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WATER USE, PROJECTED WATER REQUIREMENTS, AND RELATED DATA AND INFORMATION FOR THE METROPOLITAN STATISTICAL AREAS IN TEXAS

LP-201

TEXAS DEPARTMENT OF WATER RESOURCES

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ABSTRACT

Currently, Texas has twenty-seven (27) Metropolitan Statistical Areas (MSAs) consisting of forty-nine (49) of the State's largest counties having thirty-seven (37) of the State's largest cities. Each of the MSAs is a growing urban center which during the next fifty (50) years will be expected to need a steadily increasing dependable annual supply of water having good quality. In 1980, the twenty-seven (27) MSAs used approximately 3.6 million acre-feet of water with 1.1 million acre-feet or 31 percent from ground-water resources and 2.5 million acre-feet or 69 percent from surface-water resources. In the years 2000 and 2030, respectively, water needs in these urban centers under drought conditions are expected to be 6.5 and 11.1 million acre-feet. To effectively use and protect ground-water supplies and yet meet the urban water needs of the MSAs, it will be necessary to develop and use available surface-water resources. In the years 2000 and 2030, respectively, approximately 83 and 90 percent of the MSA's water needs are expected to be supplied by surface-water resources. The report provides current and projected data and information on each of the twenty-seven (27) MSAs with respect to economic, population and employment conditions, water quality management planning, floodplain management, water needs and supply, and water supply outlook and problems.

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WATER USE, PROJECTED WATER REQUIREMENTS, AND RELATED DATA AND INFORMATION FOR THE METROPOLITAN STATISTICAL AREAS IN TEXAS

Introduction

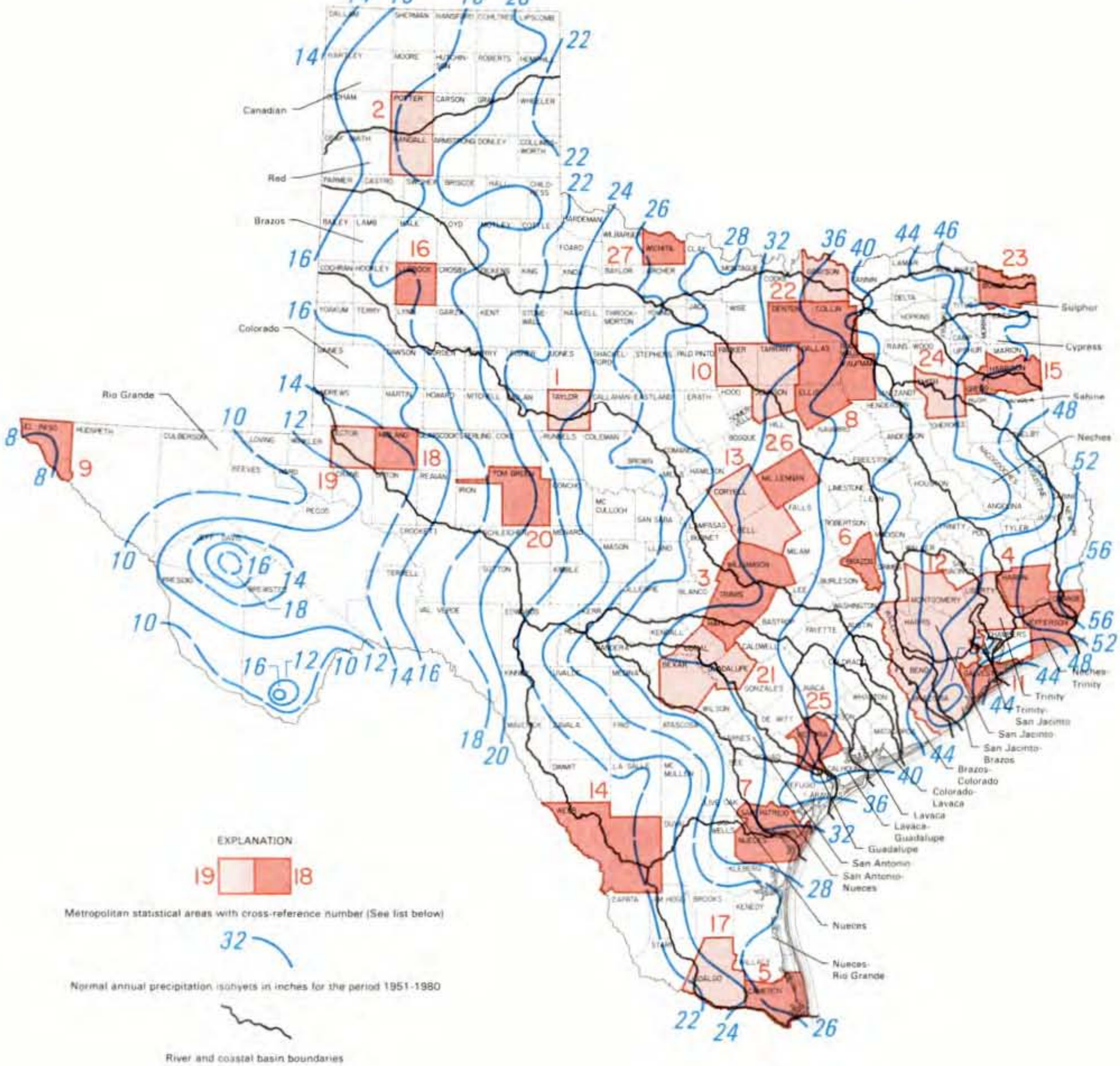
The purpose of this report is to present current and projected water resources data and related information for Texas and for each of the twenty-seven (27) Metropolitan Statistical Areas (MSAs) in Texas. The twenty-seven (27) MSAs are located and cross-referenced on Figure 1 which also shows the location of the MSAs in relation to the State's twenty-three (23) river and coastal basins and the distribution of normal annual precipitation within the State. The twenty-seven (27) MSAs consist of forty-nine (49) of the State's 254 counties, thirty-seven (37) of the State's largest cities, and about 46.1 thousand square miles or 17.2 percent of the land and water area of the State (267.3 thousand square miles). The following discussion presents a statewide perspective on water resources, their development and use, water quality management planning, floodplain management, water supply and demand information for each of the MSAs, and the State, and water supply outlook and problems in Texas and in each of the MSAs.

Statewide Perspective

Texas has fifteen (15) major river basins and eight (8) coastal basins (Figures 1 and 2) which have approximately 3,700 designated streams and tributaries and more than 80,000 miles of streambed. Average annual runoff or streamflow is about 49 million acre-feet (one acre-foot of water is 325,851 gallons). Runoff ranges from about 1,100 acre-feet per square mile at the Texas-Louisiana border to practically zero (0) in parts of the Trans-Pecos Region of far West Texas. From 1940 through 1970, statewide runoff averaged 57 million acre-feet per year during the wettest period (1940-1950), and 23 million acre-feet per year during the severe drought of the early and mid-1950's.

Surface-Water Resource Development and Use

Currently, Texas has 184 major reservoirs (36-Federal and 148-non-Federal) with 5,000 acre-feet or greater total capacity (Figure 2, reservoirs in solid brown, solid blue and stippled in blue). In addition, there are 5 reservoirs presently under construction (4-Federal and 1-non-Federal) (Figure 2, reservoirs outlined in blue). Conservation storage capacity in major reservoirs and reservoirs under construction totals about 32.3 million acre-feet. Flood control storage capacity totals about 17.5 million acre-feet. The dependable (firm) yield from major reservoirs is about 11 million acre-feet annually; i.e., the uniform yield which can be withdrawn annually through extended drought periods.



MSAs in Texas
(Effective June 30, 1983)

	Name of MSA	County(s) in MSA		Name of MSA	County(s) in MSA
1.	Abilene	Taylor	14.	Laredo	Webb
2.	Amarillo	Potter, Randall	15.	Longview-Marshall	Gregg, Harrison
3.	Austin	Hays, Travis, Williamson	16.	Lubbock	Lubbock
4.	Beaumont-Port Arthur	Hardin, Jefferson, Orange	17.	McAllen-Edinburg-Mission	Hidalgo
5.	Brownsville-Harlingen	Cameron	18.	Midland	Midland
6.	Bryan-College Station	Brazos	19.	Odessa	Ector
7.	Corpus Christi	Nueces, San Patricio	20.	San Angelo	Tom Green
8.	Dallas	Collin, Dallas, Denton, Ellis, Kaufman, Rockwall	21.	San Antonio	Bexar, Comal, Guadalupe
9.	El Paso	El Paso	22.	Sherman-Denison	Grayson
10.	Fort Worth-Arlington	Johnson, Parker, Tarrant	23.	Texarkana	Bowie
11.	Galveston-Texas City	Galveston	24.	Tyler	Smith
12.	Houston	Brazoria, Fort Bend, Harris, Liberty, Montgomery, Waller	25.	Victoria	Victoria
13.	Killeen-Temple	Bell, Coryell	26.	Waco	McLennan
			27.	Wichita Falls	Wichita

Figure 1
Metropolitan Statistical Areas and Distribution of Normal Annual Precipitation in Texas

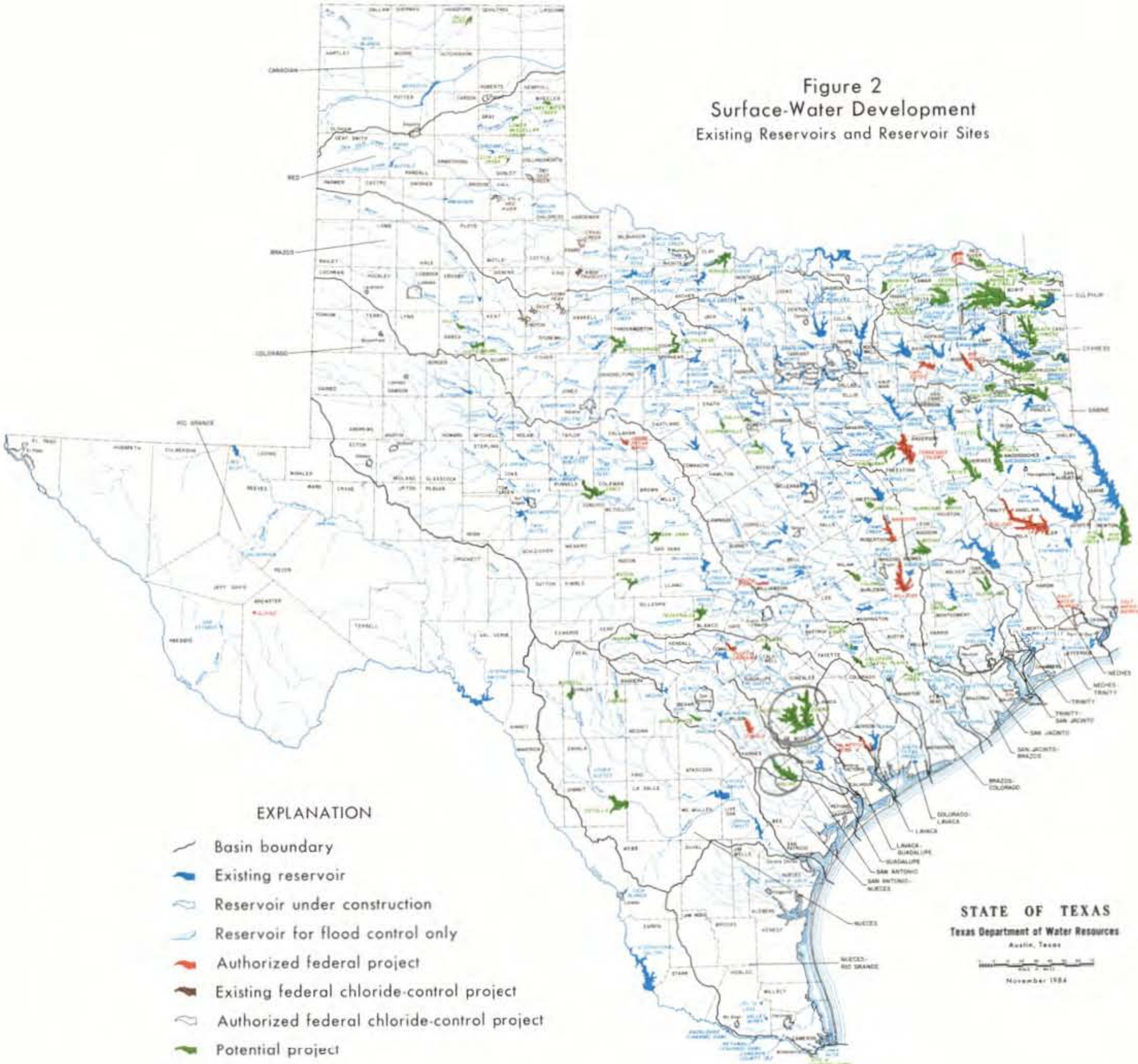


Figure 2
Surface-Water Development
Existing Reservoirs and Reservoir Sites
EXPLANATION
Basin boundary
Existing reservoir
Reservoir under construction
Reservoir for flood control only
Authorized federal project
Existing federal chloride-control project
Authorized federal chloride-control project
Potential project
STATE OF TEXAS
Texas Department of Water Resources
Austin, Texas
November 1984

Currently, Texas has 65 potential reservoir projects of which 19 are authorized Federal projects (Figure 2, reservoirs in red and outlined in brown), and 46 are potential Federal/State/local projects (Figure 2, reservoirs in green). Included in the 46 potential projects are reservoir enlargements of Lakes Wright Patman (Sulphur River Basin) and Caddo (Cypress Creek Basin). About 4.3 million acre-feet per year of additional dependable surface-water yield can be developed with construction of these 65 potential reservoir projects.

In 1980, Texans used about 7.00 million acre-feet or 64 percent of the 11 million acre-feet of dependable surface-water supply available. Of the 7.00 million acre-feet of surface water used, about 21.7 percent was for municipal uses, 18.1 percent was for manufacturing purposes, 4.0 percent was for steam-electric power generation (consumptive use for cooling), 0.8 percent was for mining, 1.8 percent was for livestock watering, and 53.6 percent was for irrigation.

A large portion of the remaining 4.0 million acre-feet of current dependable surface-water supply is committed or planned for municipalities and industries to meet growing municipal and industrial needs of major metropolitan areas of the State during the foreseeable 20 to 30 year period of time. However, this quantity of supply will not meet all of the municipal and industrial needs in the foreseeable future; i.e., many cities in the central, south, north central, and west Texas areas have practically no dependable surface-water supplies that are unused at the present time, and projections show that many cities in eastern portions of the State will need additional surface-water supplies in the immediate future.

In the central, south, north central, and west Texas areas, annual precipitation is low, in comparison to precipitation rates in eastern portions of the State. Thus, surface-water flows are relatively low per square mile of land area, total surface-water supplies are smaller, and the supply is less reliable on an annual basis. In addition, the quality of available supplies is lowered due to natural sources of salt and minerals. However, additional supply can be developed locally in some of these areas through construction of the few remaining undeveloped reservoir sites, through construction of chloride control structures to keep saline flows from entering streams, and perhaps through desalting of brackish surface and ground waters of some of these areas.

Ground-Water Resource Development and Use

More than fifty (50) percent of Texas is underlain by seven (7) major aquifers (Figure 3) and sixteen (16) minor aquifers (Figure 4). The seven (7) major aquifers and the sixteen (16) minor aquifers have a total average annual natural recharge of about 5.3 million acre-feet. Six (6) aquifers (4 major and 2 minor) are known to have a total recoverable reserve or storage of about 430 million acre-feet, of which about 90 percent or 385 million acre-feet are in the High Plains (Ogallala) Aquifer.

Figure 3
Major Aquifers

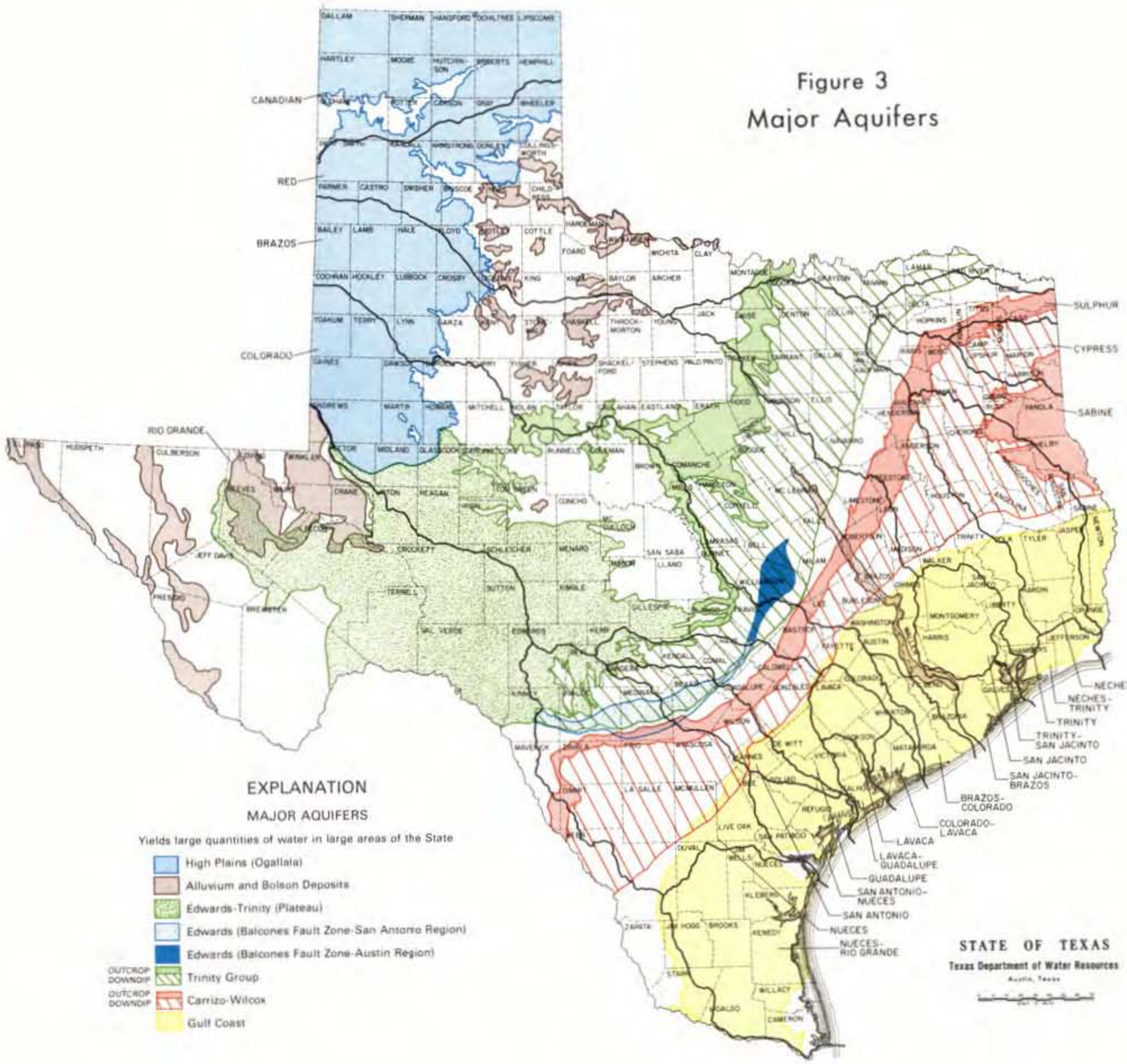
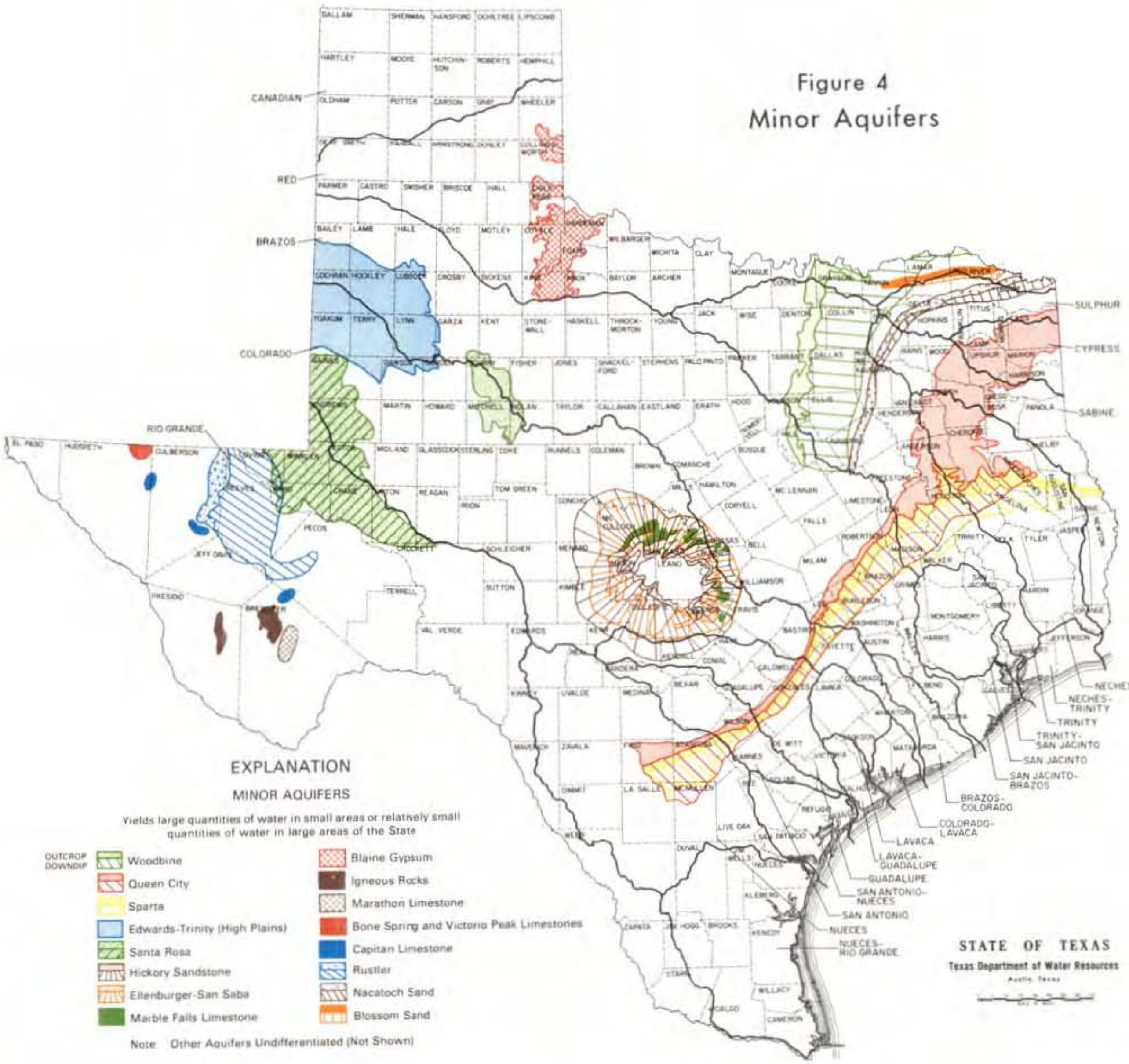


Figure 4
Minor Aquifers



In 1980, Texans used about 17.85 million acre-feet of water annually, of which about 10.85 million acre-feet were from ground-water sources. Of the 10.85 million acre-feet of ground water used, 11.9 percent or 1.29 million acre-feet were for municipal uses, 2.3 percent or 249 thousand acre-feet were for manufacturing purposes, 0.5 percent or 53.0 thousand acre-feet were for steam-electric power generation (consumptive use for cooling), 1.6 percent or 178 thousand acre-feet were for mining, 1.1 percent or 120 thousand acre-feet were for livestock watering, and 82.6 percent or 8.96 million acre-feet were for irrigation. According to 1980 water-use statistics obtained from annual water-use surveys of the municipalities of Texas, about 46 percent of municipal water is obtained from ground-water sources. Ground water is used for municipal purposes in all areas of Texas and in practically every county. However, in many areas, the long term use of well fields is lowering water levels to such an extent that major water supply problems are occurring or are projected to occur in the foreseeable future. Thus, there is a need to develop surface-water supplies to supplement ground-water supplies.

Water Quality and Water Quality Management Planning

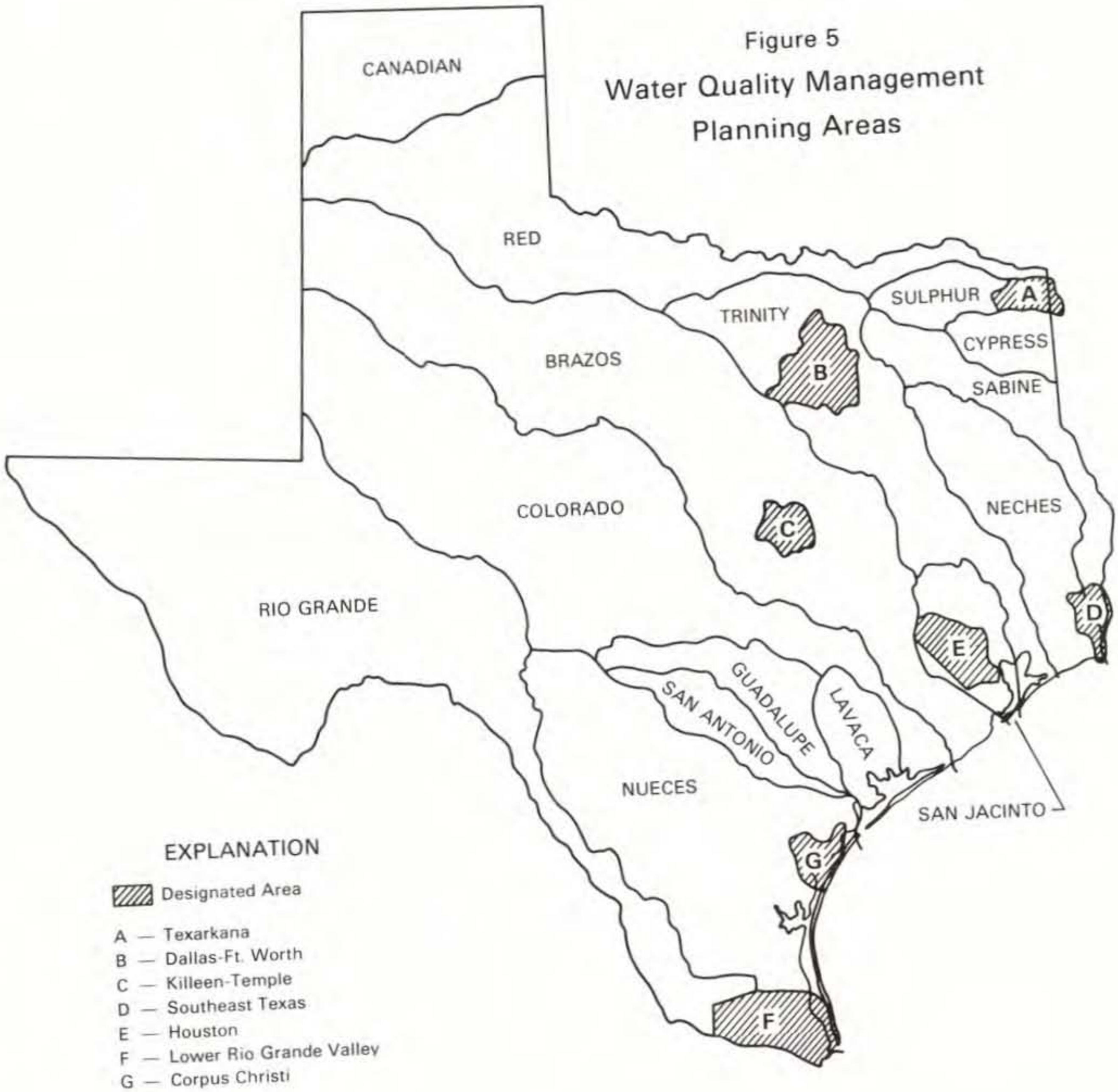
Since many areas of Texas are water-short, the maintenance or recovery of the quality of the State's limited water supplies is absolutely essential. Recognition of this fact occurred years ago and led to the passage of the Texas Water Quality Act in 1967 which resulted in a water quality management program that contained the basic elements included in the Federal Water Quality Program.

Texas has had an instream water quality monitoring program since 1956 and water quality standards (stream standards) since 1967. These water quality standards define the quality of water necessary in each stream to provide for all the beneficial uses that are deemed desirable for a given stream. Of the nearly 16,000 stream miles subject to water quality standards, about 91 percent currently meet those standards.

Basic water quality management planning and areawide waste treatment and management studies were begun in 1967 and were essentially complete when the Federal Water Pollution Control Act of 1972 was passed. Following passage of the Federal Act, basin planning and waste load evaluation studies were accelerated. When additional funding was made available through Section 208 of the Federal Clean Water Act, (Appendix A), Texas' planning process was reoriented to meet the requirements of the Federal Act and to provide the information and framework to insure that the national goals stated in the Act were met.

In mid-1975, the Governor designated eight urban areas of the State as areas in which intensive planning was to be done and selection of the designated planning entity (the local regional council) for each area was made. Later one area was removed from the designation which resulted in the seven designated urban areas (Figure 5). The Texas Department of Water Resources was assigned the responsibility for

Figure 5
Water Quality Management
Planning Areas



insuring statewide consistency and acceptability of the plans developed by the local entities. The Department was also assigned the responsibility for developing updated water quality management plans for the remaining or nondesignated areas of the State.

Water quality management plans covering all designated and undesignated areas of the State have received Environmental Protection Agency approval. The approved plans are kept current through periodic reviews, and are revised when necessary, under a continuing planning process. Funding is presently provided through a reserve from the State's construction grants allocation as set forth in Section 205(j) of the 1981 Amendments to the Federal Clean Water Act (Appendix B). These water quality management plans define the actions that will be taken by the State, public/private wastewater dischargers, and local agencies in order to attain water quality goals and protect the State's streams, rivers, lakes and estuaries from degradation. Significant portions of these plans are already being implemented at this time through the construction grants and permits programs and will, with updating to reflect changing conditions, be relied upon to protect the quality of Texas' valuable water resources.

Floodplain Management

All of the 254 counties in Texas have been designated by the Federal Emergency Management Agency to have some flood prone areas. Flood hazard boundary maps which identify flood-prone areas have been published for most of the counties and many of the cities within the twenty-seven (27) MSAs (Appendix C). Also, many of the counties and cities within the MSAs have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplains, and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would perhaps help to assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies presently in various stages of completion within the MSAs will supply detailed 10-year, 50-year, 100-year, and 500-year flood event data (Appendix C).

Population and Employment Data for Texas

Effective planning of water resource development projects requires the estimation and projection of future population and economic conditions. Population and employment for MSA counties, other counties and State totals are provided in Tables 1 and 2. The population of the State grew by over 27 percent in the decade from 1970 to 1980, a substantial increase from the 17 percent growth of the previous decade. Texas now ranks third among the 50 states in total

Table 1. Texas Population

Area	1960[1]	1970[1]	1980[1]	Series	Projections[2] 1990	2000	2010	2020	2030
	------(Millions)------				---------------(Millions)-------------				
MSA Counties									
Urban	6.1	7.6	9.5	Low	11.3	13.1	14.9	16.8	18.9
				High	11.9	14.2	16.5	19.5	23.0
Other	1.0	1.1	1.8	Low	2.2	2.8	3.3	3.7	4.3
				High	2.4	3.1	3.8	4.5	5.5
Totals	7.1	8.7	11.3	Low	13.5	15.9	18.2	20.5	23.2
				High	14.3	17.3	20.3	24.0	28.5
Other Counties									
Urban	1.4	1.4	1.6	Low	1.9	2.2	2.4	2.7	3.0
				High	2.0	2.3	2.6	3.0	3.4
Other	1.1	1.1	1.3	Low	1.3	1.5	1.7	1.9	2.1
				High	1.5	1.6	1.9	2.1	2.4
Totals	2.5	2.5	2.9	Low	3.2	3.7	4.1	4.6	5.1
				High	3.5	3.9	4.5	5.1	5.8
Total State									
Urban	7.5	9.0	11.1	Low	13.2	15.3	17.3	19.5	21.9
				High	13.9	16.5	19.1	22.5	26.4
Other	2.1	2.2	3.1	Low	3.5	4.3	5.0	5.6	6.4
				High	3.9	4.7	5.7	6.6	7.9
Totals	9.6	11.2	14.2	Low	16.7	19.6	22.3	25.1	28.3
				High	17.8	21.2	24.8	29.1	34.3

1/ 1960, 1970 and 1980 populations are from the U.S. Bureau of the Census.

2/ Low and high series projections of population for each decade from 1990 through 2030 were made by the Texas Department of Water Resources.

Table 2. Texas Employment

Area	1960[1]	1970[1]	1980[1]	Series	1990	2000	2010	2020	2030
		Projections [2]							
	(Millions)				(Millions)				
MSA Counties	2.5	3.3	5.7	Low	7.2	8.4	9.4	10.5	11.6
				High	7.6	9.1	10.6	12.2	14.2
Other Counties	0.8	1.5	1.2	Low	1.4	1.6	1.9	1.8	2.0
				High	1.5	1.7	2.1	2.1	2.3
Total State	3.3	4.8	7.9	Low	8.6	10.0	11.3	12.3	13.6
				High	9.1	10.8	12.7	14.3	16.5

1/ 1960, 1970 and 1980 amounts of employment are from the U.S. Bureau of the Census.

2/ Low and high series projections of employment for each decade from 1990 through 2030 were made by the Texas Department of Water Resources.

population. Since 1900, Texas has shifted from 83 percent rural population to about 80 percent urban population. Since 1950, Texas has expanded from a ranching, farming and energy based economy, to a complex, interdependent agricultural, energy, manufacturing, national defense, high technology and services economy.

Estimated Water Use, Projected Water Requirements and Water Supply Outlook, and Water Problems

Projections of municipal water requirements in 1990 and 2000 are based upon projected population and projected per capita water use, and incorporate estimated variances to take into account variations in climatic factors which affect per capita water requirements. Therefore, in the following discussion of water requirements, and in the presentation of water requirement data for each MSA, water requirements for urban needs in 1990 through 2030 by decade will be presented in terms of quantities needed annually under average conditions (low series) and drought conditions (high series). Projections for manufacturing, steam-electric power generation, mining, and municipal uses are based upon the best available estimates of population and economic growth and upon the assumption that water quality goals of the Federal Water Pollution Control (Clean Water) Act, as amended, will be met according to schedule. The latter affects water use per unit product, in that, in order to meet water quality goals of the Act, wastewater treatment costs are increasing and water users are responding by reducing the quantity of water used per unit product produced. Agricultural water requirements projections are based on the assumption that water-use efficiency in irrigation will improve significantly by 1990.

In 1990, statewide water requirements for municipal, manufacturing, and other needs in all of the State's urban areas have been projected at about 7.1 million acre-feet under drought conditions (Table 3). The 2000, 2010, 2020 and 2030 statewide water requirements in all of the State's urban areas (including the MSAs) under drought conditions are projected at about 8.9, 10.6, 12.6 and 15.0 million acre-feet, respectively (Table 3). Total corresponding water requirements for urban needs in the MSAs only are provided in Table 4. Projections for each MSA are presented later in the discussion of each MSA.

During the 1980s and 1990s, local ground-water use in Texas for food and fiber production is projected to increase from about 8.9 million acre-feet per year to about 11.6 million acre-feet in the year 2000. This level of use will result in continued overdrafting of ground-water reserves. By the year 2000, approximately 1.6 million acre-feet per year of additional water will be needed for irrigation to meet the needs of the growing Texas population and expanding Texas markets. Statewide estimated 1980 water use for livestock was about 244 thousand acre-feet. Water requirements for livestock watering purposes throughout the State are projected to be 288 and 332 thousand acre-feet per year in 1990 and 2000, respectively.

Table 3. 1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, For Urban Needs Within the State 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	STATE TOTALS Low	STATE TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	1290.3		248.6		53.0		178.4		1770.3	
1980	Surface-Water	1522.9		1271.4		277.1		60.7		3132.1	
1980	Total Use 6/	2813.2		1520.0		330.1		239.1		4902.4	
1990	Total Demand	2955.4	4202.3	1968.4	2122.4	535.3	535.3	232.0	232.0	5691.1	7092.0
1990	Ground-Water	1088.4	1303.7	177.1	167.0	71.8	71.8	138.1	137.9	1475.4	1680.4
1990	Surface-Water	1848.2	2837.0	1636.8	1772.2	462.3	461.6	93.8	93.8	4041.1	5164.6
1990	Total Supply 7/	2936.6	4140.7	1813.9	1939.2	534.1	533.4	231.9	231.7	5516.5	6845.0
1990	Shortage	18.8	61.6	154.5	183.2	1.2	1.9	0.1	0.3	174.6	247.0
2000	Total Demand	3512.1	5080.5	2407.1	2717.7	717.4	816.9	267.7	267.7	6904.3	8882.8
2000	Ground-Water	1250.9	1439.6	182.3	191.0	123.2	164.8	121.3	120.6	1677.7	1916.0
2000	Surface-Water	2210.2	3506.7	2108.7	2355.9	593.2	651.0	146.2	146.3	5058.3	6659.9
2000	Total Supply 7/	3461.1	4946.3	2291.0	2546.9	716.4	815.8	267.5	266.9	6736.0	8575.9
2000	Shortage	51.0	134.2	116.1	170.8	1.0	1.1	0.2	0.8	168.3	306.9
2010	Total Demand	3992.5	5934.0	2861.3	3314.4	835.4	1017.1	321.6	321.6	8010.8	10587.1
2010	Ground-Water	1350.9	1549.1	206.0	216.6	165.7	212.6	140.6	142.7	1863.2	2121.0
2010	Surface-Water	2556.8	4164.8	2534.5	2918.3	667.9	798.8	180.8	178.3	5940.0	8060.2
2010	Total Supply 7/	3907.7	5713.9	2740.5	3134.9	833.6	1011.4	321.4	321.0	7803.2	10181.2
2010	Shortage	84.8	220.1	120.8	179.5	1.8	5.7	0.2	0.6	207.6	405.9
2020	Total Demand	4497.8	6953.0	3472.3	4078.7	975.6	1217.2	375.5	375.5	9321.2	12624.4
2020	Ground-Water	1436.3	1636.7	212.8	255.8	185.5	233.1	150.8	155.3	1985.4	2280.9
2020	Surface-Water	2929.0	4931.7	3116.8	3640.0	776.0	983.0	224.2	219.2	7046.0	9773.9
2020	Total Supply 7/	4365.3	6568.4	3329.6	3895.8	961.5	1216.1	375.0	374.5	9031.4	12054.8
2020	Shortage	132.5	384.6	142.7	182.9	14.1	1.1	0.5	1.0	289.8	569.6
2030	Total Demand	5059.0	8177.5	4230.5	5014.0	1118.6	1417.4	387.1	387.1	10795.2	14996.0
2030	Ground-Water	1312.0	1603.8	242.8	288.7	215.5	227.4	157.1	156.1	1927.4	2267.0
2030	Surface-Water	3356.1	5783.0	3853.3	4528.1	875.0	1153.8	229.6	230.2	8314.0	11695.1
2030	Total Supply 7/	4668.1	7386.8	4096.1	4816.8	1090.5	1381.2	386.7	386.3	10241.4	13971.1
2030	Shortage	390.9	790.7	134.4	197.2	28.1	36.2	0.4	0.8	553.8	1024.9

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the State. Total statewide agricultural uses were 12.95 million acre-feet in 1980. Total statewide low series agricultural requirements are projected to be 10.5 million acre-feet per year (maf/y) in 1990, 10.4 maf/y in 2000, 10.9 maf/y in 2010, 11.0 maf/y in 2020 and 11.4 maf/y in 2030. For the high series, statewide agricultural requirements are projected to be 13.3 maf/y in 1990, 17.5 maf/y in 2000, 19.9 maf/y in 2010, 20.2 maf/y in 2020 and 21.1 maf/y in 2030.

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Table 4. 1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, for Urban Needs Within the MSAs 1/

Year	Analyses Catagory	Demand Catagories: Municipal2/		Manufacturing3/		Steam Electric4/		Mining5/		Total In All MSAs	
		Low	High	Low	High	Low	High	Low	High	Low	High
		(Thousands of Acre-Feet)									
1980	Ground-Water	951.1		119.1		35.7		21.0		1126.9	
1980	Surface-Water	1342.1		955.4		165.6		25.9		2489.0	
1980	Total Use 6/	2293.2		1074.5		201.3		46.9		3615.9	
1990	Total Demand	2413.6	3424.1	1416.4	1532.1	244.0	244.0	55.1	55.1	4129.1	5255.3
1990	Ground-Water	781.2	889.7	80.6	67.2	29.8	29.8	22.4	17.3	914.0	1004.0
1990	Surface-Water	1616.2	2481.5	1332.6	1461.5	214.2	214.2	32.7	37.8	3195.7	4195.0
1990	Total Supply 7/	2397.4	3371.2	1413.2	1528.7	244.0	244.0	55.1	55.1	4109.7	5199.0
1990	Shortage	16.2	52.9	3.2	3.4	--	--	--	--	19.4	56.3
2000	Total Demand	2879.7	4170.1	1780.2	2015.3	249.0	261.8	79.4	79.4	4988.3	6526.6
2000	Ground-Water	901.5	968.2	73.6	72.3	29.8	29.8	23.9	18.3	1028.8	1088.6
2000	Surface-Water	1933.4	3082.6	1702.3	1938.3	219.2	232.0	55.5	61.1	3910.4	5314.0
2000	Total Supply 7/	2834.9	4050.8	1775.9	2010.6	249.0	261.8	79.4	79.4	4939.2	6402.6
2000	Shortage	44.8	119.3	4.3	4.7	--	--	--	--	49.1	124.0
2010	Total Demand	3288.1	4898.2	2146.8	2503.7	258.6	272.0	86.3	86.3	5779.8	7760.2
2010	Ground-Water	963.9	1025.9	77.2	72.5	30.8	30.8	31.5	28.1	1103.4	1157.3
2010	Surface-Water	2249.7	3675.8	2064.2	2425.1	227.8	241.2	54.8	58.2	4596.5	6400.3
2010	Total Supply 7/	3213.6	4701.7	2141.4	2497.6	258.6	272.0	86.3	86.3	5699.9	7557.6
2010	Shortage	74.5	196.5	5.4	6.1	--	--	--	--	79.9	202.6
2020	Total Demand	3713.8	5771.7	2650.9	3135.7	268.2	282.3	93.6	93.6	6726.5	9283.3
2020	Ground-Water	1016.5	1041.4	71.8	82.7	31.7	31.7	31.0	28.7	1151.0	1184.5
2020	Surface-Water	2582.1	4377.3	2572.3	3045.2	236.5	250.6	62.6	64.9	5453.5	7738.0
2020	Total Supply 7/	3598.6	5418.7	2644.1	3127.9	268.2	282.3	93.6	93.6	6604.5	8922.5
2020	Shortage	115.2	353.0	6.8	7.8	--	--	--	--	122.0	360.8
2030	Total Demand	4186.2	6833.1	3281.7	3927.6	276.9	292.5	85.1	85.1	7829.9	11138.3
2030	Ground-Water	853.5	944.2	77.7	84.0	32.7	32.7	26.9	20.9	990.8	1081.8
2030	Surface-Water	2968.5	5155.0	3195.6	3828.3	244.2	259.8	58.2	64.2	6466.5	9307.3
2030	Total Supply 7/	3822.0	6168.7	3273.3	3917.3	276.9	292.5	85.1	85.1	7457.3	10463.6
2030	Shortage	364.2	664.4	8.4	10.3	--	--	--	--	372.6	674.7

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSAs. Total MSA agricultural uses were 2.99 million acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSAs and the resulting potential for this growth to impinge on irrigation in the MSAs has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSAs which supply electrical energy to users within the MSAs.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

In the two decades ahead, under drought conditions, water requirements for municipal, manufacturing, steam-electric power generation, and mining purposes in the State are projected to increase from about 4.9 million acre-feet per year to approximately 8.9 million acre-feet per year. Of the 8.9 million acre-feet, approximately 73 percent or 6.5 million acre-feet per year will be required in the twenty-seven (27) MSAs. Of the estimated current water use in the MSAs for urban needs, approximately 31 percent or 1.1 million acre-feet are from ground-water resources and about 69 percent or 2.5 million acre-feet are from developed surface-water resources. By the year 2000, because of physical and economic problems related to overdraft or mining of ground water, this relationship is expected to change, i.e., approximately 83 percent of the 6.5 million acre-feet of the water requirements for urban needs will have to be supplied from developed surface-water resources in or adjacent to the MSAs.

Of the estimated 17.9 million acre-feet of water used currently in Texas, 61 percent or 10.9 million acre-feet are from ground-water resources and 39 percent or 7.0 million acre-feet are from developed surface-water resources. By the year 2000, if current water use trends continue, the State's ground-water sources are projected to be capable of supplying only about 9.1 million acre-feet annually or about 83 percent of the present level.

In most areas of the State, ground water is being withdrawn more rapidly than recharge is taking place. Currently, on a net statewide basis, approximately 5 to 6 million acre-feet per year of ground water is withdrawn from reserves or storage. This net withdrawal from reserves is causing water level declines, decreasing well yields, land subsidence, movement of geologic faults, and saline-water encroachment. Serious water-level declines are currently evident on a local and regional basis in the El Paso, High Plains, north-central, and east Texas areas. Land subsidence and fault movement are serious problems related to overdrafts of ground water from the Gulf Coast Aquifer in the Houston region. Saline-water encroachment has caused abandonment and relocation of municipal well fields in Galveston, Brazoria and Calhoun counties. Overdrafts of ground water are causing deterioration of ground-water quality in the Lufkin, Kingsville and El Paso areas. During the drought of the 1950's, withdrawals of ground water in the San Antonio region increased to such an extent that Comal Springs stopped flowing for several months in 1956.

Currently, without extracting ground-water reserves, the total annual dependable statewide water yield is about 16.3 million acre-feet; approximately 5.3 million acre-feet of sustained ground-water yield from natural recharge and approximately 11.0 million acre-feet of dependable yield from surface water projects. The surface-water yield is from those reservoirs shown in blue on Figure 2 as those "existing" plus those "under construction." About 4.3 million acre-feet per year of additional dependable surface-water yield can be developed with construction of reservoirs that have been authorized by Congress plus those that are being planned by the State and local units of governments (those reservoirs in red, orange and green on Figure 2).

This construction would bring the total dependable annual yield of ground and surface waters to about 20.6 million acre-feet. In addition, there would be about 1.0 million acre-feet of capturable return flows. This would make an annual total dependable water supply of approximately 21.6 million acre-feet. By the year 2000, total statewide annual projected water requirements, under drought conditions are 25.4 million acre-feet.

In several urban areas there is strong potential for serious water supply shortages in the immediate future, especially under moderate to severe drought conditions; i.e., the San Antonio, Lower Rio Grande Valley, North Central Texas, West Texas, El Paso and some cities in the North and East Texas areas. During the next two decades, overdrafts of ground water in urban areas will need to be eliminated or significantly controlled through additional, well planned, and implemented surface-water developments, and through conjunctive use of the dependable yield of surface-water projects and the sustained ground-water yields available to the areas. Cooperative local, State, and Federal planning and development programs are in progress that can, if fully implemented effectively meet municipal, manufacturing, steam-electric power generation (consumptive use for cooling), and mining water requirements related to urban needs in the 1980s and 1990s.

Description of Abilene MSA - The MSA is area No. 1 on Figure 1, and is comprised of Taylor County which has about 912 square miles in parts of the Brazos and Colorado River Basins. Average annual precipitation of the MSA is about 24 inches. The average annual temperature is about 64.0° F. The principal city is Abilene. Other cities in the MSA are listed in Appendix C.

Economy of Abilene MSA - The area economy has higher-than-average concentrations in the agricultural, mining, and military sectors. The food and kindred products industry is the most important source of manufacturing employment. Manufacturing contributes 9.4 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on agriculture and trade with increasing employment opportunities in manufacturing and oil production.

Water Quality Management Planning in Abilene MSA - The Abilene MSA is located in both the Brazos River Basin and the Colorado River Basin. The Texas Department of Water Resources contracted with the Brazos River Authority for water quality management planning in the Brazos River Basin, and with the Lower Colorado River Authority and the Colorado River Municipal Water District for the Colorado River Basin portion of the MSA. The initial plans for both basins identified wastewater facility needs within the MSA and subsequent planning efforts reviewed the needs and updated them, as found necessary. The Brazos River Basin initial planning also identified the Clear Fork Brazos River, which drains a portion of the MSA, as being a eutrophic stream and as having a high potential of being impacted by nonpoint sources of pollution. High nutrient levels could be due to municipal sewage effluent as well as springs and seeps in the headwaters. The stream is characterized by elevated levels of total dissolved solids, chlorides, and sulfates. A recent sampling study has isolated areas in the watershed most affected by geologic conditions, and areas in the watershed most affected by oil and gas production. Alternative control measures have been identified, and are being evaluated at this time. All recommendations made during the water quality management process in both basins are considered by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Abilene MSA - The Federal Emergency Management Agency has designated Taylor County and 8 incorporated cities in the Abilene MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for Taylor County and for eight of the incorporated cities in the MSA (Appendix C). Presently, Taylor County and only two cities in the MSA

(Appendix C) have adopted local floodplain management programs in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. The City of Abilene is the only entity within the MSA which has had a Detailed Flood Insurance Rate Study completed to supply detailed 10-year, 50-year, 100-year, and 500-year flood event data (Appendix C).

Population and Employment within the Abilene MSA

Item	1960	1970	1980	Series	Projections 1990	2000	2010	2020	2030
	-------(Thousands)----				-------------(Thousands)-------------				
				Low	123.5	133.4	143.8	157.5	176.4
Total Population	101.1	97.8	110.9	High	126.8	138.1	153.3	177.4	209.1
				Low	115.6	124.7	134.0	147.1	164.8
Urban Population	92.5	91.4	101.7	High	118.6	129.1	142.9	165.7	195.4
				Low	7.9	8.7	9.8	10.4	11.6
Other Population	8.6	6.4	9.2	High	8.2	9.0	10.4	11.7	13.7
				Low	64.2	69.3	73.5	79.2	87.3
Employment	34.3	35.2	61.1	High	65.8	71.7	78.4	89.2	103.4

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Abilene MSA 1/

Year	Analyses Catagory	Municipal[2/] Low	Municipal[2/] High	Manufacturing[3/] Low	Manufacturing[3/] High	Steam Electric[4/] Low	Steam Electric[4/] High	Mining[5/] Low	Mining[5/] High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	0.3		--		--		--		0.3	
1980	Surface-Water	26.0		1.8		--		--		27.8	
1980	Total Use 6/	26.3		1.8		--		--		28.1	
1990	Total Demand	21.0	29.6	2.5	2.7	--	--	--	--	23.5	32.3
1990	Ground-Water	0.3	0.3	--	--	--	--	--	--	0.3	0.3
1990	Surface-Water	20.7	29.3	2.5	2.7	--	--	--	--	23.2	32.0
1990	Total Supply 7/	21.0	29.6	2.5	2.7	--	--	--	--	23.5	32.3
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	23.2	32.8	3.5	3.8	--	--	--	--	26.7	36.6
2000	Ground-Water	0.8	0.8	--	--	--	--	--	--	0.8	0.8
2000	Surface-Water	22.4	32.0	3.5	3.8	--	--	--	--	25.9	35.8
2000	Total Supply 7/	23.2	32.8	3.5	3.8	--	--	--	--	26.7	36.6
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	25.0	36.3	4.4	5.0	--	--	--	--	29.4	41.3
2010	Ground-Water	0.8	0.8	--	--	--	--	--	--	0.8	0.8
2010	Surface-Water	24.2	35.5	4.4	5.0	--	--	--	--	28.6	40.5
2010	Total Supply	25.0	36.3	4.4	5.0	--	--	--	--	29.4	41.3
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	27.3	42.1	5.6	6.5	--	--	--	--	32.9	48.6
2020	Ground-Water	0.8	0.8	--	--	--	--	--	--	0.8	0.8
2020	Surface-Water	26.5	41.3	5.6	6.5	--	--	--	--	32.1	47.8
2020	Total Supply 7/	27.3	42.1	5.6	6.5	--	--	--	--	32.9	48.6
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	30.6	49.6	7.1	8.2	--	--	--	--	37.7	57.8
2030	Ground-Water	0.8	0.8	--	--	--	--	--	--	0.8	0.8
2030	Surface-Water	29.8	48.8	7.1	8.2	--	--	--	--	36.9	57.0
2030	Total Supply 7/	30.6	49.6	7.1	8.2	--	--	--	--	37.7	57.8
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 3.9 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030).

