DRAFT Demand and Supply Assessment

May 28

2010

This Assessment is a compilation and study of historical water demand and supply characteristics for the Tucson AMA from the year 1985 through 2006. In addition, the Assessment calculates seven water supply and demand projection scenarios to the year 2025.

Tucson Active Management Area

DRAFT
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1985-2025
Tucson Active Management Area

MAY 2010

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Executive Summary

The *Water Demand and Supply Assessment 1985-2025, Tucson Active Management Area* (Assessment) is a compilation and study of historical water demand and supply characteristics for the Tucson Active Management Area (AMA) for the years 1985 through 2006. In addition, the Assessment calculates seven water supply and demand projection scenarios to the year 2025. The Arizona Department of Water Resources (ADWR) conducted this Assessment as preparation for the *Fourth Management Plan for Tucson Active Management Area* as required by the *1980 Groundwater Management Code (Code)*.

The statutory management goals established for each of the five AMAs are the foundation for the implementation of the groundwater management programs established by the Code. The statutory management goal of the Tucson Active Management Area (AMA) is to attain safe-yield, on an AMA-wide basis, by the year 2025. Safe-yield is a balance between the amount of groundwater pumped from the AMA annually, and the amount of water naturally or artificially recharged. Groundwater withdrawals in excess of natural and artificial recharge leads to an overdraft of the groundwater supply in the AMA basin. The Code identified management strategies which relied, in part, on continuing mandatory conservation by all water major water using sectors to reduce total groundwater withdrawals in the AMAs, identified in the Management Plan for the AMA, and on increasing the use of renewable water supplies in place of groundwater supplies. Five management periods were identified for the development of these Management Plans which were to assist in moving the AMA closer to its management goal by 2025.

A review of historical annual water demand, supply and overdraft in the Tucson AMA from 1985 to 2000 shows that although groundwater overdraft fluctuated somewhat, it steadily increased through 2000 due to increased demands and continued reliance on groundwater. In spite of this, success seems to be attainable. After the year 2000, groundwater overdraft in the Tucson AMA began a steady decline with the increased utilization of CAP water and increased conservation activities across all water using sectors. While this success in reducing groundwater overdraft in the Tucson AMA is expected to continue, ADWR has evaluated several different possible scenarios for future groundwater overdraft.

The three baseline scenarios for future water use in this Assessment indicate that without additional reductions in groundwater pumping, increased demands and a lack of sustainable growth patterns combined with a finite supply of CAP water may result in continued groundwater overdraft in the Tucson AMA in the future. Three additional shortage scenarios examine the effects of a possible shortage of CAP supplies due to possible climate effects for several years before 2025, which could exacerbate groundwater overdraft. However, a seventh scenario demonstrates that increasing the use of available reclaimed water supplies could result in a positive turn in enabling the AMA to come very close to achieving the statutorily mandated management goal of safe-yield by 2025.

The purpose of this Assessment is to identify the success through 2006 with achievement of the Tucson AMA management goal. By developing future projections, ADWR can analyze different supply and demand mechanisms that may affect the AMA's ability to achieve safe-yield by 2025. While ADWR recognizes these future projections are not exact representations of what will occur in the future, they do identify a range of possibilities that provide valuable information that benefits decisions regarding water management in the Tucson AMA. Most importantly, the information in this Assessment will be used to assist ADWR in working with the Tucson community to develop management strategies to assist the AMA in moving even closer to safe yield by the end of the Fourth Management Plan.

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LIST OF ACRONYMS

ADWR	Arizona Department of Water Resources
ADES	Arizona Department of Economic Security
AMA	Active Management Area
ASFCs	Areas of Similar Farming Conditions
AWBA	Arizona Water Banking Authority
AWS	Assured Water Supply
BMP	best management practices
BOR	United State Bureau of Reclamation
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
C AWS	Certificate of Assured Water Supply
CMID	Cortaro-Marana Irrigation District
Code	Groundwater Code
CRM	Colorado River Management
DAWS	Designation of Assured Water Supply
DCDC	Decision Center for Desert Cities
DWID	Domestic Water Improvement District
FICO	Farmers Investment Company
GIU	General Industrial Use Permit
GPCD	gallons per capita per day
GSF	Groundwater Savings Facility
IGFR	Irrigation Grandfathered Right
IPCC	International Panel on Climate Change
MAG	Maricopa Association of Governments
M&I	Municipal and Industrial
NOI	Notice of Intention to Drill
PAG	Pima Association of Governments
SAHRA	Sustainability of semi-Arid Hydrology and Riparian Areas
SAWRSA	Southern Arizona Water Rights Settlement Act
SNWA	Southern Nevada Water Authority
TON	Tohono O'odham Nation
Type 1 Right	Type 1 non-irrigation grandfathered right
Type 2 Right	Type 2 non-irrigation grandfathered right
USF	Underground Storage Facility
USGS	United States Geological Survey
WWTF	Wastewater Treatment Facility
1MP	First Management Plan

2MP	Second Management Plan
3MP	Third Management Plan
4MP	Fourth Management Plan
5MP	Fifth Management Plan

PART I INTRODUCTION TO THE ASSESSMENT

1. INTRODUCTION

1.1 Purpose of the Tucson Active Management Area Assessment

The *Water Demand and Supply Assessment 1985-2025, Tucson Active Management Area* (Assessment) is a compilation and study of historical water demand and supply characteristics for this groundwater basin from 1985 to 2006. It reviews past conditions and makes projections through the year 2025 using seven scenarios. The Arizona Department of Water Resources (ADWR) conducted this Assessment as preparation for the planning and public interaction that will precede the drafting of the *Fourth Management Plan for Tucson Active Management Area* (4MP) as required by the *1980 Groundwater Management Code* (Code). For more information regarding the Code, Management Plans, ADWR's mission and the governmental and institutional setting for this Active Management Area (AMA), refer to the *Third Management Plan for Tucson Active Management Area 2000 – 2010* (3MP).

The Assessment is divided into five parts, as described below:

- The Introduction, which provides a general overview of the Tucson AMA, the statutory management goal, the Assured Water Supply requirements, the Central Arizona Project, the Central Arizona Groundwater Replenishment District, the Underground Storage Program, and the Arizona Water Bank;
- The Budget Components and Calculation of Overdraft, which defines the major components of the water budget used in this Assessment and how overdraft is calculated;
- The Historical Water Demand and Overdraft for each water use sector (Municipal, Industrial, Agriculture, and Indian Tribes);
- The Projected Demand and Overdraft by Sector using assumptions formulated by ADWR based on historical use, population projected by the Department of Economic Security (ADES), and others; and
- The Fourth Management Plan process that will follow this Assessment.

1.2 General Overview of the Tucson AMA

Five AMAs (Phoenix, Pinal, Prescott, Santa Cruz and Tucson) have been designated as requiring specific, mandatory management practices to preserve and protect groundwater supplies for the future (*See Figure 1-1*). The Tucson AMA is 3,869 square miles in area and was established in 1980 upon enactment of the Code. Over the past 30 years, water users in the Tucson AMA have increased the use of renewable supplies, facilitated by the completion of the Central Arizona Project (CAP) canal, allowing use of Colorado River water either directly or indirectly through artificial recharge and recovery projects. The use of reclaimed water has also increased in the Tucson AMA since the creation of the AMA, further assisting in reducing historic reliance on groundwater supplies. For a detailed overview of the geography, hydrology, climate, and environmental conditions in the Tucson AMA, refer to the *Draft Arizona Water Atlas, Volume 8, Active Management Area Planning Area* (ADWR, 2010).

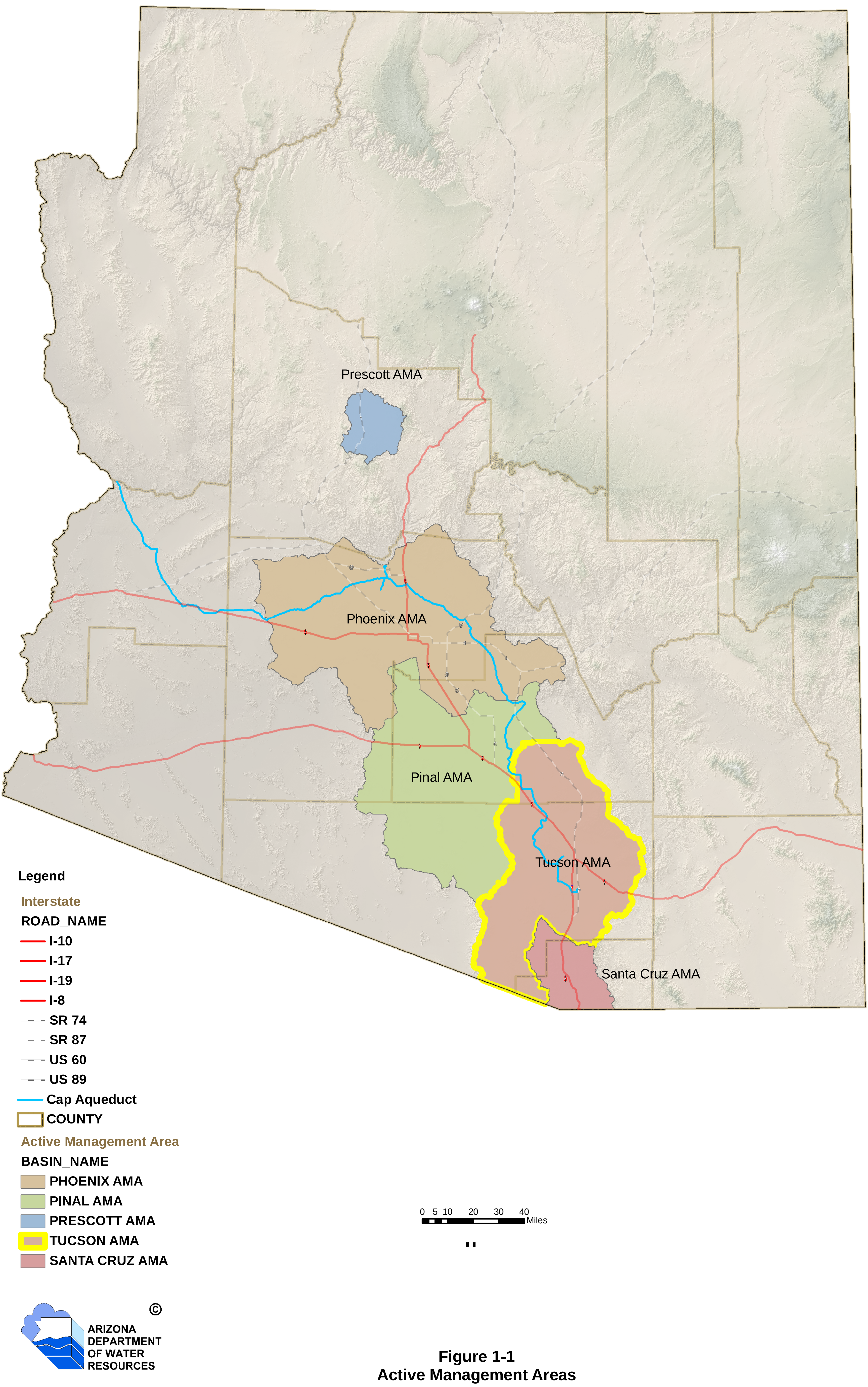


Figure 1-1
Active Management Areas

1.3 The Management Goal of the Tucson AMA

The Code established management goals for each of the AMAs, focused primarily on the reduction of groundwater dependence. The statutory management goal of the Tucson AMA is to achieve safe-yield by 2025 and maintain it thereafter. Safe-yield means that the amount of groundwater pumped from the AMA on an average annual basis does not exceed the amount of water that is naturally or artificially recharged. Safe-yield is a basin-wide balance; water level declines in one portion of the AMA could be offset by reducing groundwater pumping or recharging water in another part of the AMA. The safe-yield goal was established as part of the Code, and is intended to guide the water management strategies to address the long-term implications of groundwater overdraft.

1.4 Groundwater Management in the AMAs

To address groundwater depletion in the state's most populous areas, the state legislature created the Code in 1980 and created ADWR to implement it. The goal of the Code is twofold: 1) to control severe groundwater depletion, and 2) to provide the means for allocating Arizona's limited groundwater resources to most effectively meet the state's changing water needs. This effort to manage Arizona's groundwater resources was so progressive that in 1986 the Code was named one of the ten most innovative programs in state and local government by the Ford Foundation and Harvard University. When granting the award, it was noted that no other state had attempted to manage its water resources so comprehensively. Accordingly, Arizona built consensus around its policy and then followed through to make it work in practice.

Areas where groundwater depletion is most severe are designated as AMAs. There are five AMAs. These areas are subject to regulation pursuant to the Code. Each AMA has a statutory management goal. In the Phoenix, Prescott, and Tucson AMAs, the primary management goal is to achieve safe-yield by the year 2025. In the Pinal AMA, where the economy is primarily agricultural, the management goal is to preserve that economy for as long as feasible, while considering the need to preserve groundwater for future non-irrigation uses. Recognizing that the Santa Cruz AMA is currently at the safe-yield status, the goal of the Santa Cruz AMA is to maintain safe-yield and prevent local water tables from experiencing long-term decline. Each AMA carries out its programs in a manner consistent with these goals while considering and incorporating the unique character of each AMA and its water users.

Since groundwater use in AMAs is regulated, withdrawal of groundwater in these AMAs requires a permit from ADWR. On most of these wells state law assesses withdrawal fees and requires annual groundwater withdrawal and use reports to be filed.

In order to withdraw and use groundwater, an individual must complete the following steps:
1. Obtain a groundwater withdrawal authority;
2. Obtain a well permit and employ a licensed well driller;
3. Measure and report annual groundwater withdrawals; and
4. Meet conservation program requirements under the AMA Management Plans.

The following groundwater withdrawal authorities are used to allocate groundwater resources and to limit demand for groundwater in the AMAs.

<u>1. Irrigation Grandfathered Rights</u>
Within AMAs, anyone who owns land that was legally irrigated with groundwater at any time from January 1, 1975 to January 1, 1980 and has been issued a Certificate of

Irrigation Grandfathered Right (IGFR) by ADWR has the right to use groundwater for the irrigation of that land. The term irrigation is limited to the growing of crops for sale, human consumption or livestock feeding on two or more acres.

2. Type 1 and Type 2 Non-Irrigation Grandfathered Rights
A Type 1 non-irrigation grandfathered right (Type 1 right) is associated with land permanently retired from farming and converted to a non-irrigation use. This right, like an irrigation grandfathered right, may be sold or leased only with the land. The maximum amount of groundwater that may be pumped each year using a Type 1 right is three acre-feet per acre.

Groundwater withdrawn pursuant to a Type 2 non-irrigation grandfathered right (Type 2 right) can generally be used for any non-irrigation purpose. The right is based on historical pumping of groundwater for a non-irrigation use from a non-exempt well (pumping capacity of greater than 35 gallons per minute) and equals the maximum amount pumped in any one year between 1975 and 1980. Type 2 rights can be sold separately from the land or well. These rights are most often used for industrial purposes such as sand and gravel facilities, golf courses and dairies. Type 1 and Type 2 right holders are generally required to comply with the conservation requirements associated with the Industrial Conservation Programs in the Management Plans.

3. Service Area Rights
Service area rights allow cities, towns, private water companies and irrigation districts to withdraw and transport groundwater to serve their customers. Most persons within an AMA receive water through service area rights. Entities with service area rights must comply with the Municipal Conservation Program requirements in the Management Plans.

4. Groundwater Withdrawal Permits
Groundwater withdrawal permits allow new withdrawals of groundwater for non-irrigation uses. Currently, seven types of withdrawal permits are allowed under the Code. A General Industrial Use Permit (GIU), the most commonly used type of permit, allows the withdrawal of groundwater for industrial uses outside the service area of a city, town or private water company. Generally, users of these permits are required to comply with the Industrial Conservation Program requirements in the Management plans.

Wells
Two types of applications for well drilling authority exist. A Notice of Intent (NOI) to Drill is required to be filed with ADWR for all wells which are to be drilled outside the AMAs and exempt wells which will be located inside an AMA. Exempt wells are typically small domestic wells, pumping not more than 35 gallons per minute. Under the Code, exempt wells are not required to meter or report water use and are not regulated by ADWR, other than being required to file an NOI. For non-exempt wells within an AMA an application for a Drilling Permit is required.

Water Measurement, Groundwater Withdrawal Fees and Reporting Requirements
Groundwater withdrawn from non-exempt wells must be measured using an approved measuring device or method. In addition, all groundwater withdrawn from non-exempt wells is subjected to an annual groundwater withdrawal fee. Fees collected for augmentation, conservation assistance, and monitoring and assessing water availability are used to finance the augmentation and conservation assistance programs that are part of the Management Plans for AMAs, plus funding the Arizona Water Banking Authority (discussed below).

Annual water withdrawal and use reports are required to be filed for most groundwater withdrawn within an AMA. Accurate records of the right holder's withdrawals, transportation, delivery and use of groundwater must be kept by the right holder and reported to ADWR on a yearly basis.

Management Plans and Conservation Requirements
Management Plans reflect the evolution of the Code, assisting in moving Arizona toward its long-term water management goals. Management Plans are required from each AMA for five sequential management periods extending from 1980 through 2025. The First Management Plan (1MP) applied from 1985-1990. The Second Management Plan (2MP) was in effect until 2000, and the Third Management Plan (3MP) from 2001 until 2010. ADWR is in the initial stages of formulating the Fourth Management Plan (4MP), through the development of this Assessment, scheduled for release in 2010. The provisions of the 4MP will be in effect from 2010 through 2020. A Fifth Management Plan (5MP) will be developed for the years 2020 through 2025.

Most entities withdrawing groundwater from a non-exempt well are required, pursuant to the Management Plan, to participate in one of the following: the Agricultural Conservation Program, the Municipal Conservation Program or the Industrial Conservation Program.

Holders of an IGFR who withdraw water from a non-exempt well are subject to the Agricultural Conservation Program, which determines conservation requirements based on water duties and maximum annual groundwater allotments or through Best Management Practices (BMP). A key component of the Code prohibits the establishment of new IGFRs – eliminating new acres from being put into agricultural production.

Under the Municipal Conservation Program, municipal water providers are required to meet conservation requirements based on reductions in total per capita use or through implementation of BMPs. Additionally, municipal providers are required to limit the amount of lost and unaccounted for water in their delivery system.

All Type 1 and Type 2 right holders and some GIU permit holders are subject to the Industrial Conservation Program. Conservation requirements are based on the best available technology for the end use and range, based on the permit or right type, from BMPs to specific groundwater allotments for water users such as turf-facilities.

Compliance and Enforcement Program
ADWR developed a compliance and enforcement program to ensure that conservation requirements are being met. The annual water withdrawal and use reports previously mentioned are one part of this program. Additionally, ADWR conducts audits to determine if water users comply with conservation requirements. If a water user is out of compliance, ADWR sends out a notice of non-compliance, conducts post audit meetings with the water user, and attempts to negotiate a settlement for the excess groundwater used.

Conservation and Augmentation Assistance Programs
In 1991, the 2MP was modified to include a program for conservation assistance to water users within an AMA. The goal of the Conservation Assistance Program is to assist water users in achieving the Management Plan requirements, leading ultimately to a realization of the management goal of the AMA.

The 2MP and the 3MP also include an Augmentation Assistance Program designed to provide augmentation grants for construction and pilot recharge projects designed to directly increase water supplies or water storage, conservation assistance, and planning, research and feasibility studies.

The Conservation Assistance and Augmentation Assistance Program grants are funded by groundwater withdrawal fees collected from those who pump groundwater in each AMA.

1.5 The Assured Water Supply Program

The Assured Water Supply (AWS) program, created as part of the Code, is designed to preserve groundwater resources and to promote long-term water supply planning in the AMAs. This is accomplished by regulations that limit the use of groundwater by new subdivisions. Every person proposing to subdivide land within an AMA must demonstrate the availability of a 100-year AWS.

In 1995, ADWR adopted AWS Rules to implement the AWS program. Under the AWS Rules, developers can demonstrate a 100-year supply by either satisfying the criteria described below and obtaining a Certificate of Assured Water Supply (CAWS) from ADWR or by obtaining a written commitment of service from a water provider with that has a Designation of Assured Water Supply (DAWS).

An AWS demonstration must include proof that the proposed subdivision will meet the following criteria, that the water supply or supplies:1) will be of adequate quality; 2) will be physically, legally, and continuously available for the next 100 years; 3) will be consistent with the management goal for the AMA; 4) will be consistent with the Management Plan for the AMA; and 5) financial capability will be demonstrated to construct the necessary water storage, treatment, and delivery systems. The Arizona Department of Real Estate will not issue a public report that allows the developer to sell lots without a demonstration of an AWS within an AMA. For more information on the AWS Program, please visit the ADWR website at www.azwater.gov/AzDWR/WaterManagement/AAWS.

The AWS requirement is only one important tool to help attain the management goal of the AMA. Because the AWS requirements only apply to new subdivisions (existing uses and other non-subdivision new uses are exempt from the assured water supply requirement under the Code), its ability on its own to bring the AMA into safe-yield is limited.

1.6 Central Arizona Project

The Central Arizona Project (CAP) is designed to bring about 1.5 million acre-feet of Colorado River water per year to its three-county service area (Maricopa, Pima and Pinal counties). The CAP carries water from Lake Havasu near Parker, Arizona to the southern boundary of the San Xavier Indian Reservation southwest of the City of Tucson. It is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines and is the largest single resource of renewable water supplies in the state of Arizona. The Central Arizona Water Conservation District (CAWCD) manages and operates the CAP.

For more information on the CAP, please visit www.cap-az.com

1.7 The Central Arizona Groundwater Replenishment District

One of the most important criteria for demonstrating an AWS is the consistency with management goal. The consistency with management goals section of the AWS Rules limits the quantity of mined groundwater that an applicant may use to demonstrate an AWS – ultimately decreasing the ability to mine groundwater to zero acre-feet – which assists in meeting the statutory goal of safe-yield. In 1993, the legislature created a groundwater replenishment authority to be operated by CAWCD throughout its three-county service area. This replenishment authority of CAWCD is referred to as the Central Arizona Groundwater Replenishment District (CAGRD). In 1999, the legislature expanded CAWCD's replenishment authorities and responsibilities by passing the Water Sufficiency and Availability Act.

Membership in the CAGRD provides a means by which an AWS applicant can satisfy the requirement that the proposed water use be consistent with the water management goals of the AMA. The effect of this groundwater pumping limitation is to prevent new development from relying solely on mined groundwater to serve its water demands. Development, however, is not eliminated for those landowners and water providers who have no direct access to CAP water or other renewable supplies. If a water provider or a landowner has access to groundwater and desires to rely exclusively on groundwater to demonstrate a 100-year water supply, it may do so, provided it joins the CAGRD. As a member of the CAGRD, the landowner or provider must pay the CAGRD to replenish any groundwater pumped by the member, which exceeds the pumping limitations imposed by the AWS Rules. For more information on the CAGRD, please visit the CAGRD website at www.cagrd.com.

1.8 The Underground Storage & Recovery Program

For decades, more groundwater has been pumped from Arizona's aquifers than has naturally recharged back into the aquifers. This imbalance has left some aquifers significantly depleted. Using renewable supplies and recharging water underground reduces this imbalance. Artificial recharge is a means of storing excess water supplies so that they may be used in the future. Artificial recharge is an increasingly important tool in the management of Arizona's water supplies, particularly in meeting the goals of the Code. Storing water underground to ensure an adequate supply for the purpose of satisfying current and future needs is both a practical and cost-effective alternative to direct use of renewable supplies.

In 1986, the Arizona Legislature established the Underground Water Storage and Recovery program to allow persons with surplus supplies of water to store that water underground and recover it at a later time. In 1994, the Legislature enacted the Underground Water Storage, Savings, and Replenishment Act, which further refined the recharge program.

A person who wishes to store, save, replenish, or recover water through the recharge program must apply for permits through ADWR. Depending on what the applicant intends to accomplish, different types of permits may be required.

An Underground Storage Facility (USF) Permit allows the permit holder to operate a facility that stores water in the aquifer. A Constructed USF Permit allows for water to be stored in an aquifer by using some type of constructed device, such as an injection well or percolation basin.

A Managed USF Permit allows for water to be discharged to a naturally water-transmissive area such as a streambed that allows the water to percolate into the aquifer without the assistance of a constructed device.

A Groundwater Savings Facility (GSF) Permit allows renewable water supplies, owned by the water storer, to be delivered to a separate recipient who agrees to curtail groundwater pumping on a gallon-for-gallon basis, thus creating a groundwater savings.

A Water Storage Permit allows the permit holder to store water at a USF or GSF. In order to store water, the applicant must provide to ADWR evidence of its legal right to the source water proposed for recharge. Water storage must occur at a permitted facility, as described above.

A Recovery Well Permit allows the permit holder to recover long-term storage credits or to recover stored water annually. Recovery can occur inside the area of impact of the stored water (the area where the water artificially recharged into the aquifer actually occurs) or outside the impact area of the stored water; however, recovery must occur in the same AMA where the water was stored. For more information on the Underground Storage and Program, please visit the ADWR website at www.azwater.gov/AzDWR/WaterManagement/Recharge.

1.9 The Arizona Water Banking Authority

The Arizona Water Banking Authority (AWBA) was established in 1996 to increase utilization of the state's Colorado River entitlement and develop long-term storage credits for the state. The AWBA stores or "banks" unused Colorado River water to be used in times of shortage to firm (or secure) water supplies for Arizona. These water supplies help to benefit municipal and industrial users and communities along the Colorado River, fulfill the water management objectives of the state, store water for use as part of water rights settlement agreements among Indian communities, and assist Nevada and California through interstate water banking. Through these mechanisms, the AWBA aids in ensuring long-term water supplies for Arizona.

Each year, the AWBA pays the delivery and storage costs to bring Colorado River water into central and southern Arizona through the CAP canal. The water is stored underground in existing aquifers (direct recharge) or is used by irrigation districts in lieu of pumping groundwater (indirect or in-lieu recharge). For each acre-foot stored, the AWBA accrues credits that are redeemable in the future when Arizona's communities or neighboring states need this backup water supply.

PART II BASIC BUDGET COMPONENTS AND CALCULATION OF OVERDRAFT

2. BUDGET DATA OVERVIEW

The historical data contained in this Assessment were compiled from Annual Water Withdrawal and Use Reports (annual reports) filed by water users since 1984; other components required to estimate both historical and projected overdraft came from the *ADWR Tucson Regional Groundwater Flow Model*. The detailed dataset compiled during this effort is stored in the *Tucson Master Data Template* (Template)(ADWR, 2009). The Template is an inventory of the demand and supply for the AMA. The data housed in the Template has been summarized in a budget format, referred to as the Summary Budget. Both the Template and Summary Budget are available online www.azwater.gov/AzDWR/WaterManagement/Assessments/default.htm.

In order to be consistent across the years and sectors, staff took extensive efforts to re-evaluate demand and supply data from the individual annual reports submitted by water providers, irrigation districts, industrial facilities, farms and recharge facilities to populate the Template and Summary Budget, rather than relying on previously compiled totals. The years considered as the historical period for this Assessment are 1985 to 2006. During those 21 years, the data required by annual reports has become more complicated as the statutes, rules and Management Plans have changed, and as water management itself has become more complex. Meanwhile, the methods used to store, retrieve and compile the data have become more sophisticated. This evolution of data development and retrieval may cause the more recently compiled totals for demand or supply to be slightly inconsistent with previously published numbers in previous Management Plans. While data reporting details and data retrieval have changed over the years, annual water use data have been reported in a relatively consistent manner for over 21 years. This long period of consecutive annual reporting provides the opportunity for ADWR to analyze past use and project future water demand using the longest period of record yet available. The data regarding future potential demand and supply were projected using various methods, as explained in detail beginning in Part III. Appendices 1-8 contain additional information regarding how these numbers were developed.

3. THE BASIC BUDGET COMPONENTS

The basic components of the Summary Budget are demand, supply, artificial recharge, and offsets to overdraft. Each of these components, necessary for calculating overdraft, is discussed in greater detail in the following sections.

3.1 Demand

Demand consists of the beneficial use of water for cultural purposes by the Municipal, Industrial, and Agricultural sectors and use on Indian reservations. Demand also includes natural system uses such as riparian demand.

3.1.1 Municipal Demand

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 Provider, Small Provider, Institutional Provider, and Domestic Exempt subsectors. The demand of Individual Users, such as turf-related facilities, is also included in the Municipal demand since municipal providers often serve them. These subsectors are listed and defined below in the order of magnitude of use.

Large Provider Demand: Large provider demand is the sum of residential, non-residential, and lost and unaccounted for water delivered by a large provider. A large provider is a municipal provider serving more than 250 acre-feet of water for non-irrigation use per year.

The components of Large Provider Demand are:

Large Provider Residential Deliveries: A non-irrigation use of water, delivered by a large provider, related to the activities of single family or multifamily housing units, including interior and exterior water use.

Large Provider Non-residential Deliveries: Water supplied by a large provider for a non-irrigation use other than a residential use. Deliveries to individual users are included in this category. Individual users are facilities that receive water from a municipal provider for non-irrigation uses to which specific Industrial conservation program requirements apply, including turf-related facilities, large-scale cooling facilities, and publicly owned rights-of-way.

Large Provider Lost and Unaccounted for water: The difference between the total water withdrawn, diverted or received for use within the water provider's water service area and the sum of the residential and non-residential metered deliveries to customers.

Small provider demand: Small provider demand consists of deliveries by a municipal provider for non-irrigation use related to the activities of single family or multifamily housing units. Small provider demand may also includes deliveries to non-residential customers and individual users. A small provider is a municipal provider that supplies 250 acre-feet or less of water for non-irrigation use per year.

Institutional Providers: Institutional providers are those municipal providers who supply 90 percent or more of their total water deliveries to prisons, hospitals, military installations, airports, or schools.

Domestic Exempt: Domestic Exempt Water use is non-irrigation water supplied by exempt wells (pumping not more than 35 gallons per minute) for domestic purposes to persons not on a large or small provider distribution system.

Population Numbers: Although not used directly to calculate water use during the historical period, population numbers are included in the Template and are broken out by persons served by large providers, small providers, institutional providers and those who use domestic exempt wells. Population is used directly in the projected scenarios to estimate Municipal use.

3.1.2 Industrial Demand

Industrial use is a non-irrigation use of water, not supplied by a city, town, or private water company, including animal industry use and expanded animal industry use. In general, Industrial users withdraw water from their own wells that are associated with Type 1 and Type 2 rights, GIUs or other withdrawal permits. In the Tucson AMA, Industrial demand is composed of the following subsectors: Sand and Gravel, Mining, Turf, Electric Power, Dairy, Feedlot, Other, Drainage and Dewatering, as well as, Non-Conservation/Non-Municipal Facilities. All of these categories except two (Non-Conservation/Non-Municipal and Drainage & Dewatering) have specific conservation requirements. These subsectors are defined below.

Sand and gravel: Sand and Gravel demand is the water use at a facility that produces sand and gravel and that uses more than 100 acre-feet of water from any source per year.

Mining: Mining demand is the water use at a facility at which mining and processing of metallic ores is conducted, and which uses or has the potential to use more than 500 acre-feet of water per year.

Turf: Turf demand is the water use by cemeteries, golf courses, parks, schools, or common areas within housing developments with a water-intensive landscaped area of 10 or more acres. Turf-related facilities that use any groundwater, regardless of whether they are Industrial users or are served by a municipal provider (individual users) have a maximum annual water allotment based on the size and age of the facility. The use by golf courses is further broken out in the Template, as it is the largest turf user. Golf course demand is water use at turf-related facilities that are used for playing golf that have a minimum of nine holes including any practice areas.

Electric Power: Electric power demand is the water use at large-scale power plants, which are industrial facilities that produce, or are designed to produce, more than 25 megawatts of electricity.

Dairy: Dairy demand is the water use at facilities that house an average of 100 or more lactating cows per day during a calendar year.

Feedlot: Feedlot demand is the water use at a facility that houses and feeds an average of 100 or more beef cattle per day during a calendar year.

Other Industrial: Other Industrial demand is the non-irrigation use of water not supplied by a city, town, or private water company, including animal industry use and expanded animal industry use that are not included in any of the specific Industrial subsectors described above.

Non-Conservation/Non-Municipal Facilities: Non-Conservation/Non Municipal Facility demand is the use by the few facilities (typically golf courses) that, because they are served entirely by CAP (having their own contract), are exempt from the turf and golf course conservation requirements in the Management Plans.

Drainage & Dewatering: Drainage and dewatering demand pertains to entities that must pump groundwater in order to drain or dewater a site for construction or continued use of a site. The water is not put to a beneficial use and as such is not included in overdraft calculations, although some of the water may return to the aquifer.

3.1.3 Agricultural Demand

Agricultural demand is composed of the use of water by IGFRs for agricultural uses not on Indian Reservations, and its associated lost and unaccounted for water. Agricultural use is the application of water to two or more acres of land to produce plants or parts of plants for sale or human consumption, or for use as feed for livestock, range livestock or poultry. In the Tucson AMA, and the other AMAs, only land associated with a certificate of IGFR can legally be irrigated with groundwater. During the early 1980s, ADWR issued these certificates based on the types of crops and the number of acres planted from 1975 to 1980. Land not irrigated during this period may not be irrigated, except under certain circumstances. The sub-categories of Agricultural demand and lost and unaccounted for water are explained below:

Non-Exempt IGFRs: Non-exempt IGFR use is the water use on land to which an IGFR is appurtenant and is greater than ten acres in size, or greater than two acres in size and part of an integrated farming operation. A person using groundwater pursuant to a non-exempt IGFR must comply with conservation requirements established in the Management Plan for each management period. Historically, the Base Conservation Program requirements were allotment-based: the number of IGFR acres was multiplied by the average water duty (the quantity of water reasonably required for crops grown on the IGFR acres between 1975 and 1980); the result was then divided by an assigned irrigation efficiency listed in each Management Plan (ADWR, 1999). Beginning in 2003, an optional BMP program was developed for non-exempt IGFRs as an alternative to allotments in the Base Conservation Program (ADWR, 2003).

Exempt IGFRs: In 1994, IGFRs less than ten acres in size and not part of an integrated farming operation were exempted from conservation requirements and reporting obligations. Water use by these rights located in the Tucson AMA was not considered in this Assessment, nor was demand projected for them, because it is negligible.

Agricultural Lost and Unaccounted for Water: This lost water is the total amount of water pumped or diverted minus the demand.

3.1.4 Indian Demand

Indian Demand is composed of *Municipal*, *Agricultural* and *Industrial* Demand on Indian Reservations, as described below. Indian water use is exempt from state regulation; however, it is included in this Assessment because of the physical impacts on the aquifer.

Municipal Indian Demand: Indian Municipal demand is the residential and non-residential water use on reservations.

Industrial Indian Demand: Indian Industrial demand is the water use associated with uses such as mines and other types of Industrial uses on Reservations.

Agricultural Indian Demand: Indian Agricultural demand is the water use required to grow crops on reservations.

