

CHAPTER THREE:
WATER DEMAND
AND SUPPLY

3.1 INTRODUCTION

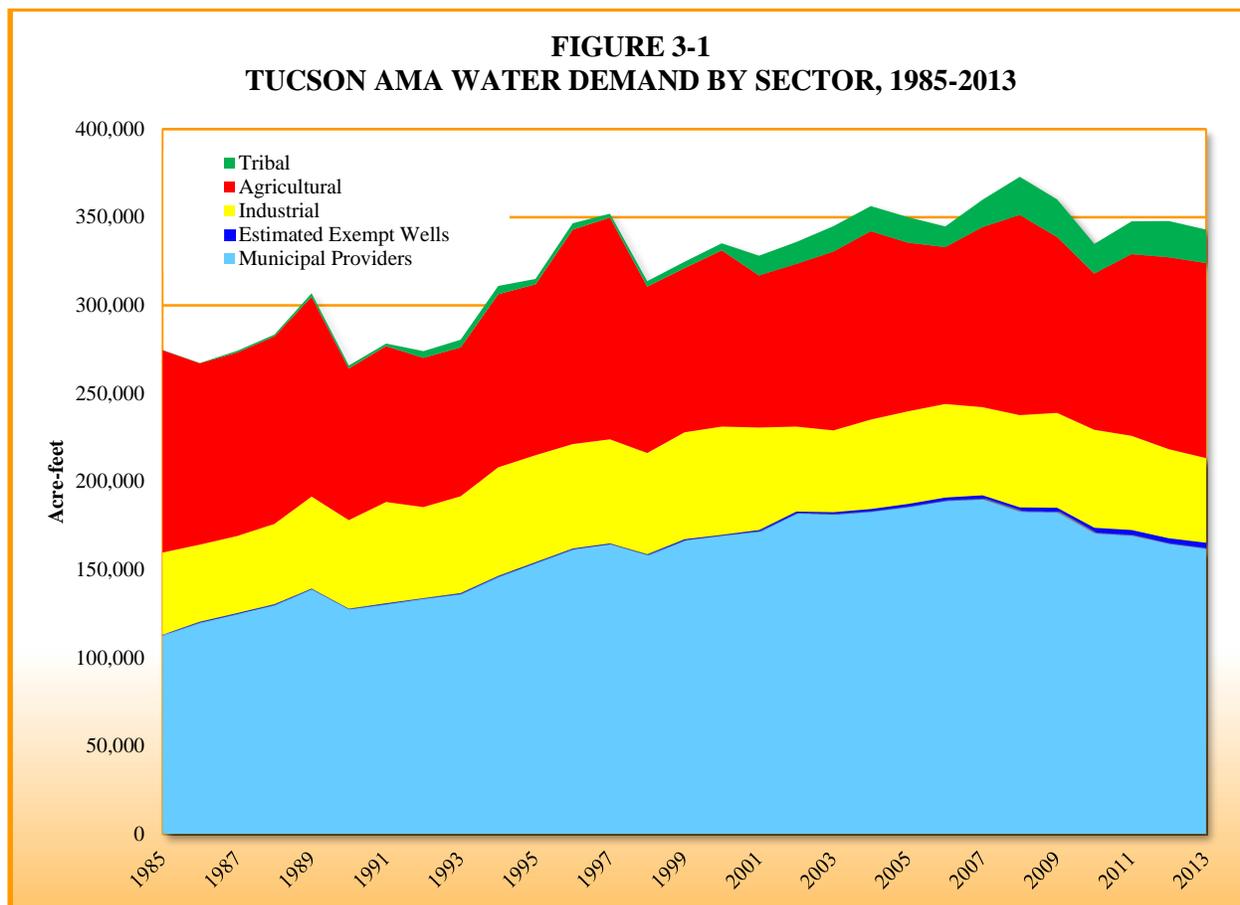
The Arizona Department of Water Resources (ADWR) conducted the *Demand and Supply Assessment 1985-2025, Tucson Active Management Area* (Assessment) in 2010 (See: <http://www.azwater.gov/AzDWR/WaterManagement/Assessments/default.htm>) (ADWR, 2010), as preparation for this *Fourth Management Plan for Tucson Active Management Area* (4MP). Chapter 3 of the 4MP updates the data included in the Assessment and analyzes and identifies the implications of that data.

Until Central Arizona Project (CAP) water became available in the mid-1990s, water users in the Tucson AMA (TAMA) relied almost exclusively on groundwater. A small volume of reclaimed water was used in the municipal and agricultural sectors and a very small volume of surface water was used in the industrial sector. Underground storage and recovery began in 1993. For a detailed overview of the geography, hydrology, climate and environmental conditions in the TAMA, refer to the *Arizona Water Atlas, Volume 8, Active Management Area Planning Area* (ADWR, 2010) (See: <http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/ActiveManagementAreas/default.htm>).

The proportion of water demand among the sectors shifted between 1985 and 2013. Demand from the municipal sector, comprised of large and small municipal water providers, increased from 41 percent of the total TAMA demand in 1985 to 47 percent in 2013. Due primarily to the fluctuation in commodity prices associated with mining operations, industrial sector demand fluctuated between approximately 15 and 20 percent of the total TAMA demand. Agricultural sector demand declined from 42 percent in 1985 to approximately 32 percent in 2013. Tribal demand, which is composed of municipal, industrial and agricultural demand on tribal reservations, increased from less than one percent in 1985 to six percent by 2013, primarily due to increased agriculture. Exempt wells accounted for approximately one percent of the total TAMA water demand in 2013.

Historically, water users in the TAMA relied heavily on groundwater. Over the past 30 years, utilization of renewable supplies has increased significantly. Although groundwater remains the primary source of supply for water users in the TAMA, the use of reclaimed water and CAP water is increasing. The City of Tucson (Tucson Water), the largest water user in the TAMA, began receiving direct delivery of CAP water in 1992. Peak direct delivery occurred in 1993. Treatment and delivery issues caused Tucson Water to cease direct delivery of CAP in 1994 and shift its use of CAP via recharge and recovery of CAP in the TAMA. Agricultural and industrial water users are also increasingly taking advantage of indirect utilization of CAP water and/or reclaimed water.

Figure 3-1 illustrates the trend of water demand by sector in the TAMA. Table 3-1(A) and Table 3-1(B) list the data for municipal, industrial, agricultural and tribal water use within the TAMA from 1985 through 2013, as well as estimated water use from private, domestic wells for the same period. In Table 3-1(A), municipal water use includes water delivered for non-irrigation uses by a city, town, private water company or irrigation district. Municipal demand is composed of the large municipal provider and small municipal provider subsectors. Turf-related facilities, which have their own conservation requirements under the management plan, are included in the large and small municipal provider demand category if they receive water from a municipal provider. Note that for purposes of categorizing water demand in the Assessment, ADWR included estimated water demand associated with domestic exempt wells in the municipal demand category. However, for the 4MP, ADWR is showing estimated exempt well demand as a separate category of use. An exempt well is a well with a pump capacity of 35 gallons per minute or less; ADWR has no regulatory authority over water withdrawn from exempt wells. In general, industrial users withdraw water



from their own wells that are associated with Type 1 and Type 2 non-irrigation grandfathered groundwater rights, General Industrial Use (GIU) groundwater withdrawal permits or other withdrawal permits. In the TAMA, industrial demand is composed of the following subsectors: mining, turf, sand and gravel, electric power, dairy, feedlot, de-watering and other uses. Agricultural demand is composed of the use of water by Irrigation Grandfathered Groundwater Rights (IGFRs) for agricultural uses not on tribal land, as well as the lost and unaccounted for water associated with the delivery of agricultural water. Agricultural demand equates to use of water to irrigate two or more acres of land to produce crops or feed. Tribal demand is composed of municipal, industrial and agricultural demand on tribal land. Tribal water use is exempt from state regulation; however, it is included in ADWR water budgets because of the physical impacts on the aquifer.

