELINA COUNTY
INDIVIDUAL SYSTEMS ANALYSIS-BASED ON WELL SUPPLY SOURCE
YEAR 2010 MAINS AND WATER TREATMENT COSTS

LINE SEGMENT	LINE LENGTH	BURKE WSC SIZE	BURKE WSC UNIT COST	BURKE WSC EXTENDED COST	CENTRAL WCID SIZE	CENTRAL WCID UNIT COST	CENTRAL WCID EXTENDED COST	DIBOLL SIZE	DIBOLL UNIT COST	DIBOLL EXTENDED COST	FOUR-WAY WSC SIZE	FOUR-WAY WSC UNIT COST	FOUR-WAY WSC EXTENDED COST	HUDSON WSC SIZE	HUDSON WSC UNIT COST	HUDSON WSC EXTENDED COST	HUNTINGTON SIZE	HUNTINGTON UNIT COST	HUNTINGTON EXTENDED COST	LUFKIN SIZE	LUFKIN UNIT COST	LUFKIN EXTENDED COST	N & N WSC SIZE	N & N WSC UNIT COST	N & N WSC EXTENDED COST	POLLOCK - REDTOWN WSC SIZE	POLLOCK - REDTOWN WSC UNIT COST	POLLOCK - REDTOWN WSC EXTENDED COST	RAYBURN WATER SIZE	RAYBURN WATER UNIT COST	RAYBURN WATER EXTENDED COST	REDLAND WSC SIZE	REDLAND WSC UNIT COST	REDLAND WSC EXTENDED COST	ZAVALLA WCSID SIZE	ZAVALLA WCSID UNIT COST	ZAVALLA WCSID EXTENDED COST	WAY 67 AND SOUTH OF ZAVALLA SIZE	WAY 67 AND SOUTH OF ZAVALLA UNIT COST	WAY 67 AND SOUTH OF ZAVALLA EXTENDED COST	CLUSA - TOTAL OF INDIVIDUAL SYSTEMS TOTAL COSTS	TOTAL FLOW (MGD)	YEAR 2010 TOTAL STEEN NEEDED BY PARTICIPANTS SIZE	YEAR 2010 TOTAL STEEN NEEDED BY PARTICIPANTS UNIT COST	YEAR 2010 TOTAL STEEN NEEDED BY PARTICIPANTS EXTENDED COST
A1	5280																																							0.000	8	$0	$0
B1	31584																																							0.000	8	0	$0
B2	11616																																							0.000	8	$0	$0
B3	4224										4	$10	$42,240				4	$10	$42,240																				0.125	11	$11	$39,130
B4	37488										6	$10	$374,880				6	$10	$374,880																				0.125	17	$23	$862,274
C1a	3170	6	$16	$53,920				8	$23	$77,510																													0.125	18	$53	$178,810
C1b	8448																																							0.125			
C2	12960																																							0.125			
C3	13190	6	$16	$214,240				8	$23	$307,970	6	$16	$214,240				6	$16	$214,240																				0.125	18	$53	$709,670
C4	8448																																							0.125			
C5a	5016																																							0.125			
C5b	5748																																							0.125	16	$44	$429,722
C6a	3160																																							0.125	16	$0	$0
C6b	11510																																							0.867			
C6	11580																																										
C7	7920																																							0.867	6	$10	$118,800
C8	4400	6	$10	$44,000				8	$23	$156,400																													0.867	6	$10	$79,200
C9	24000	6	$10	$240,000				8	$23	$566,700																													0.867	18	$53	$1,440,000
C10	15700	6	$10	$157,000				8	$14	$51,800																													0.867	18	$53	$951,700
C11	36000	6	$10	$360,000				6	$14	$91,200																													0.867	18	$53	$2,160,000
C12	31900	6	$10	$319,000				8	$14	$114,520																													0.867	18	$53	$1,914,000
C13	17144	6	$10	$171,440				8	$14	$170,016																													0.867	18	$53	$1,028,640
C14	4752	6	$10	$47,520				8	$14	$68,328																													0.867	18	$53	$285,120
C15	13728																																							0.867	18	$53	$823,680
C16	6152	6	$10	$61,250				10	$29	$177,625	6	$10	$61,250				6	$10	$61,250																				0.867	18	$53	$369,120
C17	5453																																							0.867	18	$53	$327,150
C18	15822																																							0.867	18	$53	$949,320
C19	13416																																							0.867	18	$53	$804,960
C20	42176										6	$10	$42,240																										0.867	18	$53	$2,529,120
H1	4224																																							0.867	18	$53	$253,440
I1	3580																																						4	$0	$0	0.867	18	$53	$214,740
I2	45232																																						4	$0	$0	0.867	18	$53	$2,713,920
I3	1584																																									0.867	18	$53	$95,040
WH1	22230	6	$10	$222,300	6"	$10	$158,400	10	$29	$644,670	6	$10	$222,300	6"	$10	$316,800	6	$10	$222,300	16	$44	$978,120	6"	$10	$222,300	6"	$10	$211,852			$0	6"	$10	$52,800	6	$0	$0	4	$0	$0	0.867	24	$67	$1,489,410
WATER PLANT SIZE, MGD				0.27			0.25			0.70			0.31			0.38			0.31			3.18			0.27			0.11			0.15			0.88			0.00	5.08			5.89
WATER PLANT COSTS				$110,850			$101,750			$279,500			$125,400			$156,800			$125,400			$217,969			$122,125			$88,750			$52,800			$0			$0	$1,313,145			$2,039,000
SUPPLY LINE COSTS				$990,478			$158,400			$1,914,959			$997,158			$316,800			$974,910			$3,841,969			$222,560			$211,852			$52,800			$0			$0	$8,782,578			$4,786,927
ELEVATED STORAGE TANK																																											$600,000
WATER WELL COSTS				$331,320			$331,320			$579,120			$331,320			$331,320			$331,320			$1,737,340			$331,320			$250,000			$250,000			$0			$0	$4,804,400			$900,000
TOTAL FOR WELLS				$1,441,340			$601,470			$2,673,559			$1,416,070			$785,020			$1,371,830			$6,992,567			$675,745			$550,002			$397,800			$0			$0	$14,903,403			$10,129,959
AMORTIZED COST PER 1000 GALS				$1.46			$0.66			$1.06			$1.24			$0.58			$1.20			$0.44			$0.64			$1.33			$0.74			ERR			ERR	$0.70			$0.47
PERCENT OF INDIVIDUAL SYSTEMS WELLS AND PLANT				7.30%			7.24%			12.40%			7.67%			7.65%			7.67%			31.88%			7.61%			5.43%			5.44%			0.00%			0.00%	100.00%			
LINES EXCLUSIVE OF LUFKIN				14.79%			2.36%			28.49%			14.24%			4.71%			13.81%			14.33%			3.31%			3.16%			0.79%			0.00%			0.00%	100.00%			
TOTAL COSTS				9.7%			4.0%			17.9%			9.5%			5.3%			9.2%			33.5%			4.5%			3.7%			2.7%			0.0%			0.0%	100.00%			ADJUSTMENT DAMPING
COST TO PARTICIPATE IN YEAR 2010 DISTRIBUTION FOR DAMPING SYSTEM PROJECT BASED ON % OF TOTAL INDIVIDUAL COSTS				$110,757			$101,798			$283,000			$127,859			$152,698			$127,859			$1,271,259			$118,493			$46,420			$59,857			$0			$0	$2,400,000			$2,200,000 $200,000
AMORTIZED COST PER 1000 GALS				$859,430			$423,276			$1,649,636			$663,211			$568,431			$841,722			$3,809,796			$478,119			$338,045			$275,203			$0			$0	$10,125,959			
O & M COST PER 1000 GALS				$0.57			$0.47			$0.66			$0.76			$0.72			$0.76			$0.53			$0.43			$0.61			$0.51			ERR			ERR	$0.57			
YR 2010 TOTAL COST PER 1000 GA				$0.46			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			$0.48			ERR			ERR	$0.48			
YR 2010 TOTAL WATER PURCHASE				$1.13			$0.95			$1.16			$1.24			$0.90			$1.22			$0.52			$0.91			$1.30			$0.79			ERR			ERR	$0.92			
				$133,961			$86,297			$209,395			$141,679			$122,770			$139,552			$929,458			$98,966			$53,913			$53,293							$2,069,275			

12.2 SUMMARY OF TAKE-OR-PAY COSTS

Table 12-7 summarizes the take-or-pay quantities and costs. This table includes factors for both surface water and groundwater. As was discussed previously in the report, generally take quantities for surface water are larger. In some cases, the cost per thousand is less for surface water, but because systems are required to purchase larger quantities of surface water, the overall impact on the system is greater though the cost per thousand is less.

TABLE 12-7
SUMMARY OF PROBABLE TAKE-OR-PAY QUANTITIES AND COSTS
SURFACE WATER VERSUS GROUNDWATER

	WATER NEEDS				TAKE-OR-PAY ANNUAL COSTS				COST PER THOUSAND GALS.			
	SURFACE WATER		GROUNDWATER		SURFACE WATER		GROUNDWATER		SURFACE WATER		GROUNDWATER	
ENTITY	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
BURKE WSC	0.40	0.49	0.21	0.27	$210,314	$233,478	$129,161	$142,682	$1.44	$1.32	$1.69	$1.45
CENTRAL WCID	0.26	0.47	0.14	0.25	$237,688	$305,083	$63,248	$79,886	$2.50	$1.78	$1.24	$0.88
DIBOLL	0.50	1.02	0.34	0.70	$317,038	$441,270	$214,973	$303,003	$1.74	$1.19	$1.73	$1.19
FOURWAY WSC	0.39	0.45	0.21	0.31	$181,830	$194,507	$126,751	$148,639	$1.28	$1.18	$1.67	$1.31
HUDSON WSC	0.35	0.71	0.19	0.38	$269,862	$367,400	$86,884	$116,209	$2.11	$1.42	$1.29	$0.84
HUNTINGTON	0.27	0.31	0.20	0.31	$139,931	$119,716	$121,090	$145,689	$1.42	$1.06	$1.66	$1.29
LUFKIN	2.05	4.56	1.40	3.12	$1,073,393	$1,582,978	$592,710	$872,545	$1.43	$0.95	$1.16	$0.77
M & M WSC	0.13	0.37	0.07	0.29	$129,175	$198,115	$41,944	$92,733	$2.72	$1.49	$1.64	$0.88
POLLOK-REDTOWN WSC	0.15	0.17	0.09	0.11	$135,664	$151,967	$49,171	$52,519	$2.48	$2.45	$1.50	$1.31
RAYBURN WATER INC	0.25	0.25	0.00	0.00	$102,261	$99,999	N/A	N/A	$1.12	$1.10	N/A	N/A
REDLAND WSC	0.23	0.27	0.04	0.15	$153,344	$169,704	$26,421	$48,092	$1.83	$1.72	$1.81	$0.88
ZAVALLA WCID	0.14	0.17	0.12	0.15	$65,635	$72,014	N/A	N/A	$1.28	$1.16	N/A	N/A
HWY. 147 AREA	0.28	0.33	0.22	0.26	$122,101	$132,072	N/A	N/A	$1.19	$1.10	N/A	N/A
TOTAL	5.40	9.56	3.22	6.30	$3,138,236	$4,068,303	$1,452,353	$2,001,997	$1.59	$1.17	$1.23	$0.87

As can be noted, the groundwater cost for Zavalla and the southern part of the County do not appear to be cost-effective. Therefore, another possibility of a smaller surface water plant is being pursued for that area as part of the regional plan.

Table 12-8 further includes the cost of purchasing additional surface water as outlined in Chapter 11. This would take average costs up $0.13 in Phase I and $0.07 per thousand in Phase II. Lufkin is already purchasing their own surface water, while the other systems would need nearly 10 MGD of water.

Table 12-8 also includes costs for annualizing interest during construction. This figure is not included in Tables 12-1 through 12-6 because it is an approximate figure, it can be offset by investment of bond proceeds during the construction phase, and because each system may choose to pay this cost out of pocket rather than borrowing the money to pay for it.

TABLE 12-8
ANNUAL AND PER THOUSAND COSTS FOR GROUNDWATER OPTION
INCLUDING PURCHASE COSTS FOR ADDITIONAL SURFACE WATER
AND FOR ANNUALIZED INTEREST DURING CONSTRUCTION

	WATER NEEDS			TAKE-OR-PAY ANNUAL COSTS		PURCHASE OF ADD. SURFACE WATER ANNUAL COSTS		ANNUALIZED INTEREST DURING CONSTRUCT.	ADJUSTED COST PER 1000 GALS.	
ENTITY	2000	2010	2090	2000	2010	QUANT.	COST	COST	2000	2010
GROUNDWATER										
BURKE WSC	0.21	0.27	1.06	$135,335	$133,961	0.67	$13,746	$4,059	$2.00	$1.54
CENTRAL WCID	0.14	0.25	2.00	$68,704	$86,297	1.02	$20,824	$1,674	$1.78	$1.19
DIBOLL	0.34	0.70	2.60	$221,854	$289,395	1.67	$34,188	$7,491	$2.12	$1.30
FOURWAY WSC	0.21	0.31	1.14	$132,963	$141,679	0.74	$15,195	$3,975	$2.00	$1.42
HUDSON WSC	0.19	0.38	1.86	$93,369	$122,770	1.08	$22,163	$2,218	$1.74	$1.08
HUNTINGTON	0.20	0.32	0.84	$127,208	$139,522	0.63	$12,926	$3,850	$1.97	$1.34
LUFKIN	1.40	3.12	15.43	$609,918	$929,458	25.00	$66,938	$14,019	$1.35	$0.89
M & M WSC	0.07	0.29	0.86	$45,653	$98,986	0.61	$12,462	$1,883	$2.49	$1.07
POLLOK-REDTOWN WSC	0.09	0.11	0.57	$53,146	$53,913	0.33	$6,723	$1,549	$1.87	$1.55
REDLAND WSC	0.04	0.15	0.56	$29,999	$53,293	0.36	$7,324	$1,130	$2.63	$1.13
SUBTOTAL	2.88	5.90	26.92	$1,518,149	$2,049,274	32.12	$212,489	$41,848	$1.69	$1.07
SURFACE WATER										
ZAVALLA WCID	0.12	0.15	0.40	$77,668	$82,387	0.30	$6,122	$2,584	$1.92	$1.67
HWY. 147 AREA	0.22	0.26	1.05	$138,919	$142,103	0.65	$13,336	$4,456	$1.95	$1.70
SUBTOTAL	0.34	0.41	1.45	$216,587	$224,490	0.95	$19,458	$7,040	$1.94	$1.69
TOTAL	3.22	6.30	28.37	$1,734,736	$2,273,764	33.07	$231,947	$48,888	$1.71	$1.11

12.3 PROPOSED TAKE-OR-PAY QUANTITIES AND COSTS

Table 12-9 summarizes the total project costs along with outlining the methodology for take-or-pay and proportioning of costs. The column title "Pct. of Capital Costs" would show the percentage of construction costs for which each entity would be responsible. The money for construction would be borrowed by the regional entity but the individual systems would make annual payments which would retire the debt.

