Water Distribution System Master Plan Update

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Prepared for

City of San Angelo

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1. EXECUTIVE SUMMARY

1.1 Scope of Study

This report presents the results of a study of the City of San Angelo's water distribution system. The purpose of the study is to determine what water system improvements are necessary to better serve present water demands, as well as future growth. The scope of services for this study includes the following:

1. Utilize Concho Valley Council of Governments (CVCOG) data and City of San Angelo land use maps to distribute population throughout the City.

2. Review records of water consumption to determine existing and projected 2005 and 2020 water demands.

3. Prepare and calibrate CYBERNET computer model to simulate the operation of the existing water distribution system to determine system deficiencies.

4. Utilize the CYBERNET computer model to evaluate the performance and determine the necessary water system improvements for year 2005 and 2020 growth conditions

5. Develop capital improvement plan for the water distribution system including project costs and recommended in-service dates.

1.2 Summary and Recommendations

The projected year 2005 and 2020 populations for the City of San Angelo are 102,275 and 119,200 respectively. These population projections represent a 26.7% increase in the City of San Angelo's population over the next two decades. This report describes the necessary water system improvements to meet existing deficiencies and to adequately serve this projected growth. In 1998, the City of San Angelo's maximum day water demand was approximately 42.8 MGD. The City of San Angelo's water distribution system is divided into lower and upper pressure

planes.

Table 1.1 presents a summary of projected populations and water demands for each of the planning periods studied. Presently the lower pressure plane accounts for approximately 94% of the total maximum day water demand. It is recommended that a portion of the current lower plane be moved into the upper pressure plane within the next 5 years to allow the City to maximize existing and future storage facilities. The change in the pressure plane boundary will reduce the lower plane's service area to approximately 62% of the total maximum day demand.

Table 1.1
City of San Angelo
Summary of Projected Water Demands

Year	Population	Average Day Water Demand (MGD)	Maximum Day Water Demand (MGD)	Peak Hour Water Demand (MGD)	Tank Refilling Water Demand (MGD)
1998	94,066	19.0	42.8	85.7	9.5
2005	102,275	21.6	48.6	97.1	10.8
2020	119,200	26.7	60.1	120.3	13.4

The immediate improvements for the water distribution system from 1998 through 2000 include the construction of additional elevated storage in the lower pressure plane and increased water transmission capacity to the Southwest tank and pump station. It is recommended that a new 1.25 million gallon elevated tank be constructed in the northern part of the city as shown in Plate 5 to provide additional elevated storage to the lower pressure plane. It is recommended that a new 36-inch/30-inch water transmission line be constructed in two phases from the water treatment plant to the location on an existing 36-inch supply line along Loop 306. The first phase

would consist of a 30-inch transmission line from the intersection of Loop 306 and College Hills Boulevard to an existing 27-inch supply line along the Sante Fe Railroad. The second phase of the transmission line from the Sante Fe Railroad to the water treatment plant should be constructed shortly after 2000. It is also recommended that a standby diesel generator capable of operating two pumps on both the lower and upper side of the pump station be added at the Southwest pump station to improve system reliability for both the lower and upper pressure planes.

The water system improvements recommended from 2000 to 2005 include changing the pressure plane delineation between the lower plane (Central pressure plane) and the upper plane (Westside I pressure plane). Additional pumping and elevated storage will be needed to serve the new Westside I pressure plane. Ground storage tanks can be utilized for elevated storage if constructed on high enough ground above the tanks service area. The natural topography on the west side of San Angelo provides an excellent application for this concept. Therefore, it is recommended that a new 3.0 million gallon ground storage tank be constructed on high ground west of the City along with a new 36-inch transmission line to provide elevated storage for the new expanded Westside I pressure plane. This storage facility can also be utilized as pump station supply to serve the higher ground shown on Plate 5 as the Westside II pressure plane. Even though it is not required, a larger 4.0 MG tank might be considered to take more advantage of the lower cost elevated storage. Alternate bids can be taken for a 4.0 MG and 5.0 MG tank to determine if the additional cost warrants the larger tank. It will also be necessary to expand the pumping capacity of the upper plane side of the Southwest and Abilene booster pump station to serve increased demand in this pressure plane. Additional water system improvements for 2000

to 2005 are listed in section 6.2.