Municipal demand has been gradually increasing in the TAMA since 1985, peaking in 2007. The reduction in municipal demand in subsequent years may be due, at least in part, to the economic downturn; however, data from the Central Arizona Groundwater Replenishment District (CAGR) and Annual Water Withdrawal & Use Reports for large municipal providers with service areas comprised mostly of post-2000 housing stock indicates that the water demand of new homes is much less water than older homes, and less than the Third Management Plan (3MP) models for new residential development. Studies have also found passive water conservation (replacement of old fixtures and appliances with new more efficient ones) generated significant per capita use reductions. Increased efficiency of use has been observed in all water use sectors in the TAMA over time.

TABLE 3-1(A)
TUCSON AMA WATER DEMAND, 1985-2013 (ac-ft)
MUNICIPAL, EXEMPT WELLS & INDUSTRIAL

Year	Municipal				Exempt Wells	Industrial				
	Ground water	CAP Water	Reclaimed Water	Surface Water	Ground water	Ground water	In-lieu Ground water	CAP Water	Reclaimed Water	Surface Water
1985	112,655				425	45,896				720
1986	119,974				436	42,905				930
1987	124,837				447	42,770				934
1988	126,522		3,449		458	45,024				395
1989	134,587		4,263		470	51,990				178
1990	123,164		4,290		482	50,121				
1991	125,351		5,131		495	57,337				
1992	120,231	7,840	5,360		507	51,434			56	
1993	86,805	43,918	5,441		520	54,902			63	
1994	119,771	20,676	5,590		534	61,350			92	
1995	147,215		6,525		547	60,500			89	
1996	153,178		8,288		562	59,054			83	
1997	155,827		8,511		576	58,968			78	
1998	149,513		8,722		591	57,440				
1999	156,768		9,807		606	60,582			248	
2000	158,984	69	10,189		621	60,952		209	108	
2001	143,329	17,378	10,881		854	56,435		1,624	132	
2002	151,029	19,047	11,784		1,087	47,941			216	
2003	119,129	49,659	12,227	233	1,320	45,271		160	533	400
2004	105,553	64,340	12,744	173	1,554	49,622		178	565	400
2005	100,792	71,132	13,453	188	1,787	51,116		175	732	400
2006	100,641	72,179	15,947	210	2,020	51,665		135	883	400
2007	72,907	99,118	17,456	413	2,253	48,404	1,028		617	
2008	69,778	94,220	18,167	585	2,486	49,576	2,460		430	
2009	47,412	114,874	20,179		2,719	45,017	8,240		545	
2010	40,327	114,811	15,421	12	3,124	47,496	7,680		525	
2011	39,335	113,978	15,958	14	3,202	43,750	8,995	82	547	
2012	35,930	112,279	16,259	14	3,282	42,990	7,036	81	531	
2013	38,681	108,135	15,084	17	3,364	40,612	6,547	451	411	

NOTE: The columns above for Groundwater include remediated groundwater withdrawn and treated pursuant to a remedial action.

Although municipal demand has increased since 1985, beginning in 2000 the proportion of the demand met with groundwater has decreased as CAP storage and recovery have been actively pursued. Reclaimed water use has also steadily increased in the municipal sector. Industrial demand has historically been dominated by groundwater use, although reclaimed use also shows a steady increase in the industrial sector. Both the municipal and industrial sectors show small volumes of surface water use; however, there are no surface water reservoirs in the TAMA as exist in the Phoenix AMA (PHXAMA) and the Prescott AMA (PRAMA). Surface water displayed in Tables 3-1(A) and 3-1(B) reflects information reported by water users.

Agricultural water use in Table 3-1(B) includes water deliveries by the Cortaro-Marana Irrigation District as well as groundwater withdrawals pursuant to individual IGFR holders. In-lieu Groundwater is CAP water

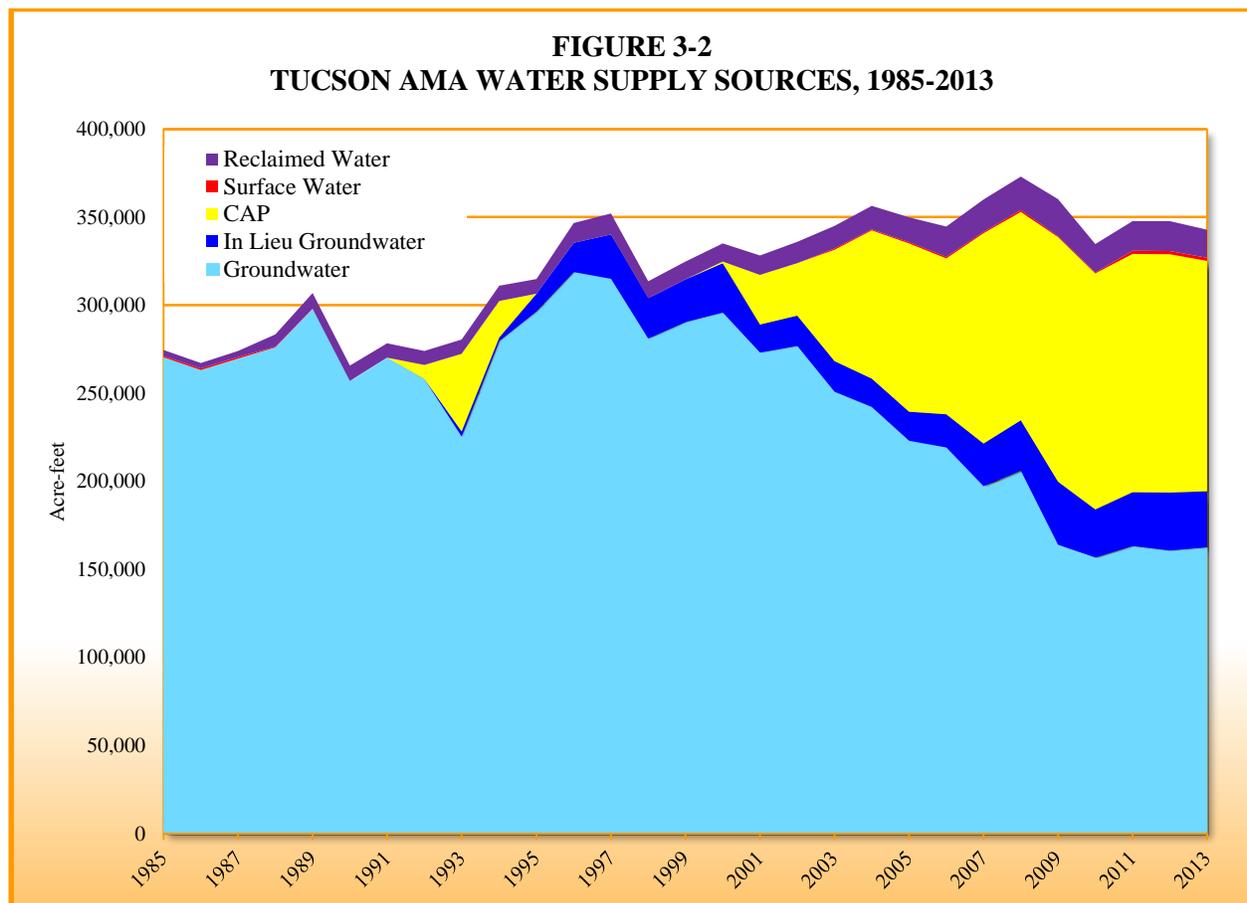
delivered to Groundwater Savings Facilities (GSFs). This water is referred to as in-lieu because the farmers use the CAP water in-lieu of pumping groundwater, which results in a groundwater savings. This savings is accounted for as a stored water credit (long-term or annual) for the entity which supplied the CAP water to the farmer. In-lieu water counts as groundwater in the farmer's flexibility account, which determines his compliance with his IGFR annual groundwater allotment. In-lieu groundwater is counted as groundwater in the calculation of overdraft. GSFs are discussed further in Chapter 8, titled Underground Water Storage, Savings & Replenishment. Tribal demand includes municipal, industrial and agricultural purposes. Beginning in the year 2000, CAP water has been used for tribal agricultural demand.