The column labeled "Pct. of Production" establishes the percentage of the total system production to which that entity is entitled. Therefore, assuming the total system could produce 3.22 MGD in the first phase(which would cover till the Year 2000), then Burke W.S.C. would be entitled to 4.29% of the production, or .21 MGD. Their costs would include the payback on 8.36% of construction costs, as well as the actual cost per thousand gallons of operation and maintenance costs.

TABLE 12-9
SUMMARY OF TOTAL COSTS AND APPORTIONING OF COSTS

ENTITY	WATER NEEDS 2000	2010	2090	YR. 2010 PROJECTED TOTAL ANNUAL COSTS	PCT. OF CAPITAL COSTS	PCT. OF TOTAL ANNUAL COSTS	PCT. OF PRODUCTION
GROUNDWATER							
BURKE WSC	0.21	0.27	1.06	$160,487	8.36%	6.40%	4.29%
CENTRAL WCID	0.14	0.25	2.00	$102,384	3.42%	4.08%	3.97%
DIBOLL	0.34	0.70	2.60	$344,682	15.31%	13.75%	11.11%
FOURWAY WSC	0.21	0.31	1.14	$167,809	8.13%	6.69%	4.92%
HUDSON WSC	0.19	0.38	1.86	$140,590	4.53%	5.61%	5.95%
HUNTINGTON	0.20	0.32	0.84	$162,465	7.87%	6.48%	5.08%
LUFKIN	1.40	3.12	15.43	$953,502	28.65%	38.03%	49.52%
M & M WSC	0.07	0.29	0.86	$107,078	3.85%	4.27%	4.60%
POLLOK-REDTOWN WSC	0.09	0.11	0.57	$60,791	3.16%	2.42%	1.75%
REDLAND WSC	0.04	0.15	0.56	$56,546	2.31%	2.26%	2.38%
SUBTOTAL	2.88	5.90	26.92	$2,256,334	85.60%	89.99%	93.56%
SURFACE WATER							
ZAVALLA WCID	0.12	0.15	0.40	$91,092	5.16%	3.63%	2.36%
HWY. 147 AREA	0.22	0.26	1.05	$159,895	9.24%	6.38%	4.08%
SUBTOTAL	0.34	0.41	1.45	$250,988	14.40%	10.01%	6.44%
TOTAL	3.22	6.30	28.37	$2,507,322	100%	100%	100%

12.4 PROJECTED IMPACT ON INDIVIDUAL SYSTEMS

Because each system has its own particular financial structure, the projecting of impacts of purchase of water is very difficult and very risky. However, in an effort to give some concept of the relative impact of the proposed project on the individual system, Table 12-10 makes some rough projections using general rules of thumb of operating procedures.

TABLE 12-10
PROBABLE IMPACT ON EXISTING RATE STRUCTURES

ENTITY	CURRENT BASE RATE	CURRENT PER 1000 RATE	CURRENT NO. OF CONNECT.	CURRENT USAGE (MGD)	PROJ. YR. 2000 USAGE	ESTIMATED CURRENT BUDGET	YR. 2000 WATER PURCH. (MGD)	PROJECT. ANNUAL PURCHASES YR. 2000	AVOIDED COSTS	PROJECT. NEW ANNUAL BUDGET	CURRENT AVG. MO. BILL	PROJ. AVG. MO. BILL	PCT. INCREASE REQUIRED
URKE WSC	$14.50	$2.50	837	0.23	0.42	$300,593	0.24	$148,434	$63,860	$385,167	$29.93	$38.35	28.14%
CENTRAL WCID	$6.50	$1.30	1635	0.42	0.72	$248,902	0.14	$91,232	$22,177	$317,957	$12.69	$16.21	27.74%
DIBOLL	$5.50	$1.35	1375	0.85	1.07	$443,558	0.47	$295,788	$90,750	$648,596	$26.88	$39.31	46.23%
OURWAY WSC	$7.00	$2.00	990	0.21	0.39	$238,560	0.25	$150,444	$48,271	$340,733	$20.08	$28.68	42.83%
UDSON WSC	$7.00	$2.00	1472	0.42	0.84	$397,715	0.19	$117,131	$33,357	$481,489	$22.52	$27.26	21.06%
UNTINGTON	$9.50	$3.50	766	0.24	0.27	$326,503	0.24	$144,808	$46,340	$424,971	$35.52	$46.23	30.16%
LUFKIN	$6.04	$1.48	11296	5.43	6.41	$3,352,599	1.40	$729,752	$198,268	$3,884,083	$24.73	$28.65	15.85%
M & M WSC	$9.00	$2.00	677	0.14	0.32	$161,167	0.14	$87,374	$22,177	$226,364	$19.84	$27.86	40.45%
OLLOK-REDTOWN	$10.00	$1.50	300	0.08	0.15	$60,830	0.10	$59,688	$19,309	$101,210	$16.90	$28.11	66.38%
EDLAND WSC	$8.50	$1.00	607	0.14	0.23	$90,601	0.08	$50,300	$12,673	$128,228	$12.44	$17.60	41.53%
AVALLA WCID	$11.00	$1.50	368	0.08	0.14	$75,410	0.13	$87,432	$25,101	$137,741	$17.08	$31.19	82.66%
	$8.59	$1.83	20323	8.24	10.96	$5,696,438	3.38	$1,962,383	$582,285	$7,076,537	$23.36	$29.02	24.23%

NOTE: This chart is based on rates in 1989 and on approximations based on connections and rate structures. It is intended only to give some general idea of the impact of the new water source and its cost on current rate structures. This approach is very cautious and does not consider the impact of growth and the resulting greater income from that source.

Table 12-10 uses some very general assumptions, one of which is that the system is not putting money into reserve and that all current debt payments will continue. Additionally, this table does not take into consideration any additional income from new growth within the system. This means that Table 12-10 should represent a worst case scenario since systems would be purchasing water sufficient for at least the Year 2000 but paying for it on the basis of the current number of connections. Each system should perform its own individual analysis of the impact of purchasing regional water.

Generally, the Phase I impact will be the greatest since most of the lines would be constructed under that Phase. This cost would be distributed on a lesser base of water usage than at the later time when the system's water usage and sales will have grown.

Two of the columns estimate the current average monthly bill per user and the projected average monthly water bill. These columns should give some rough idea of the degree of the impact of the costs of this new water source.

Zavalla WCID would show the greatest increase, 82.7%, due to the relatively small current amount of usage, the location in the southern end of the county which would be served by a surface water plant, and the relatively low current water rates. Pollok-Redtown also shows a significant increase, again primarily due to the low amount of water usage and the low current average bill. Most of the entities would increase rates from 15.9-46.2% based on the assumptions made above.

13.0 ORGANIZATIONAL OPTIONS

13.1 GENERAL CONSIDERATIONS

The decision on the type of entity to be selected to pursue the regional system is dependent on a number of critical issues. Those that are readily evident include the following:

1. Control of the system. In this case, the City of Lufkin would be using roughly half of the water from the system, and in addition would be "sharing" lines around Loop 287 and to the south. On the other hand, there is some concern that Lufkin might simply dictate the operation of the system, and the other entities would simply have to comply.

2. Financing. Due to various legal requirements, different types of financing are available to different types of entities. Tax-free bonds and the accompanying lower interest rates can only be issued by tax-free type entities. For instance, in this case, non-profit water supply corporations would not individually have access to tax-free bonds, but cities and districts would.

A concern in this area is that if more than ten percent of the bond proceeds are used to provide for entities that are not tax-free, then the issuance of the bonds in a tax-free status is clouded. However, if twenty-five percent of the water is used for residential purposes, then a bond issue could be made but it would be on a taxable bond basis. Probably in excess of eighty percent of the water of these entities is being used for residential purposes. There are then probably different ways to structure the overall program to comply with these regulations in order to sell tax-free bonds.

One area that will require consideration involves the possible conversion of the Water Supply Corporations to Special Utility Districts. This would allow them to be eligible for tax-exempt status saving money on financing, ad valorem taxes, and sales taxes. This conversion process would require a confirmation election, and elections may be difficult if residents do not understand that Special Utility Districts cannot levy property taxes.

3. Legal Requirements. In addition to the financing considerations outlined above, there are also legal restrictions as to types of entities and the activities they can be involved in. A number of entities can provide water to the area, but the most likely candidates appear to be either a water control and improvement district, a special utility district, a municipal utility district, or a regional authority such as a River Authority.

In each of these cases, financial arrangements will have some ramifications since, for instance, in the case of a special utility district, no tax base exists and legally taxes cannot be implemented. Therefore revenue bonds could not have a cross-pledge of taxes. Although in any of the financing cases, taxes **have not** been

considered as a means of paying for improvements, the cross-pledge security might provide a lower interest rate on bonds.

Generally, the means of formation for a regional district includes legislative action. Therefore, the timing of formation is dictated somewhat by legislative activity.

4. Public Acceptability. No matter how good a solution looks, it must be palatable to the general public. This probably includes all of the items above, although certainly the actual impact on the pocket-book should be the greatest factor.

5. Operation of System. Much of the decision about the type of entity is dependent on how the system will be operated. Will the individual system have its own staff and do the operations of the regional system, or should they be contracted out to an entity?

Since the well field option appears to be the most feasible, since the City of Lufkin has well fields in the same general area as the Champion fields, and since the water production operations are very similar, it stands to reason that one strong option would be that the City of Lufkin would operate the system. This has the additional advantage of not building a staff which would essentially parallel the Lufkin staff.

13.2 REGIONAL WATER AUTHORITY

13.2.1 REGIONAL WATER DISTRICT

One of the early options with the Executive Committee included the formation of a district with a diverse board. Potential composition of the board would include the following:

ENTITY	NO. OF REPRESENTATIVES	NO. OF VOTES
City of Lufkin	1	6
City of Diboll	1	1
City of Huntington	1	1
Water Districts	1	1
Water Supply Corporations	2	2
Angelina County	1	1/2
A.N.R.A.	1	1/2

Mathematically, this gives the City of Lufkin half of the votes, so that the City of Lufkin can effectively veto any action, but also cannot dominate the activities of the District. Since the regional effort appears to be good for all parties involved, there are not any readily

evident conflicts, and certainly at this time there is a sound, sharing attitude. However, the composition of the board can insure against possible future conflicts.

By legislative action, a regional agency could be established without taxing power, but with broad powers to provide services supported by contract revenue bond financing. This entity would act as an umbrella agency with County-wide responsibilities and would be responsible for planning and financing the services to be provided on a regional basis, including raw water supplies, transmission mains, water treatment plants and regional storage facilities. This agency could operate or contract for operation of the regional facilities and provide wholesale services to customer entities. The regional agency would facilitate joint funding of major facilities, and with the agreement of affected, could facilitate the creation of sub-regional systems with powers to finance local facilities through taxes where utility revenues are not sufficient. The regional agency could implement the County-wide plan as an interconnected network and provide for emergency interconnections with water systems in adjoining counties.

PROS:

1. A county-wide district would be a truly regional, County-wide agency that can be made capable of implementing the objective.

2. It could be tailor-made to precisely suit the needs and desires of the County entities, with appropriate powers, duties and responsibilities as are considered necessary to achieve the objective.

3. Provides flexibility.

4. Can contract on a regional needs basis without any separate entity becoming responsible for the debts of another.

5. Can easily define boundaries as those of the County.

6. No general elections required since no general taxing powers are to be requested, except in the case of specific subregions having special needs and desiring taxing power.

7. Ability to easily contract with other agencies.

CONS:

1. Is required to explicitly address geopolitical/legal questions such as method of selecting governing board and the types of services and powers to be vested in the agency.

2. Requires passage of legislation and requires substantial support of general population of County.

The district might also be formed as an Underground Water Control District to meet other state requirements as well. Since it would be the predominant underground water user of the county, this might make good sense.

The negative side of this approach is the difficulty of forming a district. Additionally, the bond rating would be somewhat in doubt initially since it is not an existing entity. Another consideration is that this option would require a confirmation election, and the public would have to understand the need for the district, and the other options. However, bonds would also probably require an election, so the educational process is needed anyway.

13.2.2 INDIVIDUAL CITY OR WATER ENTITY

The City of Lufkin appears to be the only entity that would be large enough to handle a project of this size. Additionally, since the system would share lines with the City of Lufkin, an option with another city or water entity being the owner would probably not be acceptable to Lufkinites.

This option is far more streamlined than that of the district in the issuing of bonds, and in fact in the decision-making process. Future reactions to changes in operations and costs would be quicker and more decisive.

However, this option would leave the City in control of the entire system--a situation that might not be acceptable to at least some of the entities of the County. If an agreement cannot be reached on the formation of a district, this option might become the best. Ultimately, in that case, the City would probably extend lines to those entities desiring to buy water and the regional system would be completed in that way.

Another option might be the formation of a separate board under the City of Lufkin which would be the "Water Supply Board." This board would have authority over the water supply system, and the accounting of this system would be separated from other City activities. This would be similar to the regional system except that the City of Lufkin would actually issue the bonds and own the system.

13.2.3 RIVER AUTHORITY

River authorities have historically played a role in the construction and operations of regional water systems. In this case the Angelina and Neches River Authority has its offices in Lufkin. In addition, some negotiations on surface water rights might well ensue with the Lower Neches Valley Authority. However, since the Angelina and Neches River Authority generally serves this area, an option to go with a river authority would probably include working with A.N.R.A.

Since the Board of A.N.R.A. is appointed by the governor and is in theory, at least, subject to some political activities, the executive board has been cautious about considering the option of the use of a river authority.

However, this remains an option, both for ownership and for operations. Additionally, it is conceivable that even if the river authority were not the entity to construct the system they might still be the financing vehicle. This could be accomplished through an agreement to issue bonds with a contract for construction and operations with the regional district. Ownership of the facilities would pass to the regional authority upon retirement of the bonds.

This same scenario might occur with the formation of some sort of legal corporation whose membership would consist of the participating entities, and which would contract with A.N.R.A. for financing arrangements.

13.3 COST FACTORS

13.3.1 FORMATION AND OPERATIONAL COSTS

Since the City of Lufkin and A.N.R.A. are existing entities, there would be no costs for the formation of a new entity. On the other hand, costs to form a new countywide entity such as a water district could be in excess of $75,000-$100,000. Additionally, where Lufkin and A.N.R.A. have existing staff and office space, the new entity would require starting from scratch. The estimated "extra costs" which would be incurred annually by an independent entity would be about $60,000 including the full salary of a general manager(as opposed to partial salaries in the other cases) and the costs of a secretary. Office space would be required, as well as all of the equipment and furnishings required. If the system fully operated the system, then operators and other field personnel would be required. This would also be true if A.N.R.A. were the operator, though to a lesser degree.

13.3.2 GENERAL COMPARISON OF COST FACTORS

Generally speaking, since the City of Lufkin is already fully operational in producing water from a well system, and treating and distributing it, Lufkin can produce water less expensively than the other two options. A.N.R.A. could be used as outlined and could subcontract operations to the City of Lufkin to take advantage of these efficiencies. If A.N.R.A.

14.0 OTHER CONSIDERATIONS

The process for determining the feasibility of a regional water supply plan should include a review of requirements expected of the various regulatory or funding agencies most likely to be involved in implementation of the project.