The long term water system improvements beyond 2005 will include water treatment plant and high service pumping expansion. It is also recommended that a 0.5 million gallon elevated storage tank be constructed in the northeast part of the City to serve increased growth in the lower pressure plane. Additional water system improvements are listed in section 6.3. The projected costs for water system improvements from 1998 to 2020 are shown below in Table 1.2.

Table 1.2
City of San Angelo
Summary of Water Project Costs

Year 1998-2000	$3,158,640
Year 2000-2005	$10,647,360
Year 2005-2020	$7,961,280
Total	$21,767,280

2. POPULATION

2.1 Historical & Projected Population Growth

Population projection is an important element in the analysis of a water distribution system. Historical population data for the City of San Angelo were obtained from the Concho Valley Council of Governments (CVCOG) database for the year 1990. These 1990 populations as well as the projected populations for years 1998, 2005, 2010, and 2020 for the City of San Angelo are shown in Table 2.1.

Table 2.1
City of San Angelo
Historical and Projected Population Growth

Year	Population	Average Annual Growth Rate
1990	84,744	
1998	94,066	1.38%
2005	102,275	1.25%
2010	108,090	1.14%
2020	119,200	1.03%

The growth in the City is primarily occurring in the west and southwest side of the City. This trend will mean that the population of the upper (Westside I) pressure plane will increase at a faster rate than that of the lower (Central) pressure plane.

2.2 Population Distributions for Water and Wastewater Systems

Census tract information obtained from the CVCOG was utilized to allocate population

throughout the City of San Angelo. The CVCOG maintains existing and projected population databases of the City of San Angelo. There are 20 census tracts that occupy the area in and around the City of San Angelo. These census tracts and the existing water system are shown on Plate 1. The City's approximate population distribution by census tract for the 1990, 1998, 2005, 2010, and 2020 planning periods are shown in Table 2.2.

For the water system analysis, these census tracts were utilized as planning areas for distributing population growth. The census tracts and projected populations were divided into the lower and upper pressure planes of the water system, as shown in Table 2.3. After the change in pressure plane delineation, the approximate 1998 population of the lower and upper pressure planes are 56,030 and 38,036 respectively. The upper pressure plane will account for 40.4% of the total population in 1998. By the year 2020, it is projected that the lower and upper pressure plane populations will be 66,700 and 52,500 respectively. Under year 2020 projections, the upper pressure plane will account for approximately 44.0% of the total population of the City.

Table 2.2
Projected Population Distribution by Census Tract
City of San Angelo

Census Tract #	Estimated 1990 Population	Estimated 1998 Population	Projected 2005 Population	Projected 2010 Population	Projected 2020 Population
1	1,895	1,960	2,050	2,165	2,300
2	4,170	4,230	4,539	4,709	5,250
3	4,286	4,450	5,200	5,475	6,000
4	6,368	6,368	6,395	6,405	6,430
5	1,791	1,810	1,865	1,870	1,890
6	987	987	1,000	1,010	1,030
7	4,476	4,540	4,730	4,820	4,975
8	6,854	6,920	7,475	7,975	8,300
9	3,224	3,260	3,400	3,450	3,575
10	5,240	5,440	5,800	6,210	6,560
11.01	3,415	5,500	6,050	6,500	7,750
11.02	4,525	4,525	4,550	4,565	4,585
12	7,375	7,390	7,500	7,525	7,565
13.01	6,933	7,590	7,975	8,300	8,750
13.03	4,309	4,890	5,200	5,450	5,675
13.04	2,899	3,160	3,425	3,640	3,980
14	4,610	5,030	5,625	5,825	6,389
15	1,946	1,946	1,946	1,946	1,946
17.01	4,140	5,460	7,800	9,450	13,950
17.03	5,301	8,610	9,750	10,800	12,300
Total	84,744	94,066	102,275	108,090	119,200

Annual Population Growth

1990-1998	1.38%			
1998-2005		1.25%		
2005-2010			1.14%	
2010-2020				1.03%

Table 2.3
Population Distribution by Census Tract
for Upper and Lower Pressure Plane
City of San Angelo