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Abilene MSA - Currently within the MSA, approximately 99 percent of the water used for urban needs (municipal, and manufacturing purposes) is supplied by developed surface-water resources. The remaining one percent is supplied by very limited ground-water resources. Approximately 98 and 99 percent of the MSAs projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately two and one percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the smaller yet growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the smaller, growing systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of the smaller urban systems may not be readily available or surface-water supplies may not be accessible through a larger system having water rights.

Surface-water facilities currently serving the Abilene MSA (Abilene Lake, Kirby Lake, Fort Phantom Hill Lake and diversions from the Clear Fork Brazos River - Figure 6), plus additional supplies available to the MSA from Hubbard Creek Lake (Figure 6) in Stephens County (outside the MSA) are expected to be adequate to meet projected municipal and manufacturing water requirements of the MSA to the year 2005. These surface-water facilities, the Clear Fork Brazos diversion, and associated return flows are expected to be capable of providing about 36 thousand acre-feet per year of dependable supply under drought conditions. However, any further significant increases in the salinity of water stored in Hubbard Creek Lake over current levels, and further degradation of the Clear Fork Brazos River diversion into Fort Phantom Hill Lake, under specified river-flow conditions, could result in severe water supply problems in the MSA.

The long-term projected municipal and manufacturing water needs of the MSA are expected to exceed the supplies currently available to the area in about the year 2005. Possible solutions to this problem include (1) construction of the proposed Breckenridge Reservoir on the Clear Fork Brazos River in southwestern Throckmorton County (Figure 6), (2) diversions from Possum Kingdom Lake which is located in Palo Pinto County a considerable distance east of the MSA (Figure 2), or (3) construction of the proposed South Bend Reservoir in Young and Stephens counties (Figure 6). Water from Possum Kingdom Lake, which has high salinity, would be used for oil field secondary recovery purposes releasing current secondary recovery demands on Lake Hubbard Creek for municipal urban water needs.

High concentrations of fluoride, nitrate, sulfate, chloride, and total dissolved solids are often encountered in ground-water supplies from the Alluvium and Trinity Group Aquifers (See Figure 3). Salinity

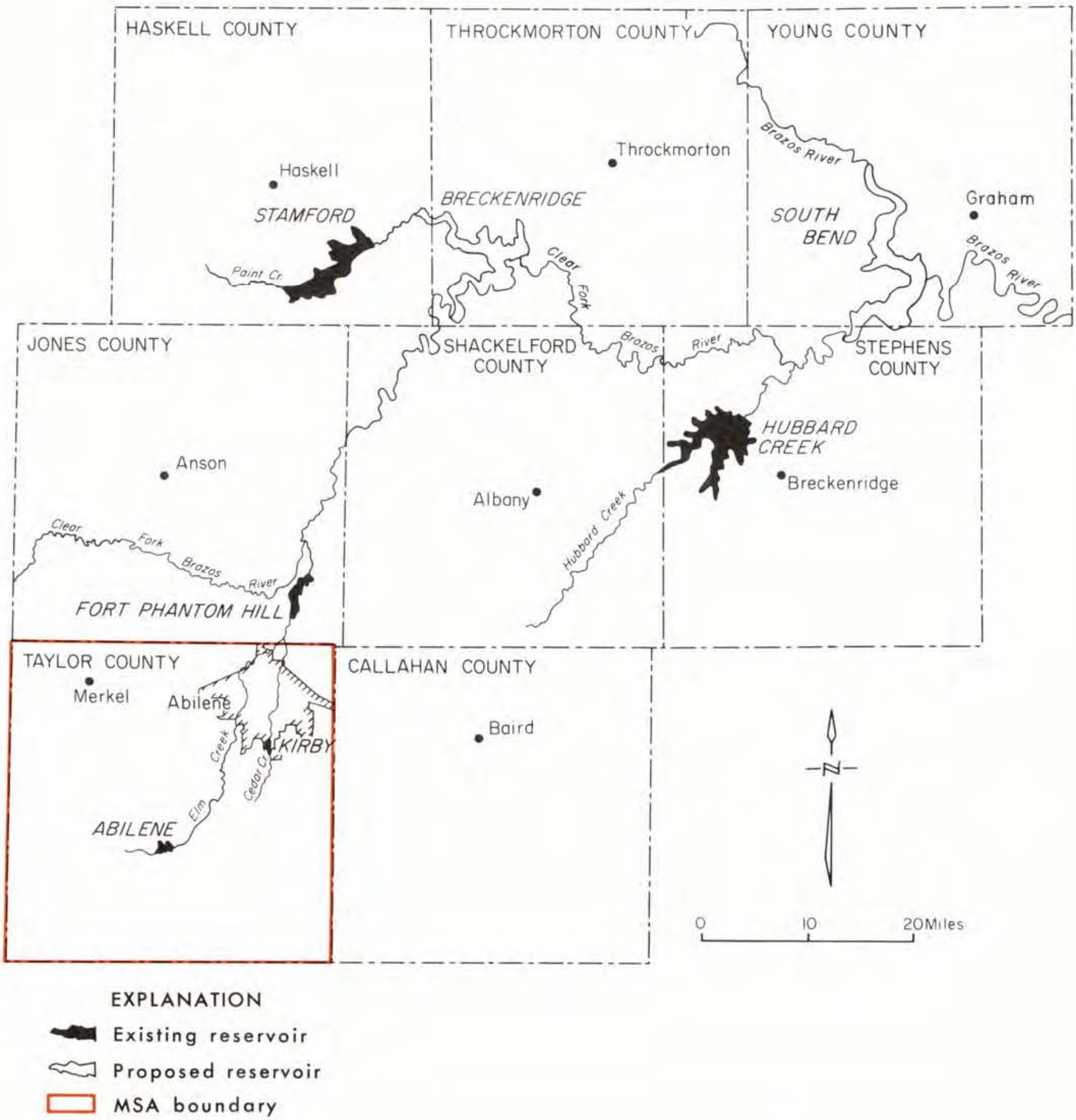


Figure 6

Abilene MSA Water Supply Projects

coupled with the low permeability of the aquifers and low recharge rates do not permit adequate amounts of ground water to be developed for moderate to large municipal and manufacturing supplies.

AMARILLO MSA

Description of Amarillo MSA - The MSA is area No. 2 on Figure 1, and is comprised of Potter and Randall counties which cover about 1,812 square miles in parts of the Canadian River and Red River Basins. Average annual precipitation is about 18.5 inches. Average annual temperatures range from about 56°F to 58°F. The principal cities are Amarillo and Canyon.

Economy of Amarillo MSA - The area economy has high concentrations of employment in services, trade, manufacturing, transportation, communication, and public utilities. The agricultural products and processing industries are important sources of manufacturing employment. Manufacturing contributes 9.9 percent to the total personal income of the MSA. The regional economic outlook is for continuing economic growth with increasing employment opportunities caused by industrial expansion.

Water Quality Management Planning in Amarillo MSA - The City of Amarillo is located in both Potter and Randall counties and is on the divide between the Canadian River Basin and Red River Basin. For planning purposes, the City of Amarillo was assigned to the Canadian River Basin. The Texas Department of Water Resources contracted with the Panhandle Regional Planning Commission for water quality management planning in the Canadian River Basin and with the Red River Authority for the same type of activity in the Red River Basin. The initial plans for both basins identified wastewater facility needs within the MSA and subsequent planning efforts reviewed these needs and updated them where necessary. A limited stormwater sampling program to determine the effects of urban runoff was conducted in the Amarillo area as part of the Canadian River Basin initial plan. The study concluded that pollutants from urban runoff were not a serious problem warranting additional examination. The Amarillo MSA contains a portion of the Canadian River that is experiencing naturally occurring high levels of chlorides, sulfates, and total dissolved solids. The most significant source of the pollutants is apparently from the headwaters of the river in New Mexico. Although there are no significant violations of water quality standards in this segment of the river, the Canadian River Municipal Water Authority in cooperation with the Bureau of Reclamation has a feasibility study under way to see if a concentrated brine source in the upper watershed in New Mexico can be eliminated. All recommendations made in the water quality management planning process in both basins were considered by local advisory committees as required by regulations under the Federal Clean Water Act.

Floodplain Management Program in Amarillo MSA - The Federal Emergency Management Agency has designated both counties and three incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for both counties and the incorporated cities in the MSA (Appendix C). Presently, Randall County and all three cities (Appendix C) have adopted local floodplain management programs in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Randall County and three cities in the MSA (Appendix C).

Population and Employment within the Amarillo MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	149.5	144.4	173.7	Low	191.6	205.2	221.3	240.8	264.5
				High	205.6	222.1	243.9	273.6	308.7
Urban Population	143.8	135.3	160.0	Low	169.7	179.0	192.3	208.0	228.4
				High	181.3	192.2	211.3	236.7	266.8
Other Population	5.7	9.1	13.7	Low	21.9	26.2	29.0	32.8	36.1
				High	24.3	29.9	32.6	36.9	41.9
Employment	53.9	59.3	86.0	Low	106.4	114.0	121.0	129.5	139.9
				High	114.2	123.4	133.3	147.1	163.3

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Amarillo MSA 1/

Year	Analyses Category	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	20.6		4.9		1.8		0.5		27.8	
1980	Surface-Water	16.4		2.2		10.8		--		29.4	
1980	Total Use 6/	37.0		7.1		12.6		0.5		57.2	
1990	Total Demand	40.5	56.1	8.8	9.2	17.1	17.1	0.6	0.6	67.0	83.0
1990	Ground-Water	13.6	25.8	0.2	5.3	--	--	0.6	0.6	14.4	31.7
1990	Surface-Water	26.9	30.3	8.6	3.9	17.1	17.1	--	--	52.6	51.3
1990	Total Supply 7/	40.5	56.1	8.8	9.2	17.1	17.1	0.6	0.6	67.0	83.0
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	43.7	60.9	10.8	11.8	17.1	17.1	0.7	0.7	72.3	90.5
2000	Ground-Water	18.7	27.8	2.6	7.8	--	--	0.7	0.7	22.0	36.3
2000	Surface-Water	25.0	33.1	8.2	4.0	17.1	17.1	--	--	50.3	54.2
2000	Total Supply 7/	43.7	60.9	10.8	11.8	17.1	17.1	0.7	0.7	72.3	90.5
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	47.1	66.8	12.8	14.3	17.1	17.1	0.8	0.8	77.8	99.0
2010	Ground-Water	23.6	33.2	3.8	10.4	--	--	0.8	0.8	28.2	44.4
2010	Surface-Water	23.5	33.6	9.0	3.9	17.1	17.1	--	--	49.6	54.6
2010	Total Supply 7/	47.1	66.8	12.8	14.3	17.1	17.1	0.8	0.8	77.8	99.0
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	51.1	75.0	15.4	17.5	17.1	17.1	0.9	0.9	84.5	110.5
2020	Ground-Water	29.8	41.5	3.1	13.8	--	--	0.9	0.9	33.8	56.2
2020	Surface-Water	21.3	33.5	12.3	3.7	17.1	17.1	--	--	50.7	54.3
2020	Total Supply 7/	51.1	75.0	15.4	17.5	17.1	17.1	0.9	0.9	84.5	110.5
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	56.2	84.6	18.6	21.3	17.1	17.1	1.0	1.0	92.9	124.0
2030	Ground-Water	33.0	51.0	3.8	17.3	--	--	1.0	1.0	37.8	69.3
2030	Surface-Water	23.2	33.6	14.8	4.0	17.1	17.1	--	--	55.1	54.7
2030	Total Supply 7/	56.2	84.6	18.6	21.3	17.1	17.1	1.0	1.0	92.9	124.0
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 87.8 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Amarillo MSA - Through the year 2000, the City of Amarillo water system plus steam-electric power generation plants in the MSA are expected to continue to obtain their water supplies from Lake Meredith (Figure 7) in the Canadian River Basin through the Canadian River Municipal Water Authority; from various City of Amarillo well fields completed in the High Plains Aquifer in Deaf Smith, Randall and Carson Counties (Figure 7); and from return flows from the City of Amarillo. Currently within the MSA, approximately 48 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining) is supplied by ground-water resources. The remaining 52 percent is supplied by Lake Meredith. In the year 2000, approximately 40 percent of the area's projected urban water requirements are expected to be supplied by ground-water resources of the High Plains Aquifer, and approximately 60 percent by the limited surface-water resources of Lake Meredith. In the year 2030, about 56 percent of the water needs are expected to be supplied by ground water and 44 percent by surface water. However, during the next 20 years, water-level declines and related declines of well yields are expected to continue in the High Plains Aquifer due to large overdrafts of ground water. If this situation should adversely affect the productivity and performance of the currently established well fields, then part of the Amarillo system's water requirements may have to be met by available treated return flows from the system. To increase their ground-water supply, the City of Amarillo uses Bivins Lake (Figure 7) to artificially recharge the High Plains Aquifer in the Randall County well field southwest of the city (Figure 7).

Many of the smaller yet growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the smaller, growing systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable water supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of the urban systems may not be readily available or surface-water supplies may not be accessible through a larger system having water rights.

Delivery of water from Lake Meredith to Amarillo and other member cities of the Canadian River Municipal Water Authority in the Canadian, Red, Brazos, and Colorado River Basins will probably continue on a long-term basis. The dependable supply from Lake Meredith for urban needs within the Amarillo MSA is 38.2 thousand acre-feet annually under terms of the contract between Amarillo and the Canadian River Municipal Water Authority. It is anticipated that this supply can be supplemented by annual return flows which will produce a total surface-water supply of approximately 54.2 thousand acre-feet and 54.7 thousand acre-feet in 2000 and 2030 respectively. Projected long-term water needs of the Amarillo MSA will have to continue to be met through a combination of ground- and surface-water supplies, even though ground

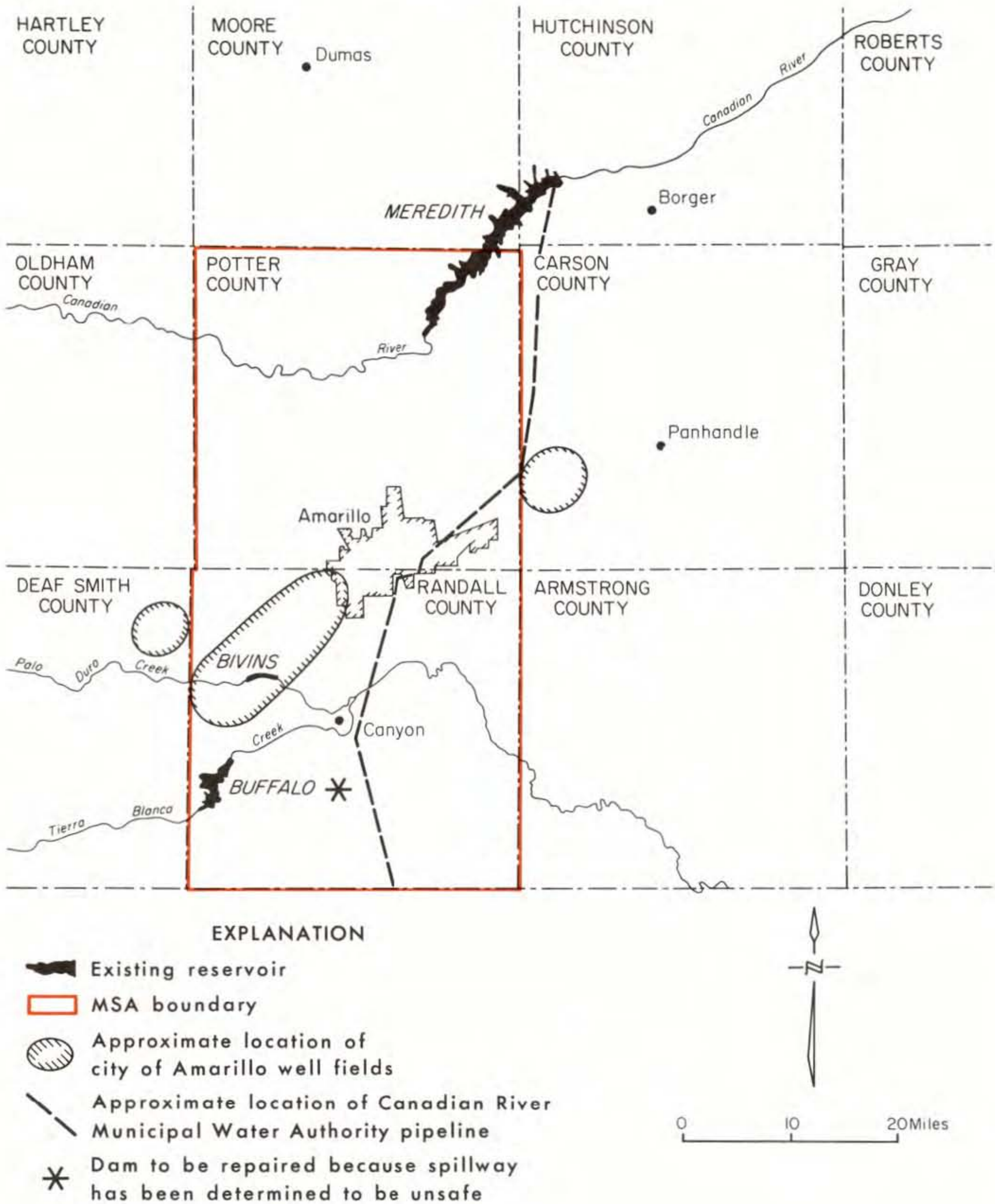


Figure 7
Amarillo MSA Water Supply Projects

water in the High Plains Aquifer will continue to be depleted. It is very likely that after the year 2000, the Amarillo system will have to develop additional High Plains Aquifer well fields; particularly in areas north of the Canadian River in western Hartley County where sufficient saturated thickness is expected to be present to support such well fields. However, it is emphasized that new well fields in the High Plains Aquifer will ultimately be dewatered as is the case of present well fields, due to the fact that recharge to the aquifer is quite low.

Salinity of water stored in Lake Meredith is expected to continue to present a problem until measures for alleviating this problem are implemented. The Bureau of Reclamation is conducting studies and preparing to implement salinity control measures in the upstream reaches of the Canadian River Basin which would include the installation of brine-pumping wells, a pipeline, and brine re-injection wells near and downstream of Ute Lake in New Mexico. It is estimated that these measures would eventually remove about 70 percent of the present salt load that now enters Lake Meredith. By diverting the salt load into the injection wells, the quality of Lake Meredith water should improve within 10 to 15 years after the project is initiated.

Description of Austin MSA - The MSA is area No. 3 on Figure 1, and is comprised of Travis, Williamson, and Hays counties which cover about 2,766 square miles in parts of the Colorado River, Brazos River, and Guladalupe River Basins. Average annual precipitation ranges from about 30 to 34 inches. Average annual temperatures range from 66°F to 68°F. The principal cities are Austin, San Marcos, Georgetown, Round Rock and Taylor. Other cities in the MSA are listed in Appendix C.

Economy of the Austin MSA - The area's economy has experienced recent rapid expansion in the manufacturing, construction, and real estate sectors, but employment remains concentrated in the sectors of government, wholesale and retail trade, and services. Electronics and other high-technology industries are the most important source of manufacturing employment. Manufacturing contributes 11.1 percent to the total personal income of the Austin MSA. The regional economic outlook is for continuing dependence on trade, services and government earnings with increasing employment opportunities in the steadily growing industrial sector.

Water Quality Management Planning in Austin MSA - The MSA includes Travis, Hays and Williamson counties as well as portions of three river basins, the Colorado, Guadalupe and Brazos. The southern half of Hays County is in the Guadalupe River Basin and the water quality planning agency is the Guadalupe-Blanco River Authority (GBRA). The Brazos River Authority (BRA) is the planning agency for Williamson County. The remainder of the MSA consists of Travis and northern Hays counties for which the Lower Colorado River Authority (LCRA) was named the planning agency responsible for the initial (Section 208) planning program and subsequent facility needs updates to the plan. Similar planning was conducted by the BRA and GBRA for their respective areas. An upgrading of wastewater treatment plants within the MSA has resulted from past water quality planning and facility needs programs. Input from the general public was utilized in public participation programs under Section 208 planning and the Nationwide Urban Runoff Program (NURP). In the initial phase of the Section 208 program, citizen advisory committees contributed to the various aspects of the program and reviewed all documents developed. The advisory committee of the NURP also maintained a similar function. A primary concern of the 208 program in this MSA has been to study the effects of urban runoff on area lakes. A sampling program initiated in 1977 established a starting point to quantify loadings associated with urban runoff. This program was expanded under the Nationwide Urban Runoff Program, Lake Austin Study, through the efforts of the City of Austin, the Texas Department of Water Resources and the U.S. Environmental Protection Agency. Contracts signed in the fall of 1983 under the research and planning fund of the TDWR will continue to monitor and evaluate water quality in Lake Travis. The University of Texas is undertaking a eutrophication analysis of Lake Travis which may be used as a model for other Texas reservoirs and the LCRA has started a septic tank evaluation of Lakes Travis and Austin. The City of Austin may join in the latter project and the scope may be expanded to include Town Lake in the future. Water quality in the area lakes is among the highest of any lakes in Texas, so continued planning and possible water quality control measures are likely. Policies determined from these studies may well have statewide impacts.

Floodplain Management Program in Austin MSA - The Federal Emergency Management Agency has designated all three counties and 18 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the three counties and for 16 incorporated cities in the MSA (Appendix C). Presently, all three counties and 17 cities (Appendix C) have adopted local floodplain management programs in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Travis County and 10 cities in the MSA (Appendix C).

Population and Employment within the Austin MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	267.1	360.5	536.7	Low	695.6	899.7	1098.4	1274.2	1433.0
				High	775.6	1053.3	1337.5	1662.1	2073.8
Urban Population	219.9	294.9	414.9	Low	524.9	662.9	802.3	924.5	1030.7
				High	576.1	765.9	965.6	1192.1	1466.3
Other Population	47.2	65.6	121.8	Low	170.7	236.8	296.1	349.7	402.3
				High	199.5	287.4	371.9	470.0	607.5
Employment	96.2	142.0	281.9	Low	373.6	483.1	580.2	662.1	732.2
				High	416.6	565.6	706.5	863.6	1059.5

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Austin MSA 1/

Year	Analyses Category	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	24.3		1.8		---		1.1		27.2	
1980	Surface-Water	85.3		3.8		7.0		3.8		99.9	
1980	Total Use 6/	109.6		5.6		7.0		4.9		127.1	
1990	Total Demand	131.5	190.4	8.7	9.4	7.0	7.0	6.0	6.0	153.2	212.8
1990	Ground-Water	20.6	25.0	0.2	0.2	---	---	---	---	20.8	25.2
1990	Surface-Water	110.9	165.4	8.5	9.2	7.0	7.0	6.0	6.0	132.4	187.6
1990	Total Supply 7/	131.5	190.4	8.7	9.4	7.0	7.0	6.0	6.0	153.2	212.8
1990	Shortage	---	---	---	---	---	---	---	---	---	---
2000	Total Demand	172.0	261.1	12.1	13.6	7.0	7.0	7.1	7.1	198.2	288.8
2000	Ground-Water	24.4	32.5	0.3	0.4	---	---	---	---	24.7	32.9
2000	Surface-Water	147.6	228.6	11.8	13.2	7.0	7.0	7.1	7.1	173.5	255.9
2000	Total Supply 7/	172.0	261.1	12.1	13.6	7.0	7.0	7.1	7.1	198.2	288.8
2000	Shortage	---	---	---	---	---	---	---	---	---	---
2010	Total Demand	209.1	330.8	15.8	18.1	7.0	7.0	8.3	8.3	240.2	364.2
2010	Ground-Water	28.3	27.1	0.4	0.5	---	---	---	---	28.7	27.6
2010	Surface-Water	180.8	303.7	15.4	17.6	7.0	7.0	8.3	8.3	211.5	336.6
2010	Total Supply 7/	209.1	330.8	15.8	18.1	7.0	7.0	8.3	8.3	240.2	364.2
2010	Shortage	---	---	---	---	---	---	---	---	---	---
2020	Total Demand	241.7	410.0	20.2	23.5	7.0	7.0	9.5	9.5	278.4	450.0
2020	Ground-Water	26.6	27.6	0.5	0.7	---	---	---	---	27.1	28.3
2020	Surface-Water	215.1	382.4	19.7	22.8	7.0	7.0	9.5	9.5	251.3	421.7
2020	Total Supply 7/	241.7	410.0	20.2	23.5	7.0	7.0	9.5	9.5	278.4	450.0
2020	Shortage	---	---	---	---	---	---	---	---	---	---
2030	Total Demand	270.7	508.2	25.6	30.1	7.0	7.0	10.6	10.6	313.9	555.9
2030	Ground-Water	27.0	27.6	0.7	0.8	---	---	---	---	27.7	28.4
2030	Surface-Water	243.7	480.6	24.9	29.3	7.0	7.0	10.6	10.6	286.2	527.5
2030	Total Supply 7/	270.7	508.2	25.6	30.1	7.0	7.0	10.6	10.6	313.9	555.9
2030	Shortage	---	---	---	---	---	---	---	---	---	---

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 5.6 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Austin MSA - Currently within the MSA, approximately 79 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 21 percent is supplied by ground-water resources. In the year 2000, approximately 89 percent of the MSA's projected urban water demands are expected to be supplied by developed surface-water resources, and approximately 11 percent by ground-water resources. In the year 2030, about 95 percent of the demands will be met by surface-water supplies and five percent by ground-water supplies.

Many of the smaller yet growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the smaller, growing systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of the smaller urban systems may not be readily available or surface-water supplies may not be accessible through a larger system having water rights.

City of Austin power plants in the MSA are expected to continue to obtain their water supplies from Lake Walter E. Long and the Colorado River (Figure 8).

Currently, Lakes Travis and Buchanan (Figure 8) supply water for urban and irrigation water needs downstream in the lower Colorado River Basin as well as portions of the adjacent Lavaca River Basin, the Colorado-Lavaca Coastal Basin, and the Brazos-Colorado Coastal Basin in Fayette, Colorado, Wharton, and Matagorda counties (Figure 2). Projected urban and irrigation water requirements for the Austin MSA and the above mentioned downstream areas indicate that surface-water supplies from Lakes Travis and Buchanan will have to be supplemented with additional surface-water supplies shortly after the year 2000. This includes the City of Austin water system and other large to moderate urban water supply systems in Travis and Hays counties within the Colorado River Basin. These additional future water needs could be met through the construction of the Colorado Coastal Plains Reservoir (Figure 2) on the Colorado River near Columbus in Fayette and Colorado counties. Construction of this reservoir would allow additional water to be available from Lakes Travis and Buchanan to meet the urban water needs of the Austin MSA through the year 2030.

Urban water needs within the Guadalupe River Basin portion of Hays County are expected to continue to be supplied from the Edwards (Balcones Fault Zone) Aquifer until 2010. By 2010 projected needs indicate an additional supply source is needed to supplement the ground-water supplies of the Edwards. An alternative for meeting these needs is construction of Cloptin Crossing Reservoir on the Blanco River in Hays County (Figure 8).

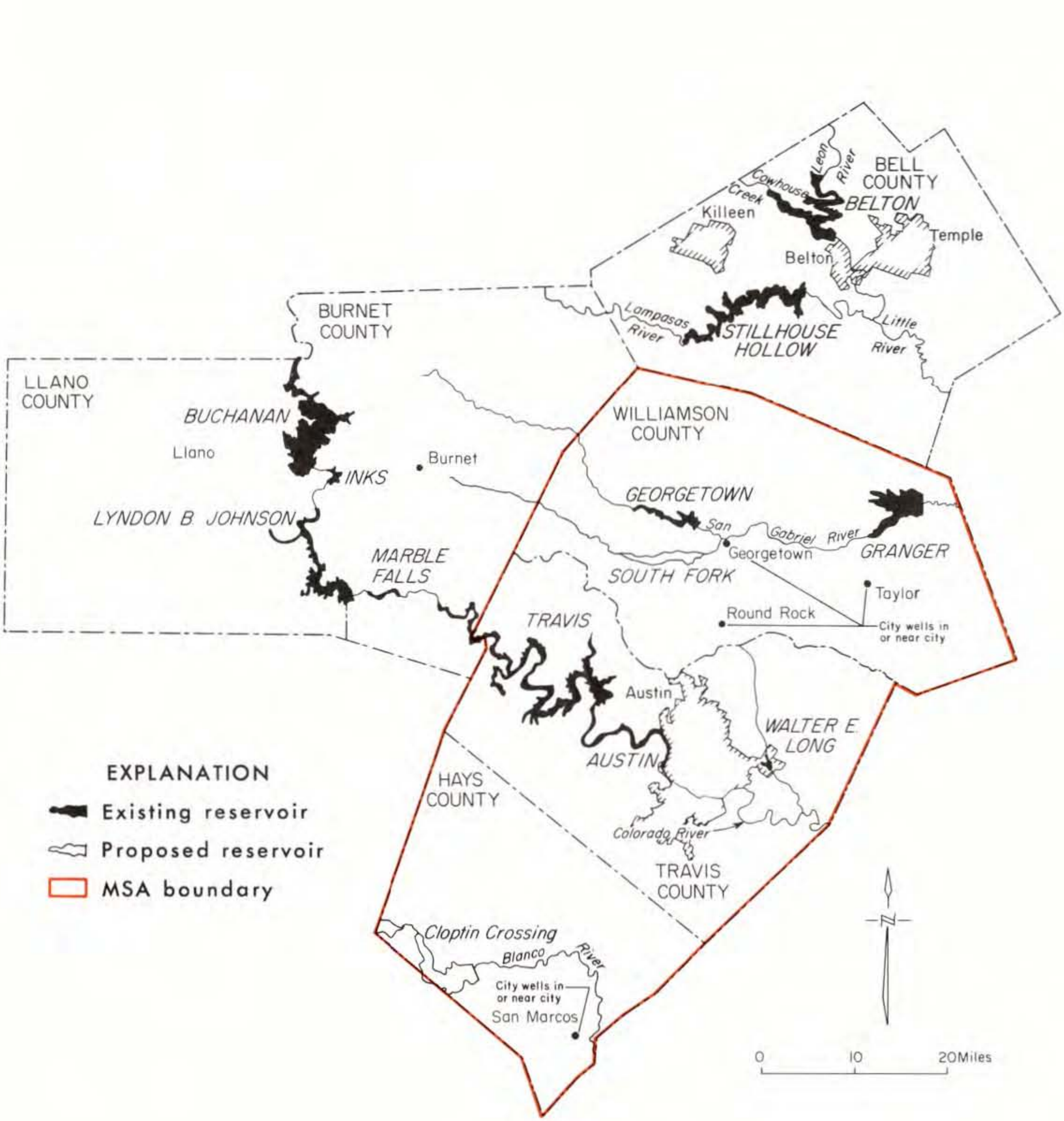


Figure 8
Austin MSA Water Supply Projects

In Williamson County, rapidly declining ground-water levels, and in some cases the inferior quality of ground-water supplies, dictate that future ground-water pumpage for municipal and manufacturing purposes not exceed the current level. The recently completed Lakes Georgetown and Granger (Figure 8) will provide additional water supplies for urban water systems in Williamson County. The dependable supplies of these reservoirs will be capable of meeting the projected urban water needs in Williamson County throughout the year 2005, provided adequate conveyance and treatment facilities are installed. After the year 2005, the growing urban systems in Williamson County will have to seek additional supplies perhaps from South Fork Lake (Figure 8) on the south San Gabriel River in Williamson County, and from Stillhouse Hollow and Belton Lakes in Bell County (Figure 8), if other arrangements can be made to meet the downstream needs in the lower Brazos River Basin now being served by these reservoirs.

Description of Beaumont-Port Arthur MSA - The MSA is area No. 4 on Figure 1, and is comprised of Jefferson, Orange and Hardin counties which cover about 2,207 square miles in parts of the Neches River, Sabine River and Trinity River Basins and the Neches-Trinity Coastal Basin. Average annual precipitation ranges from 50 to about 56 inches. Average annual temperatures range from about $67^{o}F$ to $69^{o}F$. The principal cities are Beaumont, Port Arthur and Orange. Other cities in the MSA are listed in Appendix C.

Economy of Beaumont-Port Arthur MSA - Manufacturing, contract construction, and port activity are the major economic sectors of the area. Petroleum refining, petrochemicals and transportation equipment are the major sources of manufacturing employment. Manufacturing contributes 28.8 percent of the total personal income of the MSA. The regional economic outlook is for continuing specialization in the processing of extractive materials.

Water Quality Management Planning in Beaumont-Port Arthur MSA - Water quality management planning has been conducted by two organizations in the Beaumont-Port Arthur MSA. The South East Texas Regional Planning Commission (SETRPC) was named the planning agency for the designated area portion of the MSA which includes most of Orange County and the northeastern, urbanized area of Jefferson County. The Lower Neches Valley Authority, under contract to the Texas Department of Water Resources, carries out planning activities for the rest of the MSA which includes Hardin County and the non-designated area of Jefferson County. The initial plans produced for both planning areas contained inventories and projections of point and nonpoint sources of pollution, formulation of alternative technical plans capable of handling these sources of pollution, analyses of the effectiveness of these plans in improvement of water quality and an evaluation of the environmental, socio-economic and political impacts of these alternative technical plans. Wastewater facility needs were identified within the MSA and subsequent planning efforts reviewed the needs and updated them as necessary. The initial plans for both areas also recommended further nonpoint source pollution studies involving specific, dry/wet weather sampling programs. In the designated area, SETRPC implemented the recommendation by completing a nonpoint source study in early 1982 for Adams Bayou in Orange County and Hillebrandt Bayou in Jefferson County. The study developed information about observed high levels of fecal coliforms, depressed dissolved oxygen, and excessive aquatic plant growth in the two bayous. Recommendations were made concerning stormwater management planning and the establishment of an ongoing water quality monitoring program to gauge water quality benefits as a result of current sewerage system improvements as well as to assess the impacts of additional pollutant sources. One of these recommendations for the non-designated portion of the area led to a comprehensive nonpoint source water quality study of Pine Island Bayou, which was found to contain high fecal coliform levels. This study, shows improved (though still elevated) coliform levels due to the replacement of septic tanks with sewage treatment plants, and high chloride levels occurring immediately downstream from several oilfield operations. Alternative management practices and recommendations were formulated to reduce these pollutants in the watershed and efforts to implement them are ongoing. All recommendations made during the water quality management process in both areas are considered by local advisory committees as required by the regulations of the Federal Clean Water Act.

<u>Floodplain Management Program in Beaumont-Port Arthur MSA</u> - The Federal Emergency Management Agency has designated all three counties and 20 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the three counties and for 18 of the incorporated cities in the MSA (Appendix C). Presently, the three counties and 16 of the cities in the MSA (Appendix C) have adopted local floodplain management programs in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance availale to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for all three counties and 17 cities in the MSA (Appendix C).

Population and Employment within the Beaumont-Port Arthur MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	330.7	345.9	375.5	Low	404.4	440.6	480.8	528.2	584.8
				High	416.9	463.3	520.0	593.1	689.1
Urban Population	280.0	288.4	297.5	Low	328.5	358.1	386.1	418.4	456.9
				High	335.6	372.5	411.0	460.3	530.5
Other Population	50.7	57.5	78.0	Low	75.9	82.5	94.7	109.8	127.9
				High	81.3	90.8	109.0	132.8	158.6
Employment	112.9	124.4	164.4	Low	190.7	207.9	223.2	241.3	262.7
				High	196.6	218.6	241.5	270.9	309.6

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Beaumont-Port Arthur MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	25.1		9.4		6.1		0.6		41.2	
1980	Surface-Water	30.6		196.7		7.5		0.3		235.1	
1980	Total Use 6/	55.7		206.1		13.6		0.9		276.3	
1990	Total Demand	57.2	85.9	240.9	260.4	13.6	13.6	1.2	1.2	312.9	361.1
1990	Ground-Water	14.3	21.5	1.4	1.5	2.0	2.0	0.9	0.9	18.6	25.9
1990	Surface-Water	42.9	64.4	239.5	258.9	11.6	11.6	0.3	0.3	294.3	335.2
1990	Total Supply 7/	57.2	85.9	240.9	260.4	13.6	13.6	1.2	1.2	312.9	361.1
1990	Shortage	—	—	—	—	—	—	—	—	—	—
2000	Total Demand	63.8	97.1	280.8	314.2	13.6	13.6	1.5	1.5	359.7	426.4
2000	Ground-Water	16.6	25.6	1.4	1.5	2.0	2.0	1.3	1.3	21.3	30.4
2000	Surface-Water	47.2	71.5	279.4	312.7	11.6	11.6	0.2	0.2	338.4	396.0
2000	Total Supply 7/	63.8	97.1	280.8	314.2	13.6	13.6	1.5	1.5	359.7	426.4
2000	Shortage	—	—	—	—	—	—	—	—	—	—
2010	Total Demand	69.5	108.7	311.7	361.3	13.6	13.6	1.5	1.5	396.3	485.1
2010	Ground-Water	19.0	29.4	1.4	1.4	2.0	2.0	1.3	1.3	23.7	34.1
2010	Surface-Water	50.5	79.3	310.3	359.9	11.6	11.6	0.2	0.2	372.6	451.0
2010	Total Supply 7/	69.5	108.7	311.7	361.3	13.6	13.6	1.5	1.5	396.3	485.1
2000	Shortage	—	—	—	—	—	—	—	—	—	—
2020	Total Demand	76.1	123.8	361.6	423.9	13.6	13.6	1.6	1.6	452.9	562.9
2020	Ground-Water	21.9	33.6	1.4	1.5	2.0	2.0	1.4	1.4	26.7	38.5
2020	Surface-Water	54.2	90.2	360.2	422.4	11.6	11.6	0.2	0.2	426.2	524.4
2020	Total Supply 7/	76.1	123.8	361.6	423.9	13.6	13.6	1.6	1.6	452.9	562.9
2000	Shortage	—	—	—	—	—	—	—	—	—	—
2030	Total Demand	84.1	143.6	423.3	501.5	13.6	13.6	1.6	1.6	522.6	660.3
2030	Ground-Water	25.3	37.5	1.4	1.5	2.0	2.0	1.5	1.5	30.2	42.5
2030	Surface-Water	58.8	106.1	421.9	500.0	11.6	11.6	0.1	0.1	492.4	617.8
2030	Total Supply 7/	84.1	143.6	423.3	501.5	13.6	13.6	1.6	1.6	522.6	660.3
2000	Shortage	—	—	—	—	—	—	—	—	—	—

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 367.2 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Beaumont-Port Arthur MSA - Currently within the MSA, approximately 85 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 15 percent is supplied by developed ground-water resources. In the years 2000 and 2030, approximately 93 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately seven percent by ground-water resources.

Many of the smaller yet growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the smaller, growing systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA.

Through the year 2030, there will be more than enough dependable supply from Lakes Sam Rayburn, B.A. Steinhagen, (both in the lower Neches River Basin), and Toledo Bend (lower Sabine River Basin) (Figure 9) to meet the surface-water requirements for all expected needs of the MSA, and all of the remaining expected needs (municipal, manufacturing, steam-electric power, and irrigation) of the lower Neches River Basin, lower Sabine River Basin (Texas), and the Jefferson County area of the Neches-Trinity Coastal Basin.

With these reservoirs, both the lower Sabine River and lower Neches River basins will have surface-water surpluses after meeting the projected in-basin needs; including the MSA and the needs of the MSA in Jefferson County within the Neches-Trinity Coastal Basin. Surpluses could be available for conveyance to water-deficient areas, such as part of the Houston MSA, provided institutional arrangements can be made, and adequate conveyance facilities are constructed. Additional surface-water surpluses within the lower Sabine River and lower Neches River Basins could be obtained by the year 2030 with construction of Lakes Bon Wier and Rockland (Figure 2).

During periods of low flow and high water withdrawals, salt water from Sabine Lake and the Gulf of Mexico intrudes the Sabine and Neches Rivers in sufficient quantities to contaminate the freshwater supplies for urban needs within the MSA. To prevent contamination of these water supplies, permanent salt water barriers need to be constructed at the locations shown on Figure 9. The small amounts of water requirements for navigation facilities associated with these barriers can be met from the projected surpluses in the two river basins.

The J.D. Murphree Wildlife Management Area Impoundments (a group of shallow reservoirs - Figure 9) are owned and operated by the Texas Parks and Wildlife Department for wildlife management purposes. Surface-water supplies are delivered to these reservoirs by major canal systems originating in the Neches River and Trinity River Basins.

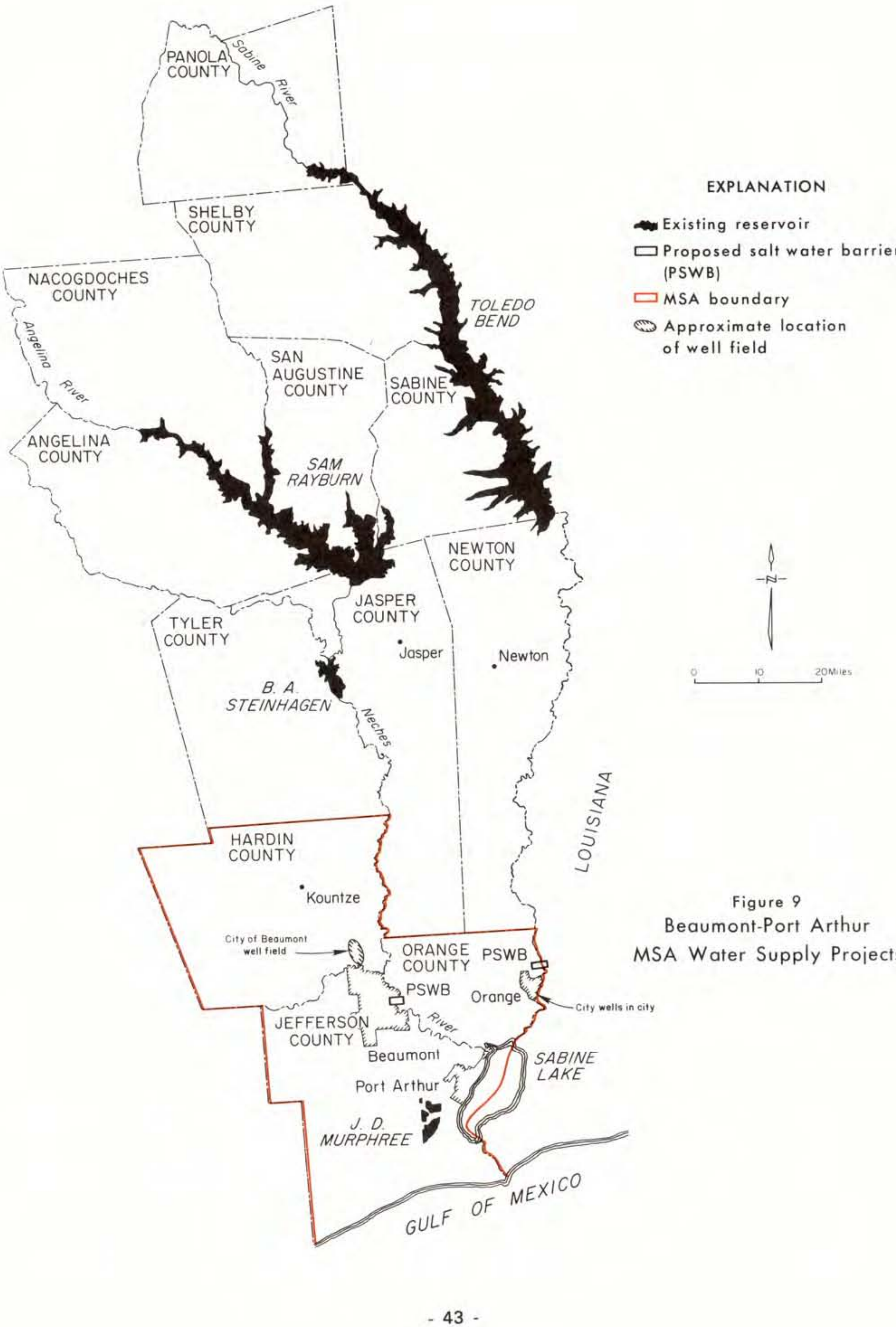


Figure 9
Beaumont-Port Arthur
MSA Water Supply Projects

Description of Brownsville-Harlingen MSA - The MSA is area No. 5 on Figure 1, and is comprised of Cameron County which has about 896 square miles in parts of the Rio Grande Basin and the Nueces-Rio Grande Coastal Basin. Average annual precipitation is about 26 inches. Average annual temperature is about 73.5°F. The principal cities are Brownsville, Harlingen, and San Benito. Other cities in the MSA are listed in Appendix C.

Economy of Brownsville-Harlingen MSA - The area economy has high concentrations in the agriculture, services and trade sectors. Food processing and apparel production are the most important sources of manufacturing employment. Manufacturing contributes 12.0 percent to the total personal income of the MSA. The regional outlook is for rapid growth with enhanced industrial potential and continuing emphasis on agriculture.

Water Quality Management Planning in Brownsville-Harlingen MSA - The Brownsville-Harlingen MSA is located in the Lower Rio Grande Valley Designated Area. The Lower Rio Grande Valley Development Council (LRGVDC) is the designated planning agency. The initial plan for the designated area identified wastewater facility needs, developed a management plan for wastewater treatment, and assessed the impacts of point and nonpoint sources of pollution. Continuing planning activities have focused on sewage disposal needs as needed; the development of management systems and identification of sewage disposal needs for the many unincorporated communities or "colonias"; and the impacts of nonpoint sources (including pesticides and toxic substances). The first two topics are currently underway. The nonpoint source evaluation included the monitoring of water, sediments and fish tissue by the LRGVDC, the Texas Department of Water Resources (TDWR), and the U.S. Fish and Wildlife Service. The net result of these studies indicates that relatively high levels of some chlorinated hydrocarbon pesticides can be found in sediments and some fish species. No particular existing source of these pesticides could be determined. The TDWR believes that these elevated levels are probably residual effects from the heavy agricultural use of these pesticides in the past. The situation will be monitored through the TDWR's stream monitoring network to see if levels decline over time, as they should. All recommendations made during the water quality management process in the designated area are reviewed by a local advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in the Brownsville-Harlingen MSA - The Federal Emergency Management Agency has designated Cameron County and

15 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for 10 of the incorporated cities in the MSA (Appendix C). Presently, the county and 14 cities in the MSA (Appendix C) have adopted local floodplain management programs in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Cameron County and eight cities in the MSA (Appendix C).

Population and Employment within the Brownsville-Harlingen MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
				Low	286.4	360.1	428.5	495.1	569.2
Total Population	151.1	140.3	209.7	High	305.5	399.5	482.3	579.7	681.2
				Low	222.5	278.8	331.8	383.3	440.7
Urban Population	116.5	110.8	162.3	High	237.3	309.3	373.4	448.8	527.4
				Low	63.9	81.3	96.7	111.8	128.5
Other Population	34.6	29.5	47.4	High	68.2	90.2	108.9	130.9	153.8
				Low	115.7	145.5	170.3	193.5	218.8
Employment	43.3	40.2	74.0	High	123.5	161.4	191.7	226.6	261.9

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Brownsville-Harlingen MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	0.4		--		--		--		0.4	
1980	Surface-Water	39.1		1.7		3.2		--		44.0	
1980	Total Use 6/	39.5		1.7		3.2		--		44.4	
1990	Total Demand	58.4	80.9	2.3	2.5	3.2	3.2	--	--	63.9	86.6
1990	Ground-Water	4.5	4.5	--	--	--	--	--	--	4.5	4.5
1990	Surface-Water	44.2	55.5	2.3	2.5	3.2	3.2	--	--	49.7	61.2
1990	Total Supply 7/	48.7	60.0	2.3	2.5	3.2	3.2	--	--	54.2	65.7
1990	Shortage	9.7	20.9	--	--	--	--	--	--	9.7	20.9
2000	Total Demand	76.1	108.9	3.0	3.4	3.2	3.2	--	--	82.3	115.5
2000	Ground-Water	4.5	4.5	--	--	--	--	--	--	4.5	4.5
2000	Surface-Water	50.2	62.8	3.0	3.4	3.2	3.2	--	--	56.4	69.4
2000	Total Supply 7/	54.7	67.3	3.0	3.4	3.2	3.2	--	--	60.9	73.9
2000	Shortage	21.4	41.5	--	--	--	--	--	--	21.4	41.6
2010	Total Demand	90.6	131.4	3.8	4.4	3.2	3.2	--	--	97.6	139.0
2010	Ground-Water	4.5	4.5	--	--	--	--	--	--	4.5	4.5
2010	Surface-Water	57.9	64.1	3.8	4.4	3.2	3.2	--	--	64.9	71.7
2010	Total Supply 7/	62.4	68.6	3.8	4.4	3.2	3.2	--	--	69.4	76.2
2010	Shortage	28.2	62.8	--	--	--	--	--	--	28.2	62.8
2020	Total Demand	104.6	158.0	4.8	5.6	3.2	3.2	--	--	112.6	166.8
2020	Ground-Water	4.5	4.5	--	--	--	--	--	--	4.5	4.5
2020	Surface-Water	64.9	65.3	4.8	5.6	3.2	3.2	--	--	72.9	74.1
2020	Total Supply 7/	69.4	69.8	4.8	5.6	3.2	3.2	--	--	77.4	78.6
2020	Shortage	35.2	88.2	--	--	--	--	--	--	35.2	88.2
2030	Total Demand	120.3	185.6	6.0	7.0	3.2	3.2	--	--	129.5	195.8
2030	Ground-Water	4.5	4.5	--	--	--	--	--	--	4.5	4.5
2030	Surface-Water	69.6	66.1	6.0	7.0	3.2	3.2	--	--	78.8	76.3
2030	Total Supply 7/	74.1	70.6	6.0	7.0	3.2	3.2	--	--	83.3	80.8
2030	Shortage	46.2	115.0	--	--	--	--	--	--	46.2	115.0

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 496.8 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Brownsville-Harlingen MSA - Currently within the MSA, approximately 99 percent of the water used for urban needs (municipal, manufacturing, and steam-electric power generation purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining one percent is supplied by ground-water resources. In the year 2000, only about 60 percent of the MSA's projected urban water requirements (115.5 thousand acre-feet) can be met by available surface-water resources, and only about four percent by ground-water resources. In the year 2030, only about 39 percent of the MSA's projected urban water requirements (195.8 thousand acre-feet) can be met by available surface-water resources, and only about two percent by ground-water resources. Water shortages for urban water needs within the MSA are expected to be about 41.6 thousand acre-feet in 2000 and about 115.0 thousand acre-feet in 2030. The shortages are expected to begin occurring between 1985 and 1990 as described below.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Some of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply will be relatively high. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems are not readily available or surface-water supplies may not be accessible through an entity having water rights.

The MSA is located within the Lower Rio Grande Valley which will continue to be provided, along with the Middle Rio Grande Valley, surface water from the Lake Amistad-Lake Falcon system (Figure 10). Supplies from the system for in-basin needs, as well as needs for the southern portion of the Nueces-Rio Grande Coastal Basin in the Lower Rio Grande Valley, are presently allocated on the basis of 1977 rules of the Texas Water Commission. These rules are based upon water rights recognized in the "Lower Rio Grande Valley Water Case," and in the Middle Rio Grande (between Lake Amistad and Lake Falcon) upon a "Final Determination" of water rights and claims by the Commission. The 1977 specific water allocation for urban uses from the reservoir system is about 186.0 thousand acre-feet per year. Total urban water needs within the MSA and other areas served by the Lake Amistad-Lake Falcon system are expected to reach about 312.9 thousand acre-feet in the year 2000. Serious regional urban water shortages within the Lake Amistad-Lake Falcon service area are expected to occur between 1985 and 1990 based on the current urban water allocation (supply) of 186.0 thousand acre-feet. Under present conditions, 100.0 thousand acre-feet of storage in Lake Amistad and Lake Falcon are set aside for emergency urban needs under drought conditions for the Middle and Lower Rio Grande Valleys for authorized allocations by the adjudication certificates. By 1990, new operation of Retamal channel dam for water supply purposes (Figure 2) and the completion of the proposed Site "A" channel dam near Brownsville (Figure 10) could provide more than 50 thousands acre-feet of additional surface-water supply to the MSA.