14.1 PERMITS/AGENCIES

14.1.1 U.S. ARMY CORPS OF ENGINEERS

Under the provisions of Section 10 of the Rivers and Harbors Act of 1899, the Corps of Engineers has jurisdiction to regulate certain structures and or work in or affecting navigable waters of the United States. In addition, the Corps of Engineers has jurisdiction to regulate the discharge of dredged or fill material into waters of the United States, including their adjacent wetlands, pursuant to Section 404 of the Clean Water Act. Any activities subject to Section 10 and/or Section 404 would warrant a permit from the Department of the Army.

14.1.2 TEXAS DEPARTMENT OF HEALTH

All plans and specifications for construction of public water supply, treatment and distribution systems must be reviewed and approved by the Texas Department of Health prior to construction. In addition, sanitary control easements must be obtained for any new water well in accordance with health department regulations.

14.1.3 TEXAS STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

A permit must be obtained for any facilities proposed to be constructed in state highway right-of-way.

14.1.4 ANGELINA COUNTY COMMISSIONERS COURT

A permit must be obtained for any facilities proposed to be constructed in county road right-of-way.

14.2 ENVIRONMENTAL ANALYSIS

While it is beyond the scope of this study to prepare a detailed environmental assessment, a few comments can be made regarding potential benefits and problems anticipated if the water supply alternative recommended in this study is implemented. A full environmental assessment will be required prior to construction if any state or federal funds are to be used for the project.

The greatest potential environmental benefit expected from the recommended project is the management of the groundwater aquifers by a regionally responsible entity. Withdrawal of water from the aquifers can be kept within the safe yield and the region's water needs supplemented by surface water sources as demand for water increases.

Other than the normal, temporary effects of construction, such as increased noise and dust, no long-term negative impacts are anticipated due to this project. One area of potential concern in our East Texas environment, however, is the habitat of the Red Cockaded Woodpecker. Plant site locations and waterline routes must be chosen so as not to disturb this species.

At such time as the full environmental effects of the proposed project are analyzed, the assessment must conform to Texas Water Development Board Rule 363.53. Basically, this environmental assessment shall: (1) predict anticipated changes which are the result of a proposed action, and (2) determine magnitude and extent of the particular changes through research, professional judgement, and/or discussions. The assessment should demonstrate that a systematic interdisciplinary approach was used in addressing environmental, social and economic impacts; all reasonable alternatives were considered; and, the assessment was relied upon to support decisions made in planning the project.

As a part of the environmental assessment procedures, the following agencies must be notified and asked to provide comments:

1. Texas Parks and Wildlife Department
   - endangered species

2. Texas Antiquities Committee
   - sites of historical and cultured significance

3. Historic Preservation Officer
   Texas Historical Commission
   - sites with historical or archeological significance.

14.3 ARCHEOLOGICAL AND HISTORICAL ANALYSIS

While it is beyond the scope of this study to prepare a detailed archeological and historical analysis, some general comments are provided for consideration should the recommendations of this study be implemented, at which time a full archeological and historical study may be required.

Sites of archeological significance are scattered over the East Texas area. It is advisable to have the project reviewed by a qualified person or entity in the very preliminary stages of design so that any known sites may be avoided. The following agencies must be notified and asked for comments:

1. Texas Antiquities Committee
   - sites of historical and cultured significance

2. Historic Preservation Officer
   Texas Historical Commission
   - sites with historical or archeological significance.

14.4 WATER CONSERVATION PLANNING

This study projects the anticipated growth, both for population and water demand, for Angelina County, and this growth will lead to significantly increased demands for water resources and subsequently to more capital investment in the County's water utility systems. The increased expenditures will not be only in the supply pipes, storage tanks and pumping facilities, but also in the actual acquisition of water sources.

The anticipated growth will also provide opportunities to reduce demands upon the water utility systems through the adoption and implementation of water conservation strategies aimed specifically at new residential, commercial and industrial development. These opportunities come from the ability to require improved water use efficiency in the planning, design and construction of new development.

In addition to water conservation strategies directed at new development, there are many other conservation concepts that are aimed at improving the efficient use of water by existing customers. Some of these other water conservation concepts are:

1. Implementation of utility rate structures that promote conservation,

2. Implementation of programs for gradual replacement of wasteful water fixtures in existing homes, businesses and industry,

3. Continued customer education/information programs that instill the need for and provide practical applications for water conservation,

4. Water demand controls that place limits on non-essential uses for water (i.e., car washing, landscape, irrigation, washing down of driveways and sidewalks, etc.)

5. Water system monitoring plans to identify and replace leaking pipes and faulty meters.

The potential benefits of water conservation are indeed significant. The reduction of water demands and wastewater flows by the implementation of water conservation measures should reduce costs to utilities and subsequently reduce future increases in utility rates for customers. In addition, the water conservation plan will have a positive impact on our environment by minimizing the water taken from underground or from surface reservoirs, and

by limiting the discharges from wastewater treatment facilities. Another benefit of water conservation is the potential reduction in utility costs provided by more optimal sizing of new pipelines and facilities, and by providing a more favorable thumb and sizing of existing facilities expansions.

For the Angelina County area, the water conservation techniques previously mentioned, and many others, are applicable on a system by system basis. The actual application/implementation of these techniques is more suitably addressed once there is an agreement on a regional entity with the proper representation and authority.

This study involves various types of entities - municipalities, water supply corporations, water control and improvement districts, counties and industries. Each entity will need to adopt and implement the special water conservation strategies that will best suit its type of entity and its goals/objectives. In the interim, this study recommends the adoption of the attached "Water Conservation Resolution" (Appendix C) by each of the participating entities to demonstrate their determination to implement a viable water conservation plan.

As a part of this water study, the following recommended strategy for water conservation was developed. Each individual water agency or governmental entity should have the flexibility to develop and implement its own water conservation program, consistent with the goals and intents of the future regional agency, but best suited to its type of entity and its goals/objectives. In the interim, this study recommends the adoption of the attached "Water Conservation Resolution" (Appendix C) by each of the participating entities to demonstrate their determination to implement a viable water conservation plan. As a specific part of the individual conservation programs, it is recommended that a reasonable and achievable goal for conservation would be a ten percent (10%) reduction in per capita water demand by the year 2000. This ten percent reduction would result in a decrease in the average daily demand within the County of approximately 0.55 MGD in the year 2000 and 1.10 mgd in 2010.

The Texas Water Development Board has established regulations for financial assistance that include requirements for water conservation planning and drought contingency planning. All water conservation and drought contingency plans must address the water conservation measures specified in 31 Texas Annotated Code 363.52 and follow the Texas Water Development Board's "Guidelines for Municipal Water Conservation Planning and Program Development" (copy included in Appendix C).

The following format must be used. Each plan element should be addressed and if not applicable, a brief explanation should be presented/discussed.

I. INTRODUCTION
- A. Brief Description of Planning Area and Proposed Project (if applicable)
- B. Utility Evaluation Data
- C. Need for and Goals of the Program

II. LONG TERM WATER CONSERVATION PLAN
- A. Plan Elements
  - 1. Education and Information
    - a. First Year Program
    - b. Long Term Program
    - c. Information to Customers
  - 2. Water Conservation Plumbing Code
  - 3. Water Conservation Retrofit Program
  - 4. Conservation Oriented Water Rate Structure
  - 5. Universal Metering and Meter Checking, Repair and Replacement
  - 6. Water Conserving Landscaping
  - 7. Water Audits and Leak Detection
  - 8. Recycling and Reuse
  - 9. Means of Implementation and Enforcement
- B. Annual Reporting
- C. Contracts with Other Political Entities

III. DROUGHT CONTINGENCY PLAN
- A. Trigger Conditions
  - 1. Mild
  - 2. Moderate
  - 3. Severe
- B. Drought Contingency Measures
  - 1. Mild
  - 2. Moderate
  - 3. Severe
- C. Information and Eduction
- D. Initiation Procedures
- E. Termination Notification Actions
- F. Means of Implementation

IV. LEGAL AND REGULATORY COMPONENTS

- A. Plan Adoption Resolution (required)
- B. Drought Contingencies Ordinance/Regulation (required)
- C. Water Conservation Plumbing Code Regulation (optional)

Drought contingency planning is recommended to be included in the water conservation plans that must be adopted by customer entities. It is recommended that the regional entity make the initial determination of "drought conditions" and recommend measures to be implemented by customer entities, and be responsible for making the general public aware of the drought conditions and efforts being taken to address the problem.

APPENDIX A

OUTLINE FOR PROPOSED WATER SUPPLY CONTRACT

APPENDIX B

ANALYSIS OF EXISTING DISTRIBUTION SYSTEM
CITY OF LUFKIN

APPENDIX B

ANALYSIS OF EXISTING DISTRIBUTION SYSTEM
CITY OF LUFKIN

B.1 PROJECT SCOPE

A separate document entitled "Lufkin Water Distribution Study - May 1989" was prepared by Everett Griffith, Jr. & Associates, Inc. to analyze the City of Lufkin's water distribution system to identify deficiencies, evaluate alternatives, recommend improvements and provide estimated costs to implement the recommendations. The City's current needs were examined in light of projected needs for the years 2000 and 2010. This information will enable the City to begin a program of water system improvements by phases to best fit area growth and funding ability. In addition, by defining the City's needs and comparing them to the regional needs, a joint use of certain proposed water lines can be explored for cost-sharing benefits. This is discussed in more detail in Chapter 8 of the regional study.

B.2 ANALYSIS

Hydraulic analysis of Lufkin's existing and future water distribution system was accomplished through the use of a computer. This analysis provided a method to estimate the effect of changing demands on the water distribution system. The hydraulic model used in this study was developed at the University of Kentucky and is known as the "Kentucky Pipe Network Analysis Program" or "KYPIPE".

B.3 RECOMMENDATIONS

Based upon the hydraulic analysis of the Lufkin system, water plant and distribution system improvements were determined. These improvements were divided into a three phase construction program, as shown in the following Table and on Figure B-1. Total cost for all three phases is estimated at $7,672,000.

TABLE B-1
CITY OF LUFKIN
WATER SYSTEM

PHASE I - CURRENT NEEDS
IMPROVEMENTS
COST ESTIMATE

Description	Estimated Quantity
24" Diameter Waterline	2,100 L.F.
16" Diameter Waterline	21,310 L.F.
12" Diameter Waterline	27,400 L.F.
8" Diameter Waterline	3,450 L.F.
1.0 million gal. Ground Storage Tank	1 Each
1.0 million gal. Elevated Storage Tank	1 Each
Add 2,200 gpm High Service Pump	1 Each
Fire Hydrants	302 Each

PHASE II - YEAR 2000
IMPROVEMENTS
COST ESTIMATE

Description	Estimated Quantity
16" Diameter Waterline	13,860 L.F.
12" Diameter Waterline	24,100 L.F.
8" Diameter Waterline	22,870 L.F.
1.0 million gal. Ground Storage Tank	1 Each
Fire Hydrants	262 Each

PHASE III - YEAR 2010
IMPROVEMENTS
COST ESTIMATE

Description	Estimated Quantity
8" Diameter Waterline	5,450 L.F.
1.0 million gal. Ground Storage Tank	1 Each
Add 1,500 gpm High Service Pump	1 Each
Fire Hydrants	210 Each

APPENDIX C

WATER CONSERVATION PLANNING

APPENDIX C

WATER CONSERVATION RESOLUTION

Whereas it is recognized that water conservation is a necessity; and

Whereas planning for future water supply needs and promoting water conservation go together; and

Whereas Angelina County's cities and water entities are committed to the prudent use of the available water and financial resources,

Now Therefore be it Resolved, that:

- It appears that a reasonable and achievable goal for water conservation is a ten percent (10%) reduction in water demands by the year 2000; and
- Each water utility agency should have the flexibility to develop and implement its own water conservation program; and
- That a water conservation program should include:
    1. The adoption of utility rate programs that reflect the true cost of water and that promotes conservation,
    2. A continuing customer education and information program that informs customers of the need for and methods of how to conserve water,
    3. Adoption and implementation of other water conservation methods that are applicable to local circumstances.

Accepted and Approved this _____ day of _____, 19___.

Signed:_____

GUIDELINES FOR MUNICIPAL WATER CONSERVATION AND DROUGHT CONTINGENCY PLANNING AND PROGRAM DEVELOPMENT

Texas Water Development Board
April 1986

Guidelines for Municipal Water Conservation
and Drought Contingency Planning
and Program Development

Texas Water Development Board
April 1986

A water conservation plan and a drought contingency plan are required as a part of an application submitted by a political subdivision to the Texas Water Development Board for financial assistance from the Development Fund or the Water Loan Assistance Fund. Furthermore, a successful applicant is required to have a program in place before loan funds can be released. The origin of these requirements is action taken by the 69th Texas Legislature in 1985. The conservation requirements were established by House Bill (HB) 2 and House Joint Resolution (HJR) 6. On November 5, 1985, Texas voters approved an amendment to the Texas Constitution that provided for the implementation of HB 2.

The Texas Water Development Board has promulgated Financial Assistance Rules which specify water conservation planning requirements. This document provides the guidelines for developing conservation and drought contingency plans and programs that will meet the regulatory requirements of the Texas Water Development Board.

Included in these guidelines are the required elements of the **water conservation plan** that must accompany an application. The implemented plan is anticipated to become the required **water conservation program.** Included with these guidelines are three tables (Tables 1, 2, and 3) that present examples of methods, structural techniques, and behavioral changes that can be used in designing and implementing a water conservation plan. Tables 4, 5, and 6, which list water conserving devices for retrofit and new construction and the expected energy savings associated with various water conserving devices, are also provided. A **Sample Review Checklist,** which provides a convenient method of insuring that all components important in developing a water conservation plan have been considered, has also been included as an appendix.

The rules and, therefore, these guidelines apply to eligible applicants who sell water or provide wastewater service directly to individual customers and to those utilities that sell water or provide wastewater service to other political subdivisions of the state. In the latter case, the requirements of the Board for water conservation and drought contingency planning and program implementation will need to be met through contractural agreements between the selling political subdivision and the purchasing political subdivision.

Guidelines for Water Conservation and Drought Contingency Plan Development

I. INTRODUCTION

Water used in the residential and commercial sector involves the day-to-day activities of all citizens of the state and includes water used for drinking, bathing, cooking, toilet flushing, fire protection, lawn watering, swimming pools, laundry, dish washing, car washing, and sanitation. Since the early 1960s, per capita water use in the state has increased about four gallons per person per decade. More important, per capita water use during droughts is usually about one-third greater than during periods of average precipitation.

The objective of a conservation program is to reduce the quantity required for each water using activity, insofar as is practical, through the implementation of efficient water use practices. A drought contingency program provides procedures for voluntary and mandatory actions to be put into effect to temporarily reduce the demand placed upon a water supply system during a water shortage emergency. Drought contingency procedures include conservation but may also include prohibition of certain uses. Both programs are tools that water purveyors should have available to operate effectively in all situations.

Many communities throughout the United States have used conservation measures to successfully cope with various water and wastewater problems. Reductions in water use of as much as 25 percent or more have been achieved, but the

normal range is from 5 percent to 15 percent. As a result of reduced water use, wastewater flows have also been reduced by 5 percent to 10 percent.