Census Tract #	Estimated 1998 Population	Projected 2005 Population	Projected 2010 Population	Projected 2020 Population
		LOWER PRESSURE PLANE		
1	1,960	2,050	2,165	2,300
2	4,230	4,539	4,709	5,250
3	4,450	5,200	5,475	6,000
4	6,368	6,395	6,405	6,430
5	1,810	1,865	1,870	1,890
6	987	1,000	1,010	1,030
7	4,540	4,730	4,820	4,975
8	6,920	7,475	7,975	8,300
9	3,260	3,400	3,450	3,575
10	4,080	4,350	4,658	4,920
11.02	2,263	2,275	2,283	2,443
13.01	1,898	1,994	2,075	2,188
13.04	3,160	3,425	3,640	3,980
14	5,030	5,625	5,825	6,389
15	1,946	1,946	1,946	1,946
17.01	546	780	945	1,395
17.03	2,583	2,925	3,240	3,690
Total Lower Plane	56,030	59,974	62,490	66,700
		UPPER PRESSURE PLANE		
10	1,360	1,450	1,553	1,640
11.01	5,500	6,050	6,500	7,750
11.02	2,263	2,275	2,283	2,143
12	7,390	7,500	7,525	7,565
13.01	5,693	5,981	6,225	6,563
13.03	4,890	5,200	5,450	5,675
17.01	4,914	7,020	8,505	12,555
17.03	6,027	6,825	7,560	8,610
Total Upper Plane	38,036	42,301	45,600	52,500
Total City Population	94,066	102,275	108,090	119,200

3. WATER DEMANDS

The performance of the water distribution system was evaluated by simulating the following operating conditions: maximum day demands, peak hour demands, night time tank filling demands and maximum day demand with fire flows. These demands represent the range of extreme conditions that are typically encountered in water distribution systems. In addition to these various operating conditions, there are various industrial, commercial and domestic customers throughout the distribution system. The following section presents the existing and future water demands for the various conditions for each customer class.

3.1 Industrial and Commercial Water Demands

For 1998 the top fourteen industrial and commercial water customers accounted for 2.27 MGD, as shown in Table 3.1. The two major customers in the water distribution system are Goodfellow Air Force Base and Angelo State University. These two customers account for almost half of the total industrial and commercial water demands. Most of the current industrial demand is located in the lower pressure plane. With the shift in the pressure plane boundary, it is estimated that the upper pressure plane will have approximately 17.6% (0.40 MGD) of the total industrial and commercial demand of the City. By the year 2020, it is projected that the upper pressure plane will have 36.7% (1.2 MGD) of the industrial and commercial demand of the City. Industrial and commercial water demands for the upper and lower pressure planes are shown in Table 3.2.

Table 3.1
Existing Major Industrial and Commercial Water Customers
City of San Angelo

Customer	Average Day Water Usage (MGD)
Goodfellow Air Force Base	0.689
Angelo State University	0.381
Shannon St. Johns	0.206
Shannon Medical Center	0.190
Ethicon Inc.	0.182
Baptist Memorial Hospital	0.153
Columbia Hospital	0.116
San Angelo Packing Co.	0.114
Lone Star Beef	0.070
Rio Concho	0.053
Ranchers	0.042
Millersview Doole WSC	0.030
Holiday Inn	0.028
Bollman Industries	0.018
Total	2.272

Table 3.2 Projected Average Day Industrial and Commercial Water Demand City of San Angelo				
	1998	2005	2010	2020
Lower Plane	1.87 MGD	1.94 MGD	2.02 MGD	2.07 MGD
Upper Plane	0.40 MGD	0.58 MGD	0.76 MGD	1.20 MGD
Total	2.27 MGD	2.52 MGD	2.77 MGD	3.27 MGD

3.2 Domestic Water Demands

The existing domestic water demands were determined by subtracting the industrial and commercial water demands from the total water demands. Based on the historical records, as shown in Figure 3.1, it is recommended that 182 gallons per capita per day(gpcd) be used for the water distribution system for 1998. The resulting 1998 domestic water demand for the City is 16.8 MGD. The historical records water use data over the last five years indicate an increasing trend in the per capita water usage. There are two reasons for this trend. The first is weather conditions. 1993 was a wet year, while 1998 was a dry year. The second reason is the increase in the construction of new more expensive homes and commercial areas. New homes typically use more water through water sprinklers and modern appliances. The trend to a lesser extent is expected to continue over the next twenty years. The City will be making water conservation efforts, to reduce the per capita water usage. However, capital improvements are designed based on the worst case scenario. As a result, it is recommended that 190, 195, and 200 gpcd domestic water consumption rates be used for the 2005, 2010, and 2020 planning periods.