3.1.5 Riparian Demand

A natural demand on the AMA's regional water supply is *riparian demand.* The majority of the riparian demand in the Tucson AMA is the water used as a result of evapotranspiration by riparian vegetation along the Santa Cruz River and its major tributaries. A significant portion of this riparian demand in the Tucson AMA is satisfied by reclaimed water discharged into and infiltrating from Managed USFs.

3.2 Supply

Historically water users in the Tucson AMA have relied heavily on groundwater. Over the past 30 years, utilization of renewable supplies has increased significantly. The following is a list of water supplies used during the period of 1985 to 2006 to meet the demands of the sectors in the Tucson AMA.

Groundwater: Groundwater is water from below the earth's surface.

Direct Use CAP: Direct use CAP is water distributed via the CAP canal and put to direct beneficial use.

Recovered CAP: Recovered CAP is water originally distributed via the CAP canal, then stored in either a USF or a GSF, then recovered under the authority of a recovery well permit. When recovered, this water legally counts as CAP water. In graphs in this Assessment that depict water use by source, recovered CAP is included with direct use CAP in the category "CAP".

Reclaimed Water: Reclaimed water is water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated as a sewage system, disposal plant or wastewater treatment facility. Such water remains reclaimed water until it acquires the characteristics of groundwater or surface water.

Recovered Reclaimed Water: Recovered reclaimed water is water that was stored in either an USF or a GSF, and then recovered under the authority of a recovery well permit. When recovered, this water legally counts as reclaimed water. In graphs in this Assessment that depict water use by source, recovered reclaimed water is included with reclaimed water in the category "reclaimed water".

Surface water: Surface water is the waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwater, wastewater or surplus water, and of lakes, ponds and springs on the surface.

Poor quality groundwater: Poor quality groundwater is water withdrawn pursuant to a poor quality groundwater withdrawal permit. Poor quality groundwater withdrawal permits are issued to non-irrigation users to withdraw poor quality groundwater if the groundwater withdrawn, because of its quality, has no other beneficial use at the present time. One exception is poor quality groundwater used pursuant to an approved remedial action, which is recognized in the AWS program as a supply that can be utilized in place of mined groundwater without affecting the allowable groundwater volume allotted to a DAWS.

In-lieu groundwater: In-lieu groundwater is water used in-lieu of groundwater pumped or delivered at a GSF. The entities that provide the alternative supplies to the GSF are permitted to pump an equivalent volume of water at some time in the future, via a recovery well permit. Because this recovered water retains the legal characteristics of the water originally used at the GSF (such as reclaimed water or CAP), the initial use by the recipients at the GSF (usually irrigation districts or individual farmers) is groundwater and as such is depicted as In-lieu groundwater in the Summary Budget.

Table 3-1 lists the water supplies that are in use, or have been used by each sector at some point from 1985 through 2006. These water supplies used historically in the Tucson AMA are the same supplies anticipated to be used in the future, although the various sectors may utilize them in different amounts than in the past.

Table 3-1 Historical Sector Use of Water Supplies Through 2006
Tucson Active Management Area

Source	Municipal	Industrial	Agriculture	Indian
Groundwater	√	√	√	√
Direct Use CAP	√		√	√
Recovered CAP	√	√		
Reclaimed Water	√	√	√	
Recovered Reclaimed Water	√	√		
In-lieu groundwater			√	
Surface water	√	√		
Poor Quality Groundwater	√			

3.3 Artificial Recharge

Artificial Recharge is a means of artificially adding water to the aquifer. In the Tucson AMA, artificial recharge is accomplished through the use of USFs and GSFs (described in Section 1.8). Water stored at these sites becomes long-term storage credits for the storers, which can be recovered at a later date. At the time these long-term storage credits are used (recovered), the recovered water retains the legal characteristic of the water supply stored at the recharge facility (such as reclaimed water or CAP). Water may also be stored at USFs on an annual basis so that it is stored and recovered during the same calendar year and does not accrue a long-term storage credit.

Underground Storage Facilities (USFs): A USF is a facility that stores water in the aquifer. There are two types: *Constructed* and *Managed.* A Constructed USF is one in which water is stored in an aquifer by using some type of constructed device, such as an injection well or percolation basin. A Managed USF is a facility at which water is discharged to a naturally water-transmissive area such as a streambed that allows the water to percolate into the aquifer without the assistance of a constructed device. Historically, USFs in Tucson have stored CAP, reclaimed water, and a very small amount of surface water.

Groundwater Savings Facilities (GSFs): A GSF is a facility, such as an irrigation district or specific farm, to which a renewable supply is delivered to a recipient who agrees to curtail groundwater pumping and use the water in-lieu of that groundwater. Typically, a separate entity holds the Water Storage Permit (and has the legal right to the renewable supply) and accrues long-term storage credits for each acre-foot of water used in-lieu of the groundwater. Historically, GSFs in the Tucson AMA have stored CAP.

Artificial recharge plays an important role in meeting the safe-yield management goal. Pursuant to the AWS requirements, development associated with CAWS and DAWS must prove 100-year water supplies that are consistent with the Tucson AMA safe-yield management goal. This dictates that most or all of these supplies must come from renewable sources. For example, using CAP water can meet or offset a provider's obligation to use renewable supplies. However, there are some factors that affect a water user's ability to utilize CAP water directly, including having a CAP allocation and/or access to excess or leased CAP supplies, proximity to the main CAP distribution system, and access to treatment facilities and distribution systems to directly treat and deliver CAP water to customers.

Many municipal providers may not have physical or legal access to CAP water. For these providers, membership in, and replenishment by, the CAGRD is an option for meeting consistency with the management goal. Entities who are seeking to demonstrate an AWS can voluntarily join the CAGRD to meet the consistency with management goal requirement. The CAGRD must replenish any groundwater used in excess of the allowable groundwater volume (excess groundwater) used by its members within three years after the amount of excess groundwater use is reported, and does so through replenishment (storage) at a USF or GSF.

Some of the water stored at a USF or GSF is also debited to assist the AMA in achieving the statutory management goal. CAP water stored for long-term storage credits is debited a five percent cut to the aquifer, unless it is stored directly into specific CAGRD accounts that do not incur the debit. Annual or long-term reclaimed water storage at a Constructed USF or a GSF does not have a cut to the aquifer; however, reclaimed water stored at a Managed USF is debited 50 percent. These cuts to the aquifer help the AMA reach safe-yield and are included in the Summary Budget as an offset to overdraft.

Another mechanism that can be used to assist the AMA in achieving its management goal is unrecoverable recharge (or groundwater augmentation). Although this is rarely, if ever, used, an entity could recharge water for the benefit off the AMA, without accruing long-term storage credits. The stored water does not retain its original legal characteristic but would simply become part of the available groundwater supply for the benefit of all water users in the AMA.

Underground storage and recovery is an important water management tool, but it does not always directly offset overdraft. Although CAGRD replenishment is factored into the Summary Budget, and cuts to the aquifer assist in reaching safe-yield, many of the recharge activities (such as accrual of long-term storage credits) are not factored into the Summary Budget. Even though local water levels may rise in the areas of hydrologic impact of artificial recharge, that water is in effect already spoken for – it has been stored with the intent of recovering it at a later date.

3.4 Offsets to Overdraft

Offsets to overdraft are quantities of water that recharge the aquifer, either as a result of the natural system or cultural activity, and therefore “offset”, at least in part, groundwater pumping. These include, net natural recharge, incidental recharge, cuts to the aquifer, supplies identified in the AWS Rules, CAGRD replenishment, reclaimed water discharge, and conservation.

3.4.1 Net Natural Recharge

The natural components that affect groundwater overdraft include mountain front recharge, streambed infiltration of runoff, and underflow (subsurface migration of water) into and out of the Tucson AMA. These components are described in more detail below.

Mountain Front Recharge: Mountain front recharge is natural recharge that originates as precipitation falling in the mountains of the two sub-basins (Upper Santa Cruz Valley and Avra Valley) that compose the Tucson AMA. Precipitation falling in the mountains and along the valley floors is the largest source of natural inflow to the Tucson AMA (Mason & Bota, 2006).

Streambed infiltration: Streambed recharge occurs when precipitation creates flow events that infiltrate into the normally dry beds of the Santa Cruz River and its tributaries (Mason & Bota, 2006).

Groundwater Inflow: Groundwater Inflow is water that flows into the Tucson AMA as groundwater flows northward from the Santa Cruz AMA into the Tucson AMA in the Upper

Santa Cruz Valley Subbasin, and to the east through the bedrock gap near Vail, Arizona, where Pantano Wash enters the Tucson AMA (Mason & Bota, 2006).

Groundwater Outflow: Groundwater outflow occurs when groundwater exits the Tucson AMA and flows into the Pinal AMA through the gap between the Silverbell and Picacho Mountains (Mason & Bota, 2006).

The sum of mountain front recharge, streambed infiltration, and groundwater inflow minus groundwater outflow gives the total *Net Natural Recharge*. The amount of Net Natural Recharge can vary from year to year with the amount of precipitation and the timing and magnitude of storm events; however, the rates for mountain front recharge and streambed infiltration used in this Assessment are averages based on historical rates and are held constant through the historical and projected periods (*See Table 3-2*). Average rates for groundwater inflow and groundwater outflow varied slightly for the historical and projected period and were based on the ADWR Tucson Regional Groundwater Flow Model (Mason & Bota, 2006).

Table 3-2 Components of Net Natural Recharge
1985 – 2025
Tucson Active Management Area

Element of Net Natural Recharge	Acre Feet/Year
Mountain Front Recharge	34,445
Streambed Infiltration	39,270
Groundwater Inflow	24,710
Groundwater Outflow	-16,461
Total Net Natural Recharge	**81,964**

All values are in acre-feet. Source: (Mason & Bota, 2006)

3.4.2 Incidental Recharge

Another offset to groundwater overdraft is incidental recharge. Incidental recharge is a by-product of water used for human activities; one example is percolation of irrigation water below the root zone of irrigated crops. ADWR assigns incidental recharge rates for Municipal, Industrial and Agricultural demands (both on and off Indian Reservations) and for canal seepage (*See Table 3-3)*.

For purposes of this Assessment, incidental recharge for the Municipal and Industrial sectors is assumed to occur in the year the water is applied. However, for the Agricultural sector, the incidental recharge is assumed to gradually reach the water table over a 20-year period, based on information from the ADWR Tucson Regional Groundwater Flow Model (Mason & Bota, 2006).

The final component of incidental recharge is *Canal Seepage*, which is the water that seeps annually into the aquifer from canals. Canal seepage amounts for this Assessment are consistent with the information contained in the Tucson AMA Regional Groundwater Flow Model and are held constant at 3,657 acre-feet annually.

Table 3-3 Incidental Recharge Rates Used in the Summary Budget
1985, 1995, and 2006
Tucson Active Management Area

Source of Incidental Recharge	Percent of Total Demands or Volume Applied to Source of Recharge		
	1985	1995	2006
Municipal Demand			
Municipal Demand	4%	4%	4%
Agricultural Demand[1]			
Agriculture	60,779	23,173	22,003
Indian Agriculture	n/a	n/a	n/a
Industrial Demand			
Turf-related Facilities, Sand and Gravel Operations, and Metal Mines	12%	12%	12%
Other Industrial Facilities	4%	4%	4%
Dairies, Feedlots and Power Plants	0%	0%	0%
Canal Seepage	3,657	3,657	3,657

Note: [1]Agricultural incidental recharge is calculated in the ADWR Tucson Regional Groundwater Flow Model on a cell-by-cell basis and is in acre-feet. Indian Agricultural recharge is combined with Agricultural incidental Recharge through 2006. Volumes are in acre-feet.

3.4.3 Cuts to the Aquifer

Pursuant to Underground Storage and Recovery Program, permitted artificial recharge, in many cases, requires that a certain percentage of the recharged volume is non-recoverable, to benefit the aquifer. These required non-recoverable volumes are called *cuts to the aquifer* and help offset groundwater overdraft. CAP water stored at constructed facilities carries a five percent cut to the aquifer; reclaimed water stored at Constructed USFs carries no cut to the aquifer; and reclaimed water stored at Managed USF carries a 50 percent cut to the aquifer. In addition to the 50 percent cut to the aquifer, reclaimed water delivered to a Managed USF can also offset a portion of the riparian demand in the wash or river where the project is located. The amount of reclaimed water used by the riparian vegetation is calculated and then subtracted from the total amount delivered before the 50 percent cut is calculated for the facility. It is assumed in this Assessment that a significant portion of the Tucson AMA riparian demand is accounted for as ET losses occurring at two permitted managed reclaimed water USFs in the Santa Cruz River channel.

3.4.4 Assured Water Supply and CAGRD Replenishment

The AWS Rules require use of primarily renewable supplies, such as CAP water and reclaimed water by DAWS and CAWS issued after 1995. However, pursuant to the AWS Rules, a certain volume of groundwater is allowed to be used. These groundwater allowances are intended to help municipal providers transition from groundwater to renewable supplies. Groundwater use by a DAWS or CAWS can be classified into two categories: allowable groundwater or excess groundwater.

When a CAWS or DAWS is issued, a groundwater allowance account is established. ADWR credits additional allowable groundwater to these accounts based on a number of factors. The AWS Rules allow for a limited volume of groundwater to be pumped based on formulas for each AMA in the AWS Rules. The volume of this allowable groundwater use is reduced over time to zero in 2025 in the Tucson AMA. The AWS Rules also allow for a limited volume of poor quality groundwater, used pursuant to an approved remedial action plan, to be added each year to the groundwater allowance through the year 2025. Additionally, groundwater withdrawn in areas that have been identified by ADWR as "waterlogged" and are exempt from the conservation requirements, may be deemed by ADWR to be consistent with the management goal. The AWS Rules also allow for a DAWS or CAWS to add to the groundwater allowance by extinguishing (or retiring) grandfathered rights (IGFRs, Type 1 and Type 2 rights) within the same AMA. The calculation of theses extinguishment credits are contained in the AWS Rules and are calculated differently for each AMA. Finally, a DAWS, regardless of date issued, is annually allocated an incidental recharge volume (four percent of the water provider's total demand in the previous calendar year), which is credited to their groundwater allowance account. Groundwater use reported pursuant to the provider's or subdivision's allowable groundwater volume, is considered consistent with the management goal of the AMA.

In contrast, excess groundwater is not considered consistent with the management goal, and must be replaced by a renewable supply. A provider may choose to utilize their own renewable supplies or can voluntarily join the CAGRD. The CAGRD has the obligation to replenish the amount of excess groundwater reported by member service areas (providers with a DAWS) or member lands (subdivisions issued CAWS) with renewable supplies. CAGRD replenishment must take place within three years after excess groundwater is reported. Excess groundwater must be replenished within the AMA where it was withdrawn, but is not required to be replenished in the same *location* within the same AMA as where it was withdrawn. Excess groundwater is debited in the year it is utilized; however, while the CAGRD has three years to replenish the excess groundwater, for purposes of this Assessment, replenishment by the CAGRD is an offset to overdraft in the same year the groundwater is debited.

3.4.5 Reclaimed Water Discharge

Historically, reclaimed water has been discharged into the Santa Cruz River from the Pima County Regional Wastewater Treatment Facilities (WWTF) at Roger and Ina Roads. The percentage of the total volume of discharged reclaimed water counted as an offset to groundwater overdraft is calculated based on infiltration studies (Galyean, 1996). Portions of the reclaimed water discharged from the Roger Road WWTF after 1996 and from the Ina Road WWTF after 2003 were included as supply in Managed USFs. These changes have not affected the amounts of reclaimed water discharged from the WWTFs or the total amount of reclaimed water that infiltrates and recharges the aquifer, but the permitting and subsequent credit accrual does affect accounting with respect to the overdraft calculation, as those credits may later be used by the storer.

3.4.6 Contribution of Conservation and Renewable Supplies

Conservation of water supplies, including groundwater, is not explicitly accounted for in the Summary Budget. However, because less groundwater is withdrawn, conservation intuitively provides a clear benefit toward reaching safe-yield. Each water use sector (Municipal, Agricultural and Industrial) has associated conservation requirements that are described in the *Third Management Plan for Tucson Active Management Area, 2000-2010*.

Direct use of renewable supplies also offsets the amount of groundwater that would otherwise be used, and assists in reaching safe-yield. Management Plan provisions provide incentives for use of renewable supplies including surface water, CAP water, and reclaimed water to meet conservation requirements.

4. CALCULATING OVERDRAFT IN THE SUMMARY BUDGET

The management goal of the Tucson AMA is safe-yield; therefore, monitoring the effects of the cumulative impacts of demand on the aquifer is critical. The components listed in Section 3 above are included in the Summary Budget and are critical in identifying the AMA's success toward achieving the statutory management goal of safe-yield. If the AMA has not achieved safe-yield, it is in an overdraft condition and the ADWR uses this information to evaluate what additional tools are necessary to assist the AMA in achieving its goal.

Table 4-1 lists the various inputs to and withdrawals from the aquifer that are used to estimate groundwater overdraft. Inputs, which are considered additions to the aquifer, include incidental recharge contributed by the various sectors, net natural recharge, cuts to the aquifer as required by the Underground Storage and Recovery statutes, and replenishment by the CAGRD as required by the AWS Rules (See Section 3.4 for a discussion on these components). Withdrawals from the aquifer include withdrawals of groundwater by various water use sectors, riparian demand, and groundwater outflow. In addition, when a farmer uses CAP or reclaimed water in-lieu of groundwater pumping at a GSF, that use is considered a withdrawal because at some unknown point in the future, the storer, such as a municipal provider, will withdraw water from the aquifer.

Table 4-1 Overdraft Inputs and Withdrawals

Inputs	**Withdrawals**
Sector Incidental Recharge	Sector Pumpage
Municipal	*Municipal*
Industrial	*Industrial*
Agriculture	*Agriculture*
Indian Agriculture	*Indian Agriculture, Municipal and Industrial*
Canal Seepage	Riparian Demand
Net Natural Recharge	
Riparian Use of Managed Reclaimed Water	
Reclaimed Water Discharge	
CAGRD Replenishment	
Artificial Recharge Cut to the Aquifer	

Note: Estimated Overdraft (with and without the Groundwater Allowance) = Inputs – Withdrawals

Annual groundwater overdraft is calculated by subtracting withdrawals from the inputs, or recharge. If groundwater withdrawals exceed the offsets or inflows, there is overdraft. Part III describes and quantifies the historical water use and overdraft for the Tucson AMA for the historical period of 1985 to 2006.

PART III HISTORICAL WATER DEMANDS AND OVERDRAFT

5. HISTORICAL WATER DEMANDS BY SECTOR

The proportion of water demand among the sectors has changed (primarily in the Agricultural and Municipal sectors) since 1985. In 1985, Municipal demand accounted for 40 percent of the total AMA demand, Agricultural demand accounted for an additional 40 percent and the remaining 20 percent was for Industrial demand. In 1995, Municipal demand accounted for 50 percent of the total AMA demand, Agricultural demand was down to 31 percent of the total AMA demand and the remaining 19 percent was for Industrial demand (ADWR, 2003).

Historically, water users in the Tucson AMA have been groundwater dependant. Although groundwater remains the primary source of supply for water users in the Tucson AMA, the use of reclaimed water and CAP is increasing. Tucson Water, the largest water user in the Tucson AMA, began receiving direct delivery of CAP water in 1992. Peak delivery occurred in 1993. Treatment and delivery issues caused Tucson Water to cease direct delivery of CAP in 1994, although, they have led efforts in recharge and recovery of CAP in the AMA. Agricultural and Industrial water users are also increasingly taking advantage of indirect utilization of CAP water and/or reclaimed water. Historical demand and supplies for each sector are discussed in more detail below.

5.1 Municipal Sector Demands & Supplies

The Municipal sector in the Tucson AMA includes five categories of water users: Large, small, and institutional providers, domestic exempt well users and individual users. The Arizona Corporation Commission regulates 18 of the 26 large providers and 24 of 118 small providers in the Tucson AMA as private water companies. The other providers are cities, towns, domestic water improvement districts, community facilities districts, cooperatives, mobile home parks, and providers serving specific locations such as colleges and small correctional facilities.

5.1.1 Municipal Demands

Total Municipal water demand in the Tucson AMA was 75,887 acre-feet greater in 2006 than in 1985, an increase of slightly more than 66 percent (*See Table 5-1*). Even though small provider and exempt well demand has increased at a similar rate, large municipal providers account for most of this demand. Between 1985 and 2006, eight small providers began using more than 250 acre-feet of water per year and became regulated by ADWR as large providers. Overall, the number of small providers has remained relatively stable. *Figure 5-1* shows the locations of the large and small provider service areas. The single institutional provider in the Tucson AMA, the Arizona State Prison increased its usage from 115 acre-feet in 1985 to 731 acre-feet in 2006. Between 1985 and 2006, the number of exempt domestic wells in the Tucson AMA has nearly doubled.

Table 5-1 Municipal Water Demand 1985, 1995 and 2006
Tucson Active Management Area

Municipal Use Category	1985	1995	2006
Large Providers			
Number	18	18	26
Total Use	109,812	147,675	182,891
Groundwater	109,812	141,150	94,556
Small Providers			
Number	116	122	118
Total Use	2,728	5,472	4,624

Municipal Use Category	1985	1995	2006
Groundwater	2,728	5,472	4,624
Institutional Providers			
Number	1	1	1
Total Use	115	593	731
Groundwater	115	593	731
Domestic Well			
Number	3,725	4,701	7,389
Total Use	425	548	721
Groundwater	425	548	721
Total Demand	**113,080**	**154,288**	**188,967**
Total Groundwater	**113,080**	**147,763**	**100,631**

Note: All water values are in acre-feet.

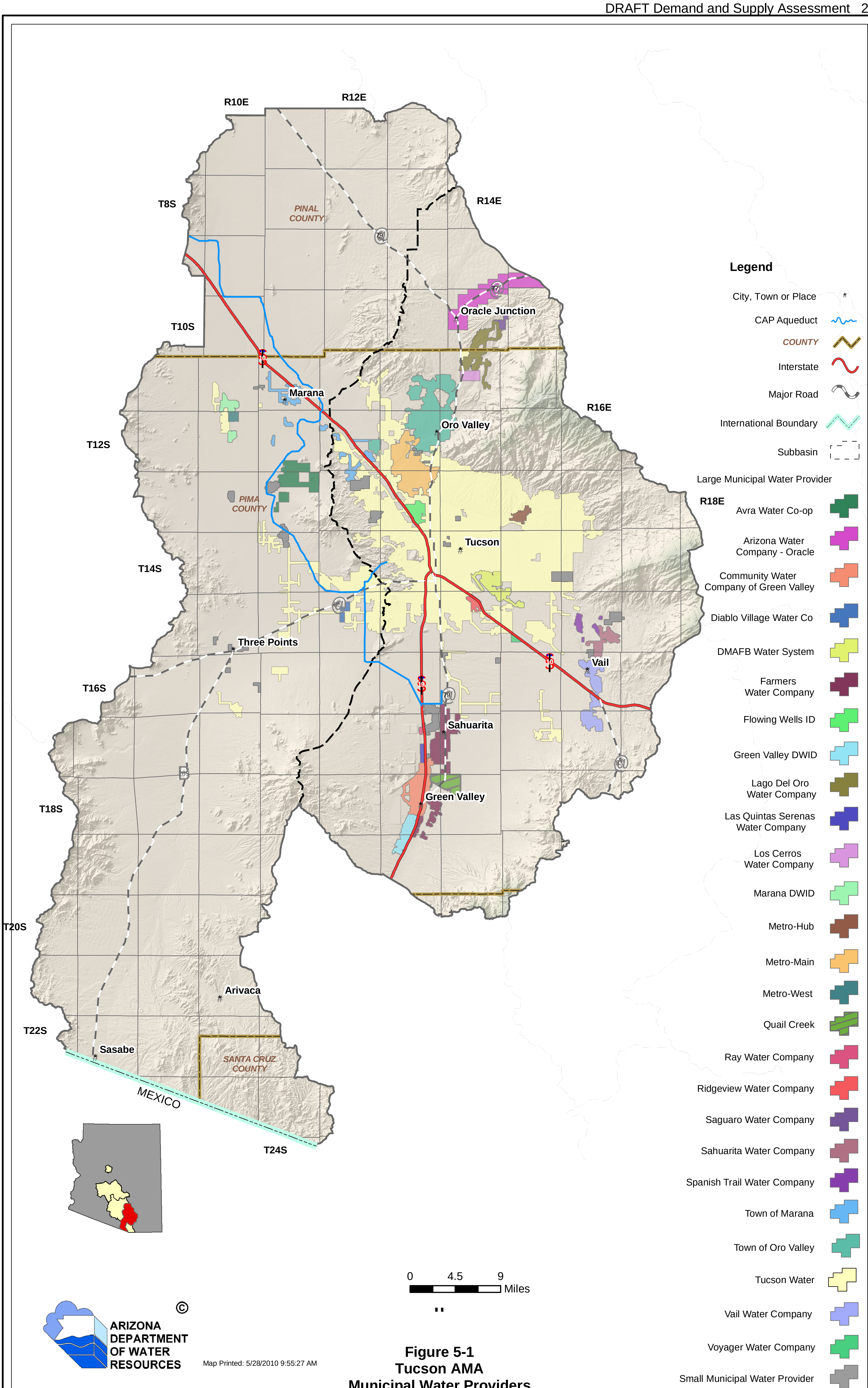
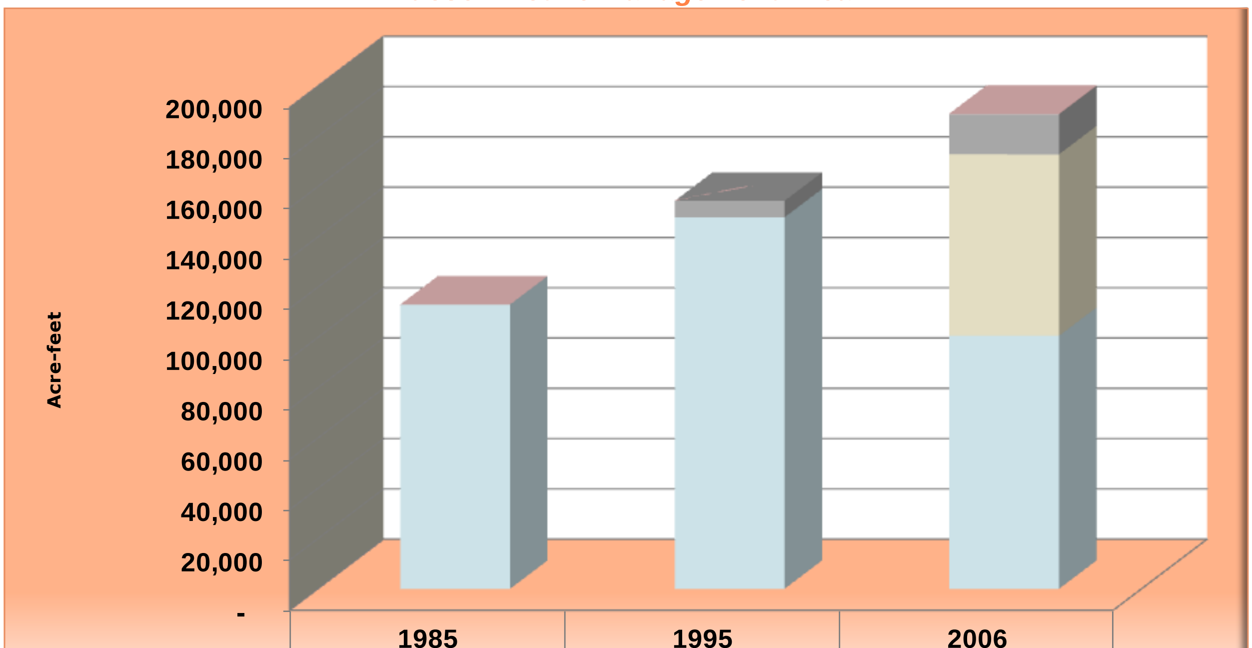


Figure 5-1
Tucson AMA
Municipal Water Providers

5.1.2 Municipal Supply

Groundwater is still the largest source of supply used in the Municipal sector. Since CAP water became available and was first used in 1992, its use has increased significantly. Direct use of reclaimed water has increased each year since 1988 when reporting of its use began. Supplies utilized by municipal providers are illustrated below in *Figure 5-2.*

Figure 5-2 Historical Municipal Supplies, 1985, 1995 and 2006
Tucson Active Management Area



	1985	1995	2006
TOTAL	113,080	154,288	188,967
Surface Water	-	-	210
Reclaimed Water	-	6,525	15,947
CAP	-	-	72,179
Groundwater	113,080	147,763	100,631

5.1.3 Large Municipal Providers

Large Provider Water Use Characteristics

There are currently 26 large municipal providers in the Tucson AMA (*See Figure 5-1*). As shown on *Table 5-1*, more than half of the large municipal provider demand is met with groundwater. Central Arizona Project (CAP) water and reclaimed water make up the non-groundwater portion of the demand, primarily through underground storage and recovery, increasing from less than 100 acre-feet in 2000 to more than 70,000 acre-feet in 2006. Utilization of reclaimed water occurs primarily for landscape irrigation and indirectly through storage and recovery.

Large Provider Demand and Supply

Large provider demand has steadily increased since 1985, increasing more than 66 percent between 1985 and 2006. Although other areas of the state have seen rapid growth in recent years, large provider population in the Tucson AMA has increased an average of only 2.5 percent per year.

The *City of Tucson* is the largest water provider in the Tucson AMA, representing 78 percent of the large municipal provider demand and 76 percent of the total Municipal sector demand. In 2006, Tucson Water's demand was met with 44 percent CAP water, 46 percent groundwater, and 10 percent reclaimed water.

The *Town of Oro Valley* is the second largest municipal provider in the Tucson AMA based on the amount of water served. In 2006, it accounted for almost six percent of total large provider demand. Historically, the Town of Oro Valley has relied exclusively on groundwater. In 2005, it added CAP water to its supply and began using some reclaimed water to serve golf courses. In 2006, groundwater made up 83 percent of the Town of Oro Valley's supply, CAP water accounted for three percent and direct use of reclaimed water accounted for the remaining 14 percent.

The *Metropolitan Domestic Water Improvement District's* main system (Metro-Main) is the third largest provider in the Tucson AMA, accounting for slightly less than five percent of large provider demand in 2006. Metro-Main has used a high percentage of CAP water since 2003. By 2006, 98 percent of Metro-Main's demand was met with recovered CAP water, with the remainder being groundwater.

Other large municipal providers using renewable supplies include Green Valley Domestic Water Improvement District (DWID), which indirectly uses untreated CAP water for golf course irrigation; the University of Arizona, which uses reclaimed water for landscape irrigation; and Vail Water Company, which uses CAP water indirectly through underground storage and recovery. The remainder of Municipal demand is met with groundwater.

Factors Affecting Large Provider Water Use

The Tucson AMA lacks a large CAP storage reservoir; however, municipal providers are committed to using CAP water and reclaimed water as much as is feasible. So far, the number of USFs has met provider demand, but more CAP water could be used if additional distribution infrastructure were in place. The same holds true for reclaimed water, although reclaimed distribution lines have been extended over time.

With the exception of Tucson Water, municipal providers in the Tucson AMA that are designated as having an assured water supply rely to a significant extent on the CAGRD (*See Table 5-2*). The CAGRD recharges water to offset groundwater pumping, allowing designated providers to meet consistency with the safe-yield goal of the AMA as required by the AWS Rules.

Green Valley DWID and Community Water Company of Green Valley both have CAP allocations, but the infrastructure to deliver the CAP water to the Green Valley area does not yet exist. However, Green Valley DWID has been recovering stored CAP water on an annual basis in recent years.

As long as sufficient underground storage capacity is available and to the extent that distribution infrastructure continues to expand, the limiting factor on the use of renewable supplies by Tucson AMA large providers will be availability of the supplies: the allocations and excess CAP water available and reclaimed water that can be stored underground or directly used.

Table 5-2 Designated Water Providers
Tucson Active Management Area

Municipal Provider	Date Designation Issued or Modified	Projected Estimated Demand	Year of Projected Estimated Demand
City of Tucson	06/12/07	183,956	2015
Marana Municipal Water System	05/07/07	7,580	2017
Metropolitan Domestic Water Imp. Dist – West	09/25/06	1,014	2016
Metropolitan Domestic Water Imp. Dist – Main	07/31/06	13,302	2016
Sahuarita Water Company	12/01/04	2,578	2014
Spanish Trail Water Company	01/05/09	4,388	2020
Town of Oro Valley	06/26/03	15,049	2013
Vail Water Company	11/01/05	3,749	2015
Willow Springs Utilities Company	04/15/08	2,635	2017

Note: All water values are in acre-feet.

5.1.4 Small Municipal Providers

Small Provider Water Use Characteristics

The number of small municipal providers has not changed significantly in the Tucson AMA since 1985, although small provider demand has increased (*See Table 5-1*). Small providers rely solely on groundwater.

Small Provider Demand and Supply

Small provider demand has had two periods of relative stability separated by a large increase between 1993 and 1994. This increase corresponds to the statutory change that redefined large providers from providers serving over 100 acre feet of water per year to providers serving over 250 acre-feet of water per year. From 1985 through 1993, small provider demand ranged from 2,500 to 3,000 acre-feet per year. From 1994 through 2006, it ranged from about 4,000 to 6,000 acre-feet per year due to the addition of systems previously defined as large providers.

Small providers within the Tucson AMA use 100 percent groundwater; none have CAP allocations.

Factors Affecting Small Provider Water Use

Small providers have little incentive to initiate use of renewable supplies. New subdivisions, served by small providers that have not obtained a DAWS, must obtain a CAWS. If the CAWS is issued, the subdivision can meet the consistency with the management goal requirement through a combination of using their groundwater allowance, extinguishment credits, and/or by joining the CAGRD as a member land.

5.1.5 Exempt Well Demand and Supply

The number of exempt wells in the Tucson AMA have increased steadily from 3,725 in 1985 to 7,389 in 2006. Exempt well demand is estimated to have been about 721 acre-feet in 2006.

Exempt Well Demand and Supply

Exempt well owners are not required to report volume used or number of people relying on the exempt well. Because of this, exempt well demand and population were estimated for the historical period. The exempt well population in the year 2000 was calculated by subtracting the known populations of the large providers and small providers based on data from the 2000 US

Census population for the AMA. The Pima County historical growth rate was used to regress from the year 2000 exempt well population to an estimate of the 1985 exempt well population. The same growth rate was used to estimate exempt well population from 2001 through 2006. This method yielded exempt well populations of 3,621 in 1985 and 6,143 in 2006.

The exempt well water demand can only be estimated because the statutes do not require reporting by exempt wells. In previously published documents, ADWR has used an assumption of between 0.5 and 1.0 acre-feet per well per year. For this Assessment, ADWR used a different approach. The interior and exterior demand models for new single family development (ADWR, 2003) and the 2000 US Census average persons per household for Pima County were used to estimate exempt well demand. As a result, a demand of 105 gallons per person per day was applied to the population number.

Exempt wells are assumed to use 100 percent groundwater.

Factors Affecting Exempt Well Use

Because exempt wells are unregulated, there is no requirement or incentive to use renewable water supplies. Under the AWS Rules, dry lot subdivisions of 20 or fewer lots are not required to meet the consistency with management goal requirement. A dry lot subdivision is a development where each lot purchaser is responsible for drilling and maintaining their own private domestic exempt well. Consequently, new exempt wells added to the AMA in small subdivisions or through un-subdivided lot splits do not join the CAGRD and their withdrawals of groundwater are not replenished.