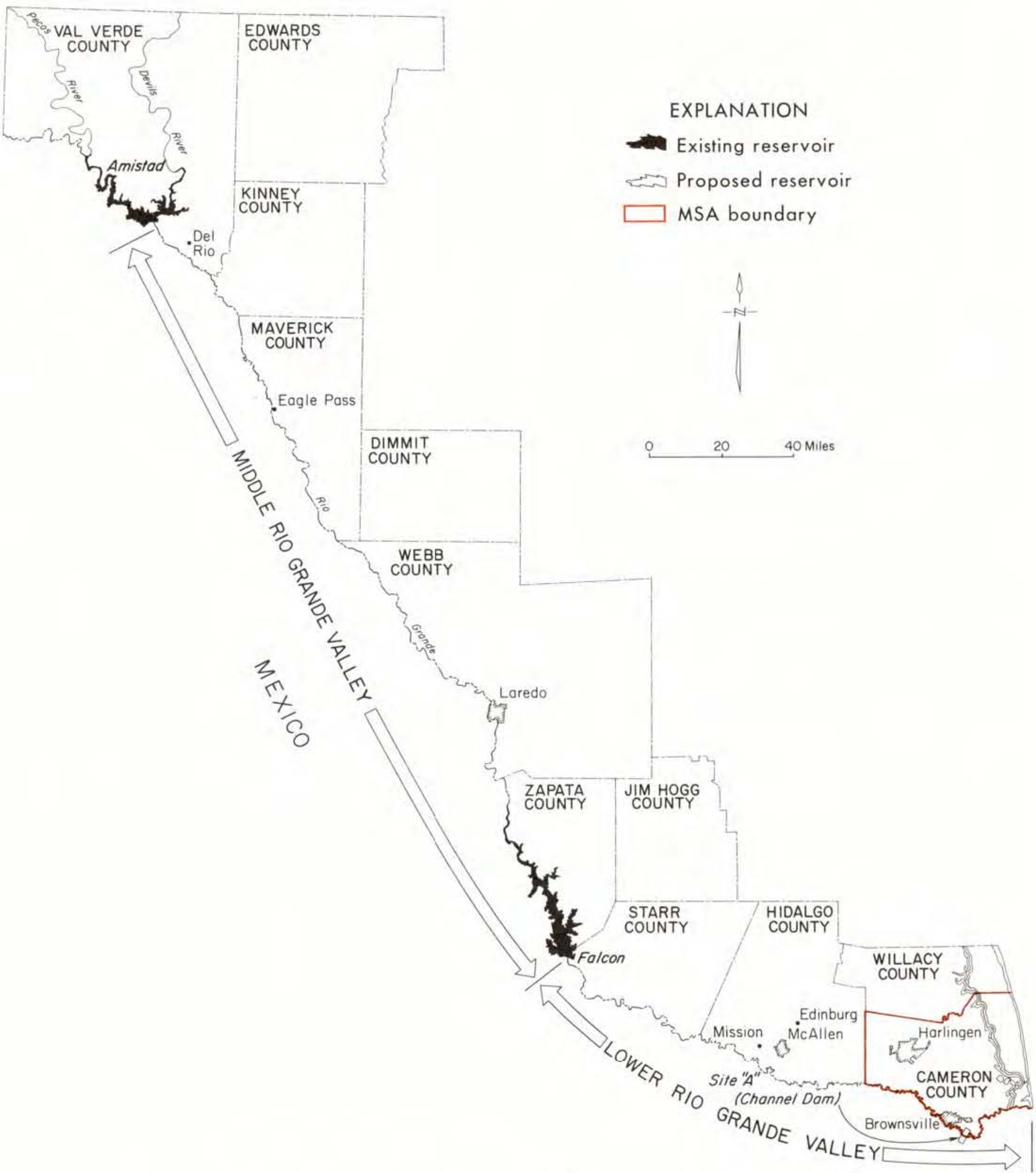


Figure 10
Brownsville-Harlingen MSA Water Supply Projects

On the basis of experience of the irrigators served by the Lake Amistad-Lake Falcon system, and the results of the Department's analysis of long-term reservoir operation studies of the system that were conducted by the International Boundary and Water Commission, shortages of water necessary to meet the full demands of the currently adjudicated acreage in the Lower Valley below Lake Falcon (about 740 thousand acres needing about 1.87 million acre-feet of water annually) are expected to occur more than 70 percent of the time, although substantial or serious shortages would occur less than 30 percent of the time. During critical drought periods, substantial shortages will occur and a significant part of the current irrigated acreage would have no irrigation water supply.

High concentrations of total dissolved solids are often encountered in ground-water supplies from the Gulf Coast Aquifer (Figure 3) within the MSA. Salinity coupled with the low permeability of the aquifer and low recharge rates do not permit adequate amounts of ground water to be developed for moderate to large municipal and manufacturing supplies within the MSA.

BRYAN-COLLEGE STATION MSA

Description of Bryan-College Station MSA - The MSA is area No. 6 on Figure 1, and is comprised of Brazos County which has about 586 square miles in the Brazos River Basin. Average annual precipitation ranges from 38 to 40 inches. Average annual temperature is about 67.5° F. Principal cities are Bryan and College Station.

Economy of Bryan-College Station MSA - The area economy has a significant concentration of employment in the State University and local government sectors, with recent increases of activity in the construction, mining and manufacturing sectors. Manufacturing contributes 7.0 percent to the total personal income of the MSA with fabricated metals and printing industries as important employment sources. The economic outlook for the MSA is rapid growth of Texas A&M University and continued activity in the mining and manufacturing sectors.

Water Quality Management Planning in Bryan-College Station MSA - The Bryan-College Station MSA is located entirely within the Brazos River Basin. The Texas Department of Water Resources contracted with the Brazos River Authority for water quality management planning in the basin. The initial plan for the MSA portion of the basin identified wastewater facility needs and subsequent planning efforts reviewed the needs and updated them as found necessary. Additionally, the impacts of point and nonpoint sources of pollution were analyzed. The wasteloads were found to be within the assimilative capacity of the streams and no further special studies were identified. All recommendations made during the water quality management process are reviewed by an advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Bryan-College Station MSA - The Federal Emergency Management Agency has designated Brazos County and the two incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and the incorporated cities in the MSA (Appendix C). Presently, the two cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for the two incorporated cities in the MSA (Appendix C).

Population and Employment within the Bryan-College Station MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	44.9	58.0	93.6	Low	128.1	158.3	176.9	192.0	203.1
				High	146.4	172.4	192.3	205.5	219.6
Urban Population	38.9	51.4	81.6	Low	112.7	139.5	155.9	169.2	179.0
				High	128.9	151.9	169.4	181.1	193.5
Other Population	6.0	6.6	12.0	Low	15.4	18.8	21.0	22.8	24.1
				High	17.6	20.5	22.9	24.4	26.1
Employment	15.6	21.9	42.7	Low	65.5	80.9	89.0	94.9	98.8
				High	74.9	88.1	96.7	101.6	106.8

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Bryan-College Station MSA 1/

Year	Analyses Catagory	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	19.8		0.4		--		1.2		21.4	
1980	Surface-Water	--		--		3.0		--		3.0	
1980	Total Use 6/	19.8		0.4		3.0		1.2		24.4	
1990	Total Demand	28.5	41.9	0.6	0.6	3.0	3.0	1.6	1.6	33.7	47.1
1990	Ground-Water	10.8	10.8	0.2	0.2	3.0	3.0	1.6	1.6	15.6	15.6
1990	Surface-Water	17.7	31.1	0.4	0.4	--	--	--	--	18.1	31.5
1990	Total Supply 7/	28.5	41.9	0.6	0.6	3.0	3.0	1.6	1.6	33.7	47.1
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	36.7	50.9	0.8	0.9	3.0	3.0	1.9	1.9	42.4	56.7
2000	Ground-Water	10.8	10.8	0.2	0.2	3.0	3.0	1.9	1.9	15.9	15.9
2000	Surface-Water	25.9	40.1	0.6	0.7	--	--	--	--	26.5	40.8
2000	Total Supply 7/	36.7	50.9	0.8	0.9	3.0	3.0	1.9	1.9	42.4	56.7
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	41.0	56.8	1.0	1.2	3.0	3.0	2.2	2.2	47.2	63.2
2010	Ground-Water	10.8	10.8	0.2	0.2	3.0	3.0	2.2	2.2	16.2	16.2
2010	Surface-Water	30.2	46.0	0.8	1.0	--	--	--	--	31.0	47.0
2010	Total Supply 7/	41.0	56.8	1.0	1.2	3.0	3.0	2.2	2.2	47.2	63.2
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	44.5	60.7	1.3	1.6	3.0	3.0	2.5	2.5	51.3	67.8
2020	Ground-Water	10.8	10.8	0.2	0.2	3.0	3.0	2.5	2.5	16.5	16.5
2020	Surface-Water	33.7	49.9	1.1	1.4	--	--	--	--	34.8	51.3
2020	Total Supply 7/	44.5	60.7	1.3	1.6	3.0	3.0	2.5	2.5	51.3	67.8
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	47.1	64.9	1.7	2.0	3.0	3.0	2.8	2.8	54.6	72.7
2030	Ground-Water	10.8	10.8	0.2	0.2	3.0	3.0	2.8	2.8	16.8	16.8
2030	Surface-Water	36.3	54.1	1.5	1.8	--	--	--	--	37.8	55.9
2030	Total Supply 7/	47.1	64.9	1.7	2.0	3.0	3.0	2.8	2.8	54.6	72.7
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 7.1 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Bryan-College Station MSA - Currently within the MSA, approximately 88 percent of the water for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed ground-water resources, and 12 percent is supplied by surface-water resources. In the year 2000, approximately 72 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 28 percent by ground-water resources. In the year 2030, about 77 percent of the requirements are expected to be supplied by surface-water resources, and about 23 percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

Based on projected water requirements and estimated ground-water yields, the cities of Bryan and College Station, as well as other smaller urban water systems and power plants in the MSA, will need to acquire surface water to supplement current ground-water supplies. The authorized Corps of Engineers' reservoir on the Navasota River, Lake Millican (Figure 11), could provide the major part of these supplemental requirements provided development of the Navasota River can be implemented in a timely manner. The Millican Reservoir Project is in the advanced engineering and design phase. However, the existence of potentially commercial, near-surface lignite deposits in the reservoir area, part of which have been acquired by utilities, poses a significant conflict. The Corps of Engineers is currently reassessing the plan of development for the Navasota River, which includes examination of several alternatives and possible reformulation of the authorized plan of development of the Navasota River. For current planning purposes, it has been estimated that the authorized Millican Lake will be constructed before the year 2000. This would provide an additional firm yield of 141.6 thousand acre-feet annually to the basin supply.

An alternative water supply source near the MSA is Lake Caldwell (Figure 11) which is a proposed project currently in the planning stage. This project is proposed to be built on Cedar Creek in Burleson and Milam counties by the Brazos River Authority (BRA). The project could be supplemented with diversions of Brazos River floodwater, and could be used as an alternative for suppling BRA customers in the lower Brazos River Basin and adjoining basins as well as the MSA. These conditions of use also would allow water from Stillhouse Hollow and Belton Lakes (Figure 2) to be used to supply increased future water needs in the Killeen-Temple and Austin MSAs.

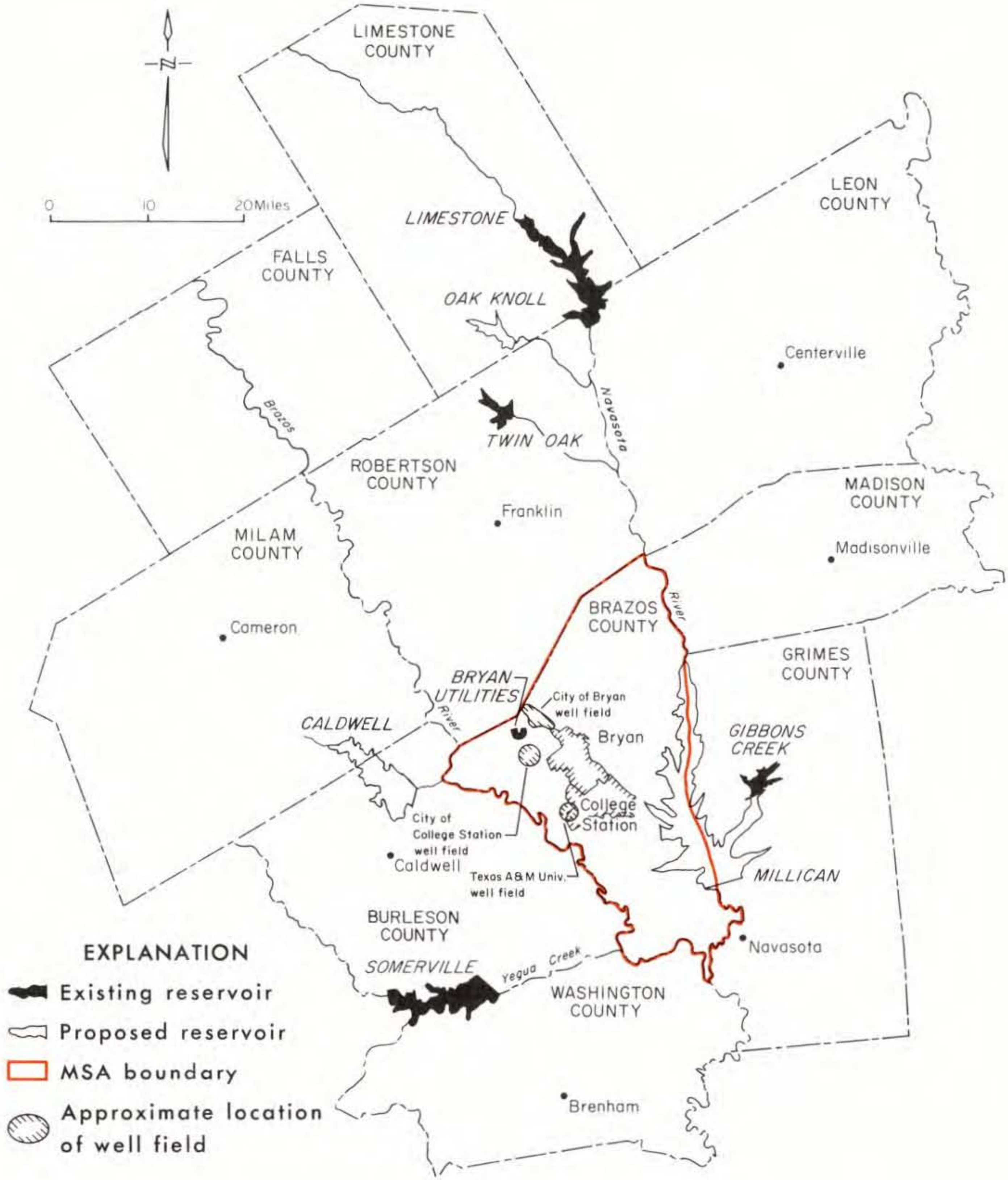


Figure 11
Bryan-College Station MSA Water Supply Projects

From the late 1980's through the year 2030, urban water systems within the MSA are expected to be using about 15 to 17 thousand acre-feet per year of ground-water from the Carrizo-Wilcox Aquifer (Figure 3). Bryan Utilities Lake (Figure 11) in Brazos County is owned by the City of Bryan and is used to store a small amount of local surface-water runoff as a supplemental water supply. The lake is also used to store and cool a small amount of high temperature ground water pumped from the city's well field near the lake (Figure 11).

CORPUS CHRISTI MSA

Description of Corpus Christi MSA - The MSA is area No. 7 on Figure 1, and is comprised of Nueces and San Patricio counties which cover about 1,526 square miles in parts of the Nueces River Basin and the San Antonio-Nueces Coastal and Nueces-Rio Grande Coastal Basins. Average annual precipitation ranges from 28 to 36 inches. Average annual temperature is about 72°F. The principal cities are Corpus Christi, Robstown, Sinton and Aransas Pass. Other cities in the MSA are listed in Appendix C.

Economy of Corpus Christi MSA - The area economy is weighted toward the agricultural, mining and construction sectors. Refining, petrochemicals, primary metal industries and production of offshore drilling equipment are important sources of manufacturing employment. Manufacturing contributes 12.0 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on the port and continued growth in the petrochemical industries and recreation and tourism.

Water Quality Management Planning in Corpus Christi MSA - The MSA includes Nueces and San Patricio counties. In 1975, the Coastal Bend Council of Governments (CBCOG) was designated as the areawide planning agency for the Corpus Christi Designated Area, under Section 208 of the Federal Clean Water Act. One main objective of the planning program was to develop a cost-effective and implementable plan that would meet the goals of the Act. Other objectives dealt with water pollution problems, nonstructural approaches to pollution control, deficiencies in collection, transportation and treatment of residential and industrial wastes, point and nonpoint sources of pollution and their interrelationship. Additional objectives were the development and selection of a management system best suited for assuring implementation of the plan and the production of a method for periodic review and updating of the plan. This initial 208 plan was the first designated area plan in Texas to be fully approved by the Environmental Protection Agency. Public participation is involved in all of the continuing planning programs. The Planning Advisory Committee for the CBCOG is a very active one and has representation from four groups: private citizens, public officials, public interests, and economic interests. This committee reviews all documents released by CBCOG. CBCOG also identified the wastewater facility needs for communities through the year 2000 in five year increments. The needs are expressed in three categories: collection systems, interceptor and sewage treatment plant construction, and/or rehabilitation. In 1981-1982, the CBCOG continued to develop long-range water quality management programs focusing on wastewater facility needs and nonpoint source, urban runoff and nutrient assimilation studies of area bays. Under Section 205(j), CBCOG is assisting the Texas Department of Water

Resources (TDWR) in developing wastewater treatment management agencies in unincorporated areas of the region with facility needs. CBCOG also is providing coordination between the approved water quality management plan and proposed construction grant projects for wastewater treatment works in their area. The work involved in this effort consists of conflict resolution between the water quality management plan and proposed construction grant projects including recommendations to TDWR for plan/grant project changes.

Floodplain Management Program in Corpus Christi MSA - The Federal Emergency Management Agency has designated both counties and 14 incorporated cities in the Corpus Christi MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for both counties and the 14 incorporated cities in the MSA (Appendix C). Presently, both counties and 13 cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for both counties and 12 cities in the MSA (Appendix C).

Population and Employment within the Corpus Christi MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
				Low	376.4	415.6	458.7	516.3	595.9
Total Population	266.6	284.9	326.2	High	388.8	433.9	497.5	600.7	720.7
				Low	352.2	391.2	430.9	485.4	561.2
Urban Population	215.6	262.5	300.4	High	363.8	408.1	467.3	565.1	679.5
				Low	24.2	24.4	27.8	30.9	34.7
Other Population	51.0	22.4	25.8	High	25.0	25.8	30.2	35.6	41.2
				Low	178.1	196.8	213.8	236.7	268.7
Employment	82.4	96.3	148.3	High	184.1	205.5	231.9	275.4	325.0

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Corpus Christi MSA 1/

Year	Analyses Catagory	Municipal Low	Municipal High	Manufacturing3/ Low	Manufacturing3/ High	Steam Electric4/ Low	Steam Electric4/ High	Mining5/ Low	Mining5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	4.4		0.5		--		0.3		5.2	
1980	Surface-Water	67.7		40.8		3.2		0.2		111.9	
1980	Total Use 6/	72.1		41.3		3.2		0.5		117.1	
1990	Total Demand	66.3	93.6	49.6	53.1	3.2	3.2	0.7	0.7	119.8	150.6
1990	Ground-Water	1.9	1.9	2.7	2.7	--	--	0.2	0.2	4.8	4.8
1990	Surface-Water	64.4	91.7	46.9	50.4	3.2	3.2	0.5	0.5	115.0	145.8
1990	Total Supply 7/	66.3	93.6	49.6	53.1	3.2	3.2	0.7	0.7	119.8	150.6
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	74.9	106.0	57.4	63.6	3.2	3.2	0.8	0.8	136.3	173.6
2000	Ground-Water	1.9	1.9	2.6	2.6	--	--	0.3	0.3	4.8	4.8
2000	Surface-Water	73.0	104.1	54.8	61.0	3.2	3.2	0.5	0.5	131.5	168.8
2000	Total Supply 7/	74.9	106.0	57.4	63.6	3.2	3.2	0.8	0.8	136.3	173.6
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	82.4	121.5	64.3	73.7	3.2	3.2	0.8	0.8	150.7	199.2
2010	Ground-Water	1.9	1.9	2.7	2.7	--	--	0.2	0.2	4.8	4.8
2010	Surface-Water	80.5	119.6	61.6	71.0	3.2	3.2	0.6	0.6	145.9	194.4
2010	Total Supply 7/	82.4	121.5	64.3	73.7	3.2	3.2	0.8	0.8	150.7	199.2
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	92.9	147.1	74.7	86.8	3.2	3.2	0.7	0.7	171.5	237.8
2020	Ground-Water	1.9	1.9	2.7	2.7	--	--	0.1	0.1	4.8	4.8
2020	Surface-Water	91.0	145.2	72.0	84.1	3.2	3.2	0.6	0.6	166.8	233.1
2020	Total Supply 7/	92.9	147.1	74.7	86.8	3.2	3.2	0.7	0.7	171.5	237.8
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	107.7	177.2	87.6	103.0	3.2	3.2	0.7	0.7	199.2	284.1
2030	Ground-Water	1.9	1.9	2.7	2.7	--	--	0.1	0.1	4.7	4.7
2030	Surface-Water	105.8	175.3	84.9	100.3	3.2	3.2	0.6	0.6	194.5	279.4
2030	Total Supply 7/	107.7	177.2	87.6	103.0	3.2	3.2	0.7	0.7	199.2	284.1
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 3.4 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Corpus Christi MSA - Currently within the MSA, approximately 96 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining four percent is supplied by ground-water resources. In the years 2000 and 2030, approximately 98 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately two percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Corpus Christi water system and other urban water systems within the MSA and the adjacent area will obtain their water supplies from the Choke Canyon Lake - Lake Corpus Christi system (Figure 12) in the Nueces River Basin. The system started operating with Choke Canyon Lake in 1983 and has a dependable yield of about 252 thousand acre-feet annually, when Choke Canyon is filled and fully operational. In addition, the system is expected to capture annually about 10.2 and 14.8 thousand acre-feet of reusable return flows in 2000 and 2030, respectively. The total projected urban needs to be served by the Choke Canyon Lake-Lake Corpus Christi system (including the MSA) is expected to be about 197 and 315.7 thousand acre-feet per year in the years 2000 and 2030, respectively. Based on these projections and the dependable supply of the reservoir system, the MSA and adjacent area will need an additional surface-water supply between the years 2010 and 2020 to meet the regional urban water needs.

The additional supplies could be obtained from either the proposed Goliad or Cuero Reservoir Projects (Figure 2). The Goliad Reservoir Project has been proposed by the City of San Antonio and the San Antonio River Authority (SARA) to meet the long-range needs of the San Antonio MSA and neighboring areas. The project is presently under study by the City of San Antonio, SARA and the Edwards Underground Water District (EUWD). The Cuero Reservoir Project is proposed by the Guadalupe-Blanco River Authority (GBRA) for construction on the Guadalupe River near Cuero, Texas. The project is presently under study by the City of San Antonio, SARA, EUWD and the GBRA. The City of Corpus Christi has expressed some interest in becoming involved in these studies of the Goliad and Cuero Reservoir Projects.

During the drought of 1984, the City of Corpus Christi reactivated its Carrizo Aquifer well field (Figure 12) in Atascosa County. Water is

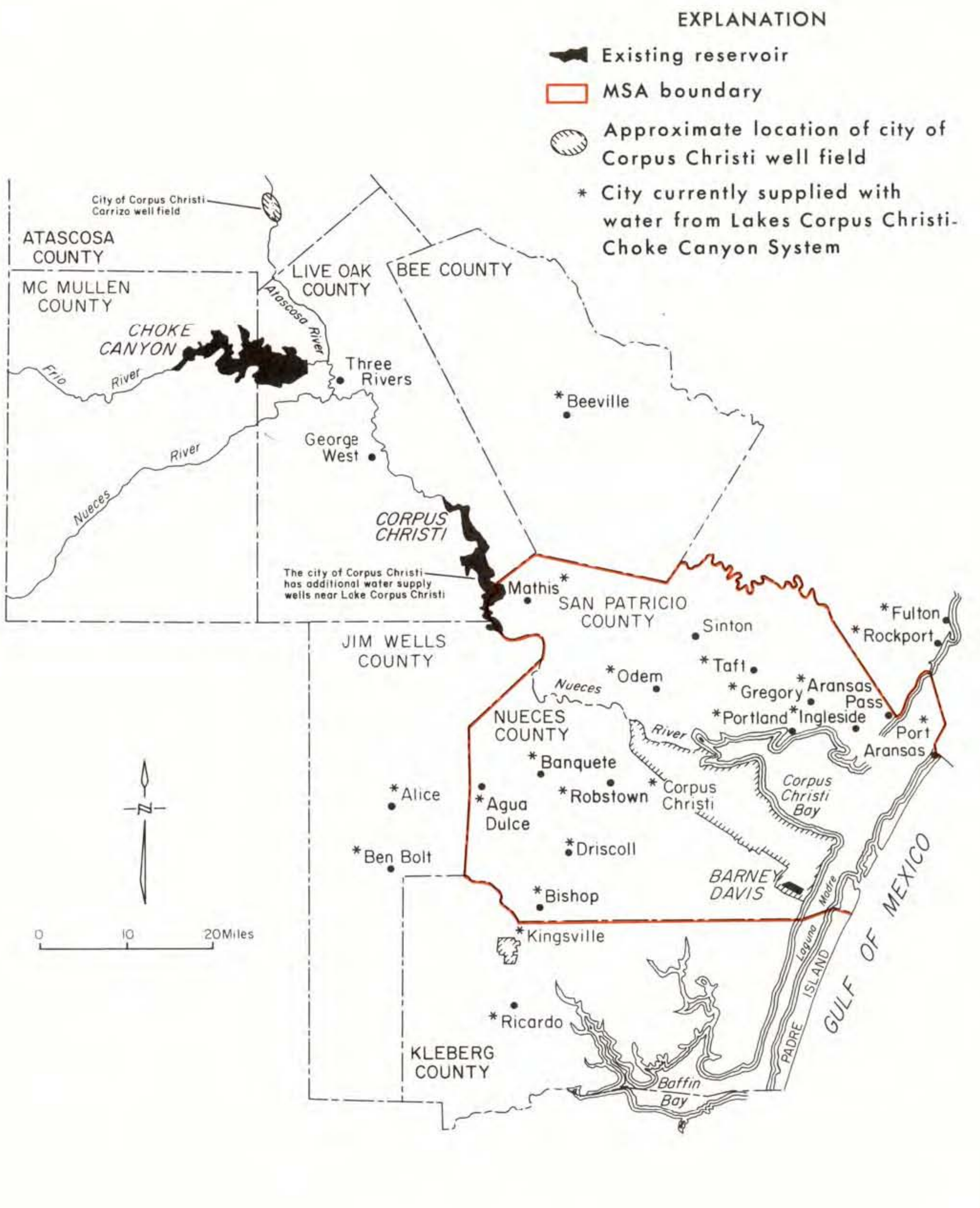


Figure 12
Corpus Christi MSA Water Supply Projects

pumped from this well field into the Atascosa River which conveys the water to Lake Corpus Christi. In 1984, the City of Corpus Christi also reactivated additional Gulf Coast Aquifer wells near Lake Corpus Christi (Figure 12) for additional water for drought relief. The City is currently acquiring land around the lake to complete new Gulf Coast Aquifer wells for additional supplies to help meet the water demands of future drought conditions.

The Barney M. Davis Lake in Nueces County (Figure 12) is a Central Power and Light cooling-water reservoir which uses saline water from the Laguna Madre.

Some of the small water systems currently supplied by ground water from the Gulf Coast Aquifer may need to seek surface-water supplies in the future due to limited and inferior quality ground-water supplies. Over development of ground water within the MSA and parts of the adjacent area are expected to cause problems due to land subsidence, movement of geologic faults, and saline-water encroachment.

DALLAS MSA

Description of Dallas MSA - The MSA is area No. 8 on Figure 1, and is comprised of Collin, Dallas, Denton, Ellis, Kaufman, and Rockwall counties which cover about 4,508 square miles in parts of the Trinity River and Sabine River Basins. Average annual precipitation ranges from 32 to 40 inches. Average annual temperatures range from 64 F to 66 $^{\circ}$F. The principal cities are Dallas, Irving, Denton, McKinney, Plano, Rockwall, Terrell, and Waxachachie. Other cities in the MSA are listed in Appendix C.

Economy of Dallas MSA - The area's economy is diverse; being fairly well balanced in manufacturing, trade, transportation, finance and services. Manufacturing industries producing electronics, apparel, transportation equipment, and machinery are the most important sources of manufacturing employment. Manufacturing contributes 17.2 percent to the total personal income of the MSA. The regional economic outlook is for a good continuing business climate and steady growth.

Water Quality Management Planning in Dallas MSA - The North Central Texas Council of Governments (NCTCOG) is designated as the areawide water quality management planning agency for the Dallas-Fort Worth area which includes all of Dallas County and portions of Collin, Denton, Ellis, Kaufman and Rockwall counties of the Dallas MSA. The Trinity River Authority of Texas, under contract to the Texas Department of Water Resources, carries out planning activities for the balance of Denton and Ellis counties and portions of Kaufman and Rockwall counties. The Sabine River Authority of Texas performs the same role for the rest of Collin, Kaufman, and Rockwall counties of the Dallas MSA. The initial plans of all three agencies identified wastewater facility needs within the MSA and subsequent planning efforts reviewed these needs and updated them where necessary. In the designated area, a committee of local governments, working through the NCTCOG, had already developed the "Upper Trinity River Basin Comprehensive Sewerage Plan." The plan included a system of joint wastewater treatment works, each designed to serve several cities at one location, thereby eliminating many smaller single-community plants. During the 1970's and early 80's, upgrading and expansion has occurred at most of these treatment plants. The Dallas Central and TRA Central plants are the two largest joint system treatment works in the Dallas MSA. Significant improvements have occurred to the treatment works since 1975-76, resulting in substantial reductions of biological oxygen demand (BOD) concentrations and loadings from 1975-76 to 1982-83. For the Dallas Central plants, BOD concentrations have been reduced from 59 mg/l to 10 mg/l, while BOD concentrations for the TRA Central plant have been reduced from 32 mg/l to 5 mg/l, even though sewage flow has increased at both plants. Overall, the joint system treatment plants in the designated planning area have reduced the total annual loadings by 10.4 million kilograms since 1975, which represents a 57 percent decrease, even though flow has increased by 50 percent. A network of continuous automated monitors has been recording the changes in dissolved oxygen water quality of the Trinity River for several years. The areawide water quality management plan is being updated annually by NCTCOG. The most recent plan Clean Water 84, addresses water resources, treatment works and stormwater management as associated with nonpoint source pollution. Possible solutions using stormwater and watershed management techniques are being evaluated by local governments in the region as part of the Lake Ray Hubbard Watershed Planning Program. All recommendations made in the water quality management planning process are reviewed by local advisory committees as required by regulations under the Federal Clean Water Act.

Floodplain Management Program In Dallas MSA - The Federal Emergency Management Agency has designated all five counties and 85 incorporated cities in the Dallas MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for all five counties and 79 incorporated cities in the MSA (Appendix C). Presently, four counties and 53 cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for two counties and 48 cities in the MSA (Appendix C).

Population and Employment within the Dallas MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
				Projections					
	(Thousands)				(Thousands)				
Total Population	1119.4	1556.0	1957.3	Low	2320.5	2667.6	3033.3	3425.7	3820.6
				High	2416.6	2871.7	3406.4	3967.3	4535.8
Urban Population	1033.7	1469.5	1858.5	Low	2173.1	2471.7	2792.5	3138.2	3486.8
				High	2258.6	2645.5	3111.4	3600.5	4095.1
Other Population	85.7	86.5	98.8	Low	147.4	195.9	240.8	287.5	333.8
				High	158.0	226.2	295.0	366.8	440.7
Employment	453.9	665.5	1151.1	Low	1314.6	1511.8	1691.7	1879.5	2061.6
				High	1369.0	1627.5	1899.7	2176.7	2447.5

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Dallas MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	27.6		3.8		1.0		---		32.4	
1980	Surface-Water	402.5		35.1		24.0		4.1		465.7	
1980	Total Use 6/	430.1		38.9		25.0		4.1		498.1	
1990	Total Demand	410.4	581.8	60.0	64.9	24.9	24.9	5.0	5.0	500.3	676.6
1990	Ground-Water	17.3	19.7	1.3	1.3	---	---	0.3	0.3	18.9	21.3
1990	Surface-Water	393.1	562.1	58.7	63.6	24.9	24.9	4.7	4.7	481.4	655.3
1990	Total Supply 7/	410.4	581.8	60.0	64.9	24.9	24.9	5.0	5.0	500.3	676.6
1990	Shortage	---	---	---	---	---	---	---	---	---	---
2000	Total Demand	479.1	697.8	84.6	95.0	24.9	24.9	5.9	5.9	594.5	823.6
2000	Ground-Water	18.9	19.7	1.3	1.3	---	---	0.2	0.2	20.4	21.2
2000	Surface-Water	460.2	678.1	83.3	93.7	24.9	24.9	5.7	5.7	574.1	802.4
2000	Total Supply 7/	479.1	697.8	84.6	95.0	24.9	24.9	5.9	5.9	594.5	823.6
2000	Shortage	---	---	---	---	---	---	---	---	---	---
2010	Total Demand	542.2	823.9	111.5	128.0	24.9	24.9	6.8	6.8	685.4	983.6
2010	Ground-Water	18.9	19.9	1.3	1.3	---	---	0.2	0.2	20.4	21.4
2010	Surface-Water	523.3	804.0	110.2	126.7	24.9	24.9	6.6	6.6	665.0	962.2
2010	Total Supply 7/	542.2	823.9	111.5	128.0	24.9	24.9	6.8	6.8	685.4	983.6
2010	Shortage	---	---	---	---	---	---	---	---	---	---
2020	Total Demand	610.2	956.0	143.3	167.0	24.9	24.9	7.7	7.7	786.1	1155.6
2020	Ground-Water	15.6	20.1	1.9	1.3	---	---	0.2	0.2	17.7	21.6
2020	Surface-Water	594.6	935.9	141.4	165.7	24.9	24.9	7.5	7.5	768.4	1134.0
2020	Total Supply 7/	610.2	956.0	143.3	167.0	24.9	24.9	7.7	7.7	786.1	1155.6
2020	Shortage	---	---	---	---	---	---	---	---	---	---
2030	Total Demand	678.5	1089.8	182.2	214.5	24.9	24.9	8.6	8.6	894.2	1337.8
2030	Ground-Water	17.2	18.5	1.1	1.1	---	---	0.2	0.2	18.5	19.8
2030	Surface-Water	661.3	1071.3	181.1	213.4	24.9	24.9	8.4	8.4	875.7	1318.0
2030	Total Supply 7/	678.5	1089.8	182.2	214.5	24.9	24.9	8.6	8.6	894.2	1337.8
2030	Shortage	---	---	---	---	---	---	---	---	---	---

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 6.2 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

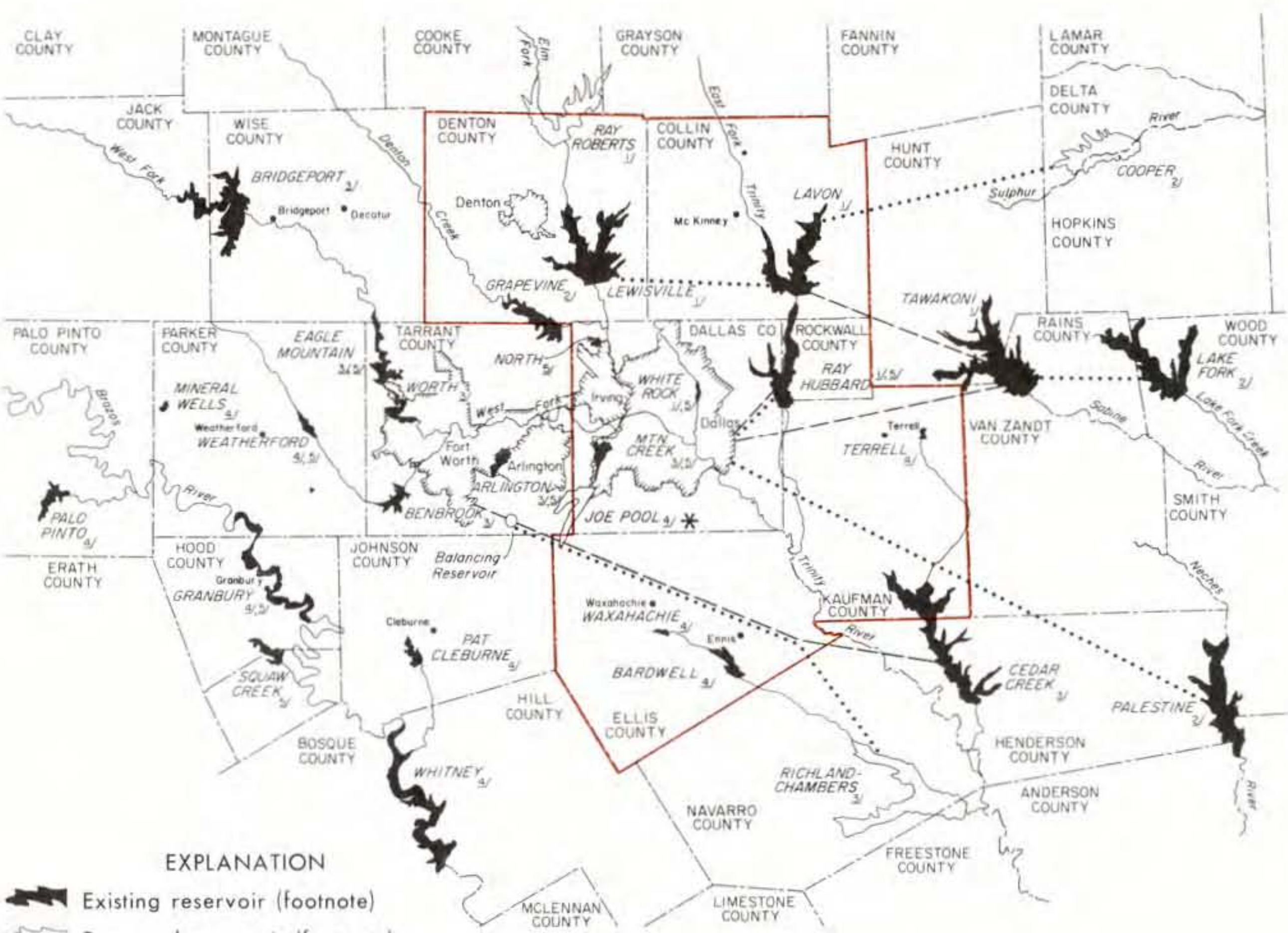
7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Dallas MSA - Currently within the MSA, approximately 94 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 11 percent is supplied by ground-water resources. In the years 2000 and 2030, about 98 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and two percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The existing and proposed surface-water projects related to the current and future urban water needs of the MSA are shown on Figure 13, which also generally explains the interrelated reservoir (supply) - water system (user) relationship that exists within the MSA. Surface-water development is near maximum potential in the upper Trinity River basin in the MSA. The following surface-water projects are anticipated for completion in the 1980's to provide additional water supplies for the MSA:

Project	River Basin Location of Lake (Figure 13)	Additional Supply Permitted by
Ray Roberts Lake	Upper Trinity	Cities of Dallas and Denton
Joe Pool Lake	Upper Trinity	Cities of Cedar Hill, et al. through the Trinity River Authority
Pipeline from Lake Fork Lake to Lake Tawakoni	Upper Sabine	City of Dallas
Cooper Lake	Upper Sulphur	North Texas Municipal Water District, City of Irving, and Sulphur River Municipal Water District



EXPLANATION

- Existing reservoir (footnote)
- Proposed reservoir (footnote)
- Approximate location of major existing pipeline
- Approximate location of major proposed pipeline
- MSA boundary

Footnotes

1/ Existing or proposed water supply for the Dallas, North Texas Municipal Water District, and Denton systems

2/ Existing or proposed water supply for the Dallas, et al systems from a part of the reservoir's yield

3/ Existing or proposed water supply for the Fort Worth, Tarrant County WCID No. 1, and Arlington systems

4/ Existing water supply currently used or proposed for use by other urban water systems within the MSA

5/ Existing water supply for power plants within the MSA

* Planned for completion in 1988

Figure 13

Dallas MSA Water Supply Projects

Projected urban water demands indicate that the Dallas MSA will need additional water supplies in about the years 2020 to 2024. These additional supplies will have to be obtained from additional development of the surface-water resources of the upper (western) portions of the Neches, Sabine and Sulphur River basins (Figure 2) or imports from the Red River basin (Figure 2).

Recoverable ground-water storage in the major and minor aquifers (Figures 3 and 4) within the MSA has been depleted to such an extent that depths to water levels occur at more than 1,000 feet below the land surface. These deep water levels are causing pumping costs to be burdensome. The quality of ground water has deteriorated in some areas within the MSA. Fluoride concentrations in ground waters produced by many of the urban water systems within the MSA are too high, exceeding the Environmental Protection Agency-Texas State Health Department (EPA-TSAD) maximum allowable level of 1.6 milligrams per liter for the MSA. Also, many of the urban ground-water systems have water with high iron concentrations which exceed the EPA-TSHD maximum allowable level of 0.3 milligrams per liter.

Description of El Paso MSA - The MSA is area No. 9 on Figure 1, and is comprised of El Paso County which covers about 1,057 square miles in the western most part of the Rio Grande Basin in Texas. Average annual precipitation is about 8 inches. Average annual temperature is about 63°F. The principal city is El Paso. Other cities in the MSA are listed in Appendix C.

Economy of El Paso MSA - The area economy has relatively high employment concentrations in the trades, transportation, communications, and public utilities sectors, with significant activity in the processing and distribution of products of the extractive industries. The apparel industry is the most important source of manufacturing employment. Manufacturing contributes 13.9 percent to the total personal income of the MSA. The regional economic outlook is for steady growth. El Paso will continue its role as a transportation and trade center.

Water Quality Management Planning in El Paso MSA - The El Paso MSA is located entirely within the Upper Rio Grande River Basin. The Texas Department of Water Resources contracted with the West Texas Council of Governments for water quality management planning in the Upper Rio Grande Basin. The initial plan identified wastewater facility needs within the basin and subsequent planning efforts reviewed the needs and updated them as found necessary. An analysis of point and nonpoint sources of pollution indicated that point sources are the major contributors to pollution in the area. All recommendations made during the water quality management process in the basin were reviewed by a local advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in El Paso MSA - The Federal Emergency Management Agency has designated El Paso County and three incorporated cities as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for the three incorporated cities (Appendix C). Presently, the county and the three cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. The City of El Paso is the only entity within the MSA for which a Detailed Flood Insurance Rate Study has been completed (Appendix C). Such studies provide detailed data on 10-year, 50-year,. 100-year, and 500-year flood events.

Population and Employment within the El Paso MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
				Low	601.9	725.1	853.6	922.1	1146.0
Total Population	314.1	359.3	479.9	High	632.4	791.0	965.1	1173.2	1379.8
				Low	592.8	717.4	842.1	976.4	1126.0
Urban Population	282.3	346.8	449.9	High	622.8	782.6	952.1	1154.6	1355.7
				Low	9.1	7.7	11.5	15.7	20.0
Other Population	31.8	12.5	30.0	High	9.6	8.4	13.0	18.6	24.1
				Low	263.9	318.1	368.5	421.4	478.7
Employment	86.9	106.9	199.3	High	277.3	347.0	416.6	498.3	576.3

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the El Paso MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	83.4		9.2		3.9		—		96.5	
1980	Surface-Water	18.9		0.4		—		—		19.3	
1980	Total Use 6/	102.3		9.6		3.9		—		115.8	
1990	Total Demand	131.7	140.9	11.4	12.1	3.9	3.9	—	—	147.0	156.9
1990	Ground-Water	120.4	129.5	10.7	11.3	3.9	3.9	—	—	135.0	144.7
1990	Surface-Water	11.3	11.4	0.7	0.8	—	—	—	—	12.0	12.2
1990	Total Supply 7/	131.7	140.9	11.4	12.1	3.9	3.9	—	—	147.0	156.9
1990	Shortage	—	—	—	—	—	—	—	—	—	—
2000	Total Demand	159.7	177.1	13.1	14.3	3.9	3.9	—	—	176.7	195.3
2000	Ground-Water	146.5	163.8	12.3	13.6	3.9	3.9	—	—	162.7	181.3
2000	Surface-Water	13.2	13.3	0.8	0.7	—	—	—	—	14.0	14.0
2000	Total Supply 7/	159.7	177.1	13.1	14.3	3.9	3.9	—	—	176.7	195.3
2000	Shortage	—	—	—	—	—	—	—	—	—	—
2010	Total Demand	186.9	214.8	14.4	16.2	4.9	4.9	—	—	206.2	235.9
2010	Ground-Water	171.8	199.6	13.5	15.4	4.9	4.9	—	—	190.2	219.9
2010	Surface-Water	15.1	15.2	0.9	0.8	—	—	—	—	16.0	16.0
2010	Total Supply 7/	186.9	214.8	13.5	16.2	4.9	4.9	—	—	206.2	235.9
2010	Shortage	—	—	—	—	—	—	—	—	—	—
2020	Total Demand	216.2	259.9	16.5	18.7	5.8	5.8	—	—	238.5	284.4
2020	Ground-Water	199.2	186.8	15.5	17.8	5.8	5.8	—	—	220.5	210.4
2020	Surface-Water	17.0	16.9	1.0	0.9	—	—	—	—	18.0	17.8
2020	Total Supply 7/	216.2	203.7	16.5	18.7	5.8	5.8	—	—	238.5	228.2
2020	Shortage	—	56.2	—	—	—	—	—	—	—	—
2030	Total Demand	248.9	304.6	19.0	21.7	6.8	6.8	—	—	274.7	333.1
2030	Ground-Water	33.8	35.3	17.9	20.6	6.8	6.8	—	—	58.5	62.7
2030	Surface-Water	18.9	18.9	1.1	1.1	—	—	—	—	20.0	20.0
2030	Total Supply 7/	52.7	54.2	19.0	21.7	6.8	6.8	—	—	78.5	82.7
2030	Shortage	196.2	250.4	—	—	—	—	—	—	196.2	250.4

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 192.7 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the El Paso MSA - Currently within the MSA, approximately 83 percent of the water used for urban needs (municipal, manufacturing, and steam-electric power generation purposes) is supplied by ground water resources within the MSA. The remaining 17 percent is supplied by surface-water resources. In the year 2000, approximately 93 percent of the MSA's projected urban water requirements are expected to be supplied by ground-water resources, and approximately seven percent by surface-water resources. If the City of El Paso is unable to obtain additional water supplies from outside of the MSA, the MSA is expected to experience very serious water shortages in the year 2020 and beyond.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

Through the year 1995, the City of El Paso water system and other municipal, manufacturing, and steam-electric power generation water systems in the MSA will continue to obtain most of their water supply from the exhaustible ground-water resources of the Hueco and Mesilla Bolson Aquifers (Figure 14) within the MSA. Under these conditions, water levels will continue to decline, individual well yields will decrease, and ground-water quality will surely deteriorate. The City of El Paso is very concerned that ground-water reserves within the MSA may not be able to supply the city's summer peak demand by 1995. Since the MSA and Juarez, Mexico have a common aquifer (Hueco Bolson Figure 14), the large withdrawal of ground water for municipal and manufacturing uses anticipated in the City of Juarez area will significantly add to the ground-water mining problems. The City of El Paso water system is expected to continue to receive through the year 2030 comparatively small quantities (12.0 to 20.0 thousand acre-feet per year) of Rio Grande Project surface water through the El Paso County Water Improvement District. Historically on an average annual basis the Rio Grande Project has supplied about 128.7 thousand acre-feet to irrigation farmers in the Mesilla and El Paso Valleys and the City of El Paso. This average annual supply is expected to continue through the year 2030. Rio Grande Project water is obtained from the Elephant Butte-Caballo Reservoir system in New Mexico (Figure 14).

In 1985, the City of El Paso plans to implement a pilot-type project to treat sewage effluent (about 10 million gallons per day) which will be artificially recharged into the Hueco Bolson Aquifer north of the city. If proven feasible, the program and future programs using additional treated effluent could provide a significant net increase in the city's ground-water supply.

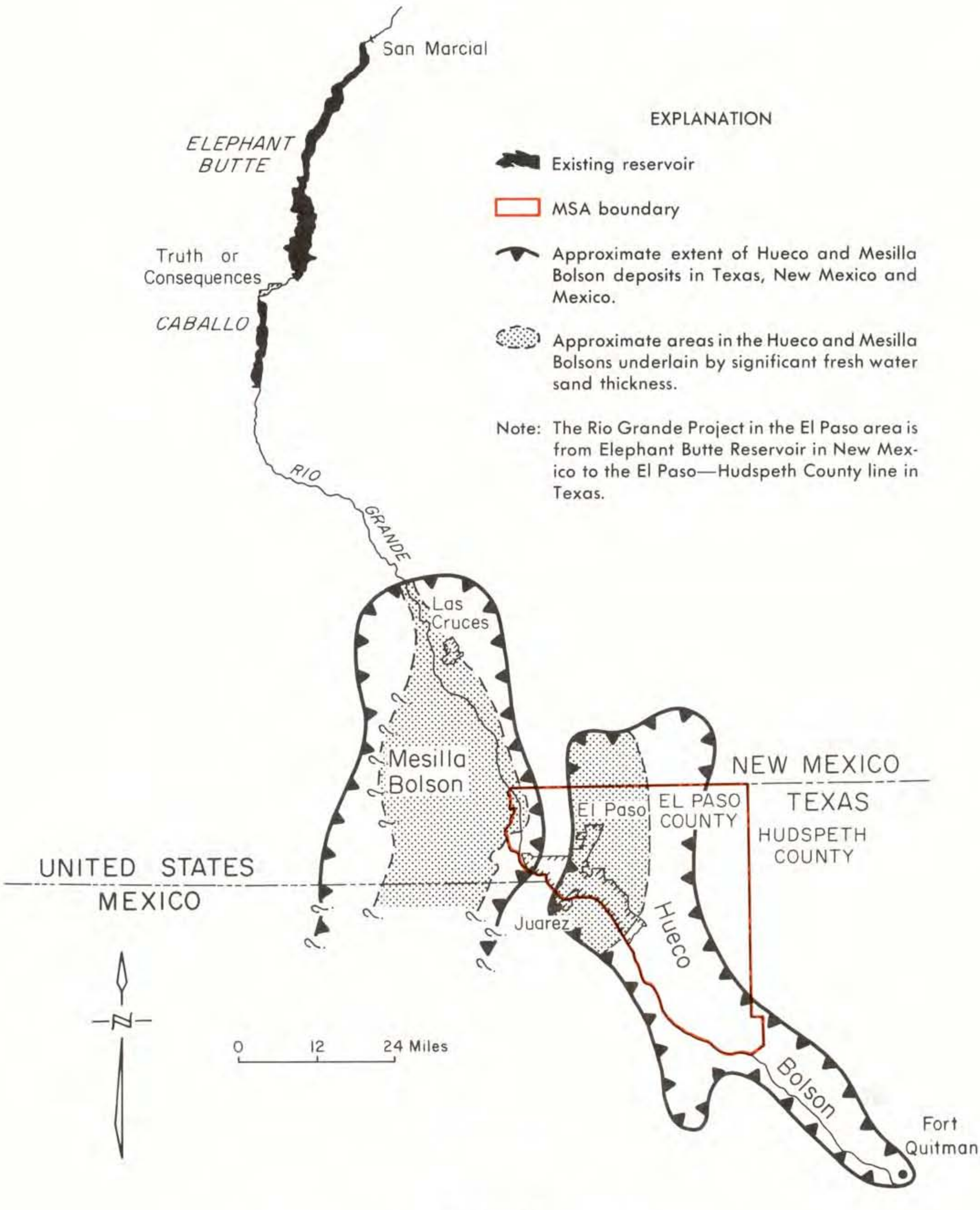


Figure 14
El Paso MSA Water Supply Projects

Significant reserves of ground water which have adequate water quality for municipal use exist in New Mexico in the Hueco and Mesilla Bolsons just across the State line from El Paso County (Figure 14). Based on recent litigation and on a change in New Mexico State law to conditionally allow export of ground water from New Mexico, the City of El Paso has obtained the right to apply to the New Mexico State Engineer to drill municipal water supply wells in the Hueco and Mesilla Bolsons in New Mexico (Figure 14). If the city receives permits to drill and produce these proposed wells on a timely basis by 1995 and beyond, the city will be capable of solving the problem of not meeting summer peak water demands by 1995, and the water shortages previously described for the year 2020 and beyond will not be experienced. No significant ground-water reserves or surface-water resources exist at a reasonable distance east of the MSA in Texas.