Figure 3.1
City of San Angelo
Projected Per Capita Water Usage

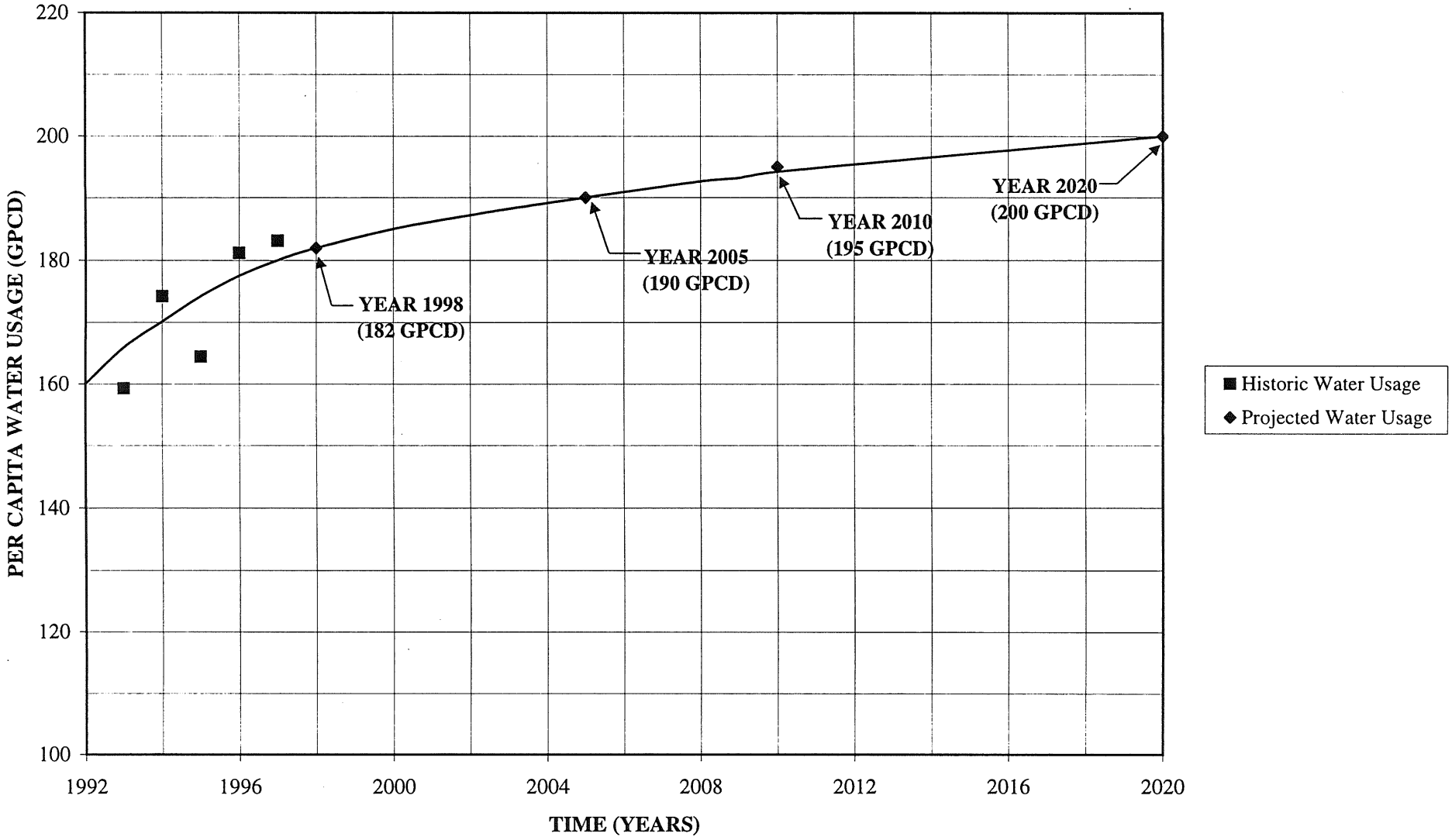

Table 3.3
Historical Maximum and Average Day Water Usage

Month/Year	Average Day Water Usage (MGD)	Max. Day Water Usage (MGD)
Jan., 1993	9.665	12.72
Feb., 1993	10.016	12.72
Mar., 1993	12.037	16.72
Apr., 1993	17.26	25.44
May, 1993	16.28	23.57
Jun., 1993	18.399	25.44
Jul., 1993	25.668	34.79
Aug., 1993	25.608	34.36
Sep., 1993	14.385	18.5
Oct., 1993	13.632	18.34
Nov., 1993	10.576	12.26
Dec., 1993	9.563	12.01
Overall Average	**15.257**	
Yearly Max. Day		**34.79**
Max. Day/Avg. Day Ratio		**2.28**
Jan., 1994	9.606	12.38
Feb., 1994	9.541	11.92
Mar., 1994	13.089	18.42
Apr., 1994	19.881	31.06
May, 1994	14.887	22.1
Jun., 1994	25.466	37.04
Jul., 1994	28.169	36.665
Aug., 1994	26.602	32.98
Sep., 1994	17.878	24.32
Oct., 1994	13.059	21.6
Nov., 1994	11.779	12.245
Dec., 1994	11.39	11.86
Overall Average	**16.779**	
Yearly Max. Day		**37.04**
Max. Day/Avg. Day Ratio		**2.21**
Jan., 1995	10.779	11.8
Feb., 1995	10.683	14.13
Mar., 1995	11.279	17.62
Apr., 1995	15.902	24.36
May, 1995	17.462	24.34
Jun., 1995	18.152	30.34
Jul., 1995	23.31	34.38
Aug., 1995	24.904	38.375
Sep., 1995	19.482	33.8

* Boxed Water Demands Represent Maximum Day Demand for Year

Table 3.3 (continued)
Historical Maximum and Average Day Water Usage

Month/Year	Average Day Water Usage (MGD)	Max. Day Water Usage (MGD)
Oct., 1995	16.007	18.6
Nov., 1995	12.47	18.6
Dec., 1995	12.755	17.982
Overall Average	**16.099**	
Yearly Max. Day		**38.375**
Max. Day/Avg. Day Ratio		**2.38**
Jan., 1996	12.645	17.76
Feb., 1996	14.832	20.08
Mar., 1996	16.073	28.805
Apr., 1996	17.87	24.44
May, 1996	24.937	38.6
Jun., 1996	23.542	32.67
Jul., 1996	30.002	34.3
Aug., 1996	21.666	32.18
Sep., 1996	16.553	23.61
Oct., 1996	16.345	20.42
Nov., 1996	12.569	14.4
Dec., 1996	11.999	13.66
Overall Average	**18.253**	
Yearly Max. Day		**38.6**