5.1.6 Individual User Water Use Characteristics

Water demands for individual users are included in the demands for large, small and institutional providers – although they have their own conservation requirements under the Industrial Conservation Program in the Management Plans. Of the 87 individual users in the Tucson AMA, 29 are golf courses, 26 are parks, and 32 are schools. Reclaimed water is the primary source of supply, accounting for more than 80 percent of the demand. Untreated CAP water is also used, but accounts for less than five percent of the demand. The remainder of the water supply is groundwater.

5.2 Industrial Sector Demands and Supplies

The 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 and expanded animal industry use. In general, 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 (*See Table 5-3)*. Although industrial users are primarily dependant on groundwater, some use renewable supplies, such as CAP water or reclaimed water. Historically, industrial uses in the Tucson AMA have included metal mining, turf related facilities, sand and gravel operations, electric power generation, and dairies. For more information regarding Industrial users, refer to Section 3.1.2.

5.2.1 Overview of Industrial Rights and Authorities

Type 1 and Type 2 rights are the predominant withdrawal authority used by Industrial users. Industrial users can also withdraw water pursuant to groundwater withdrawal permits such as GIU permits or Mineral Extraction permits (limited permits used for mining operations or sand and gravel operations). All of these rights and permits have an allotment associated with them that limits the amount of water that can be withdrawn on an annual basis. In addition to these associated right and permit allotments, certain types of Industrial facilities are subject to conservation requirements that may impose additional restrictions on the amount of water that can be used at a facility.

Table 5-3 Industrial Groundwater Rights and Withdrawal Summary
2006
Tucson Active Management Area

User Category	Right or Permits	Number of Facilities	Right or Permit Volume	Groundwater Use	Total Water Use
Metal Mines	Type 1 Non-Irrigation Rights, Type 2 Mineral Extraction Rights, Mineral Extraction Permits	4	66,522	34,905	34,905
Turf-Related Facilities[1]	Type 1 and 2 Non-Irrigation Rights, General Industrial Use Permits	29	11,726	6,830	8,249
Sand and Gravel Facilities	Type 1 and 2 Non-irrigation Rights, Type 2 Mineral Extraction Rights, General Industrial Use Permits, Mineral Extraction Permits	18	12,783	3,807	3,807
Other Industrial Facilities	Type 1and 2 Non-Irrigation Rights, General Industrial Use Permits	120	66,974	3,357	3,357
Large-Scale Power Plants	Type 2 Electrical Generation Rights	2	10,079	2,656	2,656
Dairies	Type 2 Non-Irrigation Rights	1	283	110	110
Total		**174**	**168,367**	**51,665**	**53,084**

Note: All water values are in acre-feet. [1]Includes Industrial turf-related facilities only. The majority of turf-related facilities in the Tucson AMA are served municipal water and are considered individual users.

Industrial use is dependent on population growth and the economy. In some cases, the difference between the actual water use and the total allotment is substantial (*See Table 5-3*), and is generally explained as a result 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. On average, approximately 30 percent of the Tucson AMA's industrial rights and permit volumes are used.

5.2.2 Industrial Demand and Supply by Subsector

The Industrial sector in the Tucson AMA has been relatively stable since 1985 with the exception of periodic fluctuations caused by its largest subsector - metal mining. Total Industrial water use in the Tucson AMA was 46,616 acre-feet in 1985, 60,589 acre-feet in 1995, and 53,084 acre-feet in 2006 (*See Table 5-4*).

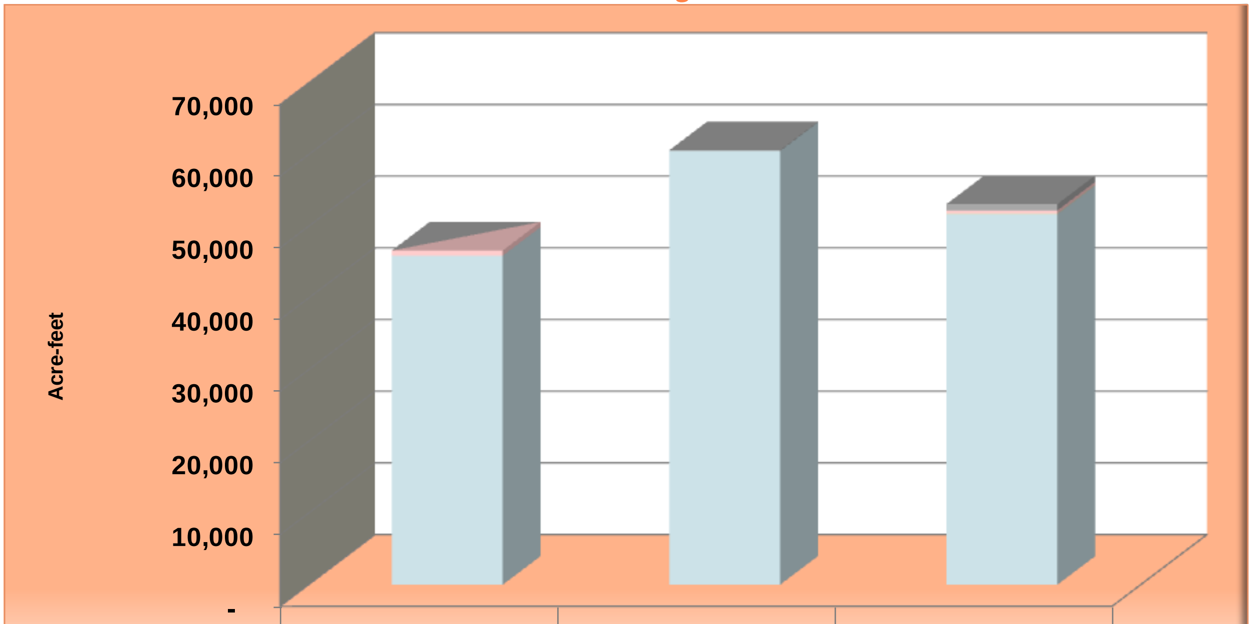
Table 5-4 Industrial Water Demand by Subsector
1985, 1995 and 2006
Tucson Active Management Area

Type of Facility	1985	1995	2006
Metal Mines	26,945	42,014	34,905
Turf-Related Facilities	6,423	7,610	8,249
Sand and Gravel Operations	4,420	5,337	3,807
Other Industrial Users	5,782	3,943	3,357
Large Scale Power Plants	2,598	1,611	2,656
Dairies	449	73	110
Total	**46,616**	**60,589**	**53,084**

Note: All values are in acre-feet. In 1985, Other Industrial Use includes 20 acre-feet of water used by feedlots. By 1993, feedlot water use in the Tucson AMA was zero.

The increase in water use in 1995 corresponds to a period of peak metal mining production. The non-mining subsector water use in the Tucson AMA has remained relatively static at approximately 20,000 acre-feet per year over the last twenty years; mining use has fluctuated between 25,000 and 43,000 acre-feet per year depending on the condition of the copper market. Groundwater has been, and continues to be, the primary source of Industrial water supply in the Tucson AMA (*See Figure 5-3*). Each sub-sector of Industrial water demand and supply are discussed below.

Figure 5-3 Historical Industrial Supplies, 1985, 1995 and 2006
Tucson Active Management Area



	1985	1995	2006
TOTAL	46,616	60,589	53,084
Reclaimed Water	-	89	883
Surface Water	720	-	400
CAP	-	-	135
Groundwater	45,896	60,500	51,665

Metal Mining

There are three active mines and one inactive mine in the Tucson AMA. ASARCO owns and operates two of the active mines. The ASARCO Mission mine is an open pit mine in the Sahuarita area. The ASARCO Silver Bell mine is a surface leaching mine located near the Pinal /Tucson AMA boundary close to the Silver Bell Mountains. Freeport McMoRan owns and operates the largest of the Tucson AMA open pit mines, the Sierrita mine, located just west of the Sahuarita/Green Valley area. The Twin Buttes Mine, located adjacent to the Sierrita mine, is currently inactive (*See Figure 5-6*).

In 2006, the mining subsector had a combined total of 66,522 acre-feet of grandfathered groundwater rights and permits available. In 2006, it used 34,905 acre-feet of water, approximately half of its total allotment. Metal mining has been the dominant Industrial subsector in the Tucson AMA since 1985 accounting for approximately 65 to 70 percent of the sector's total demand (*See Figure 5-4* and *Figure 5-5)*. Mining water use in the Tucson AMA peaked in the mid-1990s when the annual total neared 43,000 acre-feet then decreased to levels similar to those of the late 1980s (*See Table 5-4*).

Metal mining in the Tucson AMA has historically relied on groundwater. However, the SAWRSA gave ASARCO the right to use up to 10,000 acre-feet of CAP water from the Tohono O'odham Nation (TON) annually. ASARCO Mission Mine Complex, located adjacent to the San Xavier District, has historically received a portion of its groundwater supply from the TON's wells. In 1995, ASARCO pumped approximately 2,982 acre-feet of groundwater from three wells on the TON. In 2006, this amount had dropped to 842 acre-feet. This groundwater use has been categorized as Indian Industrial use in this Assessment and is discussed further in Section 5.4. ASARCO has agreed to decrease its groundwater pumping and to increase its use of CAP water at their Mission Mine Complex.

Figure 5-4 Proportion of Industrial Demand by Subsectors 1995
Tucson Active Management Area

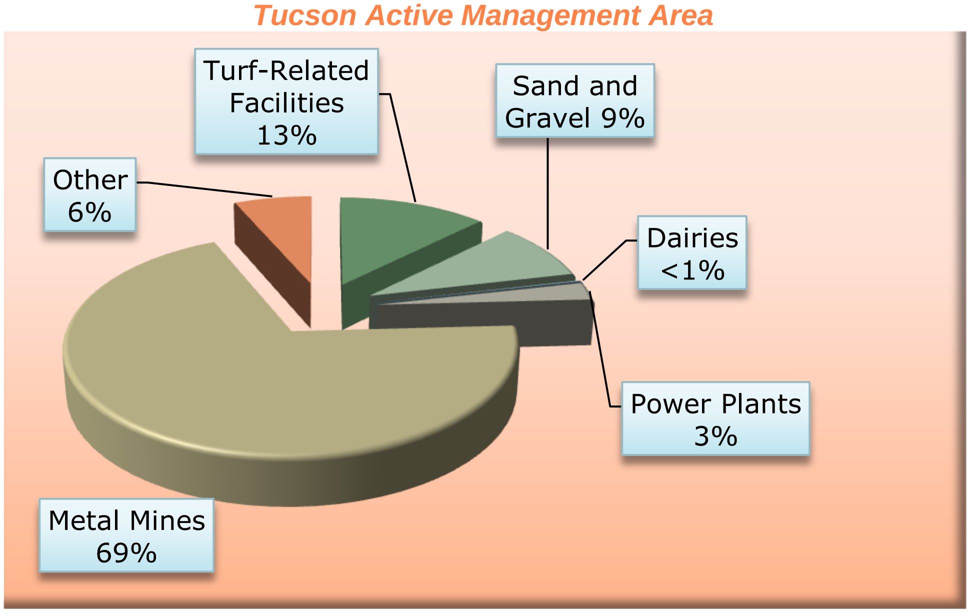
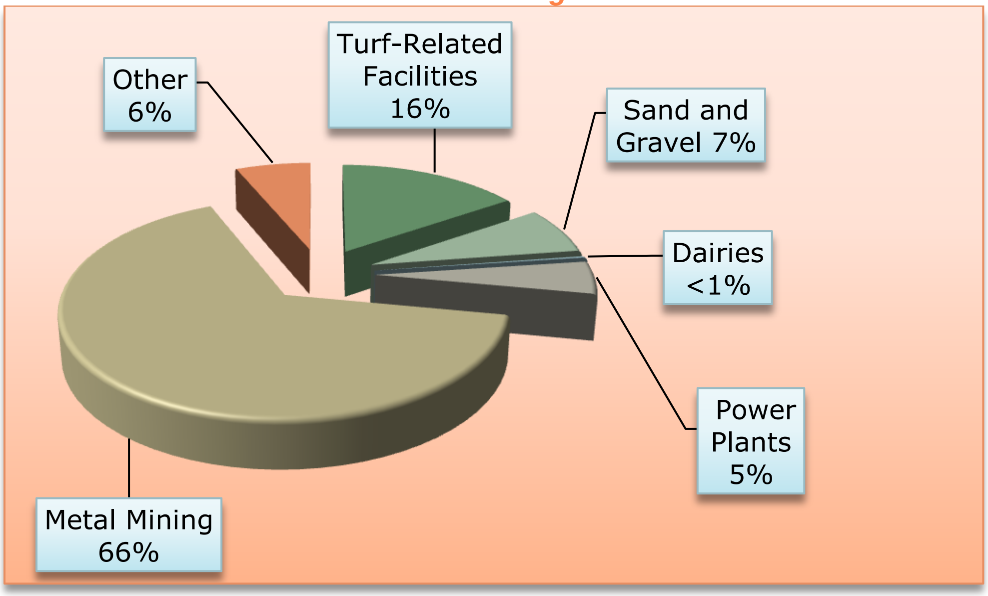


Figure 5-5 Proportion of Industrial Demand by Subsectors 2006
Tucson Active Management Area



Turf-Related Facilities

A turf-related facility is defined in the *Third Management Plan for Tucson Active Management Area, 2000-2010* as a facility with 10 or more acres of water intensive landscaped area. Turf-related facilities are generally parks, schools, cemeteries, and golf courses. In 2006, there were a total of 116 turf-related facilities in the Tucson AMA. Total water use by all turf-related facilities in the Tucson AMA was 26,736 acre-feet in 2006. Eighty-seven of these facilities received all or a portion of their water from municipal providers and were classified as *individual users.* Their use is included in the water demand for the Municipal sector. The remaining 29 turf-related facilities are Industrial users that were either in existence before the Code and use Type 2 rights or were developed after the Code on retired agricultural land using Type 1 rights. This industrial subsector has grown moderately from using 6,423 acre-feet of water in 1985 to using 8,249 acre-feet in 2006. Total demand by industrial turf-related facilities is second only to the metal mining subsector in the Tucson AMA.

In 2006, there were 42 golf courses in the Tucson AMA; approximately one-third were Industrial users; the other two-thirds were Municipally served (or individual users). Golf courses in the Tucson AMA used slightly more than 20,000 acre-feet of water in 2006. Approximately 42% of this use was groundwater. The balance of the use was predominantly direct use reclaimed water. Turf-related facilities that use any groundwater, regardless of whether they are Industrial users or served by a municipal provider, must comply with a maximum annual water allotment based on the size and age of the facility. *Table 5-5* illustrates the split of turf-related facilities that are included in the Industrial and Municipal sectors.

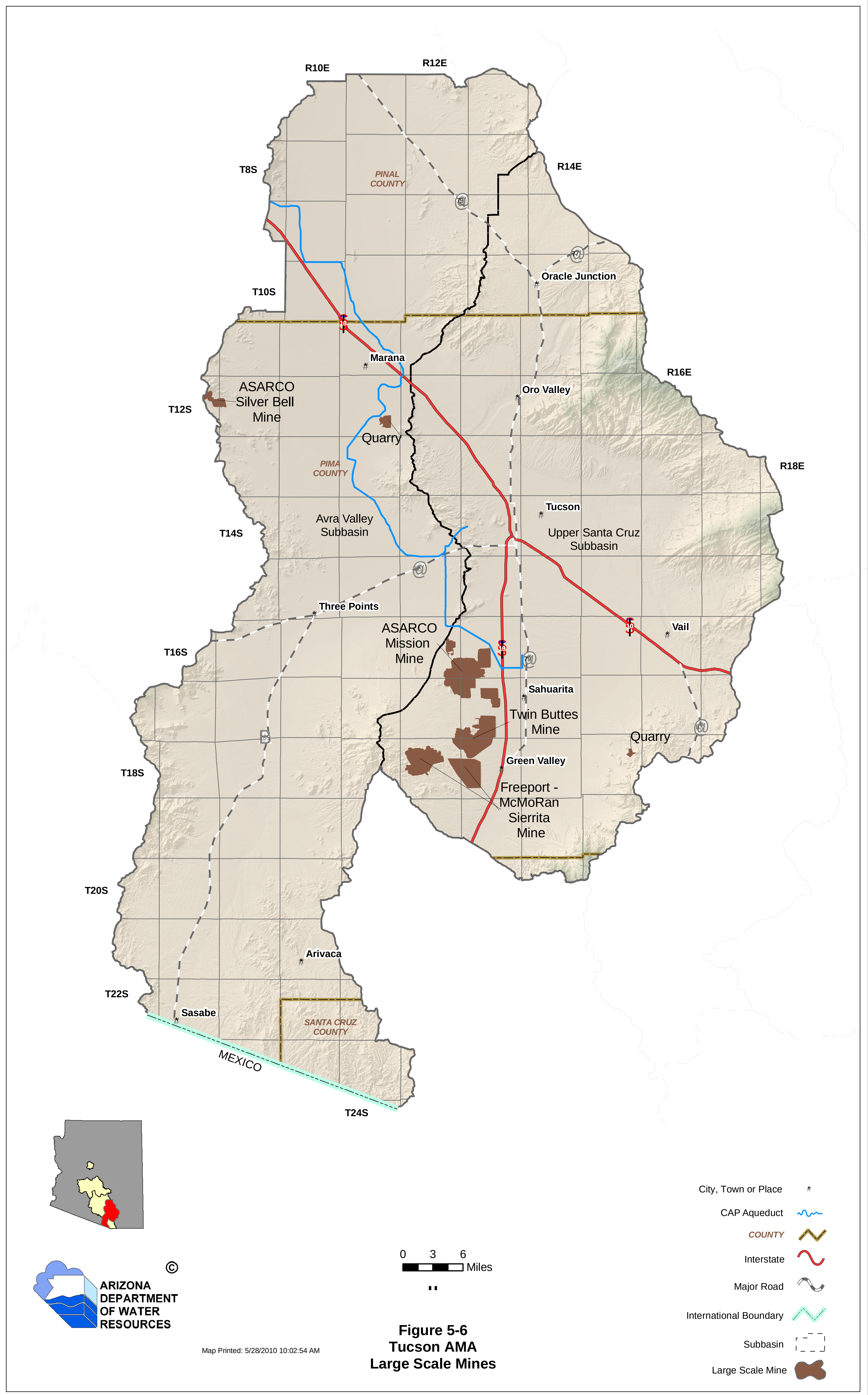


Figure 5-6
Tucson AMA
Large Scale Mines

Table 5-5 Turf-Related Facilities Demands in 2006
Tucson Active Management Area

Type of Facility	Number of Facilities		Water Source				
	Municipal	Industrial	Municipal		Industrial		Total
			Groundwater	Total Use	Groundwater	Total Use	
Golf Courses	29	13	3,675	13,968	4,834	6,063	20,031
Parks	26	4	604	3,088	509	614	3,702
Cemeteries	0	4	0	0	514	599	599
Schools	32	8	253	1,431	973	973	2,404
TOTAL	**87**	**29**	**4,532**	**18,487**	**6,830**	**8,249**	**26,736**

Sand and Gravel

Sand and gravel facilities in the Tucson AMA used 5,337 acre-feet of water in 1995 and 3,807 acre-feet in 2006. In 2006, there were 18 active sand and gravel operations in the AMA. Water in this subsector is primarily used to wash aggregate before sale; a small amount is used to clean trucks and equipment. Increases in sand and gravel production and associated water use are closely tied to population growth and urbanization. Sand and gravel operations in the Tucson AMA have historically relied solely on groundwater.

Electric Power Generation

There are two large-scale power plants located in the Tucson AMA. The largest, the Wilson Sundt Generating Station (formerly the Irvington Station) is operated by Tucson Electric Power. It is located near Irvington Road and Interstate 10. The Saguaro Station, operated by Arizona Public Service, is a peaking plant and is located in the northern portion of the Tucson AMA in Pinal County. Total water demand for the electric power generation sector in the Tucson AMA was 2,598 in 1985 and 2,656 acre-feet in 2006. In 2001, at the height of the California energy crisis, electric power generation water demand spiked to approximately 5,500 acre-feet because of an increase in local power generation and associated water use. Much of the excess power generated at that time was exported out of state. The power sector in the Tucson AMA currently holds over 10,000 acre-feet 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 Tucson AMA have relied solely on groundwater to meet their cooling needs.

Dairies

In 2006, the one active dairy in the Tucson AMA used 110 acre-feet of groundwater. This subsector currently holds a total of 283 acre-feet of water per year in withdrawal authority. Water is used at dairies primarily for watering animals, cooling, and cleaning. Dairies in the Tucson AMA have historically relied on groundwater.

Feedlots

In 1985, approximately 20 acre-feet of water was used by feedlots in the Tucson AMA. By 1993, water use by feedlots had fallen to zero in the AMA.

Other Industrial

Other Industrial is a water use category that typically includes a variety of commercial and manufacturing uses that do not fit into the subsectors listed above. Other Industrial water use has remained relatively constant in the Tucson AMA over the last decade. Water use in this subsector totaled 3,943 acre-feet in 1995 and 3,357 acre-feet in 2006. Groundwater has historically been used to meet the demands of this subsector.

5.3 Agricultural Sector Demands and Supplies

5.3.1 Overview of Agricultural Rights and Allotments

As mentioned previously, only land associated with a certificate of IGFR can legally be irrigated with groundwater within an AMA (*See Figure 5-7*). IGFRs are categorized as either non-exempt or exempt. Non-exempt IGFRs have specific conservation requirements established in the Management Plan for each management period. Exempt IGFRs, which are ten acres or less and not part of an integrated farming operation, are no longer required to comply with specific conservation requirements. For more information on IGFRs, refer to Section 3.1.3.

Since the Code generally prohibits newly irrigated acres the total number of IGFR certified acres has decreased over time as lands have urbanized (*See Table 5-6*). The decrease in allotments was due in part to the reduction in acreage, but it was also due to reductions in assigned irrigation efficiencies, as a result of Management Plan requirements. Historically, use has been substantially lower than allotments; in the future, use may exceed allotments because of flexibility accounting provisions in the Base Program. For more information on flexibility accounting, refer to the *Third Management Plan for the Tucson Active Management Area, 2000 – 2010*.

5.3.2 Agricultural Demands and Supplies

Agriculture is a small, but not insignificant demand sector in the Tucson AMA. Municipal and Industrial uses have increased; however, total Agricultural demand has decreased (*See Table 5-6*).

Cropping patterns have changed only slightly. Primary crops include cotton, pecans, small grains, alfalfa, and pasture. Most of the semi-permanent orchards have not changed; however, the field crop mix has changed in response to changes in local growing conditions and markets.

Table 5-6 Agricultural Total Water Use, Certified Irrigation Acres and Allotments By Irrigation Grandfathered Rights 1985, 1995, and 2006 Tucson Active Management Area

Year	Total Water Use	Certified Irrigation Acres	Allotments
1985	114,879	46,605	212,401
1995	96,943	38,273	168,633
2006	87,755	36,216	162,353

Note: All values are in acre-feet.

Extinguishment of IGFRs pursuant to the AWS Rules between 1985 and 2006 accounts for 857 acres in the Tucson AMA that can no longer be used for agricultural production. Extinguishment of these rights generated 32,778 acre-feet of extinguishment credits, which can be used to help meet the consistency with management goal criteria of proving a 100-year AWS.

5.3.3 Non-Exempt IGFR Water Use Characteristics

Demand in the Agricultural sector has averaged slightly less than 100,000 acre-feet per year since 1985 (*See Table 5-6*). Although it appears that demand has declined since 1985, there has been significant variation from year to year. In 1985, water use in this sector was the second highest demand year on record, 1995 was an average use year, and 2006 was a particularly low use year. The average from 1985 through 1995 was 98,303 acre-feet per year; the average from 1996 through 2006 was 100,543 acre-feet per year.

Demand and Supplies by Area of Similar Farming Conditions

For purposes of establishing conservation requirements in the 1MP for the Agricultural sector, ADWR identified areas of similar farming conditions. The Tucson AMA is divided into seven areas of similar farming conditions (ASFC) (*See Figure 5-7*). The major Agricultural demand centers are clustered in four areas within ASFCs 1, 2, 3, and 5.

Cortaro-Marana Irrigation District (CMID) is the only irrigation district in the Tucson AMA with a consolidated distribution system. CMID encompasses most of ASFC 2 and totaled approximately 11,900 acres in 2006. Approximately 75 percent of CMID's acreage was irrigated yearly between 1996 and 2006, requiring over 34,000 acre-feet per year of water on average. The primary crops grown in the district are cotton, wheat, barley, and alfalfa. Demand from 1996 to 2006 was slightly higher than from 1985 to 1995, because of variations in economic and climatic conditions. Approximately 93 percent of CMID's supplies are groundwater or in-lieu groundwater; the remaining seven percent is CAP water. CMID has several surface water rights and wells they claim as points of diversion; however, ADWR will account for this water as groundwater until CMID's claims are adjudicated (ADWR, 2010). Historically, CMID had a contract for reclaimed water from the Pima County, however the contract expired and no reclaimed water was used after 1998.

The *Avra Valley* area in Marana (ASFC 3) encompassed approximately 11,700 acres in 2006. It includes the Avra Valley Irrigation District, BKW Farms, and several other irrigators. Approximately 50 percent of Avra Valley acreage was irrigated yearly between 1996 and 2006, requiring approximately 25,000 acre-feet of water on average. The primary crops grown in Avra Valley are cotton and small grains. Demand was stable from 1985 to 2006. Approximately 87 percent of Avra Valley's supplies are groundwater or in-lieu groundwater; the remaining 13 percent was CAP water.

Farmer's Investment Company (FICO) operates a large pecan farm of approximately 5,800 acres in the Green Valley-Sahuarita area (ASFC 5). Approximately 95 percent of FICO acreage was irrigated yearly between 1996 and 2006, requiring an average of 26,500 acre-feet of water per year. Demand from 1996 to 2006 was significantly higher than from 1985 to 1995, primarily because of climate conditions. Currently, all of FICO's demand is met with groundwater withdrawn from private wells.

The *Red Rock* area in Pinal County (ASFC 1) has several rights totaling approximately 3,800 acres as of 2006. Approximately 60 percent of the ASFC 1 acreage was irrigated yearly between 1996 and 2006, requiring an average of 9,000 acre-feet of water per year. The primary crops grown in the area are cotton, pecans, and small grains. Two of these rights are within the boundary of the Central Arizona Irrigation and Drainage District (CAIDD); for more information regarding CAIDD, refer to the *Demand and Supply Assessment, 1985-2025, Pinal Active Management Area* (ADWR, 2010). Demand from 1996 to 2006 was significantly higher than from 1985 to 1995. This increase was primarily due to a large irrigation right that was fallow from 1990 to 1996 that returned to production. Approximately 91 percent of ASFC 1's demand is met with groundwater or in-lieu groundwater; the remaining nine percent was CAP water.

Irrigation rights in the remaining ASFCs account for 15 percent of total AMA demand. Primary crops in these areas are Bermuda grass and alfalfa for pasture. IGFRs in these ASFCs rely on groundwater withdrawn from private wells.

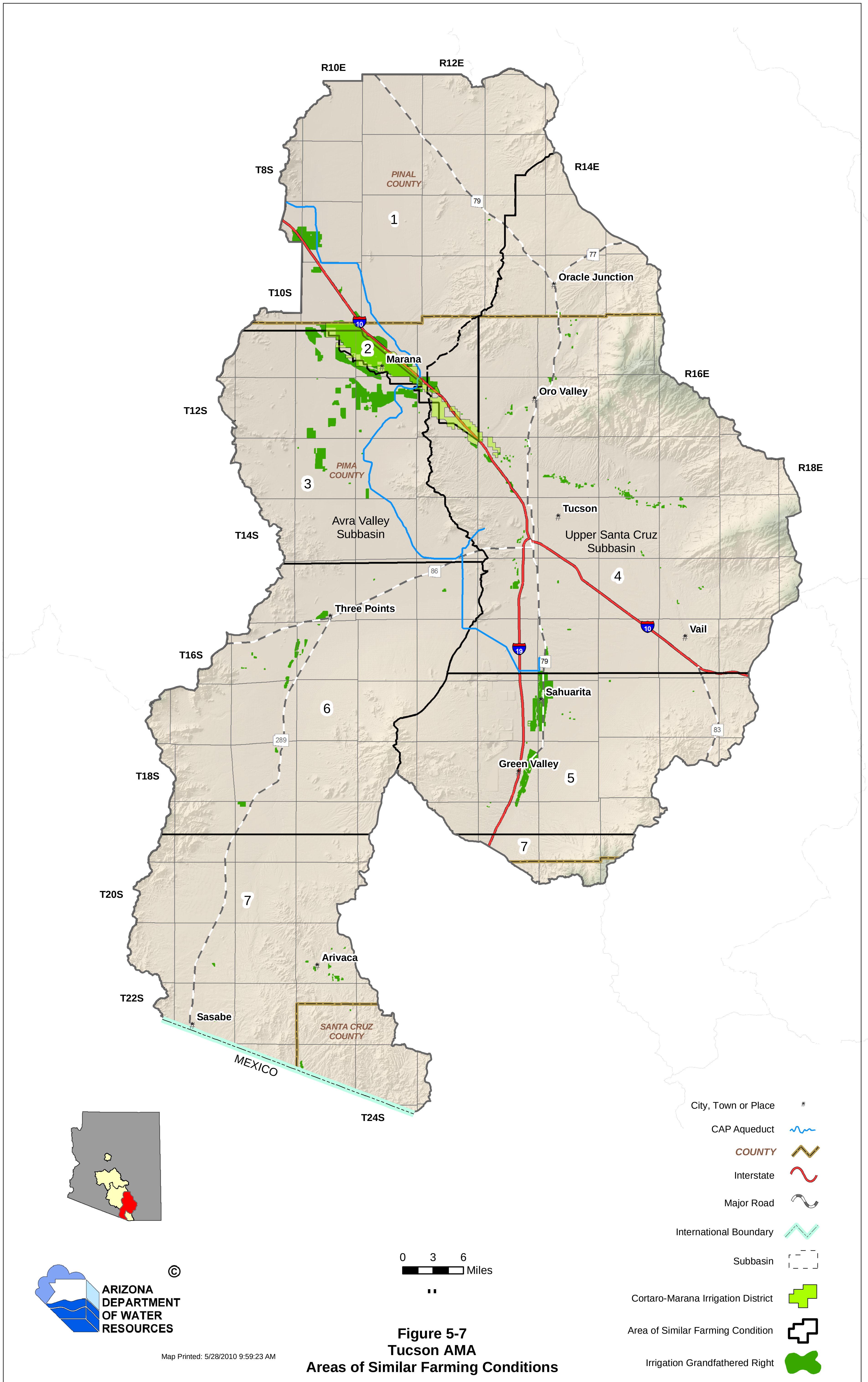
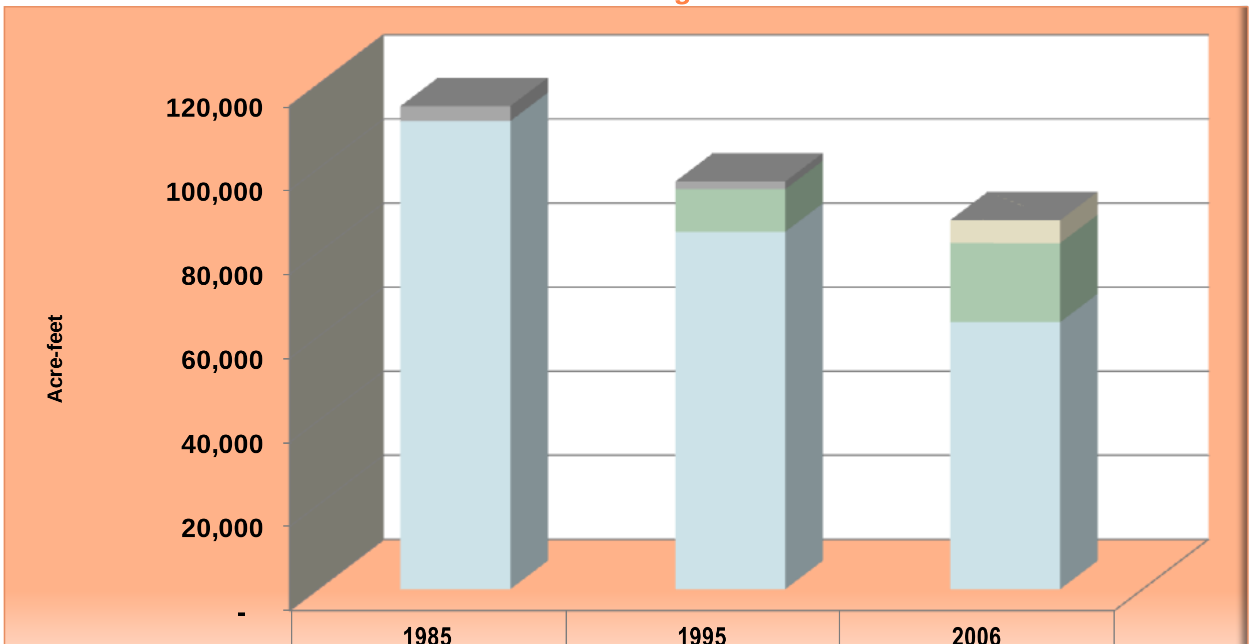


Figure 5-7
Tucson AMA
Areas of Similar Farming Conditions

5.3.4 Exempt IGFR Water Use Characteristics

In 1994, IGFRs less than 10 acres in size and not part of an integrated farming operation were exempted from conservation requirements and reporting obligations; therefore, their demand since 1993 is not known. Historical use of such rights in the Tucson AMA was not considered in this Assessment because they were negligible.

Figure 5-8 Historical Agricultural Supplies, 1985, 1995, and 2006
Tucson Active Management Area



	1985	1995	2006
TOTAL	114,879	96,943	87,755
Recaimed Water	3,546	1,801	-
CAP	-	-	5,450
In-Lieu Groundwater	-	10,137	18,794
Groundwater	111,333	85,005	63,511

5.4 Indian Demands and Supplies

5.4.1 Overview and Non-Regulatory Status

The Pascua Yaqui tribal lands, part of the Schuk Toak District, and the entire San Xavier District of the TON are within the Tucson AMA. Their 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.

5.4.2 Water Rights Settlement

The Southern Arizona Water Rights Settlement Act (SAWRSA) of 2004 (Title III of the Arizona Water Settlements Act) resulted in a modification of state law to include the San Xavier Reservation Water Protection Program to provide for the protection of groundwater resources on the San Xavier District, which may affect the location of future pumping in the AMA. Under this program, the ADWR well-spacing rules are extended to a border outside of the San Xavier District within the Tucson AMA, in which the drilling of certain new wells is restricted.

The entire TON holds a 74,000 acre-foot CAP allocation. The SAWRSA and the subsequent settlement agreement specified that the TON was entitled to 79,200 acre-feet of water rights in the Tucson AMA for use on the San Xavier District and the Eastern Schuk Toak District. Of this total 66,000 acre-feet is CAP water and 13,200 acre-feet is groundwater. The TON may also lease up to 15,000 acre-feet of CAP water to off reservation users (ADWR, 2010).