FORT WORTH-ARLINGTON MSA

Description of Fort Worth-Arlington MSA - The MSA is area No. 10 on Figure 1, and is comprised of Tarrant, Johnson and Parker counties which cover about 2,504 square miles in parts of the Trinity River and Brazos River Basins. Average annual precipitation ranges from 30 to 32 inches. Average annual temperatures range from 64°F to 66° F. The principal cities are Fort Worth, Arlington, Cleburne and Weatherford. Other cities in the MSA are listed in Appendix C.

Economy of Fort Worth-Arlington MSA - The area economy has employment concentrations in the manufacturing, services, and trade sectors. The manufacturing sector contributes 19.6 percent to the total personal income of the MSA, with transportation equipment, machinery and electronics industries the major sources of manufacturing employment. The regional economic outlook is for rapid growth and increasing employment opportunities in manufacturing.

Water Quality Management Planning in Fort Worth-Arlington MSA - The North Central Texas Council of Governments (NCTCOG) is designated as the areawide water quality management agency for the Dallas-Fort Worth area which includes most of Tarrant County and a minor portion of Johnson County in the Fort Worth-Arlington MSA. The Trinity River Authority of Texas, under contract to the Texas Department of Water Resources (TDWR), conducts water quality planning for the balance of Tarrant County, approximately one-half of Parker County and a part of Johnson County. The Brazos River Authority, also under contract to TDWR, does planning for the rest of Johnson County in the Fort Worth-Arlington MSA. The initial plans produced by the three agencies identified wastewater needs within the MSA and subsequent planning efforts reviewed these needs and updated them where necessary. In the designated area, a committee of local governments working through the NCTCOG, had already developed the "Upper Trinity River Basin Comprehensive Sewerage Plan." The plan included a system to join wastewater treatment works, each designed to serve several cities at one location, thereby eliminating many smaller single-community plants. During the 1970's and early 1980's, upgrading and expansion has occurred at most of these treatment plants. The largest joint treatment work in the Fort Worth-Arlington MSA is the Fort Worth Village Creek plant. In 1979-80, the Village Creek plant assumed the total flow for the entire Fort Worth Water System with the abandonment of the Riverside plant. In 1980-81, the annual average biological oxygen demand (BOD) concentration in the effluent had increased to 58 mg/l. As a result of improvements to the plant operation, the average BOD concentration level has been reduced to 14 mg/l in 1982-83 even with a significant flow increase. Overall, the joint system treatment plants in the designated planning area have reduced the total annual loadings by 10.4 million kilograms since 1975, which represents a 57 percent decrease, even though flow has increased by 50 percent. A network of continuous automated monitors has been recording the changes in dissolved oxygen water quality of the Trinity River for several years. The areawide water quality management plan is being updated annually by NCTCOG. The most recent plan, Clean Water 84, adresses water resources, treatment works and stormwater management as associated with nonpoint source pollution. Possible solutions using stormwater and watershed techniques, including a special program for the City of Arlington, are being evaluated by local governments in the region. All recommendations made in the water quality management planning process are reviewed by local advisory committees as required by regulations under the Federal Clean Water Act.

Floodplain Management Program in Fort Worth-Arlington MSA - The Federal Emergency Management Agency has designated all three counties and 48 incorporated cities as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying floodprone areas have been published for the three counties and 46 incorporated cities (Appendix C). Presently, Tarrant County and 38 cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which will supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for 22 incorporated cities in the MSA (Appendix C). Such studies have not been completed for any of the three counties.

Population and Employment within the Fort Worth-Arlington MSA

Item	1960	1970	1980	Series	Projections 1990	2000	2010	2020	2030
	(Thousands)				(Thousands)				
				Low	1109.2	1212.6	1309.0	1409.4	1510.6
Total Population	596.1	796.0	973.2	High	1141.3	1266.1	1403.1	1548.2	1712.4
				Low	1009.6	1100.0	1179.9	1262.1	1344.3
Urban Population	545.5	735.1	887.7	High	1038.9	1146.0	1257.4	1375.5	1505.6
				Low	99.6	112.6	129.1	147.3	166.4
Other Population	50.6	60.9	85.5	High	102.4	120.1	145.7	172.7	206.8
				Low	628.4	687.3	730.0	773.2	815.1
Employment	222.8	322.8	467.5	High	646.5	717.6	782.5	849.5	924.0

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Fort Worth-Arlington MSA 1/

Year	Analyses Category	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	27.0		1.6		--		--		28.6	
1980	Surface-Water	176.3		49.8		4.3		1.1		231.5	
1980	Total Use 6/	203.3		51.4		4.3		1.1		260.1	
1990	Total Demand	182.1	260.8	69.6	73.7	4.3	4.3	1.4	1.4	257.4	340.2
1990	Ground-Water	8.7	9.0	--	--	--	--	--	--	8.7	9.0
1990	Surface-Water	173.4	251.8	69.6	73.7	4.3	4.3	1.4	1.4	248.7	331.2
1990	Total Supply 7/	182.1	260.8	69.6	73.7	4.3	4.3	1.4	1.4	257.4	340.2
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	202.9	293.4	92.6	102.0	4.3	4.3	1.7	1.7	301.5	401.4
2000	Ground-Water	8.7	9.2	--	--	--	--	--	--	8.7	9.2
2000	Surface-Water	194.2	284.2	92.6	102.0	4.3	4.3	1.7	1.7	292.8	392.2
2000	Total Supply 7/	202.9	293.4	92.6	102.0	4.3	4.3	1.7	1.7	301.5	401.4
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	218.7	324.5	116.7	131.6	4.3	4.3	2.0	2.0	341.7	462.4
2010	Ground-Water	8.9	9.5	--	--	--	--	--	--	8.9	9.5
2010	Surface-Water	209.8	315.0	116.7	131.6	4.3	4.3	2.0	2.0	332.8	452.9
2010	Total Supply 7/	218.7	324.5	116.7	131.6	4.3	4.3	2.0	2.0	341.7	462.4
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	235.1	357.4	146.4	167.9	4.3	4.3	2.3	2.3	388.1	531.9
2020	Ground-Water	9.2	9.9	--	--	--	--	--	--	9.2	9.9
2020	Surface-Water	225.9	347.5	146.4	167.9	4.3	4.3	2.3	2.3	378.9	522.0
2020	Total Supply 7/	235.1	357.4	146.4	167.9	4.3	4.3	2.3	2.3	388.1	531.9
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	251.6	394.5	182.5	212.1	4.3	4.3	2.6	2.6	441.0	613.5
2030	Ground-Water	9.0	9.7	--	--	--	--	--	--	9.0	9.7
2030	Surface-Water	242.6	384.8	182.5	212.1	4.3	4.3	2.6	2.6	432.0	603.8
2030	Total Supply 7/	251.6	394.5	182.5	212.1	4.3	4.3	2.6	2.6	441.0	613.5
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 5.5 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

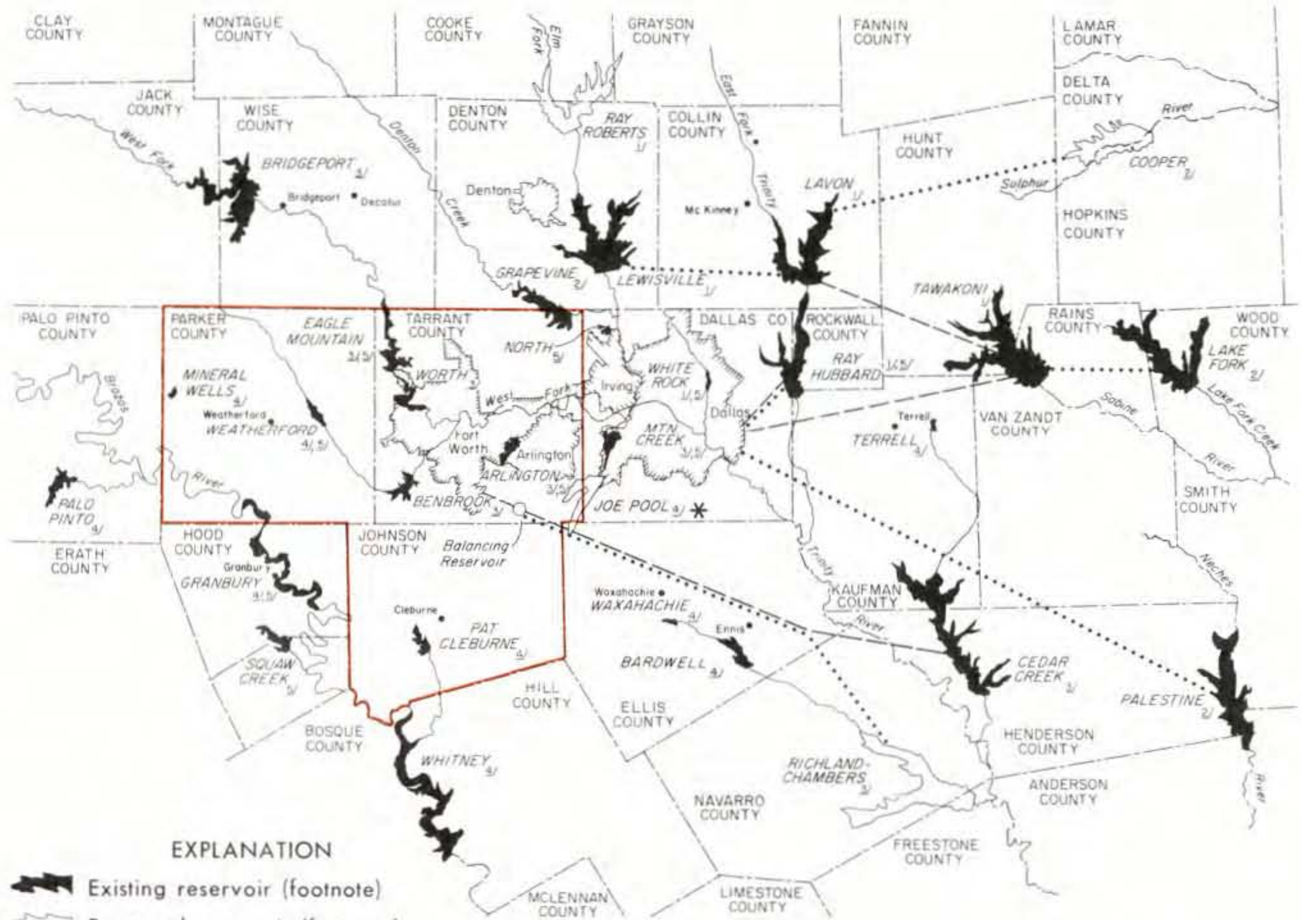
7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Fort Worth-Arlington MSA - Currently within the MSA, approximately 89 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 11 percent is supplied by ground-water resources. In the years 2000 and 2030, approximately 98 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately two percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface-water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The existing and proposed surface-water projects related to the current and future urban water needs of the MSA are shown on Figure 15, which also generally explains the interrelated reservoir (supply) - water system (user) relationship that exists within the MSA. Surface-water development is near maximum potential in the upper Trinity River basin in the MSA. With the completion of the proposed Richland-Chambers Reservoir (Figure 15) in the 1980's, Tarrant County should have an adequate water supply to about the year 2010. After the year 2010, urban water systems in Tarrant County and adjacent parts of the MSA are expected to need an additional surface-water supply. This additional supply could be provided by the development of Lake Tehuacana in Freestone County (Figure 2).

Recoverable ground-water storage in the major and minor aquifers (Figures 3 and 4) within the MSA has been depleted to such an extent that depths to water levels occur at more than 1,000 feet below the land surface. These deep water levels are causing pumping costs to be burdensome. The quality of ground water has deteriorated in some areas within the MSA. Fluoride in ground waters produced by many of the urban water systems within the MSA are too high; exceeding the Environmental Protection Agency-Texas State Health Department (EPA-TSAD) maximum allowable level of 1.6 milligrams per liter for the MSA. Also, many of the urban ground-water systems produce water with high iron concentrations which exceed the EPA-TSHD maximum allowable level of 0.3 milligrams per liter.



EXPLANATION

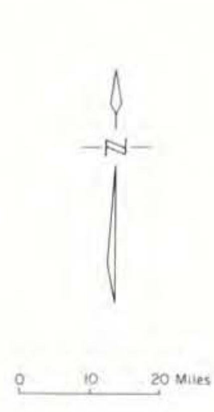
Existing reservoir (footnote)

Proposed reservoir (footnote)

--- Approximate location of major existing pipeline

.... Approximate location of major proposed pipeline

MSA boundary



Footnotes

1/ Existing or proposed water supply for the Dallas, North Texas Municipal Water District, and Denton systems

2/ Existing or proposed water supply for the Dallas, et al systems from a part of the reservoir's yield

3/ Existing or proposed water supply for the Fort Worth, Tarrant County WCID No. 1, and Arlington systems

4/ Existing water supply currently used or proposed for use by other urban water systems within the MSA

5/ Existing water supply for power plants within the MSA

* Planned for completion in 1988

Figure 15

Fort Worth-Arlington MSA Water Supply Projects

GALVESTON-TEXAS CITY MSA

Description of Galveston-Texas City MSA - The MSA is area No. 11 on Figure 1, and is comprised of Galveston County which covers about 399 square miles in parts of the Neches-Trinity Coastal and San Jacinto-Brazos Coastal Basins. Average annual precipitation ranges from 44 to 50 inches. Average annual temperature is about 69.5°F. The principal cities are Galveston and Texas City. Other cities in the MSA are listed in Appendix C.

Economy of Galveston-Texas City MSA - The area economy has high concentrations in the manufacturing, services and trade sectors. The petrochemical and shipbuilding industries remain the most important source of manufacturing employment. Manufacturing contributes 16.1 percent to the total personal income of the MSA. The regional economic outlook is for steady growth with continuing dependence on the manufacturing sector.

Water Quality Management Planning in Galveston-Texas City MSA - The Galveston-Texas City MSA is located in the San Jacinto-Brazos Coastal Basin. The mainland portion of Galveston County is approximately equally divided into two planning areas. The northern portion is included in the Houston Designated Area and the southern portion, along with the remainder of Galveston County, is included in the San Jacinto Basin Planning Area. The Houston-Galveston Area Council (H-GAC) is the planning agency for the designated area and the Texas Department of Water Resources (TDWR) contracted with the San Jacinto River Authority to conduct water quality management planning in the basin planning area. The initial plans for both areas identified wastewater facility needs, developed a management plan for wastewater treatment, and assessed the impacts of point and nonpoint sources of pollution. Subsequent planning activities in both areas have focused on updating sewerage needs as necessary. In the designated portion of the MSA, planning activities also focused on analysis of point and nonpoint sources of pollution in the Clear Lake watershed. This watershed has had more eutrophication related water quality problems than any other in the State. Based on a recommendation in the initial plan, TDWR conducted extensive water quality monitoring surveys and mathematical water quality modeling of Clear Lake and Clear Creek to reanalyze the most stringent basin-wide point source effluent limitation requirements in the State. These studies resulted in a modification of the effluent limitations. The H-GAC assessed ordinances which were currently in effect in the basin and which could have beneficial effects on the reduction of nonpoint source pollution. Recommendations made during the water quality management process in the areas are reviewed by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Galveston-Texas City MSA - The Federal Emergency Management Agency has designated Galveston County and 13 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for Galveston County and 12 of the incorporated cities in the MSA (Appendix C). Presently, the county and all 13 of the cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Galveston County and 11 cities in the MSA (Appendix C).

Population and Employment within the Galveston-Texas City MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	140.4	169.9	196.0	Low	219.2	247.5	279.5	313.2	346.1
				High	225.1	262.9	307.0	351.1	404.4
Urban Population	124.2	152.4	166.9	Low	201.4	234.1	264.4	296.3	327.4
				High	206.8	248.7	290.4	332.1	382.6
Other Population	16.2	17.5	29.1	Low	17.8	13.4	15.1	16.9	18.7
				High	18.3	14.2	16.6	19.0	21.8
Employment	50.8	65.0	78.4	Low	93.2	105.2	116.9	129.0	140.1
				High	95.7	111.8	128.5	144.5	163.7

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Galveston-Texas City MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	19.8		2.3		1.6		0.5		24.2	
1980	Surface-Water	14.6		44.8		---		---		59.4	
1980	Total Use 6/	34.4		47.1		1.6		0.5		83.6	
1990	Total Demand	37.7	53.1	59.1	64.4	1.6	1.6	0.6	0.6	99.0	119.7
1990	Ground-Water	11.5	10.9	---	---	1.6	1.6	0.6	0.6	13.7	13.1
1990	Surface-Water	26.2	42.2	59.1	64.4	---	---	---	---	85.3	106.6
1990	Total Supply 7/	37.7	53.1	59.1	64.4	1.6	1.6	0.6	0.6	99.0	119.7
1990	Shortage	---	---	---	---	---	---	---	---	---	---
2000	Total Demand	44.0	63.7	71.8	81.7	1.6	1.6	0.8	0.8	118.2	147.8
2000	Ground-Water	12.8	12.7	---	---	1.6	1.6	0.8	0.8	15.2	15.1
2000	Surface-Water	31.2	51.0	71.8	81.7	---	---	---	---	103.0	132.7
2000	Total Supply 7/	44.0	63.7	71.8	81.7	1.6	1.6	0.8	0.8	118.2	147.8
2000	Shortage	---	---	---	---	---	---	---	---	---	---
2010	Total Demand	49.7	74.3	34.4	99.3	1.6	1.6	0.8	0.8	136.5	176.0
2010	Ground-Water	14.0	14.0	---	---	1.6	1.6	0.8	0.8	16.4	16.4
2010	Surface-Water	35.7	60.3	34.4	99.3	---	---	---	---	120.1	159.6
2010	Total Supply 7/	49.7	74.3	84.4	99.3	1.6	1.6	0.8	0.8	136.5	176.0
2010	Shortage	---	---	---	---	---	---	---	---	---	---
2020	Total Demand	55.7	85.0	102.1	121.7	1.6	1.6	0.8	0.8	160.2	209.1
2020	Ground-Water	15.3	15.2	---	---	1.6	1.6	0.8	0.8	17.7	17.6
2020	Surface-Water	40.4	69.8	102.1	121.7	---	---	---	---	142.5	191.5
2020	Total Supply 7/	55.7	85.0	102.1	121.7	1.6	1.6	0.8	0.8	260.3	209.1
2020	Shortage	---	---	---	---	---	---	---	---	---	---
2030	Total Demand	61.5	97.9	124.1	149.6	1.6	1.6	0.8	0.8	188.0	249.9
2030	Ground-Water	12.2	16.8	---	---	1.6	1.6	0.8	0.8	14.6	19.2
2030	Surface-Water	49.3	81.1	124.1	149.6	---	---	---	---	173.4	230.7
2030	Total Supply 7/	61.5	97.9	124.1	149.6	1.6	1.6	0.8	0.8	188.0	249.9
2030	Shortage	---	---	---	---	---	---	---	---	---	---

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 54.2 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Galveston-Texas City MSA - Currently within the MSA, approximately 71 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 29 percent is supplied by ground-water resources. Approximately 90 and 92 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 10 and 8 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The major water supply projects providing water to the MSA (Galveston County) are shown on Figure 16. Canals A and B are operated by the Brazos River Authority and supply Brazos River water to the industrial complex in the Texas City area and irrigation within the MSA. Canals A and B also provide Brazos River water for urban and agricultural needs in Brazoria and Fort Bend counties. Galveston County Lake shown on Figure 16 is a holding reservoir for Brazos River water delivered by Canals A and B. Texas City which currently uses ground water from the Gulf Coast Aquifer (Figure 3) for municipal purposes (most of the city's wells are located within the city limits), is planning to obtain Brazos River water from the Canal A-B system.

Current urban water needs for the City of Galveston are met from two sources. The oldest source is the city's well field (Figure 16) which is completed in the Gulf Coast Aquifer (Figure 3) and currently supplies via pipeline (Figure 16) only about 2,200 acre-feet annually. Pumpage from the well field was reduced in about 1973, because of saline-water encroachment. Before about 1973, the well field was the sole supply of water for the City of Galveston. The second and newest source (since about 1973) of water for the city is surface water delivered via pipeline (Figure 16) from the Houston Water System. This surface water is treated by Houston and supplied by the Houston System from Lake Houston in northeastern Harris County (Figure 16).

Most of the MSA's urban water requirements through the year 2030 will have to be met by surface water secured from the Houston Water System and the Brazos River via the Canal A-B system. Through the year 2030, ground-water withdrawals for urban needs within the MSA (Galveston County) will need to be held at a maximum level of about 20 thousand acre-feet annually to control land subsidence, fault movement, and

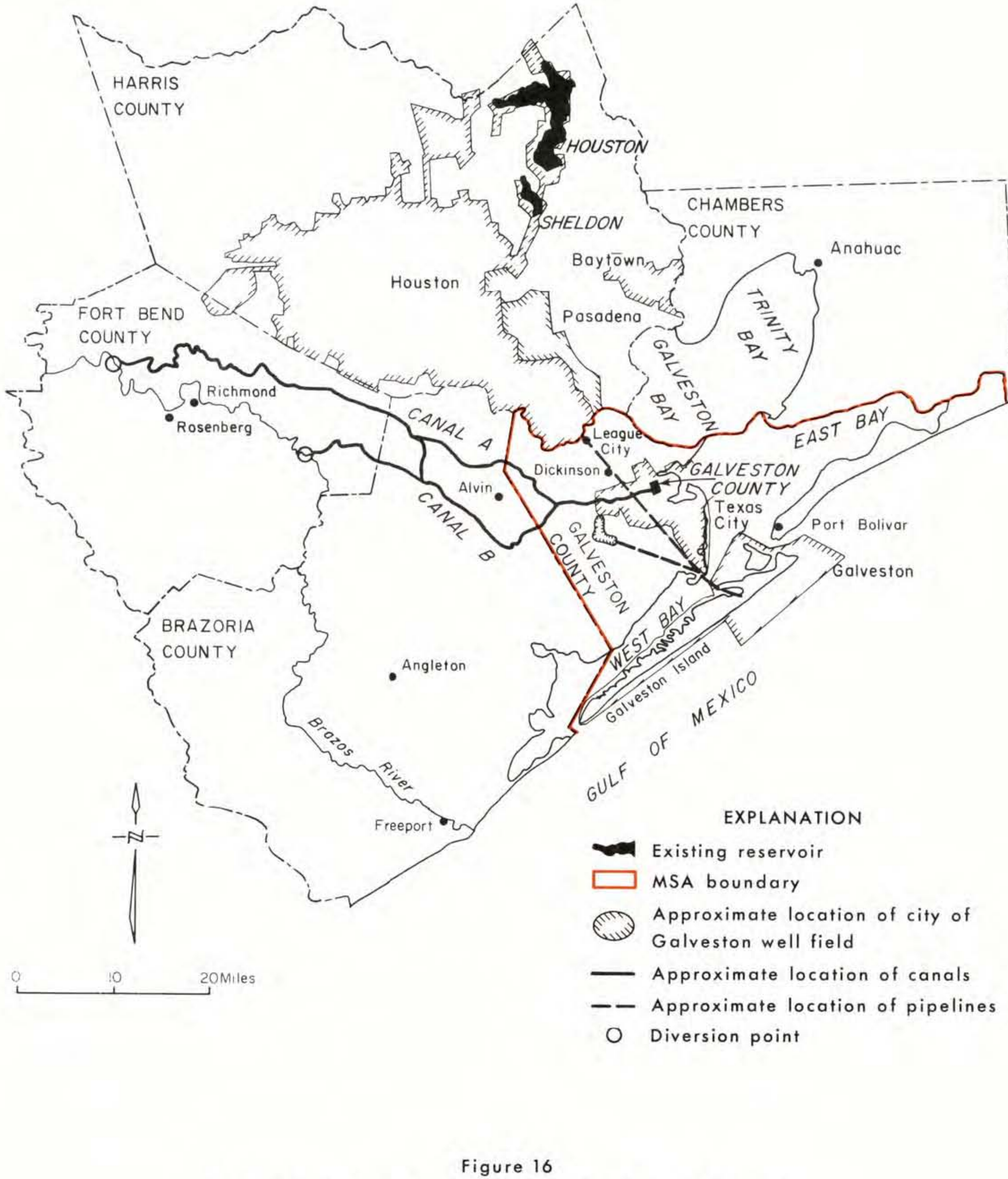


Figure 16
Galveston-Texas City MSA Water Supply Projects

saline water encroachment. Under these conditions, approximately 148 and 231 thousand acre-feet of surface water will have to be delivered to the MSA in the years 2000 and 2030, respectively.

HOUSTON MSA

Description of Houston MSA - The MSA is area No. 12 on Figure 1, and is comprised of Brazoria, Fort Bend, Harris, Liberty, Montgomery, and Waller counties which cover about 6,794 square miles in parts of the Brazos River, San Jacinto River, Trinity River and Neches River Basins and the Brazos-Colorado Coastal, San Jacinto-Brazos Coastal, Trinity-San Jacinto Coastal, and Neches-Trinity Coastal Basins. Average annual precipitation ranges from about 40 to 52 inches. Mean annual temperatures range from about 67°F to 70°F. The principal cities are Houston, Pasadena, Baytown, Conroe, Freeport, Angleton, Richmond, Rosenburg, Hempstead and Liberty. Other cities in the MSA are listed in Appendix C.

Economy of Houston MSA - The area economy has a balanced distribution among the various sectors with some concentration in manufacturing and mining. The oil and petrochemical industry remains the most important source of manufacturing employment. Manufacturing contributes 15.6 percent to the total personal income of the Houston MSA. The regional economic outlook is for continuing dependence on oil and natural gas.

Water Quality Management Planning in Houston MSA - Because of the numerous hydrologic boundaries covered by this large six county MSA, water quality management planning for the MSA was conducted by several agencies. All of Harris County and portions of Brazoria, Fort Bend, Montgomery, and Waller counties are in the Houston Designated Area. The remainder of Montgomery County and portions of Brazoria, Fort Bend, and Liberty counties are included in the San Jacinto Basin planning area. The middle/eastern portions of Liberty County are in the Trinity and Lower Neches Basins, respectively. The majority of Fort Bend County and the remaining portions of Brazoria and Waller counties are included in the Brazos Basin planning area. The Texas Department of Water Resources (TDWR) contracted with the San Jacinto River Authority (SJRA), the Trinity River Authority, the Lower Neches Valley Authority and the Brazos River Authority (BRA), respectively, for water quality management planning for each of the basin planning areas. The Houston-Galveston Area Council (H-GAC) is the planning agency for the Houston Designated Area. The initial plans for all of the areas identified facility needs, developed a management plan for wastewater treatment, and assessed the impacts of point and nonpoint sources of pollution. Subsequent planning activities in all the areas have focused on updating sewerage needs as necessary. Additionally, because the water bodies in this MSA are greatly impacted by both point and nonpoint sources of pollution from the large population and high industrial activities present, several special studies have been conducted by the three planning agencies (H-GAC, BRA, and SJRA) which cover most of the MSA.

Starting with the designated area, the H-GAC conducted a local coordination study of the many agencies and units of local governments which have authority to regulate control, and abate point and nonpoint sources of pollution. H-GAC also conducted a nonpoint source and sedimentation study of Lake Houston and a nonpoint source assessment focusing on governmental regulations and policies in the Clear Lake watershed. The Lake Houston Study revealed that water quality conditions in the lake are controlled by a complex interaction of point source loadings, sediment transport during runoff events, and resuspension of sediments in the lake caused by wave action. The Clear Lake study concluded that management agencies in the watershed have sufficient authority to implement best management practices to abate nonpoint source pollution. Although no need was identified for new regulations, more active implementation of existing ordinances and policies may well be required to abate expected increases in nonpoint sources pollution.

A nonpoint source pollution study was conducted on the West Fork San Jacinto River by the SJRA. Although runoff related water quality problems were observed, it was not possible to discern the extent that they were related to nonpoint sources because of the obvious impact of point source discharges bypassing poorly treated sewage into the river and its tributaries. These problems with the point sources are currently being addressed; therefore, further nonpoint source assessment should wait until the corrective measures have been taken at the point sources.

A water quality management study has been conducted by the BRA to determine the impacts of rapid urbanization in the Oyster Creek watershed which is a vital link in the BRA fresh water supply delivery system. This study indicates that in terms of annual loads, estimated nonpoint source loads for biochemical oxygen demand and sediment exceed point source loads; whereas, point source loads exceed nonpoint source loads for nitrogen and phosphorus.

In addition to these studies conducted by the local planning agencies, the TDWR has conducted intensive water quality monitoring surveys and developed water quality models to analyze point source discharges in many of the streams, bayous, bays, and estuaries that are located within the MSA. Based on these studies, efforts are underway to modify point source effluent limitation requirements in many of the area water bodies. Partly because of the rapid urbanization of the area (with commensurate increases in point source loadings) and the naturally low assimilative capacity of area streams, more stringent requirements will probably be necessary. To address the potential economic impacts of these requirements, several more studies will be undertaken to better define the relationship among the various factors contributing to water quality conditions in the MSA. Recommendations made during the water quality management process in the designated area and the various basin planning areas are reviewed by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Houston MSA - The Federal Emergency Management Agency has designated all six counties and 90 incorporated cities and 11 special use districts in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the six counties, 75 of the incorporated cities and four of the special use districts in the MSA (Appendix C). Presently, five counties, 77 cities and the 11 special use districts in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for four counties, 67 cities and two special use districts in the MSA (Appendix C).

Population and Employment within the Houston MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
	(Thousands)				Projections (Thousands)				
Total Population	1430.4	1999.3	2905.3	Low	3618.1	4317.5	4955.7	5592.0	6295.6
				High	3876.1	4718.5	5516.6	6459.3	7653.0
Urban Population	1222.7	1638.0	2172.1	Low	2590.0	2994.1	3464.2	3911.9	4380.4
				High	2758.6	3250.4	3801.4	4454.4	5278.5
Other Population	207.7	361.3	733.2	Low	1028.1	1323.4	1491.5	1680.1	1915.2
				High	1117.5	1468.1	1715.2	2004.9	2374.5
Employment	530.4	802.2	1599.9	Low	2082.1	2483.6	2804.7	3112.9	3446.1
				High	2230.6	2714.2	3122.1	3595.7	4189.1

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Houston MSA 1/

Year	Analyses Category	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	372.4		58.5		16.8		9.1		456.8	
1980	Surface-Water	181.6		484.8		28.9		14.6		709.9	
1980	Total Use 6/	554.0		543.3		45.7		23.7		1166.7	
1990	Total Demand	617.3	902.4	729.3	790.7	57.7	57.7	28.7	28.7	1433.0	1779.5
1990	Ground-Water	248.9	275.2	37.4	33.1	17.3	17.3	10.2	10.2	313.8	335.8
1990	Surface-Water	368.4	627.2	691.9	757.6	40.4	40.4	18.5	18.5	1119.2	1443.7
1990	Total Supply 7/	617.3	902.4	729.3	790.7	57.7	57.7	28.7	28.7	1433.0	1779.5
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	747.6	1111.5	917.7	1046.5	57.7	57.7	33.8	33.8	1756.8	2249.5
2000	Ground-Water	285.3	307.6	38.0	33.1	17.3	17.3	11.3	11.3	351.9	369.3
2000	Surface-Water	462.3	803.9	879.7	1013.4	40.4	40.4	22.5	22.5	1404.9	1880.2
2000	Total Supply 7/	747.6	1111.5	917.7	1046.5	57.7	57.7	33.8	33.8	1756.8	2249.5
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	860.0	1300.9	1104.9	1299.2	57.7	57.7	37.7	37.7	2060.3	2695.5
2010	Ground-Water	300.3	323.7	38.4	29.2	17.3	17.3	11.8	11.8	367.8	382.0
2010	Surface-Water	559.7	977.2	1066.5	1270.0	40.4	40.4	25.9	25.9	1692.5	2313.5
2010	Total Supply 7/	860.0	1300.9	1104.9	1299.2	57.7	57.7	37.7	37.7	2060.3	2695.5
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	971.3	1524.8	1376.1	1641.9	57.7	57.7	41.7	41.7	2446.8	3266.1
2020	Ground-Water	318.7	336.6	35.2	30.8	17.3	17.3	12.0	12.3	383.2	397.0
2020	Surface-Water	652.6	1188.2	1340.9	1611.1	40.4	40.4	29.7	29.4	2063.6	2869.1
2020	Total Supply 7/	971.3	1524.8	1376.1	1641.9	57.7	57.7	41.7	41.7	2446.8	3266.1
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	1092.8	1807.8	1720.1	2076.7	57.7	57.7	45.7	45.7	2916.3	3987.9
2030	Ground-Water	322.5	350.9	35.3	29.3	17.3	17.3	12.6	12.8	387.7	410.3
2030	Surface-Water	770.3	1456.9	1684.8	2047.4	40.4	40.4	33.1	32.9	2528.6	3577.6
2030	Total Supply 7/	1092.8	1807.8	1720.1	2076.7	57.7	57.7	45.7	45.7	2916.3	3987.9
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 599.5 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See Footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030).

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Houston MSA - Currently within the MSA, approximately 40 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 60 percent is supplied by ground-water resources. Approximately 83 and 90 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 17 and 10 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The existing and proposed surface-water projects related to the current and future urban water needs of the MSA are shown on Figure 17. Currently, most of the urban water needs within and just adjacent to the MSA are supplied by the following sources and systems:

Source	System	Location Reference	User
Gulf Coast Aquifer	Numerous Well Fields	Figure 3	City of Houston, other cities, and industries
Trinity River from Lake Livingston (City of Houston has 70 percent share of yield)	Coastal Industrial Water Authority Canal and Pipe-line System	Figure 17	Mainly industries in the ship channel area of Harris County and indus-tries in eastern Chambers County.
Trinity River from Lake Livingston through Trinity River Authority	Devers Canal System	Figure 17	Small amount used by sulfur mining industry in southern Liberty County. Mainly-for irrigators in Liberty and Chambers Counties.

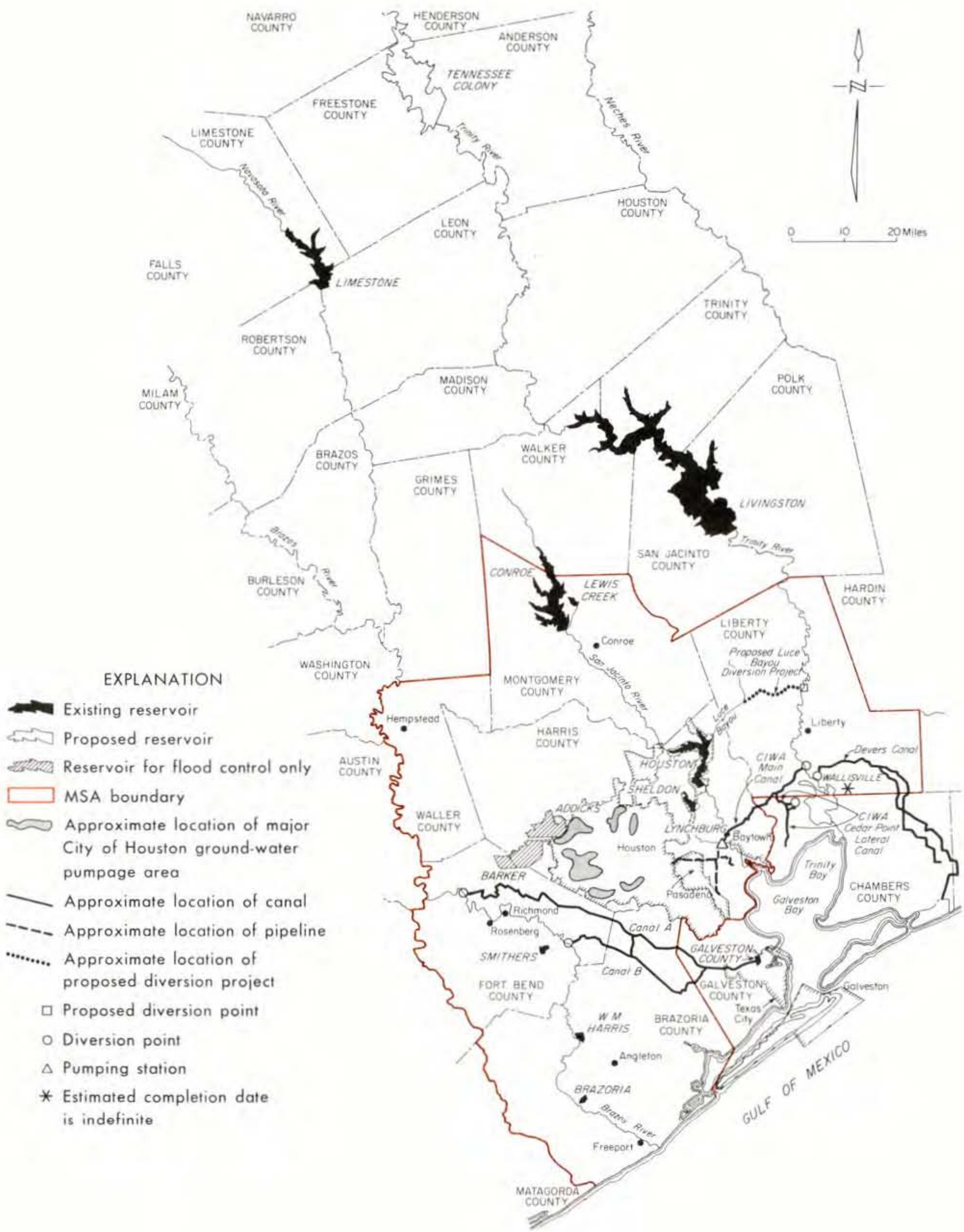


Figure 17
Houston MSA Water Supply Projects

Source	System	Location Reference	User
San Jacinto River from Lakes Conroe, Lewis Creek, Houston and Sheldon	River and Pipeline	Figure 17	City of Houston, San Jacinto River River Authority, and power plants.
Brazos River through the Brazos River Authority	Canals A and B System	Figure 17	Various cities and industries in Fort Bend, Brazoria and Galveston Counties.

Municipal, manufacturing, steam-electric, and mining water requirements during the 1980's in Harris, Galveston, and Montgomery counties (including the Houston Water System and other large systems) will have to continue to be met by both ground-water and surface-water resources. However, because of land subsidence, movement of geologic faults, and potential saline-water encroachment, ground water withdrawals will need to be reduced. The remainder of the requirements throughout the 1980's need to be met by existing surface-water supplies in the San Jacinto and Trinity River Basins; namely Lakes Conroe, Houston, and Livingston (Figure 17). Supplies from Lake Livingston in the Trinity River Basin will be conveyed to the Houston area via the Coastal Industrial Water Authority (CIWA) canal and pipeline system (Figure 17) and the Luce Bayou Diversion Project (Figure 17). The City of Houston's share of Wallisville Lake in Chambers and Liberty counties (Figure 17) could be conveyed to the Houston area via the CIWA System. The projected urban needs for surface water for the Houston system and other systems in Harris, Galveston and Montgomery counties is expected to be 2.2 million acre-feet in the 2000. Therefore, between 1990 and 1995, the Houston system and other large systems in the three counties are expected to need additional surface-water supplies. Also, comparison of projected surface-water requirements (1.8 and 3.5 million acre-feet in 2000 and 2030, respectively) with the supplies from Lakes Conroe and Houston and the delivery capabilities of the CIWA System and the Luce Bayou Diversion Project (a total of about 1.8 million acre-feet) indicate that additional facilities for conveyance of water from the Trinity River Basin to the three counties will be needed after the year 2000. Additional surface-water supplies needed in the three counties within the MSA after 2000 could be obtained from new and existing reservoirs in (1) the Trinity River Basin, such as Lake Tennessee Colony (Figure 17), (2) the San Jacinto River Basin, or (3) the Neches and Sabine River Basins (Figure 2) east of the Trinity River Basin where substantial surface-water surpluses are expected to exist in the year 1990 and beyond.

The ground-water resources of the Gulf Coast Aquifer (Figure 3), Brazos River water delivered by the Canals A and B System (Figure 17), and Trinity River water delivered by the Devers Canal System (Figure 17) supply other large urban water needs within and adjacent to the MSA in Waller, Fort Bend, Brazoria, Galveston and Liberty counties. Lakes

W.M. Harris and Brazoria (Figure 17-Brazoria County) are off-channel regulating reservoirs which are used in a system to deliver Brazos River water for municipal and industrial needs in the Freeport area. Lake Smithers (Figure 17-Fort Bend County) is a relatively small impoundment on Dry Creek which is used as a cooling reservoir by a power plant operated by Houston Lighting and Power Company. All of these water supplies and their related facilities are expected to adequately supply the remaining large urban water needs of the MSA through the year 2030.

KILLEEN-TEMPLE MSA

Description of Killeen-Temple MSA - The MSA is area No. 13 on Figure 1, and is comprised of Bell and Coryell counties which cover about 2,090 square miles in the Brazos River Basin. Average annual precipitation ranges from about 28 to 35 inches. Average annual temperatures range from 65 F to 68 F. The principal cities are Temple, Killeen, Belton, Copperas Cove, and Gatesville. Other cities in the MSA are listed in Appendix C.

Economy of Killeen-Temple MSA - The area economy has concentrations in trade, government, hospitals, and military. The furniture industry remains the most important source of manufacturing employment. Manufacturing contributes 7.2 percent to the total personal income of the MSA. The regional economic outlook is for continuing dominance of the economy by the military sector, with increasing employment opportunities due to industrial expansion.

Water Quality Management Planning in Killeen-Temple MSA - The Killeen-Temple MSA is located in both the Killeen-Temple Designated Area and the Brazos Basin planning area. The Central Texas Council of Governments is the planning agency for the designated area and the Texas Department of Water Resources (TDWR) contracted with the Brazos River Authority (BRA) to do the planning in the MSA. The initial plans for both areas identified wastewater facility needs, developed a management plan for wastewater treatment, and assessed the impact of point and nonpoint sources of pollution. Subsequent planning activities in both areas have focused on updating sewerage needs as necessary.

Continuing planning in the designated area also focused on the impacts of septic tank communities on the water quality of Lake Belton and Stillhouse Hollow Reservoir. The effects of other nonpoint sources and point sources on these lakes were also addressed. The study concluded that the current water quality is good and that no immediate threat to the lakes from development is apparent. However, some signs of accelerated euthrophication are apparent, especially in the upper Leon River arm of Lake Belton. The report concludes that the situation should be closely monitored for changing trends in water quality. The TDWR has conducted an intensive survey of Nolan Creek and is revising the waste load evaluation of point source dischargers. The survey results indicate that the previously poor condition of this stream has improved considerably after the upgrading of the dischargers as identified in the initial plan.

In the Brazos River Basin portion of the MSA, the BRA is conducting a study of the impacts of septic systems in the community of Salado on Salado Creek in Bell County. The report concluded that septic systems did not adversely affect the quality of the creek. Septic systems should continue to be suitable, if properly regulated, and if population density does not increase drastically. All recommendations made during the water quality management process in both areas are considered by local advisory committees as required by the regulations of the Federal Clean Water Act.

<u>Floodplain Management Program in Killeen-Temple MSA</u> - The Federal Emergency Management Agency has designated both counties and 14 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for both counties and 12 incorporated cities in the MSA (Appendix C). Presently, the two counties and 12 of the cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for both counties and 11 of the incorporated cities in the MSA (Appendix C).

Population and Employment within the Killeen-Temple MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
	(Thousands)				Projections (Thousands)				
Total Population	118.1	159.8	214.7	Low	250.0	304.6	372.3	445.7	515.6
				High	258.9	343.0	449.6	563.1	715.3
Urban Population	72.6	132.8	170.6	Low	221.3	265.6	316.6	372.6	425.3
				High	229.2	299.0	381.9	470.3	588.8
Other Population	45.5	27.0	44.1	Low	28.7	39.0	55.7	73.1	90.3
				High	29.7	44.0	67.7	92.8	126.5
Employment	28.8	38.3	108.6	Low	142.7	173.8	209.1	246.2	280.0
				High	147.8	195.8	252.4	311.0	388.5

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Killeen-Temple MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	6.0		0.2		--		0.1		6.3	
1980	Surface-Water	31.1		1.0		--		--		32.1	
1980	Total Use 6/	37.1		1.2		--		0.1		38.4	
1990	Total Demand	41.8	59.7	1.8	1.9	--	--	0.2	0.2	43.8	61.8
1990	Ground-Water	3.7	4.1	--	--	--	--	0.2	0.2	3.9	4.3
1990	Surface-Water	38.1	55.6	1.8	1.9	--	--	--	--	39.9	57.5
1990	Total Supply 7/	41.8	59.7	1.8	1.9	--	--	0.2	0.2	43.8	61.8
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	51.2	79.3	2.4	2.6	--	--	0.2	0.2	53.8	82.1
2000	Ground-Water	3.7	4.1	--	--	--	--	0.2	0.2	3.9	4.3
2000	Surface-Water	47.5	75.2	2.4	2.6	--	--	--	--	49.9	77.8
2000	Total Supply 7/	51.2	79.3	2.4	2.6	--	--	0.2	0.2	53.8	82.1
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	61.6	102.6	3.0	3.4	--	--	0.2	0.2	64.8	106.2
2010	Ground-Water	3.9	4.7	--	--	--	--	0.2	0.2	4.1	4.9
2010	Surface-Water	57.7	97.9	3.0	3.4	--	--	--	--	60.7	101.3
2010	Total Supply 7/	61.6	102.6	3.0	3.4	--	--	0.2	0.2	64.8	106.2
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	73.0	127.4	3.7	4.3	--	--	0.3	0.3	77.0	132.0
2020	Ground-Water	4.0	5.4	--	--	--	--	0.3	0.3	4.3	5.7
2020	Surface-Water	69.0	122.0	3.7	4.3	--	--	--	--	72.7	126.3
2020	Total Supply 7/	73.0	127.4	3.7	4.3	--	--	0.3	0.3	77.0	132.0
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	83.7	160.7	4.6	5.4	--	--	0.3	0.3	88.6	166.4
2030	Ground-Water	3.6	4.8	--	--	--	--	0.3	0.3	3.9	5.1
2030	Surface-Water	80.1	155.9	4.6	5.4	--	--	--	--	84.7	161.3
2030	Total Supply 7/	83.7	160.7	4.6	5.4	--	--	0.3	0.3	88.6	166.4
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 5.0 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Killeen-Temple MSA - Currently within the MSA, approximately 83 percent of the water used for urban needs (municipal, manufacturing, and mining purposes) is supplied by developed surface-water resources in the MSA. The remaining 17 percent is supplied by ground-water resources. Approximately 95 and 97 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately five and three percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

All major municipal, military and manufacturing water systems in the MSA will be adequately supplied by Lakes Belton or Stillhouse Hollow (Figure 18) or by other reservoirs in the Brazos River Authority system through the year 2030. The larger systems include Temple, Killeen, Fort Hood, Belton, and Copperas Cove. The Gatesville system is currently using ground water from the Trinity Group Aquifer (Figure 3); however, the city is investigating the possibility of obtaining a surface-water supply.

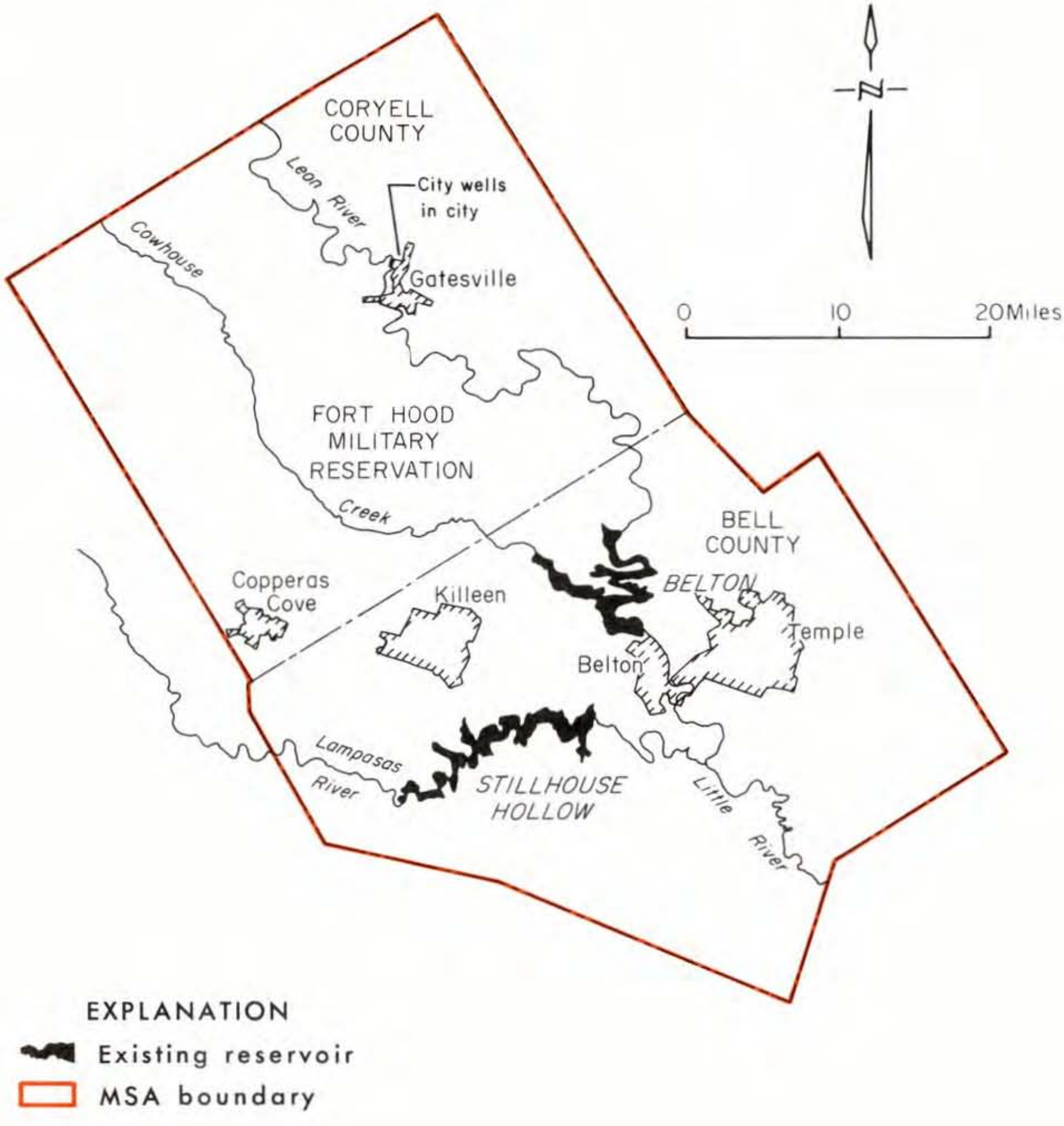


Figure 18
Killeen-Temple MSA Water Supply Projects

Description of Laredo MSA - The MSA is area No. 14 on Figure 1, and is comprised of Webb County which covers about 3,306 square miles in parts of the Rio Grande and Nueces River Basins. Average annual precipitation ranges from 21 to 23 inches. Average annual temperatures range from about 71°F to 73°F. The principal city is Laredo.