TABLE 3-1 (B)
TUCSON AMA WATER DEMAND, 1985-2013 (ac-ft)
AGRICULTURAL & TRIBAL

Year	Agricultural						Tribal	
	Ag. Allotment	Ground water	In-lieu Ground water	CAP Water	Reclaimed Water	Surface Water	Ground water	CAP Water
1985	212,718	111,333			3,546		72	
1986	214,227	99,808			3,102		75	
1987	214,645	100,874			3,420		810	
1988	214,359	103,104			3,572		902	
1989	213,742	108,808			4,518		2,091	
1990	215,192	81,843			4,375		1,516	
1991	214,133	85,461			3,047		1,557	
1992	209,327	82,208			2,629		3,800	
1993	209,724	78,915	2,900		2,684		4,349	
1994	204,819	93,176	2,014		3,056		4,786	
1995	169,053	85,005	10,137		1,801		3,089	
1996	169,788	102,497	16,661		2,676		3,566	
1997	170,957	97,525	25,095		3,199		2,210	
1998	168,253	70,490	22,924		980		2,988	
1999	164,310	68,782	24,289				3,675	
2000	156,876	72,033	27,973				3,258	702
2001	157,853	70,333	15,998				2,083	9,157
2002	162,701	75,223	17,085				1,626	10,882
2003	162,935	84,301	17,342				933	13,408
2004	162,271	83,900	16,113	6,950			1,507	12,752
2005	165,325	68,458	16,400	10,990			941	13,365
2006	159,792	64,040	18,794	5,450	270	419	984	10,635
2007	161,438	73,558	23,219	4,635	287	425	165	15,484
2008	158,875	84,038	26,176	2,635	274	507	170	21,476
2009	157,875	68,745	27,544	2,635	281	533	175	21,243
2010	157,931	65,674	19,502	2,635	251	524	180	16,617
2011	159,215	76,868	21,473	2,635	251	1,877	187	18,561
2012	157,744	78,425	25,728	2,635	184	1,875	194	20,323
2013	154,810	80,553	25,356	2,635	268	1,857	201	18,702

NOTE: Tribal groundwater is for municipal/domestic purposes and is estimated assuming 57 GPCD and the growth rate between the 2000 and 2010 Census population. Tribal agricultural demand equals the reported delivery of CAP water to the districts of the TON that are within the TAMA.

Figure 3-2 shows the sources of supply used to meet demand by all the sectors in the TAMA during the historical period from 1985-2013. Municipal groundwater demand declined significantly over the historical period as use of CAP water and reclaimed water increased. The industrial sector groundwater demand has fluctuated, but remained within the range of about 42,000 to 61,000 ac-ft per year. Industrial reclaimed water has increased over the historical period and some CAP in-lieu use has occurred in recent years. TAMA agricultural groundwater demand has also fluctuated over time but appears to be generally decreasing. Agricultural CAP in-lieu and direct CAP use, after an initial ramp-up, have been fairly stable for many years. Tribal groundwater demand increased through the year 1994, and then steadily declined while CAP use increased.



3.2 OVERVIEW OF DEMAND AND SUPPLY BY WATER USE SECTOR

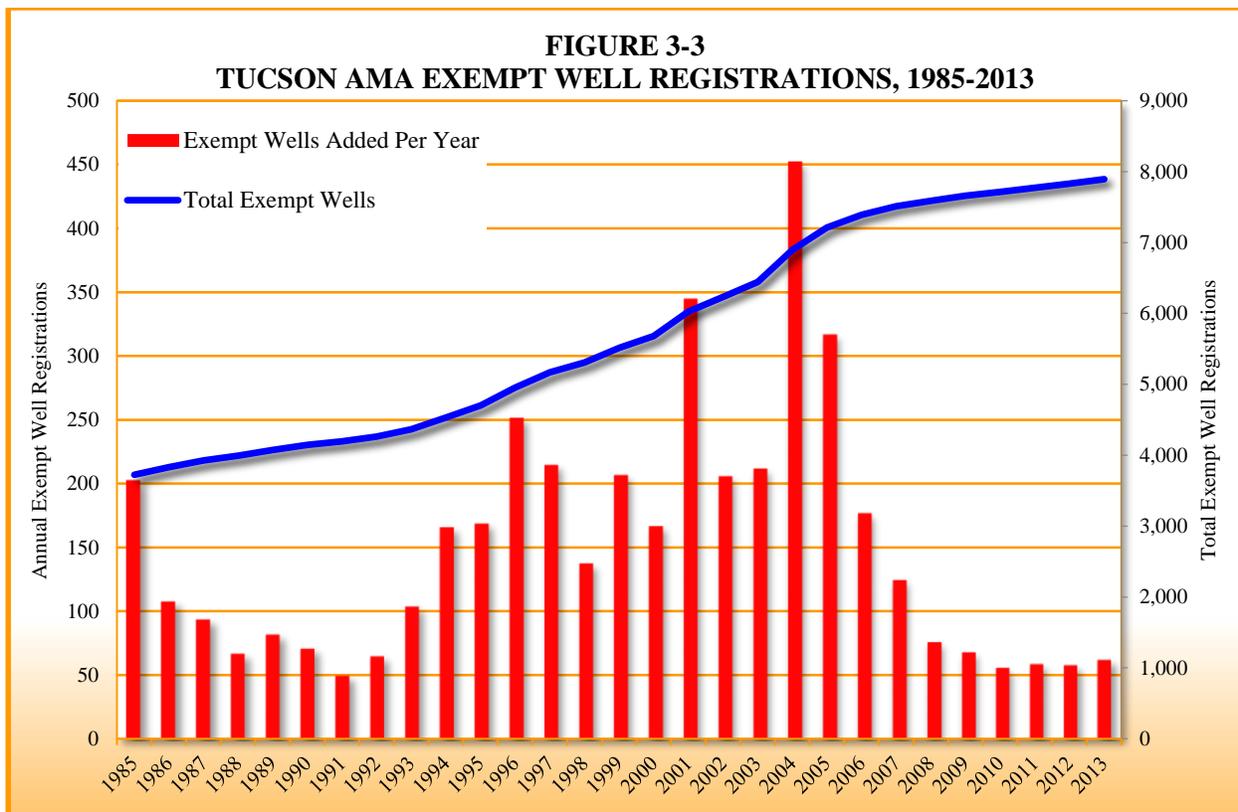
3.2.1 Municipal Sector

The TAMA includes portions of Pima, Santa Cruz and Pinal Counties. Incorporated cities and their 2010 Census populations include Tucson (520,116), South Tucson (5,652), Marana (34,961), Oro Valley (41,011) and Sahuarita (25,259). It is important to note that the incorporated area population and the population of the water service area do not precisely correspond. Some municipalities serve outside their municipal boundary, and some municipalities are served by one or more private water companies rather than solely by a municipal entity. The TAMA 2010 Census population within unincorporated areas of the three counties totaled approximately 354,000 people. Part of the Schuk Toak District and the entire San