Max. Day/Avg. Day Ratio		**2.11**
Jan., 1997	13.202	21.32
Feb., 1997	13.481	19.88
Mar., 1997	13.772	19.66
Apr., 1997	14.731	24.45
May, 1997	17.867	27.116
Jun., 1997	20.156	30.085
Jul., 1997	30.786	35.84
Aug., 1997	25.835	35.74
Sep., 1997	24.361	29.92
Oct., 1997	18.881	26.92
Nov., 1997	16.131	23.68
Dec., 1997	13.728	18.467
Overall Average	**18.578**	
Yearly Max. Day		**35.84**
Max. Day/Avg. Day Ratio		**1.93**

Table 3.4
City of San Angelo Projected Water Demands for 1998

Census Tract #	Projected Population	Average[1] Day Demand (MGD)	(GPM)	Maximum[2] Day Demand (MGD)	(GPM)	Peak[3] Hour Demand (MGD)	(GPM)	Night Time Tank[4] Filling Demand (MGD)	(GPM)
1	1,960	0.357	248	0.803	557	1.605	1,115	0.178	124
2	4,230	0.770	535	1.732	1,203	3.464	2,406	0.385	267
3	4,450	0.810	562	1.822	1,265	3.645	2,531	0.405	281
4	6,368	1.159	805	2.608	1,811	5.215	3,622	0.579	402
5	1,810	0.329	229	0.741	515	1.482	1,029	0.165	114
6	987	0.180	125	0.404	281	0.808	561	0.090	62
7	4,540	0.826	574	1.859	1,291	3.718	2,582	0.413	287
8	6,920	1.259	875	2.834	1,968	5.667	3,936	0.630	437
9	3,260	0.593	412	1.335	927	2.670	1,854	0.297	206
10	5,440	0.990	688	2.228	1,547	4.455	3,094	0.495	344
11.01	5,500	1.001	695	2.252	1,564	4.505	3,128	0.501	348
11.02	4,525	0.824	572	1.853	1,287	3.706	2,574	0.412	286
12	7,390	1.345	934	3.026	2,102	6.052	4,203	0.672	467
13.01	7,590	1.381	959	3.108	2,158	6.216	4,317	0.691	480
13.03	4,890	0.890	618	2.002	1,391	4.005	2,781	0.445	309
13.04	3,160	0.575	399	1.294	899	2.588	1,797	0.288	200
14	5,030	0.915	636	2.060	1,430	4.120	2,861	0.458	318
15	1,946	*							
17.01	5,460	0.994	690	2.236	1,553	4.472	3,105	0.497	345
17.03	8,610	1.567	1,088	3.526	2,448	7.052	4,897	0.784	544
Subtotal	94,066	16.766	11,643	37.723	26,197	75.446	52,393	8.383	5,821
Existing Industrial & Commercial Customers		2.272	1,578	5.112	3,550	10.224	7,100	1.136	789
TOTAL		19.038	13,221	42.835	29,747	85.670	59,493	9.519	6,610