Economy of Laredo MSA- The area economy is primarily concentrated in the services and trade sectors. The apparel, food processing and printing industries remain the most important sources of manufacturing employment. Manufacturing contributes 4.1 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on trade generated by Laredo's location on the Mexican border.

Water Quality Management Planning in Laredo MSA - The Laredo MSA is approximately equally divided between the Middle Rio Grande River Basin and the Nueces River Basin; however, most of the population is located within the Middle Rio Grande Basin. The Texas Department of Water Resources contracted with the Nueces River Authority for water quality management planning in the Nueces Basin and directly conducted the planning for the Middle Rio Grande Basin. The initial plans for both basins identified wastewater facility needs within the MSA and subsequent planning efforts reviewed the needs and updated them as found necessary. All recommendations made during the water quality management process in both basins are considered by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Mangement Program in Laredo MSA - The Federal Emergency Management Agency has designated Webb County and the City of Laredo as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for both the county and the city (Appendix C), but presently, only the city has adopted a local floodplain management program (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies have been completed for Webb County and the City of Laredo (Appendix C). These studies provide detailed 10-year, 50-year, 100-year, and 500-year flood event data.

Population and Employment within the Laredo MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	64.8	72.8	92.2	Low	129.6	160.0	190.5	221.9	256.4
				High	137.1	176.1	214.7	259.3	299.8
Urban Population	60.7	69.0	91.4	Low	119.2	146.6	174.5	203.3	234.9
				High	126.1	161.3	196.7	237.5	274.6
Other Population	4.1	3.8	7.8	Low	10.4	13.4	16.0	18.6	21.5
				High	11.0	14.8	18.0	21.8	25.2
Employment	16.4	19.0	36.6	Low	51.2	63.2	74.0	84.8	96.4
				High	54.2	69.5	83.4	99.7	112.6

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Laredo MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	0.2		0.1		---		0.4		0.7	
1980	Surface-Water	23.5		0.2		1.7		---		25.4	
1980	Total Use 6/	23.7		0.3		1.7		0.4		26.1	
1990	Total Demand	26.5	36.9	0.4	0.4	1.7	1.7	0.5	0.5	29.1	39.5
1990	Ground-Water	0.5	0.6	0.1	0.1	---	---	0.5	0.5	1.1	1.2
1990	Surface-Water	25.4	29.2	0.3	0.3	1.7	1.7	---	---	27.4	31.2
1990	Total Supply 7/	25.9	29.8	0.4	0.4	1.7	1.7	0.5	0.5	28.5	32.4
1990	Shortage	0.6	7.1	---	---	---	---	---	---	0.6	7.1
2000	Total Demand	33.6	48.3	0.5	0.5	1.7	1.7	0.6	0.6	36.4	51.1
2000	Ground-Water	0.6	0.7	0.2	0.2	---	---	0.6	0.6	1.4	1.5
2000	Surface-Water	29.2	29.2	0.3	0.3	1.7	1.7	---	---	31.2	31.2
2000	Total Supply 7/	29.8	29.9	0.5	0.5	1.7	1.7	0.6	0.6	32.6	32.7
2000	Shortage	3.8	18.4	---	---	---	---	---	---	3.8	18.4
2010	Total Demand	40.0	58.9	0.5	0.6	1.7	1.7	0.8	0.8	43.0	62.0
2010	Ground-Water	0.6	0.8	0.2	0.2	---	---	0.8	0.8	1.6	1.8
2010	Surface-Water	29.2	29.2	0.3	0.4	1.7	1.7	---	---	31.2	31.3
2010	Total Supply 7/	29.8	30.0	0.5	0.6	1.7	1.7	0.8	0.8	38.8	33.1
2010	Shortage	10.2	28.9	---	---	---	---	---	---	10.2	28.9
2020	Total Demand	46.6	71.1	0.7	0.7	1.7	1.7	1.0	1.0	50.0	74.5
2020	Ground-Water	0.7	0.9	0.2	0.2	---	---	1.0	1.0	1.9	2.1
2020	Surface-Water	29.2	29.2	0.5	0.5	1.7	1.7	---	---	31.4	31.4
2020	Total Supply 7/	29.9	30.1	0.7	0.7	1.7	1.7	1.0	1.0	33.3	33.5
2020	Shortage	16.7	41.0	---	---	---	---	---	---	16.7	41.0
2030	Total Demand	53.8	82.2	0.8	0.9	1.7	1.7	1.2	1.2	57.5	86.0
2030	Ground-Water	0.8	1.0	0.2	0.2	---	---	1.2	1.2	2.2	2.4
2030	Surface-Water	29.2	29.2	0.6	0.7	1.7	1.7	---	---	31.5	31.6
2030	Total Supply 7/	30.0	30.2	0.8	0.9	1.7	1.7	1.2	1.2	33.7	34.0
2030	Shortage	23.8	52.0	---	---	---	---	---	---	23.8	52.0

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 20.2 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Laredo MSA - Currently within the MSA, approximately 97 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources adjacent to the MSA. The remaining three percent is supplied by ground-water resources. In the year 2000, only about 61 percent of the MSA's projected urban water requirements (51.1 thousand acre-feet) are expected to be supplied from developed surface-water resources, and only about three percent by ground-water resources. In the year 2030, only about 37 percent of the MSA's projected urban water requirements (86.0 thousand acre-feet) are expected to be supplied by developed surface-water resources, and only about three percent by ground-water resources. Water shortages for urban needs within the MSA are expected to be about 18.4 thousand acre-feet in 2000 and about 52.0 thousand acre-feet in 2030. The shortages are expected to begin between 1985 and 1990 as described below.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities within the MSA. Also, sufficient surface or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The Laredo MSA is located within the Middle Rio Grande Valley which will continue to be provided surface water from Lake Amistad which is part of the Lake Amistad-Lake Falcon system (Figure 19). Supplies from the system for in-basin needs, as well as needs for the southern portion of the Nueces-Rio Grande Coastal Basin in the Lower Rio Grande Valley, are presently allocated on the basis of 1977 rules of the Texas Water Commission. These rules are based upon water rights recognized in the Middle Rio Grande (between Lake Amistad and Lake Falcon) from water rights and claims of a "Final Determination" by the Commission, and in the "Lower Rio Grande Valley Water Case." The 1977 specific water allocation for urban uses from the reservoir system is about 186.0 thousand acre-feet per year. Total urban water needs within the service area of the Lake Amistad-Lake Falcon system including the Laredo MSA is expected to reach about 312.9 thousand acre-feet in the year 2000. Serious regional urban water shortages within the Lake Amistad-Lake Falcon service area are expected to occur between 1985 and 1990 based on the current urban water allocation (supply) of 186.0 thousand acre-feet. Under present conditions, 100.0 thousand acre-feet of storage in Lake Amistad and Lake Falcon are set aside for emergency urban needs under drought conditions for the Middle and Lower Rio Grande Valleys for authorized allocations by the adjudication certificates.

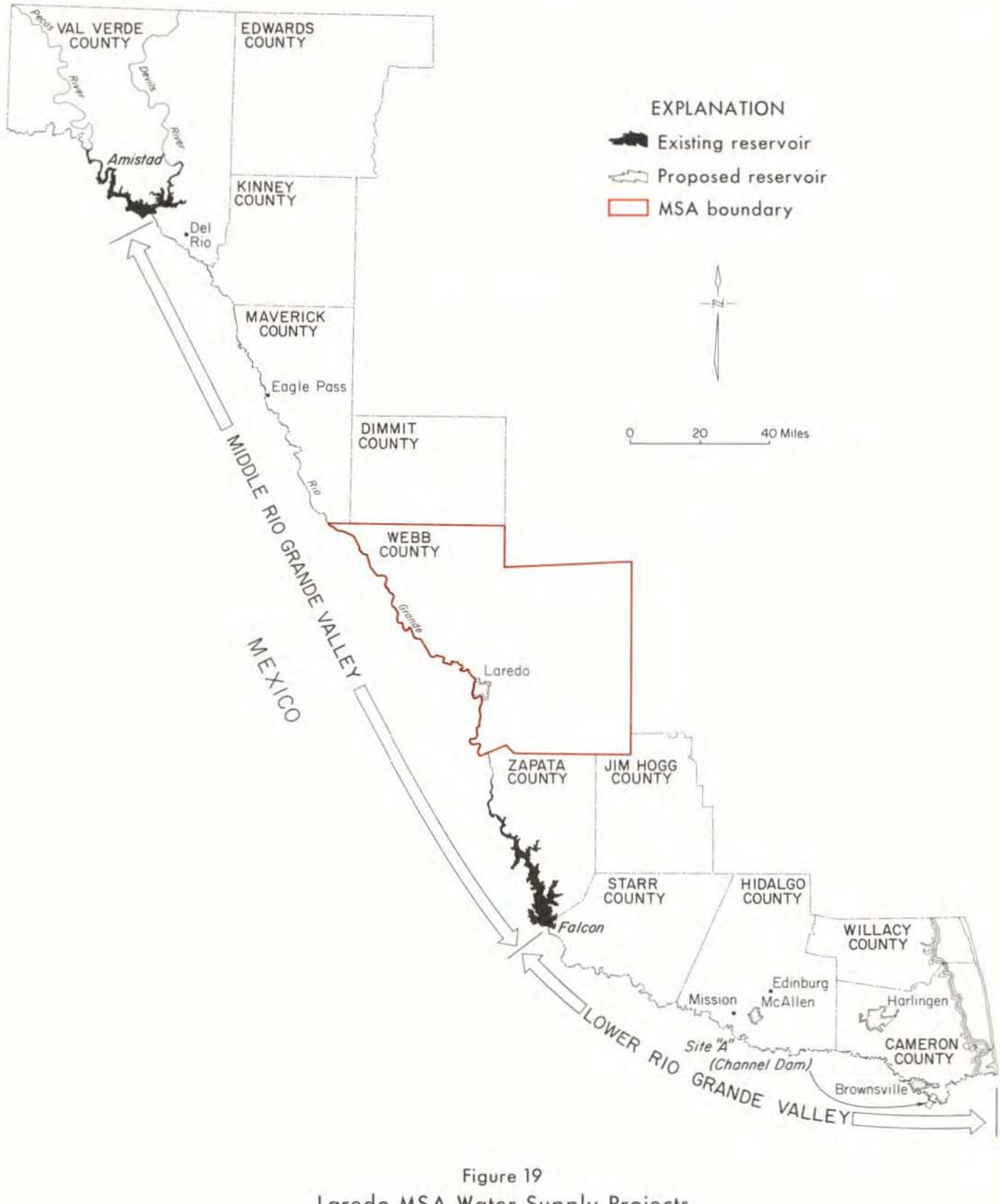


Figure 19
Laredo MSA Water Supply Projects

On the basis of experience of the irrigators served by the Lake Amistad-Lake Falcon system, and the results of the Department's analyses of long-term reservoir operation studies of the system that were conducted by the International Boundary and Water Commission, shortages of water necessary to meet the full demands of the currently adjudicated acreage in the Lower Valley below Lake Falcon (about 740 thousand acres needing about 1.87 million acre-feet of water annually) are expected to occur more than 70 percent of the time, although substantial or serious shortages would occur less than 30 percent of the time. During critical drought periods, substantial shortages will occur and a significant part of the current irrigated acreage would have no irrigation water supply.

High concentrations of total dissolved solids occur in ground-water supplies from the Carrizo-Wilcox Aquifer (Figure 3) within Webb County (MSA). This salinity as well as the great depths at which the aquifer occurs, the low permeability of the aquifer and the aquifer's low recharge rates do not permit adequate amounts of ground water to be developed for moderate to large municipal and manufacturing supplies within the MSA.

Description of Longview-Marshall MSA - The MSA is area No. 15 on Figure 1, and is comprised of Gregg and Harrison counties which cover about 1,176 square miles in parts of the Cypress Creek and Sabine River Basins. Average annual precipitation ranges from 45 to 47 inches. Mean annual temperature is about 64°F. The principal cities are Longview, Marshall, Kilgore and Gladewater. Other cities in the MSA are listed in Appendix C.

Economy of Longview-Marshall MSA -The area economy has high concentrations of activity in the manufacturing, trade and mining sectors. Manufacturing is diversified and contributes 24.4 percent to the total personal income of the MSA. The regional economic outlook is for steady growth and continuing development of the oil, gas, and lignite extraction industries.

Water Quality Management Planning in Longview-Marshall MSA - The Longview-Marshall MSA is located in both the Sabine River Basin and the Cypress Creek Basin. The Texas Department of Water Resources (TDWR) contracted with the Sabine River Authority of Texas for water quality management planning for that portion of the MSA in the Sabine River Basin comprising the greater part of Gregg County and the southern half of Harrison County. The TDWR also contracted with the Northeast Texas Municipal Water District to do the planning for the remainder of the MSA which is in the Cypress Creek Basin. The initial plans for both basins identified wastewater facility needs within the MSA and subsequent planning efforts reviewed the needs and updated them as necessary. In recent years, the Sabine River above Toledo Bend Reservoir has experienced recurrent critical dissolved oxygen levels, particularly in the area downstream from the City of Longview. An important part of the initial planning efforts in the Sabine River Basin was mathematical modeling of the stream system. Simplified modeling of the instream impact of combined point and nonpoint source loads has indicated that stormwater runoff may represent a potentially significant detriment to the oxygen resources in the Longview area stream segment. To refine and substantiate the nonpoint source loading estimates, an urban runoff sampling program was completed in February 1984 in the Longview urban area. In general, the data collected in the study do not indicate significant impacts from nonpoint sources upon the Sabine River in the study area. Due to historic water quality problems documented in the Longview area (segment 0505), continued monitoring of water quality conditions was recommended. All recommendations made during the water quality management process in both basins are considered by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Longview-Marshall MSA - The Federal Emergency Management Agency has designated both counties and 12 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas has been published for both counties and for 11 of the incorporated cities in the MSA (Appendix C). Presently, one county and six cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for four cities in the MSA (Appendix C).

Population and Employment within the Longview-Marshall MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
				Low	155.3	189.3	213.1	235.5	266.9
Total Population	115.0	120.8	151.7	High	186.4	212.3	236.4	269.7	306.9
				Low	113.6	140.1	156.5	172.0	194.6
Urban Population	80.1	84.9	109.3	High	137.4	156.3	172.8	196.5	223.1
				Low	41.7	49.2	56.6	63.5	72.3
Other Populaton	34.9	35.9	42.4	High	49.0	56.0	63.6	73.2	83.8
				Low	86.1	105.0	116.2	124.4	140.9
Employment	40.0	44.4	76.6	High	103.3	117.7	129.0	142.4	162.0

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Longview-Marshall MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	6.2		0.5		--		1.1		7.8	
1980	Surface-Water	16.4		35.1		2.6		0.1		54.2	
1980	Total Use 6/	22.6		35.6		2.6		1.2		62.0	
1990	Total Demand	22.3	38.4	53.8	58.9	14.7	14.7	1.0	1.0	91.8	113.0
1990	Ground-Water	5.4	1.7	--	--	--	--	1.0	1.0	6.4	2.7
1990	Surface-Water	16.9	36.7	53.8	58.9	14.7	14.7	--	--	85.4	110.3
1990	Total Supply 7/	22.3	38.4	53.8	58.9	14.7	14.7	1.0	1.0	91.8	113.0
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	28.0	44.8	72.7	84.0	14.7	14.7	0.8	0.8	116.2	144.3
2000	Ground-Water	6.1	1.9	--	--	--	--	0.8	0.8	6.9	2.7
2000	Surface-Water	21.9	42.9	72.7	84.0	14.7	14.7	--	--	109.3	141.6
2000	Total Supply 7/	28.0	44.8	72.7	84.0	14.7	14.7	0.8	0.8	116.2	144.3
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	31.6	49.9	96.4	113.8	14.7	14.7	0.7	0.7	143.4	179.1
2010	Ground-Water	6.8	2.0	--	--	--	--	0.7	0.7	7.5	2.7
2010	Surface-Water	24.8	47.9	96.4	113.8	14.7	14.7	--	--	135.9	176.4
2010	Total Supply 7/	31.6	49.9	96.4	113.8	14.7	14.7	0.7	0.7	143.4	179.1
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	34.9	57.0	122.6	146.7	14.8	14.8	0.5	0.5	172.8	216.0
2020	Ground-Water	7.1	2.1	--	--	--	--	0.5	0.5	7.6	2.6
2020	Surface-Water	27.8	54.9	122.6	146.7	14.8	14.8	--	--	165.2	216.4
2020	Total Supply 7/	34.9	57.0	122.6	146.7	14.8	14.8	0.5	0.5	172.8	219.0
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	39.6	64.8	156.1	188.9	14.8	14.8	0.3	0.3	210.8	268.8
2030	Ground-Water	7.5	2.2	--	--	--	--	0.3	0.3	7.8	2.5
2030	Surface-Water	32.1	62.6	156.1	188.9	14.8	14.8	--	--	203.0	266.3
2030	Total Supply 7/	39.6	64.8	156.1	188.9	14.8	14.8	0.3	0.3	210.8	268.8
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 1.1 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Longview-Marshall MSA - Currently within the MSA, approximately 87 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 13 percent is supplied by ground-water resources. Approximately 98 and 99 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately two and one percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The urban surface-water requirements within the MSA are expected to be about 141.6 thousand acre-feet in the year 2000, which includes the municipal and industrial water needs for the Longview, Marshall, Kilgore, Gladewater, and other urban water systems. After the year 2000, the urban water needs of these systems cannot be adequately met by the dependable supplies from Lakes Cherokee, Gladewater, Caddo, and Lake Fork (Figure 20). The MSA's additional water needs after 2000 may be met by the construction and development of the proposed Big Sandy Lake (Figure 20) and the proposed Prairie Creek Lake (Figure 20) with direct diversion capabilities from the Sabine River. An alternative to the above proposed reservoir projects would be the development of Little Cypress Lake (Figurre 20) a proposed reservoir project on Little Cypress Bayou.

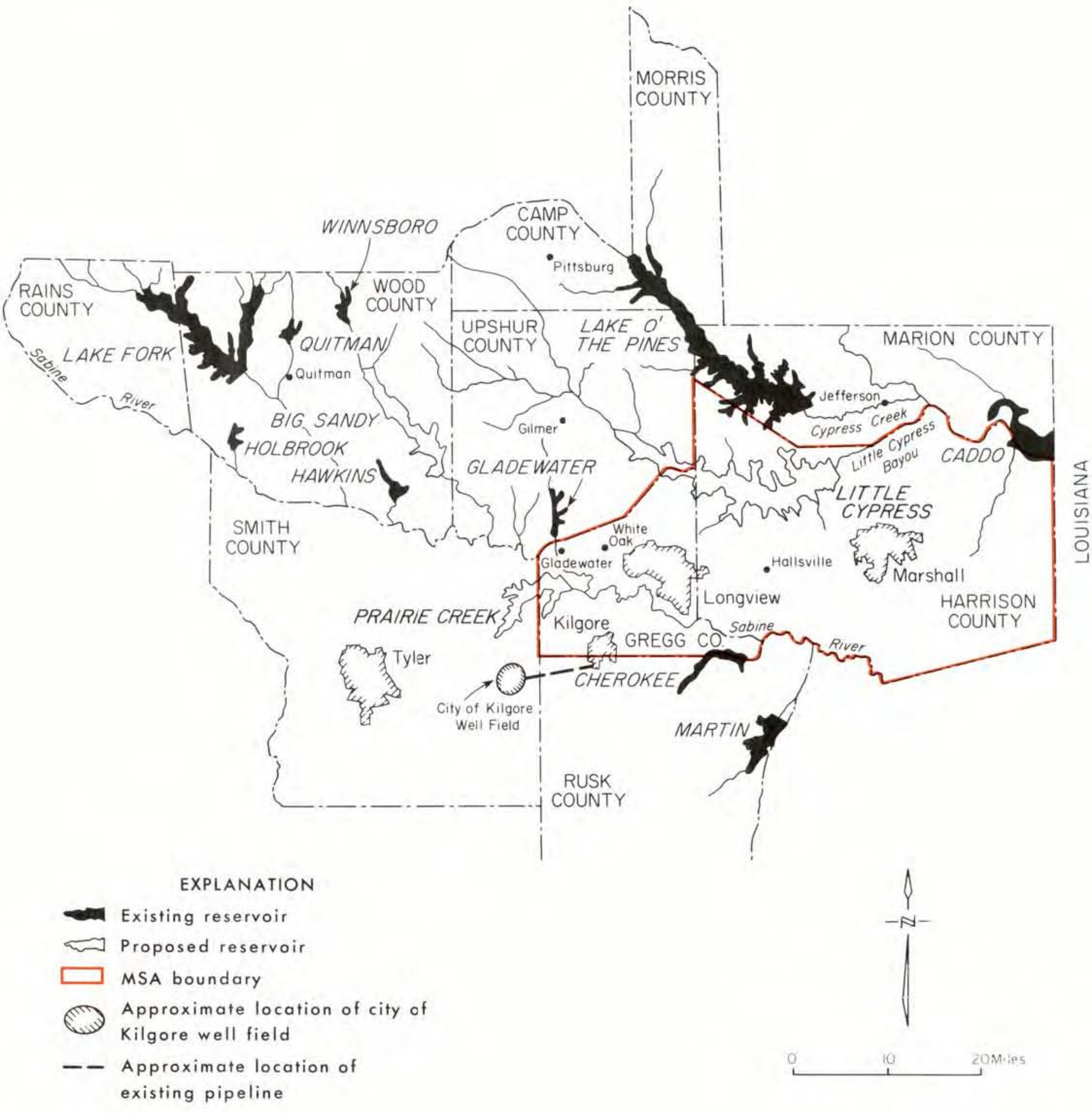


Figure 20
Longview-Marshall MSA Water Supply Projects

LUBBOCK MSA

Description of Lubbock MSA - The MSA is area No. 16 on Figure 1, and is comprised of Lubbock County which covers about 893 square miles in the Brazos River Basin. Average annual precipitation is about 18 inches. Average annual temperature is about 60 F. The principal city is Lubbock. Other cities in the MSA are listed in Appendix C.

Economy of Lubbock MSA - The area economy has high employment concentrations in the trade and services sectors. The heavy equipment and electronics industries are the most important sources of manufacturing employment. Manufacturing contributes 10.8 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on agriculture with increasing employment opportunities in manufacturing.

Water Quality Management Planning in Lubbock MSA - The Lubbock MSA is located entirely within the Brazos River Basin. The Texas Department of Water Resources contracted with the Brazos River Authority for water quality management planning in the basin. The initial plan for the MSA portion of the basin identified wastewater facility needs and subsequent planning efforts reviewed the needs and updated them as found necessary. Additionally, the impacts of point and nonpoint sources of pollution were analyzed. The wasteloads were found to be within the assimilative capacity of the streams and no further special studies were identified. All recommendations made during the water quality management process are reviewed by an advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Lubbock MSA - The Federal Emergency Management Agency has designated Lubbock County and six incorporated cities in the county as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for four of the incorporated cities in the MSA (Appendix C). Presently, four of the cities have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. As indicated in Appendix C, Detailed Flood Insurance Rates Studies have been completed for two of the incorporated cities. These studies provide detailed 10-year, 50-year, 100-year, and 500-year flood event data.

Population and Employment within the Lubbock MSA

Item	1960	1970	1980	Series	Projections 1990	2000	2010	2020	2030
	(Thousands)				(Thousands)				
Total Population	156.3	179.3	211.7	Low	242.4	270.8	299.3	328.4	356.8
				High	250.0	285.4	323.5	361.9	415.7
Urban Population	138.8	163.1	189.4	Low	220.6	246.7	272.4	298.7	324.3
				High	227.6	260.0	294.4	329.2	377.8
Other Population	17.5	16.2	22.3	Low	21.8	24.1	26.9	29.7	32.5
				High	22.4	25.4	29.1	32.7	37.9
Employment	56.6	67.6	106.7	Low	129.9	145.2	157.8	170.3	181.9
				High	134.1	153.0	170.6	187.7	212.0

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Lubbock MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	8.2		0.6		0.6		--		9.4	
1980	Surface-Water	31.8		1.5		4.4		--		37.7	
1980	Total Use 6/	40.0		2.1		5.0		--		47.1	
1990	Total Demand	44.3	61.5	3.2	3.5	13.2	13.2	--	--	60.7	78.2
1990	Ground-Water	12.0	22.5	--	--	--	--	--	--	12.0	22.5
1990	Surface-Water	32.3	39.0	3.2	3.5	13.2	13.2	--	--	48.7	55.7
1990	Total Supply 7/	44.3	61.5	3.2	3.5	13.2	13.2	--	--	60.7	78.2
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	50.7	71.5	4.5	5.0	13.2	13.2	--	--	68.4	89.7
2000	Ground-Water	18.4	17.3	--	--	--	--	--	--	18.4	17.3
2000	Surface-Water	32.3	54.2	4.5	5.0	13.2	13.2	--	--	50.0	72.4
2000	Total Supply 7/	50.7	71.5	4.5	5.0	13.2	13.2	--	--	68.4	89.7
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	56.0	81.0	5.9	6.8	13.2	13.2	--	--	75.1	101.0
2010	Ground-Water	23.6	11.8	--	--	--	--	--	--	23.6	11.8
2010	Surface-Water	32.4	69.2	5.9	6.8	13.2	13.2	--	--	51.5	89.2
2010	Total Supply 7/	56.0	81.0	5.9	6.8	13.2	13.2	--	--	75.1	101.0
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	61.4	90.6	7.6	8.8	13.2	13.2	--	--	82.2	112.6
2020	Ground-Water	23.9	16.9	--	2.6	--	--	--	--	23.9	19.5
2020	Surface-Water	37.5	73.7	7.6	6.2	13.2	13.2	--	--	58.3	93.1
2020	Total Supply 7/	61.4	90.6	7.6	8.8	13.2	13.2	--	--	82.2	112.6
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	66.7	104.0	9.7	11.3	13.2	13.2	--	--	89.6	128.5
2030	Ground-Water	27.4	30.3	--	4.8	--	--	--	--	27.4	35.1
2030	Surface-Water	39.3	73.7	9.7	6.5	13.2	13.2	--	--	62.2	93.4
2030	Total Supply 7/	66.7	104.0	9.7	11.3	13.2	13.2	--	--	89.6	128.5
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 139.0 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 8 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Lubbock MSA - Currently within the MSA, approximately 80 percent of the water used for urban needs (municipal, manufacturing, and steam-electric power generation purposes) is supplied by developed surface-water resources adjacent to the MSA. The remaining 20 percent is supplied by ground-water resources. Approximately 81 and 73 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 19 and 27 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Lubbock is the largest urban water system in the MSA. Currently, the Lubbock System receives its water supply from (1) Lake Meredith (Figure 2) via the Canadian River Municipal Water Authority (CRMWA) pipeline (Figure 21), and (2) the Sand Hills well field, Shallowater well field, and wells within the city (Figure 21), all of which are completed in the High Plains (Ogallala) Aquifer (Figure 3). Currently, on an average basis, these supplies could provide about 59.9 thousand acre-feet annually to the Lubbock System with about 73 percent from Lake Meredith and 27 percent from the High Plains (Ogallala) Aquifer well fields. However, the High Plains (Ogallala) Aquifer within and near the city's well fields as well as throughout the Southern High Plains is not a renewable source of water. A steam electric power plant and an irrigator within the MSA are presently using sewage effluent from the Lubbock System as a source of water, in order to increase overall water-use efficiency, and reduce the load on existing water supplies.

The use of ground water from within and adjacent to the MSA is expected to continue to cause declining water levels and reduction of well yields. The City of Lubbock has developed plans and secured the permits to obtain additional surface-water supplies to supplement present supplies from Lake Meredith and the High Plains (Ogallala) Aquifer well fields. The additional supplies being considered include Lakes Post and Justiceburg which are proposed to be located on the North and South Forks of the Double Mountain Fork of the Brazos River in Garza County (Figure 21). These reservoirs operated as one system are expected to be capable of delivering a dependable supply of about 45.6 thousand acre-feet annually. One possible plan, if implemented, could result in the city receiving water from Lake Justiceburg initially and from the Lakes Post-Justiceburg system prior to 2000. These additional surface-water supplies and additional, potential

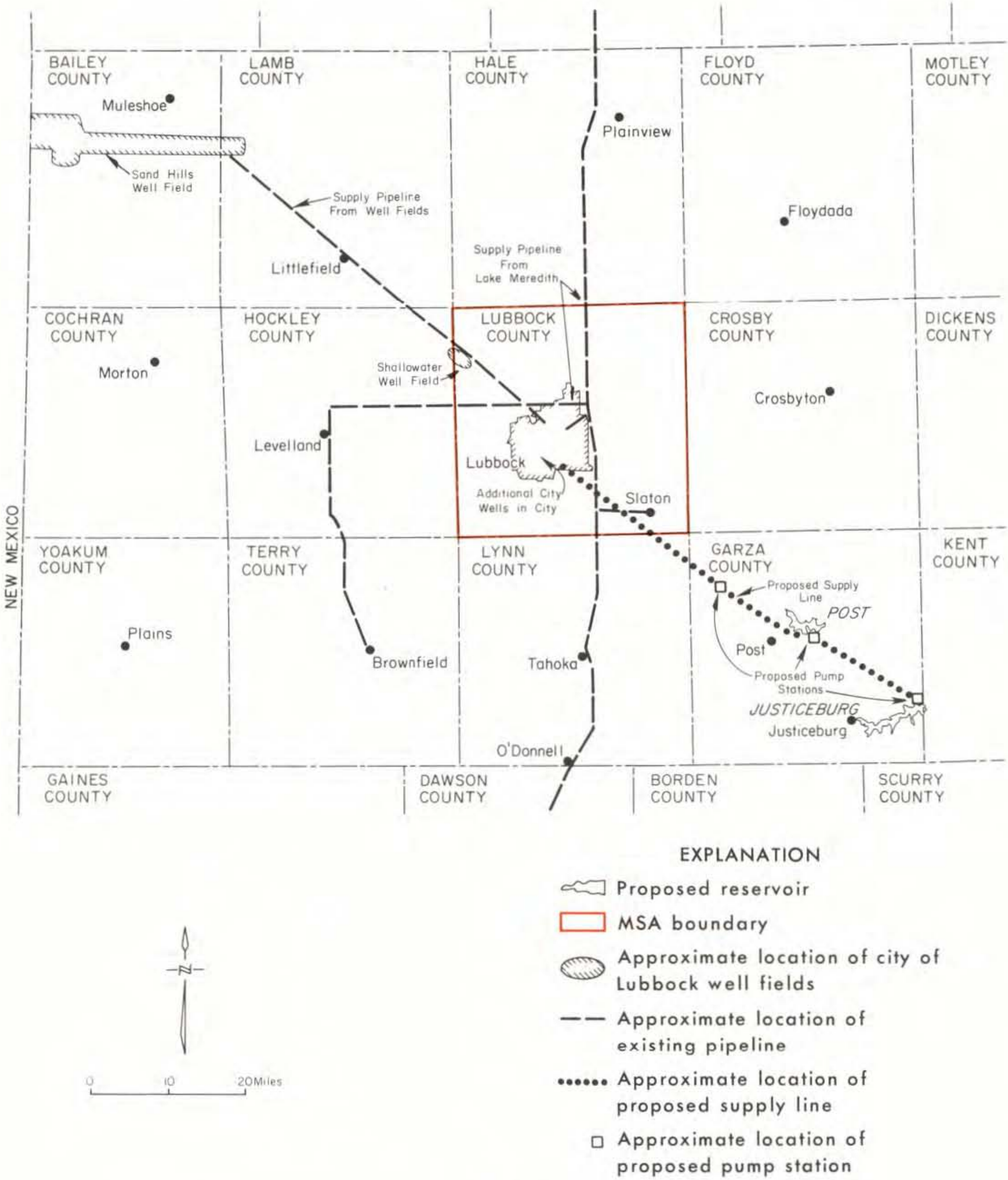


Figure 21
Lubbock MSA Water Supply Projects

ground-water supplies from the High Plains (Ogallala) Aquifer outside of the MSA would be needed to meet the additional urban water needs of Lubbock and the MSA after the year 2000 and through the year 2030. The City of Lubbock is expected to continue using water supplies from Lake Meredith and their currently established well fields through the year 2030.

MCALLEN-EDINBURG-MISSION MSA

Description of McAllen-Edinburg-Mission MSA - The MSA is area No. 17 on Figure 1, and is comprised of Hidalgo County which covers above 1,543 square miles in parts of the Rio Grande Basin and the Nueces-Rio Grande Coastal Basin. Average annual precipitation ranges from about 22 to 26 inches. Average annual temperatures range from 73 F to 74 F. The principal cities are McAllen, Edinburg, Mission, and Pharr. Other cities in the MSA are listed in Appendix C.

Economy of McAllen-Edinburg-Mission MSA - The area economy has concentrations of employment in the trade and services sectors. The food processing and textile industries are the most important sources of manufacturing employment. Manufacturing contributes 7.4 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on agriculture with a rapid growth rate.

Water Quality Management Planning in McAllen-Edinburg-Mission MSA - The McAllen-Edinburg-Mission MSA is located in the Lower Rio Grande Valley Designated Area. The Lower Rio Grande Valley Development Council (LRGVDC) is the designated planning agency. The initial plan for the designated area identified wastewater facility needs, developed a management plan for wastewater treatment, and assessed the impacts of point and nonpoint sources of pollution. Continuing planning activities have focused on updating sewage disposal needs as needed; the development of management systems and identification of sewage disposal needs for the many unincorporated communities or "colonias"; and the impacts of nonpoint sources (including pesticides and toxic substances). The first two topics are currently underway. The nonpoint source evaluation included the monitoring of water, sediments and fish tissue by LRGVDC, the Texas Department of Water Resources (TDWR), and the U.S. Fish and Wildlife Service. The net result of these studies indicates that relatively high levels of some chlorinated hydrocarbon pesticides can be found in sediments and some fish species. No particular existing source of these pesticides could be determined. The TDWR believes that these elevated levels are probably residual effects from the heavy agricultural use of these pesticides in the past. The situation will be monitored through the TDWR's stream monitoring network to see if levels decline over time, as they should. All recommendations made during the water quality management process in the designated area are reviewed by a local advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in McAllen-Edinburg-Mission MSA - The Federal Emergency Management Agency has designated Hidalgo County and 15 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for Hidalgo County and for 12 of the incorporated cities in the MSA (Appendix C). Presently, Hidalgo County and all 15 incorporated cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Hidalgo County and nine cities in the MSA (Appendix C).

Population and Employment within the McAllen-Edinburg-Mission MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	180.9	181.6	283.2	Low	402.1	529.5	674.2	844.6	1048.5
				High	431.9	599.7	808.3	1086.8	1411.8
Urban Population	131.2	135.9	205.5	Low	293.6	385.4	490.8	614.8	763.2
				High	315.4	436.5	588.4	791.1	1027.7
Other Population	49.7	45.7	77.7	Low	108.5	144.1	183.4	229.8	285.3
				High	116.5	163.2	219.9	295.7	384.1
Employment	57.1	52.1	92.6	Low	149.3	196.6	246.2	303.4	370.3
				High	160.4	222.6	295.2	390.4	498.7

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the McAllen-Edinburg-Mission MSA 1/

Year	Analyses Catagory	Municipal[2/] Low	Municipal High	Manufacturing[3/] Low	Manufacturing High	Steam Electric[4/] Low	Steam Electric High	Mining[5/] Low	Mining High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	3.3		0.2		--		0.2		3.7	
1980	Surface-Water	45.6		3.0		2.2		0.2		51.0	
1980	Total Use 6/	48.9		3.2		2.2		0.4		54.7	
1990	Total Demand	64.6	96.4	3.9	4.1	2.2	2.2	0.4	0.4	71.1	103.1
1990	Ground-Water	7.8	8.1	--	--	--	--	0.2	0.2	8.0	8.3
1990	Surface-Water	50.9	63.4	0.7	0.7	2.2	2.2	0.2	0.2	54.0	66.5
1990	Total Supply 7/	58.7	71.5	0.7	0.7	2.2	2.2	0.4	0.4	62.0	74.8
1990	Shortage	5.9	24.9	3.2	3.4	--	--	--	--	9.1	28.3
2000	Total Demand	87.7	137.0	5.0	5.4	2.2	2.2	0.4	0.4	95.3	145.0
2000	Ground-Water	10.7	11.2	--	--	--	--	0.1	0.1	10.8	11.3
2000	Surface-Water	57.4	66.5	0.7	0.7	2.2	2.2	0.3	0.3	60.6	69.7
2000	Total Supply 7/	68.1	77.7	0.7	0.7	2.2	2.2	0.4	0.4	71.4	81.0
2000	Shortage	19.6	59.3	4.3	4.7	--	--	--	--	23.9	64.0
2010	Total Demand	111.7	184.7	6.1	6.8	2.8	2.8	0.4	0.4	121.0	194.7
2010	Ground-Water	10.9	11.6	--	--	--	--	0.1	0.1	11.0	11.7
2010	Surface-Water	64.7	68.2	0.7	0.7	2.8	2.8	0.3	0.3	68.5	72.0
2010	Total Supply 7/	75.6	79.8	0.7	0.7	2.8	2.8	0.4	0.4	79.5	83.7
2010	Shortage	36.1	104.9	5.4	6.1	--	--	--	--	41.5	111.0
2020	Total Demand	139.9	248.3	7.5	8.5	3.4	3.4	0.5	0.5	151.3	260.7
2020	Ground-Water	10.4	11.5	--	--	--	--	0.1	0.1	10.5	11.6
2020	Surface-Water	66.2	69.2	0.7	0.7	3.4	3.4	0.4	0.4	70.7	73.7
2020	Total Supply 7/	76.6	80.7	0.7	0.7	3.4	3.4	0.5	0.5	81.2	85.3
2020	Shortage	63.3	167.6	6.8	7.8	--	--	--	--	70.1	175.4
2030	Total Demand	173.6	322.5	9.1	10.5	4.0	4.0	0.5	0.5	187.2	337.5
2030	Ground-Water	7.7	9.1	--	--	--	--	0.1	0.1	7.8	9.2
2030	Surface-Water	67.8	70.0	0.7	0.7	4.0	4.0	0.4	0.4	72.9	75.1
2030	Total Supply 7/	75.5	79.1	0.7	0.7	4.0	4.0	0.5	0.5	80.7	84.3
2030	Shortage	98.1	243.4	8.4	9.8	--	--	--	--	106.5	253.2

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 761.2 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

<u>Water Supply Outlook and Problems in the McAllen-Edinburg-Mission MSA</u> - Currently within the MSA, approximately 93 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources adjacent to the MSA. The remaining seven percent is supplied by ground-water resources. In the year 2000, only about 48 percent of the MSA's projected urban water requirements (145.0 thousand acre-feet) are expected to be supplied from developed surface-water resources, and only about eight percent by ground-water resources. In the year 2030, only about 22 percent of the MSA's projected urban water requirements (337.5 thousand acre-feet) are expected to be supplied by developed surface-water resources, and only about three percent by ground-water resources. Water shortages for urban water needs within the MSA are expected to be about 64.0 thousand acre-feet in 2000 and about 253.2 thousand acre-feet in 2030. The shortages are expected to begin between 1985 and 1990 as described below.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Some of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems are not readily available or surface-water supplies may not be accessible through an entity having water rights.

The MSA is located within the Lower Rio Grande Valley which will continue to be provided, along with the Middle Rio Grande Valley, surface water from the Lake Amistad-Lake Falcon system (Figure 22). Supplies from the system for in-basin needs, as well as needs for the southern portion of the Nueces-Rio Grande Coastal Basin in the Lower Rio Grande Valley, are presently allocated on the basis of 1977 rules of the Texas Water Commission. These rules are based upon water rights recognized in the "Lower Rio Grande Valley Water Case," and in the Middle Rio Grande (between Lake Amistad and Lake Falcon) upon a "Final Determination" of water rights and claims by the Commission. The 1977 specific water allocation for urban uses from the reservoirs system is about 186.0 thousand acre-feet per year. Total urban water needs within the MSA and other areas served by the Lake Amistad-Lake Falcon system is expected to reach about 312.9 thousand acre-feet in the year 2000. Serious regional urban water shortages within the Lake Amistad-Lake Falcon service area are expected to occur between 1985 and 1990 based on the current urban water allocation (supply) of 186.0 thousand acre-feet. Under present conditions, 100.0 thousand acre-feet of storage in Lake Amistad and Lake Falcon are set aside for emergency urban needs under drought conditions for the Middle and Lower Rio Grande Valleys for authorized allocations by the adjudication certificates.

On the basis of experience of the irrigators served by the Lake Amistad-Lake Falcon system, and the results of the Department's

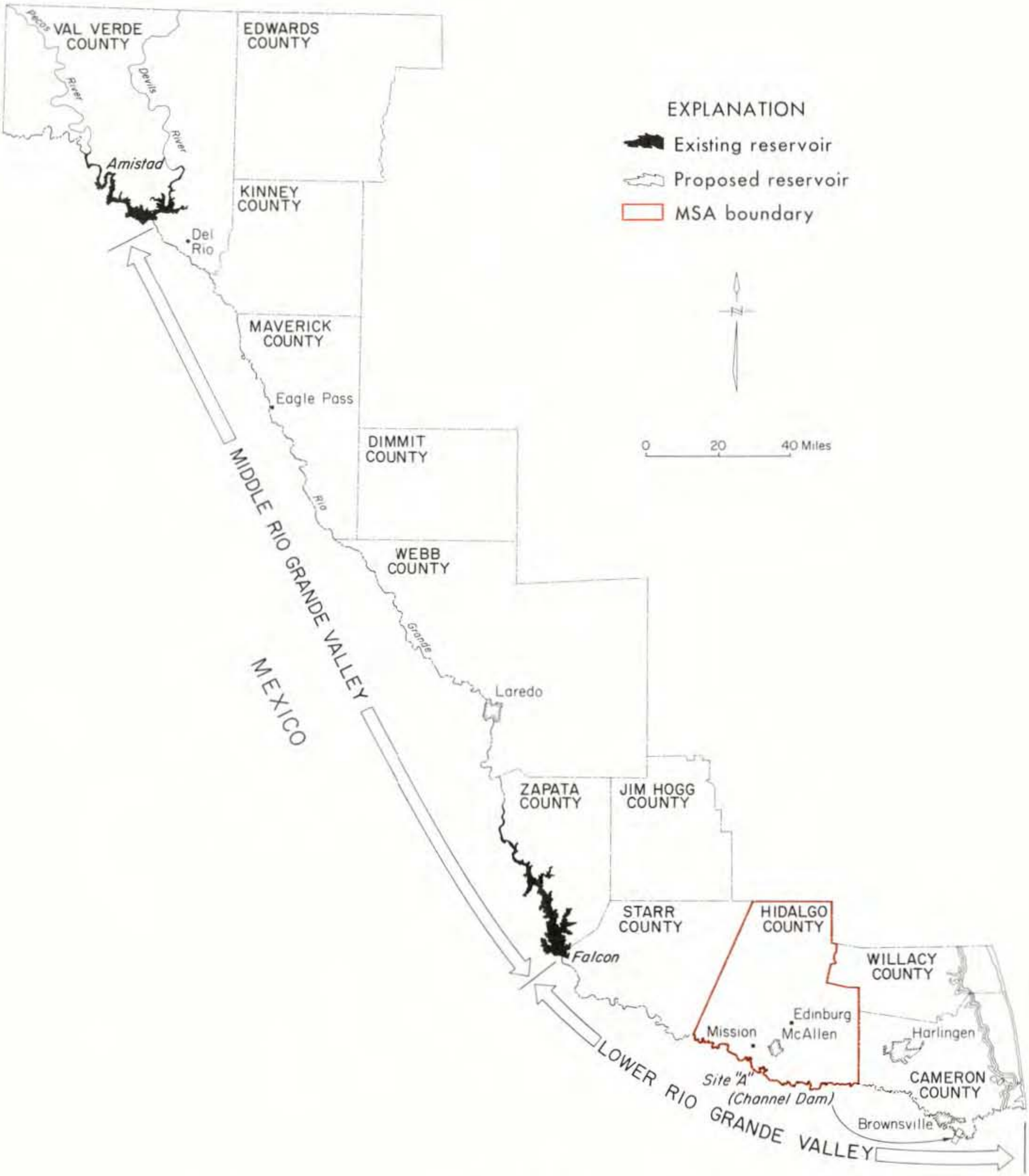


Figure 22
McAllen-Edinburg-Mission MSA Water Supply Projects

analyses of long-term reservoir operation studies of the system that were conducted by the International Boundary and Water Commission, shortages of water necessary to meet the full demands of the currently adjudicated acreage in the Lower Valley below Lake Falcon (about 740 thousand acres needing about 1.87 million acre-feet of water annually) are expected to occur more than 70 percent of the time, although substantial or serious shortages would occur less than 30 percent of the time. During critical drought periods, substantial shortages will occur and a significant part of the current irrigated acreage would have no irrigation water supply.

High concentrations of total dissolved solids are often encountered in ground-water supplies from the Gulf Coast Aquifer (Figure 3) within the MSA. Salinity coupled with the low permeability of the aquifer and low recharge rates do not permit adequate amounts of ground water to be developed for moderate to large municipal and manufacturing supplies within the MSA.

Description of Midland MSA - The MSA is area No. 18 on Figure 1, and is comprised of Midland County which covers about 839 square miles, all of which is within the Colorado River Basin. Average annual precipitation is about 14 inches. Average annual temperature is about 64 F. The principal city is Midland.

Economy of Midland MSA - The area economy has high employment concentrations in the petroleum sector, with secondary emphasis in construction, services and trade. The petrochemical and oil and gas drilling equipment industries are the most important sources of manufacturing employment. Manufacturing contributes 6.7 percent to the total personal income of the MSA. The regional economic outlook is for steady growth and diversification with continuing dependence on energy resources.

Water Quality Management Planning in Midland MSA - The MSA, which consists of Midland County, lies within the upper part of the Colorado River Basin, but is essentially non-contributing to the Colorado River. Through contract with the Texas Department of Water Resources, the Colorado River Municipal Water District is the water quality planning agency for the MSA and adjacent areas. The initial phase of the water quality management planning program included information on existing wastewater treatment facilities, existing water quality, existing land use patterns, existing population, and projections of economic growth, population, and probable land use patterns. During this phase, problems with the wastewater treatment plants of Midland were identified. During the later phases of the plan, feasible alternative solutions were developed and an environmental assessment was done. The area's continuing water quality management planning program has included public participation. A citizens advisory committee consisting of representatives from four groups (private citizens, public officials, public interest, and economic interest) reviewed all documents developed during the program, and provided input to the planning process.

Floodplain Management Program in Midland MSA - The Federal Emergency Management Agency has designated Midland County and the City of Midland (Appendix C) as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for Midland County and the City of Midland (Appendix C), and both entities have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have not been completed in Midland County and the City of Midland (Appendix C).

Population and Employment within the Midland MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	67.7	65.5	82.6	Low	102.0	110.6	115.2	119.8	125.5
				High	114.4	126.2	134.7	143.7	154.3
Urban Population	62.6	59.5	70.5	Low	84.1	89.2	92.9	96.6	101.2
				High	94.3	101.8	108.6	115.9	124.4
Other Population	5.1	6.0	12.1	Low	17.9	21.4	22.3	23.2	24.3
				High	20.1	24.4	26.1	27.8	29.9
Employment	26.1	26.5	50.5	Low	62.6	67.9	69.6	71.2	73.3
				High	70.2	77.4	81.3	85.4	90.1

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Midland MSA 1/

Year	Analyses Catagory	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	7.3		--		--		0.3		7.6	
1980	Surface-Water	12.1		0.1		--		--		12.2	
1980	Total Use 6/	19.4		0.1		--		0.3		19.8	
1990	Total Demand	21.0	30.3	0.2	0.2	--	--	0.2	0.2	21.4	30.7
1990	Ground-Water	5.8	11.0	--	--	--	--	0.2	0.2	6.0	11.2
1990	Surface-Water	15.2	19.3	0.2	0.2	--	--	--	--	15.4	19.5
1990	Total Supply 7/	21.0	30.3	0.2	0.2	--	--	0.2	0.2	21.4	30.7
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	22.9	33.6	0.3	0.3	--	--	0.1	0.1	23.3	34.0
2000	Ground-Water	5.5	7.3	--	--	--	--	0.1	0.1	5.6	7.4
2000	Surface-Water	17.4	26.3	0.3	0.3	--	--	--	--	17.7	26.6
2000	Total Supply 7/	22.9	33.6	0.3	0.3	--	--	0.1	0.1	23.3	34.0
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	23.8	35.8	0.4	0.5	--	--	0.1	0.1	24.3	36.4
2010	Ground-Water	5.4	6.8	--	--	--	--	0.1	0.1	5.5	6.9
2010	Surface-Water	18.4	29.0	0.4	0.5	--	--	--	--	18.8	29.5
2010	Total Supply 7/	23.8	35.8	0.4	0.5	--	--	0.1	0.1	24.3	36.4
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	24.8	38.1	0.5	0.6	--	--	0.1	0.1	25.4	38.8
2020	Ground-Water	5.2	6.6	--	--	--	--	0.1	0.1	5.3	6.7
2020	Surface-Water	19.6	31.5	0.5	0.6	--	--	--	--	20.1	32.1
2020	Total Supply 7/	24.8	38.1	0.5	0.6	--	--	0.1	0.1	25.4	38.8
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	25.9	40.9	0.6	0.8	--	--	0.1	0.1	26.6	41.8
2030	Ground-Water	5.3	6.7	--	--	--	--	0.1	0.1	5.4	6.8
2030	Surface-Water	20.6	34.2	0.6	0.8	--	--	--	--	21.2	35.0
2030	Total Supply 7/	25.9	40.9	0.6	0.8	--	--	0.1	0.1	26.6	41.8
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 25.8 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

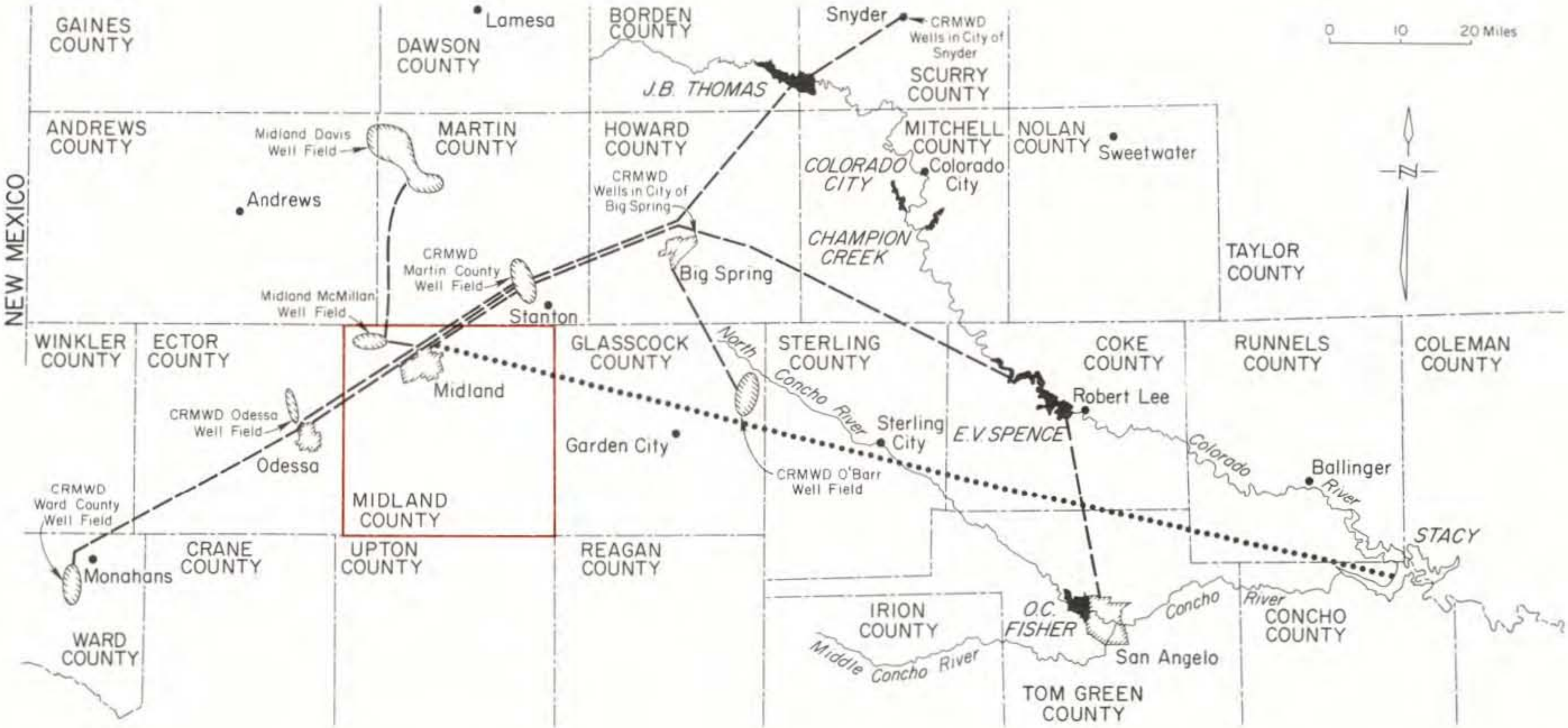
7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Midland MSA - Currently within the MSA, approximately 62 percent of the water used for urban needs (municipal, manufacturing, and mining purposes) is supplied by developed surface-water resources adjacent to the MSA. The remaining 38 percent is supplied by ground-water resources. Approximately 78 and 84 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 22 and 16 percent by ground-water resources in the years 2000 and 2030, respectively.

The growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. These systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water and ground water to adequately fulfill the water needs of the urban systems may not be readily available or surface-water supplies may not be accessible through a system having water rights.

The City of Midland which is the only large urban water system in the MSA (Midland County) obtains part of its water supply from the Colorado River Municipal Water District (CRMWD). Currently, most of Midland's supply is from surface water provided by Lakes J.B. Thomas (Scurry and Borden County) and E.V. Spence (Coke County) (Figure 23). The other current CRMWD supply for Midland is ground water from the Martin County well field (Figure 23). The city has a contract with the CRMWD to receive water supplies from the above CRMWD sources. Current city contracts with the CRMWD have arrangements for the city to receive about a 50 million gallon per year increase. The City of Midland's remaining water supply is ground water from the city owned and operated Davis and McMillan well fields (Figure 23). However, both well fields when operated extensively have demonstrated water-level declines and decreasing well yields. Currently, the City of Midland produces most of its supplemental supply from the Davis well field. During the winter, the city takes 4 to 5 million gallons per day of Davis well field water and recharges the McMillan well field where a significant amount of dewatered, unsaturated formation is available for underground storage. In the summer, the recharged water is pumped from the McMillan well field to meet the city's peak demand.

The major current and proposed water supply projects and distribution facilities of the CRMWD are shown on Figure 23. The CRMWD not only supplies part of the water for the City of Midland but also provides all or part of the water supply for the cities of Odessa, Big Spring, Snyder, Stanton, San Angelo and Robert Lee (Figure 23), and thirteen (13) industrial customers throughout the region involved in petroleum refining, production of petrochemicals, natural gas processing, metal refining, and oil field enhanced recovery operations. Currently, the CRMWD delivers about 56 thousand acre-feet per year to its customer cities and industries. Of the 56 thousand acre-feet annual delivery, about 89 percent was for municipal use and 11 percent was for



EXPLANATION

Existing reservoir

Proposed reservoir

MSA boundary

Approximate location of major pipelines of the CRMWD

Approximate location of proposed supply line of the CRMWD

Approximate location of well fields used as water supplies for urban needs within the Midland and Odessa MSAs

CRMWD Colorado River Municipal Water District

Figure 23

Midland MSA Water Supply Projects

manufacturing and mining. Approximately 79 percent of the annual water supply of the CRMWD is from Lakes J.B. Thomas and E.V. Spence and other diversions from the Colorado River. The remaining 21 percent of the annual supply is from the region's very limited ground-water resources provided by well fields which are indicated on Figure 23 in Scurry, Howard, Glasscock, Martin, Ector, and Ward counties.

The projected urban surface-water requirements of the CRMWD service area, including the Midland MSA, are expected to be about 106 thousand acre-feet in the year 2000. These requirements will continue to be met from Lakes J.B. Thomas and E.V. Spence. However, shortly after 1990, an additional surface-water supply will be needed by the CRMWD and its customer cities and industries. This additional firm supply can be provided by Lake Stacy, a proposed reservoir to be located on the Colorado and Concho Rivers in Runnels, Coleman and Concho counties (Figure 23). This annual supply plus the annual dependable supplies from Lakes J.B. Thomas and E.V. Spence would be capable of meeting the projected surface-water requirements of the CRMWD including the Midland MSA through the year 2030.

Description of Odessa MSA - The MSA is area No. 19 on Figure 1, and is comprised of Ector County which covers about 907 square miles in parts of the Rio Grande and Colorado River Basins. Average annual precipitation ranges from 12 to 14 inches. Average annual temperatures are from about 63°F to 65°F. The principal city is Odessa.

Economy of Odessa MSA - The area economy has high employment concentrations in the petroleum sector, with secondary emphasis in construction, services, and trade. The petrochemical and oil and gas drilling equipment industries are the most important source of manufacturing employment. Manufacturing contributes 13.8 percent to the total personal income of the MSA. The regional economic outlook is for continuing dependence on energy resources.

Water Quality Management Planning in Odessa MSA - Since most of the MSA (Ector County) lies within the Colorado River Basin, the Colorado River Municipal Water District through a contract with the Texas Department of Water Resources is the principal water quality management planning agency for the MSA and adjacent area. The MSA essentially is noncontributing to the Colorado River. The initial phase of the water quality planning program included information on existing wastewater treatment facilities, existing water quality, existing land use patterns, existing population, and projections of economic growth, population, and probable land use patterns. During this phase, problems with the wastewater treatment plants of Odessa were identified. During the later phases of the plan, feasible alternative solutions were developed and an environmental assessment was done. The continuing water quality management planning programs included a public participation program. A citizens advisory committee consisting of representatives of four groups (private citizens, public officials, public interest and economic interest) reviewed all documents developed during the program and provided input to the planning process.

Floodplain Management Program in Odessa MSA - The Federal Emergency Management Agency has designated Ector County and two incorporated cities in the MSA (Appendix C) as being subject to potential flooding problems from a 100-year flood event. Flood hazard boundary maps identifying flood-prone areas have been published for Ector County and the City of Odessa (Appendix C). Presently, the county and the City of Odessa have local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have not been completed in Ector County and the two incorporated cities (Appendix C).

Population and Employment within the Odessa MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	91.0	91.8	115.3	Low	142.0	157.2	168.0	179.5	194.7
				High	154.7	173.7	189.5	211.1	235.1
Urban Population	80.3	78.4	90.0	Low	104.6	111.7	119.4	127.6	138.4
				High	113.9	125.5	134.7	150.0	167.1
Other Population	10.7	13.4	25.3	Low	37.4	45.5	48.6	51.9	56.3
				High	40.8	50.2	54.8	61.1	68.0
Employment	33.3	35.9	58.9	Low	83.8	92.4	96.0	99.6	104.8
				High	91.2	102.1	108.3	117.1	126.6

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Odessa MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	13.9		1.7		--		3.2		18.8	
1980	Surface-Water	10.7		4.2		--		--		14.9	
1980	Total Use 6/	24.6		5.9		--		3.2		33.7	
1990	Total Demand	23.5	34.8	8.5	9.3	--	--	2.3	2.3	34.3	46.4
1990	Ground-Water	12.0	13.4	1.0	0.6	--	--	2.3	2.3	15.3	16.3
1990	Surface-Water	11.5	21.4	7.5	8.7	--	--	--	--	19.0	30.1
1990	Total Supply 7/	23.5	34.8	8.5	9.3	--	--	2.3	2.3	34.3	46.4
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	26.4	39.5	11.1	12.9	--	--	1.5	1.5	39.0	53.9
2000	Ground-Water	11.5	12.6	0.3	0.6	--	--	1.5	1.5	13.3	14.7
2000	Surface-Water	14.9	26.9	10.8	12.3	--	--	--	--	25.7	39.2
2000	Total Supply 7/	26.4	39.5	11.1	12.9	--	--	1.5	1.5	39.0	53.9
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	28.2	43.1	14.3	16.9	--	--	1.4	1.4	43.9	61.4
2010	Ground-Water	11.3	12.6	0.3	0.6	--	--	1.4	1.4	13.0	14.6
2010	Surface-Water	16.9	30.5	14.0	16.3	--	--	--	--	30.9	46.8
2010	Total Supply 7/	28.2	43.1	14.3	16.9	--	--	1.4	1.4	43.9	61.4
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	30.1	48.0	18.2	21.8	--	--	1.4	1.4	49.7	71.2
2020	Ground-Water	11.3	3.3	--	0.6	--	--	1.4	1.4	12.7	5.3
2020	Surface-Water	18.8	44.7	18.2	21.2	--	--	--	--	37.0	65.9
2020	Total Supply 7/	30.1	48.0	18.2	21.8	--	--	1.4	1.4	49.7	71.2
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	32.7	53.5	22.9	27.9	--	--	1.4	1.4	57.0	82.8
2030	Ground-Water	2.1	3.3	--	0.6	--	--	1.4	1.4	3.5	5.3
2030	Surface-Water	30.6	50.2	22.9	27.3	--	--	--	--	53.5	77.5
2030	Total Supply 7/	32.7	53.5	22.9	27.9	--	--	1.4	1.4	57.0	82.8
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 8.3 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

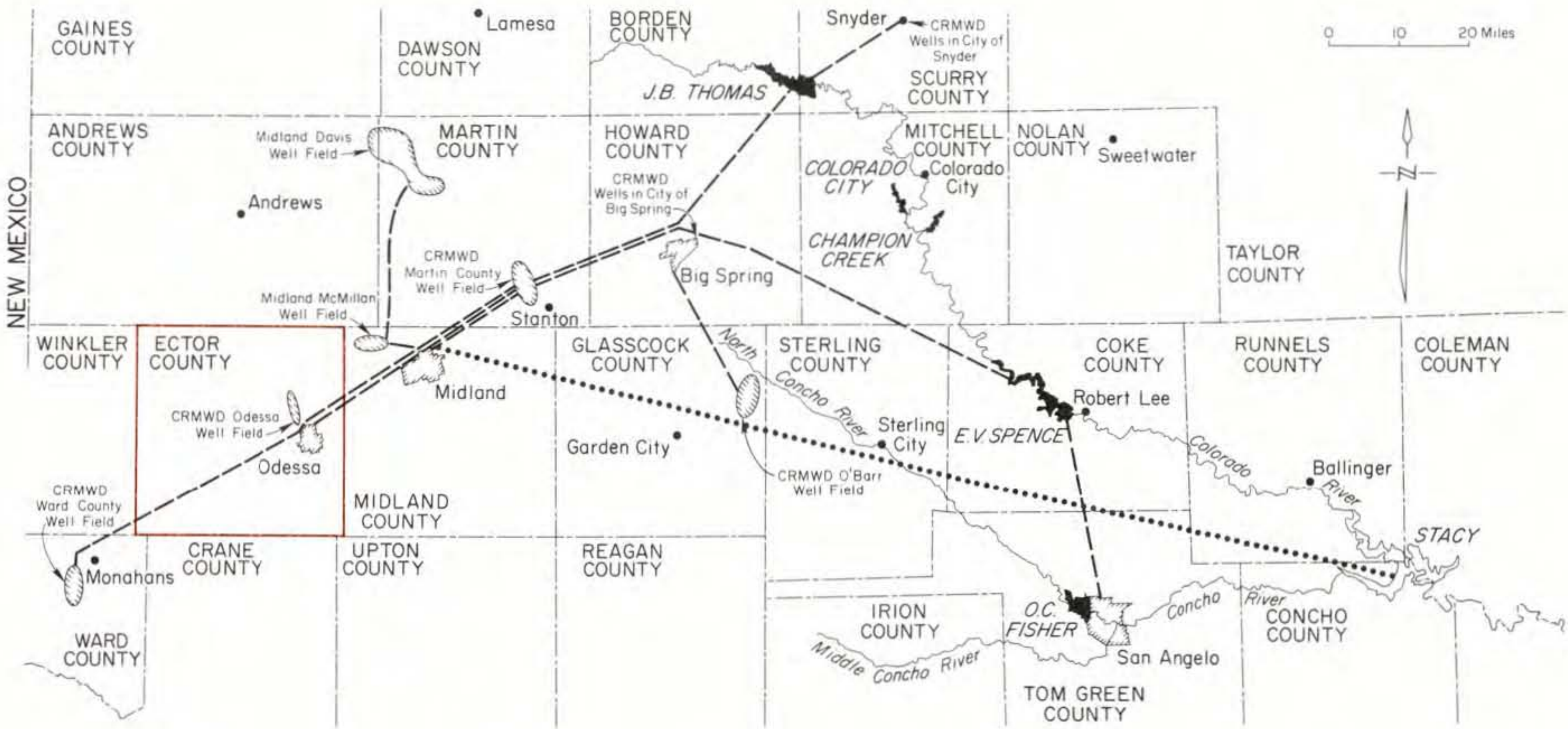
Water Supply Outlook and Problems in the Odessa MSA - Currently within the MSA, approximately 44 percent of the water used for urban needs (municipal, manufacturing and mining purposes) is supplied by ground-water resources in and adjacent to the MSA. The remaining 56 percent is supplied by developed surface-water resources adjacent to the MSA. Approximately 73 and 94 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 27 and 6 percent by ground-water resources in the years 2000 and 2030, respectively.

The growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. These systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of the urban systems may not be readily available or surface-water supplies may not be accessible through a system having water rights.

The City of Odessa, which is the only large urban water system in the MSA (Ector County) obtains its water supply through the Colorado River Municipal Water District (CRMWD). Currently, most of Odessa's supply is from surface water provided by Lakes J.B. Thomas (Scurry and Borden Counties) and E.V. Spence (Coke County) (Figure 24). Deliveries of this water at times may contain some ground water from the CRMWD's Martin County well field (Figure 24). The other source of supply is ground water from the CRMWD's Ector County and Ward County well fields (Figure 24).

The major current and proposed water supply projects and distribution facilities of the CRMWD are shown on Figure 24. The Davis well field, McMillan well field, and related pipeline shown on Figure 24 are owned and operated by the City of Midland. The CRMWD not only supplies water to the City of Odessa but also provides all or part of the water supply for the cities of Midland, Big Spring, Snyder, Stanton, San Angelo, and Robert Lee (Figure 24), and thirteen (13) industrial customers throughout the region involved in petroleum refining, production of petrochemicals, natural gas processing, metal refining, and oil field enhanced recovery operations. Currently, the CRMWD delivers about 56 thousand acre-feet per year to its customer cities and industries. Of the 56 thousand acre-feet annual delivery, about 89 percent was for municipal use and 11 percent was for manufacturing and mining. Approximately 79 percent of the annual water supply for the CRMWD is from Lakes J.B. Thomas and E.V. Spence and other diversions from the Colorado River. The remaining 21 percent of the annual supply is from the regions very limited ground-water resources provided by well fields which are indicated on Figure 24 in Scurry, Howard, Glasscock, Martin, Ector and Ward counties.

The projected urban surface-water requirements of the CRMWD service area including the Odessa MSA are expected to be about 106 thousand acre-feet in the year 2000. These requirements can continue to be met



EXPLANATION

- Existing reservoir
- Proposed reservoir
- MSA boundary
- Approximate location of major pipelines of the CRMWD
- Approximate location of proposed supply line of the CRMWD
- Approximate location of well fields used as water supplies for urban needs within the Midland and Odessa MSAs

CRMWD Colorado River Municipal Water District

Figure 24
Odessa MSA Water Supply Projects

from Lakes J.B. Thomas and E.V. Spence. However, shortly after 1990 an additional surface-water supply will be needed by the CRMWD and its customer cities and industries. This additional firm supply can be provided by Lake Stacy, a proposed reservoir to be located on the Colorado and Concho Rivers in Runnels, Coleman and Concho counties (Figure 24). This annual supply plus the annual dependable supplies from Lakes J.B. Thomas and E.V. Spence would be capable of meeting the expected surface-water requirements of the CRMWD including the Odessa MSA through the year 2030.

SAN ANGELO MSA

Description of San Angelo MSA - The MSA is area No. 20 on Figure 1, and is comprised of Tom Green County which covers about 1,500 square miles in the Colorado River Basin. Average annual precipitation ranges from about 17 to 21 inches. Average annual temperature is about 65.5°F. The principal city is San Angelo.

Economy of San Angelo MSA - The area economy has high concentrations of employment in the fields of manufacturing, trade and services. Manufacturing employment, which is diversified and expanding, contributes 11.2 percent to the total personal income of the MSA. The regional economic outlook is for continuing development of industrial potential and reduction of its dependence on an agricultural base.

Water Quality Management Planning in San Angelo MSA - The Concho Valley Council of Governments (CVCOG), through contracts with the Texas Department of Water Resources, is the water quality planning agency for the Middle Colorado Basin which includes the San Angelo MSA (Tom Green County). The City of San Angelo operates sewage treatment plants using irrigation of farmland as their method of wastewater disposal, rather than discharging to a watercourse. Simplified modeling during the initial water quality management planning study indicated that discharge to the Concho River by the city, even under the most stringent effluent limits, would depress the dissolved oxygen concentration below the stream standard of 5.0 mg/l. Initial planning also revealed that significant impacts on North Concho River water quality are attributable to pollutants associated with urban runoff in and around San Angelo. Nonpoint source and urban runoff studies in this area, recently completed as follow-up investigations, have identified the types of pollutants, their severity and distribution, and suggested control measures with estimated costs. The City of San Angelo has been designated as the management agency for the implementation of recommended control measures and is interested in pursuing these measures (both structural and nonstructural), subject to available funding. Other water quality management planning work in the area involved wastewater facility needs analyses by CVCOG during the initial and subsequent plans and wastewater treatment management agency identification. Public participation has been an element of the planning process from initial through subsequent planning studies with citizens advisory committees available for input and review of all relevant material.

Floodplain Management Program in San Angelo MSA - The Federal Emergency Management Agency has designated Tom Green County and the City of San Angelo (only incorporated city in the MSA) as being subject to potential flood problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for both the county and for the city (Appendix C). Both entities have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. A Detailed Flood Insurance Rate Study has been completed for the City of San Angelo (Appendix C). This study supplies detailed 10-year, 50-year, 100-year and 500-year flood event data.

Population and Employment within the San Angelo MSA

Item	1960	1970	1980	Series	Projections 1990	2000	2010	2020	2030
	(Thousands)				(Thousands)				
Total Population	64.6	71.1	84.8	Low	83.9	96.4	102.9	111.4	125.0
				High	96.8	103.3	111.9	125.6	141.0
Urban Population	58.8	63.9	73.2	Low	70.9	80.3	85.7	92.8	104.2
				High	81.8	86.1	93.2	104.7	117.5
Other Population	5.8	7.2	11.5	Low	13.0	16.1	17.2	18.6	20.8
				High	15.0	17.2	18.7	20.9	23.5
Employment	22.8	25.5	43.4	Low	45.7	52.5	55.2	58.7	64.9
				High	52.7	56.3	60.0	66.3	73.1

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the San Angelo MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	0.9		--		--		--		0.9	
1980	Surface-Water	21.3		0.5		1.0		--		22.8	
1980	Total Use 6/	22.2		0.5		1.0		--		23.7	
1990	Total Demand	15.3	23.6	0.7	0.7	1.0	1.0	--	--	17.0	25.3
1990	Ground-Water	0.9	0.9	0.2	0.2	--	--	--	--	1.1	1.1
1990	Surface-Water	14.4	22.7	0.5	0.5	1.0	1.0	--	--	15.9	24.2
1990	Total Supply 7/	15.3	23.6	0.7	0.7	1.0	1.0	--	--	17.0	25.3
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	18.0	25.6	1.0	1.1	1.0	1.0	--	--	20.0	27.7
2000	Ground-Water	1.0	1.0	0.2	0.2	--	--	--	--	1.2	1.2
2000	Surface-Water	17.0	24.6	0.8	0.9	1.0	1.0	--	--	18.8	26.5
2000	Total Supply 7/	18.0	25.6	1.0	1.1	1.0	1.0	--	--	20.0	27.7
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	19.2	27.7	1.2	1.4	1.0	1.0	--	--	21.4	30.1
2010	Ground-Water	1.0	1.0	0.2	0.2	--	--	--	--	1.2	1.2
2010	Surface-Water	18.2	26.7	1.0	1.2	1.0	1.0	--	--	20.2	28.9
2010	Total Supply 7/	19.2	27.7	1.2	1.4	1.0	1.0	--	--	21.4	30.1
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	20.8	31.1	1.6	1.8	1.0	1.0	--	--	23.4	33.9
2020	Ground-Water	1.0	1.0	0.2	0.2	--	--	--	--	1.2	1.2
2020	Surface-Water	19.8	30.1	1.4	1.6	1.0	1.0	--	--	22.2	32.7
2020	Total Supply 7/	20.8	31.1	1.6	1.8	1.0	1.0	--	--	23.4	33.9
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	23.3	34.9	2.0	2.3	1.0	1.0	--	--	26.3	38.2
2030	Ground-Water	2.4	2.4	0.2	0.2	--	--	--	--	2.6	2.6
2030	Surface-Water	20.9	32.5	1.8	2.1	1.0	1.0	--	--	23.7	35.6
2030	Total Supply 7/	23.3	34.9	2.0	2.3	1.0	1.0	--	--	26.3	38.2
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 54.7 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the San Angelo MSA - Currently within the MSA, approximately 96 percent of the water used for urban needs (municipal, manufacturing and steam-electric power generation purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining four percent is supplied by ground-water resources. Approximately 96 and 93 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately four and seven percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of San Angelo and two power plants are the only large urban water users within the MSA (Tom Green County). The San Angelo Water System presently obtains most of its water supply from Lakes Nasworthy, Twin Butes, and O.C. Fisher (Figure 25). Currently, about 23 thousand acre-feet are used from these sources. In addition, the city has a contract with the Colorado River Municipal Water District (CRMWD) to receive up to about 3.0 thousand acre-feet annually by pipeline from Lake E.V. Spence (Figure 25). The most current historical annual use from this source was only about 160 acre-feet. The capacity of the pipeline from E.V. Spence is about 13.2 thousand acre-feet per year. Currently, two power plants which use water from Lake Nasworthy for cooling have a consumptive water use of about 1,000 acre-feet per year.

Lake Twin Buttes also provides an annual irrigation water supply for up to about 10,000 acres of irrigated land in the San Angelo Project in the Veribest area of Tom Green County east of San Angelo. In 1980, Department records indicate that 10,000 acres were irrigated in the San Angelo Project using about 15.2 thousand acre-feet of water from Lake Twin Buttes. In 1983, the amount of acreage irrigated was 8,000 acres and the amount of water used was 4.8 thousand acre-feet. The irrigation delivery from the reservoir varies from year to year depending on available or expected storage in the reservoir. Irrigation deliveries are determined through periodic negotiations between the irrigators and the City of San Angelo. Under current arrangements, the irrigators do not receive water if storage in the reservoir is expected to be less than 50.0 thousand acre-feet. The city is then the sole user of water from Lake Twin Buttes when storage drops below the 50.0 thousand acre-feet level.

Several times in the last 30 years, San Angelo has experienced water availability problems because of extreme drought conditions. As an

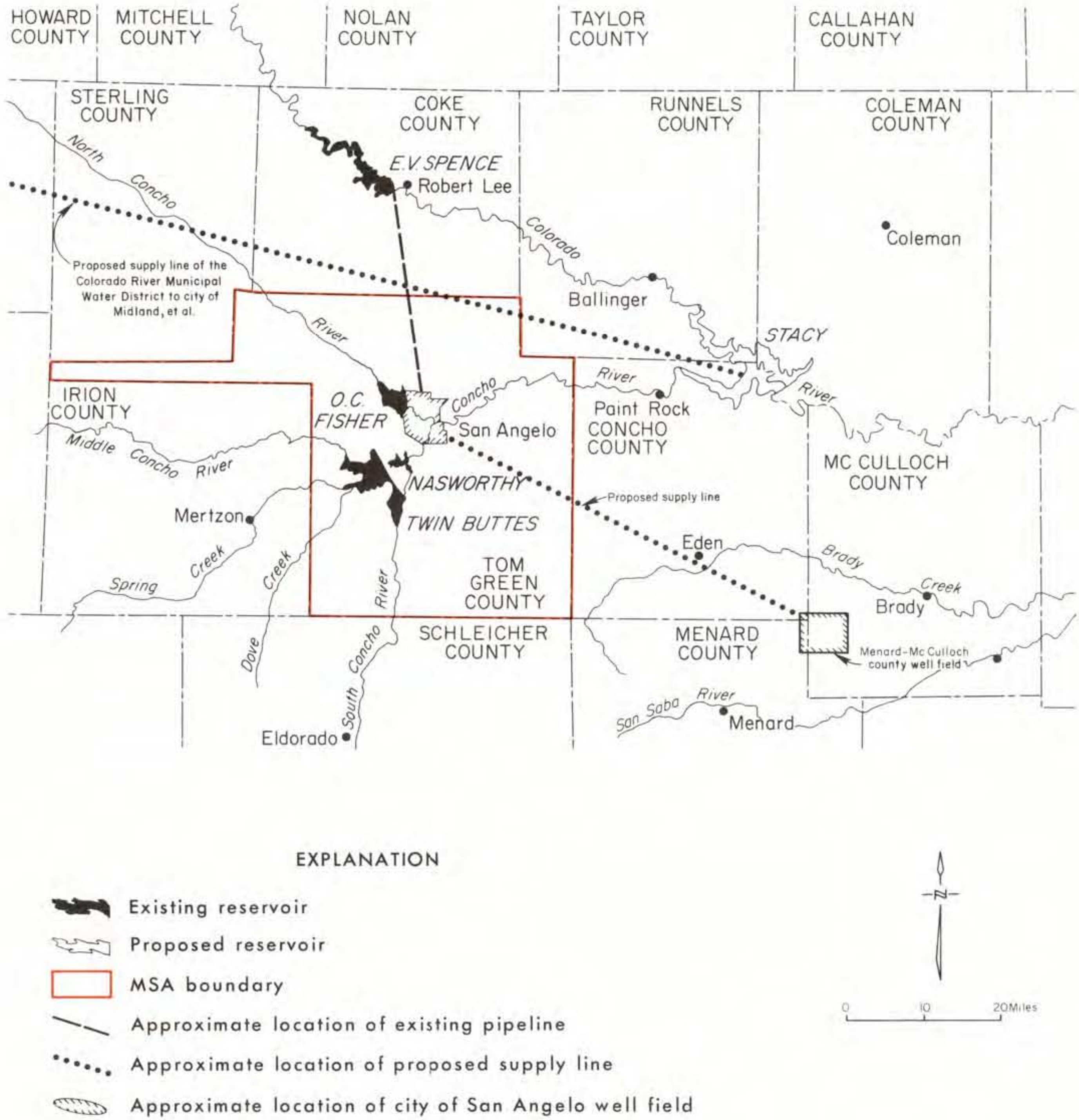


Figure 25

San Angelo MSA Water Supply Projects

example, in the Spring of 1980 the only reservoirs having sufficient storage available were Lakes Twin Buttes and Nasworthy (Figure 25). Lake O.C. Fisher (Figure 25) was dry. Recently, because of similar conditions, the city made arrangements with the CRMWD and constructed a 13.2 thousand acre-feet per year capacity pipeline from Lake E.V. Spence (Figure 25).

Also the city has obtained ground-water rights in McCulloch, Menard and Concho counties and has completed an eight-well well field (Figure 25) in the Hickory Aquifer (Figure 4). Currently the city plans to drill and complete additional wells, and eventually construct a pipeline (Figure 25) from the Menard-McCulloch-Concho County well field to the city. Current information indicates that the completed well field will have about 30 wells which will be capable of delivering, on a short-term basis, about 21 million gallons per day (23.5 thousand acre-feet annually). If feasible, the city will probably construct the pipeline in the mid- to late 1980's, and use ground-water from the well field during periods of extended drought, and perhaps in the summer during periods of peak demand.

The dependable supply from Lakes Twin Buttes, Nasworthy, O.C. Fisher and E.V. Spence for the urban and irrigation water needs of the MSA is expected to be about 58 and 52 thousand acre-feet annually in the years 2000 and 2030, respectively. If the Menard-McCulloch-Concho County well field is completed to include 30 wells, a supplemental annual ground-water supply of about 23.5 thousand acre-feet will be available on a stand-by basis. The exact annual sustained yield of the well field is unknown, but is probably quite low.

The total projected surface-water requirements for the urban and irrigation water needs of the MSA are expected to be about 58 and 68 thousand acre-feet in the years 2000 and 2030, respectively. A comparison of supply and demand indicates that an additional firm surface-water supply will be needed by the MSA soon after the year 2000. One alternative for this additional supply is Lake Stacy a proposed reservoir located on the Colorado and Concho Rivers east of San Angelo (Figure 25). When completed, Lake Stacy will be part of the CRMWD water supply system which could be connected to the San Angelo Water System (Figure 25).

SAN ANTONIO MSA

Description of San Antonio MSA - The MSA is area No. 21 on Figure 1, and is comprised of Bexar, Comal, and Guadalupe counties which cover about 2,527 square miles in parts of the San Antonio River, Guadalupe River, and Nueces River Basins. Average annual precipitation ranges from about 28 to 34 inches. Average annual temperatures range from about 66°F to 69°F. The principal cities are San Antonio, New Braunfels and Seguin. Other cities in the MSA are listed in Appendix C.

Economy of San Antonio MSA - The area economy has concentrations in the manufacturing, trade, and services sectors. Diversified light industry and machinery are the sources of most manufacturing employment. Manufacturing contributes 8.3 percent to the total personal income of the San Antonio MSA. The regional economic outlook is for a continuing impact of military spending and steady growth in all economic sectors.

Water Quality Management Planning in San Antonio MSA - Several organizations have been involved with the water quality management planning in the San Antonio MSA. Initial planning for the designated area (Bexar County and minor parts of Comal and Guadalupe counties in the San Antonio River Basin) was completed by the Alamo Area Council of Governments. The basic objectives of its Areawide Waste Treatment Plan were to provide a system for classification, storage, processing and retrieval of water quality data, a methodology for predicting nonpoint source pollution, a cost-effective and environmentally sound sewage treatment system, and a management framework to allow local officials to work in concert with local agencies to implement the initial plan and to insure continuing water quality planning. The designation of the area was cancelled after the initial planning effort and subsequent planning for the former designated area was conducted by the City of San Antonio, Cibolo Creek Municipal Authority and the San Antonio River Authority under contract to the Texas Department of Water Resources (TDWR). The review and update of wastewater facility needs was the primary focus of the continuing water quality management planning. The balance of the MSA (most of Comal and Guadalupe counties) lies within the Guadalupe River Basin where planning was undertaken by the Guadalupe-Blanco River Authority under contract to the TDWR. In addition to identifying wastewater facility needs in the MSA, the initial plan of the Guadalupe River Basin contained a review and discussion of existing water quality data and conditions in Lake Dunlap in Guadalupe County. The emphasis of the study was placed on nutrients (namely nitrogen and phosphorus) to determine their historical behavior in the lake, to make initial estimates of their sources and to determine their effect on phytoplankton concentrations and macrophyte biomass. The study included the development of a water quality, phytoplankton, and macrophyte model to be used to formulate and assess alternative pollution control strategies for point and nonpoint sources. Subsequent to the initial planning, a three phase study was conducted. Feasible control strategies were identified; water quality, phytoplankton and macrophyte responses were analyzed; and the socio-economic impacts of the most feasible alternative control strategies were determined. Phosphorus removal at the New Braunfels sewage treatment plant was predicted to have the most positive effect on the reduction of phytoplankton concentrations in Lake Dunlap; however, the additional cost of phosphorus removal appears excessive for the marginal predicted gains (ten percent reduction in phytoplankton). Therefore, no action has been taken in this regard at the current time. All recommendations made during the water quality management process in both the San Antonio and Guadalupe River Basins are considered by local advisory committees as required by the regulations of the Clean Water Act.

Floodplain Management Program in San Antonio MSA - The Federal Emergency Management Agency has designated all three counties and 25 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the three counties and for the 25 incorporated cities in the MSA (Appendix C). Presently, all three counties and 22 of the cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for the three counties and 22 cities in the MSA (Appendix C).

Population and Employment within the San Antonio MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	736.0	888.2	1072.0	Low	1270.9	1498.8	1725.4	1974.8	2301.3
				High	1335.4	1622.2	1905.8	2318.2	2959.0
Urban Population	639.2	771.2	938.8	Low	1148.6	1349.5	1547.7	1765.6	2052.5
				High	1202.1	1457.0	1705.1	2069.2	2638.8
Other Population	96.8	117.0	133.2	Low	122.3	149.3	177.7	209.2	248.8
				High	133.3	165.2	200.7	249.0	320.2
Employment	221.8	285.5	488.6	Low	586.9	692.5	784.4	883.3	1012.3
				High	616.7	749.4	866.4	1036.8	1301.6

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the San Antonio MSA 1/

Year	Analyses Catagory	Municipal[2/] Low	Municipal[2/] High	Manufacturing[3/] Low	Manufacturing[3/] High	Steam Electric[4/] Low	Steam Electric[4/] High	Mining[5/] Low	Mining[5/] High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	233.3		16.0		1.4		1.4		252.1	
1980	Surface-Water	5.0		4.0		27.9		--		36.9	
1980	Total Use 6/	238.3		20.0		29.3		1.4		289.0	
1990	Total Demand	244.6	340.3	24.8	26.0	29.3	29.3	1.8	1.8	300.5	397.4
1990	Ground-Water	240.6	272.5	22.2	7.7	--	--	1.8	1.8	264.6	282.0
1990	Surface-Water	4.0	67.8	2.6	18.3	29.3	29.3	--	--	35.9	115.4
1990	Total Supply 7/	244.6	340.3	24.8	26.0	29.3	29.3	1.8	1.8	300.5	397.4
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	293.4	419.0	31.4	34.1	29.3	29.3	2.1	2.1	356.2	484.5
2000	Ground-Water	273.0	272.8	11.3	8.3	--	--	1.9	1.9	286.2	283.0
2000	Surface-Water	20.4	146.2	20.1	25.8	29.3	29.3	0.2	0.2	70.0	201.5
2000	Total Supply 7/	273.4	419.0	31.4	34.1	29.3	29.3	2.1	2.1	356.2	484.5
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	336.9	491.2	38.5	42.7	29.3	29.3	2.4	2.4	407.1	565.6
2010	Ground-Water	275.7	277.3	11.9	8.3	--	--	2.2	2.1	289.8	287.7
2010	Surface-Water	61.2	213.9	26.6	34.4	29.3	29.3	0.2	0.3	117.3	277.9
2010	Total Supply 7/	336.9	491.2	38.5	42.7	29.3	29.3	2.4	2.4	407.1	565.6
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	384.7	596.5	47.4	53.6	29.3	29.3	2.8	2.8	464.2	682.2
2020	Ground-Water	276.1	279.2	8.0	8.0	--	--	2.4	2.4	286.5	289.6
2020	Surface-Water	108.6	317.3	39.4	45.6	29.3	29.3	0.4	0.4	177.7	392.6
2020	Total Supply 7/	384.7	596.5	47.4	53.6	29.3	29.3	2.8	2.8	464.2	682.2
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	447.3	760.5	58.1	66.7	29.3	29.3	3.1	3.1	537.8	859.6
2030	Ground-Water	275.2	292.0	11.4	2.6	--	--	2.6	2.6	289.2	297.2
2030	Surface-Water	172.1	467.2	46.7	63.6	29.3	29.3	0.5	0.5	248.6	560.6
2030	Total Supply 7/	447.3	759.2	58.1	66.2	29.3	29.3	3.1	3.1	537.8	857.8
2030	Shortage	--	1.3 8/	--	0.5 8/	--	--	--	--	--	1.8 8/

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 41.9 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

8/ Edwards aquifer shortage in northern Guadalupe County.

Water Supply Outlook and Problems in the San Antonio MSA - Currently within the MSA, approximately 87 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by ground water from the Edwards (Balcones Fault Zone), Trinity Group and Carrizo-Wilcox Aquifers (Figure 3). The remaining 13 percent is supplied by surface-water resources; mainly from the Guadalupe River at New Braunfels and Seguin. Approximately 58 and 35 percent of the MSA's projected urban water requirements are expected to be supplied by ground water and approximately 42 and 65 percent by developed surface-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of San Antonio and other water systems in Bexar County are the largest users of water in the MSA. Currently, most of the municipal and manufacturing water needs in the county are met by ground water from the Edwards (Balcones Fault Zone) Aquifer (Figure 3). Several small urban water systems in southern Bexar County use ground water from the Carrizo-Wilcox Aquifer (Figure 3). The City of San Antonio Municipal Water System is probably the largest such water system in the United States which relies entirely on ground water. Water for cooling purposes at steam-electric power plants operated by the City of San Antonio in Bexar County is obtained from Lakes Victor Brauning and Calaveras (Figure 26), and from the Edwards Aquifer. Lake Olmos (Figure 26) which is owned and operated by the city is used only for flood control. Also, the city owns and operates Mitchell Lake (Figure 26) which is a holding reservoir for treated sewage effluent. Part of this effluent is used for irrigation in the immediate area of the lake.

The City of New Braunfels in Comal County relies entirely on ground water from the Edwards Aquifer. A textile mill in New Braunfels uses water from the Guadalupe River. Most of the City of Sequin's water supply is from the Guadalupe River. The city also uses water from an Edwards Aquifer well in Comal County (Figure 26). Most of the other smaller urban water systems in Comal and Guadalupe counties use water from the Edwards, Trinity Group, and Carrizo-Wilcox Aquifers. All of these systems in Comal and Guadalupe counties are expected to continue to receive their supply from these sources through the year 2030.

The Nueces, San Antonio and Guadalupe River Basins (generally from Kinney County to Hays County within the extent of the Edwards (Balcones Fault Zone) Aquifer, see Figures 2 and 3) are hydrologically connected

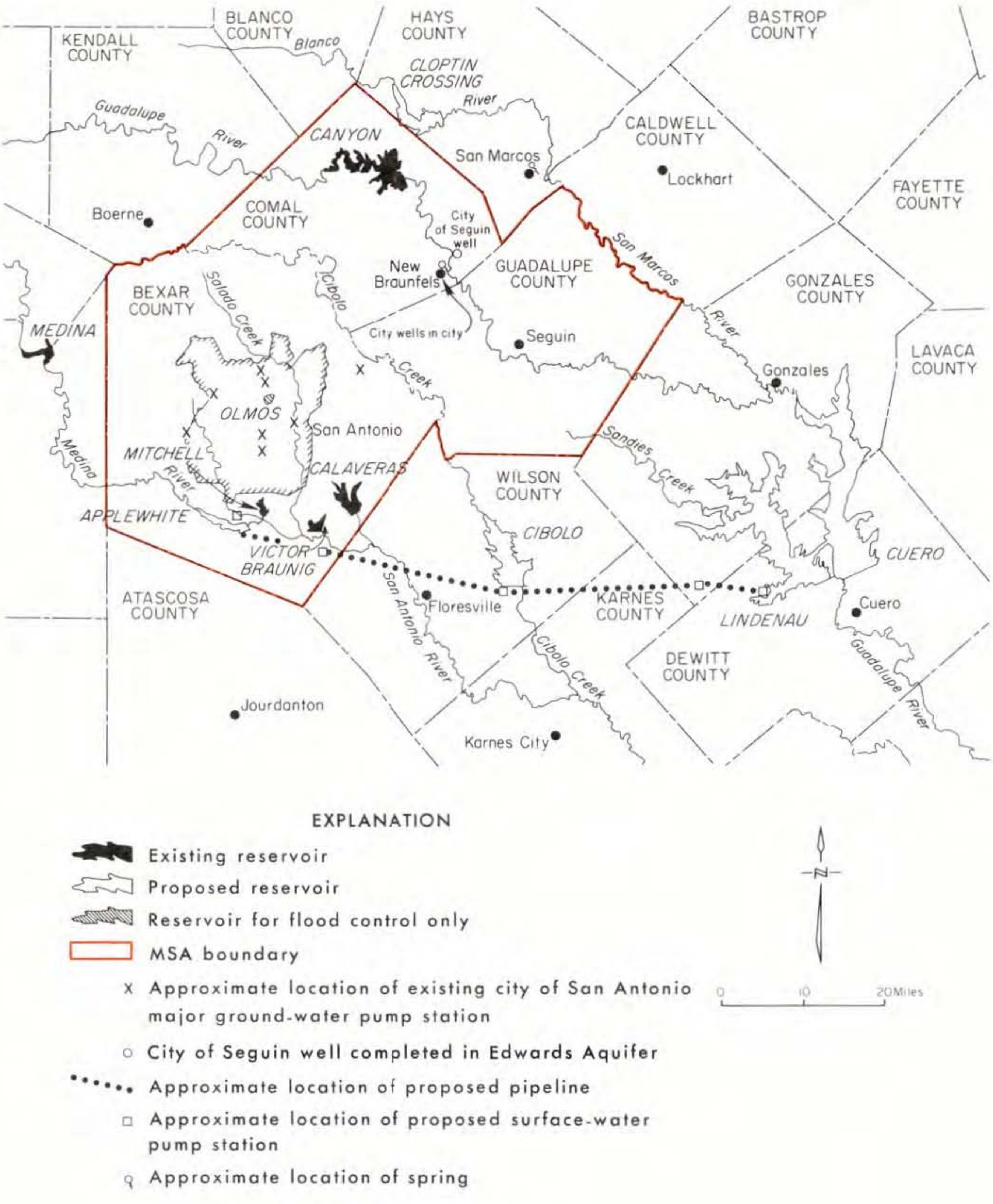


Figure 26
San Antonio MSA Water Supply Projects

in the subsurface by the Edwards (Balcones Fault Zone) Aquifer. During the drought of the 1950's when natural recharge was at its lowest, withdrawals from the Edwards Aquifer mainly for irrigation in Uvalde and Medina counties and for urban needs in Bexar County caused Comal Springs at New Braunfels (Figure 26) to cease flowing, and San Marcos Springs (Figure 26) to flow at its lowest recorded rate. Consequently, the Texas Department of Water Resources made a comprehensive study of this problem. The results of the study indicate the advisability of instituting an Edwards Aquifer management program which would result in total pumpage from the aquifer not exceeding 425 thousand acre-feet annually in the Nueces, San Antonio and Guadalupe River basins. Such a management program necessitates coordinated use of ground- and surface-water supplies which would provide an annual minimum sustained flow of about 34 thousand acre-feet from San Marcos Springs, and which may prevent the possibility of saline water encroachment along the aquifer's "bad water line" (southern extent on Figure 3). Such a management program would constrain annual ground-water withdrawals from the Edwards Aquifer to about 272 thousand acre-feet in Bexar County. Total projected urban water requirements in Bexar County are expected to be about 444 thousand acre-feet in the year 2000. Using the 272 thousand acre-feet as the level of withdrawal from the Edwards Aquifer, approximately 172 thousand acre-feet of surface water will be required to meet the total requirements in Bexar County in the year 2000. Approximately 30 thousand acre-feet of this requirement is for power plant cooling water which is expected to be supplied by Lakes Victor Brauning and Calveras (Figure 26), which under existing permits impound local runoff and return flows of the City of San Antonio that are pumped from the San Antonio River. The remaining 142 thousand acre-feet are the year 2000 surface-water requirements for expected municipal and manufacturing needs in Bexar County.

To meet these expected municipal and manufacturing water needs in Bexar County in the year 2000, Lake Applewhite on the Medina River in Bexar County (Figure 26) and Lake Lindenau on Sandies Creek in DeWitt and Gonzales Counties (Figure 26) are proposed to be constructed. Lake Applewhite would be constructed first, followed by construction of Lake Lindenau, additional facilities for diversions from the Guadalupe River, and a pipeline with pump stations as shown on Figure 26.

To meet additional municipal and manufacturing water needs in Bexar County through the year 2030, it may be necessary to construct Goliad Reservoir on the San Antonio River in Goliad and Karnes Counties (Figure 2) and also use return flows from the Bexar County water systems. An alternative for this additional supply to meet 2030 water needs in Bexar County would be the proposed Cuero Reservoir on the Guadalupe River in DeWitt and Gonzales Counties (Figure 26).

SHERMAN-DENISON MSA

Description of Sherman-Denison MSA - The MSA is area No. 22 on Figure 1, and is comprised of Grayson County which covers about 940 square miles in parts of the Red River and Trinity River Basins. Average annual precipitation ranges from about 34 to 39 inches. Average annual temperature is about 63.5 F. The principal cities are Sherman and Denison. Other cities in the MSA are listed in Appendix C.

Economy of Sherman-Denison MSA - The area economy is characterized primarily by manufacturing, services and trade with a secondary emphasis on transportation. The electronics industry is the most important source of manufacturing employment. Manufacturing contributes 27.0 percent to the total personal income of the Sherman-Denison MSA. The regional economic outlook is for the continuing of recent trends in expansion and location of manufacturing plants.

Water Quality Management Planning in Sherman-Denison MSA - The Sherman-Denison MSA is located in both the Red River Basin and the Trinity River Basin. The Texas Department of Water Resources contracted with the Red River Authority of Texas for water quality management planning for the northern portion of the MSA in the Red River Basin and with the Trinity River Authority of Texas for the southern portion in the Trinity River Basin. The initial plans for both basins identified wastewater facility needs within the MSA and subsequent planning efforts reviewed the needs and updated them as found necessary. The Red River Basin initial planning also included the collection and analysis of water quality and hydrologic data in the Sherman-Denison area for stream mathematical modeling purposes. In addition to these efforts, the Red River Basin plan examined the need for an additional, specialized study of potential water quality problems in the Lake Texoma area due to developmental pressures. The overall scope of the project included an inventory of existing conditions, development of criteria for acceptable septic tank operations, projection of future conditions, identification of existing and potential septic tank problem areas, and the development and recommendation of control strategies. The study was completed in 1983 and determined that there was no immediate need for a centralized wastewater treatment system on the Texas side of Lake Texoma. All recommendations made during the water quality management process in both basins are reviewed by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Sherman-Denison MSA - The Federal Emergency Management Agency has designated Grayson County and 10 incorporated cities in the Sherman-Denison MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for nine of the incorporated cities in the MSA (Appendix C). Presently, only the county and three cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for two cities in the MSA (Appendix C).

Population and Employment within the Sherman-Denison MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	73.0	83.2	89.8	Low	99.5	106.3	112.7	119.8	127.8
				High	101.9	109.5	119.1	130.6	147.4
Urban Population	53.8	62.0	63.2	Low	69.2	73.0	77.4	82.3	87.8
				High	70.8	75.2	81.8	89.7	101.2
Other Population	19.2	21.2	26.6	Low	30.3	33.3	35.3	37.5	40.0
				High	31.1	34.3	37.3	40.9	46.2
Employment	24.8	31.5	42.7	Low	49.2	52.6	54.8	57.4	60.2
				High	50.4	54.2	58.0	62.6	69.4

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Sherman-Denison MSA 1/

Year	Analyses Catagory	Municipal2/ Low	Municipal2/ High	Manufacturing3/ Low	Manufacturing3/ High	Steam Electric4/ Low	Steam Electric4/ High	Mining5/ Low	Mining5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	11.6		3.3		--		--		14.9	
1980	Surface-Water	5.1		1.1		--		--		6.2	
1980	Total Use 6/	16.7		4.4		--		--		21.1	
1990	Total Demand	16.5	23.3	6.6	7.1	--	--	--	--	23.1	30.4
1990	Ground-Water	3.5	3.8	0.2	0.2	--	--	--	--	3.7	4.0
1990	Surface-Water	13.0	19.5	6.4	6.9	--	--	--	--	19.4	26.4
1990	Total Supply 7/	16.5	23.3	6.6	7.1	--	--	--	--	23.1	30.4
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	18.1	25.6	9.2	10.3	--	--	--	--	27.3	35.9
2000	Ground-Water	3.6	3.9	0.2	0.2	--	--	--	--	3.8	4.1
2000	Surface-Water	14.5	21.7	9.0	10.1	--	--	--	--	23.5	31.8
2000	Total Supply 7/	18.1	25.6	9.2	10.3	--	--	--	--	27.3	35.9
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	19.2	27.8	12.1	13.8	--	--	--	--	31.3	41.6
2010	Ground-Water	3.7	3.9	0.2	0.2	--	--	--	--	3.9	4.1
2010	Surface-Water	15.5	23.9	11.9	13.6	--	--	--	--	27.4	37.5
2010	Total Supply 7/	19.2	27.8	12.1	13.8	--	--	--	--	31.3	41.6
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	20.4	30.5	15.5	17.9	--	--	--	--	35.9	48.4
2020	Ground-Water	3.7	3.9	0.2	0.2	--	--	--	--	3.9	4.1
2020	Surface-Water	16.7	26.6	15.3	17.7	--	--	--	--	32.0	44.3
2020	Total Supply 7/	20.4	30.5	15.5	17.9	--	--	--	--	35.9	48.4
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	21.8	34.4	19.6	23.0	--	--	--	--	41.4	57.4
2030	Ground-Water	3.7	3.9	0.2	0.2	--	--	--	--	3.9	4.1
2030	Surface-Water	18.1	30.5	19.4	22.8	--	--	--	--	37.5	53.3
2030	Total Supply 7/	21.8	34.4	19.6	23.0	--	--	--	--	41.4	57.4
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 6.8 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Sherman-Denison MSA - Currently within the MSA, approximately 71 percent of the water used for urban needs (municipal and manufacturing purposes) is supplied by ground-water resources in the MSA. The remaining 29 percent is supplied by surface-water resources. Approximately 89 and 93 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 11 and 7 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

Currently, the City of Sherman receives its water supply from about 30 wells completed in the Trinity Group (Figure 3) and Woodbine (Figure 4) Aquifers. The City of Denison's supply is from Lakes Texoma and Randell (Figure 27) and a well field (Figure 27) completed in the Woodbine Aquifer. Most of Denison's supply is surface water from Lakes Texoma and Randell. The Cities of Howe, Whitesboro, Whitewright, Van Astyne and other smaller urban water systems in the MSA obtain their supplies from the Trinity Group and Woodbine Aquifers.

Because of serious water-level declines and expected decreasing well yields, most of these urban water systems will eventually have to shift to surface-water supplies. By the year 2000, the Cities of Denison and Sherman are expected to meet about 97 percent of their total water requirements with surface water. By 2000, the Cities of Howe, Whiteboro, Whitewright and others are expected to convert their entire supplies from ground water to surface water. The City of Van Alstyne is expected to remain on ground water through the year 2000 and beyond.

The major source for these additional, future urban, surface-water supplies is expected to be Lake Texoma (Figure 27). The Red River Compact among the States of Texas, Oklahoma, Arkansas, and Louisiana provides that 400 thousand acre-feet of water in Lake Texoma be allocated to conservation storage for urban water needs in Texas and Oklahoma. This conservation storage is equally divided between Texas and Oklahoma; thus allowing Texas to have 200 thousand acre-feet of storage annually from the reservoir. This quantity of storage would provide a dependable supply adequate to meet the urban surface-water needs of the MSA to the year 2030 and beyond and also would provide supplies for adjacent areas of Texas. However, at this time water supply is not a project purpose in Lake Texoma, although under specific authorization by Congress several entities have contracted with the U.S. Army Corps of Engineers for water supply storage in the reservoir.