5.4.3 Indian Demand, Supply and Factors Affecting Use

The TON is the only tribe with a recent history of agriculture in the Tucson AMA. The TON's farming activities have varied over the years, largely because of water availability and infrastructure. Historically, the only major farming area was in the San Xavier District. More recently, an area has been developed in the Garcia Strip in the Eastern Schuk Toak District. Farms relied almost entirely on groundwater pumped from wells until 2000 (*See Figure 5-9).* Indian communities are not required to report their groundwater pumping to ADWR; however, records show that the San Xavier Cooperative Farm pumped a total of 4,500 acre-feet in 1980 and 1,100 acre-feet in 2001***(ADWR, 2006)****.*

The SAWRSA directed the United States Bureau of Reclamation (BOR) to develop farming areas in the San Xavier District and the Garcia Strip. *Figure 5-10* illustrates the approximately 2,900 acres of active farmland on TON lands in the Tucson AMA: a 2,000 acre farm on the Garcia Strip, completed in 2002; and a rehabilitated 880 acre San Xavier Cooperative farm, completed in 2007 (Edwards, 2008). Crops farmed include field crops such as alfalfa and cotton and traditional crops such as corn, beans, melons, and squash. All water supplied to the farms is CAP. Current demand totals approximately 10,000 acre-feet per year.

Under SAWRSA, the BOR was also directed to extend the existing San Xavier Cooperative Farm. The extension farm has not been built yet, but it is expected to be located on the south end of the existing farm and cover 1,400 acres of allotted lands between the Santa Cruz River and Interstate 19 (ADWR, 2006).

There is no irrigated acreage on the Pascua Yaqui Tribe reservation (ADWR, 2010).

Indian Municipal

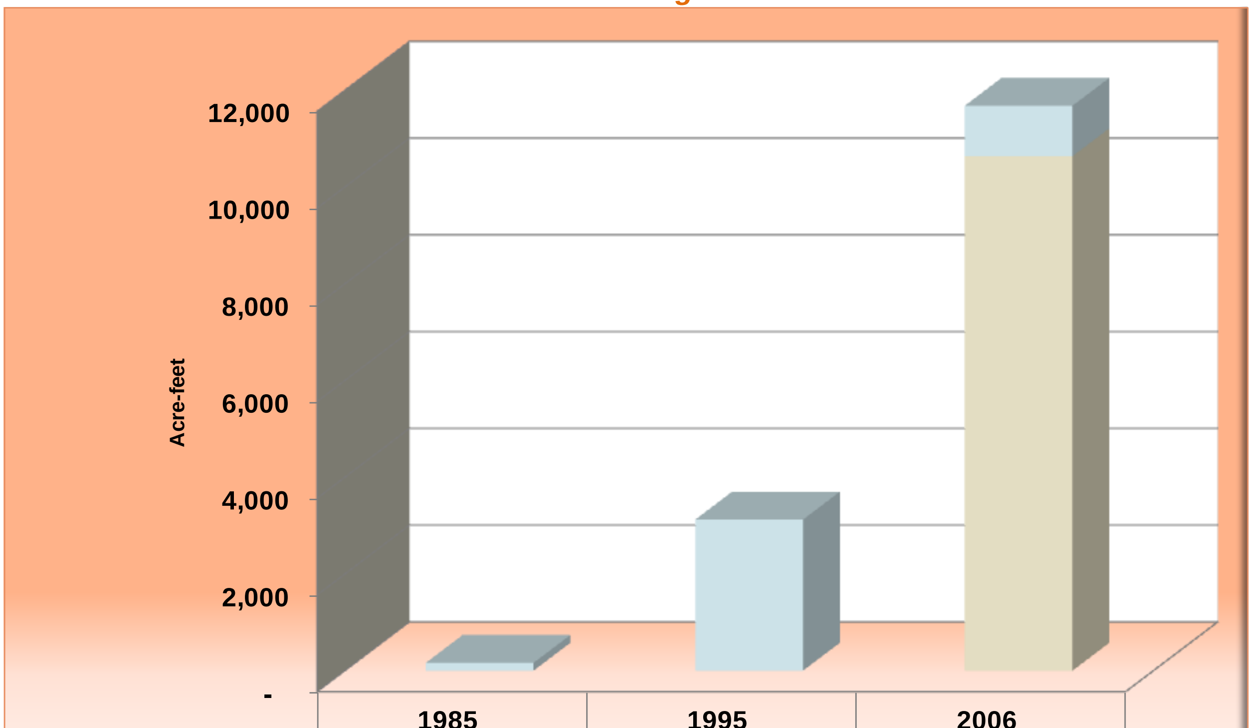
The population on reservation land in the Tucson AMA has been increasing. ADWR used an estimate of approximately 1,500 residents of the TON within the Tucson AMA in 1995. In 2000, the estimated Indian population within the Tucson AMA was 5,397 people (3,315 Pascua Yaqui, 2,053 San Xavier, and 29 Shuk Toak), some of whom lived off-reservation. The *Third Management Plan for Tucson Active Management Area, 2000-2010* assumed an annual on-reservation Indian Municipal demand of 100 acre-feet. Tucson Water served at least a portion of the historical potable water demands. In 2006, Tucson Water served 219 acre-feet to Indian population within the Tucson AMA *(See Table 5-7).*

Table 5-7 Indian Municipal Demand and Groundwater Use
1985, 1995 and 2006
Tucson Active Management Area

Year	Total Water Use	Groundwater
1985	160	160
1995	140	140
2006	219	219

Note: All values are in acre-feet.

Figure 5-9 Indian Municipal, Industrial and Agricultural Historical Supplies
1985, 1995, and 2006
Tucson Active Management Area



	1985	1995	2006
Total	160	3,122	11,678
Indian Groundwater	160	3,122	1,043
Indian CAP	-	-	10,635

The supply for Indian Municipal demand is 100 percent groundwater (*See Table 5-7*).

Indian Industrial

As discussed in Section 5.2.2, the TON supplies groundwater from three of its wells to ASARCO's Mission Mine facility. In 1995, ASARCO withdrew approximately 2,982 acre-feet of groundwater from these three wells; in 2006, this amount had dropped to 824 acre-feet. This groundwater use has been categorized as Indian Industrial use in this Assessment. Through the SAWRSA, ASARCO has agreed to decrease its groundwater pumping and use up to 10,000 acre-feet of the TON's CAP water. The TON will accrue credits for the CAP water that ASARCO uses in-lieu of groundwater.

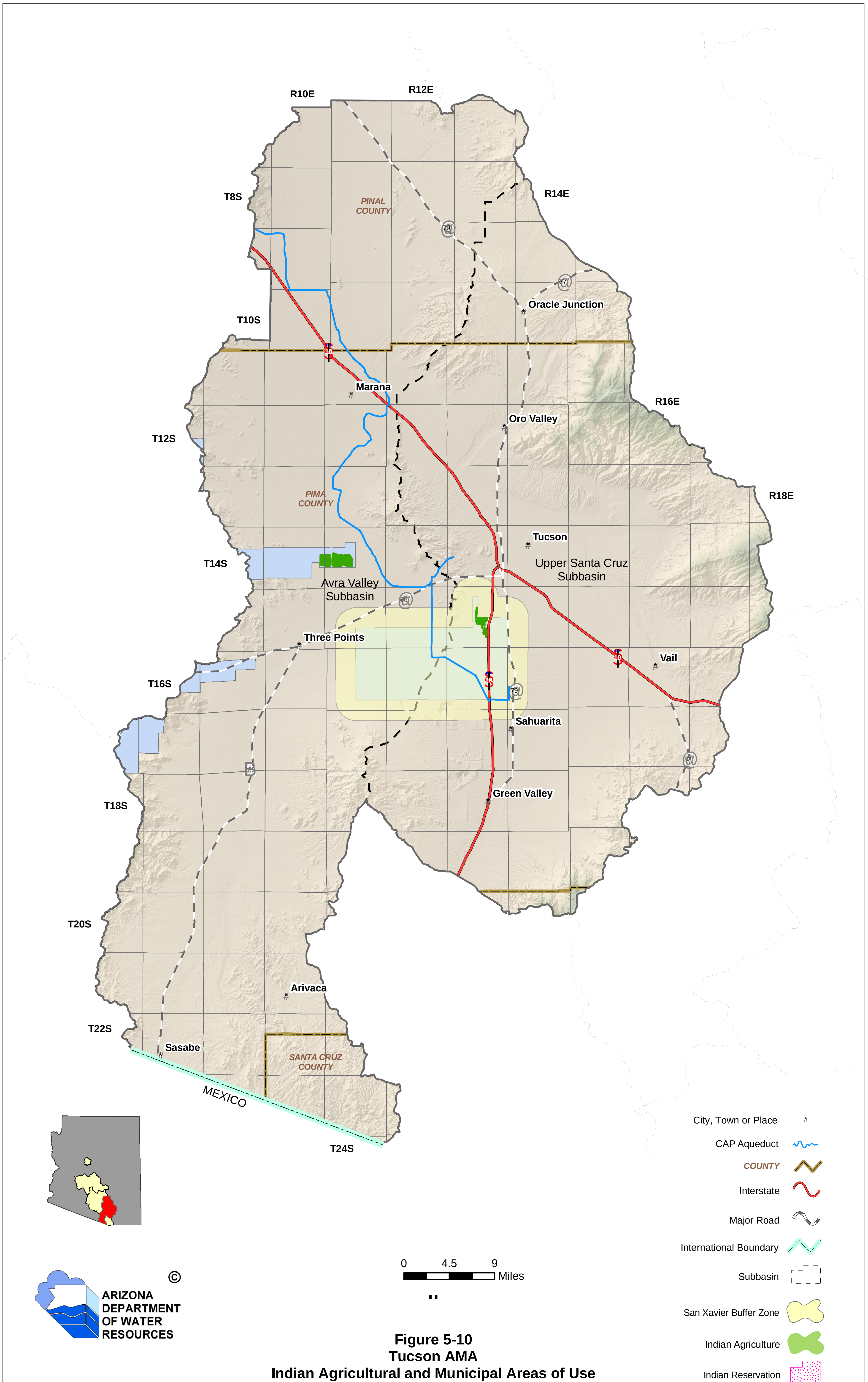


Figure 5-10
Tucson AMA
Indian Agricultural and Municipal Areas of Use

5.5 Artificial Recharge

Artificial recharge consists of artificial means of adding water to the aquifer, but it also results in the increased use of renewable water supplies, such as reclaimed water, CAP and surface water, over non-renewable groundwater by allowing for flexible and effective storage and recovery of renewable water supplies. For more information regarding the role of artificial recharge and the types of facilities used, refer to Section 3.3.

5.5.1 Underground Storage Facilities

Artificial recharge in the Tucson AMA is primarily accomplished at USFs (*See Figure 5-11*). In 1990, the legislature authorized CAWCD to construct State Demonstration Recharge Projects with property tax revenues collected in Pima and Maricopa Counties. Three of these projects were constructed in the Tucson AMA in 1995 and 1997 and have been heavily utilized by CAWCD, the AWBA and municipal and industrial entities. The amount of water stored through 2006, by facility type, is shown in *Table 5-7*.

Managed Facilities

There are currently two permitted Managed USFs in the Tucson AMA. Both are located in the Santa Cruz River channel and are permitted to store 9,307 and 43,000 acre-feet of reclaimed water respectively. The smaller facility, permitted to the City of Tucson in 1996, is 5.1 miles long. It stores water from the Roger Road Wastewater Treatment Facility (WWTF). The larger facility was permitted in 2003 to a group of nine entities with rights to reclaimed water from the Ina Road WWTF. It extends 11.2 miles farther downstream to within three miles of the Tucson AMA/Pinal AMA boundary. Storage at both of these Managed reclaimed water USFs is subject to a 50 percent cut to the aquifer and does not accrue any credits during substantial natural storm events.

Constructed Facilities

The Tucson AMA currently has ten Constructed USFs with annual permitted volumes ranging from 350 acre-feet to 100,000 acre-feet. The two largest facilities are owned and operated by the City of Tucson and are collectively known as the Clearwater Facility. The Central Avra Valley (CAVSARP) and Southern Avra Valley Storage and Recovery Projects (SAVSARP) are permitted to store 100,000 and 60,000 acre-feet of CAP water per year respectively. In addition to the Clearwater Facility, the City of Tucson is a 50 percent partner with CAWCD in the Pima Mine Road USF, a State Demonstration Project permitted to store 30,000 acre-feet of CAP water annually. CAWCD also holds two additional USF permits for State Demonstration Projects, which store CAP water.

The City of Tucson operates the Sweetwater reclaimed water USF as an integral part of their reclaimed water distribution system. Four smaller reclaimed water USFs are permitted in the Tucson AMA, one of which is also permitted for surface water storage.

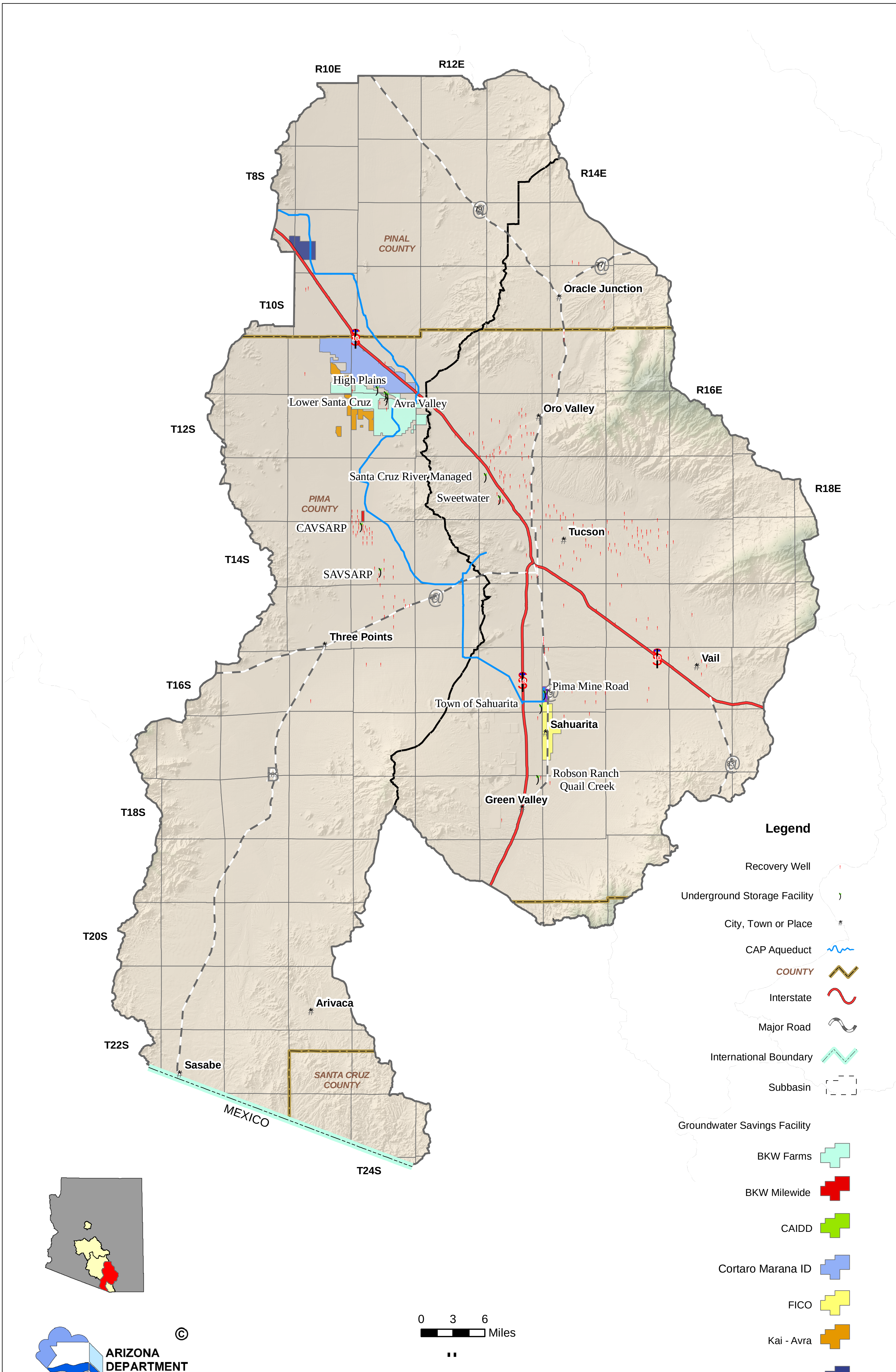


Figure 5-11
Tucson AMA
Recharge Facilities

Table 5-7 Artificial Recharge Volumes
1985, 1995 and 2006
Tucson Active Management Area

Recharge Facilities	1995	2000	2006
Groundwater Savings Facilities			
Number of Facilities	2	5	6
CAP Stored	10,137	27,973	18,794
Underground Storage Facilities (Constructed)			
Number of Facilities	3	4	10
CAP Stored	0	45,354	128,143
Surface Water	0	0	149
Reclaimed Water Stored	2,601	6,286	10,508
Underground Storage Facilities (Managed)			
Number of Facilities	0	1	2
Reclaimed Water Stored	0	6,475	24,577
Total Stored	**12,738**	**84,088**	**182,172**

Note: All water volumes are in acre-feet and include water delivered to be stored minus physical losses.

5.5.2 Groundwater Savings Facilities

The Tucson AMA has six permitted Groundwater Savings Facilities (GSFs) (*See Figure 5-11*). Two of these facilities are inactive because they currently have no operating distribution system to deliver renewable supplies. Of the four active GSFs, CMID is the only organized district; the others are individual or groups of individual irrigation grandfathered rights. All Tucson AMA GSFs are permitted to store only CAP water. Their permitted annual volumes range from 627 to 20,000 acre-feet per year. These permits require GSFs, with the exception of CMID, to use their non-Indian agriculture (NIA) pool of excess CAP water (CAP NIA settlement pool), before credits may be accrued using GSF CAP water. The CAP NIA settlement pool is a volume of CAP water that the CAWCD Board of Director's identified for use on NIA lands. The policy was adopted in May of 2000. This policy established an NIA pool of 400,000 acre-feet from 2004 through 2016. The pool will decline to 300,000 acre-feet in 2017 and to 225,000 acre-feet beginning in 2024 through 2030. CMID is not currently required to use their CAP NIA settlement pool water because of low groundwater pumping costs. The permits also contain limitations on total water from all sources (including all CAP sources, surface water, and groundwater) and require proof that there is a direct reduction in groundwater pumping.

Municipal providers who store their Municipal and Industrial (M&I) subcontract CAP water or excess CAP water are the major entities using GSFs in the Tucson AMA. The AWBA does store limited volumes of CAP water at two of these facilities; however, they have historically maintained a higher state wide cost share for CAP water than GSFs in the Tucson AMA have been willing to pay.

5.5.3 Credits Accrued Through 2006

Long-Term Storage Credits

There are 32 long-term storage (LTS) accounts, including the AWBA and two CAGRD replenishment accounts, in the Tucson AMA. Many municipal providers with DAWS store M&I subcontract or excess CAP water and recover that water annually or from long-term storage accounts to meet their AWS consistency with management goal requirements. For many of these providers, recovery occurs outside the area of impact of storage at both USF and GSF facilities, creating potential localized water supply issues related to the continuing decline in water levels where the credits are withdrawn. The City of Tucson's Clearwater USF facilities and the Sweetwater reclaimed water USF contain substantial recovery resources, which allow them to recover storage credits annually or long-term from the recharge area. This provides water management and operational benefits to the City of Tucson. While most water is stored for municipalities, there are a few other entities that store and recover relatively smaller volumes of either CAP or reclaimed water credits for landscape and golf course irrigation. Recharge credit types and amounts through 2006 are shown in *Table 5-8*.

Other long-term storage account holders in the Tucson AMA include Aqua Capital, a Nebraska based investment firm, and the TON, which stores CAP water for investment and possible sale of the credits to water users in the AMA. The TON also accrue credits through an agreement with ASARCO by providing CAP water in-lieu of groundwater for mining operations pursuant to a special statutory provision. Augusta Resources Corporation is accruing CAP credits in anticipation of a future proposed mining project east of Green Valley.

AWBA Credits

The AWBA has been storing CAP water primarily at USFs in the Tucson AMA since 1997. Using a variety of funding sources, the AWBA has utilized these facilities to meet goals and obligations for the Tucson AMA CAP subcontract holders as well as firming Colorado River on-river M&I supplies and, through interstate agreements such as storage for the Southern Nevada Water Authority (SNWA).

CAGRD Storage and Replenishment

CAWCD, on behalf of the CAGRD, began storing and replenishing CAP water at GSFs in 1993 and at USFs in 1998 in the Tucson AMA (See Section 3.4.4). CAWCD operates three USFs in the Tucson AMA, but their storage activity there has been relatively minor.

The CAGRD has stored limited volumes of water in the Tucson AMA, with most of the storage occurring at State Demonstration Project USFs. Because the AWS Rules for the Tucson AMA require significant replenishment obligations for designated providers, many of these providers have transferred their own long-term storage credits to the CAGRD. This reduces the overall replenishment cost to the provider and has resulted in substantial credit balances in CAGRD accounts. Long-term storage credits that are transferred into CAGRD's long-term storage accounts may not be recovered.

Table 5-8 Artificial Recharge Credit Types and Amounts Through 2006
Tucson Active Management Area

Credit Type	Amount (acre-feet)
Long Term Storage Credits	
Underground Storage Facilities	10
CAP	514,225
Reclaimed water	43,933
Total	558,158
Groundwater Savings Facilities	6
CAP	116,709
Total USF/GSF	674,868
Arizona Water Bank	
Intrastate	351,001
Interstate - Nevada	78,376
Total	429,377
CAWCD/CAGRD	
CAWCD	4,132
CAGRD	
Conservation District Account	36,731
Replenishment Reserve Account	13,855
Total	54,718
Total AMA Recovery	77,733
Credits Remaining in Storage	**597,135**

Note: All water volumes are in acre-feet. Stored water is water delivered to be stored minus losses and the cut to the aquifer. "Credits Remaining in Storage" is the difference between Total USF/GSF Storage and Total AMA Recovery.

6. HISTORICAL DEMANDS AND OVERDRAFT

6.1 Summary Budget

The following discussion considers historical total demands and groundwater overdraft in the Tucson AMA from 1985 to 2006, referencing three water-use years: 1985, 1995, and 2006. The Historical Summary Budget is shown in *Table 6-1* below. The basic budget components, and how they relate to the overdraft calculation, were discussed in further detail in Sections 3 and 4. Detailed water use figures for all years between 1985 and 2006 may be found at www.azwater.gov/AzDWR/WaterManagement/Assessments/default.htm.

Overdraft, depicted in *Table 6-1*, is the sum of the groundwater use (including in-lieu groundwater) for all four sectors plus the riparian demand, minus the sum of the incidental recharge values for the four sectors plus the additional offsets to overdraft (including net natural recharge, riparian use of managed reclaimed water, reclaimed water discharges, canal seepage, cuts to the aquifer, and CAGRD replenishment). Groundwater withdrawn pursuant to poor quality groundwater permits and pursuant to approved remedial actions is also subtracted from the overdraft value. For purposes of this Assessment, overdraft is depicted in two values: 1) including the groundwater allowance volume in overdraft, to identify the physical impact of these withdrawals on the aquifer and 2) excluding groundwater allowance volumes, in recognition that this volume of groundwater is considered to be consistent with the management goal under the AWS Rules.

Table 6-1 Historical Summary Budget and Overdraft
1985, 1995 and 2006
Tucson Active Management Area

SECTOR	CATEGORY	1985	1995	2006
Municipal				
Demand		113,080	154,288	188,967
Supply	*Groundwater*	113,080	147,763	100,631
	Other Surface water	0	0	210
	CAP (direct use & credits recovered)	0	0	72,179
	Reclaimed water (direct use & credits recovered)	0	6,525	15,947
	Incidental Recharge	4,523	6,172	7,559
Industrial				
Demand		46,616	60,589	53,084
Supply	*Groundwater*	45,896	60,500	51,665
	Other Surface	720	0	400
	CAP (direct use & credits recovered)	0	0	135
	Reclaimed water (direct use & credits recovered)	0	89	883
	Incidental Recharge	4,765	6,753	5,770
Agricultural				
Demand		114,879	96,943	87,755
Supply	*Groundwater*	111,333	85,005	63,511
	In-Lieu Groundwater	0	10,137	18,794
	Other Surface water	0	0	0
	CAP (direct use)	0	0	5,450
	Reclaimed water (direct use & credits recovered)	3,546	1,801	0
	Incidental Recharge	60,779	23,173	22,033
Indian				
Demand		160	3,122	11,678
Supply	*Groundwater*	160	3,122	1,043
	Other Surface Water	0	0	0
	CAP	0	0	10,635
	Reclaimed Water	0	0	0
	Incidental Recharge	0	0	0
Other				
Demand	*Riparian*	3,817	3,817	3,817
Supply	*Cuts to the aquifer*	0	0	16,364
	CAGRD Replenishment	0	0	10,496

SECTOR	CATEGORY	1985	1995	2006
	Net Natural Recharge	81,964	81,964	81,964
	Reclaimed Water Discharge	32,149	32,349	4,245
	Canal Seepage	3,657	3,657	3,657
	Riparian Use of Reclaimed Water from Managed USFs	0	0	2,116
Groundwater use not counted towards	*GW Allowance*	0	0	28,067
	Remediation Groundwater	0	0	6,852
	Poor Quality Groundwater	0	224	103
Overdraft	**Subtracting GW Allowance**	**86,449**	**156,052**	**50,235**
	Without Subtracting GW Allowance	**86,449**	**156,052**	**78,302**

Note: All values are rounded and are in acre-feet

6.1.1 Demand

In 1985, total demand for the water using sectors (Municipal, Industrial, Agriculture, and Indian) in the Tucson AMA was 274,735 acre-feet. Agricultural uses accounted for approximately 42 percent of total demand in the Tucson AMA; Municipal uses accounted for approximately 41 percent. From 1985 to 2006, demand in the Agricultural sector varied. By 2006, it had decreased to 26 percent of total sector demand (341,484 acre-feet); this decrease was accompanied by a 22 percent decrease in the amount of legally irrigable acreage as farmland was retired for development. During the same period, Municipal demand increased to 55 percent of the total Tucson AMA demand; this increase corresponded to a 69 percent increase in population, from approximately 574,000 people in 1985 to 979,000 people in 2006. Most of the Indian water demand in the Tucson AMA has been for agricultural irrigation purposes. A small amount has been used for Municipal and Industrial purposes on reservations. Total Indian demands are only three percent of the total AMA demands. During this time, Industrial demand fluctuated with mining use, which is closely tied to copper prices. Industrial use has typically averaged less than 20 percent of the total AMA demand.

6.1.2 Supply

In 1985, groundwater was the primary supply used to meet demands in the Tucson AMA. The use of CAP water has increased from zero in 1985 to 88,399 acre-feet in 2006 – approximately 26 percent of total use. The use of reclaimed water has increased from approximately 3,500 acre-feet in 1985 to nearly 17,000 acre-feet in 2006, approximately five percent of total use.

Of the total amount of CAP used in the Tucson AMA in 2006, 19 percent was direct use, 70 percent was annual storage and recovery, and 11 percent was recovery of long-term storage credits. Of the total reclaimed water used in 2006, 64 percent was direct use and 36 percent was annual storage and recovery. Renewable supplies, including CAP, reclaimed water, and surface water, were 30 percent of the total supply in 2006. In contrast, renewable supplies were only one percent of total AMA water use in 1985.

6.1.3 Offsets to Overdraft

The various offsets to overdraft for the historic period, as explained in more detail in Section 3.4, are listed in *Table 6-2*.

Table 6-2 Offsets to Overdraft
1985, 1995, and 2006
Tucson Active Management Area

TYPE OF OFFSET	1985	1995	2006
Incidental Recharge			
Municipal	4,523	6,172	7,559
Industrial	4,765	6,753	5,770
Agricultural[1]	60,779	23,173	22,033
Indian Agricultural	1	1	1
Net Natural Recharge	81,964	81,964	81,964
Riparian use of Managed Reclaimed Water	0	0	2,116
Reclaimed Water Discharge	32,149	32,349	4,245
CAGRD Replenishment	0	0	8,477
Canal Seepage	3,657	3,657	3,657
Cuts to the Aquifer	0	0	16,364
Total	**187,837**	**154,067**	**152,185**

1 Agricultural incidental recharge includes Indian Agricultural Recharge through 2006.

Artificial recharge cuts to the aquifer are shown in greater detail in *Table 6-3.* In the Tucson AMA, no recharge projects were permitted and operational in 1985; therefore the years listed begin with 1995, although no cuts to the aquifer occurred in 1995 because water stored was recovered the same year (annual recovery).

Table 6-3 Artificial Recharge Cuts to the Aquifer
1995, 2000 and 2006
Tucson Active Management Area

Recharge Facilities	1995	2000	2006
Underground Storage Facilities (Constructed)			
CAP	0	2,268	3,329
Reclaimed Water	0	0	0
Underground Storage Facilities (Managed)			
Reclaimed Water	0	3,237	12,289
Groundwater Savings Facilities			
CAP	0	1,399	746
TOTAL	**0**	**6,904**	**16,364**

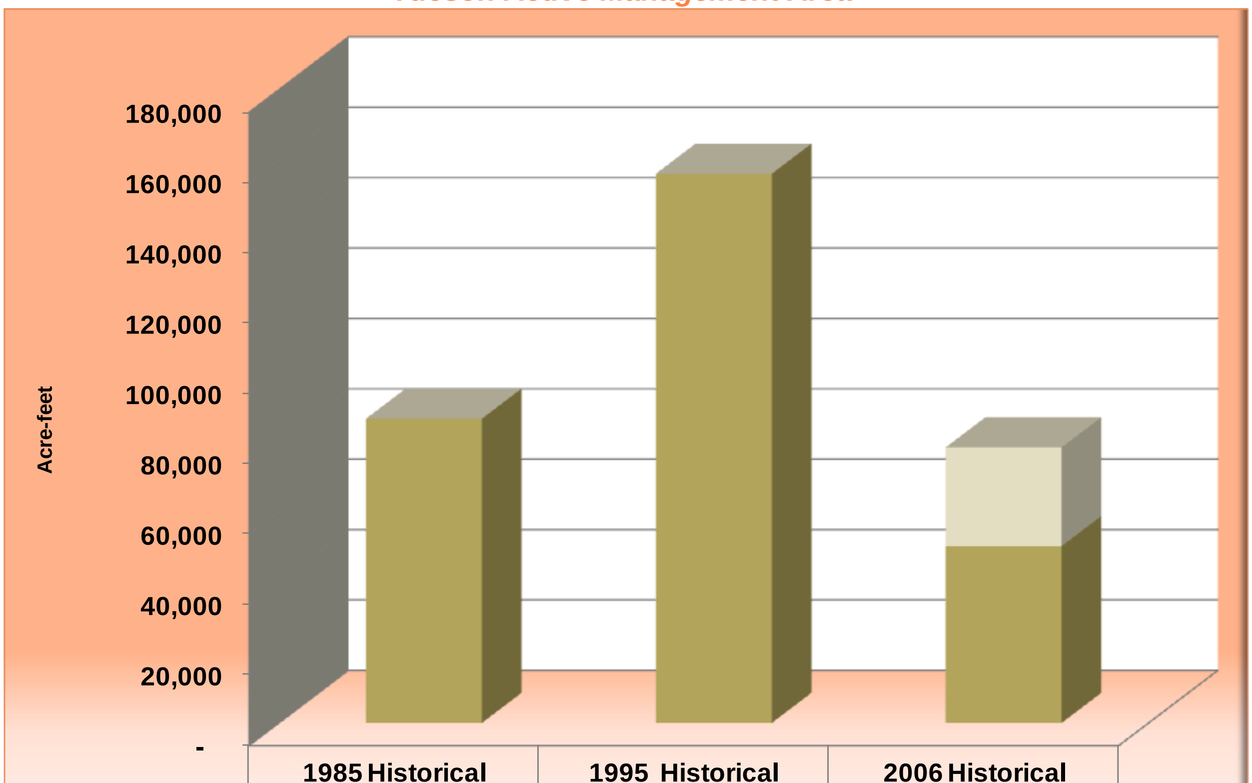
Note: All values are in acre-feet.

6.2 Historical Overdraft

Figure 6-1 displays historical overdraft in the years 1985, 1995, and 2006. The overdraft for 2006 is displayed with and without the groundwater allowance pumping included. Although groundwater allowance pumping is indeed groundwater that is not being replenished, it is allowable pumping under the AWS Rules. As described in Section 3.4,4, the groundwater allowance component to the AWS Rules illustrates a policy decision that was made to allow for growth, flexibility, and transition to the AWS Rule requirements.

Most withdrawal authorities do not have a replenishment requirement. These authorities include IGFRs, Type 1 and Type 2 rights, groundwater withdrawal permits, exempt wells, and service area rights operated by undesignated municipal providers who serve customers not covered by a CAWS issued after 1995. Groundwater pumped pursuant to these types of withdrawal authorities applies directly to groundwater overdraft because no replenishment is required.

Figure 6-1 Historical Estimated Overdraft
1985, 1995 and 2006
Tucson Active Management Area



	1985 Historical	1995 Historical	2006 Historical
Total	86,449	156,052	78,302
GW Allowance	-	-	28,067
Overdraft	86,449	156,052	50,235

6.3 Major Factors that Affected Historical Overdraft

The circumstances in 1985 provide a backdrop for the overdraft situation. The year 1985 was the second year in which major water users in the Tucson AMA were required to measure and report withdrawals and use of water. At this time, overdraft - the amount of groundwater being withdrawn in excess of the amount being recharged naturally or artificially - was about 86,000 acre-feet (*See Figure 6-1*).

In 1985, the CAP canal extension had not reached the Tucson AMA. The volume of other surface water used in the Tucson AMA has been very low compared to its use in the Phoenix and Pinal AMAs. Reclaimed water use in 1985 was only one percent of total use, largely because of the lack of infrastructure and artificial recharge capabilities. Consequently, the primary supply used in 1985 in the Tucson AMA was groundwater.

Pursuant to the Code, IGFRs and Type 2 rights were issued based on the historical use between 1975 and 1980. For entities that did not withdraw groundwater during that period and did not have grandfathered groundwater rights, the Code contained provisions for issuance of temporary groundwater withdrawal permits. These permits may be issued for a specific length of time and acre-foot volume based on projected need. Most municipal providers in the Tucson AMA have until the last decade, typically used only groundwater. The exception is reclaimed water use by the City of Tucson. The amount of groundwater a municipal provider could serve was based on conservation requirements set forth in the Management Plans, but that volume could increase as population increases. No permitted underground storage took place in the Tucson AMA until 1988, so artificial recharge was not yet a factor in 1985. Although the Code contained provisions for the AWS program, the AWS Rules were not adopted until 1995.