A drought contingency program includes those measures that a city or utility can use to cause a significant, but temporary, reduction in water use. These measures usually involve either voluntary use reductions, the restriction or elimination of certain types of water use, water rationing, or the temporary use of water from sources other than the established supplies. Communities that have used drought contingency programs have achieved short-term water use reductions in excess of 50 percent during drought emergency situations. Because the onset of emergency conditions is often rapid, it is important that a city or utility be prepared in advance. Further, the citizen or customer must know that certain measures not used in an ongoing conservation program may be necessary if drought or other emergency conditions occur.

II. WATER CONSERVATION PLAN

A water conservation plan and a drought contingency plan specify and explain the actions a specific city or utility will take to implement a water conservation program. The implementation of the water conservation plan is considered to be the water conservation program. The Texas Water Development Board will carefully review each applicant's plan to insure that the specific methods and actions described in the plan will accomplish water conservation. The nine principal water conservation methods to be examined and considered in preparing a water conservation plan that will meet the Board's regulations are as follows:

1. **Education and Information;**
2. **Plumbing Codes** or ordinances for water conserving devices in new construction;
3. **Retrofit Programs** to improve water use efficiency in existing buildings;

4. Conservation-oriented **Water Rate Structures;**
5. **Universal Metering** and meter repair and replacement;
6. **Water Conserving Landscaping;**
7. **Leak Detection** and repair;
8. **Recycling and Reuse;** and
9. Means of **Implementation and Enforcement.**

The applicant's water conservation plan will include one or more of these methods, or equivalent methods, as appropriate, in order to reduce per capita water use so that total water use and sewage flow rates are reduced. The water conservation methods are described and illustrated below.

Education and Information: The most readily available and lowest cost method of promoting water conservation is to inform water users about ways to save water inside homes and other buildings, in landscaping and lawn uses, and in recreational uses. In-home water use accounts for an average of 65 percent of total residential use, while the remaining 35 percent is used for exterior residential purposes such as lawn watering and car washing. Average residential in-home water use data indicate that about 40 percent is used for toilet flushing, 35 percent for bathing, 11 percent for kitchen uses, and 14 percent for clothes washing. Water saving methods that can be practiced by the individual water user are listed below.

In the Bathroom, Customers Should be Encouraged to:

- Take a shower instead of filling the tub and taking a bath. Showers usually use less water than tub baths.
- Install a low-flow shower head which restricts the quantity of flow at 60 psi to no more than 3.0 gallons per minute.
- Take short showers and install a cutoff valve or turn the water off while soaping and back on again only to rinse.

- Not use hot water when cold will do. Water and energy can be saved by washing hands with soap and cold water; hot water should only be added when hands are especially dirty.
- Reduce the level of the water being used in a bath tub by one or two inches if a shower is not available.
- Turn water off when brushing teeth until it is time to rinse.
- Not let the water run when washing hands. Instead, hands should be wet, and water should be turned off while soaping and scrubbing and turned on again to rinse. A cutoff valve may also be installed on the faucet.
- Shampoo hair in the shower. Shampooing in the shower takes only a little more water than is used to shampoo hair during a bath and much less than shampooing and bathing separately.
- Hold hot water in the basin when shaving instead of letting the faucet continue to run.
- Test toilets for leaks. To test for a leak, a few drops of food coloring can be added to the water in the tank. The toilet should not be flushed. The customer can then watch to see if the coloring appears in the bowl within a few minutes. If it does, the fixture needs adjustment or repair.
- Use a toilet tank displacement device. A one-gallon plastic milk bottle can be filled with stones or with water, recapped, and placed in the toilet tank. This will reduce the amount of water in the tank but still provide enough for flushing. (Bricks which some people use for this purpose are not recommended since they crumble eventually and could damage the working mechanism, necessitating a call to the

plumber). Displacement devices should never be used with new low-volume flush toilets.

- Install faucet aerators to reduce water consumption.
- Never use the toilet to dispose of cleansing tissues, cigarette butts, or other trash. This can waste a great deal of water and also places an unnecessary load on the sewage treatment plant or septic tank.
- Install a new low-volume flush toilet that uses 3.5 gallons or less per flush when building a new home or remodeling a bathroom.

In the Kitchen, Customers Should be Encouraged to:

- Use a pan of water (or place a stopper in the sink) for rinsing pots and pans and cooking implements when cooking rather than turning on the water faucet each time a rinse is needed.
- Never run the dishwasher without a full load. In addition to saving water, expensive detergent will last longer and a significant energy saving will appear on the utility bill.
- Use the sink disposal sparingly, and never use it for just a few scraps.
- Keep a container of drinking water in the refrigerator. Running water from the tap until it is cool is wasteful. Better still, both water and energy can be saved by keeping cold water in a picnic jug on a kitchen counter to avoid opening the refrigerator door frequently.
- Use a small pan of cold water when cleaning vegetables rather than letting the faucet run.
- Use only a little water in the pot and put a lid on it for cooking most food. Not only does this method save water, but food is more nutritious since vitamins and minerals are not poured down the drain with the extra cooking water.

- Use a pan of water for rinsing when hand washing dishes rather than a running faucet.
- Always keep water conservation in mind, and think of other ways to save in the kitchen. Small kitchen savings from not making too much coffee or letting ice cubes melt in a sink can add up in a year's time.

In the Laundry, Customers Should be Encouraged to:

- Wash only a full load when using an automatic washing machine (32 to 59 gallons are required per load).
- Use the lowest water level setting on the washing machine for light loads whenever possible.
- Use cold water as often as possible to save energy and to conserve the hot water for uses which cold water cannot serve. (This is also better for clothing made of today's synthetic fabrics.)

For Appliances and Plumbing, the Customer Should be Encouraged to:

- Check water requirements of various models and brands when considering purchasing any new appliance that uses water. Some use less water than others.
- Check all water line connections and faucets for leaks. If the cost of water is $1.00 per 1,000 gallons, one could be paying a large bill for water that simply goes down the drain because of leakage. A slow drip can waste as much as 170 gallons of water EACH DAY, or 5,000 gallons per month, and can add as much as $5.00 per month to the water bill.
- Learn to replace faucet washers so that drips can be corrected promptly. It is easy to do, costs very little, and can represent a substantial amount saved in plumbing and water bills.

- Check for water leakage that the customer may be entirely unaware of, such as a leak between the water meter and the house. To check, all indoor and outdoor faucets should be turned off, and the water meter should be checked. If it continues to run or turn, a leak probably exists and needs to be located.
- Insulate all hot water pipes to avoid the delays (and wasted water) experienced while waiting for the water to "run hot."
- Be sure the hot water heater thermostat is not set too high. Extremely hot settings waste water and energy because the water often has to be cooled with cold water before it can be used.
- Use a moisture meter to determine when house plants need water. More plants die from over-watering than from being on the dry side.

For Out-of-Door Use, Customers Should be Encouraged to:

- Water lawns early in the morning during the hotter summer months. Much of the water used on the lawn can simply evaporate between the sprinkler and the grass.
- Use a sprinkler that produces large drops of water, rather than a fine mist, to avoid evaporation.
- Turn soaker hoses so the holes are on the bottom to avoid evaporation.
- Water slowly for better absorption, and never water on windy days.
- Forget about watering the streets or walks or driveways. They will never grow a thing.
- Condition the soil with compost before planting grass or flower beds so that water will soak in rather than run off.
- Fertilize lawns at least twice a year for root stimulation. Grass with a good root system makes better use of less water.
- Learn to know when grass needs watering. If it has turned a dull grey-green or if footprints remain visible, it is time to water.

- Not water too frequently. Too much water can overload the soil so that air cannot get to the roots and can encourage plant diseases.
- Not over-water. Soil can absorb only so much moisture and the rest simply runs off. A timer will help, and either a kitchen timer or an alarm clock will do. An inch and one-half of water applied once a week will keep most Texas grasses alive and healthy.
- Operate automatic sprinkler systems only when the demand on the town's water supply is lowest. Set the system to operate between four and six a.m.
- Not scalp lawns when mowing during hot weather. Taller grass holds moisture better. Rather, grass should be cut fairly often, so that only 1/2 to 3/4 inch is trimmed off. A better looking lawn will result.
- Use a watering can or hand water with the hose in small areas of the lawn that need more frequent watering (those near walks or driveways or in especially hot, sunny spots).
- Learn what types of grass, shrubbery, and plants do best in the area and in which parts of the lawn, and then plant accordingly. If one has a heavily shaded yard, no amount of water will make roses bloom. In especially dry sections of the state, attractive arrangements of plants that are adapted to arid or semi-arid climates should be chosen.
- Consider decorating areas of the lawn with rocks, gravel, wood chips, or other materials now available that require no water at all.
- Not "sweep" walks and driveways with the hose. Use a broom or rake instead.
- Use a bucket of soapy water and use the hose only for rinsing when washing the car.

The water conservation plan will need to contain ways to communicate water saving practices, such as those listed above, to the public. Among the methods for public education about water conservation are television, radio, and newspaper announcements and advertisements; posters and public displays; fairs, contests, and school programs; bill stuffers, flyers and newsletters; and sales events. The appropriate combination of educational materials and the methods used to communicate with residential users will depend on the location of the applicant, the type of media available, and other factors unique to the applicant's conditions.

Plumbing Codes: Cities of 5,000 population or more and utilities and cities with general plumbing codes will need to adopt water saving plumbing codes for new construction and for replacement of plumbing in existing structures. The standards for residential and commercial fixtures should be:

Tank-type toilets	- No more than 3.5 gallons per flush
Flush valve toilets	- No more than 3.0 gallons per flush
Tank-type urinals	- No more than 3.0 gallons per flush
Flush valve urinals	- No more than 1.0 gallons per flush
Shower heads	- No more than 3.0 gallons per minute
Lavatory and kitchen faucets	- No more than 2.75 gallons per minute
All hot water lines	- Insulated
Swimming pools	- New pools must have recirculating filtration equipment

These standards are recommended because they represent readily available products and technology and do not involve additional costs when compared to "standard" fixtures. For example, conventional toilets using 1.0, 1.5, 2.5, and 3.5 gallons per flush are available at list prices that range from about $50 to $150 each. Insulated hot water lines decrease water wasted by reducing the amount of time it takes to receive hot water at the tap. Water lines can be insulated for about $0.50 per linear foot. In addition, new swimming pools

should contain recirculating filtration and disinfection equipment to eliminate the need to fill and drain the pool daily.

Utilities and cities that do not have a plumbing code will need to adopt a water saving plumbing code or distribute information to their customers and builders to guide them in purchasing and installing water saving plumbing devices.

Retrofit Programs: A city or utility should make information available through its education program for plumbers and customers to use when purchasing and installing plumbing fixtures, lawn watering equipment, or water using appliances. Information regarding retrofit devices such as low-flow shower heads or toilet dams that reduce water use by replacing or modifying existing fixtures or appliances should also be provided. A city or utility may wish to provide certain devices (toilet dams, low-flow shower heads, faucet aerators, etc.) free or at a reduced cost to the customer.

Water Rate Structures: A city or utility should adopt a conservation-oriented water rate structure. Such a rate structure usually takes the form of an increasing block rate, although continuously increasing rate structures, peak or seasonal load rates, excess use fees, and other rate forms can be used. The increasing block rate structure is the most commonly used water conservation rate structure. Under this structure, the price per unit of water increases in steps or blocks as certain customer use levels are reached. For example, the first 5,000 gallons a month may have a base rate of $5.00, the next 3,000 gallons a month may cost $1.50 per thousand gallons, and all use above 8,000 gallons a month may cost $2.00 per thousand gallons. Generally, when using a block rate structure, the first block accounts for

minimal residential water requirements and normally is 5,000 gallons per month or less. The next block accommodates all but the larger residential customers, and blocks beyond the second tier are set high enough to discourage the use of large quantities of water. Under no circumstance, however, should the price for the first block or base level be established below the actual cost of providing the service. In the event that increased prices for the base level place an excessive burden on the poor, life-line rates may need to be established. In addition, separate rate structures will probably be needed for commercial, institutional, and industrial customers.

Universal Metering: All water users, including the utility, city, and other public facilities, should be metered. In addition, the utility should have a master meter. For new multi-family dwellings that are easily metered individually (such as duplexes and fourplexes) or apartments with more than five living units or apartments, each living unit should be metered separately. A regularly scheduled maintenance program of meter repair and replacement will need to be established in accordance with the following time intervals:

1. Production (master) meters - test once a year;
2. Meters larger than 1" - test once a year; and
3. Meters 1" or smaller - test every 10 years.

Most important, metering can provide an accurate accounting of water uses throughout the system when both the utility and customers are metered. In addition, utilities may be able to identify and bill previously unbilled users and, thereby, generate additional revenues. Metering and meter repair and replacement, coupled with an annual water accounting or auditing, can be used in conjunction with other programs such as leak detection and repair and, thereby, save significant quantities of water.

Water Conserving Landscaping: As stated previously, annual in-home water use accounts for an average of 65 percent of total residential use, while the remaining 35 percent is used for exterior residential purposes, such as lawn watering and car washing. However, during the summer months, as much as 50 percent of the water used in urban areas is applied to lawns and gardens and adds greatly to the peak demands experienced by most water utilities. In order to reduce the demands placed on a water system by landscape watering, the city or utility should consider methods that either encourage, by education and information, or require, by code or ordinance, water conserving landscaping by residential customers and commercial establishments engaged in the sale or installation of landscape plants or watering equipment. Some methods that should be considered include the following:

1. Establishing platting regulations for new subdivisions that require developers, contractors, or homeowners to use only adapted, low water using plants and grasses for landscaping new homes;
2. Initiating a Xeriscape or Texscape program that demonstrates the use of adapted, low water using plants and grasses;
3. Encouraging or requiring landscape architects to use adapted, low water using plants and grasses and efficient irrigation systems in preparing all site and facility plans;
4. Encouraging or requiring licensed irrigation contractors to always use drip irrigation systems when possible and to design all irrigation systems with water conservation features, such as sprinklers that emit large drops rather than a fine mist and a sprinkler layout that accomodates prevailing wind direction;
5. Encouraging or requiring commercial establishments to use drip irrigation for landscape watering when possible and to install only ornamental fountains that recycle and use the minimum amount of water; and

6. Encouraging or requiring nurseries and local businesses to offer adapted, low water using plants and grasses and efficient landscape watering devices, such as drip irrigation systems.

Leak Detection and Repair: A continuous leak detection, location, and repair program can be an important part of a water conservation plan. An annual water accounting or audit should be part of the program. Sources of unaccounted for water include defective hydrants, abandoned services, unmetered water used for fire fighting or other municipal uses, inaccurate or leaking meters, illegal hook-ups, unauthorized use of fire hydrants, and leaks in mains and services. Once located, corrective repairs or actions need to be undertaken. An effective leak detection, location, and repair program will generally pay for itself, especially in many older systems. For example, a utility that produces an average of one million gallons per day at an average water rate of $0.95 per one thousand gallons will lose approximately $35,000 in revenue each year when system losses amount to 10 percent.