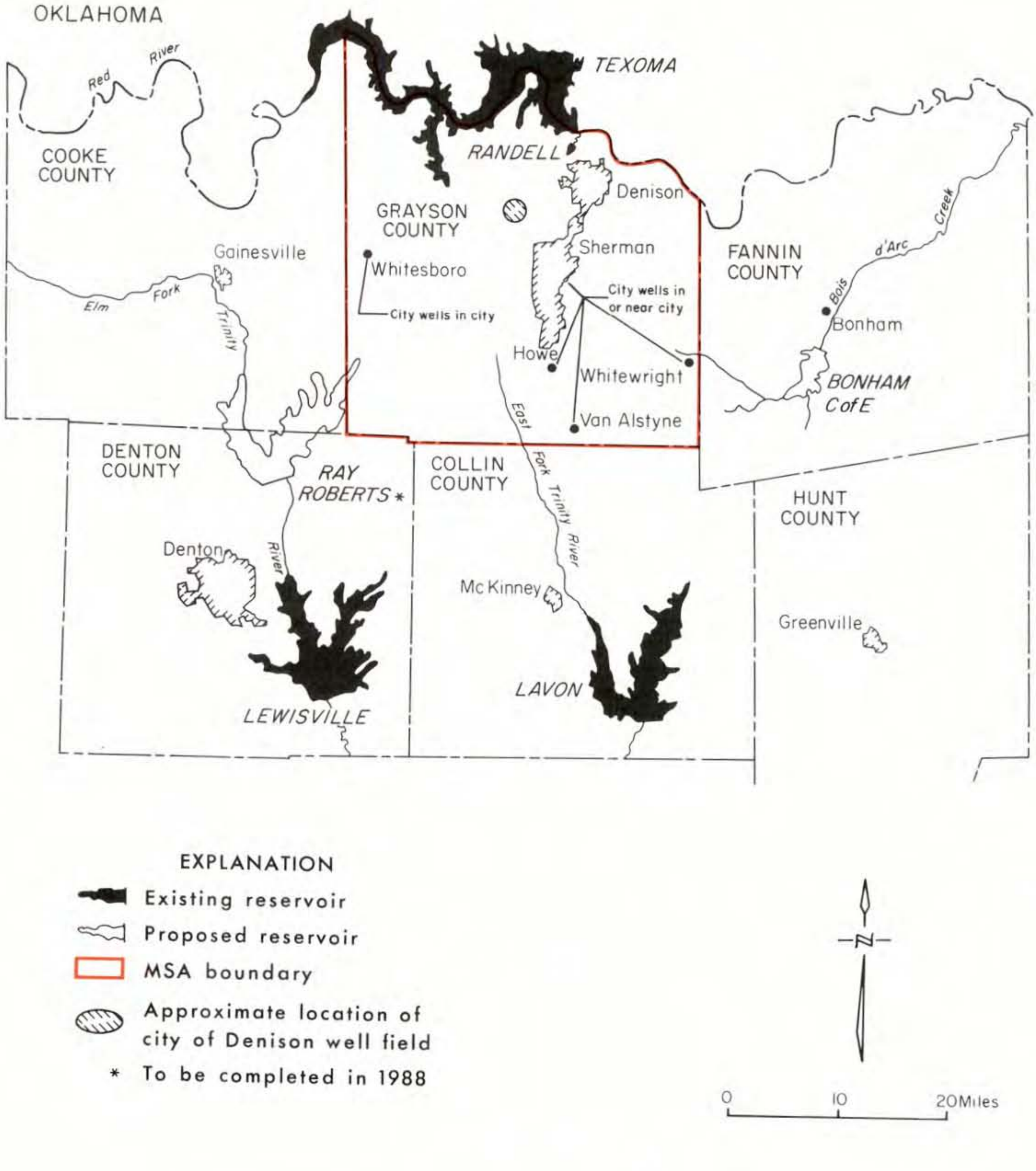


Figure 27
Sherman-Denison MSA Water Supply Projects

The U.S. Army Corps of Engineers has completed a study to determine the advisability of a re-allocation of project purposes in Lake Texoma. The Corps' preliminary recommendation provides for allocation of storage sufficient to provide 90 million gallons per day for water supply. However, the Texas Department of Water Resources (TDWR) analyses show that much higher demands, both in-basin and out-of-basin will materialize in the near future. Therefore, the TDWR has recommended that, in accordance with the Red River Compact, an allocation of water supply storage sufficient to provide at least 200 thousand acre-feet annually to Texas be recommended to Congress.

Description of Texarkana MSA - The MSA is area No. 23 on Figure 1, and is comprised of Bowie County which covers about 891 square miles in parts of the Red River and Sulphur River Basins. Average annual precipitation is about 47 inches. Average annual temperature is about 63°F. The principal city is Texarkana. Other cities in the MSA are listed in Appendix C.

Economy of Texarkana MSA - The area economy has high concentrations in the services, manufacturing and trade sectors. Increasingly diversified manufacturing industries produce tires, ammunition, railroad cars, and pulp and paper products. Manufacturing employment contributes 12.8 percent to the total personal income of the MSA. The regional economic outlook is for continuing diversification and coordination with the State of Arkansas to further economic development.

Water Quality Management Planning in Texarkana MSA - The Ark-Tex Council of Governments (ATCOG) is designated as the areawide water quality management planning agency for the Texarkana area which includes a portion of Bowie County of the Texarkana MSA. The Red River Authority of Texas and the ATCOG, both under contract to the Texas Department of Water Resources, carryout planning activities for the remainder of Bowie County that lies outside of the designated area. The initial plans for the areas involved identifying wastewater facility needs within the MSA and subsequent planning efforts reviewed these needs and updated them where necessary. The initial plans also contained assessments of potential nonpoint pollution sources with recommendations for future planning studies. The ATCOG has developed a model septic tank ordinance, and assisted local governments in implementing septic tank regulatory programs. As an ongoing project, ATCOG will continue to offer technical assistance to local governments interested in regulating septic systems. All recommendations made in the water quality management process are reviewed by local advisory committees as required by regulations under the Federal Clean Water Act.

Floodplain Management Program in Texarkana MSA - The Federal Emergency Management Agency has designated Bowie County and seven incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for the seven incorporated cities in the MSA (Appendix C). Presently, the county and six cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Presently, four cities have completed Detailed Flood Insurance Rate Studies (Appendix C). These type studies provide detailed 10-year, 50-year, 100-year, and 500-year flood event data.

Population and Employment within the Texarkana MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
	(Thousands)				Projections (Thousands)				
Total Population	60.0	67.8	75.3	Low	79.3	85.2	92.7	101.6	113.6
				High	81.9	91.3	101.6	116.3	136.6
Urban Population	40.3	44.4	47.6	Low	52.1	57.0	62.0	68.0	76.0
				High	53.8	61.1	68.0	77.8	91.4
Other Population	19.7	23.4	27.7	Low	27.2	28.2	30.7	33.6	37.6
				High	28.1	30.2	33.6	38.5	45.2
Employment	20.0	25.2	35.3	Low	37.7	40.9	43.7	47.2	51.8
				High	39.0	43.8	48.0	54.0	62.3

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Texarkana MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	2.8		0.1		--		--		2.9	
1980	Surface-Water	14.0		2.4		--		--		16.4	
1980	Total Use 6/	16.8		2.5		--		--		19.3	
1990	Total Demand	18.2	24.1	3.8	4.1	--	--	--	--	22.0	28.2
1990	Ground-Water	0.5	0.5	--	--	--	--	--	--	0.5	0.5
1990	Surface-Water	17.7	23.6	3.8	4.1	--	--	--	--	21.5	27.7
1990	Total Supply 7/	18.2	24.1	3.8	4.1	--	--	--	--	22.0	28.2
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	20.2	27.4	5.6	6.3	--	12.8	--	--	25.8	46.5
2000	Ground-Water	0.5	0.5	--	--	--	--	--	--	0.5	0.5
2000	Surface-Water	19.7	26.9	5.6	6.3	--	12.8	--	--	25.3	46.0
2000	Total Supply 7/	20.2	27.4	5.6	6.3	--	12.8	--	--	25.8	46.5
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	21.9	30.5	7.6	8.7	6.2	19.6	--	--	35.7	58.8
2010	Ground-Water	0.5	0.5	--	--	--	--	--	--	0.5	0.5
2010	Surface-Water	21.4	30.0	7.6	8.7	6.2	19.6	--	--	35.2	58.3
2010	Total Supply 7/	21.9	30.5	7.6	8.7	6.2	19.6	--	--	35.7	58.8
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	24.1	35.0	10.0	11.6	12.4	26.5	--	--	46.5	73.1
2020	Ground-Water	0.5	0.5	--	--	--	--	--	--	0.5	0.5
2020	Surface-Water	23.6	34.5	10.0	11.6	12.4	26.5	--	--	46.0	72.6
2020	Total Supply 7/	24.1	35.0	10.0	11.6	12.4	26.5	--	--	46.5	73.1
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	26.9	41.0	12.8	15.1	17.7	33.3	--	--	57.4	89.4
2030	Ground-Water	0.5	0.5	--	--	--	--	--	--	0.5	0.5
2030	Surface-Water	26.4	40.5	12.8	15.1	17.7	33.3	--	--	56.9	88.9
2030	Total Supply 7/	26.9	41.0	12.8	15.1	17.7	33.3	--	--	57.4	89.4
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high Series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 6.6 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Texarkana MSA - Currently within the MSA, approximately 85 percent of the water used for urban needs (municipal and manufacturing purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 15 percent is supplied by ground-water resources. In the years 2000 and 2030, approximately 99 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately one percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Texarkana Water System obtains its supply from Lake Wright Patman (Figure 28). Other urban systems which use Lake Wright Patman within the MSA (Bowie County) include DeKalb, New Boston, Hooks, Wake Village, Atlanta, and Maud (Figure 28). The Texarkana System and other urban water systems in and adjacent to the MSA currently use about 52 thousand acre-feet annually from Lake Wright Patman. By the year 2000, other cities in and adjacent to the MSA are expected to be using surface water from Lake Wright Patman. Some of these cities include Nash, Queen City, Naples, Bogata and Clarksville (Figure 28). Texarkana and other cities in and adjacent to the MSA are expected to use about 79 and 147 thousand acre-feet from Lake Wright Patman in the years 2000 and 2030, respectively.

The Carrizo-Wilcox Aquifer (Figure 3) and the Nacatoch, Blossom and Queen City Aquifers (Figure 4) in and adjacent to the MSA are capable of only supplying small quantities of ground water for urban needs. All of these aquifers, when subjected to moderate to large pumpage, experience serious water-level declines and decreasing well yields. The Carrizo-Wilcox and Queen City Aquifers, which are the most productive, have inherent ground-water quality problems; i.e., high concentrations of iron which may exceed 0.3 milligrams per liter and low pH values which may be less than 7.0.

Based on studies by the Texas Department of Water Resources, which assumed that 120.0 thousand acre-feet of flood-control storage will be reallocated from Lake Wright Patman to Cooper Lake (when completed in the late 1980's - Figure 2), Lake Wright Patman is expected to have dependable yields of about 245 and 238 thousand acre-feet annually in the years 2000 and 2030, respectively; assuming full use of the conservation storage. Without the reallocation of flood-control storage, Lake Wright Patman's dependable yields will be about 209 thousand acre-feet in 2000 and about 183 thousand acre-feet in about

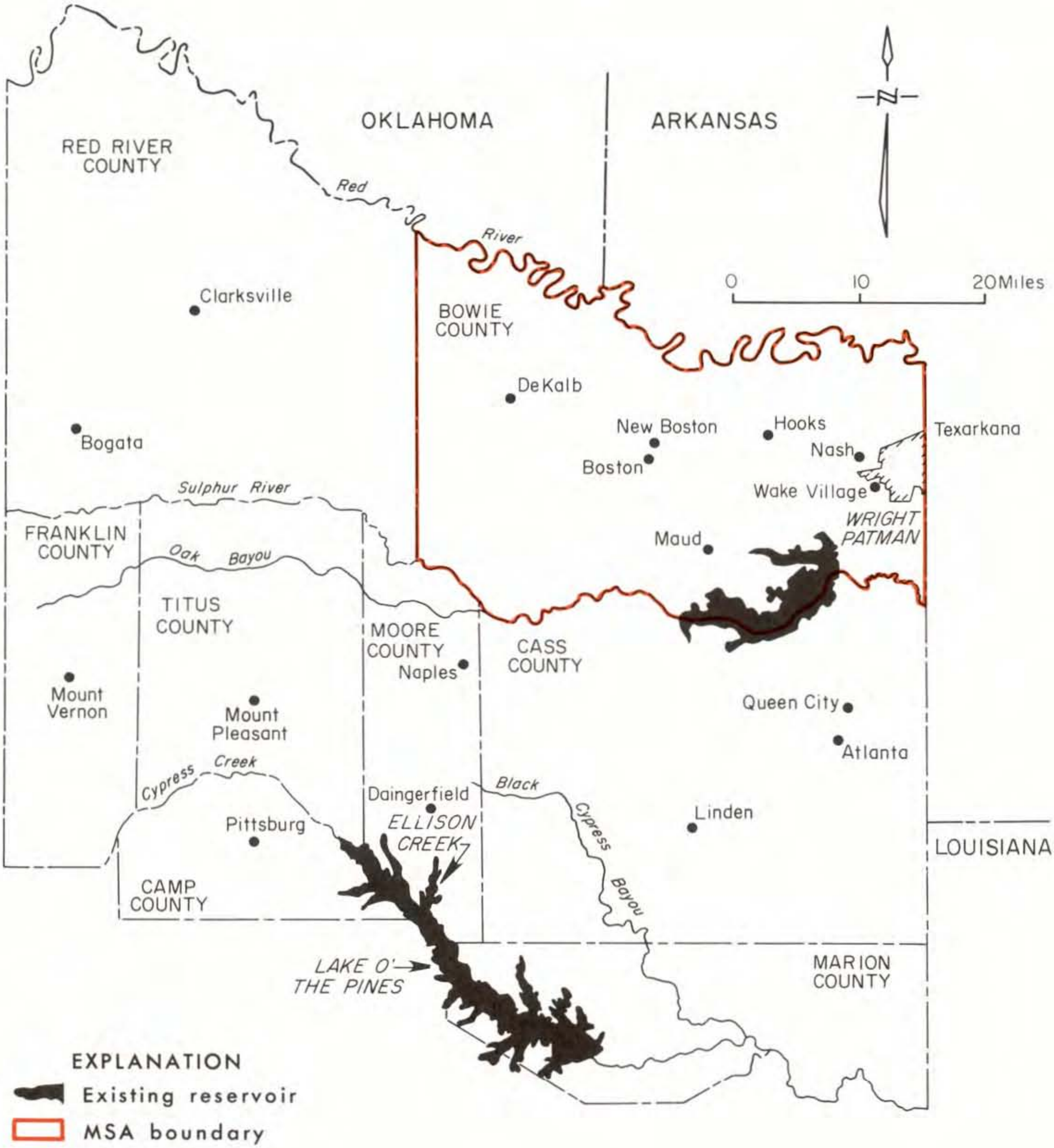


Figure 28
Texarkana MSA Water Supply Projects

2030. Comparison of these firm supplies with the 63 and 162 thousand acre-feet per year urban water requirements in 2000 and 2030, respectively, indicates that the supply from Lake Wright Patman will be sufficient to meet the urban water needs of the MSA and adjacent area through the year 2030 and beyond.

TYLER MSA

Description of Tyler MSA - The MSA is area No. 24 on Figure 1, and is comprised of Smith County which covers about 934 square miles in parts of the Sabine River and Neches River Basins. Average annual precipitation ranges from 42 to 45 inches. Average annual temperature is about 64.5°F. The principal city is Tyler. Other cities in the MSA are listed in Appendix C.

Economy of Tyler MSA - The area economy has concentrations of activity in the manufacturing, trade and service sectors. Diversified manufacturing employment contributes 17.4 percent to the total personal income of the MSA. The regional economic outlook is for a continuing stable economic base to support development of the MSA's available basic resources.

Water Quality Management Planning in Tyler MSA - The Tyler MSA is composed of Smith County which is split by the divide of the Sabine and Neches River Basins. Consequently, the MSA occurs in the Sabine Basin and the Upper Neches Basin State Planning Areas, although the City of Tyler is in the Upper Neches Basin. The Texas Department of Water Resources (TDWR) is responsible for water quality planning in these nondesignated portions of the State. The TDWR delegated certain planning responsibilities to the Sabine River Authority for the Sabine Basin State Planning Area and to the Angelina-Neches River Authority for the Upper Neches Basin State Planning Area. In these areas, wastewater facility needs were evaluated and appropriate management agencies with adequate authority to implement provisions of the plans were identified, and an initial assessment was made of nonpoint source contributions to water quality problems. In subsequent planning, facility needs of communities not evaluated in the initial plan were considered, including numerous smaller communities. Local planning advisory committees have been developed for both planning areas to review all results of studies and planning recommendations.

Water quality monitoring and intensive surveys have been performed in the Tyler area and downstream to evaluate local water quality conditions. A wasteload evaluation and use attainability study have recently been completed for stream segment 0606 of the Neches River which is near Tyler. As a result, water quality standards for dissolved oxygen in this segment are being modified to a level which has been judged to be attainable. Stricter limits on treatment of sewage effluent to conform with water quality standards has also been indicated. Stream segment 0606 is characterized by low dissolved oxygen levels and effluent dominated flows, especially during low flow conditions. One of the City of Tyler's sewage treatment plants is the primary discharger to this segment. Future planning for instream water quality management in the MSA is likely to continue on a short term, as well as a long-term basis.

Floodplain Management Program in Tyler MSA - The Federal Emergency Management Agency has designated Smith County and five incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for the five incorporated cities in the MSA (Appendix C). Presently, four cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Smith County and four cities in the MSA (Appendix C).

Population and Employment within the Tyler MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
Total Population	86.4	97.1	128.4	Low	130.8	165.8	186.8	204.7	232.1
				High	164.8	187.6	206.8	235.8	269.1
Urban Population	55.0	62.4	76.8	Low	76.8	95.8	107.9	118.2	134.0
				High	96.8	108.4	119.5	136.2	155.4
Other Population	31.4	34.7	51.6	Low	54.0	70.0	78.9	86.5	98.1
				High	68.0	79.2	87.3	99.6	113.7
Employment	32.1	38.4	64.4	Low	71.5	90.6	100.4	108.2	120.7
				High	90.1	102.5	111.1	124.7	139.9

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Tyler MSA 1/

Year	Analyses Catagory	Demand Catagories: Municipal Low	Municipal High	Manufacturing[3/] Low	Manufacturing[3/] High	Steam Electric[4/] Low	Steam Electric[4/] High	Mining[5/] Low	Mining[5/] High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	10.5		1.6		---		0.7		12.8	
1980	Surface-Water	12.9		3.5		---		---		16.4	
1980	Total Use 6/	23.4		5.1		---		0.7		29.2	
1990	Total Demand	20.5	35.2	6.6	7.2	---	---	0.9	0.9	28.0	43.3
1990	Ground-Water	7.0	7.5	1.9	1.9	---	---	0.9	0.9	9.8	10.3
1990	Surface-Water	13.5	27.7	4.7	5.3	---	---	---	---	18.2	33.0
1990	Total Supply 7/	20.5	35.2	6.6	7.2	---	---	0.9	0.9	28.0	43.3
1990	Shortage	---	---	---	---	---	---	---	---	---	---
2000	Total Demand	26.6	40.9	8.1	9.2	---	---	17.2	17.2	51.9	67.3
2000	Ground-Water	7.4	7.5	1.9	1.9	---	---	1.2	1.2	10.5	10.6
2000	Surface-Water	19.2	33.4	6.2	7.3	---	---	16.0	16.0	41.4	56.7
2000	Total Supply 7/	26.6	40.9	8.1	9.2	---	---	17.2	17.2	51.9	67.3
2000	Shortage	---	---	---	---	---	---	---	---	---	
2010	Total Demand	30.0	45.1	9.7	11.3	---	---	16.8	16.8	56.5	73.2
2010	Ground-Water	7.4	7.6	1.9	1.9	---	---	7.7	10.1	17.0	19.6
2010	Surface-Water	22.6	37.5	7.8	9.4	---	---	9.1	6.7	39.5	53.6
2010	Total Supply 7/	30.0	45.1	9.7	11.3	---	---	16.8	16.8	56.5	73.2
2010	Shortage ---	---	---	---	---	---	---	---	---		
2020	Total Demand	32.9	51.4	11.8	13.9	---	---	16.5	16.5	61.2	81.8
2020	Ground-Water	7.5	7.7	1.9	1.9	---	---	6.3	9.7	15.7	19.3
2020	Surface-Water	25.4	43.7	9.9	12.0	---	---	10.2	6.8	45.5	62.5
2020	Total Supply 7/	32.9	51.4	11.8	13.9	---	---	16.5	16.5	61.2	81.8
2020	Shortage	---	---	---	---	---	---	---	---	---	
2030	Total Demand	37.3	58.6	14.5	17.1	---	---	0.9	.09	52.7	76.6
2030	Ground-Water	7.9	8.2	1.9	1.8	---	---	0.9	0.9	10.7	10.9
2030	Surface-Water	29.4	50.4	12.6	15.3	---	---	---	---	42.0	65.7
2030	Total Supply 7/	37.3	58.6	14.5	17.1	---	---	0.9	0.9	52.7	76.6
2030	Shortage	---	---	---	---	---	---	---	---	---	

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 1.4 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Tyler MSA - Currently within the MSA, approximately 56 percent of the water used for urban needs (municipal, manufacturing, and mining purposes) is supplied by developed surface-water resources in the MSA. The remaining 44 percent is supplied by ground-water resources. Approximately 84 and 86 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 16 and 14 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Tyler Water System, which is the largest in the MSA (Smith County), presently obtains most of its water supply from Lakes Tyler and Bellwood (Figure 29). The remaining supply is provided by about 15 wells completed in the Carrizo-Wilcox Aquifer (Figure 3) within the city. The Tyler System began using surface water in the early 1950's, because the demand for water (pumpage) from the Carrizo-Wilcox Aquifer was causing serious water-level declines. From 1937 to 1950, the Carrizo-Wilcox Aquifer in the Tyler area experienced about eight feet of water-level decline per year because of heavy, concentrated ground-water withdrawals. The City of Tyler continues to use their Carrizo-Wilcox wells as a source of water. These wells currently supply about 3.0 thousand acre-feet annually. This pumpage and other Carrizo-Wilcox Aquifer pumpage in the MSA (Smith County) is continuing to cause serious water-level declines. From 1976 to 1984, the Carrizo-Wilcox Aquifer had an average water-level decline rate of about eight feet per year. Also, the ground water from the Carrizo-Wilcox Aquifer in the MSA, as well as most of east Texas, has inherent high concentrations of iron which often exceed 0.3 milligrams per liter. Within the MSA, 39 analyses for iron in Carrizo-Wilcox Aquifer ground water indicated iron concentrations ranging from 0.01 to 18.0 milligrams per liter. Approximately 33 percent of the analyses had iron concentrations greater than 0.3 milligrams per liter. Ground water having iron concentrations greater than 0.3 milligram per liter should be treated to reduce iron concentrations, if the water is to be used for municipal and manufacturing purposes. This condition will add to the cost of using ground water for municipal and manufacturing purposes within the MSA.

The cities of Lindale, Overton, Troup, Whitehouse and other small urban water systems in the MSA currently use ground water from the Carrizo-Wilcox Aquifer and the Queen City Aquifer (Figure 4). However, neither

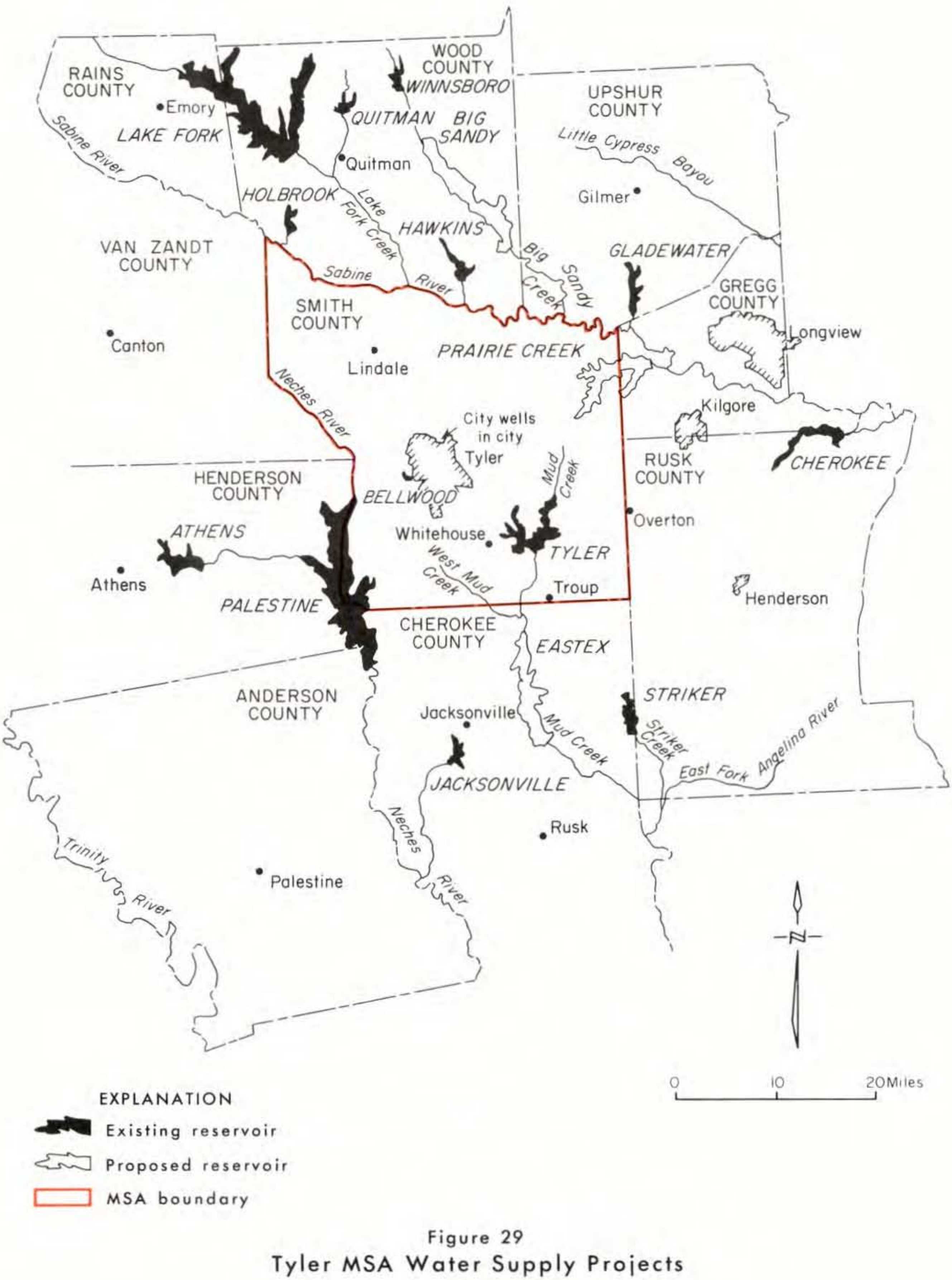


Figure 29
Tyler MSA Water Supply Projects

the Queen City Aquifer nor the Carrizo-Wilcox Aquifer are reliable source of supply due to inherent problems with high concentrations of iron and low pH (high acidity).

By the year 2000, all of the urban water systems previously mentioned, except the Troup System, are expected to obtain all or part of their water supplies from developed surface-water resources. The City of Lindale's supply will be obtained from Lake Fork Reservoir (Figure 29). The City of Overton's supply could be provided by the proposed Eastex Reservoir (Figure 29). Whitehouse is expected to obtain its surface-water supply from Lake Tyler through the City of Tyler.

By the year 2000, the Tyler Water System and other smaller systems via the Tyler System are expected to obtain practically all of their water supplies from Lakes Tyler and Bellwood (Figure 29). The City of Tyler will probably keep their wells operative only for emergency needs, and perhaps for peak demands during extreme droughts. The expected surface-water requirements for the Tyler Water System will be about 38 and 87 thousand acre-feet annually in the years 2000 and 2030, respectively. The dependable supply from Lakes Tyler and Bellwood in the year 2000 will be about 39 thousand acre-feet per year. Therefore, in about the year 2000, the Tyler Water System will need an additional surface-water supply. The City of Tyler presently has a contractual permit with the Upper Neches River Municipal Water Authority, which owns 46.27 percent of the storage in Lake Palestine (Figure 29). However, pumping and conveyance facilities will have to be constructed before water from Lake Palestine is delivered to the Tyler System. The dependable supplies of Lakes Tyler, Bellwood, and Palestine (currently available to the Tyler System) should be sufficient surface-water supplies to meet the expected urban water needs of the Tyler System through the year 2030 and beyond.

VICTORIA MSA

Description of Victoria MSA - The MSA is area 25 on Figure 1, and is comprised of Victoria County which has about 892 square miles in parts of the Guadalupe River, San Antonio River and Lavaca River Basins and the Lavaca-Guadalupe Coastal Basin. Average annual precipitation ranges from 35 to 41 inches. Average annual temperature is about 70.5°F. The principal city is Victoria.

Economy of the Victoria MSA - The area economy is fairly well balanced, with trade and services the major sectors. Manufacturing contributes 12.2 percent to the total personal income of the Victoria MSA. The regional economic outlook is for steady growth and continued diversity in the local economy.

Water Quality Management Planning in Victoria MSA - The Victoria MSA is about equally divided between the lower Guadalupe River Basin and the Lavaca-Guadalupe Coastal Basin, except for a small portion which is in the San Antonio River Basin. The Texas Department of Water Resources contracted with the Guadalupe-Blanco River Authority, the Golden Crescent Council of Governments, and the San Antonio River Authority for water quality management planning in each basin, respectively. The initial plans for all three basin portions of the MSA identified wastewater facilities needs and updated them as found necessary. All recommendations made during the water quality management process were reviewed by the basin advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Victoria MSA - The Federal Emergency Management Agency has designated Victoria County and the City of Victoria as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying floodprone areas have been published for the county and the city (Appendix C), and both entities have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. A Detailed Flood Insurance Rate Study which supplies detailed 10-year, 50-year, 100-year and 500-year flood event data has been completed in the City of Victoria (Appendix C).

Population and Employment within the Victoria MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
					Projections				
	(Thousands)				(Thousands)				
				Low	84.6	95.4	104.0	113.3	126.3
Total Population	53.7	46.5	68.8	High	88.5	100.7	111.0	127.3	145.8
				Low	66.5	75.6	82.4	89.8	100.1
Urban Population	43.0	34.8	52.6	High	69.6	79.8	88.0	100.9	115.6
				Low	18.1	19.8	21.6	23.5	26.2
Other Population	10.7	11.7	16.2	High	18.9	20.9	23.0	26.4	30.2
				Low	40.0	45.2	48.5	51.9	56.9
Employment	15.7	19.4	32.0	High	41.9	47.7	51.8	58.3	65.7

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Victoria MSA 1/

Year	Analyses Catagory	Municipal 2/ Low	Municipal 2/ High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	10.3		0.9		2.2		0.1		13.5	
1980	Surface-Water	--		33.4		18.4		0.6		52.4	
1980	Total Use 6/	10.3		34.3		20.6		0.7		65.9	
1990	Total Demand	12.4	18.6	51.9	57.0	26.6	26.6	0.9	0.9	91.8	103.1
1990	Ground-Water	6.7	8.8	--	--	2.0	2.0	0.6	0.6	9.3	11.4
1990	Surface-Water	5.7	9.8	51.9	57.0	24.6	24.6	0.3	0.3	82.5	91.7
1990	Total Supply 7/	12.4	18.6	51.9	57.0	26.6	26.6	0.9	0.9	91.8	103.1
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	14.3	21.5	69.9	81.2	31.6	31.6	1.1	1.1	116.9	135.4
2000	Ground-Water	7.4	9.5	--	--	2.0	2.0	0.8	0.8	10.2	12.3
2000	Surface-Water	6.9	12.0	69.9	81.2	29.6	29.6	0.3	0.3	106.7	123.1
2000	Total Supply 7/	14.3	21.5	69.9	81.2	31.6	31.6	1.1	1.1	116.9	135.4
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	15.6	23.7	91.9	109.2	33.4	33.4	1.2	1.2	142.1	167.5
2010	Ground-Water	7.9	10.1	--	--	2.0	2.0	0.8	0.8	10.7	12.9
2010	Surface-Water	7.7	13.6	91.9	109.2	31.4	31.4	0.4	0.4	131.4	154.6
2010	Total Supply 7/	15.6	23.7	91.9	109.2	33.4	33.4	1.2	1.2	142.1	167.5
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	17.0	27.2	118.3	142.6	35.2	35.2	1.3	1.3	171.8	206.3
2020	Ground-Water	8.3	11.1	--	--	2.0	2.0	0.9	0.9	11.2	14.0
2020	Surface-Water	8.7	16.1	118.3	142.6	33.2	33.2	0.4	0.4	160.6	192.3
2020	Total Supply 7/	17.0	27.2	118.3	142.6	35.2	35.2	1.3	1.3	171.8	206.3
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	18.9	31.1	151.0	184.1	37.0	37.0	1.4	1.4	208.3	253.6
2030	Ground-Water	9.1	12.4	--	--	2.0	2.0	1.0	1.0	12.1	15.4
2030	Surface-Water	9.8	18.7	151.0	184.1	35.0	35.0	0.4	0.4	196.2	238.2
2030	Total Supply 7/	18.9	31.1	151.0	184.1	37.0	37.0	1.4	1.4	208.3	253.6
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 27.3 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Victoria MSA - Currently within the MSA, approximately 80 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 20 percent is supplied by ground-water resources. Approximately 91 and 94 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately 9 and 6 percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Victoria is the largest urban water system in the MSA. Currently, the City of Victoria receives its water supply from the Gulf Coast Aquifer. Almost all of the manufacturing water needs are being supplied with surface water diverted from the Guadalupe River. As shown in the above supply-demand analyses, additional surface-water supplies will be required for meeting future municipal demands within the MSA. Available surface-water supplies from the Guadalupe River should be adequate for meeting future needs of the MSA past the year 2010. Prior to the year 2020, municipal and manufacturing needs are projected to be in excess of the available surface-water supplies and could necessitate the development of additional surface-water resources for the area. One alternative would be the development of the Cuero Reservoir on the Guadalupe River in DeWitt and Gonzales Counties (Figure 30).

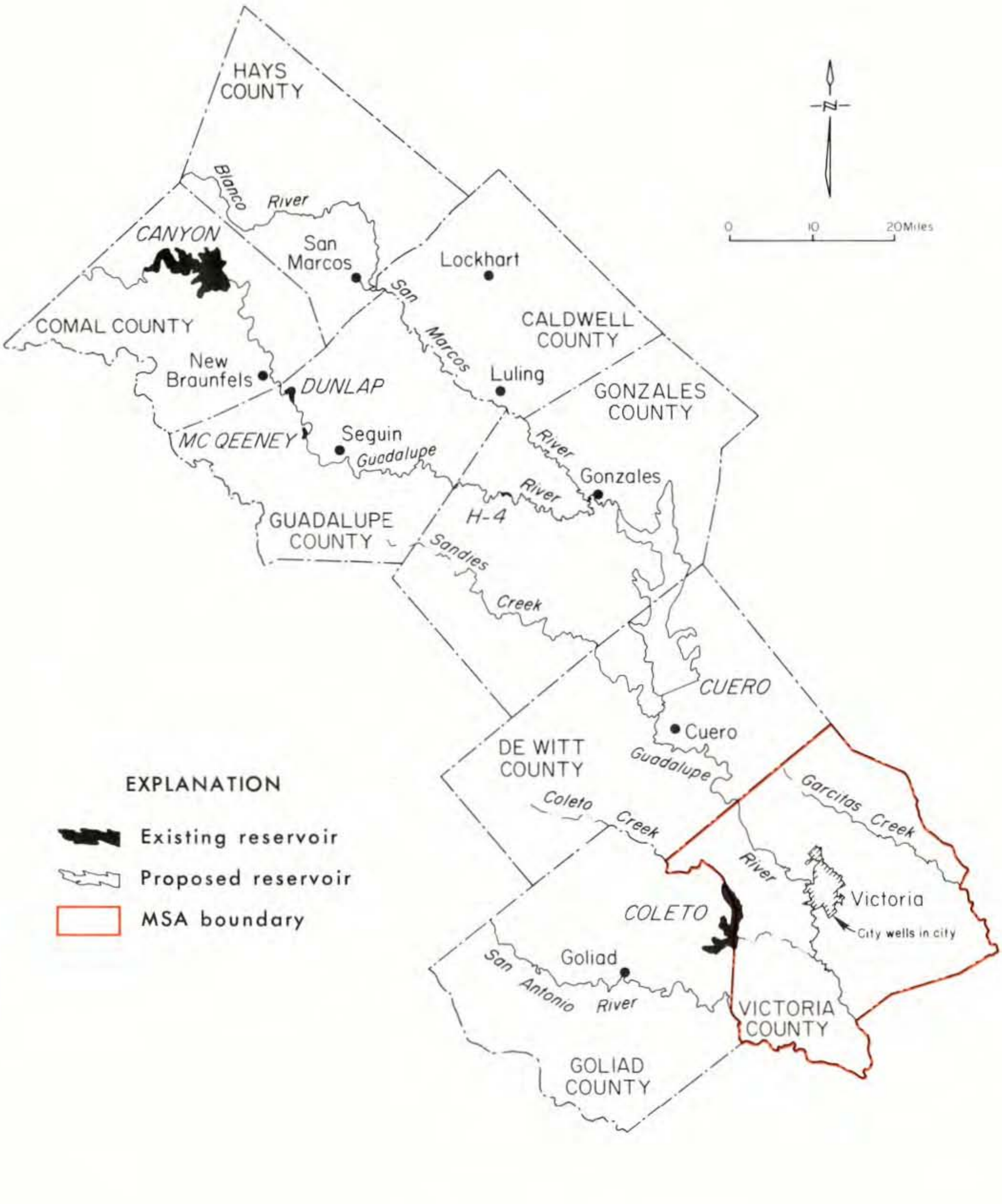


Figure 30
Victoria MSA Water Supply Projects

Description of Waco MSA - The MSA is area No. 26 on Figure 1, and is comprised of McLennan County which covers about 1,000 square miles in the Brazos River Basin. Average annual precipitation ranges from about 32 to 36 inches. Average annual temperatures range from about 66°F to 67.5°F. The principal city is Waco. Other cities in the MSA are listed in Appendix C.

Economy of Waco MSA - The area economy has diversification with a concentration in manufacturing employment. Diversified industry in the nondurable goods sectors remains the most important source of manufacturing employment. Manufacturing contributes 16.0 percent to the total personal income of the Waco MSA. The regional economic outlook is for continuing economic development, primarily in manufacturing.

Water Quality Management Planning in Waco MSA - The Waco MSA is located entirely within the Brazos River Basin. The Texas Department of Water Resources contracted with the Brazos River Authority for water quality management planning in the basin. The initial plan for the MSA portion of the basin identified wastewater facility needs and subsequent planning efforts reviewed the needs and updated them as found necessary. Additionally, the impacts of point and nonpoint sources of pollution were analyzed. The wasteloads were found to be within the assimilative capacity of the streams and no further special studies were identified. All recommendations made during the water quality management process are reviewed by an advisory committee as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Waco MSA - The Federal Emergency Management Agency has designated McLennan County and 20 incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for the county and for 19 of the incorporated cities in the MSA (Appendix C). Presently, the county and 12 cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future development will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for McLennan County and 12 cities in the MSA (Appendix C).

Population and Employment within the Waco MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
	(Thousands)				Projections (Thousands)				
Total Population	147.5	150.0	170.7	Low	184.6	188.5	191.8	200.1	215.3
				High	200.3	208.0	219.5	240.1	262.8
Urban Population	128.4	121.2	145.8	Low	162.1	166.2	169.1	176.4	189.8
				High	175.9	183.4	193.5	211.7	231.7
Other Population	19.1	28.9	24.9	Low	22.5	22.3	22.7	23.7	25.5
				High	24.4	24.6	26.0	28.4	31.1
Employment	52.5	56.6	81.3	Low	93.7	95.7	95.8	98.3	104.1
				High	101.7	105.6	109.7	118.1	127.0

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Waco MSA 1/

Year	Analyses Catagory	Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	10.2		1.4		0.3		--		11.9	
1980	Surface-Water	30.8		2.5		15.5		0.7		49.5	
1980	Total Use 6/	41.0		3.9		15.8		0.7		61.4	
1990	Total Demand	37.7	53.6	5.9	6.3	15.8	15.8	0.8	0.8	60.2	76.5
1990	Ground-Water	1.2	1.6	0.9	0.5	--	--	--	--	2.1	2.1
1990	Surface-Water	36.5	52.0	5.0	5.8	15.8	15.8	0.8	0.8	58.1	74.4
1990	Total Supply 7/	37.7	53.6	5.9	6.3	15.8	15.8	0.8	0.8	60.2	76.5
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	39.0	56.3	8.2	9.2	15.8	15.8	1.0	1.0	64.0	82.3
2000	Ground-Water	1.3	1.7	0.8	0.4	--	--	--	--	2.1	2.1
2000	Surface-Water	37.7	54.6	7.4	8.8	15.8	15.8	1.0	1.0	61.9	80.2
2000	Total Supply 7/	39.0	56.3	8.2	9.2	15.8	15.8	1.0	1.0	64.0	82.3
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	39.7	59.4	10.8	12.3	15.8	15.8	1.2	1.2	67.5	88.7
2010	Ground-Water	1.3	1.7	0.8	0.4	--	--	--	--	2.1	2.1
2010	Surface-Water	38.4	57.7	10.0	11.9	15.8	15.8	1.2	1.2	65.4	86.6
2010	Total Supply 7/	39.7	59.4	10.8	12.3	15.8	15.8	1.2	1.2	67.5	88.7
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	41.4	64.9	14.0	16.2	15.8	15.8	1.4	1.4	72.6	98.3
2020	Ground-Water	1.3	1.8	0.8	0.3	--	--	--	--	2.1	2.1
2020	Surface-Water	40.1	63.1	13.2	15.9	15.8	15.8	1.4	1.4	70.5	96.2
2020	Total Supply 7/	41.4	64.9	14.0	16.2	15.8	15.8	1.4	1.4	72.6	98.3
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	44.5	71.0	17.6	20.6	15.8	15.8	1.5	1.5	79.4	108.9
2030	Ground-Water	1.4	2.0	0.7	0.1	--	--	--	--	2.1	2.1
2030	Surface-Water	43.1	66.7	16.9	20.5	15.8	15.8	1.5	1.5	77.3	104.5
2030	Total Supply 7/	44.5	68.7	17.6	20.6	15.8	15.8	1.5	1.5	79.4	106.6
2030	Shortage	--	2.3	--	--	--	--	--	--	--	2.3

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 9.1 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.)

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

Water Supply Outlook and Problems in the Waco MSA - Currently within the MSA, approximately 81 percent of the water used for urban needs (municipal, manufacturing, steam-electric power generation, and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining 19 percent is supplied by ground-water resources. In the years 2000 and 2030, approximately 98 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately two percent by ground-water resources.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The City of Waco Water System and the City of Beverly Hills (through the Waco System) currently receive their water supplies from Lake Waco (Figure 31). The City of Bellmead's current supply is from the Waco System and the Trinity Group Aquifer (Figure 3). Other smaller, yet growing, water systems within the MSA (McLennan County) receive their current supply from the Trinity Group Aquifer (Figure 3). Some of these smaller urban systems include Lacy-Lakeview, McGregor, Mart, Moody, Robinson, West, Woodway, Bruceville, Eddy, Riesel, Axtell, Elm Mott, Lorena, and Crawford (Figure 31). Because of extreme water-level declines, the Trinity Group Aquifer will not be capable of sustaining present or future levels of pumpage. Also, the aquifer contains water having high concentrations of fluoride which exceed the Environmental Protection Agency and Texas State Health Department fluoride standard of 1.6 milligrams per liter for the MSA. A recent Texas Department of Water Resources (TDWR) study indicated about 20 community ground-water systems in the MSA had fluoride concentrations exceeding 1.6 milligrams per liter.

Lake Tradinghouse Creek and Lake Creek Lake currently supply cooling water for power plants within the MSA. These Lakes are expected to provide sufficient water supplies for steam-electric power generation within the MSA through the year 2030.

The Texas Department of Water Resources expects that by the year 2000, the following cities will be obtaining all of their water supply from Lake Waco through the Waco Water System: Bellmead, Beverly Hills, Lacy-Lakeview, Robinson, Woodway, Lorena, Bruceville, Eddy, Moody, Riesel, Mart, Axtell, and Elm Mott. The City of West will be supplied by Lake Aquilla (Figure 31). The City of McGregor is expect to be supplied from Lake Belton (Figure 2) and the City of Crawford is expected to remain on ground water from the Trinity Group Aquifer (Figure 3) through the year 2030.

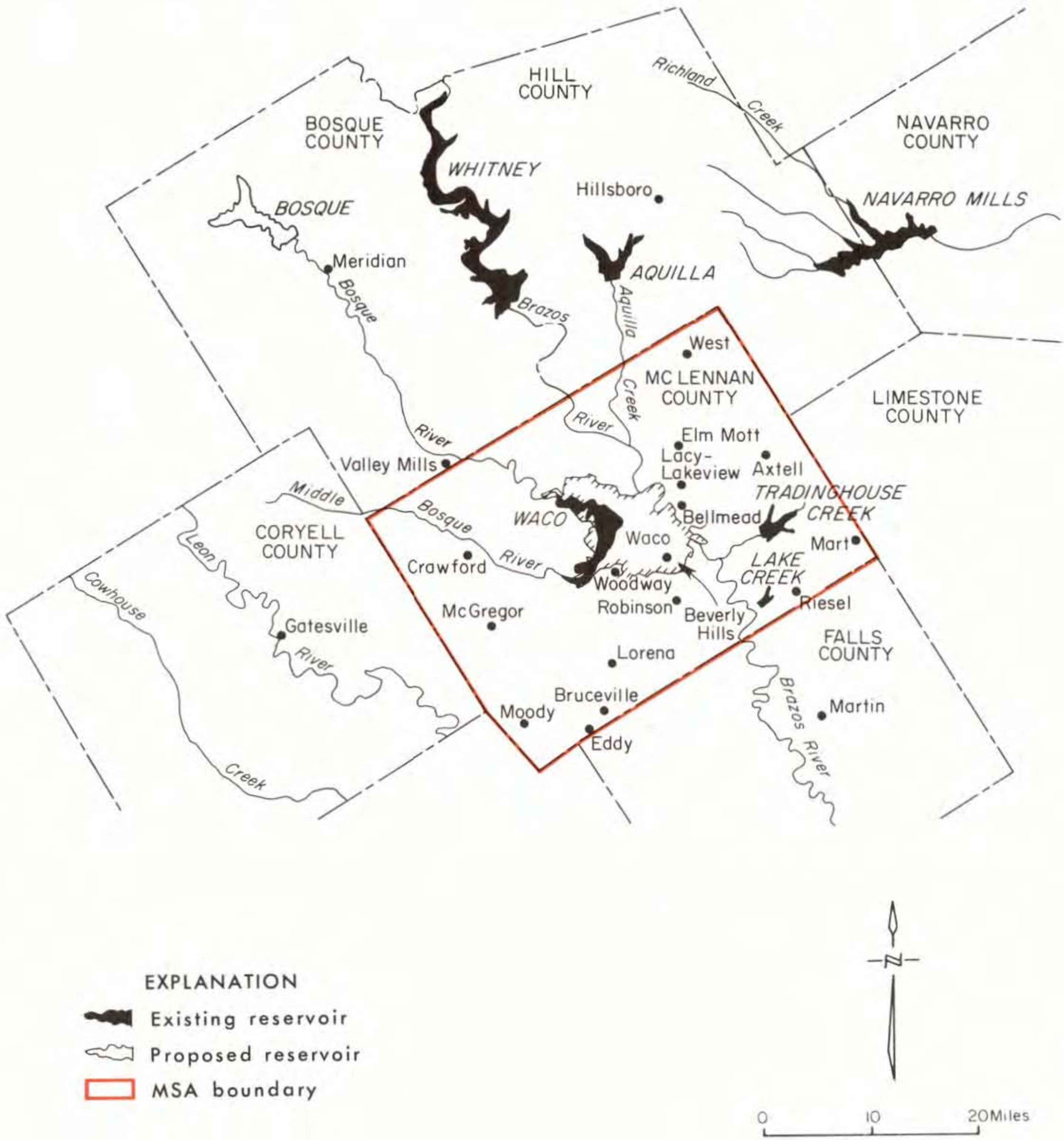


Figure 31
Waco MSA Water Supply Projects

In the next 10 to 20 years, expansion of distribution facilities will be needed in the MSA to convey treated water from Lake Waco to the expected Waco Water System customer cities described above. The Waco System and its customer cities are expected to have surface-water requirements of 63 and 89 thousand acre-feet per year in the years 2000 and 2030, respectively. The dependable supplies from Lake Waco are expected to be about 75 and 68 thousand acre-feet annually in 2000 and 2030, respectively. Therefore, supply-demand comparison indicates that the Waco System and its customer cities will need an additional firm surface-water supply between the years 2015 and 2020. The proposed Bosque Reservoir (Figure 31) is currently under study for providing an additional water supply.

Description of Wichita Falls MSA - The MSA is area No. 27 on Figure 1, and is comprised of Wichita County which has about 611 square miles in the Red River Basin. Average annual precipitation ranges from about 26 to 38 inches. Average annual temperature is about 63 F. The principal city is Wichita Falls. Other cities in the MSA are listed in Appendix C.

Economy of Wichita Falls MSA - The area economy has significant concentrations in the mining and trade sectors. Industrial plants for large national corporations are the most important source of manufacturing employment. Manufacturing contributes 13.3 percent to the total personal income of the MSA. The regional economic outlook is for rapid growth in the manufacturing sector and continuing importance of the oil industry.

Water Quality Management Planning in Wichita Falls MSA - The Wichita Falls MSA is located in the Red River Basin. The Texas Department of Water Resources has contracted with the Red River Authority of Texas for water quality management planning in the MSA. The initial plan for the basin identified wastewater facility needs within the MSA and subsequent planning efforts reviewed the needs and updated them as found necessary. The initial planning also included the collection and analysis of water quality and hydrologic data in the City of Wichita Falls' area for stream mathematical modeling purposes. In addition, the initial plan contained a preliminary assessment of the contributions of urban runoff in Wichita Falls based on theoretical loadings. High fecal coliform concentrations have been recorded for the area and violations of dissolved oxygen, sulfate and chloride criteria have occurred. To verify the pollutant contributions of urban runoff, a rainfall runoff sampling program has been started. When this program is completed in 1985, there should be enough data to determine the significance of the nonpoint source pollutants in the study area and to develop cost effective control strategies, if deemed necessary. All recommendations made during the water quality management process are reviewed by local advisory committees as required by the regulations of the Federal Clean Water Act.

Floodplain Management Program in Wichita Falls MSA - The Federal Emergency Management Agency has designated Wichita County and five incorporated cities in the MSA as being subject to potential flooding problems from a 100-year flood event (Appendix C). Flood hazard boundary maps identifying flood-prone areas have been published for Wichita County and for four of the incorporated cities in the MSA (Appendix C). Presently, the county and all five cities in the MSA have adopted local floodplain management programs (Appendix C) in compliance with the requirements regarding participation in the National Flood Insurance Program (NFIP). Participation in the NFIP makes flood insurance available to MSA residents presently in the floodplain and will afford some degree of protection against monetary losses due to flooding. Enforcement of the local floodplain management programs would assure that future developments will be located so as to eliminate damage from the 100-year flood. Detailed Flood Insurance Rate Studies which supply detailed 10-year, 50-year, 100-year, and 500-year flood event data have been completed for Wichita County and four cities in the MSA (Appendix C).