Xavier District of the Tohono O’odham Nation are located within the TAMA boundary, as are the Pascua Yaqui tribal lands. However, these tribal lands are not under the jurisdiction of ADWR.

The 2010 Census population on the Tohono O’odham District lands within the TAMA boundaries was approximately 2,814 people. The 2010 Census population on Pascua Yaqui tribal lands was approximately 912 people. More than 93 percent of the region's population resides within the northern part of the Upper Santa Cruz Valley Sub-basin which includes the Tucson metropolitan area, Oro Valley, the eastern portion of Marana, Green Valley and Sahuarita. The remaining population is centered in the Avra Valley Sub-basin communities of Three Points (Robles Junction), Arivaca and the western portion of Marana. In the Assessment ADWR projected the population in the TAMA to be between 1.4 and 1.5 million by 2025. This is an increase of 400,000 to 560,000 people over the 2010 Census population of 980,988 people within the TAMA, an increase of approximately 4 percent. The majority (72 percent) of the population in the TAMA is served by Tucson Water, the water utility operated by the City of Tucson.

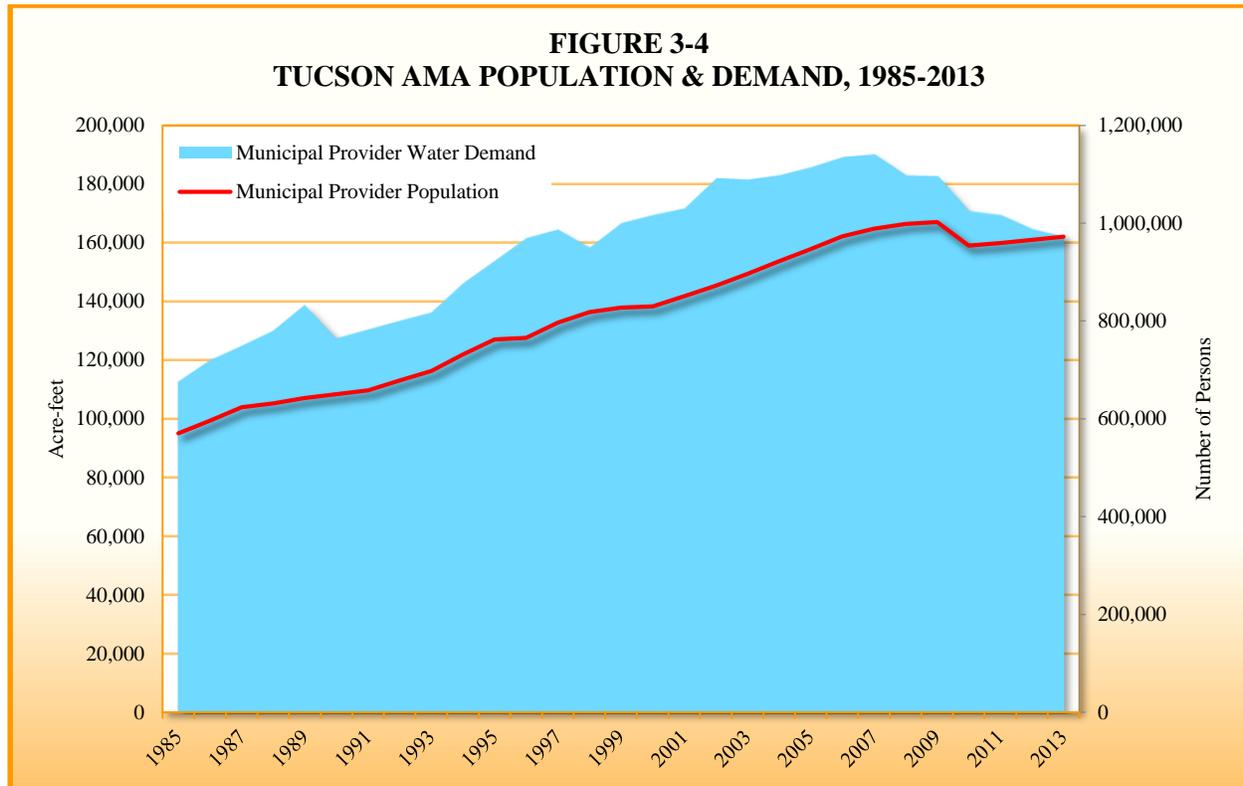
Large provider population in the TAMA was 931,627 people in 2010. Small providers were comprised of 22,746 people in 2010. An exempt well is one equipped to pump 35 gallons per minute (gpm) or less. Withdrawals from exempt wells within AMAs are exempted from measuring and reporting requirements. ADWR estimates that in 2010 there were 26,615 people relying on exempt wells (or hauled water), who were not served by a municipal water provider.



3.2.2 Exempt Wells

Since 1985, the number of exempt well registrations in the TAMA increased more than 100 percent, from 3,725 exempt well registrations in 1985 to 7,893 in 2013. The number of exempt well registrations added each year was higher from 1994 through 2006 than in years prior or since (*See Figure 3-3*). There were

more Notices of Intent (NOI) applications filed to drill exempt wells in 2004 than in any other year. Of the 452 NOIs submitted in that year 306 were within the exterior boundaries of a municipal provider holding a Designation of Assured Water Supply (DAWS). In 2005 the Arizona State Legislature passed Senate Bill 1190, which modified A.R.S. § 45-454.C prohibiting exempt wells within 100 feet of the operating distribution system of a DAWS provider, unless exempted based on the specific requirements of the law.



3.2.3 Estimated TAMA Population and the 2010 Census

Figure 3-4 compares the large and small provider population with the large and small provider demand from 1985 through 2013. Slight dips or increases in the population seem to occur as the over-or under-estimation of the population estimate is corrected by the actual Census data. Each decennial US Census is used to calibrate the inter-Census population estimates to the actual population count from the Census. Table 3-2 shows population figures based on the 2010 US Census.