Tucson Water received direct delivery of CAP water from 1992 to 1994. Peak delivery occurred in 1993. Treatment and delivery issues caused Tucson Water to cease direct delivery of CAP in 1994. Overdraft was reduced significantly between 1992 and 1994, but by 1995 that progress had been reversed because CAP water was no longer being used. Between 1985 and 1995, the Tucson AMA population increased 33 percent from approximately 574,000 people to approximately 774,000 people. This increase was accompanied by a 36 percent increase in Municipal demand. Total Agricultural demand dropped during this ten-year period; however, Industrial demand increased as copper production increased. Overall AMA increases in demand were primarily met by groundwater supplies. As a result, the overdraft figure in 1995 jumped to approximately 156,000 acre-feet (*See Figure 6-1*).

A number of underground storage facilities have been built in the Tucson AMA since 1995. Through its CAVSARP and SAVSARP facilities and its share in the Pima Mine Road underground storage facility, Tucson Water has up to 190,000 acre-feet of permitted storage capacity. In 2006, CAP water accounted for 52 percent of Tucson Water's total supply. GSFs, first implemented in 1993 in the Tucson AMA, provided another means of using CAP allocations, especially by entities such as municipal providers that did not have direct access to CAP water. Three events: 1) implementation of the CAGRD in 1994, 2) passage of the AWS Rules in 1995, 3) and the creation of the AWBA in 1996, strengthened the water management framework and led to much greater use of renewable supplies, mainly CAP water.

During 2006, approximately 96,876 acre-feet of CAP water was used in the Tucson AMA directly offsetting groundwater that would otherwise have been withdrawn or replacing excess groundwater pumped pursuant to a DAWS or CAWS. The increased use of renewable supplies, in addition to conservation, has been a major factor in reducing overdraft in the Tucson AMA.

Allowable groundwater use, groundwater reported pursuant to the provider's or subdivision's groundwater allowance, is considered consistent with the management goal of the AMA. This allowable groundwater use is not replenished and therefore contributes physically to groundwater overdraft. CAWS are allocated a specific volume of allowable groundwater based on the date the CAWS is issued. DAWS issued prior to the adoption of the AWS rules in 1995 were assigned a volume of allowable groundwater to allow them to transition to renewable supplies over time. Providers who did not exist at the date of adoption of the AWS rules receive zero groundwater allowance (*See Table 6-4*). Allowable groundwater used in the Tucson AMA pursuant to a DAWS or CAWS totaled 28,067 acre-feet in 2006, although the cumulative groundwater allowance volume for the DAWS totaled 1,464,371 acre-feet.

Table 6-4 Groundwater Allowance Balances for DAWS Providers through 2006
Tucson Active Management Area

Provider Name	Groundwater Allowance Balance
City of Tucson	1,313,380
Metro Water District	117,883
Metro Water District - West	0
Sahuarita Water Company	14,738
Spanish Trail Water Company	843
Town of Marana	1,794
Town of Oro Valley	15,682
Vail Water Company	50
Willow Springs Utilities Company	0
Total	**1,464,371**

Note: All values are in acre-feet.

Additionally, IGFRs, Type 1 rights and Type 2 rights can be extinguished for credits pursuant to the AWS rules. These credits can be used to help meet the consistency with management goal criterion in proving a 100 year AWS. As of 2006, 37 grandfathered rights, including 5,897 acres of Type 1 rights and IGFRs, and Type 2 rights totaling 12,586 acre-feet, had been extinguished for AWS extinguishment credits in the Tucson AMA. A total of 518,166 acre-feet of extinguishment credits had been issued as of that date; of those credits, 19,357 acre-feet of credits had been pledged toward CAWS or DAWS. A total of 498,808 acre-feet of credits remain unpledged. For purposes of this Assessment, extinguishment credits pledged to DAWS and CAWS are included in the groundwater allowance component of the Summary Budget.

PART IV PROJECTED DEMANDS AND OVEDRAFT

7. INTRODUCTION TO THE PROJECTIONS

7.1 Purpose and Approach for Projecting Demands

Part III, Historical Water Demand and Overdraft, describes the status of the current imbalance or groundwater overdraft. In order to determine if the Tucson AMA will achieve the statutory goal of safe-yield by 2025, future demand, supply utilization and groundwater overdraft must be projected. ADWR recognizes for this Assessment that planners and decision makers need to move away from expectations of perfect or near-perfect forecasts (Arizona State University, 2009). Instead, ADWR, in consultation with outside entities, has developed seven different scenarios, each with slightly different assumptions. This Assessment contains three baseline scenarios, three additional shortage scenarios incorporating possible climate change impacts, and one scenario that maximizes the available reclaimed water in the AMA. As defined by the Intergovernmental Panel on Climate Change, “*A scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold."* The Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) website for Scenario Development further explains scenarios as

> *"Descriptions of possible alternatives of the future that take into account the interaction of many different components of a complex system. Although scenarios are not forecasts or even predictions of the most-likely alternatives, they provide a dynamic view of the future by exploring various trajectories of change that lead to a number of possible alternative futures. Because unique and unanticipated conditions have more chances to occur over a long period of time, long-term scenarios have more uncertainty than short-term scenarios"* (Sustainability of semi-Arid Hydrology and Riparian Areas, 2009).

Recognizing that it is impossible to predict accurately what future demand will be, staff developed a plausible range of demand and overdraft scenarios up to and including the year 2025. Baseline Scenario One represents the lowest reasonable water demand, Baseline Scenario Three the highest reasonable water demand, while Scenario Two is a mid-level projection. None of the baseline scenarios incorporate changes in surface water supply as a result of climate change.

Debate continues over climate change; will it occur, and if so, to what extent? Several climate change models exist for the southwestern region of the United States, but at this time, are not localized enough to be useful for the purposes of this Assessment. However, ADWR could not ignore the potential effects of climate change, so an effort was made to incorporate a period of reduced surface water availability based on a similar historical occurrence in the three climate change scenarios. Assumptions behind these additional scenarios, and the impact on groundwater overdraft, are described in Section 14.1.

The seventh and last scenario developed for this Assessment is the Maximized Reclaimed Water Use Scenario. This scenario recognizes that with population growth, there will be an ever larger amount of reclaimed water that could be re-used, and that such re-use might move the AMA closer to achieving the goal of safe-yield by 2025 (See Section 14.2).

The scenarios developed by ADWR for this Assessment are one set of potential results in terms of projecting future demand and groundwater overdraft. Part of the work that went into the compilation of this Assessment was the creation of a centralized data repository for the historical supply and demand information. This central repository was designed with the intent to provide ADWR with a flexible and readily updateable database that is directly connected to multiple future demand and supply scenarios. This will allow ADWR to quickly update annual report information on the demand side along with continual updates of supplies and future assumptions as conditions change. ADWR's goal is to continue modifying the assumptions each year to incorporate actual data as 2025 approaches, and to incorporate more sophisticated models, such as those currently in use or in development by the Decision Center for Desert Cities (DCDC). DCDC's research on water management decisions in central Arizona incorporates factors such as the area's rapid population growth and urbanization, complex political and economic systems, variable desert climate, and the potential of global climate change. ADWR hopes to collaborate with DCDC staff and regional water managers and other decision makers to use WaterSim, its complex integrative model, to examine the interactive effects of climate conditions, rapid growth, and policy decisions on future water supply and demand conditions. Although originally developed for the Phoenix area, it is hoped that WaterSim could be adapted for use in the Tucson and Pinal AMAs as well.

7.1.1 Water Demand Projection Techniques

For the purposes of this Assessment, staff used three methods to project demands: the per capita or per unit water use approach, the time-series approach (a sequence of data points, measured at successive times spaced at uniform time intervals in order to forecast events based on known past events), and the regression analysis approach (a statistical tool for investigation of the relationship between variables - also sometimes referred to as the econometric approach). For Municipal demand estimates, the Gallons Per Capita Per Day (GPCD) rate was multiplied by the population projection. The time-series approach was employed to statistically analyze the historical water use trend line to project future demand trends based on historical trends. The Industrial and Agricultural projected demands generally resulted from this technique. Finally, the regression analysis approach utilized the Coefficient of determination (the square of the sample correlation coefficient between the outcomes and their predicted values, varying from 0 to 1) to analyze water use related to influencing factors such as demographic changes, climate changes, and socio-economic changes. This allowed staff to estimate parameters that measure the historical relationship between water use (dependent variable) and different factors (explanatory variables or independent variables), assuming that those parameters will continue into the future.

7.1.2 User Interviews and Settlement Documents

During the development of the scenarios, staff conducted user interviews of academic, government and private sector experts. Staff also reviewed public documents such as intergovernmental agreements and Indian Water Settlements. These interviews and reviews were done in order to gain more insight regarding population growth, the potential for new water users (such as mines, power plants and golf courses), the potential for a change in how current sources are used, the addition of new sources, and changes in urbanization.

8. PROJECTED DEMANDS AND OVERDRAFT

8.1 Projected Summary Budget

The three baseline scenarios correspond generally to low, medium, and high AMA projected demands, according to sets of assumptions assembled for each water use sector. In some cases, the assumptions used to project supplies also varied among the three baseline scenarios. The methodology and assumptions used in projecting the future water use of the Municipal, Industrial, Agricultural, and Indian water use sectors under these three baseline scenarios are described in detail in Sections 7 through 10.

Incidental recharge is calculated as a percentage of the demand for each water use sector. Incidental recharge rates are based on the water use sector and nature of the water use (*See Table 3-3).* Additionally, the amount of groundwater that satisfies riparian demand within the AMA is displayed in the Projected Summary Budget and assumes the projected demand is the same as the historical demand. The Projected Summary Budget includes supply figures for the amount of water added to the aquifer pursuant to Underground Storage and Recovery projects (cuts to the aquifer); CAGRD replenishment of excess groundwater in order to satisfy the consistency with management goal requirement under the Tucson AMA AWS Rules; net natural recharge on an AMA-wide basis; reclaimed water discharges; and canal seepage.

ADWR has assigned certain volumes of groundwater for use by water providers with a DAWS and for subdivisions with a CAWS. The groundwater allowance is discussed further in Section 3.4, *Offsets to Overdraft* in the Historical portion of the Assessment. In the Projected Summary Budget, projected overdraft in year 2025 is displayed in two ways: with groundwater allowance pumping subtracted from the overdraft calculation and with it included it in the overdraft calculation (*See Table 8-1)*. The amount of allowable groundwater pumped, which is the difference between the two sets of overdraft figures, ranges from 4,765 acre-feet in Baseline Scenario One, to 25,723 acre-feet in Baseline Scenario Three.

Table 8-1 2025 Projected Summary Budget - Baseline Scenarios
Tucson Active Management Area

SECTOR	CATEGORY	Baseline Scenario One	Baseline Scenario Two	Baseline Scenario Three
Municipal				
Demand		251,018	279,264	308,237
Supply	*Groundwater*	54,627	80,119	105,962
	Other Surface water	0	0	0
	CAP (direct use & credits recovered)	175,488	176,421	177,721
	Reclaimed Water	20,902	22,724	24,554
	Incidental Recharge	10,041	11,171	12,329
Industrial				
Demand		55,682	63,782	71,282
Supply	*Groundwater*	53,048	61,148	68,648
	Other Surface	400	400	400
	CAP (direct use & credits recovered)	335	335	335
	Reclaimed Water	1,899	1,899	1,899
	Incidental Recharge	5,698	6,670	7,570
Agricultural				
Demand		57,038	71,342	112,245
Supply	*Groundwater*	28,394	42,698	83,601
	In-Lieu Groundwater	23,676	23,676	23,676
	Other Surface water	0	0	0
	CAP (direct use)	4,968	4,968	4,968
	Reclaimed Water	0	0	0
	Incidental Recharge	11,555	13,351	18,015
Indian				
Demand		19,033	21,455	34,043
Supply	*Groundwater*	1,043	1,043	1,043
	Other Surface Water	0	0	0
	CAP	17,990	20,412	33,000
	Reclaimed Water	0	0	0
	Incidental Recharge	3,958	4,491	7,260
Other				
Demand	*Riparian*	2,775	2,775	2,775
Offsets to Overdraft	*Cuts to the aquifer*	12,607	12,666	12,411
	CAGRD Replenishment	3,890	5,131	1,259
	Net Natural Recharge	77,356	77,356	77,333
	Reclaimed Water	4,245	4,245	4,245
	Canal Seepage	3,657	3,657	3,657
	Riparian use of managed Reclaimed Water	2,116	2,116	2,116

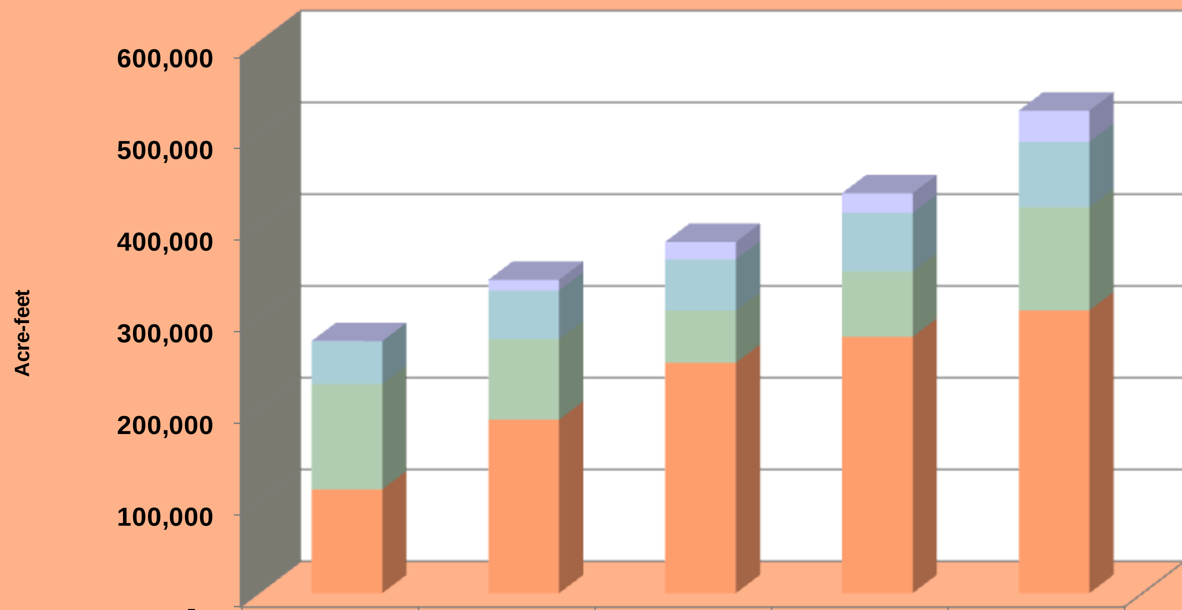
SECTOR	CATEGORY	Baseline Scenario One	Baseline Scenario Two	Baseline Scenario Three
Groundwater Use not counted towards overdraft	*GW Allowance*	4,765	13,166	*25,723*
	Remediation Water	800	800	800
	Poor Quality Groundwater	0	0	0
Overdraft	**Subtracting GW Allowance**	**22,876**	**56,640**	**112,987**
	Without Subtracting GW Allowance	**27,641**	**69,806**	**138,710**

All values are in acre-feet.

8.1.1 Demand Range

Total projected 2025 demand ranges from 382,771 acre-feet in Scenario One, to 525,807 acre-feet for Scenario Three (*See Figure 8-1*). Generally, the difference in Municipal demand between the three baseline scenarios is due to a combination of assumptions regarding future population growth and corresponding water use. The difference in Agricultural demand in the three baseline scenarios involves different assumptions concerning whether irrigable lands will be fully farmed, and whether certain irrigated lands will be taken out of production for residential development. For Indian Agricultural demand, it was assumed that by 2025, the amount of irrigation on-reservation would increase, with different assumptions on the rate of increase in each scenario. The primary difference in Industrial demand figures concerns assumptions regarding the amount of future mining production and corresponding water use. The assumptions and methodology used for water demand projections are detailed in Sections 7 through 10.

Figure 8-1 Historical and 2025 Projected Demand by Sector
Tucson Active Management Area



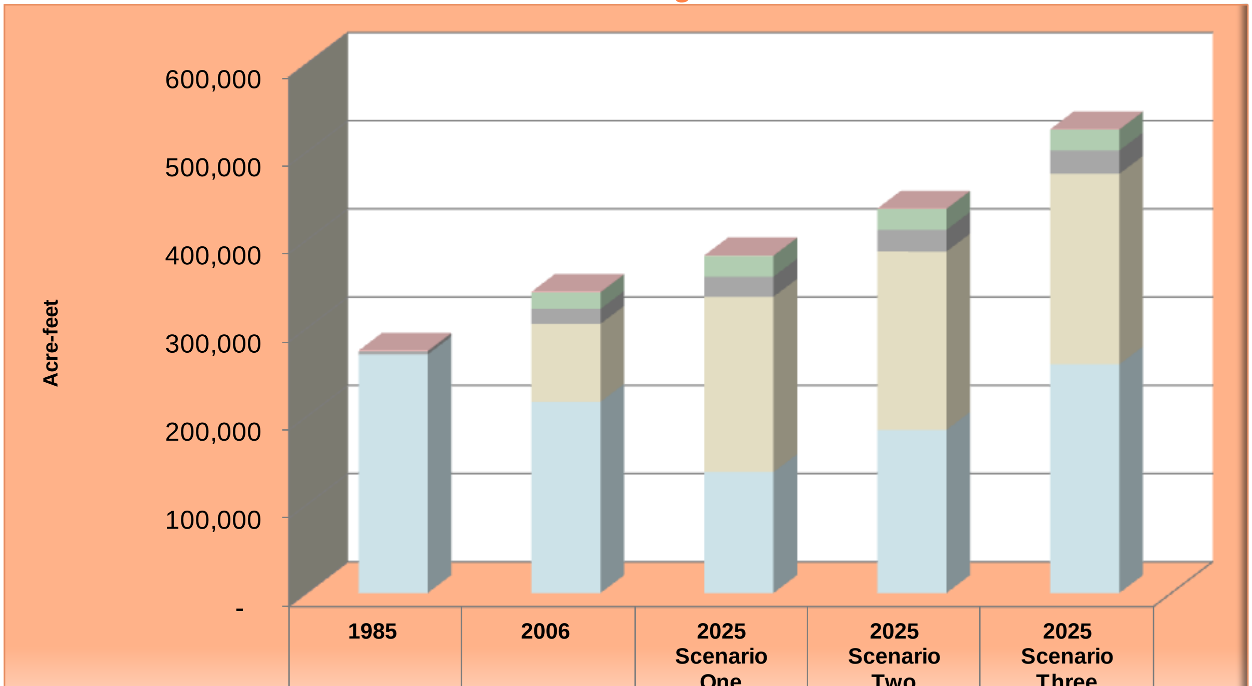
	1985 Historical	2006 Historical	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	274,735	341,484	382,771	435,843	525,807
INDIAN	160	11,678	19,033	21,455	34,043
INDUSTRIAL	46,616	53,084	55,682	63,782	71,282
AGRICULTURAL	114,879	87,755	57,038	71,342	112,245
MUNICIPAL	113,080	188,967	251,018	279,264	308,237

8.1.2 Supply Range

The total projected supplies used to meet demand are shown in *Figure* 8-2. Historically, non-CAP surface water has been a minimal use within the Tucson AMA; in Baseline Scenarios One, Two, and Three, little change is assumed in the amount of this source used. The amount of reclaimed water, both direct use and stored/recovered, has increased five-fold during the historical period; projected reclaimed water use varies from 22,801 to 26,453 acre-feet among the three baseline scenarios, as a function of projected Municipal demand. In 2025, CAP use is projected to range from 198,782 to 216,024 acre-feet. A portion of the future CAP use is assumed to be a result of the increase in on-reservation Indian Agriculture, as well as full utilization of municipal providers' CAP allocations.

By far the largest difference in projected supply among the three baseline scenarios is in groundwater use. Generally, it was assumed that if Agriculture, Municipal, and Industrial demand increases, groundwater will be a large portion of the supply needed to meet that increased demand. This additional groundwater use directly affects overdraft.

Figure 8-2 Historical and 2025 Projected Supplies
Tucson Active Management Area



	1985	2006	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	274,735	341,484	382,771	435,843	525,807
SURFACE	720	610	400	400	400
GSF	-	18,794	23,676	23,676	23,676
RECLAIMED WATER	3,546	16,830	22,801	24,623	26,453
CAP	-	88,399	198,782	202,136	216,024
GROUNDWATER	270,469	216,850	137,113	185,008	259,254

8.1.3 Offsets to Overdraft

A number of factors, as shown in *Table 8-2*, offset groundwater pumping. As mentioned previously, incidental recharge results from sector water use activities, such as water applied to fields in excess of crop consumptive use and evaporation demands within the Agricultural sector, or a similar application of water to Municipal or Industrial turf-related facilities. Incidental recharge rates are assumed to be consistent with historical rates, depending on the water use sector and nature of the water use.

Net natural recharge in the Tucson AMA, consisting of underflow in from the Santa Cruz AMA, minus underflow out to the Pinal AMA, plus streambed and mountain front recharge, is estimated to yield a benefit to the AMA of about 77,000 acre-feet under all three baseline scenarios. These rates are assumed to be consistent with the historical rates.

Historically, reclaimed water has been discharged into the Santa Cruz River from the Pima County Regional WWTFs at Roger and Ina Roads. In each of the three baseline scenarios, a higher volume of the reclaimed water discharges are included as supply in permitted Managed USFs. The remaining portion is assumed to percolate and benefit the aquifer. For each of the three baseline scenarios 4,245 acre-feet of discharge is estimated to reach the aquifer.

Pursuant to recharge statutes, in many cases permitted artificial recharge activities require that a certain percentage of the recharged volume be made non-recoverable to benefit the aquifer. These required non-recoverable volumes are called *cuts to the aquifer*, and have been discussed in Section 3.4.3. The amount of water accounted for as cuts to the aquifer varies slightly under the three baseline scenarios based on different assumptions regarding amounts of projected recharge, type of water, and type of facility. The assumptions and methodology involved in Recharge projections are detailed in Section 13.

Table 8-2 2025 Projected Offsets to Overdraft
Tucson Active Management Area

TYPE OF OFFSET	Scenario One	Scenario Two	Scenario Three
Incidental Recharge			
Municipal	10,041	11,171	12,329
Industrial	5,698	6,670	7,570
Non-Indian Agricultural	11,555	13,351	18,015
Indian Agricultural	3,958	4,491	7,260
Net Natural Recharge	77,356	77,356	77,333
Riparian Use of Managed Reclaimed Water	2,116	2,116	2,116
Reclaimed Water Discharge	4,245	4,245	4,245
CAGRD Replenishment	3,890	5,131	1,259
Canal Seepage	3,657	3,657	3,657
Cuts to the Aquifer	12,607	12,666	12,411
Total	**135,123**	**140,854**	**146,195**

Note: All values are in acre-feet.

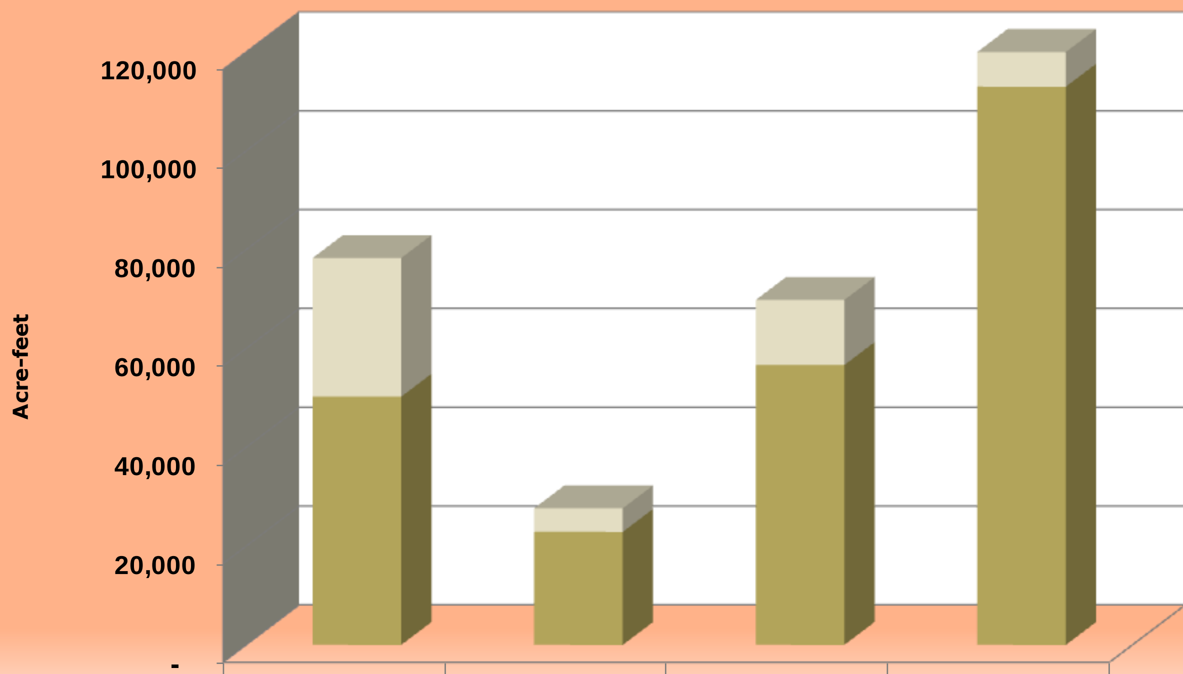
8.2 Overdraft Range

In 2006, the estimated overdraft for the Tucson AMA was approximately 78,000 acre-feet. The projected 2025 overdraft figures vary from 27,641 acre-feet in Baseline Scenario One to 138,710 acre-feet in Baseline Scenario Three (*See Figure 8-3*).

As detailed earlier in this Assessment, a portion of this overdraft is groundwater allowance under the AWS Program, and is deemed to be consistent with the management goal of the Tucson AMA. Even without counting for these groundwater allowance volumes, there remains a projected overdraft in the range of 22,876 to 112,987 acre-feet for 2025.

It should be noted again that in addition to the AWS Program groundwater allowance, certain users are legally permitted to withdraw groundwater pursuant to groundwater rights and withdrawal authorities that do not have a replenishment requirement. These withdrawal authorities include IGFRs, Type 1 and Type 2 rights, groundwater withdrawal permits, exempt wells, and service area rights operated by undesignated municipal providers who serve customers not covered by a CAWS. Groundwater pumped pursuant to these types of withdrawal authorities is included as overdraft and continues to be an impediment to reaching safe-yield because no replenishment is required.

Figure 8-3 2025 Projected Overdraft
Tucson Active Management Area



	2006 Historical	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
Total	78,302	27,641	69,806	138,710
GW Allowance	28,067	4,765	13,166	25,723
Overdraft	50,235	22,876	56,640	112,987

9. MUNICIPAL PROJECTIONS

Generally, the highest population projection was paired with the highest water demand projection method and the lowest population projection was paired with the lowest demand projection method. This established the end points of the range of projected municipal population and demand. A third scenario fell between the highest and the lowest scenarios (*See Figure 9-1*).

9.1 Description of Demand Methodologies and Assumptions

9.1.1 Population

Projecting Municipal demand begins with population. Some Industrial subsector demand is also directly related to population. This is discussed further in the Industrial projection section. Various methods of projecting population that incorporated multiple steps were used for this Assessment. Some of the scenarios used all the steps, and others did not. Methods used include:

- *Population projections prepared by other agencies* were used to develop a total Tucson AMA population projection. In Pima and Pinal counties, the regional associations of government (PAG, CAAG) projections were used. For the Santa Cruz County portion of the AMA, ADWR used the ADES projections.
- A *calculated total AMA population* was developed using different methods for large providers, small providers, and exempt wells:

- *Simple statistics* were used to project population for each individual large municipal provider that does not hold a DAWS. (For designated providers, the projected population and demand included in the provider's DAWS was used.) Trend lines with the highest statistical correlation were selected for each undesignated provider. The trend lines used data from 1985 through 2006. In some cases, water providers submitted population projections to ADWR that extended for some years beyond 2006 but did not extend out to 2025. ADWR used the providers' projections for as many years as were given, and extended the projections to 2025 with statistical trend lines.

- The small provider and exempt well sub-sector populations were projected using an *average percent growth rate or average number of people added per year growth rate*. The period used to generate the growth rate varied by scenario, but was either from 1985 to 2006 or from 2000 to 2006.

- Using these methods, the projections for large providers, small providers, and exempt wells were summed to develop a *calculated total AMA population*.

- Under Baseline Scenarios One and Two, the populations associated with large providers, small providers, and exempt wells were then "benched" or proportionately reduced, based on the difference between the total AMA population projection using the PAG/CAAG projections and the calculated total AMA population projection. The third scenario did not bench the population projections.

The methods were compared and categorized from lowest to highest. Appendices 1 through 4 describe the individual Municipal assumptions for the Tucson AMA in more detail.

9.1.2 Designations of Assured Water Supply

Water providers who hold a DAWS have provided ADWR with projected water demand, and in some cases, projected population in their applications for DAWS and in their annual reports. ADWR used information provided in the applications for DAWS for designated providers because the determinations of AWS for these providers are based on this information, which is tracked using data provided in the annual reports. If there was insufficient information, ADWR examined past water use and population trends for the provider and used that information to create an inferred projection that reasonably fit the provider's past trends and plans as submitted to ADWR.

9.1.3 Central Arizona Groundwater Replenishment District Plan of Operation

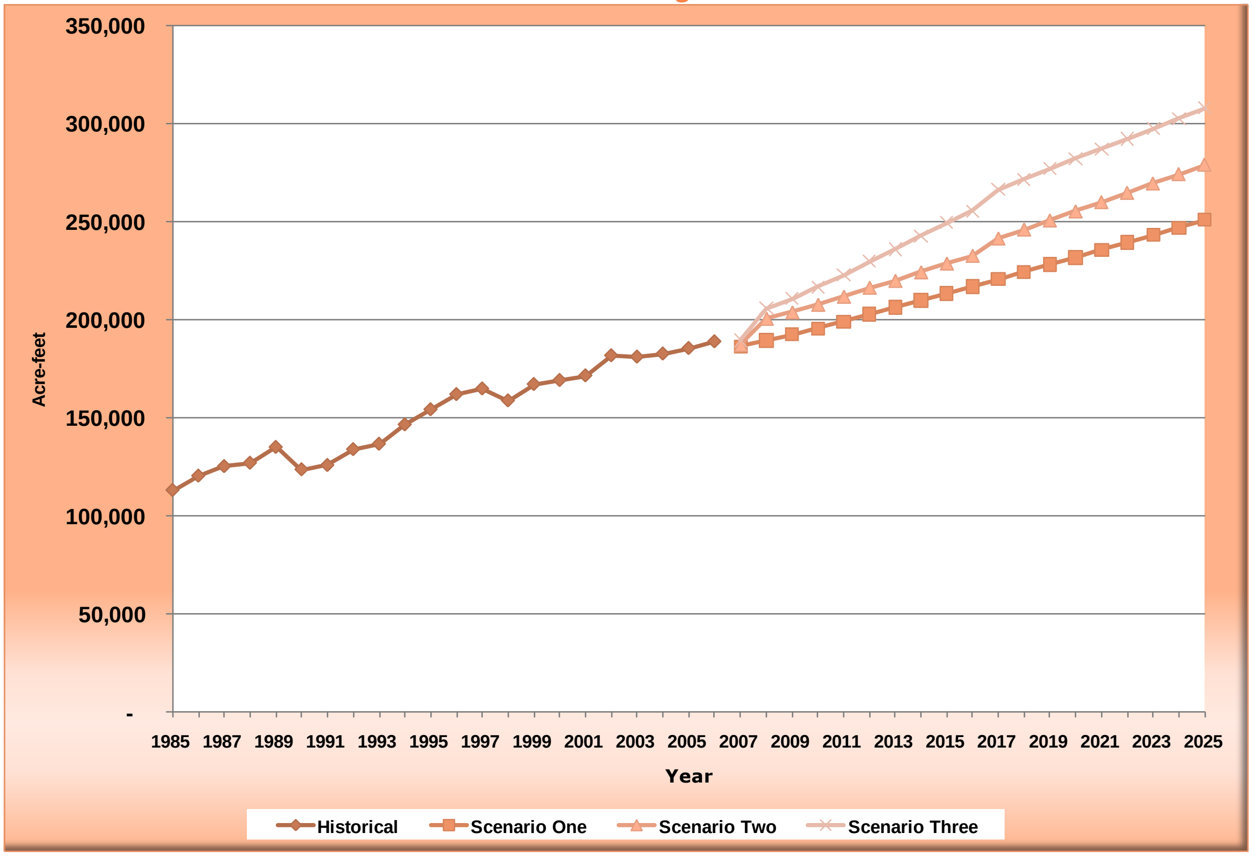
Every ten years the CAGRD is required to submit a Plan of Operation to ADWR outlining how it will meet its current and future replenishment obligations. In its 2004 Plan of Operation, the CAGRD projected the population, total demand, groundwater demand, and replenishment obligation of enrolled member lands and member service areas (MSAs), as well as future member lands not yet enrolled. The CAGRD worked with the Maricopa Association of Governments (MAG), the Pima Association of Governments (PAG), and ADES to develop population projections, using MAG's projection model and geographic boundaries. As explained in Section 9.2.1, ADWR uses several population projection methodologies including those of other agencies in this Assessment. ADWR also used demand and supply assumptions in this Assessment that differed from those used by the CAGRD in its Plan of Operation. Because of these differences, ADWR did not adopt the figures included in CAGRD's Plan of Operation, but instead developed its own estimate of the CAGRD replenishment obligation. These figures are for planning purposes only for this Assessment and are not intended to modify or replace the figures the CAGRD has used in its Plan of Operation.

ADWR did not approach the replenishment obligation from the perspective of growth in individual subdivisions (as the CAGRD used in its Plan of Operation). Instead, ADWR began with the population projection for each municipal provider as a whole, then separated out the population growth in each provider's service area since 1995 (the year of the adoption of the AWS Rules). For undesignated providers (providers who do not hold a DAWS) the sum of all post-1995 population was compared to the sum of the population and demand associated with the linear build-out of issued CAWS at the end of 2006. The difference between projected population and 1995 population represents future population that is assumed to be associated with new CAWS (comparable to future member lands projected by the CAGRD). Similarly, the difference between projected demand and 1995 demand represents future demand, however, not all future demand will be associated with a subdivision and a CAWS. To estimate the proportion of new demand that might be associated with a future CAWS, the single family to multi-family ratio for undesignated providers was applied to the future demand. This approach was taken since new subdivisions primarily consist of single family homes. Then an assumption was made in order to estimate the groundwater portion of future demand presumed to be associated with subdivisions. The ratio of the sum of all undesignated provider groundwater demand to the sum of all undesignated provider total demand was used to estimate the groundwater portion of the future CAWS demand.

For each issued CAWS, the volume of replenishment obligation was based on the CAGRD's reporting percentage for each year through 2025. The remainder of the projected annual groundwater demand minus the calculated replenishment obligation was presumed to be groundwater allowance use. When the groundwater allowance for a CAWS was exhausted, all groundwater demand was assumed to be met by the CAGRD as replenishment obligation.