Recycling and Reuse: A city or utility should evaluate the potential of recycling and reuse because these methods may be used to increase water supplies in the applicant's service area. Reuse can be especially important where the use of treated effluent from an industry or a municipal system or agricultural return flows replace an existing use that currently requires fresh water from a city's or utility's supply. Recycling of in-plant process or cooling water can reduce the amount of fresh water required by many industrial operations.

As an example, several cities in Texas now provide treated municipal effluent to industries and irrigation projects in their areas. In industry, the use of

treated wastewater for cooling purposes has a long and very successful history. The same is true for irrigation. One farm near Lubbock has been irrigated with treated wastewater from Lubbock since the 1930s. The City of El Paso has in operation a major aquifer recharge project through which up to 10 million gallons per day of highly treated municipal wastewater will be injected into the aquifer from which the City obtains its water supply.

Implementation and Enforcement: Each city or utility that adopts a water conservation program must have the authority and means to implement and enforce the provisions of the program if the goal of conserving water is to be achieved. Enforcement may be provided by utility personnel, local police, or special employees hired to administer and enforce the program. The applicant's water conservation plan will need to include a description of the means to implement and enforce a program, and to annually report on program effectiveness.

III. DROUGHT CONTINGENCY PLAN

Drought or a number of other uncontrollable circumstances can disrupt the normal availability of community or utility water supplies. Even though a city may have an adequate water supply, the supply could become contaminated, or a disaster could destroy the supply. During drought periods, consumer demand is often significantly higher than normal. Some older systems, or systems serving rapidly growing areas, may not have the capacity to meet higher than average demands without system failure or other unwanted consequences. System treatment, storage, or distribution failures can also present a city or utility with an emergency demand management situation.

The following guidelines pertain to the preparation of drought contingency plans. It is important to distinguish drought contingency planning from water conservation planning. While water conservation involves implementing permanent water use efficiency or reuse practices, drought contingency plans establish temporary methods or techniques designed to be used only as long as an emergency exists.

An effective drought contingency plan will need to include the following six elements:

1. **Trigger Conditions** signaling the start of an emergency period;
2. **Drought Contingency Measures;**
3. **Information and Education;**
4. **Initiation Procedures;**
5. **Termination Notification** actions; and
6. Means of **Implementation.**

Trigger Conditions: The city or utility will need to establish a set of trigger or threshold conditions, such as lake or well levels or peak use volumes, that will indicate when drought contingency measures need to be put into effect. Since each city and utility has different circumstances, trigger conditions will be unique for each system. In most cases, several trigger levels will be needed to distinguish among mild, moderate, or severe drought conditions. For example, mild conditions may include the following situations:

1. Water demand is approaching the safe capacity of the system;
2. Lake levels are still high enough to provide an adequate supply, but the levels are low enough to disrupt some other beneficial activity, such as recreation; and
3. The water supply is still adequate, but the water levels or reservoir capacities are low enough that there is a real possibility that the supply situation may become critical if the drought or emergency continues. (An example is a reservoir that has an 18-month supply in storage, if no more rains occur).

Moderate conditions may include the following situations:

1. Water levels are still adequate, but they are declining at such a rapid rate that a more serious problem will result in the very near future if some type of formal action is not taken;
2. Water demand occasionally reaches what has been determined to be the safe limit of the system, beyond which the failure of a pump or some other piece of equipment could cause a serious disruption of service to part or all of the system; and
3. Reservoir levels, well levels, or river flows are low enough to disrupt some major economic activity or cause unacceptable damage to a vital ecosystem.

Severe conditions could include a number of situations ranging from the inability to provide certain services to the impairment of health and safety. Some examples include:

1. The imminent or actual failure of a major component of the system which would cause an immediate health or safety hazard;
2. Lake, river, or well levels are so low that diversion or pumping equipment will not function properly;
3. Water levels are low enough in the distribution system storage reservoirs to hinder adequate fire protection; and
4. Water demand is exceeding the system's capacity on a regular basis, thus presenting the real danger of a major system failure.

Trigger conditions for the phase-out or a downgrade of the condition's severity should also be considered. Further, unforeseen events can occur so as to require the initiation of an emergency demand management response program for which no trigger condition has been established.

Drought Contingency Measures: The city or utility will need to establish a list of emergency measures and a plan for their implementation when preselected trigger conditions are reached. The types of measures will depend on local conditions, but in most cases there should be different types of measures that apply to the various levels of severity (i.e., mild, moderate, severe) for drought or emergency conditions. Specific measures could include the following:

1. Imposing restrictions or bans on non-essential uses such as lawn watering, car washing, and pool filling;
2. Communicating methods to reduce the quantity of water needed for the essential purposes of drinking, cooking, bathing, and clothes washing;

3. Implementing rationing plans;

4. Establishing pricing structures that incorporate surcharges and penalties or fines for non-compliance;

5. Locating and assessing additional sources including wells, ponds, or reservoirs; reactivating abandoned wells or dams; purchasing water from others on an emergency basis; building emergency facilities; and considering temporary reuse of wastewater for non-potable uses; and

6. Designing means of enforcement.

The measures for each level of severity should include continued implementation of relevant requirements and actions imposed under the preceding level. Examples of some of the measures that could be employed for mild, moderate, and severe conditions include:

1. **Mild Condition Measures**

   (a) Inform public by mail and through the news media that a trigger condition has been reached, and that water users should look for ways to reduce water.

   (b) Activate an information center and discuss the situation in the news media.

   (c) Advise the public of the trigger condition situation daily.

   (d) Advertise a voluntary daily lawn watering schedule.

2. **Moderate Condition Measures**

   (a) Mandatory lawn watering schedule.

   (b) Fine water wasters.

   (c) Institute an excessive use fee, special pricing structure, or surcharge.

(d) Prohibit certain uses such as ornamental water fountains or other non-essential water uses.

(e) Request industries or other non-municipal water users to stop certain uses, find additional sources, increase recycling, or modify production processes where possible.

3. **Severe Condition Measures**

(a) Prohibit all outdoor water use.

(b) Limit the amount of water each customer can use and establish legal penalities for those who fail to comply.

(c) Require industrial or commercial water users to stop operations so that remaining water is available for essential health and safety related uses.

Information and Education: Once trigger conditions and emergency measures have been established, the public should be informed of what will be expected during a drought or emergency situation. The material should describe trigger conditions and emergency measures and the need to implement the measures. Possible methods of educating and informing the public include:

1. Radio and television public service announcements and news stories;
2. Newspaper stories; and
3. Letters, bill stuffers, and brochures to water customers.

Initiation Procedures: The city or utility should have written procedures that contain adequate methods of informing customers, other utilities, and government entities as far in advance as possible that a trigger condition is

being approached or that it has been reached, and that a certain phase of the drought contingency plan must be implemented.

These written procedures may include:

1. Automatic regulatory implementation provisions;
2. Prearranged media notification or press release procedures;
3. Direct notification procedures including mail or, if needed, telephone notification systems;
4. Prearranged contract procedures to obtain emergency water supplies from other sources if needed; and
5. Checklists or operating procedures as necessary.

Termination Notification: The city or utility should have a written procedure to inform the customers and other directly affected parties that the emergency has passed. The establishment of termination triggers and the decision to terminate must be based on sound judgment by proper city or utility authorities.

Implementation: The primary reason for developing a plan is to have a guide for implementing a drought contingency program if the need occurs. It is the full intention of the Texas Water Development Board that the city or utility develop a workable plan that customers understand and which can be used in the event it is needed. In order to accomplish this, each city or utility will need to develop and adopt legal and regulatory documents or instruments that are appropriate.

Legal and **regulatory components** that may be necessary for implementation are listed below.

1. Ordinances, bylaws, or other implementing legal documents.
2. Changes in plumbing codes.
3. New or revised contracts with potential water suppliers.
4. Conditions in contracts with industries or commercial water users who may have water supplies cut off or curtailed.
5. Changes or conditions to water rights permits or contracts with current water suppliers.

Table 1. Examples of Methods Used to Implement Water Use Efficiency Practices

Education and Information	Economic and Price	Regulatory
1.Setting a good public example.	1.Providing low interest loans or grants to install water saving irrigation equipment.	1.Instituting plumbing codes requiring that water saving fixtures be used.
2.Using radio and TV public service announcements.	2.Sending out free shower heads and toilet dams to customers.	2.Passing laws which fine or penalize water wasters.
3.Teaching about water resources in public schools.	3.Providing coupons for discounts on water saving devices.	3.Requiring industries and irrigators to use water efficient equipment.
4.Using TV, newspaper, and radio to disseminate information.	4. Giving tax breaks to those who modify agricultural or industrial practices.	4.Restricting the sale of equipment that wastes water.
5.Providing bill "stuffers" and brochures.	5.Giving breaks on water rates for those who save.	5.Requiring the use of certain water saving plants or grasses or restrict the sale of water wasting plants by nurseries.
6.Conducting public meetings and seminars.	6.Using increasing block rate structures.	
7.Setting up an information "hot line."	7.Assessing tax or price increases on those who fail to save.	
8.Inviting public input.	8.Assessing fines.	
9.Providing information on water saving appliances and plumbing fixtures.	9.Providing free customer assistance and conservation device installation.	
10.Setting up demonstration projects.		

Table 2. Examples of Structural Techniques that Increase Water Use Efficiency

Municipal and Commercial	Industrial	Agricultural
1.Repairing water distribution leaks and meters.	1.Employing recirculation of water in the plant.	1.Lining canals and repairing transmission systems.
2.Retrofitting toilets, faucets, and showers with dams, (or similar devices), aerators, and low flow shower heads, respectively.	2.Using air cooling.	2.Controlling phreatophytes.
3.Installing low-flush or dual-flush toilets.	3.Modifying the plant's production process.	3.Installing water control structures.
4.Insulating hot water pipes.	4.Repairing leaks.	4.Using furrow dikes.
5.Repairing leaks.	5.Repairing steam traps.	5.Using drip or improved LEPA irrigation systems.
6.Using water efficient appliances.	6.Practicing energy conservation.	6.Recovering tailwater.
7.Installing drip or efficient lawn watering equipment.	7.Replacing high water use processes with new process technologies that use less water.	7.Installing moisture measuring devices.
8.Using low water using and drought resistance plants and grass.	8.Using low water use fixtures in office facilities.	8.Contouring land or using levees.
9.Using moisture sensing controls to determine the need to water the lawn.	9.Using drip or water efficient landscape watering equipment.	9.Consolidating canal systems.
10.Using pressure reduction.	10.Using low water using and drought resistant plants and grass.	10.Applying watershed management.
11.Practicing water harvesting.	11.Installing moisture sensing controls.	
12.Installing water meters.		

Table 3. Examples of Behavioral Changes that Increase Water Use Efficiency

Municipal and Commercial	Industrial	Agricultural
1.Taking shorter showers.	1.Minimizing the use of hosedown practices for the work area.	1.Practicing irrigation scheduling.
2.Turning off water when brushing teeth.	2.Instructing employees on water saving practices.	2.Practicing improved tillage.
3.Washing only full loads in dish and clothes washers.	3.Employing the same practices as commercial operations in the office area.	3.Practicing periodic deep plowing.
4.Using a broom to clean driveway instead of waterhose.	4.Setting good community examples and aiding in water resource information dissemination.	4.Mulching.
5.Using lawn watering equipment carefully.		5.Employing system efficiency evaluation.
6.Maintaining a high level of water conservation awareness.		6.Maintaining irrigation equipment.
7.Scheduling lawn watering.		
8.Washing the car with a bucket and hose with a shutoff valve.		
9.Demanding good conservation practices by utility and governmental authorities.		

Table 4. Water Conserving Retrofit Devices

Application	Device	Function	Water Savings	Estimated Unit Water Savings gpcd	Estimated Cost $	Service Life Years
Toilet	Two displacement bottles	Reduces flush volume	0.5 gal/flush	2.3	0-0.20	5
Toilet	Water closet dam	Reduces flush volume	1.0 gal/flush	4.5	1.50-3.00	5
Toilet	Dual-flush	Variable-flush volume	3.5 gal/flush	15.7	15.00	15
Shower	Flow restrictor	Limits flow to 3 gpm	1.5 gpm	6.7	0.50	5
Shower	Reduce-flow shower head	Limits flow to 3 gpm	1.5 gpm	6.7	3.00-20.00	15
Shower	Reduce-flow shower head with cutoff valve	Limits flow to 2.5 gpm	2 gpm	8.0	5.00-20.00	15
Shower	Cutoff valve	Facilitates "navy" shower"	-	-	2.50-5.00	15
Faucets	Aerator	Reduces splashing, enhances flow aesthetics, creates appearance of greater flow	-	0.5	0.50-2.00	15
Hot water pipes	Insulation	Reduces warm-up time	-	0.5	0.50/ft	25
Water hook-up	Pressure-reducing valve	Reduces available water pressure at fixtures and, hence, flow rate	-	3.0	85.00	25

gpcd = gallons per capita per day; gpm = gallons per minute

Table 5. Water Conserving Devices for New Construction

Application	Device	Function	Water Savings	Estimated Unit Water Savings gpcd	Estimated Additional Cost $	Service Life Years
Toilet	Low-flush, 3.5 gal/flush	Reduced flush volume	1.5 gal/flush	7.5	0	25
Toilet	Low-flush, 2.5 gal/flush	Reduced flush volume	2.5 gal/flush	12.5	0	25
Toilet	Low-flush, 1.0 gal/flush	Reduced flush volume	4.0 gal/flush	20.0	*	25
Shower	Reduced-flow shower head	Reduces shower flow rate to 3.0 gpm	1.5 gpm	6.7	0	15
Shower	Reduced-flow shower head with cutoff valve	Reduces shower flow rate to 2.5 gpm	2.0 gpm	8.0	0	15
Shower	Cutoff valve	Facilitates "navy shower"	-	-	2.50-5.00	15
Faucet	Aerator	Reduces splashing, enhances flow aesthetics, creates appearance of greater flow	-	0.5	0.50-2.00	15
Water hook-up	Pressure-reducing valve	Reduces available water pressure at fixtures and, hence, flow rate	-	3.0	45.00	25
Appliances	Water-efficient dish-washing appliances	Reduced water requirement	6-gal/cycle	2.0	0	15
Appliances	Water-efficient clothes-washing machine	Reduced water requirement	14-gal/cycle	3.5-7.0	70.00	15

*Some are expensive, but others are available at costs comparable to 3.5 gallon per flush models.