**TABLE 3-2
TUCSON AMA POPULATION BY WATER PROVIDER TYPE, 1985-2013**

Year	Total AMA Population	Large Provider Population	Small Provider Population	Exempt Well Population	Number of Exempt Wells
1985	573,864	556,850	13,393	3,621	3,725
1986	600,087	582,538	13,836	3,713	3,833
1987	627,433	609,302	14,322	3,809	3,927
1988	635,604	617,086	14,611	3,907	3,994
1989	646,830	628,190	14,633	4,007	4,076
1990	654,576	635,076	15,390	4,110	4,147

Year	Total AMA Population	Large Provider Population	Small Provider Population	Exempt Well Population	Number of Exempt Wells
1991	662,250	643,415	14,620	4,215	4,197
1992	682,651	663,582	14,746	4,323	4,262
1993	702,540	684,441	13,665	4,434	4,366
1994	736,538	704,096	27,894	4,548	4,532
1995	766,719	735,893	26,161	4,665	4,701
1996	770,458	742,701	22,972	4,785	4,953
1997	801,651	774,204	22,540	4,907	5,168
1998	823,021	793,661	24,327	5,033	5,306
1999	832,129	802,336	24,631	5,162	5,513
2000	835,504	808,959	21,250	5,295	5,680
2001	858,091	829,513	21,297	7,281	6,025
2002	881,220	850,149	21,805	9,266	6,231
2003	907,646	874,191	22,203	11,252	6,443
2004	935,281	899,211	22,833	13,237	6,895
2005	961,900	923,938	22,739	15,223	7,212
2006	990,133	950,259	22,666	17,208	7,389
2007	1,007,487	965,190	23,104	19,194	7,514
2008	1,019,641	975,157	23,305	21,179	7,590
2009	1,025,552	977,923	24,464	23,165	7,658
2010	980,988	931,627	22,746	26,615	7,714
2011	986,892	936,695	22,916	27,281	7,773
2012	993,586	942,571	23,051	27,964	7,831
2013	1,000,934	949,100	23,171	28,664	7,893

Note: Assessment data for years 2007-2010 is from Baseline Scenario One projected.

Between the 2000 Census and the 2010 Census, the exempt well population appears to have increased by an estimated 21,320 people. ADWR conducted a detailed analysis of 2010 Census data and the historical estimate of exempt well population figures included in the Assessment. Due to a change in the methodology used to compile large provider Census population between the 2000 and 2010 Censuses, ADWR believes that the disaggregation of 2000 US Census data to large municipal provider service areas included about 6,000 people who may actually have been served water via exempt wells.

Overestimation of population between Census years results in a downward bias in Gallons per Capita per Day (GPCD) figures. Census years represent an actual count of persons residing within water provider service areas in AMAs. Looking at the Census years, the large municipal provider GPCD rate in the TAMA was 175 GPCD in 1990, 182 GPCD in 2000, and 159 GPCD in 2010. Water conservation activities, the use of new, low water using fixtures and newer homes with low water using landscapes result in reductions in GPCD over time. Other factors that affect GPCD are weather conditions and water cost. The low GPCD figure in 2010 could be due to loss of income associated with the economic downturn and subsequent cut back in outdoor watering, as well as possible weather conditions (2010 experienced higher than average precipitation).

Multiple factors affect the GPCD rate, sometimes making it an unreliable measure of actual water conservation efforts. However, GPCD can be used as a basic indicator of consumption rates in the absence of more detailed data, such as end-use metering or data-logging, which cost more to collect. Taking into

consideration these factors, the data indicate that the overall average GPCD rate for TAMA large providers has reduced by just under 1.5 percent per year since the year 2000. GPCD rates for some individual large water providers decreased more than that rate, while some large providers in the TAMA experienced increased GPCD rates.

3.2.4 Industrial Sector

The *1980 Groundwater Code* (Code) defines industrial use as a non-irrigation use of water, not supplied by a city, town or private water company, including animal industry use such as dairies and cattle feedlots, and expansions of those uses. Generally, industrial users withdraw water from their own wells that are associated with grandfathered groundwater water rights (Type 1 and Type 2 rights) or withdrawal permits. Although industrial users are primarily dependent on groundwater, some use renewable supplies such as CAP water or reclaimed water. Historically, industrial uses in the TAMA have included mining, turf related facilities, sand and gravel operations, electric power generation, dairies and others (*See Table 3-3*).

Industrial use is largely dependent on population growth and the economy. In some cases, the difference between the actual water use and the total annual allotment at an individual industrial facility is substantial, and is generally a remnant of the allocation process used to establish Type 2 rights. This process assigned users allotments based on the highest annual groundwater withdrawal between the years 1975 and 1980. In 2013, under 30 percent of the TAMA's industrial rights and permit volumes were used.

**TABLE 3-3
TUCSON AMA INDUSTRIAL WATER DEMAND BY SUB-SECTOR, 1985-2013 (ac-ft)**

Year	Turf-Related Facilities	Metal Mining	Sand & Gravel	Large-Scale Power Plants	Dairies	Feedlots	Other	Total
1985	6,423	26,945	4,420	2,598	449	21	5,761	34,432
1986	6,097	25,005	4,074	2,295	399	21	5,944	31,794
1987	6,622	25,774	4,090	1,687	356	9	5,168	31,915
1988	7,147	26,854	3,609	2,736	338	15	4,719	33,553
1989	7,458	33,687	3,640	2,774	461	25	4,124	40,587
1990	6,914	33,955	3,467	1,950	58	31	3,745	39,461
1991	7,314	42,402	2,701	1,309	66	6	3,541	46,483
1992	6,453	36,531	3,026	1,772	50	25	3,633	41,404
1993	6,770	38,568	4,024	1,843	50		3,709	44,485
1994	7,130	43,072	4,664	2,524	70		3,984	50,328
1995	7,610	42,014	5,337	1,611	73		3,943	49,036
1996	7,651	39,916	4,897	1,970	85		4,619	46,867
1997	7,851	40,838	4,575	2,124	57		3,600	47,594
1998	7,484	39,243	4,416	2,427	85		3,784	46,172
1999	9,004	39,626	4,193	3,669	97		4,241	47,585
2000	8,085	39,573	4,497	4,935	115		4,064	49,120
2001	8,063	35,980	4,425	5,584	126		4,013	46,115

Year	Turf-Related Facilities	Metal Mining	Sand & Gravel	Large-Scale Power Plants	Dairies	Feedlots	Other	Total
2002	8,636	27,644	3,262	4,268	132		4,216	35,305
2003	8,349	26,725	4,626	2,885	114		3,664	34,351
2004	7,797	32,210	3,847	3,160	88		3,664	39,305
2005	8,393	33,742	3,306	3,083	124		3,775	40,255
2006	8,249	34,905	3,807	2,656	110		3,357	41,478
2007	7,873	32,516	1,739	2,923	131		4,867	37,309
2008	7,346	34,552	3,851	2,422	139		4,157	40,963
2009	8,213	36,630	3,343	2,277	83		3,256	42,333
2010	7,966	37,081	4,168	2,305	120		4,060	43,674
2011	7,788	38,929	976	2,241	125		3,315	42,271
2012	7,539	35,046	2,216	2,164	158		3,516	39,584
2013	7,679	32,094	3,385	1,643	153		3,068	37,274

Approximately 23 percent of the total Type 1, Type 2 and Withdrawal Permit allotments in the TAMA belong to Tucson Water, with a total allotment of 39,439 ac-ft. Another 26 percent of the total allotments in the TAMA belong to mining company Freeport-McMoRan, with a total allotment of 44,991 ac-ft.

Water use within the industrial sector in the TAMA has been relatively stable since 1985 with the exception of periodic fluctuations caused by its largest subsector, metal mining. The increase in industrial water use in 1994 and 1995 corresponds to a period of peak mining production. The non-mining subsector water use in the TAMA has remained relatively static at approximately 20,000 ac-ft per year over the last twenty years while mining use has fluctuated between 25,000 and 43,000 ac-ft per year depending on the condition of the commodities market. Groundwater has been, and continues to be, the primary source of industrial water supply in the TAMA as shown in Table 3-1(A).