(1) Average day demand is based on projected population and 182 gallons per day per capita water usage.

(2) Maximum day demand is projected as 2.25 times the average day demand.

(3) Peak hour demand is projected as 2.0 times the maximum day demand.

(4) Night time tank filling is projected as 0.5 times the average day demand.

* All flow from Tract 15 is from Goodfellow Air Force Base which is included in the industrial flow.

Table 3.5
City of San Angelo Projected Water Demands for 2005

Census Tract #	Projected Population	Average[1] Day Demand (MGD)	(GPM)	Maximum[2] Day Demand (MGD)	(GPM)	Peak[3] Hour Demand (MGD)	(GPM)	Night Time Tank[4] Filling Demand (MGD)	(GPM)
1	2,050	0.390	270	0.876	609	1.753	1,217	0.195	135
2	4,539	0.862	599	1.940	1,348	3.881	2,695	0.431	299
3	5,200	0.988	686	2.223	1,544	4.446	3,088	0.494	343
4	6,395	1.215	844	2.734	1,899	5.468	3,797	0.608	422
5	1,865	0.354	246	0.797	554	1.595	1,107	0.177	123
6	1,000	0.190	132	0.428	297	0.855	594	0.095	66
7	4,730	0.899	624	2.022	1,404	4.044	2,808	0.449	312
8	7,475	1.420	986	3.196	2,219	6.391	4,438	0.710	493
9	3,400	0.646	449	1.454	1,009	2.907	2,019	0.323	224
10	5,800	1.102	765	2.480	1,722	4.959	3,444	0.551	383
11.01	6,050	1.150	798	2.586	1,796	5.173	3,592	0.575	399
11.02	4,550	0.865	600	1.945	1,351	3.890	2,702	0.432	300
12	7,500	1.425	990	3.206	2,227	6.413	4,453	0.713	495
13.01	7,975	1.515	1,052	3.409	2,368	6.819	4,735	0.758	526
13.03	5,200	0.988	686	2.223	1,544	4.446	3,088	0.494	343
13.04	3,425	0.651	452	1.464	1,017	2.928	2,034	0.325	226
14	5,625	1.069	742	2.405	1,670	4.809	3,340	0.534	371
15	1,946	*							
17.01	7,800	1.482	1,029	3.335	2,316	6.669	4,631	0.741	515
17.03	9,750	1.853	1,286	4.168	2,895	8.336	5,789	0.926	643
Subtotal	102,275	19.063	13,238	42.891	29,785	85.781	59,570	9.531	6,619
Existing Industrial & Commercial Customers		2.272	1,578	5.112	3,550	10.224	7,100	1.136	789
Industrial & Commercial Growth		0.250	174	0.563	391	1.125	781	0.125	87
TOTAL		21.585	14,989	48.565	33,726	97.130	67,452	10.792	7,495

(1) Average day demand is based on projected population and 190 gallons per day per capita water usage.

(2) Maximum day demand is projected as 2.25 times the average day demand.

(3) Peak hour demand is projected as 2.0 times the maximum day demand.

(4) Night time tank filling is projected as 0.5 times the average day demand.

* All flow from Tract 15 is from Goodfellow Air Force Base which is included in the industrial flow.