For each member service area, the replenishment obligation was calculated as the difference between the projected groundwater demand and the projected groundwater allowance use rate as submitted in the provider's application for a DAWS up to any cap on maximum replenishment in the provider's Member Service Area Agreement with the CAGRD.

Figure 9-1 Historical and Projected Municipal Demand
Tucson Active Management Area



9.1.4 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One uses the "benched" large municipal provider population projection. The percent difference between the sum of the calculated large municipal provider population projection and sum of the benched (proportional reduction to the AMA total population) large municipal provider population projection was used to reduce each individual large provider's projection. The *Third Management Plan for Tucson Active Management Area 2000 – 2010* conservation requirement calculation methodology was used with the population projection for each large provider to calculate the projected Baseline Scenario One demand for each large provider.

The projected population and demand for institutional providers is included in the large provider category and was benched in the same way as large providers. Modest increases in prison population were assumed based on discussions with prison officials. Prison demand was projected using the 2000 through 2006 average prison GPCD rate multiplied by the benched population.

For small providers in Baseline Scenario One, the average rate of growth of small provider population from 1985 through 1999 was used and then benched as large providers and institutional providers were. Small provider demand was projected using the 2000 to 2006 average small provider GPCD rate multiplied by the benched small provider population.

Baseline Scenario One projects exempt well population using the average historical growth rate in exempt well population from 1985 through 1999. The methodology used to bench the other Municipal sub-sectors was also used to bench exempt well population. Exempt well demand was calculated using the *Third Management Plan for the Tucson Active Management Area 2000*

– *2010* interior and exterior water use models for single family housing units, the 2000 US Census average persons per housing unit for Pima County, and the projected exempt well population for all three scenarios.

9.1.5 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two uses the same population projection as Baseline Scenario One for large providers, but prior to benching, calculates demand using the volume in the DAWS determinations for designated providers or the 2000 to 2006 average GPCD rate for undesignated providers. This demand, like the population, is benched so that the GPCD rate remains the same for both benched and calculated.

The projected demand by institutional providers is included in the total for large municipal providers in this Assessment. Institutional demands are identical in Baseline Scenarios One and Two.

Demand for small providers in Baseline Scenario Two is the same as for Baseline Scenario One.

Exempt well population for Baseline Scenario Two is the same as for Baseline Scenario One.

9.1.6 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three used the un-benched projections. For each projection year, the projected population for each individual undesignated large provider was multiplied by the provider's 2000 to 2006 average GPCD rate to calculate projected demand. Demand for designated providers was from their DAWS determinations.

The projected demand by institutional providers is included in the total for large municipal providers in this Assessment. Baseline Scenario Three uses the same projected population and demand as Baseline Scenarios One and Two, but does not bench them.

Similarly, small provider and exempt well population and demand in Baseline Scenario Three are calculated the same as the other two baseline scenarios, but are not benched.

***Table 9-1* 2025 Projected Municipal Water Demand**
Tucson Active Management Area

Municipal Use Category	Scenario One	Scenario Two	Scenario Three
Large Providers			
Total Use	234,039	262,285	289,486
Groundwater Use	37,648	63,140	87,211
Small Providers			
Total Use	14,788	14,788	16,334
Groundwater Use	14,788	14,788	16,334
Institutional Providers			
Total Use	1,146	1,146	1,264
Groundwater Us	1,146	1,146	1,264
Domestic Exempt Well Use			
Total Use	1,045	1,045	1,153
Groundwater Use	1,045	1,045	1,153
AMA Total Use	**251,018**	**279,264**	**308,237**
AMA Total Groundwater Use	**54,627**	**80,119**	**105,962**

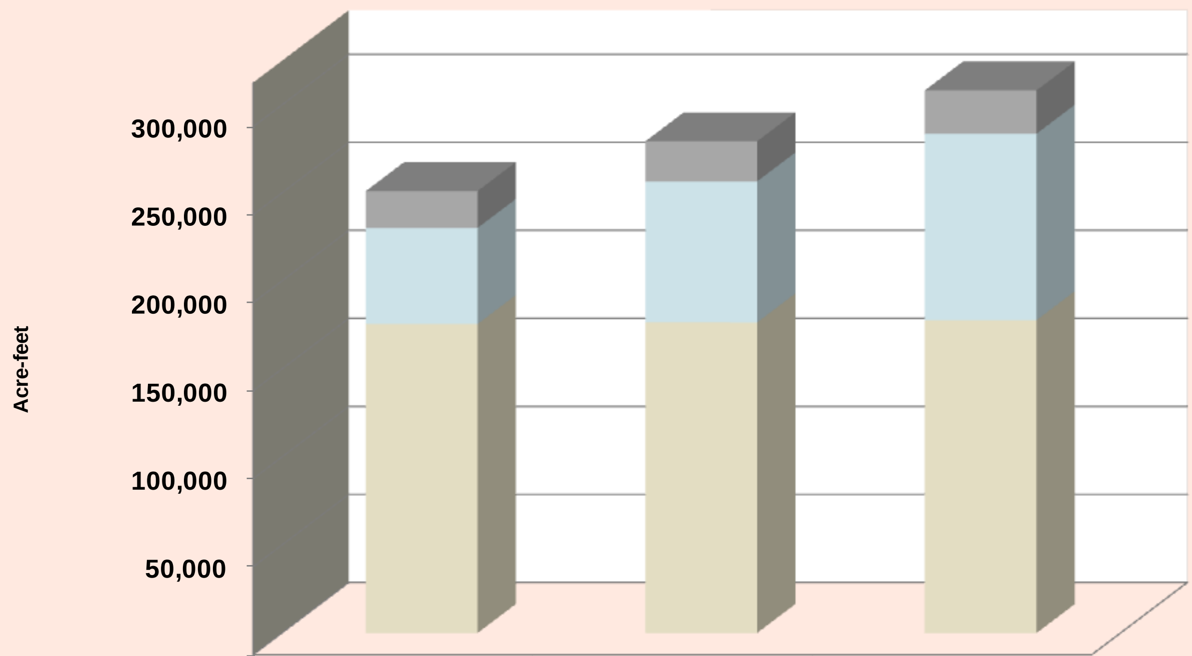
Note: All values are in acre-feet.

9.2 Description of Supply Methodology and Assumptions

Individual supply assumptions were made for each large provider based on the DAWS for designated providers or historical use of supplies for undesignated providers, with renewable supplies capped based on treatment capacity limitations or allocations. It is assumed that providers holding a DAWS will use their renewable supplies to the fullest extent feasible as indicated on their DAWS. Groundwater allowance and replenishment would be used as necessary to maintain the DAWS. CAP water use by undesignated providers begins in 2015 when plans to directly treat and deliver CAP are assumed to be realized. Direct use of reclaimed water gradually increases (*See Figure 9-2*) because all new subdivisions after 1995 must comply with the consistency with management goal requirement of the AWS Rules through replenishment by the CAGRD, by utilizing their own renewable water supplies, and through use of the groundwater allowance.

Institutional providers, small providers, and exempt well population use only mined groundwater in all three baseline scenarios.

Figure 9-2 2025 Projected Municipal Supplies
Tucson Active Management Area



	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	251,018	279,264	308,237
Reclaimed Water	20,902	22,724	24,554
Groundwater	54,627	80,119	105,962
CAP	175,488	176,421	177,721

9.3 Overview of Municipal Results

Although the recent reduction in residential construction due to current economic conditions has not been accounted for in any of the three baseline scenarios, the Municipal sector represents significant potential demand in the Tucson AMA. The three baseline scenarios are close together in terms of overall demand; Baseline Scenario Three, the highest demand scenario, is only 23 percent greater than Baseline Scenario One, the lowest demand scenario. Yet the ratio of groundwater demand is much greater; the groundwater demand for Baseline Scenario Three is 94 percent higher than in Baseline Scenario One. Therefore, the anticipated range in Municipal demand is relatively small, but the potential range in the volume of groundwater could have a significant impact on the ability of the Tucson AMA to meet its water management goal of safe-yield.

As shown in *Figure 9-2*, Municipal groundwater use remains a significant source of supply in all three municipal baseline scenarios, although more CAP water is used in Baseline Scenario Three.

9.3.1 Baseline Scenario One Results

In Baseline Scenario One, projected Municipal demand is 33 percent greater in 2025 at 251,018 acre-feet (*See Figure 9-1*) than in 2006 when it was 188,967 acre-feet.

Groundwater demand decreases by 46 percent, from 100,631 acre-feet in 2006 to 54,627 acre-feet by 2025 (*See Figure 9-2*).

The proportion of Municipal sector demand increases from 55 percent of total AMA demand in 2006, to 66 percent in 2025 (*See Figure 8-1*).

9.3.2 Baseline Scenario Two Results

Municipal demand in Baseline Scenario Two increases by 48 percent, from 188,967 acre-feet in 2006 to 279,264 acre-feet in 2025 (*See Figure 9-1*).

Groundwater demand in Baseline Scenario Two is about 20 percent less in 2025 than in 2006, decreasing from 100,631 to 80,119 acre-feet (*See Figure 9-2*).

The proportion of Municipal sector demand increases from 55 percent of the total AMA demand in 2006 to more than 64 percent by 2025 (*See Figure 8-1*).

9.3.3 Baseline Scenario Three Results

Municipal demand in Baseline Scenario Three increases by 63 percent from 188,967 acre-feet in 2006 to 308,237 acre-feet in 2025 (*See Figure 9-1*).

Baseline Scenario Three is the only scenario in which Municipal groundwater demand is greater in 2025 than in 2006, increasing approximately five percent, from 100,631 acre-feet in 2006 to 105,962 acre-feet in 2025 (*See Figure 9-2*).

The proportion of Municipal sector demand in Baseline Scenario Three increases from 55 percent of the total AMA demand in 2006 to 59 percent in 2025 (*See Figure 8-1*).

10. INDUSTRIAL PROJECTIONS

As discussed in Section 3.1.2, the Industrial sector is made up a number of different subsectors. When completing the Industrial projections, three projected baseline scenarios were developed for each Industrial subsector in the AMA. This method allowed for individual subsector analysis resulting in a broad range of potential Industrial demand in the AMA. The Tucson AMA Industrial subsectors are metal mining, turf-related facilities, sand and gravel, electric power generation, dairies, and the generic catch-all category other Industrial. Subsector demand scenarios were added together to derive the AMA's range of the total Industrial demand projections.

10.1 Description of Demand Methodologies and Assumptions

The Tucson AMA Industrial demand projection scenarios were developed using a combination of methods:

- *Trend line* analysis (where the X value is a measure of time) was generally used to predict future water use if an Industrial subsector's historical water use had a strong relationship ($R^2 > 0.6$) to time. Future water use was projected by assuming the past trend would continue through time. Trend line analysis was also used to study the rate of growth or decline in the number of facilities within a subsector over time. This analysis was especially helpful in detecting when established water use trends start to change.

- Generally, if a subsector did not exhibit a strong relationship to time, then one of the following methods were used: the scenario was developed by AMA staff or sector professional based on professional judgment, or the *average historical use* or *current use* was *held constant through time*. Subsectors, such as metal mines, that are based on a commodity generally fit into this category. See Appendix 5 for more details on the specific methodology used in projecting each Industrial subsector.

As mentioned previously, it is important to note that ADWR defines an Industrial user as an entity that uses water for a non-agricultural purpose and does not receive water from a municipal source. Generally, Industrial users have their own wells and associated water rights or withdrawal permits. The Industrial sector predominately uses groundwater to meet its demand; however, non-groundwater supplies are counted in this sector if they are not supplied by a municipal provider. See Appendix 5 for a more detailed description of individual Industrial subsector assumptions.

Factors Driving Future Industrial Use in Tucson

The major factor driving future Industrial demands in the Tucson AMA is the future level of mining production. Mining production in the Tucson AMA is driven by the global supply and demand for copper as well as local mine management and labor issues. As with any subsector based on a commodity, the uncertainty of local mining production and associated water use is difficult, if not impossible to predict.

Over the past twenty years, mining demand in the Tucson AMA has fluctuated by nearly 20,000 acre-feet per year, ranging from a low of 27,000 acre-feet to a high of 47,000 acre-feet per year due to changes in mining production levels. This fluctuating nature of mining production is expected to continue through time, however; due to the high variability in the global supply and demand of copper, ADWR did not attempt to project a single "most likely scenario." The projected demand scenarios attempt to provide a reasonable range of potential future mining demands in the Tucson AMA. Scenarios include mining production and associated water demand increasing in the short term then decreasing, remaining constant, or increasing past historical highs, as discussed below. Mining professionals were consulted about projected mining levels.

Non-mining subsectors such as turf, sand and gravel production, and electric power generation are generally driven by population and economic factors. In the Tucson AMA however, combined water use by these subsectors has been relatively constant (approximately 20,000 acre-feet per year) even with steady population increases. This trend was therefore projected to continue with only modest increases by 2025.

One possible reason historical non-mining demand in the AMA has held relatively constant even as the population increased is that many turf-related facilities built after the 1990s receive their water from municipal water providers, and therefore are classified as individual users (in the Municipal demand) and not as Industrial users. Another reason may be that historically much of the AMA's electric power has been generated outside of the AMA and imported into the AMA to meet the growing demands. In other words, the AMA's population increases were not directly matched with the equivalent increases in local electric power generation. Finally, sand and gravel water use appears to be influenced by *periods* of growth, i.e. new developments and road projects, not cumulative population growth.

10.1.1 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One for the Tucson AMA assumed the following occurs:

- Mining water use continues to increase in the short term only to decrease after 2008 due to a depressed global economy then level off at the historical average until 2025;
- Turf water demand grows at a slow but modest rate from current levels based on historical trend lines;
- Sand and gravel water demand remains relatively constant at average historical demand rates;
- Electric power generation water demand doubles by 2013 then remains relatively constant;
- Dairy water use remains relatively constant at current use; and
- Other Industrial use remains constant at its historical average.

Assumptions for all three baseline scenarios were based on the following sources: ADWR Data Management's Correlation Study of Sand and Gravel and Population, ADWR Data Management's Industrial Projections by Trend lines Study, Arizona Public Service Resource Plan 2009 through 2025, Rosemont Copper website, USPUG (Upper Santa Cruz Providers and Users Group) projections, personal communications with ASARCO, Freeport McMoRan, and personal communications with Tucson Electric Power.

10.1.2 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two for the Tucson AMA assumed the following:

- Mining water use increases in the short term, then remains relatively constant after 2008 at approximately 40,000 acre-feet until 2025;
- Turf water demand grows at a slow but modest rate from current levels based on historical trend lines;
- Sand and gravel water demand remains relatively constant at the average historical demand rates;
- Electric power generation water demand doubles by 2013 then remains relatively constant;
- Dairy water use remains relatively constant at current use; and
- Other Industrial use remains constant at its historical average.

10.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three for the Tucson AMA assumes the following:

- Mining water use is not negatively affected by the global recession and reaches historical highs due to expansion of existing mines and the development of a new mine;
- Turf water demand grows at a slow but modest rate based on historical trend lines;
- Sand and gravel water demand remains constant at the average historical demand rates;

- Electric power generation water demand doubles by 2013 then remains relatively constant;
- Dairy water use remains relatively constant at current use; and
- Other Industrial use remains constant at its historical average.

10.2 Description of Supply Methodology and Assumptions

The assumption was made that Industrial demand would be served by the same supplies in the same proportions as in 2006, with some minor exceptions based upon specific information available to ADWR. This supply methodology was similar to the one used in the 3MP when supply proportions from 1995 were projected forward.

In 2006, the Tucson Industrial demand was met primarily with groundwater; less than three percent of demand was met by CAP, reclaimed water, and surface water. This general trend is predicted to remain constant in the future, although under the SAWRSA, the ASARCO Mission mine can lease up to 10,000 acre-feet of CAP water annually from the TON in-lieu of pumping groundwater. It is important to note that the use of this CAP water will accrue credits for the TON that can either be used by the TON or leased for use anywhere within the boundaries of the Tucson AMA. For that reason, the leased CAP water used by ASARCO in projection scenarios is counted as groundwater use in the Projected Summary Budget because it contributes to overdraft in the AMA.

Table 10-1 2025 Projected Industrial Demand by Facility Type
Tucson Active Management Area

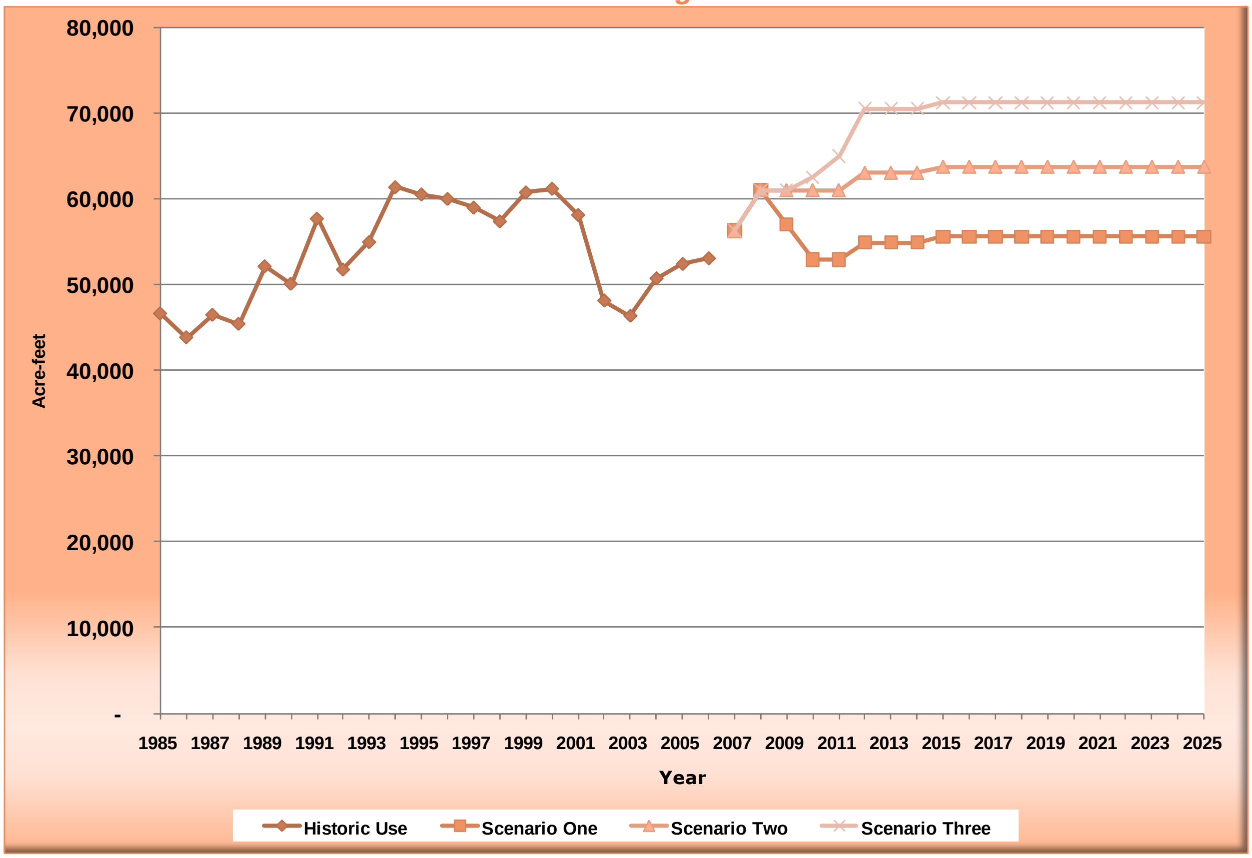
Type of Facility	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
Metal Mining	32,400	40,500	48,000
Turf-Related Facilities	9,500	9,500	9,500
Sand and Gravel Operations	4,041	4,041	4,041
Large-Scale Power Plants	5,000	5,000	5,000
Dairies	110	110	110
Other	4,631	4,631	4,631
Total	**55,682**	**63,782**	**71,282**

Note: All values are in acre-feet.

10.3 Overview of Industrial results

Historically, Industrial demand in the Tucson AMA has shown a cyclical trend caused primarily by the fluctuating water use of copper production at the AMA's large metal mines. This cyclical trend is predicted to continue, although it is nearly impossible to predict the specifics of the highs and lows of copper production. Baseline Scenarios One through Three illustrate a reasonable range of potential mining water use in the AMA, coupled with the relatively stable water use of the non-mining Industrial subsectors. It is unlikely that demand will exactly follow any one of the baseline scenarios from 2007 until 2025, but it is reasonable to assume that demand will fluctuate within this range of demand scenarios (*See Table 10-1*).

Figure 10-1 Historical and Projected Industrial Demand
Tucson Active Management Area

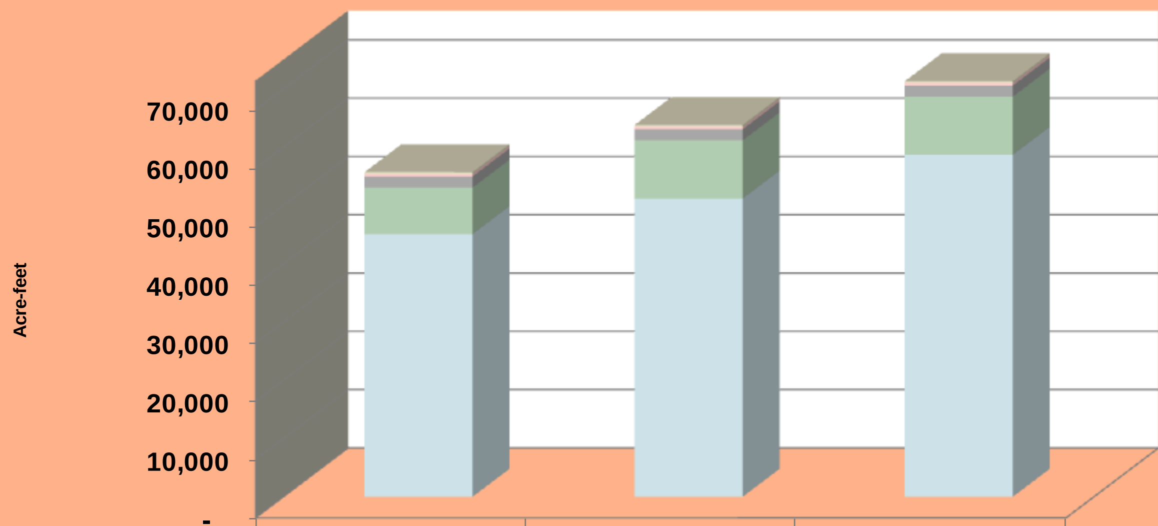


10.3.1 Baseline Scenario One Results

In Baseline Scenario One, Industrial demand continues to increase in the short term, and then decreases after 2008 primarily due to a depressed global economy. In Baseline Scenario One, total Industrial demand is approximately 55,000 acre-feet in 2025. This is approximately five percent higher than the 2006 total demand, but less than the highest historical demand in the AMA, of just over 60,000 acre-feet (*See Figure 10-1*).

By 2025, approximately 81 percent of the demand is met with groundwater, 14 percent with in-lieu CAP, one percent with direct CAP, three percent with reclaimed water, and one percent with surface water (*See Figure 10-2).*

Figure 10-2 2025 Projected Industrial Supplies
Tucson Active Management Area



	2025 Scenario One	2025 Scenario Two	2025 Scenario Three
TOTAL	55,682	63,782	71,282
CAP	335	335	335
Surface Water	400	400	400
Reclaimed Water	1,899	1,899	1,899
In-Lieu CAP	8,000	10,000	10,000
Groundwater	45,048	51,148	58,648

10.3.2 Baseline Scenario Two Results

In 2006, Industrial water use was approximately 53,000 acre-feet. It was clearly rebounding after historical lows in 2003 caused by low mining production. In Baseline Scenario Two, total Industrial demand continues to increase in the short term, but stays relatively constant after 2008 at approximately 64,000 acre-feet until 2025 (*See Figure 10-1*). This total demand is approximately 20 percent higher than 2006 demand levels, and just slightly higher than the AMA's highest historical demand.

Approximately 80 percent of the Industrial demand by 2025 is met with groundwater, 16 percent with in-lieu CAP, one percent with direct CAP, and three percent with reclaimed water (*See Figure 10-2*).

10.3.3 Baseline Scenario Three Results

In 2006, Industrial water use was approximately 53,000 acre-feet. It was clearly rebounding after historical lows primarily caused by low mining production levels in 2003. In Baseline Scenario Three, total Industrial demand continues to increase and is not negatively affected by the global recession. It reaches peak levels at approximately 71,000 acre-feet around 2012. This demand then remains relatively constant through 2025 (*See Figure 10-1*). At 71,000 acre-feet this demand would be 30 percent higher than the 2006 demand level and would easily surpass historical Industrial demand in the AMA (*See Figure 10-1*). This increase in overall Industrial demand is primarily caused by increased mining production due to expansion of existing mining projects and the start up of a new mine.

Approximately 82 percent of the demand by 2025 is met with groundwater, 14 percent with in-lieu CAP, approximately one percent with direct CAP, and three percent with reclaimed water (*See Figure 10-2*).

11. AGRICULTURAL PROJECTIONS

11.1 Description of Demand Methodology and Factors Driving Agricultural Demands

Total Agricultural demand is the sum of the IGFR demands. These demands were categorized into Area of Similar Farming Conditions (ASFC), exempt IGFR, and Other IGFR demands. Other IGFR demands include all IGFRs that are not exempt and not in the major ASFCs (See Section 5.3).

Three baseline demand scenarios were developed for each ASFC, exempt IGFRs, and Other IGFRs. The overall Agricultural demand scenarios were then calculated by adding together the individual demand scenarios. This method allowed for the greatest range of potential demand.

The Tucson AMA individual Agricultural demand projections were developed using a combination of methods:

- *Trend line analysis* of historical water use (where the x-value is a measure of time)
- *Regression analysis* using historical water use and population (where the x-value, usually population, is a factor other than time)
- *Multiple regression analysis* (where there are several independent variables such as time, population, certified irrigation acres, and precipitation)
- *Projections by AMA staff or sector professionals*
- *Average historical use*

Agricultural demand in the Tucson AMA has remained steady despite increased urbanization throughout the historical period. Geography provides an explanation. The majority of agricultural land is located away from the path of historical development.

Agricultural demand showed some correlation with climatic variability; however, climate could not explain the majority of the variability in demand. The coefficient of determination for precipitation was 9% and temperature approximately 3%. Climate did not explain the remaining 88% of variation.

Over the past 20 years, acreage and groundwater allotments have decreased while Agricultural demand has fluctuated. There is no apparent correlation between changes in Agricultural demand and the decrease in acreage and groundwater allotments (See Section 5.3). For this reason, certified irrigation acres and groundwater allotments were not projected for the Tucson AMA. Compared to maximum groundwater allotments, total Agricultural demand is typically around 50 percent of the allotments, but can fluctuate significantly with market conditions and climate. Many of the shifts in Agricultural demand in the Tucson AMA have been anecdotally linked to crop and commodity prices, along with Federal subsidy programs (both of which have been more clearly linked to water consumption in the Phoenix and Pinal AMAs). Because the flexibility account provisions permit farmers to bank the unused portion of the groundwater allotment for future use, the groundwater allotment itself does not necessarily limit demand.

Because Agricultural demand was influenced by factors other than population, certified irrigation acres, or climate factors, one of the following methods was used: 1) projections by sector professionals and AMA staff, 2) evaluating trends with time, or 3) average historical water use or current use was assumed (+/- one standard deviation for alternative scenarios). Much of the variability may be related to economic factors such as crop prices, federal subsidies, or regional demand; however, those factors are extremely difficult to project, and so were not considered.

Water use by exempt IGFRs constitutes a negligible portion of the Tucson AMA Agricultural water demand (See Section 5.3.3). Because historical water use was not calculated for these rights, no use by such rights was projected.

11.1.1 Baseline Scenario One Demand Methodology and Assumptions

Baseline Scenario One for the Tucson AMA includes the following assumptions:

- Extensive residential and commercial development occurs in the Marana area (ASFC 2) resulting in fewer irrigable acres;
- Some reductions in acreage occurs in orchard crops;
- Agricultural demands decline at rates projected by major producers, AMA staff, or by trend lines; and
- A CAP lateral is extended to FICO (ASFC 5) by 2015 and to Avra Valley Irrigation District (in ASFC 3) by 2020.

11.1.2 Baseline Scenario Two Demand Methodology and Assumptions

Baseline Scenario Two for the Tucson AMA includes the following assumptions:

- The rate of development slows, but remains substantial in the Marana area (ASFC 2), resulting in fewer irrigable acres;
- Some reductions in acreage occur in orchard crops;
- Agricultural demands decline at rates projected by major producers, AMA staff, or by trend lines; and
- A CAP lateral is extended to FICO (ASFC 5) by 2015 and to Avra Valley Irrigation District (in ASFC 3) by 2020.

11.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three for the Tucson AMA includes the following assumptions:

- Little to no additional development would occur in the Marana area (ASFC2), but instead occurs on non-agricultural lands;
- Agricultural demands increase at rates projected by certain trend lines;
- Supplies do not exceed allotted volumes based on IGFRs, settlements, and pool allocations; and
- A CAP lateral is extended to FICO (ASFC 5) by 2015 and to Avra Valley Irrigation District (in ASFC 3) by 2020.

11.2 Agricultural Supply Methodology and Assumptions

Similar techniques were used to examine the three baseline supply scenarios. Information about the current water portfolios for each irrigation district, large farm or other entity was included in the analysis. In certain cases, knowledge regarding supply availability from sector professionals, especially large-scale producers, was used.

CAP supplies were based on current CAP NIA settlement pool allocations, recent use, projected demand, and planned expansions of delivery systems. The total CAP NIA settlement pool water for all AMAs will be reduced by 25 percent in 2017 and by an additional 25 percent in 2024, reducing to zero after 2030. For the purposes of these projections, reductions were applied proportionately to each allottee's supply.

There are currently no contracts for delivery of reclaimed water to Agricultural users in Tucson AMA. Historically, CMID had a contract for reclaimed water from Pima County, however the contract expired and no reclaimed water was used after 1998 (See Section 5.3.4).

CAP and reclaimed water may be delivered to GSFs. GSF supply projections were based on current permits, and the projected amount of supplies available for storage. This supply is identified as in-lieu groundwater in this Assessment.

Projected demands not met by CAP or in-lieu groundwater were assumed to be met by mined groundwater. See Appendix 6 for more details on the specific methodology used in projecting each demand and supply component.

11.3 Overview of Agricultural Results

Historically, total Agricultural water demand in the Tucson AMA has fluctuated, but has not exhibited a steady upward or downward trend (See Section 5.3.4). Although future Agricultural demand in the Tucson AMA is highly uncertain, it will most likely depend on the rate at which the AMA urbanizes, crop prices, and the cost and availability of water supplies. Projection scenario results indicate that demand in 2025 could range from approximately 57,000 to 112,000 acre-feet (*See Table 11-1*).

Table 11-1 2025 Projected Agricultural Demand
Tucson Active Management Area

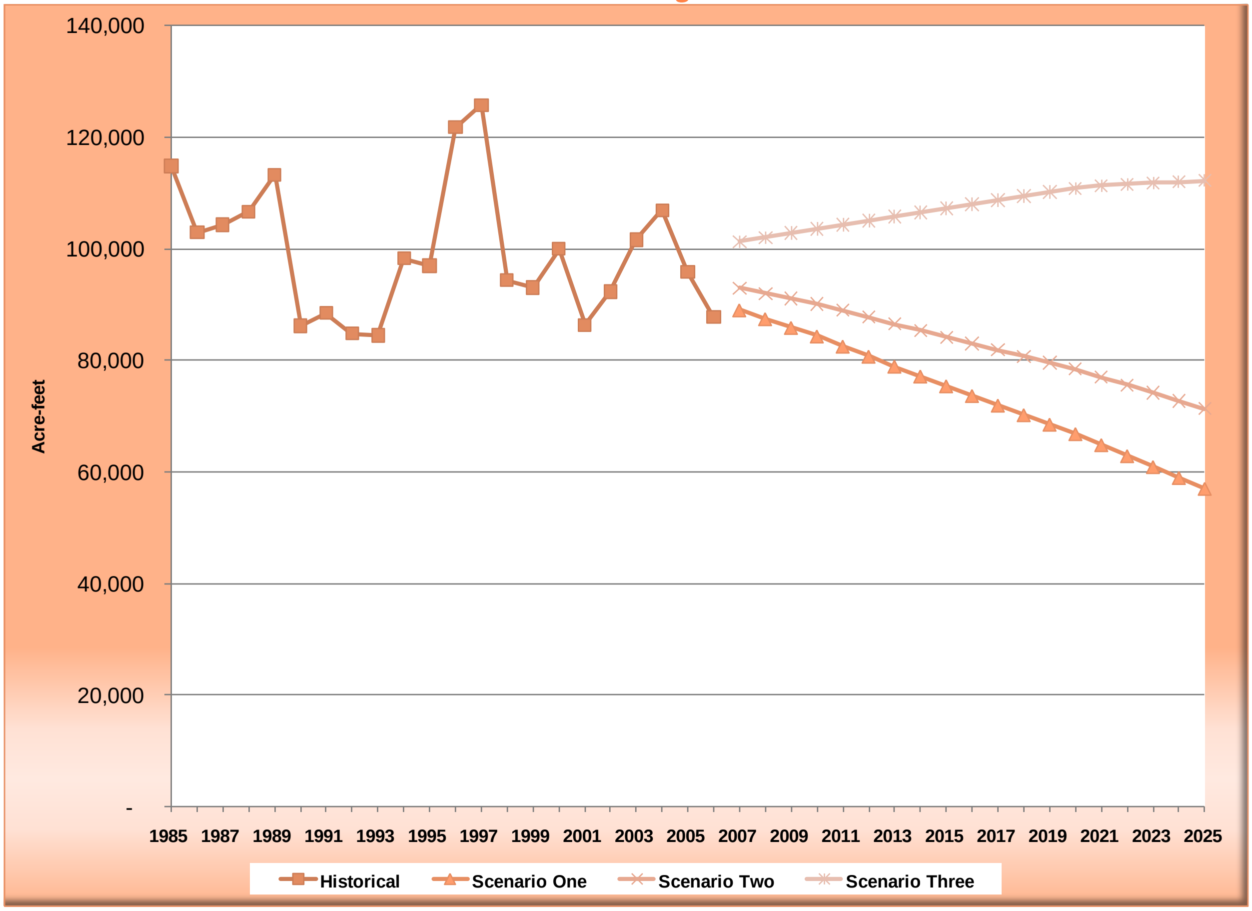
Scenario	Total Water Use	Groundwater Use
One	57,038	52,070
Two	71,342	66,374
Three	112,245	107,277

Note: All values are in acre-feet, and groundwater use includes CAP in-lieu groundwater.

11.3.1 Baseline Scenario One Results

In Baseline Scenario One, Agricultural demand increases slightly in 2007, then decreases by approximately 35 percent, from approximately 88,000 acre-feet in 2006 to approximately 57,000 acre-feet in 2025 due to increased development on agricultural lands (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately nine percent CAP, 41 percent in-lieu groundwater (stored at GSFs), and 50 percent groundwater (*See Figure 11-2*).