Table 6. Estimated Energy Savings Associated with Residential Water Conservation

Device	Hot Water Saved[a]	Amount of Energy Saved		Value of Energy Saved	
		Gas Water Heaters[c]	Electric Water[e]	Gas[f]	Electric[g]
	(Gal/day/D.U.)[b]	(Therms/year/D.U.)[d]	(Kw-hr/year/D.U.)	(Dollars/year/D.U.)	
Showerhead, 3.0 gpm	8.0	22.9	541	12.6	32.4
Water saving dishwashers	4.7	13.6	320	7.5	19.2
Water saving clothes-washing machines	2.4	6.8	160	3.7	9.6
Subtotal	15.1	43.3	1,021	23.8	61.2
Insulation of hot water pipes	4.7	13.6	320	7.5	19.2
Total	19.8	56.9	1,341	31.3	80.4

a/ 140° F water saved as follows: shower 3.4 gallons per capita per day (gpcd); dishwasher 2.0 gpcd; washing machines 1.0 gpcd; thermal pipe insulation 2.0 gpcd.
b/ D.U.= dwelling units; 2.37 persons per dwelling unit.
c/ 79 percent efficiency. Source: The California Appliance Efficiency Program - Revised Staff Rept. California Energy Resources Conservation & Devel. Comm. Conservation Div. (Nov. 1977).
d/ One Therm = 100,000 BTU.
e/ 98 percent efficiency. Source: ibid.
f/ $0.55/therm.
g/ $0.06/kw-hr.

SAMPLE REVIEW CHECKLIST

for Water Conservation and Drought Contingency Plan Development

The following checklist provides a convenient method to insure that the most important items that are needed for the development of a conservation and a drought contingency program are considered.

1. Utility Evaluation Data

   A. Population of Service Area _____ (Number)

   B. Area of Service Area _____ (Sq. mi.)

   C. Number and Type of Equvalent 5/8" Meter Connections in Service Area _____(Res.) _____(Comm.) ____(Ind.)

   D. Net Rate of New Connection Additions per year (New Connections less disconnects) _____(Res.) _____(Comm.) ____(Ind.)

   E. Water Use Information

   (1) Water Production for the Last Year _____ (gal./yr.)

   (2) Average Water Production for Last 2 Years _____ (gal./yr.)

   (3) Average Monthly Water Production for Last 2 Years _____ (gal./mo.)

   (4) Estimated Monthly Water Sales by User Category (1000 gal.) (Use latest typical year)

	Residential	Commercial-Institutional	Industrial	Total
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
Total				

   (5) Average Daily Water Use _____ (gpd)

   (6) Peak Daily Use _____ (gpd)

   (7) Peak to Average Use Ratio (average daily summer use divided by annual average daily use) _____

   (8) Unaccounted for Water (% of Water Production)

F. Wastewater Information

(1) Percent of your potable water customers sewered by your wastewater treatment system _____.

(2) Percent of potable water customers who have septic tanks or other privately operated sewage disposal systems _____%.

(3) Percent of potable water customers sewered by another wastewater treatment utility _____%.

(4) Percent of total potable water sales to the three categories described in F(1), F(2), and F(3).

(a) Percent of total sales to customers you serve _____%.

(b) Percent of total sales to customers who are on septic tanks or private disposal systems _____%.

(c) Percent of total sales to customers who are on other wastewater treatment systems _____%.

(5) Average daily volume of wastewater treated _____ (gal)

(6) Peak daily wastewater volumes _____ (gal).

(7) Estimated percent of wastewater flows to your treatment plant that originate from the following categories:

Residential	_____%
Industrial and Manufacturing	_____%
Commerical/Institutional	_____%
Stormwater	_____%
Other - Explain	_____%

G. Safe Annual Yield of Water Supply _____ (gal.)

H. Peak Daily Design Capacity of Water System _____ (gpd)

I. Major High-Volume Customers (List) _____

_____

_____

J. Population and Water Use or Wastewater Volume Projections (List) _____

_____

K. Percent of Water Supply Connections in System Metered _____(Res). _____(Comm.) _____(Ind.)

L. Water or Wastewater Rate Structure (Uniform, Increasing Block, etc.) _____

_____

M. Average Annual Revenues from Water or Wastewater Rates _____ (Dollars)

N. Average Annual Revenue from Non-Rate Derived Sources _____ (Dollars)

O. Average Annual Fixed Costs of Operation _____ (Dollars)

P. Average Annual Variable Costs of Operation _____ (Dollars)

Q. Average Annual Water or Wastewater Revenues for Other Purposes (if applicable) _____ (Dollars)

R. Copies of Applicable Local Regulations (List) _____

S. Copies of Applicable State, Federal or Other Regulations (List) _____

T. Special Information (List) _____

2. Public Involvement in Planning Process

A. Public at Large (List) _____

B. Special Interest Groups (List) _____

3. Conservation Plan Procedure. A checklist of items to be considered and, as appropriate, incorporated in the plan.

	Considered	Incorporated/Addressed Yes	No
A. Step 1 - Identify Need(s) and Establish Goals			
(1) System audit			
(a) Establish current average, seasonal, and peak use patterns	☐	☐	☐
(b) Determine unaccounted water volumes and likely causes	☐	☐	☐
(c) Determine adequacy of treatment, storage, and distribution systems	☐	☐	☐
(d) Define limits of existing supply and identify potential new sources	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
(e) Determine capacity of wastewater collection and treatment system	☐	☐	☐
(2) Define problems from audit			
(a) Peak use problem	☐	☐	☐
(b) Average use problem	☐	☐	☐
(3) Establish goal as percentage of reduction to achieve	☐	☐	☐
B. Step 2 - Assess Supply and Demand Management Potentials			
(1) Supply management methods			
(a) Metering and meter repair	☐	☐	☐
(b) Leak detection and repair	☐	☐	☐
(c) Pressure regulation	☐	☐	☐
(d) Watershed management	☐	☐	☐
(e) Evaporation suppression	☐	☐	☐
(f) Reuse	☐	☐	☐
(2) Demand management methods			
(a) Pricing	☐	☐	☐
(b) Regulation	☐	☐	☐
(c) Education	☐	☐	☐
C. Step 3 - Analyze the Cost Effectiveness and Impacts of the Management Program			
(1) Supply management methods			
(a) Metering and meter repair	☐	☐	☐
(b) Leak detection and repair	☐	☐	☐
(c) Pressure regulation	☐	☐	☐
(d) Watershed management	☐	☐	☐
(e) Evaporation Suppression	☐	☐	☐
(f) Reuse	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
(2) Demand management methods			
(a) Pricing	☐	☐	☐
(b) Regulation	☐	☐	☐
(c) Education	☐	☐	☐
D. Step 4 - Identify the Actions to Minimize Adverse Impacts			
(1) Supply management programs			
(a) Costs of program result in operating deficit	☐	☐	☐
(b) Costs of program not covered by revenue	☐	☐	☐
(c) Lack of cooperation from local government or board	☐	☐	☐
(d) Community opposition	☐	☐	☐
(2) Demand management programs			
(a) Revenue decrease	☐	☐	☐
(b) Additional expenditures needed to pay for program	☐	☐	☐
(c) User expenditures required for retrofit devices	☐	☐	☐
(d) Users water bill increases	☐	☐	☐
(e) Large volume user problems	☐	☐	☐
(f) Public and political opposition	☐	☐	☐
(g) Equity of program	☐	☐	☐
(h) Lack of cooperation of community departments	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
E. Step 5 - Choose Management Program(s) and Design the Specifics of Each			
(1) Supply management programs			
(a) Metering and meter repair	☐	☐	☐
(b) Leak detection and repair	☐	☐	☐
(c) Pressure regulation	☐	☐	☐
(d) Watershed management	☐	☐	☐
(e) Evaporation suppression	☐	☐	☐
(f) Reuse	☐	☐	☐
(2) Demand management programs			
(a) Pricing	☐	☐	☐
(b) Regulation	☐	☐	☐
(c) Education	☐	☐	☐
F. Step 6 - Evaluate and Select the Needed Hardware and Software			
(1) Supply management programs			
(a) Metering and meter repair	☐	☐	☐
(b) Leak detection and repair	☐	☐	☐
(c) Pressure regulation	☐	☐	☐
(d) Watershed management	☐	☐	☐
(e) Evaporation suppression	☐	☐	☐
(f) Reuse	☐	☐	☐
(2) Demand management programs			
(a) Water-saving fixtures	☐	☐	☐
(b) Reuse and recycle systems	☐	☐	☐
(c) User habit changes	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
G. Step 7 - Summarize the Conservation Plan			
(1) Conservation Goal	☐	☐	☐
(2) Supply management program	☐	☐	☐
(3) Demand management program	☐	☐	☐
(4) Public involvement	☐	☐	☐

4. Drought Contingency Plan Procedure

	Considered	Incorporated/Addressed Yes	No
A. Step 1 - Identify System Constraints			
(1) Source-related problems			
(a) Aquifer and well yield	☐	☐	☐
yield	☐	☐	☐
level	☐	☐	☐
well capacity	☐	☐	☐
(b) Reservoirs (specific)	☐	☐	☐
yield	☐	☐	☐
level	☐	☐	☐
special concerns	☐	☐	☐
(c) Surface water diversion (general)	☐	☐	☐
flow variation	☐	☐	☐
levels	☐	☐	☐
water rights	☐	☐	☐
environmental	☐	☐	☐
recreational	☐	☐	☐
water quality impacts	☐	☐	☐
(2) System-related problems			
(a) Peak or high demands	☐	☐	☐
(b) System limits	☐	☐	☐
(c) Public health & safety	☐	☐	☐
(d) Storage capacity	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
B. Step 2 - Locate and Assess Alternate Sources			
(1) Existing wells, ponds, or reservoirs	☐	☐	☐
(2) Reactivate abandoned wells or dams	☐	☐	☐
(3) Purchase water from others on emergency basis	☐	☐	☐
(4) Build emergency facilities	☐	☐	☐
(5) Reuse wastewater	☐	☐	☐
C. Step 3 - Assess System Management and Rank Severity of Impacts			
(1) Determine impacts drought or emergency conditions would have	☐	☐	☐
(2) Rank impacts by order of severity	☐	☐	☐
(3) Group causal condition by order of impact severity	☐	☐	☐
(4) Set "Trigger Conditions"	☐	☐	☐
D. Step 4 - Design Emergency Management Program			
(1) Evaluate measures			
(a) Information	☐	☐	☐
(b) Media programs	☐	☐	☐
(c) Economic incentives	☐	☐	☐
(d) Fines	☐	☐	☐
(e) Limits on amounts (Rationing)	☐	☐	☐
(f) Prohibition of certain uses	☐	☐	☐
(g) Legal penalties	☐	☐	☐
(2) Rank measures by order of severity of conditions determined in Step 3	☐	☐	☐

	Considered	Incorporated/Addressed Yes	No
E. Step 5 - Evaluate Procedure and Regulations and Implement Plan			
(1) Procedural considerations to address in the plan			
(a) Notification procedure	☐	☐	☐
(b) Public information on "Trigger Conditions"	☐	☐	☐
(c) Method to update plan	☐	☐	☐
(d) Utility guidebook or check list	☐	☐	☐
(2) Legal or regulatory considerations			
(a) Utility ordinances or bylaws	☐	☐	☐
(b) Changes to plumbing codes	☐	☐	☐
(c) Revised or alternate contracts with suppliers	☐	☐	☐
(d) Amended contracts with major customers to provide for cut-off procedures	☐	☐	☐
(e) Changes to water rights or other contracts	☐	☐	☐

APPENDIX D

DROUGHT CONDITIONS WATER DEMANDS STATEMENT

APPENDIX D

DROUGHT CONDITIONS WATER DEMANDS

It is recognized that during times of extended hot and dry weather, that demands for water tend to escalate. Based on experiences in this region, it appears reasonable to anticipate that the impact of drought conditions would increase water demands by between fifteen to twenty percent (15% to 20%) over normal demands. For Angelina County Water Utilities, it is recommended that a fifteen percent (15%) impact for drought condition water demands be assumed.

The determination of water supply requirements therefore should be based upon projections of "drought demand" equal to one hundred fifteen percent (115%) of normal demand.

APPENDIX E

(NOT USED)

APPENDIX F

CORPS OF ENGINEERS
CONTRACT FOR SURFACE WATER

CONTRACT BETWEEN THE UNITED STATES OF AMERICA
AND
THE LOWER NECHES VALLEY AUTHORITY
FOR
WATER STORAGE SPACE IN SAM RAYBURN RESERVOIR

THIS CONTRACT, entered into this _____ day of _____, 19__, by and between THE UNITED STATES OF AMERICA (hereinafter called the "Government") represented by the Contracting Officer executing this contract, and the Lower Neches Valley Authority (hereinafter called the "User");

WITNESSETH THAT:

WHEREAS, the River and Harbor Act approved March 2, 1945 (Public Law 14, 79th Congress, 1st Session) authorized the construction, operation, and maintenance of the Sam Rayburn Dam and Reservoir on the Angelina River, Texas, hereinafter called the Project; and

WHEREAS, on 24 August 1956, the Government and the User entered into Contract No. DA-41-443-CIVENG-57-20 wherein the Government agreed, to the extent that water is available in the Project above elevation 149 feet above mean sea level, to make releases of water from the Project as required for the generation of power, with such releases at least sufficient to generate power equivalent to 42,200 kilowatts for a minimum period of 75 hours per month for each of the six monthly periods from mid-April through mid-October of each year; and

WHEREAS, on 7 January 1969, the Government and the city of Lufkin, Texas, entered into Contract No. DACW63-69-C-0007 wherein the city of Lufkin obtained

the right to utilize an undivided 2.98 percent of the storage space in the Project between elevations 164.4 feet above mean sea level and 149.0 feet above mean sea level for water supply; and

WHEREAS, the User desires to contract with the Government for inclusion in the Project of additional storage for municipal and industrial water supply (reallocated flood control storage), and for payment of the cost thereof in accordance with the provisions of the Water Supply Act of 1958, as amended (43 U.S.C. 390b-f); and

WHEREAS, the User is empowered to contract with the Government and is vested with all necessary powers of accomplishment of the purposes of this contract, including those required by Section 221 of the Flood Control Act of 1970 (42 U.S.C. 1962d-5d) (as amended);

NOW, THEREFORE, the Government and the User agree as follows:

ARTICLE 1 - Water Storage Space.

(a) Project Construction. The Government, subject to the directions of Federal law and any limitations imposed thereby, will reallocate storage in the Project so as to include therein space for the storage of water by the User.

(b) Rights of User.

(1) The User shall have the right to utilize an undivided 0.787 percent (estimated to contain 11,467 acre-feet after adjustment for sediment deposits) of the usable storage space in the Project between elevations 164.5 feet above

mean sea level and 149.0 feet above mean sea level, which usable conservation storage space is estimated to contain 1,457,640 acre-feet after adjustment for sediment deposits. This storage space is to be used to impound water for present demand or need for municipal and industrial water supply. This storage space shall be composed of two segments, designated as No. 1 and No. 2, with Segment No. 1 constituting an undivided 52.32 percent (estimated to contain 6,000 acre-feet after adjustment for sediment deposits) and Segment No. 2 constituting an undivided 47.68 percent (estimated to contain 5,467 acre-feet after adjustment for sediment deposits) of this storage space. Use of Segment No. 1 shall begin on 1 January 1988, and use of Segment No. 2 shall begin on 1 January 1995. The User may elect to commence utilization of a segment in advance of the effective use date and in such event, payments shall be due and payable as set forth in Article 5. Use of Segment No. 1 shall commence before use of Segment No. 2.