Although the industrial sector has the authority to grow into its allotment, based on the historical trend of industrial water use in the TAMA it seems unlikely that this sector will reach a point at which the full allotments are being used.

Mining in the TAMA has historically relied on groundwater. However, the Southern Arizona Water Settlement Act (SAWRSA) gave the American Smelting and Refining Company (ASARCO) the right to use up to 10,000 ac-ft of CAP water from the Tohono O'odham Nation (TON) annually. Other mining entities in the TAMA continue to expand use of CAP and reclaimed water where available.

Turf-related facilities are the second largest industrial subsector in the TAMA. Many turf-related facilities are served reclaimed water or are supplied by municipal water providers; however, some use GFRs to withdraw groundwater. An ordinance in Pima County prohibits the use of groundwater on new turf-related facilities, so it is unlikely that groundwater demand by the turf-related subsector will increase in the future. Due in part to the economic downturn, some of the golf courses within the TAMA have seen reduced attendance resulting in decreased revenues.

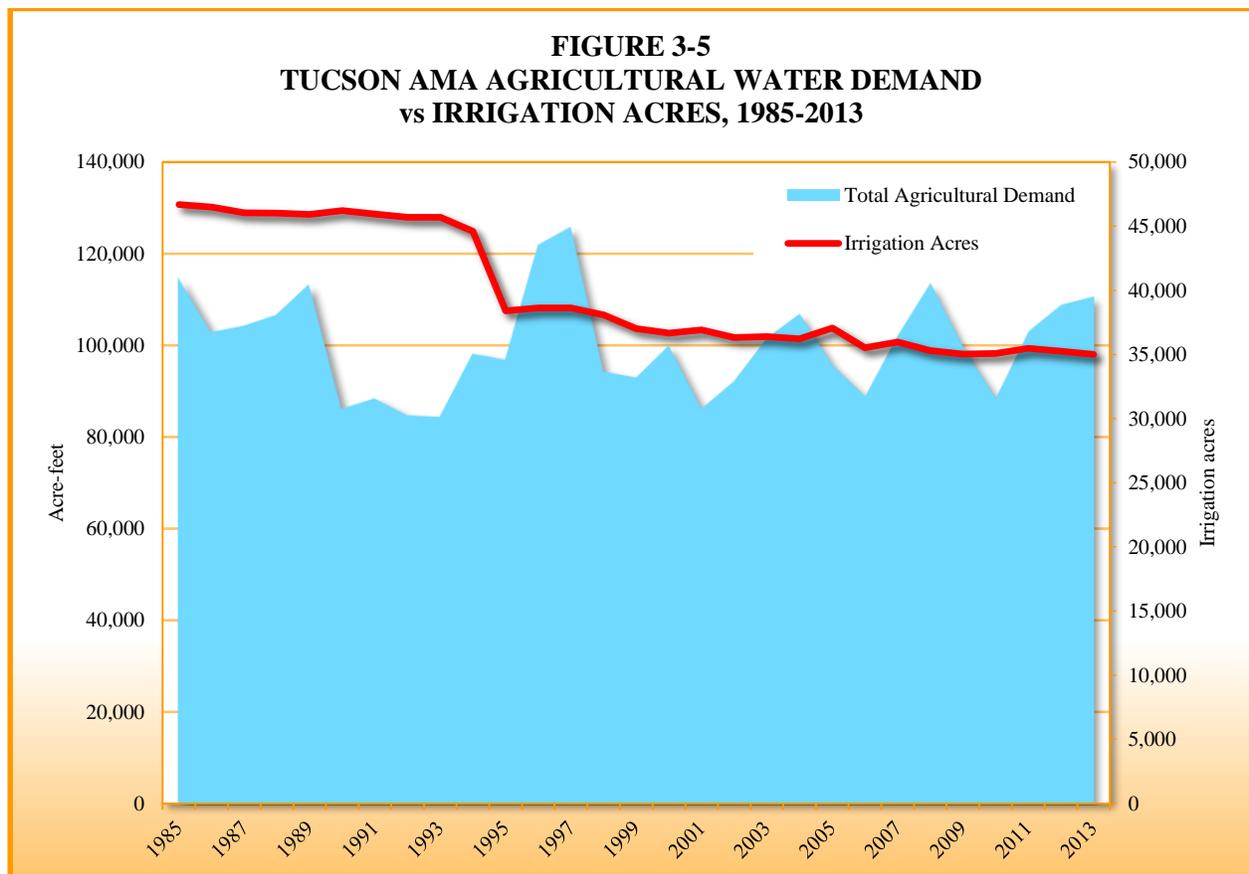
There are two large-scale power plants located in the TAMA. In 2001, at the height of the California energy crisis, electric power generation water demand spiked to approximately 5,600 ac-ft because of an increase in local power generation and associated water use. The power sector in the TAMA currently holds over 10,000 ac-ft of withdrawal authority. The primary consumptive use of water at a thermal power plant is evaporation in the cooling towers. Electric power plants in the TAMA have relied solely on groundwater to meet their cooling needs.

Water demand in the dairy and other industrial subsectors is not likely to dramatically increase. In the Assessment, industrial demand was projected to be between 55,000 and 70,600 ac-ft in the year 2013. Actual industrial demand in 2013 was about 48,000 ac-ft.

3.2.5 Agricultural Sector

The agricultural sector in the TAMA is comprised of farm acreage of two acres in size or larger actively irrigated with groundwater from 1975 to 1980. Agricultural lands that used groundwater to irrigate crops during this time period were issued an Irrigation Grandfathered Right (IGFR) by ADWR. Water use pursuant to these rights must be reported to ADWR if the right is larger than 10 acres.

Agriculture is a smaller sector in the TAMA than the municipal sector but still significant. However, as municipal and industrial uses increase, the agricultural sector comprises a smaller percentage of overall AMA water demand. The TAMA contains one consolidated irrigation distribution system, operated by the Cortaro-Marana Irrigation District (CMID), which encompassed more than 70 farms and about one-third of the total number of IGFR active acres in the TAMA in the year 2013.



Water demand in the agricultural sector has fluctuated between 1985 and 2013, while total irrigation acres have declined. There are fewer than 200 active IGFRs in TAMA, with allotments totaling about 155,000 ac-ft. Figure 3-5 shows historical agricultural water use from 1985 through 2013 and the total acres eligible to be irrigated. The amount of irrigable acreage dropped significantly between 1993 and 1995. In 1994 small rights of less than ten acres were deregulated; however, the highest number of acres that were inactivated during this period were associated with IGFRs owned by Tucson Water and Farmers Investment Company.

Since 1995, there have been 23 IGFRs that were partially or fully extinguished in the TAMA pursuant to the AWS Rules. This accounts for about 1,270 acres that can no longer be used for agricultural production. Extinguishment of these rights generated 36,915 ac-ft of extinguishment credits, of which 1,149 have been pledged and 35,766 have not been pledged to help meet the consistency with goal criterion of proving a 100-year AWS. Additional IGFR acres were either urbanized or converted to a Type 1 Non-Irrigation GFR and were not extinguished.