Figure 11-1 Historical and Projected Agricultural Demands Tucson Active Management Area



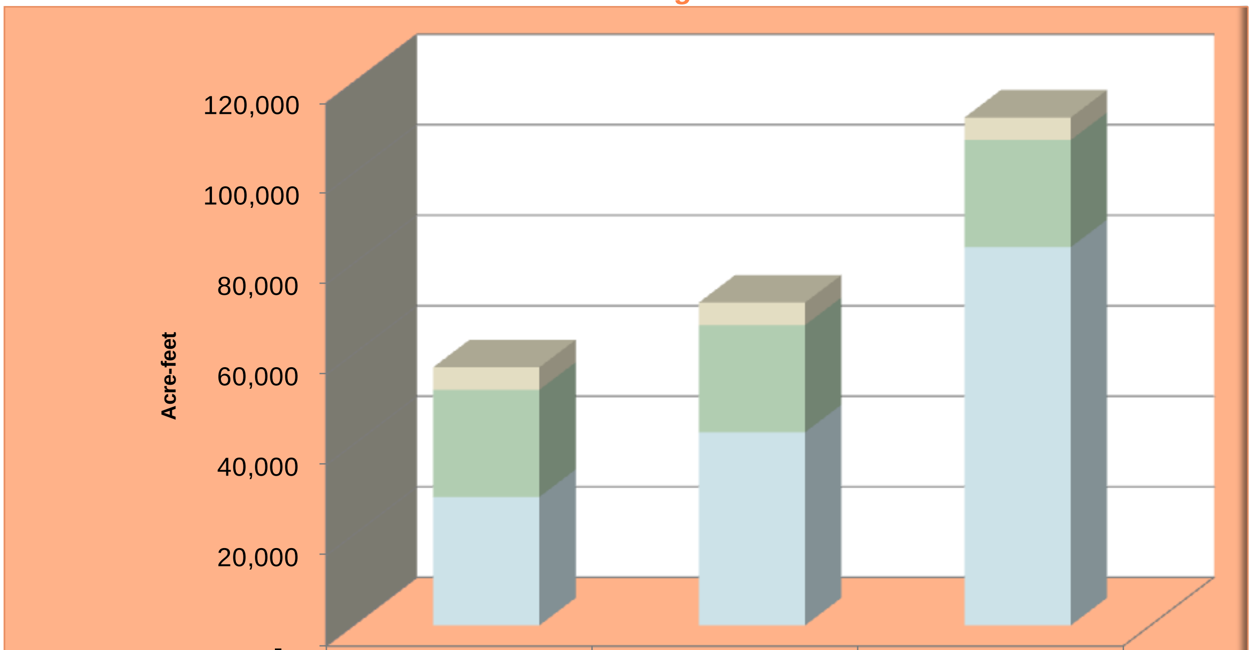
11.3.2 Baseline Scenario Two Results

In Baseline Scenario Two, Agricultural demand increases slightly in 2007, then decreases by approximately 19 percent, from approximately 88,000 acre-feet in 2006 to approximately 71,000 acre-feet in 2025 (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately seven percent CAP, 33 percent in-lieu groundwater, and 60 percent groundwater (*See Figure 11-2*).

11.3.3 Baseline Scenario Three Results

In Baseline Scenario Three, Agricultural demand increases by approximately 28 percent, from approximately 88,000 acre-feet in 2006 to approximately 112,000 acre-feet in 2025 (*See Figure 11-1*). The demands in 2025 are projected to be met with approximately four percent CAP, 21 percent in-lieu groundwater, and 75 percent groundwater (*See Figure 11-2*).

Figure 11-2 2025 Projected Agricultural Supplies
Tucson Active Management Area



	2025 SCENARIO ONE	2025 SCENARIO TWO	2025 SCENARIO THREE
TOTAL	57,038	71,342	112,245
CAP (Direct Use)	4,968	4,968	4,968
In-Lieu Groundwater	23,676	23,676	23,676
Groundwater	28,394	42,698	83,601

12. INDIAN PROJECTIONS

Indian demand information is not reported to ADWR, therefore projecting demands and supply utilization can only be assumed based on historical trends and information obtained from Indian Settlements.

12.1 Description of Demand Methodology and Assumptions

Three baseline demand scenarios were developed for Indian demands within the Tucson AMA (*See Figure 12-1*). The focus of the increased demands was in the Indian Agricultural sector. Generally, demand was projected based on evaluating trends in the available historical data, or reasonable assumptions regarding use, based on SAWRSA settlement documents. No increase in demands were projected for Indian Municipal or Indian Industrial.

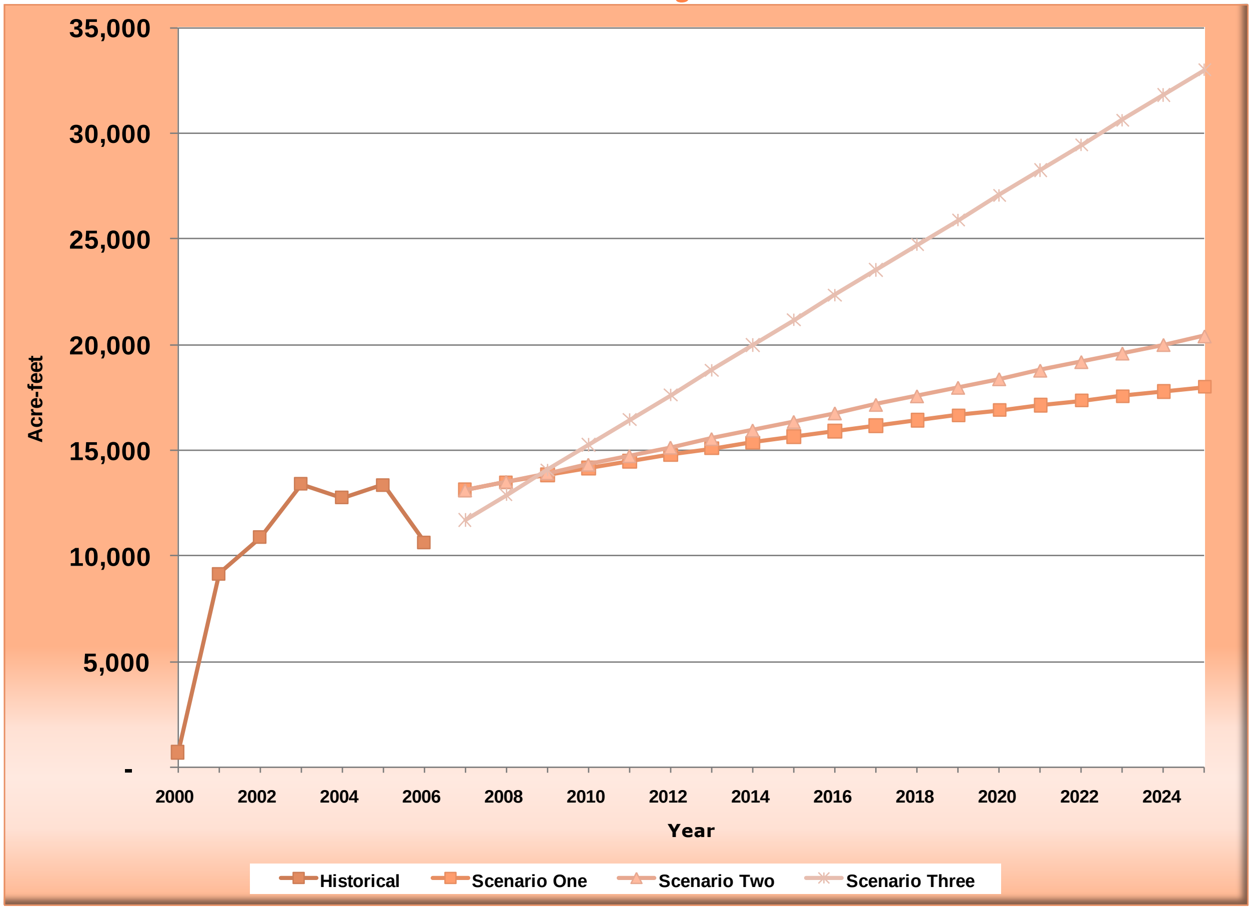
12.1.1 Baseline Scenario One Demand Methodology and Assumptions

For Baseline Scenario One Tucson AMA Indian Agriculture, a semi-log trend with time based on 2001 through 2006 use was used.

12.1.2 Baseline Scenario Two Demand Methodology and Assumptions

For Baseline Scenario Two Tucson AMA Indian Agriculture, a linear trend with time based on 2001-2006 use was used.

Figure 12-1 Historical and Projected Indian Agricultural Demand Tucson Active Management Area



12.1.3 Baseline Scenario Three Demand Methodology and Assumptions

Baseline Scenario Three for Tucson AMA Indian Agriculture assumed that demand would increase from the 2001 through 2006 average to 33,000 acre-feet (one half of the total annual volume awarded in the settlement) by 2025 (ADWR, 2006).

12.2 Description of Supply Methodology and Assumptions

Indian Agriculture in the Tucson AMA has relied almost entirely on CAP as a water supply since 2000 (See Section 5.4.3). Given the quantity of water awarded in the recent settlement, this is expected to continue (ADWR, 2006).

12.3 Overview of Indian Results

Historically, Indian Agricultural demand has increased, while fluctuating somewhat due to water supply, climate, and economic conditions (See Section 5.4.3). Although future Indian Agricultural water demand is somewhat uncertain, it is expected to continue to increase in the Tucson AMA, based on the recent settlement (ADWR, 2006). Projection scenario results indicate that demand in 2025 could range from approximately 18,000 to 33,000 acre-feet (*See Table 12-1*).

Table 12-1 2025 Projected Indian Agricultural Demand
Tucson Active Management Area

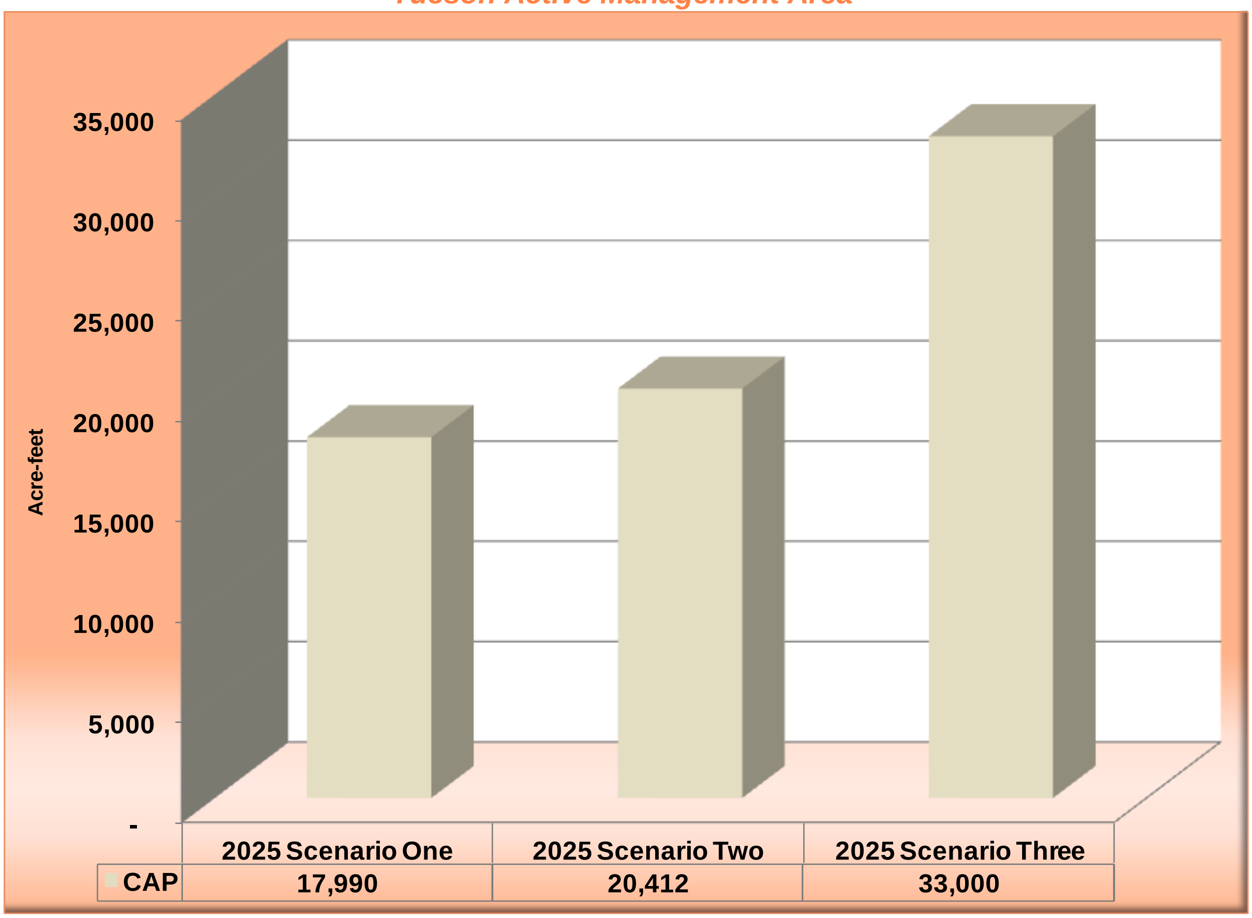
Scenario	Total Water Use	Groundwater Use
One	17,990	0
Two	20,412	0
Three	33,000	0

Note: All values are in acre-feet.

12.3.1 Baseline Scenario One Results

In Baseline Scenario One, demand increases by approximately 70 percent, from 10,635 acre-feet in 2006 to approximately 18,000 acre-feet in 2025. The demands in 2025 are projected to be met with 100 percent CAP supply (*See Figure 12-2).*

Figure 12-2 2025 Projected Indian Agricultural Supplies
Tucson Active Management Area



12.3.2 Baseline Scenario Two Results

In Baseline Scenario Two, demand increases by approximately 92 percent, from 10,635 acre-feet in 2006 to approximately 20,500 acre-feet in 2025. The demands in 2025 are projected to be met with 100 percent CAP supply (*See Figure 12-2*).

12.3.3 Baseline Scenario Three Results

In Baseline Scenario Three, demand increases by approximately 210 percent, from 10,635 acre-feet in 2006 to approximately 33,000 acre-feet in 2025. The demands in 2025 are projected to be met with 100 percent CAP supply (*See Figure 12-2*).

13. RECHARGE PROJECTIONS

13.1 Projection Methodology of CAP Recharge at Groundwater Savings Facilities

In the Tucson AMA, the majority of recharge activity consists of CAP storage at USFs. Some CAP is stored at GSFs, although the number of agricultural acres in production with direct access to CAP supplies limits the volume of storage. The amount of GSF storage is the same for all three baseline scenarios and is driven by the available storage capacity and the water available to store rather than historical patterns of GSF storage. It is assumed that more GSF storage will occur in the future to assist in fully utilizing CAP water. Reclaimed water storage is projected to increase significantly, since projected reclaimed uses do keep pace with the rate of increase in reclaimed water production, and the commitment to fully utilize renewable supplies continues.

A significant amount of recovery occurs in all three baseline scenarios, however, about half of the water projected to be stored during the period remains in storage in all three scenarios.

The Overall Projection of CAP Available to Store

The amount of CAP water available to store was projected by examining and accounting for all projected uses of CAP, direct as well as stored, for all three CAP AMAs.

Municipal CAP use was projected based on individual assumptions of supply utilization for each large provider. Assumptions were based on information included in applications for DAWS, historical use of CAP water, current and future water treatment capacity, and a review of current ability to store and recover CAP water.

A volume of CAP water stored by municipal providers was projected for each year. At a maximum, this could be equal to the total CAP M&I allocation of each provider minus any direct CAP use. Generally, if a provider was directly using less than their allocation, the remaining volume was assumed to be stored up to the provider's maximum permitted underground storage capacity for CAP water. Recovered water was assumed to be a portion of the volume assumed to be stored that year (annual recovery), except in years in which the provider's recovered volume exceeded the amount the provider stored; any amount over and above the amount stored is assumed to be recovery of long-term storage credits.

CAP use in both the Industrial and Agricultural sectors was projected based on information obtained from CAP users in those sectors and from past trends.

Potential Indian CAP use was projected based on review of settlement documents.

Arizona Water Bank

AWBA staff prepared the initial projections of Excess CAP water use by the AWBA; adjustments were made based on ADWR's projected CAP water use by other users. The projections (except for 2007 and 2008 for which historical data was used) are based on the assumptions used to develop the AWBA's Ten-Year Plan of Operation for 2010 through 2019 (AWBA Plan), adopted June 17, 2009. The assumptions in the AWBA Plan were carried forward to 2025 for the purpose of this Assessment.

The assumptions also incorporated CAWCD's Procedure to Distribute Excess Water for 2010 through 2014, adopted by the CAWCD Board of Directors in 2009. In anticipation of increasing demands for excess CAP water, CAWCD staff developed a strategy for distributing excess CAP water among competing demands. Under this strategy, CAWCD created four pools of excess CAP water, in addition to the previously established CAP NIA settlement pool, that guide how excess water will be distributed when demand for this supply exceeds the availability of the supply. One of these pools is for the AWBA, the CAGRD and the BOR, for a fixed volume of 175,000 acre-feet per year. The AWBA's portion of the pool is determined by subtracting the CAGRD's projected storage amount. Although the CAWCD Procedure to Distribute Excess Water is for a five-year period, it was assumed that it, or a similar policy, would continue through 2025. The AWBA's annual storage in each of the three CAP AMAs was also based on the availability of funding and storage capacity in the AMAs. The two main funding sources for the AWBA are withdrawal fees and *ad valorem* taxes levied by CAWCD. Expenditure of these funds is for the benefit of the AMA/county in which they were collected. The last year of *ad valorem* collections is 2016, leaving withdrawal fees as the principal funding source for the AWBA. Although funding is typically the limiting factor in the Pinal and Tucson AMAs, it does not become a limiting factor in the Phoenix AMA until after *ad valorem* tax collections cease.

Finally, the AWBA projections include interstate banking for SNWA after all funding sources and capacity for Arizona storage are utilized. Water stored on behalf of SNWA could include Colorado River supplies acquired by CAWCD with the AWBA's SNWA funds.

Adjusting the Amount of CAP Available to Store

Adjustments to the amount of CAP available to store were approached comprehensively for the CAP AMAs. In some years, the total of the projected uses exceeded the assumed available CAP supply, which varies year to year (*See Table 14-1*). In this situation, the projected storage of CAP water in each AMA was reduced based on the CAWCD Procedure to Distribute Excess Water. In other years, the sum of all projected uses of CAP water across all three AMAs was less than the volume of CAP water assumed to be available. In this situation, the surplus was distributed based on the CAWCD Procedure to Distribute Excess Water. Although the policy extends through the year 2014, the projection scenarios presume that the policy continues, rather than reverting to a pre-policy assumption after the year 2014. If any AMA did not have the capacity to store its portion of the surplus, the surplus was moved to another AMA that had the capacity to store it. This adjustment is based on the assumption that all CAP water available will be fully utilized in each projection year.

13.2 Projection Methodology of CAP Recharge at Underground Storage Facilities

CAP storage at Constructed USFs is the primary type of recharge occurring in the Tucson AMA. This is anticipated to continue through at least 2025. For purposes of this Assessment, the operational capacity of all underground storage of CAP in the Tucson AMA was assumed to be 235,000 acre-feet per year. In years where there was excess CAP water available that exceeded this volume, the additional CAP water was moved to the Phoenix AMA. Excess CAP that could not be put to use in Tucson AMA was not moved to Pinal AMA, because recharge of CAP water in the Pinal AMA is only done through GSF storage, and there is insufficient Agricultural demand projected to accommodate any additional GSF CAP in Pinal AMA in the three baseline scenarios. However, the Phoenix AMA has greater operational storage capacity so moving excess CAP to Phoenix AMA that could otherwise not be put to use in the Tucson and Pinal AMAs allows CAP water to be fully utilized in each projection year in this Assessment.

13.3 Projection Methodology of Reclaimed water Recharge at Underground Storage Facilities

Projecting reclaimed water storage began with a projection of the volume of reclaimed water supply in the AMA. The available reclaimed water supply was projected using a "reclaimed water GPCD." The reclaimed water GPCD was calculated by dividing historical reclaimed water generated by historical population. The reclaimed water GPCD was then multiplied by the projected large provider population to project future reclaimed water generated.

The projected uses of reclaimed water by all water use sectors were subtracted from the amount projected to be generated. In the Municipal sector, reclaimed water use was projected based on individual assumptions for each large provider. Assumptions were based on information included in the providers' DAWS, historical use of reclaimed water, current and future wastewater treatment capacity, and a review of current ability to store and recover reclaimed water.

The remaining reclaimed water supply was divided in half, with half assumed to be additional reclaimed water stored and half assumed to be discharged. The volume of reclaimed water available for storage varied each year based on the differences between the projected population among the three scenarios. There is no GSF reclaimed water in TAMA.

In the Tucson AMA the projection of reclaimed water stored was assumed to begin at 41,700 acre-feet in 2007. The amount of additional reclaimed water available to store was added to 41,700 acre-feet for each projected year. Managed reclaimed water was held constant. USF constructed reclaimed water is the remainder of the assumed reclaimed water to be stored minus managed reclaimed water stored.

13.4 Overview of Artificial Recharge Results

13.4.1 Baseline Scenario One Results

The projected volume of CAP stored at GSFs in the year 2025 is 23,676 acre-feet. This is an increase of about 26 percent from the 18,794 acre-feet volume stored in 2006. All three baseline scenarios have the same amount of GSF storage *(See Table* 13-1*).*

The amount of CAP stored at USFs in 2025 is 18 percent greater, or 22,669 acre-feet more than the amount stored in 2006.

Reclaimed water storage at Constructed USFs is projected to be 32,904 acre-feet in the year 2025 in Baseline Scenario One. This is an increase of 213 percent, or 22,396 acre-feet over the volume stored in 2006.

Reclaimed water storage at managed facilities remains constant at 24,577.

From 2007 through 2025, cumulative USF CAP storage of 3,280,182 acre-feet is projected in Baseline Scenario One. When added to the 514,225 acre-feet already in storage in 2006, the result is a total storage of CAP through USF of 3,794,407 acre-feet in 2025.

Table 13-1 2006 Historical and 2025 Projected Water Artificial Recharge Tucson Active Management Area

Recharge Facilities	2006	Scenario One	Scenario Two	Scenario Three
Groundwater Savings Facilities				
CAP Stored	18,794	23,676	23,676	23,676
Underground Storage Facilities (Constructed)				
CAP Stored	128,143	150,812	152,029	148,233
Surface Water	149			
Reclaimed Water Stored	10,508	32,904	33,807	39,394
Underground Storage Facilities (Managed)				
Reclaimed Water Stored	24,577	24,577	24,577	24,577
Total Stored	**182,172**	**231,969**	**234,088**	**235,881**

Note: All water volumes are in acre-feet, and include water delivered to be stored, minus physical losses.

The total reclaimed water stored by 2025 is projected to be 824,400 acre-feet, due to an additional 780,467 acre-feet projected to be stored between 2007 and 2025.

In Baseline Scenario One, the projected cumulative amount of GSF CAP storage from 2007 through 2025 is 498,869 acre-feet. Thus, by 2025, the total GSF CAP storage in Baseline Scenario One, including the amount of water that had been stored through 2006, is 615,578 acre-feet.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

Table 13-2 2006 and Projected Cumulative Artificial Recharge Credits Through 2025 Tucson Active Management Area

Long Term Storage Credits	2006	Scenario One	Scenario Two	Scenario Three
Underground Storage Facilities				
CAP	514,225	3,794,407	3,695,559	3,600,665
Reclaimed Water	43,933	824,400	828,565	900,814
Total	558,158	4,618,807	4,524,124	4,501,479
Groundwater Savings Facilities				
CAP	116,709	615,578	610,926	610,674
TOTAL USF/GSF Storage	674,868	5,234,385	5,135,050	5,112,153
Arizona Water Bank				
Intrastate	351,001	707,281	641,784	582,068
Interstate - Nevada	78,376	89,021	78,376	78,376
Total	429,377	1,225,679	1,149,537	1,089,821
CAWCD/CAGRD				

Long Term Storage Credits	2006	Scenario One	Scenario Two	Scenario Three
CAWCD	4,132			
CAGRD		179,302	125,254	84,526
Conservation District Account	36,731			
Replenishment Reserve Account	13,855			
Total	54,718			
Recovery	77,733	2,926,762	2,984,587	3,003,063
Credits Remaining in Storage	**597,135**	**2,307,623**	**2,150,463**	**2,109,090**

Note: All water volumes are in acre-feet. "Credits Remaining in Storage" is calculated by subtracting Recovery from the "Total USF/GSF Storage".

13.4.2 Baseline Scenario Two Results

The amount of CAP stored at GSFs in Baseline Scenario Two is the same as in Baseline Scenario One. In 2025, CAP storage at USFs was 23,676 acre-feet, or 19 percent, greater than in 2006.

Reclaimed water storage at constructed USFs in Baseline Scenario Two is 33,807, an increase of 23,299 acre-feet, or 222 percent, from the volume stored in 2006.

The amount of reclaimed water stored at Managed facilities is the same in Baseline Scenario Two as in Baseline Scenario One.

In Baseline Scenario Two, the cumulative CAP stored at USFs is more than in Baseline Scenario One. An additional 3,181,334 acre-feet will be stored between 2007 and 2025 for a cumulative total of 3,695,559 acre-feet.

USF reclaimed water storage in Baseline Scenario Two is slightly higher than in Baseline Scenario One. It is projected to be 828,565 acre-feet by 2025.

Cumulative GSF CAP storage from 2007 through 2025 is projected to increase by 494,217 acre-feet, which is less than the amount as projected in Baseline Scenario One.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

13.4.3 Baseline Scenario Three Results

In Baseline Scenario Three, CAP stored at GSFs in 2025 is the same as in the other two baseline scenarios. CAP stored at USFs in 2025 is just over 20,000 acre-feet, or 16 percent, greater than the volume stored in 2006.

USF reclaimed water storage in Baseline Scenario Three is projected to be 39,394 acre-feet in 2025. This is an increase of approximately 275 percent from the amount stored in 2006.

By 2025, cumulative CAP storage at USFs is 3,600,665 acre-feet in Baseline Scenario Three. This is lower than the cumulative volumes for the first two baseline scenarios. However, cumulative reclaimed water stored is highest in Baseline Scenario Three, with an additional 856,881 acre-feet stored over the volume stored in 2006.

The cumulative amount of GSF CAP storage projected in Baseline Scenario Three from 2007 through 2025 is only slightly less than the projected volume in Baseline Scenario Two, with an additional 493,965 acre-feet of GSF CAP stored between 2007 and 2025.

These figures reflect the volume of water stored, not including cuts to the aquifer or physical losses (*See Table 13-2*).

14. ADDITIONAL SCENARIOS

14.1 CAP Shortage Projected Scenarios

This Assessment includes three additional scenarios incorporating reduced CAP supplies in recognition of potential climate change impacts, resulting in a shortages of CAP supplies. The consensus of an international panel of climate science experts, the International Panel on Climate Change (IPCC), is that the southwestern United States is likely to experience significant impacts from warming, particularly in the water resources sector (Intergovernmental Panel on Climate Change, 2007). IPCC predicts with high confidence that average temperatures will continue to increase. There is now also a strong indication of reductions in winter precipitation in northern Mexico and the southern portions of the southwestern United States. This means that even if total precipitation increases on average across the globe, drought is likely to become an even greater problem in the region than it is today, perhaps becoming the new "normal" (Seagar & Ting, 2007). The IPCC findings also conclude that the intensity of precipitation is likely to increase in future climate scenarios for the southwestern United States. Therefore, both extremes of precipitation – floods and droughts – will increasingly challenge water managers in the region. Increases in temperature, particularly in summer, will affect demand for water in Arizona. Higher temperatures lead to more demand for electricity for air conditioning; more water required to support agriculture, landscaping, and ecosystems; and more evaporative losses from reservoirs, etc.

Across the Colorado River watershed, runoff information generated from the output of a strong majority of the 22 global climate models predicts that flow in the Colorado River will be reduced over the next century. These reductions in flow are primarily a result of drying caused by higher temperatures (reduced soil moisture, increased evapotranspiration and reservoir losses). As the flow in the Colorado River is already fully allocated, any reductions in flow will have consequences for the many water managers who rely on the Colorado River as a source. Additionally, within Arizona, predicted losses of snowpack along the Mogollon Rim and other high elevation areas will likely change the volume and timing of peak runoff and may impact downstream users and habitat (Jacobs, 2009).

Several climate change models exist for the southwestern region of the United States, but at this time, are not localized enough to be useful for the purposes of this Assessment. Instead, ADWR incorporated a period of reduced surface water availability by using actual historical supply records as described below.

14.1.1 CAP Shortage Projection Methodology

In addition to Baseline Scenarios One, Two, and Three, an additional three projection scenarios were prepared that included projecting a shortage of CAP supply. Demand was not altered for any of the shortage projection scenarios; therefore, reclaimed water supply remained unaffected, as did reclaimed water recharge.

ADWR Colorado River Management (CRM) staff, based on the 100-year record of Colorado River flow, generated the projected CAP shortage values. CRM based their calculations on the actual volume of water available on the Colorado River, which varies from year to year. CRM generated 101 different sequences using the BOR's Colorado River System Simulation RiverWare computer model. Forty-nine of the one hundred one sequences simulated shortages. The range of shortages is from 320,000 acre-feet to 5,275,400 acre-feet for the period 2009 to 2025. The ADWR Water Management Division selected a representative shortage sequence from 2012 to 2019 because it fell into the time period that was being evaluated to use as a shortage scenario for this Assessment. The projected CAP availability and shortage volumes from the sequence selected are shown in *Table 14-1* below.

Table 14-1 CAP Shortages for Shortage Scenarios
Shortages to Arizona and the Central Arizona Project

Year	Projected CAP Availability	Shortage	Shortage Supply
2009	1,433,223	0	1,433,223
2010	1,414,442	0	1,414,442
2011	1,412,872	0	1,412,872
2012	1,411,303	320,000	1,091,305
2013	1,409,733	400,000	1,009,733
2014	1,408,164	480,000	928,473
2015	1,406,594	400,000	1,006,596
2016	1,405,025	480,000	926,753
2017	1,403,455	400,000	1,003,457
2018	1,401,885	400,000	1,001,887
2019	1,400,550	400,000	1,000,553
2020	1,399,215	0	1,399,215
2021	1,397,902	0	1,397,902
2022	1,382,590	0	1,382,590
2023	1,381,277	0	1,381,277
2024	1,379,964	0	1,379,964
2025	1,378,651	0	1,378,651
Sum of Shortage	**23,826,844**	**3,280,000**	**20,546,844**

All values are in acre-feet.

The shortage volumes for years 2012 through 2019, illustrated in *Table 14-1*, above were subtracted from the assumed CAP availability for each year as projected by CRM to generate the shortage projection in those years. Then, the projected volume of CAP use was cut back, using the CAWCD Procedure to Distribute Excess Water Policy, to adjust CAP use to meet the shortage supply. In some years in all three shortage scenarios, the shortage went beyond the excess CAP and cut into the CAP NIA settlement pool water. In this case, the shortage to the CAP NIA settlement pool water was pro-rated among the three CAP AMAs based on the projected Agricultural direct CAP use in non-shortage years.

14.1.2 CAP Shortage Projection Results

Because the shortages mostly affect excess CAP water, cumulative projected overdraft between 2007 and 2025 is between four and 26 percent larger due to the projected CAP shortage. This is mostly due to the decrease in the cut to the aquifer because less CAP water is stored. *Figure 14-1*, *Figure 14-2*, and *Figure 14-3* show the relative difference in projected annual overdraft between non-shortage and shortage scenarios for each year from 2007 through 2025.