(2) The User shall have the right to withdraw water from the lake, or to order releases to be made by the Government through the outlet works in the Dam, subject to the provisions of Article 1(c) and to the extent the aforesaid storage space will provide; and shall have the right to construct all such works, plants, pipelines, and appurtenances as may be necessary and convenient for the purpose of diversion or withdrawals, subject to the approval of the Contracting Officer as to design and location. The grant of an easement for right-of-way, across, in and upon land of the Government at the Project shall be by a separate instrument in a form satisfactory to the Secretary of the Army, without additional cost to the User, under the authority of and in

accordance with the provisions of 10 U.S.C. 2669 and such other authorities as may be necessary. Subject to the conditions of such easement, the User shall have the right to use so much of the Project land as may reasonably be required in the exercise of the rights and privileges granted under this contract.

(c) Rights Reserved. The Government reserves the right to lower the water in the Project to elevation 164.5 feet above mean sea level during such periods of time as are deemed necessary, in its sole discretion, for flood control purposes and to control and use any water supply storage not under contract in accordance with authorized Project purposes. The Government further reserves the right to take such measures as may be necessary in the operation of the Project to preserve life and/or property, including the right not to make downstream releases during such periods of time as are deemed necessary, in its sole discretion, to inspect, maintain, or repair the Project.

(d) Quality or Availability of Water. The User recognizes that this contract provides storage space for raw water only. The Government makes no representations with respect to the quality or availability of water and assumes no responsibility therefor, or for the treatment of the water.

(e) Sedimentation Surveys.

(1) Sedimentation surveys will be made by the Contracting Officer during the term of this contract at intervals not to exceed fifteen (15) years unless otherwise agreed to in writing by both parties. When, in the opinion of the

Contracting Officer, the findings of such survey indicate any project purpose will be affected by unanticipated sedimentation distribution, there shall be an equitable redistribution of the sediment reserve storage space among the purposes served by the Project including municipal and industrial water supply. The total available remaining storage space in the Project will then be divided among the various Project features in the same ratio as was initially utilized. Adjusted pool elevations will be rounded to the nearest one-half foot. Such findings and the storage space allocated to municipal and industrial water supply shall be defined and described as an exhibit which will be made a part of this contract and the reservoir regulation manual will be modified accordingly.

(2) The Government assumes no responsibility for deviations from estimated rates of sedimentation, or the distribution thereof. Such deviations may cause unequal distribution of sediment reserve storage greater than estimated, and/or encroachment on the total storage at the Project.

ARTICLE 2 - Regulation of and Right to Use of Water. The regulation of the use of water withdrawn or released from the aforesaid storage space shall be the sole responsibility of the User. The User has the full responsi-bility to acquire in accordance with State laws and regulations, and, if necessary, to establish or defend, any and all water rights needed for utilization of the storage provided under this contract. The Government shall not be responsible for diversions by others, nor will it become a party to any controversies involving the use of the storage space by the User except as such controversies may affect the operations of the Government.

ARTICLE 3 - Operation and Maintenance. The Government shall operate and maintain the Project and the User shall pay to the Government a share of the costs of such operation and maintenance as provided in Article 5. The User shall be responsible for operation and maintenance of all installations and facilities which it may construct for the diversion or withdrawal of water, and shall bear all costs of construction, operation and maintenance of such installations and facilities.

ARTICLE 4 - Measurement of Withdrawals and Releases. The User agrees to furnish and install, without cost to the Government, suitable meters or measuring devices satisfactory to the Contracting Officer for the measurement of water which is withdrawn from the Project by any means other than through the Project outlet works. The User shall furnish to the Government monthly statements of all such withdrawals. Prior to the construction of any facilities for withdrawal of water from the Project, the User will obtain the Contracting Officer's approval of the design, location and installation of the facilities including the meters or measuring devices. Such devices shall be available for inspection by Government representatives at all reasonable times. Releases from the water supply storage space through the Project outlet works shall be made in accordance with written schedules furnished by the User and approved by the Contracting Officer and shall be subject to Article 1(c). The measure of all such releases shall be by means of a rating curve of the outlet works, or by such other suitable means as may be agreed upon prior to use of the water supply storage space.

ARTICLE 5 - Payments. In consideration of the right to utilize the aforesaid storage space in the Project for municipal and industrial water supply purposes, the User shall pay the following sums to the Government:

(a) Construction cost.

(1) The User shall repay to the Government, at the times and with interest on the unpaid balance as hereinafter specified, $902,340 which, as shown in Exhibit "A" attached to and made a part of this contract, constitutes the updated cost (entire actual amount of the construction costs escalated to present day price levels by use of the Engineering News Record Construction Index effective at the beginning of the fiscal year in which the contract is approved) allocated to the water storage right acquired by the User under this contract. The interest rate to be used for purposes of computing interest on the unpaid balance will be determined by the Secretary of the Treasury on the basis set forth in the Water Supply Act of 1958, as amended. For this Project, water supply storage was added by reassignment of storage to the existing Project by the Government, and the interest rate shall be that rate in effect at the time the contract is approved. For FY 1985, such rate is 10.898 percent. Should the contract not be approved in FY 1985, the amount due herein will be adjusted to reflect the application of the appropriate rate.

(2) Segment No. 1. The updated cost allocated to the storage space indicated in Article 1(b)(1) as Segment No. 1 is $472,140, on the basis of the costs presented in Exhibit "A". The amount of the project investment costs allocated to Segment No. 1 shall be paid within the life of the Project in not to exceed 50 years from the plant-in-service date, 29 March 1965. The payments shall be in equal consecutive annual installments, the first of which shall be due and payable within 30 days after the date of first use of Segment

No. 1 or on 1 January 1988, whichever comes first. Annual installments thereafter will be due and payable on the anniversary date of the date of first use or 1 January 1988, whichever first occurs. Except for the first payment which will be applied solely to the retirement of principal, all installments shall include accrued interest on the unpaid balance at the rate provided above. The last annual installment shall be adjusted upward or downward when due to assure repayment of all of the updated cost allocated to Segment No. 1 within 50 years from the above date. A schedule of annual payments will be provided by the Contracting Officer when use of Segment No. 1 is started or 1 January 1988.

(3) Segment No. 2. The updated cost allocated to the remaining portion of the storage space, that indicated as Segment No. 2, is $430,200, on the basis of the costs presented in Exhibit "A". No principal or interest payment with respect to Segment No. 2 is required to be made prior to 1 January 1995 unless such storage is used prior to this date. Interest at the rate provided above will be charged on the amount of updated cost allocated to Segment No. 2 from the date of first use of Segment No. 1 or 1 January 1988, whichever comes first, until the time when Segment No. 2 is first used or 1 January 1995, whichever comes first. The User may at its option pay the interest as it becomes due or allow the interest to accumulate until Segment No. 2 is used or 1 January 1995, whichever comes first. If this latter option is exercised, the interest will be compounded annually and added to the principal amount. When Segment No. 2 is used or on 1 January 1995, whichever comes first, payment of both principal and interest for Segment No. 2 must be started, and the amount of the updated cost allocated thereto, with interest on the unpaid

balance as provided above, shall be paid within the life of the Project in not to exceed 50 years from the plant-in-service date, 29 March 1965. Payments shall be in equal consecutive annual installments commencing with the next anniversary of the payment date stipulated for Segment No. 1. The first payment shall include interest on the updated cost of Segment No. 2 from the date of first use or 1 January 1995, whichever comes first, to the next anniversary date of the payment date stipulated for Segment No. 1. The last annual installment for Segment No. 2 shall be adjusted upward or downward when due to assure repayment of all of the updated cost allocated to Segment No. 2 within the repayment period. A payment schedule for Segment No. 2 will be furnished by the Contracting Officer when use of such storage is started or 1 January 1995.

(b) Major Replacement Cost.

(1) Present Use Storage. After the date of first use of Segment No. 1 or 1 January 1988, whichever comes first, the User will be required to pay 0.451 percent of the cost of joint-use major replacement items.

(2) Payment. Payment of costs, including interest during construction, shall be made either incrementally during construction or in lump sum upon completion of construction. The interest rate to be used for computing interest during construction will be the interest rate as determined by the Secretary of the Treasury on the basis as set forth in the Water Supply Act of 1958, as amended, for use in the Government fiscal year in which the major capital replacement is initiated.

(c) Annual Operation and Maintenance (O&M) Expense.

(1) Present Use Storage. The User will be required to pay 0.451 percent of the annual experienced joint-use O&M expense of the Project.

(2) Payment. Payments for O&M expense are due and payable in advance on the date for payment of updated costs for Segment No. 1 as set forth in Article 5(a)(2) and shall be based on O&M expense for the Project in the Government fiscal year most recently ended. O&M expense for a portion of a year shall be prorated on the basis of the actual experienced joint-use O&M expense for that Government fiscal year.

(d) Major Rehabilitation Programs Costs. After the date of first use of Segment No. 1 or 1 January 1988, whichever comes first, the User will be required to pay 0.451 percent of the joint-use costs associated with major rehabilitation programs. Payments for the costs associated with the programs shall be in accordance with Article 5(b)(2).

(e) The User shall have the right at any time it so elects to prepay the indebtedness under this Article, in whole or in part, with accrued interest thereon to the date of such prepayment.

(f) Delinquent Payments. If the User shall fail to make any of the aforesaid payments when due, then the overdue payments shall bear interest compounded annually until paid. The interest rate to be used for overdue payments due under the provisions of Articles 5(a), 5(b), 5(c) and 5(d) above shall be that determined by the Department of Treasury's Treasury Fiscal Requirements Manual (1 TFRM 6-8000, "Cash Management"). The amount charged on

payments overdue for a period of less than one year shall be figured on a monthly basis. For example, if the payment is made within the first month after being overdue after a 15-day grace period from the anniversary date of the date of notification, one month's interest shall be charged. Thereafter a month's interest will be charged for any portion of each succeeding month that the payment is delinquent. This provision shall not be construed as giving the User a choice of either making payments when due or paying interest, nor shall it be construed as waiving any other rights of the Government, at law or in equity, which might result from any default by the User.

ARTICLE 6 - Duration of Contract. This contract shall become effective when approved by the Secretary of the Army or his duly authorized representative and shall continue in full force and effect for the life of the Project.

ARTICLE 7 - Permanent Rights to Storage. Upon completion of payments by the User, as provided in Article 5(a) herein, the User shall have a permanent right, under the provisions of the Act of 16 October 1963 (Public Law 88-140, 43 U.S.C. 390e), to the use of the water supply storage space in the Project as provided in Article 1, subject to the following:

(a) The User shall continue payment of annual operation and maintenance costs allocated to water supply.

(b) The User shall bear the costs allocated to water supply of any necessary reconstruction, rehabilitation, or replacement of Project features which may be required to continue satisfactory operation of the Project. Such costs will be established by the Contracting Officer and repayment arrange-

ments shall be in writing in accordance with the terms and conditions set forth in Article 5(b)(2) for Major Replacement Costs, and be made a part of this contract.

(c) Upon completion of payments by the User as provided in Article 5(a), the Contracting Officer shall redetermine the storage space for municipal and industrial water supply in accordance with the provisions of Article 1(e). Such redetermination of reservoir storage capacity may be further adjusted from time to time as the result of sedimentation resurveys to reflect actual rates of sedimentation and the exhibit revised to show the revised storage space allocated to municipal and industrial water supply.

(d) The permanent rights of the User under this contract shall be continued so long as the Government continues to operate the Project. In the event the Government no longer operates the Project, such rights may be continued subject to the execution of a separate contract, or additional supplemental agreement providing for:

(1) Continued operation by the User of such part of the facility as is necessary for utilization of the water supply storage space allocated to it;

(2) Terms which will protect the public interest; and

(3) Effective absolvement of the Government by the User from all liability in connection with such continued operation.

ARTICLE 8 - Release of Claims. The User shall hold and save the Govern-ment, including its officers, agents and employees harmless from liability of any

nature or kind for or on account of any claim for damages which may be filed or asserted as a result of the storage in the Project, or withdrawal or release of water from the Project, made or ordered by the User or as a result of the construction, operation, or maintenance of the water supply facilities and appurtenances thereto owned and operated by the User except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE 9 - Assignment. The User shall not transfer or assign this contract or any rights acquired thereunder, nor suballot said water supply storage space or any part thereof, nor grant any interest, privilege or license whatsoever in connection with this contract, without the approval of the Secretary of the Army, or his duly authorized representative, provided that, unless contrary to the public interest, this restriction shall not be construed to apply to any water that may be obtained from the water supply storage space by the User and furnished to any third party or parties, nor any method of allocation thereof.

ARTICLE 10 - Officials Not to Benefit. No member of or delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 11 - Covenant Against Contingent Fees. The User warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee excepting bona fide employees or bona fide

established commercial or selling agencies maintained by the User for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to add to the contract price or consideration, or otherwise recover the full amount of such commission, percentage, broker-age, or contingent fee.

ARTICLE 12 - Environmental Quality. During any construction, operation, and maintenance by User of any facilities, specific actions will be taken to control environmental pollution which could result from such activity and to comply with applicable Federal, State, and local laws and regulations concerning environmental pollution. Particular attention should be given to (1) reduction of air pollution by control by burning, minimization of dust, containment of chemical vapors, and control of engine exhaust gases, and of smoke from temporary heaters; (2) reduction of water pollution by control of sanitary facilities, storage of fuels and other contami-nants, and control of turbidity and siltation from erosion; (3) minimiza-tion of noise levels; (4) onsite and offsite disposal of waste and spoil; and (5) prevention of landscape defacement and damage.

ARTICLE 13 - Federal and State Laws.

(a) In acting under its rights and obligations hereunder, the User agrees to comply with all applicable Federal and State laws and regulations, including but not limited to the provisions of the Davis-Bacon Act (40 U.S.C. 276a et seq.); the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333); Title 29, Code of Federal Regulations, Part 3; and Sections 210 and

305 of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (PL 91-646).

(b) The User furnishes, as part of this contract, an assurance (Exhibit C) that it will comply with Title VI of the Civil Rights Act of 1964 (78 Stat. 241, 42 U.S.C. 2000d, et seq.) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

(c) Any discharges of water or pollutants into a navigable stream or tributary thereof resulting from the User's facilities and operations undertaken under this contract shall be performed only in accordance with applicable Federal, State, and local laws and regulations.

ARTICLE 14 - Definitions.

(a) Project investment costs - The initial cost of the Project, including: land acquisition; construction; interest during construction on the value of land, labor, and materials used for planning and construction of the Project.

(b) Interest during construction - An amount of interest which accrues on expenditures during the period between the actual outlay and the time the construction is completed.

(c) Specific costs - The costs of Project features normally serving only one particular project purpose.

(d) Joint-use costs - The costs of features used for any two or more Project purposes.

(e) Major Rehabilitation - This program is to facilitate accomplishment of significant, costly, infrequent rehabilitation work at the Project without unduly distorting the Operation and Maintenance, General budget.

(f) Annual operation and maintenance (O&M) expense - Annual expenses funded under the O&M, General account. These expenses include the daily project O&M costs as well as those O&M costs which are capitalized.

(g) Major replacement cost - Costs funded under the Construction, General account but not associated with initial Project investment costs.

(h) Fiscal Year - Refers to the Government's fiscal year. This year begins on 1 October and ends on 30 September.

(i) Life of the Project - This is the physical life of the Project.