Table 3.6
City of San Angelo Projected Water Demands for 2010

Census Tract #	Projected Population	Average[1] Day Demand (MGD)	(GPM)	Maximum[2] Day Demand (MGD)	(GPM)	Peak[3] Hour Demand (MGD)	(GPM)	Night Time Tank[4] Filling Demand (MGD)	(GPM)
1	2,165	0.422	293	0.950	660	1.900	1,319	0.211	147
2	4,709	0.918	638	2.066	1,435	4.132	2,870	0.459	319
3	5,475	1.068	741	2.402	1,668	4.804	3,336	0.534	371
4	6,405	1.249	867	2.810	1,952	5.620	3,903	0.624	434
5	1,870	0.365	253	0.820	570	1.641	1,140	0.182	127
6	1,010	0.197	137	0.443	308	0.886	615	0.098	68
7	4,820	0.940	653	2.115	1,469	4.230	2,937	0.470	326
8	7,975	1.555	1,080	3.499	2,430	6.998	4,860	0.778	540
9	3,450	0.673	467	1.514	1,051	3.027	2,102	0.336	234
10	6,210	1.211	841	2.725	1,892	5.449	3,784	0.605	420
11.01	6,500	1.268	880	2.852	1,980	5.704	3,961	0.634	440
11.02	4,565	0.890	618	2.003	1,391	4.006	2,782	0.445	309
12	7,525	1.467	1,019	3.302	2,293	6.603	4,586	0.734	510
13.01	8,300	1.619	1,124	3.642	2,529	7.283	5,058	0.809	562
13.03	5,450	1.063	738	2.391	1,661	4.782	3,321	0.531	369
13.04	3,640	0.710	493	1.597	1,109	3.194	2,218	0.355	246
14	5,825	1.136	789	2.556	1,775	5.111	3,550	0.568	394
15	1,946	*							
17.01	9,450	1.843	1,280	4.146	2,879	8.292	5,759	0.921	640
17.03	10,800	2.106	1,463	4.739	3,291	9.477	6,581	1.053	731
Subtotal	108,090	20.698	14,374	46.571	32,341	93.141	64,682	10.349	7,187
Existing Industrial & Commercial Customers		2.272	1,578	5.112	3,550	10.224	7,100	1.136	789
Industrial & Commercial Growth		0.500	347	1.125	781	2.250	1,563	0.250	174
TOTAL		23.470	16,299	52.808	36,672	105.615	73,344	11.735	8,149

(1) Average day demand is based on projected population and 195 gallons per day per capita water usage.

(2) Maximum day demand is projected as 2.25 times the average day demand.

(3) Peak hour demand is projected as 2.0 times the maximum day demand.

(4) Night time tank filling is projected as 0.5 times the average day demand.

* All flow from Tract 15 is from Goodfellow Air Force Base which is included in the industrial flow.

Table 3.7
City of San Angelo Projected Water Demands for 2020

Census Tract #	Projected Population	Average[1] Day Demand (MGD)	(GPM)	Maximum[2] Day Demand (MGD)	(GPM)	Peak[3] Hour Demand (MGD)	(GPM)	Night Time Tank[4] Filling Demand (MGD)	(GPM)
1	2,300	0.460	319	1.035	719	2.070	1,438	0.230	160
2	5,250	1.050	729	2.363	1,641	4.725	3,281	0.525	365
3	6,000	1.200	833	2.700	1,875	5.400	3,750	0.600	417
4	6,430	1.286	893	2.894	2,009	5.787	4,019	0.643	447
5	1,890	0.378	263	0.851	591	1.701	1,181	0.189	131
6	1,030	0.206	143	0.464	322	0.927	644	0.103	72
7	4,975	0.995	691	2.239	1,555	4.478	3,109	0.498	345
8	8,300	1.660	1,153	3.735	2,594	7.470	5,188	0.830	576
9	3,575	0.715	497	1.609	1,117	3.218	2,234	0.358	248
10	6,560	1.312	911	2.952	2,050	5.904	4,100	0.656	456
11.01	7,750	1.550	1,076	3.488	2,422	6.975	4,844	0.775	538
11.02	4,585	0.917	637	2.063	1,433	4.127	2,866	0.459	318
12	7,565	1.513	1,051	3.404	2,364	6.809	4,728	0.757	525
13.01	8,750	1.750	1,215	3.938	2,734	7.875	5,469	0.875	608
13.03	5,675	1.135	788	2.554	1,773	5.108	3,547	0.568	394
13.04	3,980	0.796	553	1.791	1,244	3.582	2,488	0.398	276
14	6,389	1.278	887	2.875	1,997	5.750	3,993	0.639	444
15	1,946	*							
17.01	13,950	2.790	1,938	6.278	4,359	12.555	8,719	1.395	969
17.03	12,300	2.460	1,708	5.535	3,844	11.070	7,688	1.230	854
Subtotal	119,200	23.451	16,285	52.764	36,642	105.529	73,284	11.725	8,143
Existing Industrial & Commercial Customers		2.272	1,578	5.112	3,550	10.224	7,100	1.136	789
Industrial & Commercial Growth		1.000	694	2.250	1,563	4.500	3,125	0.500	347
TOTAL		26.723	18,558	60.126	41,754	120.253	83,509	13.361	9,279