CMID, referred to as Area of Similar Farming Condition (ASFC) No. 2, is the only irrigation district in the TAMA with a consolidated distribution system. Since 2009, a little less than half of CMID's supplies have been groundwater. In-lieu water has fluctuated in recent years, as has use of CAP water. CMID has several surface water rights and wells claimed as points of diversion of surface water; however, ADWR has included this water in the groundwater supply category, pending the General Stream Adjudication. This volume of water was between 27 and 40 percent of CMID's demand between 2006 and 2013. Historically, CMID had a contract for reclaimed water (effluent) from Pima County, but the contract expired and no reclaimed water was used after 1998. Pima County is cooperating with Metro Water, CMID and the Bureau of Reclamation to deliver Metro Water and SAWARSA water to CMID lands under via a Groundwater Savings Facility. Also, Metro Water is exploring the idea of delivering reclaimed water to CMID in the future via a Groundwater Savings Facility (in-lieu) water storage permit for recharge credits.

The *Avra Valley* area in Marana (ASFC 3) includes the Avra Valley Irrigation District, BKW Farms and several other irrigators. Between 2006 and 2013, about half of Avra Valley's supplies were groundwater and 40 percent in-lieu water; the remaining water included small volumes of CAP water and surface water.

Farmer's Investment Company (FICO) operates a large pecan farm in the Green Valley-Sahuarita area (ASFC 5). Currently, all of FICO's demand is met with groundwater withdrawn from private wells.

The *Red Rock* area in Pinal County (ASFC 1) meets most of its demand, about 72 percent, with in-lieu water. CAP water averaged about 18 percent from 2006 to 2013. The remaining demand was met with surface water (about eight percent).

Between 2006 and 2013, irrigation rights in the remaining ASFCs accounted for less than five percent of the total TAMA demand.

Agriculture uses a relatively minor amount of water in the TAMA, although both the agricultural and industrial sectors largely rely on groundwater and thus affect safe-yield. Although slowly declining, a significant amount of agricultural land remains in the TAMA that could continue in production for some time into the future, depending on the economy and cropping patterns. The agricultural sector uses in-lieu CAP, direct CAP and reclaimed water; however, groundwater remains the principle source of supply for irrigation in the TAMA.

3.2.6 Tribal Sector

The Pascua Yaqui tribal lands, part of the Schuk Toak District, and the entire San Xavier District of the TON are located within the TAMA. Tribal water use is exempt from regulation by the state; however, the demand characteristics of these communities are included here because they have a hydrologic impact on the safe-yield goal. In Table 3-1(B), Tribal demand includes primarily agricultural demand with a small portion of municipal and industrial demand. Municipal demand is estimated to have been about 200 ac-ft. in 2013. Tribal industrial demand is reported as the delivery of groundwater from the San Xavier District to ASARCO's Mission mine. This use discontinued in 2006; subsequently, through the Southern Arizona Water Rights Settlement Act (SAWRSA), ASARCO agreed to decrease its groundwater pumping and use up to 10,000 ac-ft of the TON's CAP water. The TON receives long-term storage credits for the CAP water that ASARCO uses in-lieu of groundwater. The entire TON total CAP allocation is 74,000 ac-ft per year.

The SAWRSA and the subsequent settlement agreement specified that the TON was entitled to 79,200 ac-ft of water rights in the TAMA for use on the San Xavier District and the Eastern Schuk Toak District. Of this total 66,000 ac-ft is CAP water and 13,200 ac-ft is groundwater. The TON may also lease up to 15,000 ac-ft of CAP water to off reservation users. In 2008 ADWR determined that the use of TON CAP water by ASARCO meets the requirements of A.R.S. § 45-841.01. Beginning in 2010, ASARCO began reporting receiving in-lieu water from the San Xavier District pursuant to this statute, although CAP use by the mines occurred as early as 2007. Tribal CAP use is primarily for agricultural irrigation. Table 3-1(B) shows water use by water type for the agricultural sector and tribal uses.