ARTICLE 15 - Approval of Contract. This contract shall be subject to the written approval of the Secretary of the Army or his duly authorized representative and shall not be binding until so approved.

IN WITNESS WHEREOF, the parties have executed this contract as of the day and year first above written.

APPROVED:

THE UNITED STATES OF AMERICA

_____

By _____

Assistant Secretary of the Army
(Civil Works)

(Contracting Officer)

DATE: _____

THE LOWER NECHES VALLEY AUTHORITY

By _____

CONTRACT NO. DACW63-85-C- _ _ _ _

SAM RAYBURN RESERVOIR

EXHIBIT A

I - RESERVOIR STORAGE

Feature	Elevation (ft - msl)	Usable Storage[1/] (acre-feet)	Percent of Usable Storage	Percent of Usable Conservation Storage
Flood control	173.0 - 164.5	1,087,960	42.739	
Conservation	164.5 - 149.0	1,457,640	57.261	100.000
Water Supply		(54,467)	(2.140)	(3.737)
User		[11,467]	[0.451]	[0.787]
City of Lufkin[2/]		[43,000]	[1.689]	[2.950]
Other Purposes		(1,403,173)	(55.121)	(96.263)
Totals		2,545,600	100.000	

1/ Storage remaining after 50 years of sedimentation from date of impoundment, March 1965.

2/ This storage covered by Contract No. DACW63-69-C-0007, approved by Secretary of the Army, 27 May 1969.

A-1

SAM RAYBURN RESERVOIR

EXHIBIT A (Cont'd)

II - ALLOCATION OF ORIGINAL CONSTRUCTION COST

Construction costs		$63,316,343.19
Specific power cost	$15,531,548.66	
Specific water supply cost	0	
Specific flood control cost	0	
Specific recreation cost	5,704,122.49	
Specific road betterments cost	965,000.00	
Total Specific Costs		$22,200,671.15
Total Joint-use Cost		$41,115,672.04

A-2

SAM RAYBURN RESERVOIR

EXHIBIT A (Cont'd)

III - DETERMINATION OF UPDATED COST OF THE WATER CONSERVATION STORAGE (REALLOCATED FLOOD CONTROL STORAGE) TO BE PAID BY USER

Update Cost = Original Cost x Updating Factor

Original Cost = Original Joint-Use Cost x $\frac{\text{Storage Reallocated}}{\text{Total Usable Storage}}$

Original Cost = \$41,115,672.04 x $\frac{11{,}467 \text{ acre-feet}}{2{,}545{,}600 \text{ acre-feet}}$

Original Cost = \$185,210

Updating Factor = Engineering News Record Construction Index at the midpoint of the original physical construction period compared to the index at the beginning of the fiscal year the contract for reallocated storage is approved.

Updating Factor = $\frac{\text{Index for October 1984}}{\text{Index for September 1961}} = \frac{4160.9}{854.01}$

Updating Factor = 4.872

Therefore:

Updated Cost = \$185,210 x 4.872

Updated Cost = \$902,340

Segment No. 1 Updated Cost = $\frac{6{,}000 \text{ acre-feet}}{11{,}467 \text{ acre-feet}}$ x \$902,340

Segment No. 1 Updated Cost = \$472,140

Segment No. 2 Updated Cost = $\frac{5{,}467 \text{ acre-feet}}{11{,}467 \text{ acre-feet}}$ x \$902,340

Segment No. 2 Updated Cost = \$430,200

SAM RAYBURN RESERVOIR

EXHIBIT A (Cont'd)

IV - ALLOCATION OF OPERATION AND MAINTENANCE COST TO BE PAID BY USER FOR WATER SUPPLY STORAGE

Annual operation and maintenance (O&M) cost to be paid by user:

Percentage of total annual joint-use O&M cost:

11,467 ac-ft/2,545,600 ac-ft = 0.451%

Estimated annual O&M charge 3/

Total FY 1984 O&M cost	$2,931,300
Less FY 1984 specific O&M cost	2,224,080
FY 1984 joint-use O&M cost	$ 707,220

0.451% x 707,220 = $3,190

3/ Based on actual experienced O&M costs for FY 1984, excluding Jobs Bill (Public Law 98-8) costs.

SAM RAYBURN RESERVOIR

AMORTIZATION SCHEDLE FOR SEGMENT NO.1

(6000 ACRE-FEET)

Annual Payment Due on or Before January 1, 1988

PRINCIPAL - $ 472140.00
NUMBER OF PAYMENTS - 28
INTEREST RATE - 10.8980 %

PMT. NO.	TOTAL PAYMENT	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	BALANCE DUE
1	49109.50	0.00	49109.50	423030.50
2	49109.50	46101.86	3007.64	420022.86
3	49109.50	45774.09	3335.41	416687.45
4	49109.50	45410.60	3698.90	412988.55
5	49109.50	45007.49	4102.01	408886.54
6	49109.50	44560.46	4549.04	404337.50
7	49109.50	44064.70	5044.80	399292.70
8	49109.50	43514.92	5594.58	393698.12
9	49109.50	42905.22	6204.28	387493.84
10	49109.50	42229.08	6880.42	380613.42
11	49109.50	41479.25	7630.25	372983.17
12	49109.50	40647.71	8461.79	364521.38
13	49109.50	39725.54	9383.96	355137.42
14	49109.50	38702.88	10406.62	344730.80
15	49109.50	37568.76	11540.74	333190.06
16	49109.50	36311.05	12798.45	320391.61
17	49109.50	34916.28	14193.22	306198.39
18	49109.50	33369.50	15740.00	290458.39
19	49109.50	31654.16	17455.34	273003.05
20	49109.50	29751.87	19357.63	253645.42
21	49109.50	27642.26	21467.22	232178.20
22	49109.50	25302.78	23806.72	208371.48
23	49109.50	22708.32	26401.18	181970.30
24	49109.50	19831.12	29278.38	152691.91
25	49109.50	16640.37	32469.13	120222.79
26	49109.50	13101.88	36007.62	84215.17
27	49109.50	9177.77	39931.73	44283.44
28	49109.45	4826.01	44283.44	.00

20 yr - 2¼ % - $43,275

$92,203

902,340

SAM RAYBURN RESERVOIR
AMORTIZATION SCHEDULE FOR SEGMENT 0.2
(5467 ACRE-FEET)
Annual Payments Due on or Before January 1, 1995

PRINCIPAL - $ 887435.00
NUMBER OF PAYMENTS - 21
INTEREST RATE - 10.8980 %

PMT. NO.	TOTAL PAYMENT	PAYMENT TO INTEREST	PAYMENT TO PRINCIPAL	BALANCE DUE
1	98420.82	0.00	98420.82	789014.18
2	98420.82	85986.77	12434.05	776580.13
3	98420.82	84631.70	13789.12	762791.01
4	98420.82	83128.96	15291.86	747499.15
5	98420.82	81462.46	16958.36	730540.79
6	98420.82	79614.34	18806.48	711734.31
7	98420.82	77564.81	20856.01	690878.30
8	98420.82	75291.92	23128.90	667749.40
9	98420.82	72771.33	25649.49	642099.91
10	98420.82	69976.05	28444.77	613655.14
11	98420.82	66876.14	31544.68	582110.46
12	98420.82	63438.40	34982.42	547128.04
13	98420.82	59636.01	38784.81	508333.23
14	98420.82	55398.16	43022.66	465310.57
15	98420.82	50709.55	47711.27	417599.30
16	98420.82	45509.97	52910.85	364688.45
17	98420.82	39743.75	58677.07	306011.38
18	98420.82	33349.12	65071.70	240939.68
19	98420.82	26257.61	72163.21	168776.47
20	98420.82	18393.26	80027.56	88748.91
21	98420.77	9671.86	88748.91	.00

SAM RAYBURN RESERVOIR

EXHIBIT B

CERTIFICATION

I _____, Attorney for the Lower Neches Valley Authority, hereby certify that the foregoing agreement executed by _____, of the Lower Neches Valley Authority, is within the scope of his authority to act upon behalf of the Lower Neches Valley Authority, and that in my capacity as Attorney for the User, I have considered the legal effect of Section 221 of the 1970 Flood Control Act (Public Law 91-611) and find that the User is legally and financially capable of entering into the contractual obligations contained in the foregoing agreement and that, upon acceptance, it will be legally enforceable.

Given under my hand, this _____ day of _____ 19__

_____
Attorney for the
Lower Neches Valley Authority

SAM RAYBURN RESERVOIR

EXHIBIT C

ASSURANCE OF COMPLIANCE WITH THE
DEPARTMENT OF DEFENSE DIRECTIVE UNDER
TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

The Lower Neches Valley Authority (hereinafter called "Applicant-Recipient") HEREBY AGREES THAT it will comply with title VI of the Civil Rights Act of 1964 (Public Law 88-352) and all requirements imposed by or pursuant to the Directive of the Department of Defense (32 CFR Part 300, issued as Department of Defense Directive 5500.11, December 28, 1964) issued pursuant to that title, to the end that, in accordance with title VI of that Act and the Directive, no person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under, any program or activity for which the Applicant-Recipient receives Federal financial assistance from the U.S. Army Corps of Engineers and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant-Recipient by the U.S. Army Corps of Engineers, assurance shall obligate the Applicant-Recipient, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant-Recipient for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant-Recipient for the period during which the Federal financial assistance is extended to it by the U.S. Army Corps of Engineers.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts, property, discounts, or other Federal financial assistance extended after the date hereof to the Applicant-Recipient by the Department, including installment payments after such date on account of arrangements for Federal financial assistance which were approved before such date.

The Applicant-Recipient recognizes and agrees that such Federal assistance will be extended in reliance on the representations and agreements made in the assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant-Recipient, its successors, transferees, and assignees; and the person or persons whose signatures appear below are authorized to sign this assurance on behalf of the Applicant-Recipient.

LOWER NECHES VALLEY AUTHORITY

Dated _____ By _____

ATTEST:

_____

APPENDIX G

ORGANIZATION AND FINANCING CONSIDERATIONS

FIRST Southwest COMPANY
INVESTMENT BANKERS
OAK FOREST CENTER — SUITE 403
911 NORTHWEST LOOP 281, No. 31
LONGVIEW, TEXAS 75604

MICHAEL D. BYRD
VICE PRESIDENT

OFFICE: (214) 297-4994
FAX: (214) 297-4544

July 7, 1989

Mr. Jim Griffith
Everett Griffith and Associates, Inc.
Post Office Box 1746
Lufkin, Texas 75901

Re: Angelina County Water Study, dated July 1989.

Dear Jim:

You've advised the captioned study is to determine water supply requirements for both municipal entities and water supply corporations within the county, and you've inquired as to financing vehicles available to those entities should all or a portion of them desire to join together in construction of additional water supply.

Basically three options exist: (1) sole ownership of the project with one entity financing, constructing, and managing the facilities and selling the product to the other entities through contractual arrangements, (2) joint ownership whereby each entity individually finances its proportionate share of construction, the entities in the aggregate appointing one (or more) member(s) by a participation agreement to oversee construction and manage the facilities, and (3) common ownership, whereby the member entities create a common organization for the purpose of financing, constructing, and managing the facilities.

A primary concern in structuring a financing vehicle for the aforementioned entities is to maintain tax-exempt status for the debt instruments. Water supply corporations, as a general rule, do not issue debt on a tax-exempt basis. Municipalities may issue tax-exempt debt for a project such as a county-wide water supply and the project can provide water to water supply corporations, provided the water supply corporations do not derive more than ten percent of the projects benefit. Should the corporations derive more than ten percent of the projects benefit, tax-exempt status of debt instruments issued to finance the project could be affected.

Variations exist within each of the three aforementioned general options. While there is never a perfect solution, I believe further study and analysis will indicate the collective interests of the participants will likely be best-served by following option three and creating an entity by act of the Legislature for the purposes of financing, constructing, and managing the water supply facilities, such entity being specifically tailored to meet the needs of the participants.

While expressing my preference for the latter option, I acknowledge that much ground is yet to be covered which may eventually lead us in another direction. I've only scratched the surface herein and suggest that at such time as the Study Committee finds that the project should move forward, I, and perhaps bond counsel, meet with the committee to more fully expound on available options and begin the process of arriving at the most satisfying solution.

I appreciate this opportunity to provide some early input into your study and ask that you feel free to call upon me should you believe that I may be of service to you or the Study Committee.

Very truly yours,

Michael D. Byrd

FLOURNOY, DEATON & STEPHENS
ATTORNEYS AT LAW

ROBERT L. FLOURNOY
THOMAS W. DEATON
W. DAVID STEPHENS

P.O. BOX 1546
118 SOUTH SECOND
LUFKIN, TEXAS 75901
(409) 639-4466

November 25, 1987

Mayor Pitser Garrison
Members, City Commission

Gentlemen:

Pursuant to your request for a recommendation for a proper vehicle for a cooperative effort between the City of Lufkin, other municipalities and rural water districts in Angelina County to take water from Sam Rayburn Reservoir, I have done considerable research and talked to numerous people. I talked first to Mr. Carl Reihn, the Executive Director of the North Texas Municipal Water District; Leroy Goodson, General Manager of the Texas Water Conservation Association; David Welsch, with the Guadalupe-Blanco River Authority; Chuck Thomas with the Angelina-Neches River Authority; and John Stover, attorney in Austin, specializing in water rights.

I think that this would best be accomplished by the City of Lufkin and the other interested entities entering into an interlocal agreement as allowed by Art. 4413 (32c) §5 of V.A.T.S. to provide for obtaining or providing water supply. Under the agreement, jointly, the group could then form a Special Utility District or a Municipal Utility District to construct and operate the water facility. It could issue revenue bonds based on the strength of the contracting entities. Each city or water district would have a contract with the S.U.D. or the M.U.D. to purchase water.

It is also possible for the entities that enter into the interlocal agreement to contract with an existing entity such as the Angelina-Neches River Authority to construct and operate a facility and sell water to each of those cooperating entities.

Whatever operating entity is chosen, it would be able to issue revenue bonds and sell them either to the Texas Water Development Board or to the general market. It might also be able to obtain loans from the F.H.A. and/or obtain a government grant. The cooperating cities or water districts would have to enter into a "take or pay" contract with the issuing authority. These would be strictly revenue bonds and not tax bonds.

It seems to me that it would be much more difficult to create a Water Control and Improvement District with taxing authority because of the dislike for any additional taxes. The creation of a Water Control and Improvement District, which is another alternative could only be created by election of the populace within that district.

If you have further questions concerning my recommendation, please call me.

Thank you.

Yours truly,

Robert L. Flournoy
RLF:sk

APPENDIX H

PROPOSED TRANSMISSION LINES AND TAKE POINTS

Angelina County Regional Water Study
Contract #8-483-619

The following maps are not attached to this report. They are located in the official file and may be copied upon request.

Map 1 – Proposed Water Transmission Line Segment Map Figure 8-7

Map 2 – Lufkin Water Distribution System – Recommended Improvements Figure B-1

Map 3 – proposed Transmission Lines and Take Points for Alternates No. 1 and No.2 – Figure H-1

Please contact Research and Planning Fund Grants Management Division at (512) 463-7926 for copies.