(1) Average day demand is based on projected population and 200 gallons per day per capita water usage.

(2) Maximum day demand is projected as 2.25 times the average day demand.

(3) Peak hour demand is projected as 2.0 times the maximum day demand.

(4) Night time tank filling is projected as 0.5 times the average day demand.

* All flow from Tract 15 is from Goodfellow Air Force Base which is included in the industrial flow.

Review of the City of San Angelo's water records yielded a maximum day to average day peaking factor of 2.25. The historical water usage record are shown on Table 3.3. The resulting 1998 maximum day domestic water demand is 37.7 MGD as shown on Table 3.4. The projected maximum day domestic water demands for 2005, 2010, and 2020 are 42.9 MGD, 46.6 MGD, and 52.8 MGD respectively as shown in Tables 3.5-3.7. The maximum day demand condition is typically used to size pumping stations and ground storage facilities.

From previous studies, a peak hour to maximum day peaking factor of 2.0 has shown to be representative for cities of San Angelo's size. The resulting 1998 peak hour domestic water demand is 75.4 MGD. The projected peak hour domestic water demands for 2005, 2010, and 2020 are 85.8 MGD, 93.1 MGD, and 105.5 MGD respectively. The peak hour demand condition is typically used to size the distribution piping, and elevated storage facilities.

A night time filling demand condition was examined to determine the water distribution system's capability to adequately refill elevated and ground storage tanks during low water use periods without overpressurizing the water system. The night time system demand has been estimated at half of the average day demand. The resulting 1998 night time tank filling domestic water demand is 8.4 MGD. The projected night time filling domestic water demands for 2005, 2010, and 2020 are 9.5 MGD, 10.3 MGD, and 11.7 MGD respectively.

A fourth demand condition examined for this study is fire flow demand. Regulatory requirements dictate that a water distribution system shall be capable of providing fire flow demands during a time in which the water distribution system is experiencing a maximum day demand. It is recommended that a 1,500 gallons per minute (gpm) residential fire flow and a

3,000 gpm commercial fire flow be used for the city of San Angelo for master planning purposes.

3.3 Total Water System Demands

The total water system demands are the combination of industrial and commercial demands and domestic demands. The resulting total water system demands for various demand conditions for 1998, 2005, 2010, and 2020 are shown in Table 3.8. The 1998 total water system maximum day demand is estimated at 42.8 MGD. The projected total maximum day water demands for 2005, 2010, and 2020 are 48.6 MGD, 52.8 MGD, and 60.1 MGD respectively. It is projected that the upper pressure plane's water demand will grow at a faster rate than that of the lower plane.

Table 3.8
City of San Angelo
Projected Total Water Demands for Various Operating Conditions

1998				
	Avg. Day Demand	Max. Day Demand	Peak Hour Demand	Tank Filling Demand
Lower	11.7	26.4	52.7	5.9
Upper	7.3	16.5	32.9	3.7
Total	19.0	42.8	85.7	9.5
2005				
	Avg. Day Demand	Max. Day Demand	Peak Hour Demand	Tank Filling Demand
Lower	13.0	29.2	58.4	6.5
Upper	8.6	19.4	38.8	4.3
Total	21.6	48.6	97.2	10.8
2010				
	Avg. Day Demand	Max. Day Demand	Peak Hour Demand	Tank Filling Demand
Lower	13.8	31.1	62.2	6.9
Upper	9.7	21.7	43.4	4.8
Total	23.5	52.8	105.6	11.7
2020				
	Avg. Day Demand	Max. Day Demand	Peak Hour Demand	Tank Filling Demand
Lower	15.0	33.8	67.6	7.5
Upper	11.7	26.3	52.7	5.9
Total	26.7	60.1	120.2	13.4