Population and Employment within the Wichita Falls MSA

Item	1960	1970	1980	Series	1990	2000	2010	2020	2030
	(Thousands)				Projections (Thousands)				
				Low	124.3	145.0	170.5	196.0	224.6
Total Population	123.5	121.9	121.1	High	125.1	158.2	188.9	224.6	265.2
				Low	121.3	143.3	168.5	193.7	222.0
Urban Population	117.4	116.5	114.8	High	122.1	156.4	186.7	222.0	262.1
				Low	3.0	1.7	2.0	2.3	2.6
Other Population	6.1	5.4	6.3	High	3.0	1.8	2.2	2.6	3.1
				Low	70.1	81.7	94.6	106.9	120.5
Employment	40.0	39.2	68.5	High	70.5	89.2	104.7	122.5	142.3

1980 Water Use and Low and High Series Water Supply-Demand Analyses, 1990-2030, Within the Wichita Falls MSA 1/

Year	Analyses Catagory	Demand Catagories: Municipal Low	Municipal High	Manufacturing 3/ Low	Manufacturing 3/ High	Steam Electric 4/ Low	Steam Electric 4/ High	Mining 5/ Low	Mining 5/ High	MSA TOTALS Low	MSA TOTALS High
		(Thousands of Acre-Feet)									
1980	Ground-Water	1.3		0.1		--		0.2		1.6	
1980	Surface-Water	22.8		1.0		--		0.2		24.0	
1980	Total Use 6/	24.1		1.1		--		0.4		25.6	
1990	Total Demand	21.8	30.0	1.5	1.7	--	--	0.3	0.3	23.6	32.0
1990	Ground-Water	0.8	1.1	--	--	--	--	0.3	0.3	1.1	1.4
1990	Surface-Water	21.0	28.9	1.5	1.7	--	--	--	--	22.5	30.6
1990	Total Supply 7/	21.8	30.0	1.5	1.7	--	--	0.3	0.3	23.6	32.0
1990	Shortage	--	--	--	--	--	--	--	--	--	--
2000	Total Demand	25.9	38.6	2.1	2.4	--	--	0.2	0.2	28.2	41.2
2000	Ground-Water	0.9	1.2	--	--	--	--	0.2	0.2	1.1	1.4
2000	Surface-Water	25.0	37.4	2.1	2.4	--	--	--	--	27.1	39.8
2000	Total Supply 7/	25.9	38.6	2.1	2.4	--	--	0.2	0.2	28.2	41.2
2000	Shortage	--	--	--	--	--	--	--	--	--	--
2010	Total Demand	30.5	46.1	2.7	3.2	--	--	0.2	0.2	33.4	49.5
2010	Ground-Water	1.1	1.2	--	--	--	--	0.2	0.2	1.3	1.4
2010	Surface-Water	29.4	44.9	2.7	3.2	--	--	--	--	32.1	48.1
2010	Total Supply 7/	30.5	46.1	2.7	3.2	--	--	0.2	0.2	33.4	49.5
2010	Shortage	--	--	--	--	--	--	--	--	--	--
2020	Total Demand	35.1	54.8	3.5	4.1	--	--	0.1	0.1	38.7	59.0
2020	Ground-Water	1.2	1.2	--	--	--	--	0.1	0.1	1.3	1.3
2020	Surface-Water	33.9	53.6	3.5	4.1	--	--	--	--	37.4	57.7
2020	Total Supply 7/	35.1	54.8	3.5	4.1	--	--	0.1	0.1	38.7	59.0
2020	Shortage	--	--	--	--	--	--	--	--	--	--
2030	Total Demand	40.2	64.7	4.5	5.3	--	--	--	--	44.7	70.0
2030	Ground-Water	0.9	1.0	--	--	--	--	--	--	0.9	1.0
2030	Surface-Water	39.3	63.7	4.5	5.3	--	--	--	--	43.8	69.0
2030	Total Supply 7/	40.2	64.7	4.5	5.3	--	--	--	--	44.7	70.0
2030	Shortage	--	--	--	--	--	--	--	--	--	--

Source: Texas Department of Water Resources projections of water demand and uses under average conditions (low series) and drought conditions (high series). One acre-foot of water is 325,851 gallons.

1/ Additional water for agriculture (irrigation and livestock watering) will be required within the MSA. Total MSA agricultural uses were 55.7 thousand acre-feet in 1980. Projected future irrigation water uses for 1990 through 2030 are not presented because urban growth within the MSA and the resulting potential for this growth to impinge on irrigation in the area has not been predicted. (See footnote 1/, Table 3 for estimated total statewide irrigation water use for 1980 and irrigation water projected requirements for 1990 through 2030.

2/ Includes water used in cities for household purposes, fire protection, drinking and sanitation in public and commercial establishments, lawn watering, car washes, and other uses.

3/ Includes water used in the production processes and for cooling and heat exchange in manufacturing establishments.

4/ Estimated evaporation of cooling water used in steam-electric power plants. Additional water will be required for steam-electric power generation at plants outside the MSA which supply electrical energy to users within the MSA.

5/ Includes water used in the flooding of petroleum-bearing formations to increase oil and gas production plus water used in sand and gravel and other mining activities.

6/ Actual total estimated and reported ground- and surface-water uses in 1980.

7/ Total allocated supply from available supply.

<u>Water Supply Outlook and Problems in the Wichita Falls MSA</u> - Currently within the MSA, approximately 94 percent of the water used for urban needs (municipal, manufacturing and mining purposes) is supplied by developed surface-water resources in and adjacent to the MSA. The remaining six percent is supplied by ground-water resources. Approximately 97 and 99 percent of the MSA's projected urban water requirements are expected to be supplied by developed surface-water resources, and approximately three and one percent by ground-water resources in the years 2000 and 2030, respectively.

Many of the growing urban water systems within the MSA have been and will continue to be faced with problems related to the physical condition of the systems, facility costs, and water rights. Many of the systems are located in areas distant from reliable sources of supply. Under this condition, the cost of required delivery and treatment facilities to develop a reliable supply may be relatively high in relation to costs for other cities in the MSA. Also, sufficient surface water or ground water to adequately fulfill the water needs of these urban systems may not be readily available or surface-water supplies may not be accessible through an entity having water rights.

The Wichita Falls Water System will continued to provide water to the City of Wichita Falls and a number of surrounding municipalities, including Burkburnett, Iowa Park, and Holiday (Figure 32). The City of Electra currently obtains its water supply from Lake Electra (Figure 32) and the Seymour Aquifer. However, by the year 2000, Electra, Henrietta, and Archer City (Figure 32) are expected to be obtaining all or part of their water supplies from the Wichita Falls Water System.

Lakes Buffalo Creek, Kickapoo, Arrowhead, Kemp, Diversion and Electra (Figure 32) will be capable of providing a dependable water supply through the year 2030, except for all of the needs of the Wichita Falls System and other urban water needs in and adjacent to the MSA. The potential urban and irrigation water needs for these reservoirs are expected to be about 84 and 117 thousand acre-feet annually in the years 2000 and 2030, respectively. The reservoirs will be capable of providing a total annual dependable supply of about 182 thousand acre-feet in 2030; however, over 100 thousand acre-feet of this available supply is not of acceptable quality for supplying municipal and manufacturing water demands. Shortly after the year 2020, additional supplies are projected to be needed for municipal and manufacturing purposes for the Wichita Falls Water System and other urban needs in and adjacent to the MSA (Wichita County). A potential reservoir which could supplement existing water supplies and meet currently expected, long-range water requirements within and adjacent to the MSA is Lake Ringgold (Figure 32). This reservoir could be operated as an integral part of the Wichita Falls Water System.

Another alternative for meeting the municipal and manufacturing water needs after the year 2020 would be to use surface waters from the existing reservoirs and implement measures for alleviating natural salinity by construction of all elements of the Arkansas-Red Basins

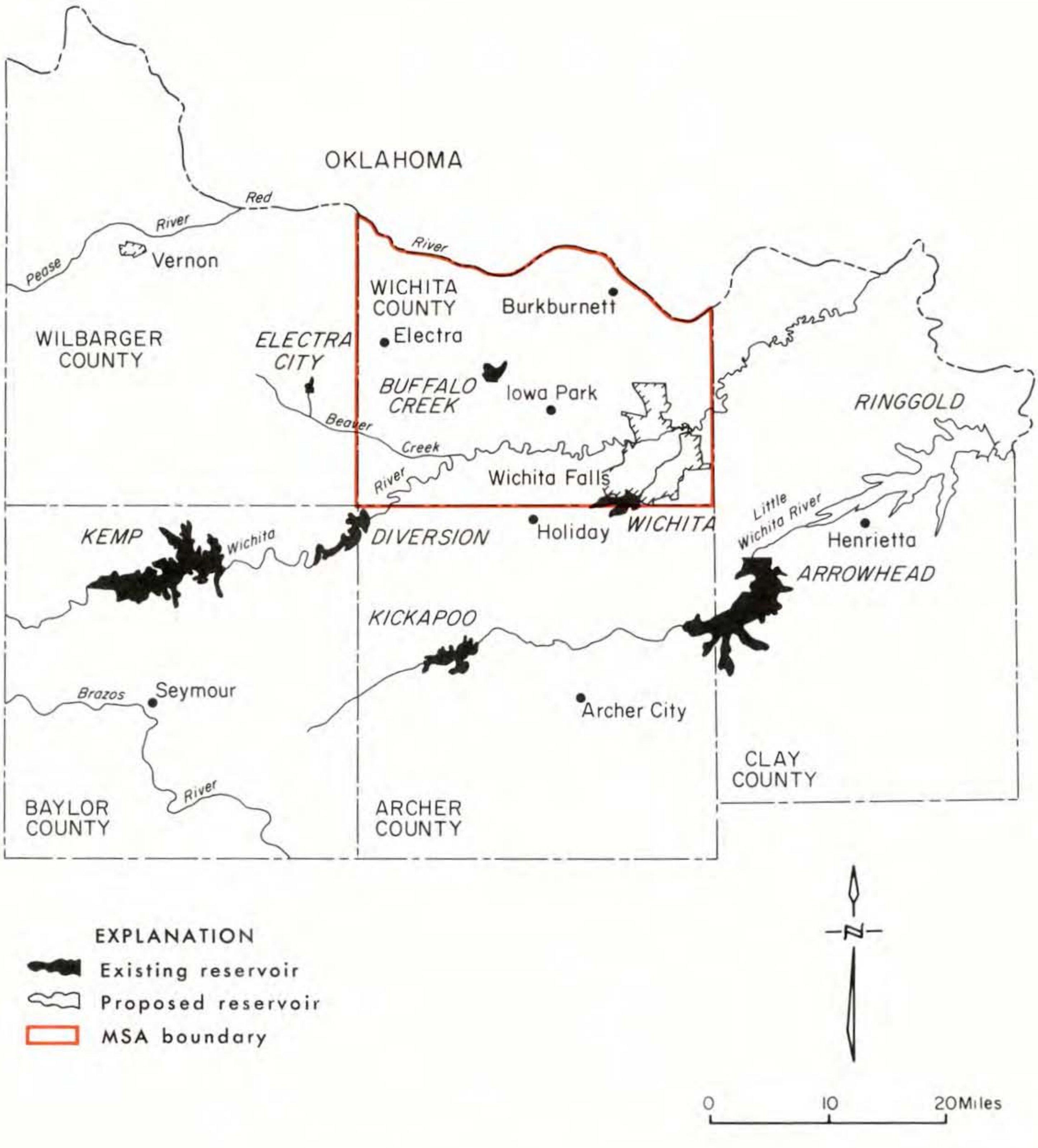


Figure 32
Wichita Falls MSA Water Supply Projects

Chloride Control Project. Also, studies are currently underway to determine the feasibility of desalting water from the Lakes Kemp-Diversion System for use in the Wichita Falls MSA and adjacent areas.

APPENDIX A

CURRENT WORDING OF SECTION 208
OF THE FEDERAL WATER POLLUTION CONTROL
ACT (P.L. 92-500) AS AMENDED BY THE
CLEAN WATER ACT OF 1977 (P.L. 95-219)
(The italic words are those amended in 1977.
Bracketed words are those deleted in 1977.)

AREAWIDE WASTE TREATMENT MANAGEMENT

SEC. 208. (a) For the purpose of encouraging and facilitating the development and implementation of areawide waste treatment management plans—

(1) The Administrator, within ninety days after the date of enactment of this Act and after consultation with appropriate Federal, State, and local authorities, shall by regulation publish guidelines for the identification of those areas which, as a result of urban-industrial concentrations or other factors, have substantial water quality control problems.

(2) The Governor of each State, within sixty days after publication of the guidelines issued pursuant to paragraph (1) of this subsection, shall identify each area within the State which, as a result of urban-industrial concentrations or other factors, has substantial water quality control problems. Not later than one hundred and twenty days following such identification and after consultation with appropriate elected and other officials of local governments having jurisdiction in such areas, the Governor shall designate (A) the boundaries of each such area, and (B) a single representative organization, including elected officials from local governments or their designees, capable of developing effective areawide waste treatment management plans for such area. The Governor may in the same manner at any later time identify any additional area (or modify an existing area) for which he determines areawide waste treatment management to be appropriate, designate the boundaries of such area, and designate an organization capable of developing effective areawide waste treatment management plans for such area.

(3) With respect to any area which, pursuant to the guidelines published under paragraph (1) of this subsection, is located in two or more States, the Governors of the respective States shall consult and cooperate in carrying out the provisions of paragraph (2), with a view toward designating the boundaries of the interstate area having common water quality control problems and for which areawide waste treatment management plans would be most effective, and toward designating, within one hundred and eighty days after publication of guidelines issued pursuant to paragraph (1) of this subsection, of a single representative organization capable of developing effective areawide waste treatment management plans for such area.

(4) If a Governor does not act, either by designating or determining not to make a designation under paragraph (2) of this subsection, within the time required by such paragraph, or if, in the case of an interstate area, the Governors of the States involved do not designate a planning organization within the time required by paragraph (3) of this subsection, the chief elected officials of local governments within an area may by agreement designate (A) the boundaries for such an area, and (B) a single representative organization including elected officials from such local governments, or their designees, capable of developing an areawide waste treatment management plan for such area.

(5) Exiting regional agencies may be designated under paragraphs (2), (3), and (4) of this subsection.

(6) The State shall act as a planning agency for all portions of such State which are not designated under paragraphs (2), (3), or (4) of this subsection.

(7) Designations under this subsection shall be subject to the approval of the Administrator.

(b)(1)(*A*) Not later than one year after the date of designation of any organization under subsection (a) of this section such organization shall have in operation a continuing areawide waste treatment management planning process consistent with section 201 of this Act. Plans prepared in accordance with this process shall contain alternatives for waste treatment management, and be applicable to all wastes generated within the area involved. The initial plan prepared in accordance with such process shall be certified by the Governor and submitted to the Administrator not later than two years after the planning process is in operation.

(B) For any agency designated after 1975 under subsection (a) of this section and for all portions of a State for which the State is required to act as the planning agency in accordance with subsection (a)(6), the initial plan prepared in accordance with such process shall be certified by the Governor and submitted to the Administrator not later than three years after the receipt of the initial grant award authorized under subsection (f) of this section.

(2) Any plan prepared under such process shall include, but not be limited to—

(A) the identification of treatment works necessary to meet the anticipated municipal and industrial waste treatment needs of the area over a twenty-year period, annually updated (including an analysis of alternative waste treatment systems), including any requirements for the acquisition of land for treatment purposes; the necessary waste water collection and urban storm water runoff systems; and a program to provide the necessary financial arrangements for the development of such treatment works, *and an identification of open space and recreation opportunities that can be expected to result from improved water quality, including consideration of potential use of lands associated with treatment works and increased access to water-based recreation*;

(B) the establishment of construction priorities for such treatment works and time schedules for the initiation and completion of all treatment works;

(C) the establishment of a regulatory program to—

(i) implement the waste treatment management requirements of section 201(c),

(ii) regulate the location, modification, and construction of any facilities within such area which may result in any discharge in such area, and

(iii) assure that any industrial or commercial waste discharged into any treatment works in such area meet applicable pretreatment requirements;

(D) the identification of those agencies necessary to construct, operate, and maintain all facilities required by the plan and otherwise to carry out the plan;

(E) the identification of the measures necessary to carry out the plan (including financing), the period of time necessary to carry out the plan, the costs of carrying out the plan within such time, and the economic, social, and environmental impact of carrying out the plan within such time;

(F) a process to (i) identify, if appropriate, agriculturally and silviculturally related nonpoint sources of pollution, including *return flows from irrigated agriculture, and their cumulative effects*, runoff from manure disposal areas, and from land used for livestock and crop production, and (ii) set forth procedures and methods (including land use requirements) to control to the extent feasible such sources;

(G) a process of (i) identify, if appropriate, mine-related sources of pollution including new, current, and abandoned surface and underground mine runoff, and (ii) set forth procedures and methods (including land use requirements) to control to the extent feasible such sources;

(H) a process to (i) identify construction activity related sources of pollution, and (ii) set forth procedures and methods (including land use requirements) to control to the extent feasible such sources;

(I) a process to (i) identify, if appropriate, salt water intrusion into rivers, lakes, and estuaries resulting from reduction of fresh water flow from any cause, including irrigation, obstruction, ground water extraction, and diversion, and (ii) set forth procedures and methods to control such intrusion to the extent feasible where such procedures and methods are otherwise a part of the waste treatment management plan;

(J) a process to control the disposition of all residual waste generated in such area which could affect water quality; and

(K) a process to control the disposal of pollutants on land or in subsurface excavations within such area to protect ground and surface water quality.

(3) Areawide waste treatment management plans shall be certified annually by the Governor or his designee (or Governors or their designees, where more than one State is involved) as being consistent with applicable basin plans and such areawide waste treatment management plans shall be submitted to the Administrator for his approval.

(4) *(A)* Whenever the Governor of any State determines (and notifies the Administrator) that consistency with a statewide regulatory program under section 303 so requires, the requirements of clauses (F) through (K) of paragraph (2) of this subsection shall be developed and submitted by the Governor [to the Administrator for application to all regions within such State] *to the Administrator for approval for application to a class or category of activity throughout such State.*

(B) Any program submitted under subparagraph (A) of this paragraph which, in whole or in part, is to control the discharge or other placement of dredged or fill material into the navigable waters shall include the following:

(i) A consultation process which includes the State agency with primary jurisdiction over fish and wildlife resources.

(ii) A process to identify and manage the discharge or other placement of dredged or fill material which adversely affects navigable waters, which shall complement and be coordinated with a State program under section 404 conducted pursuant to this Act.

(iii) A process to assure that any activity conducted pursuant to a best management practice will comply with the guidelines established under section 404(b)(1), and sections 307 and 403 of this Act.

(iv) A process to assure that any activity conducted pursuant to a best management practice can be terminated or modified for cause including, but not limited to, the following:

(I) violation of any condition of the best management practice;

(II) change in any activity that requires either a temporary or permanent reduction or elimination of the discharge pursuant to the best management practice.

(v) A process to assure continued coordination with Federal and Federal-State water-related planning and reviewing processes, including the National Wetlands Inventory.

(C) If the Governor of a State obtains approval from the Administrator of a statewide regulatory program which meets the requirements of subparagraph (B) of this paragraph and if such State is administering a permit program under section 404 of this Act, no person shall be required to obtain an individual permit pursuant to such section, or to comply with a general permit issued pursuant to such section, with respect to any appropriate activity within such State for which a best management practice has been approved by the Administrator under the program approved by the Administrator pursuant to this paragraph.

(D)(i) Whenever the Administrator determines after public hearing that a State is not administering a program approved under this section in accordance with the requirements of this section, the Administrator shall so notify the State, and if appropriate corrective action is not taken within a reasonable time, not to exceed ninety days, the Administrator shall withdraw approval of such program. The Administrator shall not withdraw approval of any such program unless he shall first have notified the State, and made public, in writing, the reasons for such withdrawal.

(ii) In the case of a State with a program submitted and approved under this paragraph, the Administrator shall withdraw approval of such program under this subparagraph only for a substantial failure of the State to administer its program in accordance with the requirements of this paragraph.

(c)(1) The Governor of each State, in consultation with the planning agency designated under subsection (a) of this section, at the time a plan is submitted to the Administrator, shall designate one or more waste treatment management agencies (which may be an existing or newly created local, regional or State agency or potential subdivision) for each area designated under subsection (a) of this section and submit such designations to the Administrator.

(2) The Administrator shall accept any such designation, unless, within 120 days of such designation, he finds that the designated management agency (or agencies) does not have adequate authority—

(A) to carry out appropriate portions of an areawide waste treatment management plan developed under subsection (b) of this section;

(B) to manage effectively waste treatment works and related facilities serving such area in conformance with any plan required by subsection (b) of this section;

(C) directly or by contract, to design and construct new works, and to operate and maintain new and existing works as required by any plan developed pursuant to subsection (b) of this section;

(D) to accept and utilize grants, or other funds from any source, for waste treatment management purposes;

(E) to raise revenues, including the assessment of waste treatment charges;

(F) to incur short- and long-term indebtedness;

(G) to assure in implementation of an areawide waste treatment management plan that each participating community pays its proportionate share of treatment costs;

(H) to refuse to receive any wastes from any municipality or subdivision thereof, which does not comply with any provisions of an approved plan under this section applicable to such area; and

(I) to accept for treatment industrial wastes.

(d) After a waste treatment management agency having the authority required by subsection (c) has been designated under such subsection for an area and a plan for such area has been approved under subsection (b) of this section, the Administrator shall not make any grant for construction of a publicly owned treatment works under section 201(g)(1) within such area except to such designated agency and for works in conformity with such plan.

(e) No permit under section 402 of this Act shall be issued for any point source which is in conflict with a plan approved pursuant to subsection (b) of this section.

(f)(1) The Administrator shall make grants to any agency designated under subsection (a) of this section for payment of the reasonable costs of developing and operating a continuing areawide waste treatment management planning process under subsection (b) of this section.

[(2) The amount granted to any agency under paragraph (1) of this subsection shall be 100 per centum of the costs of developing and operating a continuing areawide waste treatment management planning process under subsection (b) of this section for each of the fiscal years ending on June 30, 1973, June 30, 1974, and June 30, 1975, and shall not exceed 75 per centum of such costs in each succeeding fiscal year.]

(2) For the two-year period beginning on the date the first grant is made under paragraph (1) of this subsection to an agency, if such first grant is made before October 1, 1977, the amount of each such grant to such agency shall be 100 per centum of the costs of developing and operating a continuing areawide waste treatment management planning process under subsection (b) of this section, and thereafter the amount granted to such agency shall not exceed 75 per centum of such costs in each succeeding one-year period. In the case of any other grant made to an agency under such paragraph (1) of this subsection, the amount of such grant shall not exceed 75 per centum of the costs of developing and operating a continuing areawide waste treatment management planning process in any year.

(3) Each applicant for a grant under this subsection shall submit to the Administrator for his approval each proposal for which a grant is applied for under this subsection. The Administrator shall act upon such proposal as soon as practicable after it has been submitted, and his approval of that proposal shall be deemed a contractual obligation of the United States for the payment of its contribution to such proposal, *subject to such amounts as are provided in appropriation Acts.* There is authorized to be appropriated to carry out this subsection not to exceed $50,000,000 for the fiscal year ending June 30, 1973, not to exceed $100,000,000 for the fiscal year ending June 30, 1974, and not to exceed $150,000,000 *per fiscal year* for the fiscal [year] *years* ending June 30, 1975, *September 30, 1977, September 30, 1978, September 30, 1979, and September 30, 1980.*

(g) The Administrator is authorized, upon request of the Governor or the designated planning agency, and without reimbursement, to consult with, and provide technical assistance to, any agency designated under subsection (a) of this section in the development of areawide waste treatment management plans under subsection (b) of this section.

(h)(1) The Secretary of the Army, acting through the Chief of Engineers, in cooperation with the Administrator is authorized and directed, upon request of the Governor or the designated planning organization, to consult with, and provide technical assistance to, any agency designed under subsection (a) of this section in developing and operating a continuing areawide waste treatment management planning process under subsection (b) of this section.

(2) There is authorized to be appropriated to the Secretary of the Army, to carry out this subsection, not to exceed $50,000,000 per fiscal year for the fiscal years ending June 30, 1973, and June 30, 1974.

(i) (1) The Secretary of the Interior, acting through the Director of the United States Fish and Wildlife Service, shall, upon request of the Governor of a State, and without reimbursement, provide technical assistance to such State in developing a statewide program for submission to the Administrator under subsection (b) (4) (B) of this section and in implementing such program after its approval.

(2) There is authorized to be appropriated to the Secretary of the Interior $6,000,000 to complete the National Wetlands Inventory of the United States, by December 31, 1981, and to provide information from such Inventory to States as it becomes available to assist such States in the development and operation of programs under this Act.

(j) (1) The Secretary of Agriculture, with the concurrence of the Administrator, and acting through the Soil Conservation Service and such other agencies of the Department of Agriculture as the Secretary may designate, is authorized and directed to establish and administer a program to enter into contracts, subject to such amounts as are provided in advance by appropriation acts, of not less than five years nor more than ten years with owners and operators having control of rural land for the purpose of installing and maintaining measures incorporating best management practices to control nonpoint source pollution for improved water quality in those States or areas for which the Administrator has approved a plan under subsection (b) of this section where the practices to which the contracts apply are certified by the management agency designated under subsection (c) (1) of this section to be consistent with such plans and will result in improved water quality. Such contracts may be entered into during the period ending not later than September 31, 1988. Under such contracts the land owner or operator shall agree—

(i) to effectuate a plan approved by a soil conservation district, where one exists, under this section for his farm, ranch, or other land substantially in accordance with the schedule outlined therein unless any requirement thereof is waived or modified by the Secretary;

(ii) to forfeit all rights to further payments or grants under the contract and refund to the United States all payments and grants received thereunder, with interest, upon his violation of the contract at any stage during the time he has control of the land if the Secretary, after considering the recommendations of the soil conservation district, where one exists, and the Administrator, determines that such violation is of such a nature as to warrant termination of the contract, or to make refunds or accept such payment adjustments as the Secretary may deem appropriate if he determines that the violation by the owner or operator does not warrant termination of the contract;

(iii) upon transfer of his right and interest in the farm, ranch, or other land during the contract period to forfeit all rights

to further payments or grants under the contract and refund to the United States all payments or grants received thereunder, with interest, unless the transferee of any such land agrees with the Secretary to assume all obligations of the contract;

(iv) not to adopt any practice specified by the Secretary on the advice of the Administrator in the contract as a practice which would tend to defeat the purposes of the contract;

(v) to such additional provisions as the Secretary determines are desirable and includes in the contract to effectuate the purposes of the program or to facilitate the practical administration of the program.

(2) In return for such agreement by the landowner or operator the Secretary shall agree to provide technical assistance and share the cost of carrying out those conservation practices and measures set forth in the contract for which he determines that cost sharing is appropriate and in the public interest and which are approved for cost sharing by the agency designated to implement the plan developed under subsection (b) of this section. The portion of such cost (including labor) to be shared shall be that part which the Secretary determines is necessary and appropriate to effectuate the installation of the water quality management practices and measures under the contract, but not to exceed 50 per centum of the total cost of the measures set forth in the contract; except the Secretary may increase the matching cost share where he determines that (1) the main benefits to be derived from the measures are related to improving offsite water quality, and (2) the matching share requirement would place a burden on the landowner which would probably prevent him from participating in the program.

(3) The Secretary may terminate any contract with a landowner or operator by mutual agreement with the owner or operator if the Secretary determines that such termination would be in the public interest, and may agree to such modification of contracts previously entered into as he may determine to be desirable to carry out the purposes of the program or facilitate the practical administration thereof or to accomplish equitable treatment with respect to other conservation, land use, or water quality programs.

(4) In providing assistance under this subsection the Secretary will give priority to those areas and sources that have the most significant effect upon water quality. Additional investigations or plans may be made, where necessary, to supplement approved water quality management plans, in order to determine priorities.

(5) The Secretary shall, where practicable, enter into agreements with soil conservation districts, State soil and water conservation agencies, or State water quality agencies to administer all or part of the program established in this subsection under regulations developed by the Secretary. Such agreements shall provide for the submission of such reports as the Secretary deems necessary, and for payment by the United States of such portion of the costs incurred in the administration of the program as the Secretary may deem appropriate.

(6) The contracts under this subsection shall be entered into only in areas where the management agency designated under subsection (c)(1) of this section assures an adequate level of participation by

owners and operators having control of rural land in such areas. Within such areas the local soil conservation district, where one exists, together with the Secretary of Agriculture, will determine the priority of assistance among individual land owners and operators to assure that the most critical water quality problems are addressed.

(7) The Secretary, in consultation with the Administrator and subject to section 304(k) of this Act, shall, not later than September 30, 1978, promulgate regulations for carrying out this subsection and for support and cooperation with other Federal and non-Federal agencies for implementation of this subsection.

(8) This program shall not be used to authorize or finance projects that would otherwise be eligible for assistance under the terms of Public Law 83–566.

(9) There are hereby authorized to be appropriated to the Secretary of Agriculture $200,000,000 for fiscal year 1979 and $400,000,000 for fiscal year 1980, to carry out this subsection. The program authorized under this subsection shall be in addition to, and not in substitution of, other programs in such area authorized by this or any other public law.

APPENDIX B

SECTION 205(j) OF THE
FEDERAL WATER POLLUTION CONTROL ACT (P.L. 92-500)
AS ADDED BY THE 1981 AMENDMENTS TO THE
FEDERAL CLEAN WATER ACT (P.L. 97-117)

WATER QUALITY MANAGEMENT PLANNING

SEC. 205.(j)(1) The Administrator shall reserve each fiscal year not to exceed 1 per centum of the sums allotted and available for obligation to each State under this section for each fiscal year beginning on or after October 1, 1981, or $100,000 whichever amount is the greater.

(2) Such sums shall be used by the Administrator to make grants to the states to carry out water quality management planning, including, but not limited to-

(A) identifying most cost effective and locally acceptable facility and non-point measures to meet and maintain water quality standards;

(B) developing an implementation plan to obtain State and local financial and regulatory commitments to implement measures developed under subparagraph (A);

(C) determining the nature, extent, and causes of water quality problems in various areas of the State and interstate region, and reporting on these annually; and

(D) determining those publicly owned treatment works which should be constructed with assistance under this title, in which areas and in what sequence, taking into account the relative degree of effluent reduction attained, the relative contributions to water quality of other point or nonpoint sources, and the consideration of alternatives to such construction, and implementing section 303(e) of this Act.

(3) In carrying out planning with grants made under paragraph (2) of this subsection, a State shall develop jointly with local, regional, and interstate entities, a plan for carrying out the program and give funding priority to such entities and designated or undersignated public comprehensive planning organizations to carry out the purposes of this subsection.

(4) All activities undertaken under this subsection shall be in coordination with other related provisions of this Act.

APPENDIX C

FLOODPLAIN MANAGEMENT PROGRAM

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	ABILENE MSA		
Taylor	Yes	Yes	No
Abilene	Yes	Yes	Yes
Buffalo Gap	Yes	No	No
Impact	Yes	No	No
Lawn	Yes	No	No
Merkel	Yes	No	No
Trent	Yes	No	No
Tuscola	Yes	Yes	No
Tye	Yes	No	No
	AMARILLO MSA		
Potter	Yes	No	No
Amarillo	Yes	Yes	Yes
Randall	Yes	Yes	Yes
Canyon	Yes	Yes	Yes
Lake Tanglewood	Yes	Yes	Yes
	AUSTIN MSA		
Hays	Yes	Yes	No
Kyle	Yes	Yes	Yes
San Marcos	Yes	Yes	Yes
Travis	Yes	Yes	Yes
Austin	Yes	Yes	Yes
Lakeway	Yes	No	Yes
Manor	No	Yes	No
Pflugerville	Yes	Yes	Yes
Rollingwood	Yes	Yes	Yes
San Leanna	Yes	Yes	Yes
Sunset Valley	Yes	Yes	Yes
West Lake Hill	Yes	Yes	Yes
Williamson	Yes	Yes	No
Bartlett	No	Yes	No
Cedar Park	Yes	Yes	No

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
AUSTIN MSA (continued)			
Williamson (continued			
Florence	Yes	Yes	No
Georgetown	Yes	Yes	No
Granger	Yes	Yes	No
Leander	Yes	Yes	No
Round Rock	Yes	Yes	No
Taylor	Yes	Yes	Yes
BEAUMONT-PORT ARTHUR MSA			
Hardin	Yes	Yes	Yes
Kountze	Yes	No	No
Lumberton	Yes	Yes	Yes
Rose Hill Acres	Yes	Yes	Yes
Silsbee	Yes	Yes	Yes
Sour Lake	No	Yes	No
Jefferson	Yes	Yes	Yes
Beaumont	Yes	Yes	Yes
Bevil Oakes	Yes	Yes	Yes
China	No	No	No
Groves	Yes	Yes	Yes
Nederland	Yes	Yes	Yes
Nome	Yes	No	Yes
Port Arthur	Yes	Yes	Yes
Port Neches	Yes	Yes	Yes
Orange	Yes	Yes	Yes
Bridge City	Yes	Yes	Yes
Orange	Yes	Yes	Yes
Pine Forest	Yes	Yes	Yes
Pinehurst	Yes	Yes	Yes
Rose City	Yes	No	Yes
Vidor	Yes	Yes	Yes
West Orange	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	BROWNSVILLE-HARLINGEN MSA		
Cameron	Yes	Yes	Yes
Bayview	No	Yes	No
Brownsville	Yes	Yes	Yes
Combes	No	Yes	No
Harlingen	Yes	Yes	Yes
LaFeria	Yes	Yes	No
Laguna Vista	Yes	Yes	Yes
Los Fresnos	Yes	Yes	No
Palm Valley	No	Yes	No
Port Isabel	Yes	Yes	Yes
Primera	No	Yes	No
Rangerville	No	No	No
Rio Hondo	Yes	Yes	Yes
San Benito	Yes	Yes	Yes
Santa Rosa	Yes	Yes	Yes
South Padre Island	Yes	Yes	Yes
	BYRAN-COLLEGE STATION MSA		
Brazos	Yes	No	No
Bryan	Yes	Yes	Yes
College Station	Yes	Yes	Yes
	CORPUS CHRISTI MSA		
Nueces	Yes	Yes	Yes
Agua Dulce	Yes	Yes	Yes
Bishop	Yes	Yes	Yes
Corpus Christi	Yes	Yes	Yes
Driscoll	Yes	Yes	Yes
Port Aransas	Yes	Yes	Yes
Robstown	Yes	Yes	Yes
San Patricio	Yes	Yes	Yes
Aransas Pass	Yes	Yes	Yes
Gregory	Yes	Yes	Yes
Ingleside	Yes	Yes	Yes
Mathis	Yes	Yes	No
Odem	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
CORPUS CHRISTI MSA (continued)			
San Patricio (continued)			
Portland	Yes	Yes	Yes
San Patricio	Yes	No	No
Sinton	Yes	Yes	Yes
DALLAS MSA			
Collin	Yes	Yes	Yes
Allen	Yes	Yes	Yes
Altoga	Yes	No	No
Celina	Yes	Yes	Yes
Fairview	Yes	Yes	Yes
Frisco	Yes	Yes	Yes
Josephine	Yes	No	Yes
Lavon	Yes	No	No
Lucas	No	Yes	No
McKinney	Yes	Yes	Yes
Murphy	Yes	Yes	Yes
Parker	Yes	Yes	Yes
Plano	Yes	Yes	Yes
Prosper	Yes	Yes	Yes
Saint Paul	Yes	No	No
Westminster	Yes	No	No
Weston	Yes	No	No
Wylie	Yes	Yes	Yes
Dallas	Yes	Yes	Yes
Addison	Yes	No	Yes
Balch Springs	Yes	Yes	Yes
Buckingham	No	No	No
Carrollton	Yes	Yes	Yes
Cedar Hill	Yes	Yes	Yes
Cockrell Hill	Yes	No	No
Coppell	Yes	Yes	Yes
Dallas	Yes	Yes	Yes
DeSota	Yes	Yes	Yes
Duncanville	Yes	Yes	Yes
Farmers Branch	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
DALLAS MSA (continued)			
Dallas (Continued)			
Garland	Yes	Yes	Yes
Glenn Heights	Yes	Yes	Yes
Grand Prairie	Yes	Yes	Yes
Highland Park	Yes	Yes	Yes
Hutchins	Yes	Yes	Yes
Irving	Yes	Yes	Yes
Lancaster	Yes	Yes	Yes
Mesquite	Yes	Yes	Yes
Richardson	Yes	Yes	Yes
Rowlett	Yes	Yes	Yes
Sachse	Yes	Yes	Yes
Seagoville	Yes	Yes	Yes
Sunnyvale	Yes	Yes	Yes
University Park	Yes	Yes	Yes
Wilmer	Yes	Yes	Yes
Denton	Yes	Yes	No
Argyle	Yes	Yes	No
Aubrey	Yes	No	No
Bartonville	Yes	No	No
Cooper Canyon	Yes	No	No
Corinth	Yes	Yes	Yes
Cross Roads	Yes	No	No
Denton	Yes	Yes	Yes
Double Oak	Yes	Yes	No
Eastvale	Yes	No	No
Flower Mound	Yes	Yes	No
Hebron	Yes	No	No
Hickory Creek	Yes	No	No
Highland Village	Yes	Yes	No
Justin	Yes	No	No
Lake Dallas	Yes	Yes	No
Lewisville	Yes	Yes	No
Lincoln Park	No	No	No
Little Elm	Yes	No	No
Northlake	No	No	No
Roanoke	Yes	No	No
Sanger	Yes	Yes	Yes
Shady Shores	Yes	Yes	Yes
The Colony	No	Yes	No

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
DALLAS MSA (continued)			
Ellis	Yes	Yes	No
Alma	Yes	No	No
Bardwell	Yes	No	No
Ennis	Yes	Yes	Yes
Ferris	Yes	Yes	Yes
Garrett	No	No	No
Maypearl	Yes	No	No
Midlothian	Yes	No	No
Ovilla	Yes	Yes	Yes
Palmer	Yes	No	No
Waxahachie	Yes	Yes	Yes
Kaufman	Yes	No	No
Combine	Yes	No	No
Candell	Yes	No	No
Forney	Yes	Yes	Yes
Kaufman	Yes	Yes	Yes
Kemp	Yes	No	Yes
Mabank	Yes	Yes	Yes
Oak Grove	Yes	No	No
Oak Ridge	Yes	No	No
Terrell	Yes	Yes	Yes
EL PASO MSA			
El Paso	Yes	Yes	No
Anthony	Yes	Yes	No
Clint	Yes	Yes	No
El Paso	Yes	Yes	Yes
FORT WORTH_ARLINGTON MSA			
Johnson	Yes	No	No
Alvarado	Yes	Yes	Yes
Briar Oakes	Yes	No	No
Burleson	Yes	Yes	Yes
Cleburne	Yes	Yes	Yes
Godley	Yes	No	No
Joshua	Yes	No	No
Keene	Yes	No	No
Rio Vista	No	No	No

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
FORT WORTH-ARLINGTON MSA (continued)			
Parker	Yes	No	No
Reno	Yes	No	No
Sanctuary	Yes	No	No
Springtown	Yes	Yes	No
Weatherford	Yes	Yes	No
Willow Park	Yes	Yes	No
Tarrant	Yes	Yes	No
Arlington	Yes	Yes	Yes
Azle	Yes	Yes	No
Bedford	Yes	Yes	Yes
Benbrook	Yes	Yes	Yes
Blue Mound	Yes	Yes	Yes
Briar	Yes	Yes	No
Colleyville	Yes	Yes	Yes
Crowley	Yes	Yes	Yes
Dalworthington Gardens	Yes	Yes	Yes
Edgecliff	Yes	Yes	No
Euless	Yes	Yes	No
Everman	Yes	Yes	Yes
Forest Hill	Yes	Yes	Yes
Fort Worth	Yes	Yes	No
Grapevine	Yes	Yes	Yes
Haltom City	Yes	Yes	Yes
Haslet	Yes	Yes	No
Hurst	Yes	Yes	No
Keller	Yes	Yes	Yes
Kennedale	Yes	Yes	Yes
Lake Worth	Yes	No	No
Lakeside	No	Yes	No
Mansfield	Yes	Yes	No
North Richland Hills	Yes	Yes	Yes
Pantego	Yes	Yes	Yes
Richland Hills	Yes	Yes	Yes
River Oaks	Yes	Yes	No
Saginaw	Yes	Yes	Yes
Sansom Park Village	Yes	No	No
Southlake	Yes	Yes	Yes
Watauga	Yes	Yes	Yes
Westlake	Yes	No	No
Westover Hills	Yes	Yes	No
Westworth Village	Yes	Yes	No
White Settlement	Yes	Yes	No

FLOODPLAIN MANAGEMENT PROGRAM

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	GALVESTON-TEXAS CITY MSA		
Galveston	Yes	Yes	Yes
Clear Lake Shores	Yes	Yes	Yes
Crystal Beach	Yes	Yes	Yes
Dickinson	Yes	Yes	No
Friendswood	Yes	Yes	Yes
Galveston	Yes	Yes	Yes
Hitchcock	Yes	Yes	Yes
Jamaica Beach	Yes	Yes	Yes
Kemah	Yes	Yes	Yes
La Marque	Yes	Yes	Yes
League City	Yes	Yes	Yes
Santa Fe	Yes	Yes	Yes
Texas City	Yes	Yes	Yes
Tiki Island	No	Yes	No
	HOUSTON MSA		
Brazoria	Yes	Yes	Yes
Alvin	Yes	Yes	Yes
Angleton	Yes	Yes	Yes
Bailey's Prairie	Yes	Yes	Yes
Bonney	Yes	Yes	Yes
Brazoria	Yes	Yes	Yes
Brookside Village	Yes	Yes	Yes
Clute	Yes	Yes	Yes
Danbury	Yes	Yes	Yes
Freeport	Yes	Yes	Yes
Hillcrest Village	Yes	Yes	Yes
Holiday Lakes	No	Yes	No
Iowa Colony	Yes	Yes	Yes
Jones Creek	Yes	Yes	No
Lake Jackson	Yes	Yes	Yes
Liverpool	Yes	Yes	No
Mawel	Yes	Yes	Yes
Oyster Creek	Yes	Yes	Yes
Pearland	Yes	Yes	Yes
Quintana	Yes	Yes	Yes
Richwood	Yes	Yes	Yes
Surfside Beach	Yes	Yes	Yes
Sweeny	Yes	Yes	Yes
West Columbia	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
HOUSTON MSA (continued)			
Fort Bend	Yes	No	Yes
Chelford City MUD	No	Yes	No
City of Cities MUD	Yes	Yes	Yes
First Colony LID	No	Yes	No
Ft. Bend Co. LID #2	Yes	Yes	No
Ft. Bend Co. MUD #2	Yes	Yes	Yes
Ft. Bend Co. MUD #25	No	Yes	No
Ft. Bend Co. MUD #34	No	Yes	No
Ft. Bend Co. MUD #35	No	Yes	No
Fulsher	No	Yes	No
Katy	Yes	Yes	Yes
Kendleton	Yes	No	No
Kingsbridge	No	Yes	No
Meadows MUD	No	Yes	No
Mission Bend MUD #1	No	Yes	No
Missouri City	Yes	Yes	Yes
Needville	No	Yes	No
Pecan Grove MUD #1	Yes	Yes	No
Richmond	Yes	Yes	Yes
Rosenberg	Yes	Yes	Yes
Simonton	No	Yes	No
Stafford	Yes	Yes	Yes
Sugar Land	Yes	Yes	Yes
Harris	Yes	Yes	Yes
Baytown	Yes	Yes	Yes
Bellaire	Yes	Yes	Yes
Bunker Hill Village	Yes	Yes	Yes
Deer Park	Yes	Yes	Yes
El Lago	Yes	Yes	Yes
Galena Park	Yes	Yes	Yes
Hedwig Village	No	Yes	No
Hilshire Village	No	Yes	No
Houston	Yes	Yes	Yes
Humble	Yes	Yes	Yes
Hunters Creek Village	Yes	Yes	Yes
Jacinto City	Yes	Yes	Yes
Jersey Village	Yes	Yes	Yes
La Porte	Yes	Yes	Yes
Morgans Point	Yes	Yes	Yes
Nassau Bay	Yes	Yes	Yes
Pasadena	Yes	Yes	Yes
Piney Point Village	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
HOUSTON MSA (continued)			
Harris (continued)			
Seabrook	Yes	Yes	Yes
Shoreacres	Yes	Yes	Yes
South Houston	Yes	Yes	No
Southside Place	No	Yes	No
Spring Valley	Yes	Yes	Yes
Taylor Lake	Yes	Yes	Yes
Tomball	Yes	Yes	Yes
Webster	Yes	Yes	Yes
West University Place	No	Yes	No
Liberty	Yes	Yes	No
Cleveland	Yes	Yes	No
Daisetta	Yes	Yes	Yes
Dayton	Yes	Yes	No
Devers	Yes	No	No
Hardin	No	Yes	No
Kenefick	Yes	No	No
Liberty	Yes	Yes	No
North Cleveland	Yes	No	No
Plum Grove	Yes	Yes	No
Montgomery	Yes	Yes	Yes
Conroe	Yes	Yes	Yes
Cut & Shoot	Yes	No	Yes
Lake Chateau Woods	No	No	No
Magnolia	Yes	Yes	Yes
Montgomery	Yes	No	Yes
Oak Ridge North	No	Yes	Yes
Panorama Village	Yes	Yes	Yes
Patton Village	Yes	No	Yes
Roman forest	No	Yes	Yes
Shenandoah	No	Yes	No
Splendora	Yes	No	Yes
Stagecoach	No	No	Yes
Willis	Yes	No	Yes
Woodbranch Village	Yes	Yes	Yes
Woodloch	Yes	Yes	Yes
Waller	Yes	Yes	No
Brookshire	Yes	Yes	Yes
Hempstead	Yes	Yes	Yes
Pattison	Yes	No	Yes
Prairie View	Yes	No	Yes
Waller	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	KILLEEN-TEMPLE MSA		
Bell	Yes	Yes	Yes
Bartlett	No	Yes	No
Belton	Yes	Yes	Yes
Harker Heights	Yes	Yes	Yes
Holland	Yes	Yes	Yes
Killeen	Yes	Yes	Yes
Little River Academy	No	Yes	Yes
Morgans Point Resort	Yes	No	No
Nolanville	Yes	Yes	Yes
Rogers	Yes	Yes	Yes
Temple	Yes	Yes	Yes
Troy	Yes	Yes	Yes
Coryell	Yes	Yes	Yes
Copperas Cove	Yes	Yes	Yes
Gatesville	Yes	Yes	Yes
Oglesby	Yes	No	No
	LAREDO MSA		
Webb	Yes	No	Yes
Laredo	Yes	Yes	Yes
	LONGVIEW-MARSHALL MSA		
Gregg	Yes	Yes	No
Clarksville	Yes	No	No
Easton	Yes	No	No
Gladewater	Yes	Yes	Yes
Kilgore	Yes	Yes	Yes
Longview	Yes	Yes	Yes
Warren City	Yes	Yes	No
White Oak	Yes	No	No
Harrison	Yes	No	No
Hallsville	Yes	No	No
Marshall	Yes	Yes	Yes
Scottsville	Yes	No	No
Uncertain	No	Yes	No
Waskom	Yes	No	No

FLOODPLAIN MANAGEMENT PROGRAM

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	LUBBOCK MSA		
Lubbock	Yes	No	No
Idalou	Yes	Yes	No
Lake Ransom Village	No	Yes	No
Lubbock	Yes	Yes	Yes
New Deal	Yes	No	No
Slaton	Yes	Yes	Yes
Wolfforth	No	No	No
	McALLEN-EDINBURG-MISSION MSA		
Hidalgo	Yes	Yes	Yes
Alamo	Yes	Yes	No
Alton	Yes	Yes	Yes
Donna	Yes	Yes	No
Edcouch	No	Yes	No
Edinburg	Yes	Yes	Yes
Elsa	No	Yes	No
Hidalgo	Yes	Yes	No
La Joya	Yes	Yes	Yes
La Villa	Yes	Yes	Yes
McAllen	Yes	Yes	Yes
Mercedes	Yes	Yes	Yes
Mission	Yes	Yes	Yes
Pharr	Yes	Yes	Yes
San Juan	No	Yes	No
Weslaco	Yes	Yes	Yes
	MIDLAND MSA		
Midland	Yes	Yes	No
Midland	Yes	Yes	No
	ODESSA MSA		
Ector	Yes	Yes	No
Goldsmith	No	No	No
Odessa	Yes	Yes	No

FLOODPLAIN MANAGEMENT PROGRAM

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
	SAN ANGELO MSA		
Tom Green	Yes	Yes	No
San Angelo	Yes	Yes	Yes
	SAN ANTONIO MSA		
Bexar	Yes	Yes	Yes
Alamo Heights	Yes	Yes	Yes
Balcones Heights	Yes	Yes	Yes
Castle Hills	Yes	Yes	Yes
China Grove	Yes	Yes	Yes
Converse	Yes	Yes	Yes
Elmendorf	Yes	No	Yes
Grey Forest	Yes	Yes	Yes
Hill Country Village	Yes	No	No
Hollywood Park	Yes	Yes	Yes
Kirby	Yes	Yes	Yes
Leon Valley	Yes	Yes	Yes
Live Oak	Yes	Yes	Yes
San Antonio	Yes	Yes	Yes
Selma	Yes	Yes	Yes
Shavano Park	Yes	Yes	Yes
Somerset	Yes	No	No
Terrell Hills	Yes	Yes	Yes
Universal City	Yes	Yes	Yes
Windcrest	Yes	Yes	Yes
Comal	Yes	Yes	Yes
Garden Ridge	Yes	Yes	Yes
New Braunfels	Yes	Yes	Yes
Guadalupe	Yes	Yes	Yes
Cibolo	Yes	Yes	Yes
Marion	Yes	Yes	No
Schertz	Yes	Yes	Yes
Seguin	Yes	Yes	Yes
	SHERMAN-DENISON MSA		
Grayson	Yes	Yes	No
Bells	Yes	No	No
Collinsville	No	No	No

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
SHERMAN-DENISON MSA (continued)			
Grayson (continued)			
Denison	Yes	Yes	Yes
Dorchester	Yes	No	No
Gunter	Yes	No	No
Howe	Yes	No	No
Sadler	Yes	No	No
Sherman	Yes	Yes	Yes
Southmayd	Yes	No	No
Whitewright	Yes	Yes	No
	TEXARKANA MSA		
Bowie	Yes	Yes	No
Hooks	Yes	Yes	No
Leary	Yes	No	No
Maud	Yes	Yes	Yes
Nash	Yes	Yes	Yes
New Boston	Yes	Yes	Yes
Texarkana	Yes	Yes	Yes
Wake Village	Yes	Yes	No
	TYLER MSA		
Smith	Yes	No	Yes
Bullard	Yes	Yes	Yes
Troup	Yes	Yes	Yes
Tyler	Yes	Yes	Yes
Whitehouse	Yes	Yes	Yes
Winoa	Yes	No	No
	VICTORIA MSA		
Victoria	Yes	Yes	No
Victoria	Yes	Yes	Yes
	WACO MSA		
McLennan	Yes	Yes	Yes
Bellmead	Yes	Yes	Yes
Beverly Hills	Yes	Yes	Yes

County/City Designated by FEMA	Published Flood Hazard Boundary Map Available	Adopted Floodplain Management Program	Detailed Flood Insurance Rate Studies Completed as of 12/1/84
WACO MSA (continued)			
McLennan (continued)			
Bruceville-Eddy	Yes	No	Yes
Crawford	No	No	No
Gholson	Yes	No	No
Golinda	Yes	No	No
Hallsburg	Yes	No	No
Hewitt	Yes	Yes	Yes
Lacy-Lakeview	Yes	Yes	Yes
Leroy	Yes	Yes	Yes
Lorena	Yes	Yes	Yes
Mart	Yes	Yes	Yes
McGregor	Yes	Yes	Yes
Moody	Yes	No	No
Northcrest	Yes	Yes	No
Riesel	Yes	No	No
Robinson	Yes	Yes	Yes
Ross	Yes	No	No
Waco	Yes	Yes	Yes
Woodway	Yes	Yes	Yes
	WICHITA FALLS MSA		
Wichita	Yes	Yes	Yes
Burkburnett	Yes	Yes	Yes
Electra	No	Yes	No
Iowa Park	Yes	Yes	Yes
Pleasant Valley	Yes	Yes	Yes
Wichita Falls	Yes	Yes	Yes