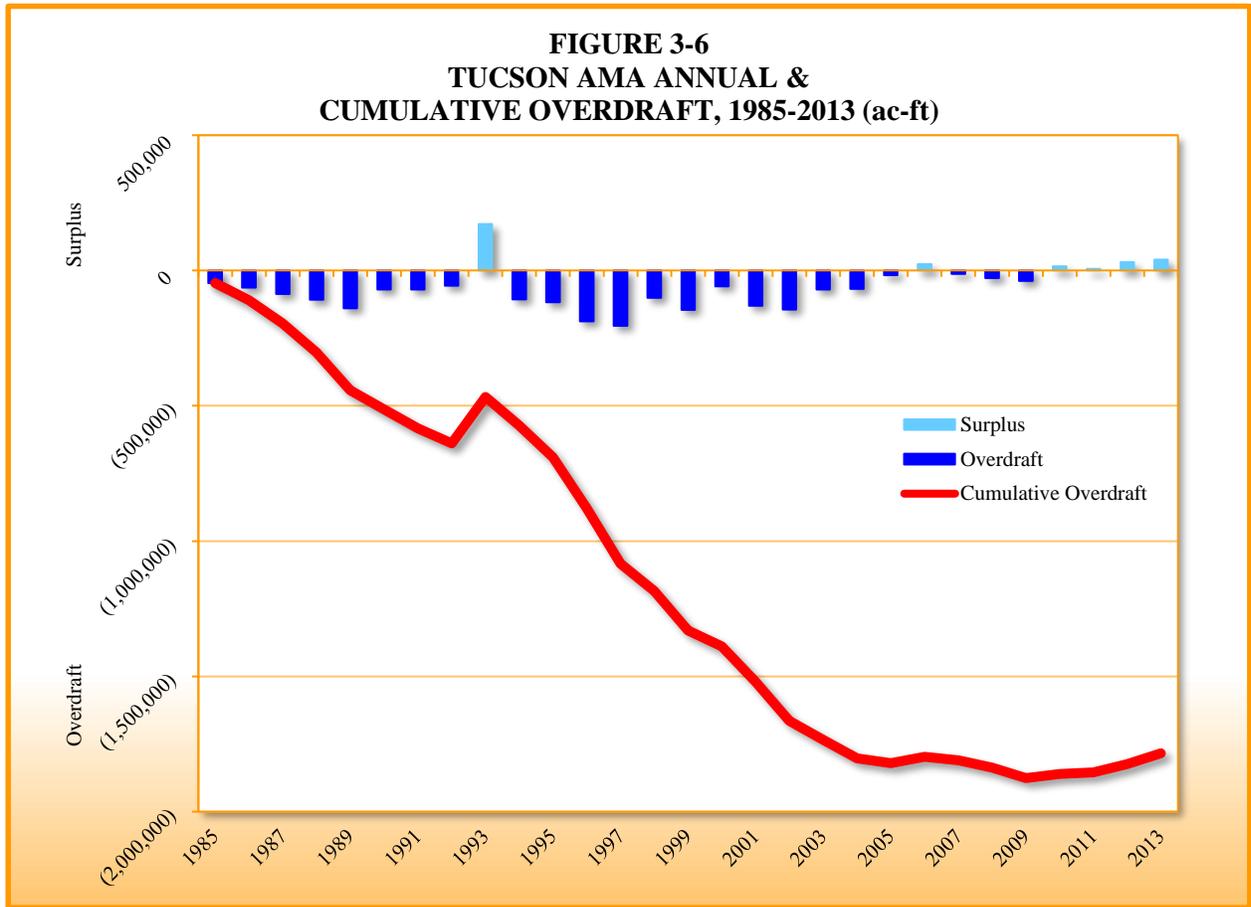
3.3 CURRENT WATER BUDGET

The management goal of the TAMA is to achieve a long-term balance between the annual amount of groundwater pumping and the annual amount of natural and artificial recharge in the TAMA by the year 2025; this goal is known as "safe-yield." Net natural recharge and the other components in the calculation of safe-yield are described in the Assessment (ADWR, 2010) in Part 3, "The Basic Budget Components." Overdraft, depicted in Figure 3-6, is equal to the sum of the groundwater use for all three sectors (estimated for exempt well demand), minus the sum of the incidental recharge, plus the additional offsets to overdraft (including net natural recharge and canal seepage). Red bars indicate overdraft, while blue bars indicate that supplies stored in the aquifer exceeded the volume of water withdrawn and leaving the aquifer through groundwater outflow in that year. The cumulative overdraft between 1985 and 2013 is shown as a line on a second axis. By 2013, the cumulative overdraft in the TAMA since 1985 was approximately 1.8 million ac-ft. However, since 2005 the TAMA cumulative overdraft has been fairly flat, reflecting the reduction in groundwater use and increased use of renewable water supplies.

For purposes of the 4MP, overdraft includes use of the groundwater allowance. Despite these volumes of allowable groundwater use being considered consistent with the management goal under the AWS Rules, they are included in the overdraft calculation to allow analysis of the groundwater allowance withdrawal's physical impact on the aquifer.

Rather than using a long-term average for stream channel recharge as was done in the Assessment, the actual estimated stream channel recharge from the hydrologic model has been incorporated into the budget template in order to show the impact of flood flow on the aquifer, as seen in Figure 3-6 for the year 1993. ADWR now has a greater understanding of the susceptibility of the TAMA aquifers to drought and natural recharge during wetter periods. Those updated figures, reflecting actual conditions from 1985 through 2013, are reflected in Figure 3-6. This period of record indicates that the TAMA has been close to safe-yield in recent years, but was in overdraft nearly every year in the 1985-2005 historical period with the exception of the 1993 flood. Values for Figure 3-6 are shown in Table 3-4. The net natural recharge in Chapter 2,

Table 2-2 and offsets to groundwater pumping in Table 3-4 do not match; this is because Table 3-4 includes incidental recharge from human activities, cuts to the aquifer and CAGRDR replenishment, while Table 2-2 in Chapter 2 does not.



**TABLE 3-4
TUCSON AMA WATER DEMAND BY SECTOR, 1985-2013 (ac-ft)**

Year	Demand					Total Demand	Supply			Overdraft
	Municipal	Estimated Exempt Well Pumpage	Industrial	Agriculture	Tribal		Renewable Supplies used*	Ground water Used	Offsets to GW Pumping**	
1985	112,655	425	46,616	114,879	72	274,647	4,266	277,545	231,046	(46,500)
1986	119,974	436	43,834	102,910	75	267,229	4,032	270,118	207,293	(62,825)
1987	124,837	447	43,704	104,294	810	274,092	4,354	275,849	189,543	(86,306)
1988	129,971	458	45,419	106,676	902	283,427	7,416	280,043	172,583	(107,460)
1989	138,850	470	52,168	113,326	2,091	306,905	8,959	300,459	160,926	(139,533)
1990	127,454	482	50,121	86,217	1,516	265,791	8,665	259,854	189,866	(69,988)
1991	130,482	495	57,337	88,508	1,557	278,380	8,178	274,588	203,790	(70,798)
1992	133,431	507	51,490	84,837	3,800	274,065	15,885	263,879	208,024	(55,856)
1993	136,164	520	54,964	84,499	4,349	280,497	52,106	238,898	411,263	172,365
1994	146,037	534	61,442	98,246	4,786	311,045	29,414	289,239	182,942	(106,297)
1995	153,740	547	60,589	96,943	3,089	314,909	8,415	313,857	195,965	(117,892)

Year	Demand					Total Demand	Supply			Overdraft
	Municipal	Estimated Exempt Well Pumpage	Industrial	Agriculture	Tribal		Renewable Supplies used*	Ground water Used	Offsets to GW Pumping**	
1996	161,466	562	59,137	121,834	3,566	346,564	11,047	339,252	151,488	(187,765)
1997	164,338	576	59,046	125,819	2,210	351,990	11,789	342,349	137,365	(204,984)
1998	158,235	591	57,440	94,394	2,988	313,647	9,702	307,756	207,235	(100,521)
1999	166,575	606	60,831	93,071	3,675	324,757	10,055	317,642	172,024	(145,618)
2000	169,242	621	61,269	100,006	3,960	335,099	11,277	326,251	267,582	(58,669)
2001	171,588	854	58,191	86,331	11,240	328,204	39,172	284,547	153,602	(130,944)
2002	181,860	1,087	48,157	92,308	12,508	335,921	41,929	287,745	143,534	(144,211)
2003	181,248	1,320	46,364	101,643	14,341	344,916	76,620	262,457	191,704	(70,753)
2004	182,810	1,554	50,765	106,963	14,259	356,351	98,102	250,025	181,423	(68,603)
2005	185,565	1,787	52,423	95,848	14,306	349,928	110,435	239,720	222,311	(17,409)
2006	188,977	2,020	53,084	88,973	11,619	344,672	106,528	236,586	260,307	23,721
2007	189,893	2,253	50,049	102,124	15,649	359,968	138,434	219,000	206,231	(12,770)
2008	182,750	2,486	52,466	113,630	21,646	372,977	138,294	230,032	202,539	(27,493)
2009	182,464	2,719	53,802	99,738	21,418	360,141	160,289	192,270	153,616	(38,654)
2010	170,571	3,124	55,701	88,586	16,797	334,777	150,795	178,554	193,962	15,408
2011	169,285	3,202	53,374	103,104	18,748	347,712	153,903	189,196	194,882	5,686
2012	164,481	3,282	50,638	108,847	20,517	347,764	154,180	189,955	220,960	31,006
2013	161,916	3,364	48,020	110,669	18,903	342,873	148,448	193,349	233,137	39,788

*Includes CAP Water and Reclaimed Water

**Includes Incidental Recharge, Net Natural Recharge, cuts to the aquifer, CAGR replenishment, effluent discharge, riparian use of managed effluent and canal seepage

3.4 CONCLUSION

Water users in the TAMA have made a strong commitment to increasing the use of reclaimed water and CAP supplies over the last decade. However, there are locations within the TAMA which are either isolated from renewable water sources or lack the infrastructure to retrieve them. It is important for the TAMA to continue to move toward a regional water management approach aimed at using renewable water supplies (CAP water and reclaimed water) to reduce reliance upon groundwater evenly and continuously throughout the TAMA.

The 4MP programs that follow were developed within current statutory guidelines. It is possible, as described in Chapter 11, for the TAMA to achieve safe-yield by the year 2025 with an increased commitment to use of renewable supplies. However, whether or not safe-yield is achieved and maintained will depend on individual choices of water right holders and the continued availability of renewable supplies. The commitment of the TAMA community to developing and putting into place a water management strategy that recognizes the need for additional water augmentation activities will help ensure the continued economic viability of the TAMA into the future and the achievement of the safe-yield goal. This situation is further discussed in Chapter 12.

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