Figure 14-1 Shortage Scenario One Projected Annual Overdraft With and Without CAP Shortage

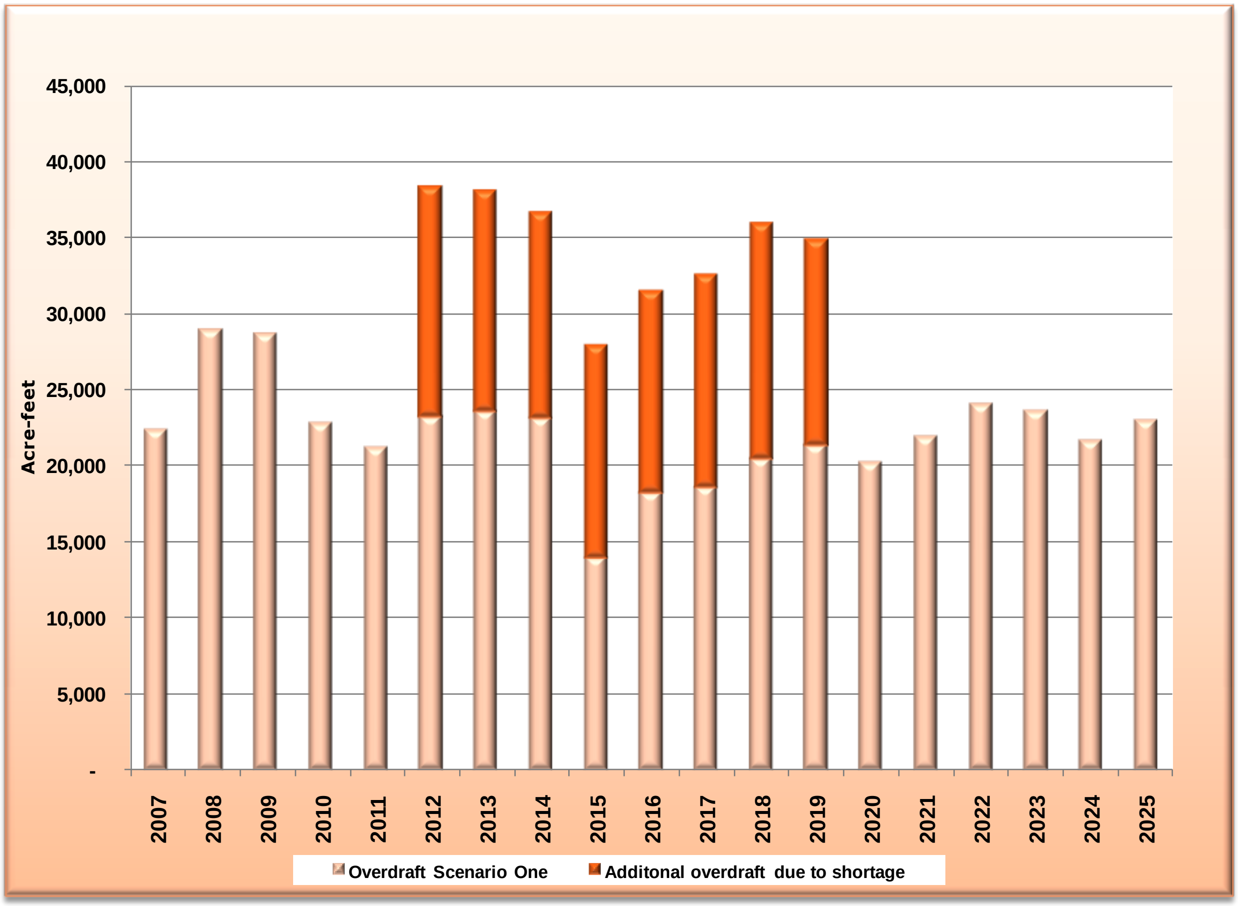
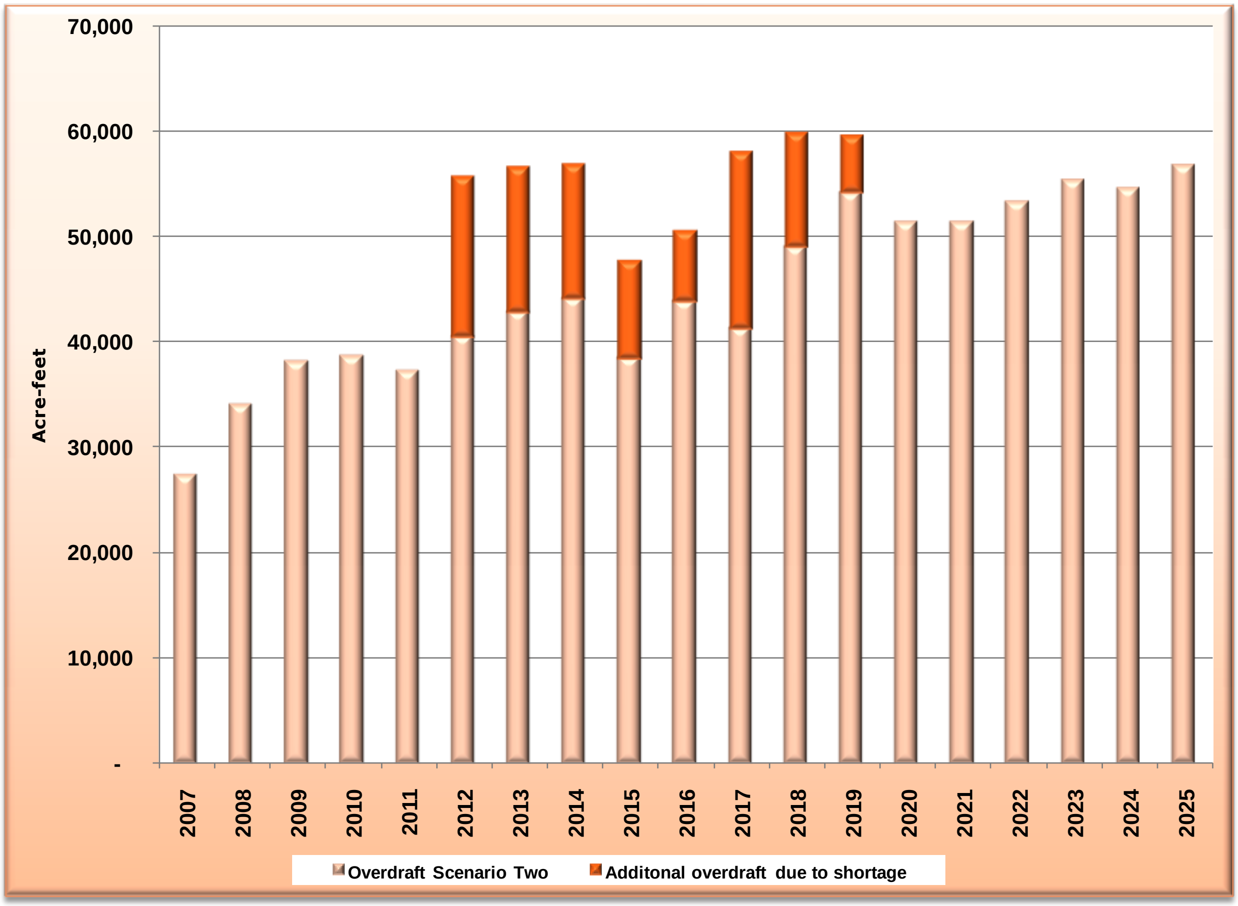


Figure 14-2 Shortage Scenario Two Projected Annual Overdraft With and Without CAP Shortage



Up to this point, the shortage has been viewed on an annual basis. However, the overall effect of a shortage of this type on the entire projection period from 2007 through 2025 is shown in *Table 14-2* below. Cumulative projected overdraft, where the overdraft of each year is added for a cumulative effect, increases between 62,450 and 112,835 acre-feet due to the shortage, which ranges from four to 27 percent.

Figure 14-3 Shortage Scenario Three Projected Annual Overdraft With and Without CAP Shortage

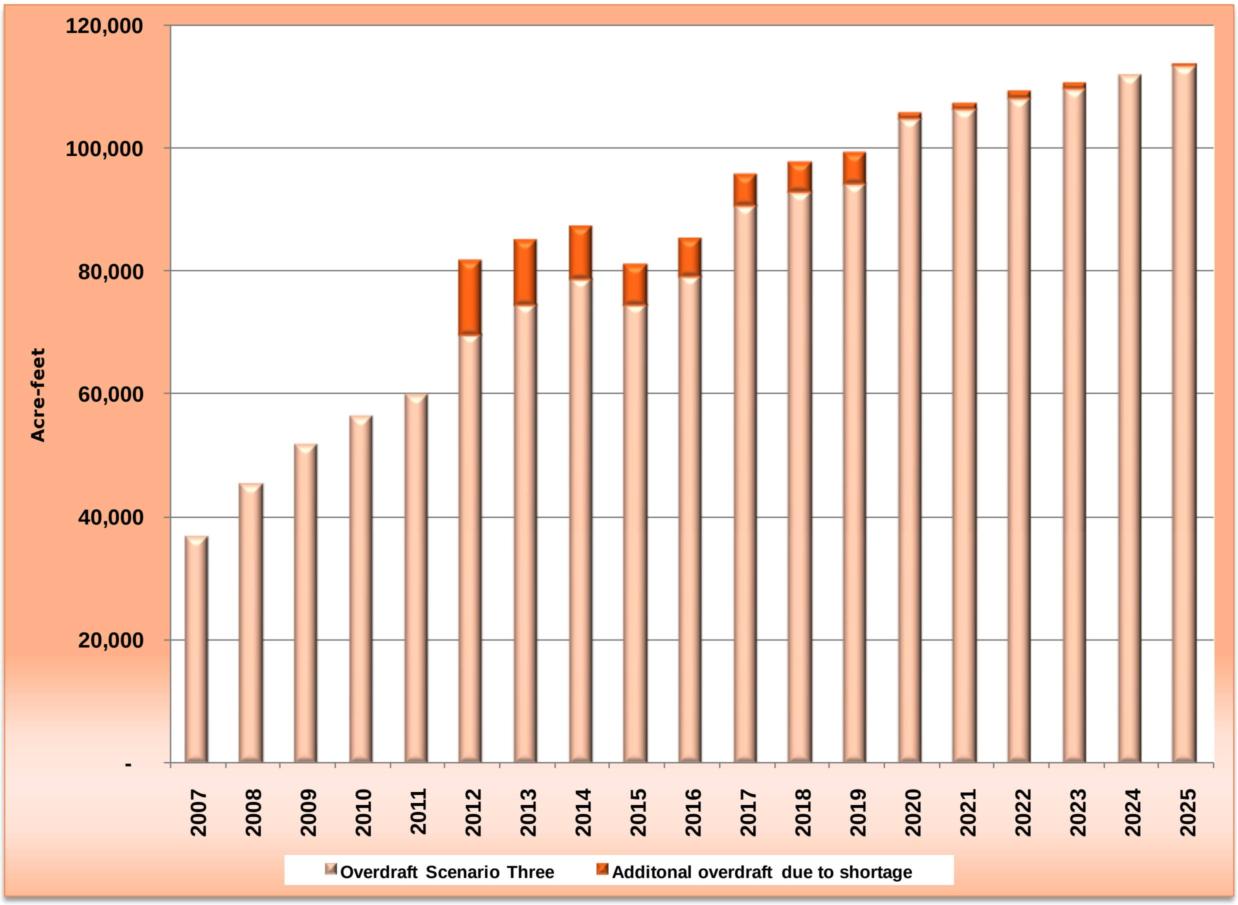


Table 14-2 Shortage Scenarios - Cumulative Projected Overdraft Tucson Active Management Area

YEAR	2010	2015	2020	2025
Baseline Scenario One				
Cumulative Overdraft	102,336	207,153	305,611	419,285
Cumulative Additional Overdraft due to Shortage		56,795	112,835	112,835
Total Overdraft Shortage Scenario One	**102,336**	**263,948**	**418,446**	**532,119**
Baseline Scenario Two				
Cumulative Overdraft	137,774	340,374	579,551	850,219
Cumulative Additional Overdraft due to Shortage		50,852	90,337	90,337
Total Overdraft Shortage Scenario Two	**137,774**	**391,227**	**669,888**	**940,555**
Baseline Scenario Three				
Cumulative Overdraft	189,637	546,321	1,006,783	1,554,743
Cumulative Additional Overdraft due to Shortage		37,655	59,624	62,450
Total Overdraft Shortage Scenario Three	**189,637**	**583,577**	**1,066,407**	**1,617,193**

The most substantial impacts of the shortage are on the AWBA and on the CAGRD, which store excess CAP water, the lowest priority CAP supply.

14.1.3 Shortage Scenario One Results

Shortage Scenario One (using Baseline Scenario One demands) predicts that storage of CAP water at USFs is 174,499 acre-feet less by the year 2025. More than half of this reduction is a reduction in water storage by the AWBA. The second biggest impact is a reduction (71,778 acre-feet) in GRD storage (*See Table 14-3 below*).

Table 14-3 Shortage Scenario One Projected Artificial Recharge Tucson Active Management Area

Long Term Storage Credits	**2006**	**2025 Baseline Scenario One**	**2025 Shortage Scenario One**
Underground Storage Facilities			
CAP	514,225	3,794,407	3,619,908
Reclaimed Water	43,933	824,400	824,400
Total	558,158	4,618,807	4,444,307
Groundwater Savings Facilities			
CAP	116,709	615,578	615,578
Total	674,868	5,234,385	5,059,895
Arizona Water Bank			
Intrastate	351,001	707,281	591,627
Interstate - Nevada	78,376	89,021	89,021
Total	429,377	1,225,679	1,110,025
CAWCD/CAGRD			
CAWCD	4,132		
CAGRD		179,302	107,524
Conservation District Account	36,731		
Replenishment Reserve Account	13,855		
Total	54,718		
Recovery	77,733	2,926,762	2,926,762
Credits Remaining in Storage	**597,135**	**2,307,623**	**2,133,123**

Note: all values are in acre-feet. "Credits Remaining in Storage" is calculated by subtracting Recovery from the "Total USF/GSF Storage".

14.1.4 Shortage Scenario Two Results

Shortage Scenario Two (using Baseline Scenario Two demands) shows a less severe impact of the shortage because Baseline Scenario Two had less CAP water being stored than Baseline Scenario One – due to higher direct use of CAP supplies as a result of higher demand. In Shortage Scenario Two 121,917 fewer acre-feet are stored at USFs by the year 2025 (*See Table* 14-4). Of this volume, the AWBA again takes more than half the storage reduction, and the CAGRD takes a 49,328 acre-feet of the reduction.

Table 14-4 Shortage Scenario Two Projected Artificial Recharge Tucson Active Management Area

Long Term Storage Credits	2006	2025 Baseline Scenario Two	2025 Shortage Scenario Two
Underground Storage Facilities			
CAP	514,225	3,695,559	3,573,642
Reclaimed Water	43,933	828,565	828,565
Total	558,158	4,524,124	4,402,207
Groundwater Savings Facilities			
CAP	116,709	610,926	610,926
TOTAL USF/GSF	674,868	5,135,050	5,013,133
Arizona Water Bank			
Intrastate	351,001	641,784	560,160
Interstate - Nevada	78,376	78,376	78,376
Total	429,377	1,149,537	1,067,913
CAWCD/CAGRD			
CAWCD	4,132		
CAGRD		125,254	75,926
Conservation District Account	36,731		
Replenishment Reserve Account	13,855		
Total	54,718		
Recovery	77,733	2,984,587	2,984,587
Credits Remaining in Storage	**597,135**	**2,150,463**	**2,028,546**

"Credits Remaining in Storage" is calculated by subtracting Recovery from the "Total USF/GSF Storage".

14.1.5 Shortage Scenario Three Results

The least impact of the projected shortages is in Shortage Scenario Three (using Baseline Scenario Three demands), with 63,517 fewer acre-feet stored at USF facilities by the year 2025 than in Baseline Scenario Three. This is because although Baseline Scenario Three has the greatest demand, it has the least amount of storage (and instead more direct use). The majority of the impacts of the shortages affect the availability of excess CAP instead of the direct users. As a result, the AWBA again takes the greatest volume of the cut, and the GRD stores 19,210 fewer acre-feet (*See Table 14-5)*.

Table 14-5 Shortage Scenario Three Projected Artificial Recharge
Tucson Active Management Area

Long Term Storage Credits	2006	2025 Baseline Scenario Three	2025 Shortage Scenario Three
Underground Storage Facilities			
CAP	514,225	3,600,665	3,537,148
Reclaimed Water	43,933	900,814	900,814
Total	558,158	4,501,479	4,437,962
Groundwater Savings Facilities			
CAP	116,709	610,674	610,674
Total USF/GSF	674,868	5,112,153	5,048,636
Arizona Water Bank			
Intrastate	351,001	582,068	533,054
Interstate - Nevada	78,376	78,376	78,376
Total	429,377	1,089,821	1,040,807
CAWCD/CAGRD			
CAWCD			
CAGRD	4,132	84,526	65,316
Conservation District Account	36,731		
Replenishment Reserve Account	13,855		
Total	54,718		
Recovery	77,733	3,003,063	3,003,063
Credits Remaining in Storage	**597,135**	**2,109,090**	**2,045,573**

"Credits Remaining in Storage" is calculated by subtracting Recovery from the "Total USF/GSF Storage".

14.1.6 Shortage Implications

Assuming the various projected CAP shortages do materialize, there are significant implications for both the AWBA being able to meet its obligations and the CAGRD's ability to meet its replenishment obligations.

If the CAGRD is not able to meet its obligation, future development may be curtailed for a period of time due to the difficulty of applicants for future subdivisions to meet the consistency with goal requirement of the AWS Rules. In some cases, if the shortage is deep enough to reduce allocations of CAP significantly, designated providers may rely on pumping pursuant to their groundwater allowance balance in order to meet the consistency with goal requirement. A further implication of the shortage may be a temporary increase in the number of extinguishments of grandfathered groundwater rights. Although the amount of credits that may be accrued pursuant to extinguishment of GFRs is finite, extinguishment credits could be used to bridge a shortage gap and allow development to continue. Storage of reclaimed water may increase to the maximum extent feasible, but this supply is limited based on the volume of reclaimed water generated and is linked to overall demand.

If financing were available, the AWBA may be able to explore other methods of meeting its contract obligations. The AWBA is currently working on strategies to deal with a potential shortage.

If the shortages impact the CAP NIA settlement pool, farmers may begin fallowing their fields, rather than demand remaining constant as has been projected here. However, crop prices would need to be high enough to offset the increased cost associated with using groundwater for maintained agricultural demand to be a reasonable assumption.

In summary, it appears that shortages of the magnitude projected in the three Shortage Scenarios, has more of an impact on the availability of excess CAP water and affects the AWBA and CAGRD more than those with CAP contracts or sub-contracts. There is still a negative impact on overdraft in 2025, due to reductions in artificial recharge and the benefits from the cut to the aquifer, as well as possible impacts from reduced replenishment by the CAGRD. In the event of the shortages above, Municipal and Agricultural water users have some flexibility to shift to groundwater supplies before demand reduction activities are required, although this is a management decision of the water user.

14.2 Maximized Reclaimed Water Use Scenario

In addition to Baseline Scenarios One, Two, Three and the three Shortage Scenarios, a Maximized Reclaimed Water Use Scenario was developed for the Tucson AMA. Given the fact that a large volume of reclaimed water was either stored or lost to the Pinal AMA in each of the scenarios and because none of the baseline scenarios achieved safe-yield by 2025, it seemed reasonable to develop an alternative scenario that increased the projected annual reclaimed water use in the AMA. Specifically, this scenario was developed to analyze whether the goal of safe-yield could be achieved by maximizing annual reclaimed water use.

The Pima County Regional Wastewater Reclamation Department estimates that by 2030, annual reclaimed water availability in the greater Tucson area could be as high as 124,663 acre-feet. Of this total, it is estimated that 95,287 acre-feet would be generated by metropolitan wastewater treatment plants and 29,377 acre-feet would be generated at smaller non-metropolitan wastewater plants (City of Tucson and Pima County, 2009). However, even with this significant supply of reclaimed water available in the future, Baseline Scenarios One through Three project that by 2025, between only 22,801 to 26,453 acre-feet of this reclaimed water will be used annually to meet the AMA's demands, the rest would be stored for credits or simply discharged. The reclaimed water usage volumes in the baseline scenarios were projected using current DAWS assumptions, Tucson Water's Long Range Water Resources Plan, historical reclaimed water use trends and current treatment and distribution capacity.

In the Maximized Reclaimed Water Scenario, new reclaimed water usage and storage assumptions were applied to Baseline Scenario One, which was chosen since it was the scenario closest to meeting safe-yield. Similar to the shortage scenarios, demand was not altered from Baseline Scenario One. The only changes in the template assumptions were an increase in the total amount of reclaimed water used annually, both directly and indirectly through recharge and recovery, as well as the cumulative amount of reclaimed water stored and the type of recharge facility used. The type of facility where reclaimed water is stored is important because 50 percent of the reclaimed water stored at a Managed USF is cut to the aquifer, whereas there are no cuts to the aquifer at Constructed USFs.

In the Maximized Reclaimed water Scenario, planners explored whether it was possible to get to safe-yield if 40 percent of the total available reclaimed water generated in 2025, excluding the reclaimed water entitled to the Secretary of the Interior, was used on an annual basis. The

Tucson AMA 3MP water budget projections and past reclaimed water use trends were also used to determine how this supply should be divided between sectors.

14.2.1 Background

In 2006, a little more than 70,000 acre-feet of reclaimed water was generated in the Tucson AMA. Of this total amount generated, only 16,830 acre-feet was used (directly or indirectly through recharge and recovery) to meet annual demands in the AMA. This accounted for approximately 25 percent of the total reclaimed water generated in the AMA.

Pima County currently owns and operates the majority of public wastewater treatment plants in the Tucson AMA. Most of the reclaimed water is produced from the metropolitan wastewater treatment plants and the remaining reclaimed water is produced by smaller non-metropolitan plants. The two largest metropolitan plants are the Roger Road Wastewater Treatment Plant and the Ina Road Water Pollution Control Center.

Although the County owns and operates the majority of the treatment plants, ownership of reclaimed water in the Tucson AMA is complex (*See Figure 14-4*). The United States Secretary of the Interior (Secretary) is entitled to 28,200 acre-feet of the reclaimed water generated. Currently this reclaimed water is being discharged into the Santa Cruz River where it accrues credits in two in-channel Managed USFs. The credits accrued by the Secretary support the settlement of the SAWRSA. Credits from the storage of this reclaimed water could potentially be sold to other entities in the AMA for future use, but for this scenario it was assumed that these credits would not be available.

The remaining portion of metropolitan reclaimed water is divided according to the 1979 Intergovernmental Agreement between the City of Tucson and Pima County in a 90 percent to 10 percent split respectively (*See Figure 14-4).* A 2000 City/County Supplemental Intergovernmental Agreement also requires that prior to this split, up to 10,000 acre-feet of water be used at riparian projects approved by both the City and the County. To date, no reclaimed water has been used for this purpose. The City of Tucson also has contracts with Metropolitan Domestic Water Improvement District as well as the Town of Oro Valley for a portion of its reclaimed water.

Similar to the reclaimed water reserved for the Secretary, a portion of the City and County's reclaimed water is currently being discharged into the Santa Cruz River where it also accrues long-term storage credits in the in-channel Managed recharge projects. This reclaimed water augments the aquifer as well as earns credits for its owners. The remaining portion of reclaimed water is either sent to a treatment plant to become reclaimed water for direct delivery through the City's reclaimed system or it is sent to the City's Sweetwater Recharge Project for storage and recovery. The City can recover this stored water to supplement the reclaimed supply during peak demand.

In 2007, according to the City/County Water and Wastewater Study Oversight Committee, the reclaimed system utilized approximately 42 percent of the City of Tucson's reclaimed water allocation and 27 percent of Pima County's allocation. This equals approximately 38 percent of the total metropolitan reclaimed water resource owned by local entities excluding the Secretary of Interior (City of Tucson and Pima County, 2009). The remaining reclaimed water was either stored in Constructed or Managed USFs for aquifer augmentation, credit accrual for future use, or lost to the Pinal AMA as surface water.

Figure 14-4 Metropolitan Reclaimed Water Entitlement
Tucson Active Management Area

Metropolitan Reclaimed Water Entitlement

(Based on 2007 Reclaimed Water Production – 68,299 ac-ft/yr)

68,299

SAWRSA: -28,200

40,099

CEP: 10,000 (Current 0)

30,099 (40,299)

10% **90%**

County: 3,010 (4,010)

Providers: 27,089 (36,089)

Oro Valley: 1,697 (2,348)

Tucson: 23,450(31,055)

Metro: 1,942 (2,686)

Source: (City of Tucson and Pima County, 2009)

In late 2009, the City of Tucson and Pima County completed Phase II of a long-term study on water and wastewater. One conclusion from the study is that there is capacity to expand the reclaimed system. The City/County Oversight Committee made recommendations on how to address the financial, physical, and legal constraints currently hindering this expansion.

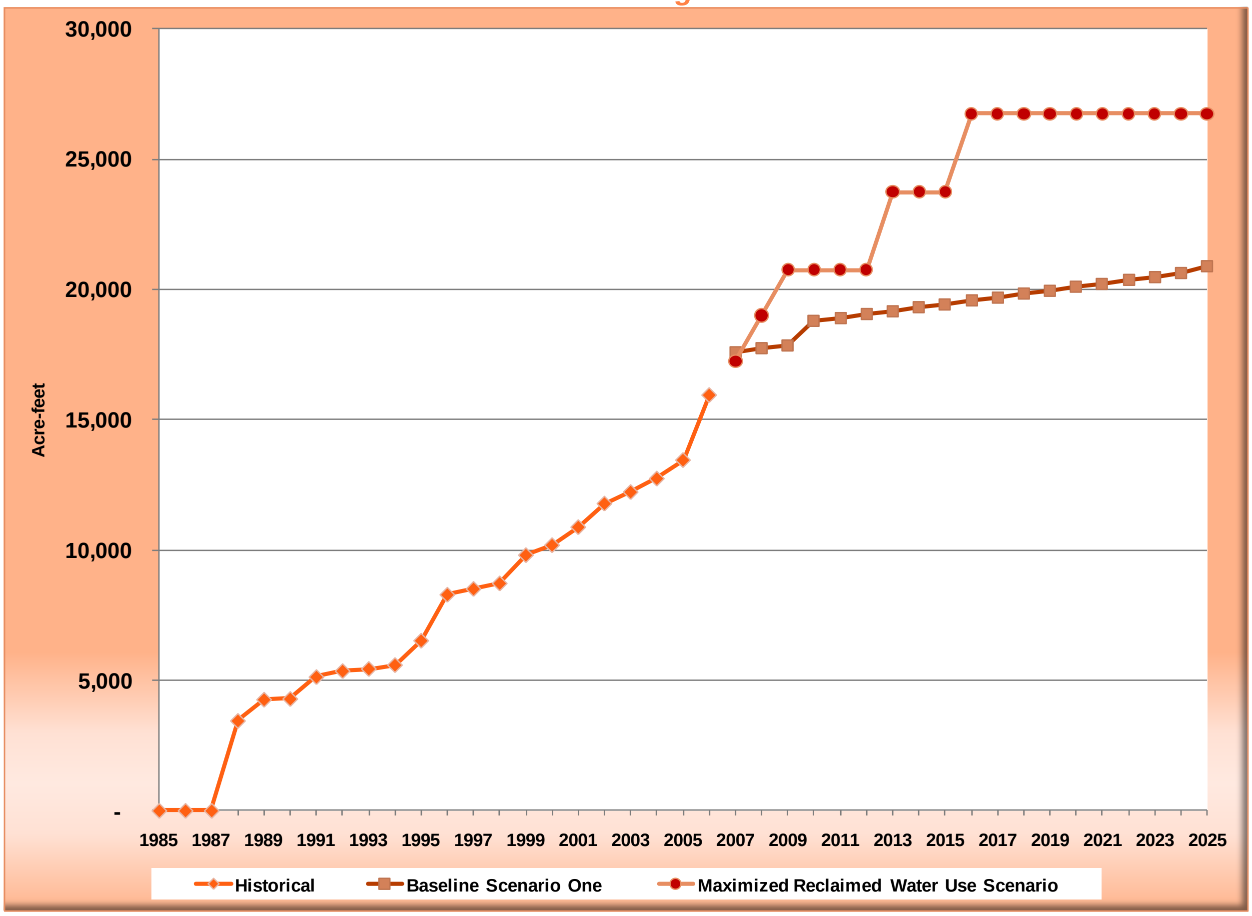
14.2.2 Methodology and Assumptions

Municipal Reclaimed Water Use

In the Maximize Reclaimed Water Use Scenario, it was assumed that reclaimed water supplies used to meet Municipal demand would increase from approximately 20,000 acre-feet or approximately eight percent of Municipal demand in 2025 (under Baseline Scenario One), to approximately 26,750 acre-feet or approximately 11 percent of the total Municipal demand by 2025 (*See Figure 14-5*). As noted earlier, Baseline Scenario One reclaimed water assumptions were based on DAWS water supply projections, historical use of supplies and current treatment and delivery capacity. Tucson Water's Long Range Water Resources Plan projects that the utility will meet at least nine percent of its projected demand with reclaimed water (City of Tucson Water Department, 2008).

The increased reclaimed water use in the new scenario assumes that expanded treatment capacity and infrastructure would need to be built in order to meet the increased use of Municipal reclaimed water. No specific assumptions were made as to which customers would use the additional reclaimed water. Currently, the main recipients of reclaimed water in the Tucson AMA receive it through the reclaimed system and are turf facilities, primarily golf courses. New users, however, should not necessarily be confined to the current reclaimed system or necessarily be turf facilities.

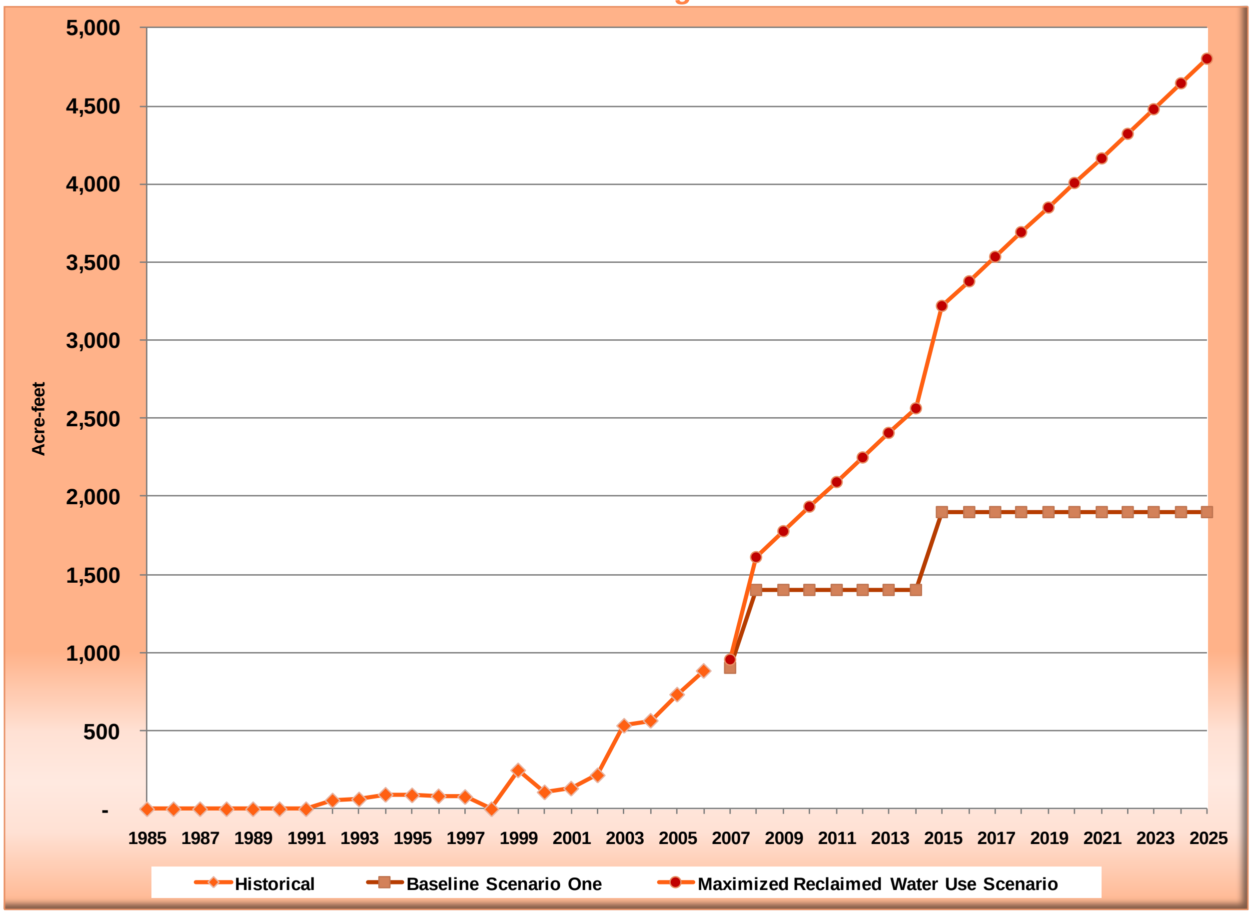
Figure 14-5 Maximized Municipal Reclaimed Water Use Tucson Active Management Area



Industrial Reclaimed Water Use

In the Industrial sector, it was assumed that reclaimed water usage would increase from approximately 2,000 acre-feet or approximately four percent of the total demand in Baseline Scenario One by 2025 to approximately 4,800 acre-feet or approximately nine percent of the total demand in the Maximized Reclaimed Water Use Scenario (*See Figure 14-6*). This assumption implies that some Industrial grandfathered right holders would stop using groundwater and would switch to reclaimed water. Sectors such as electric power generation, sand and gravel, and turf facilities may be reasonable recipients of this new supply.

Figure 14-6 Maximized Industrial Reclaimed Water Use
Tucson Active Management Area



Agricultural Reclaimed Water Use

Although historically used, reclaimed water was not projected as a supply in the Agricultural sector in Baseline Scenario One. In the Maximized Reclaimed Water Use Scenario, it was assumed that by 2011 reclaimed water would meet approximately 4,000 acre-feet of the Tucson AMA's Agricultural use and continue to do so through 2025. Based on documented historical use of reclaimed water by the Tucson AMA Agricultural sector, it was assumed that this amount of reclaimed water use was reasonable to consider in the future.

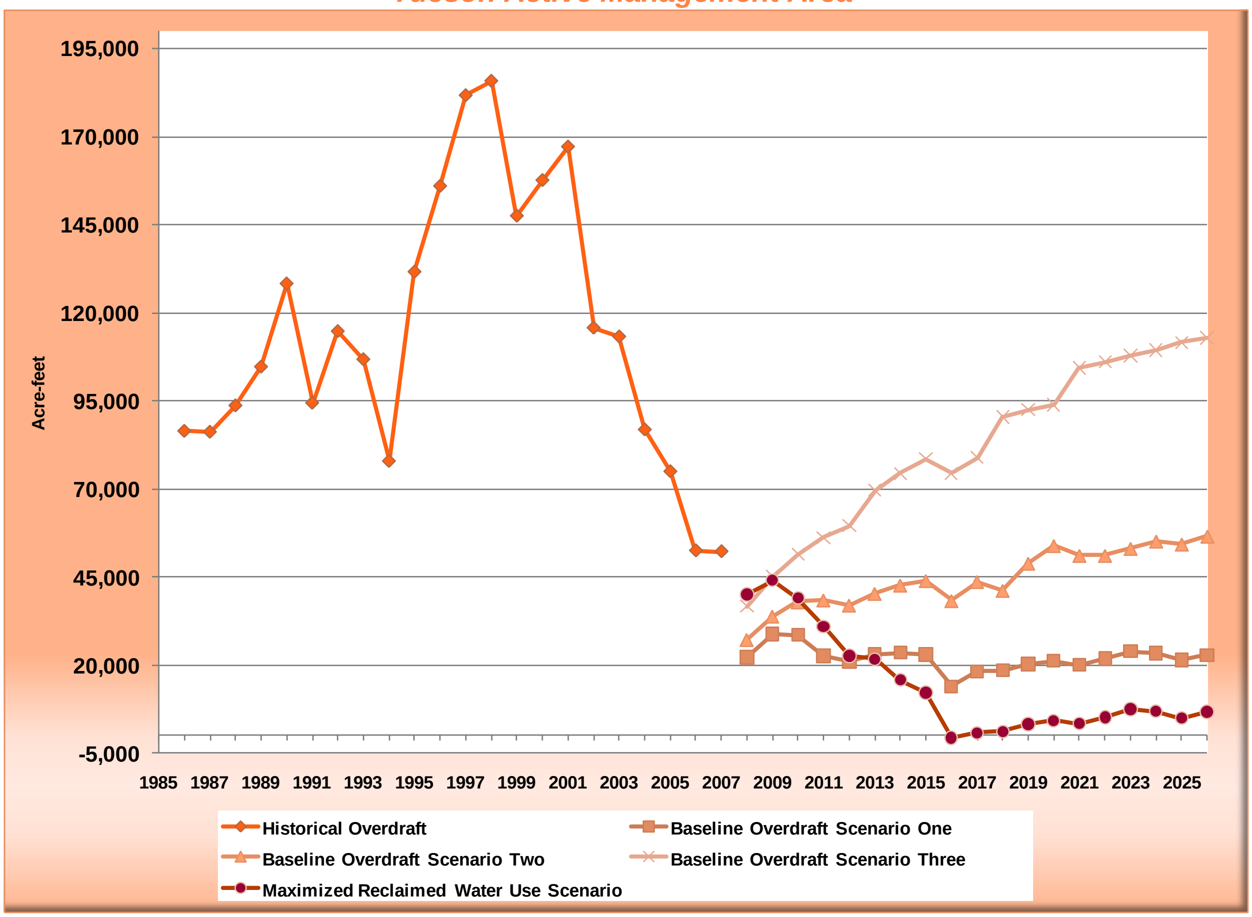
Reclaimed Water Recharge Assumptions

General assumptions about the amount of reclaimed water stored at Managed vs. Constructed USFs in this special scenario are also different from Baseline Scenario One. In the Maximized Reclaimed Water Use Scenario, the amount of water stored at Managed USFs is greater than in Constructed USFs. This is opposite of what was assumed in Baseline Scenario One. This assumption was based on actual delivery data from 2007 and 2008 that indicated a higher volume being delivered to Managed USFs than seen in 2006. This difference is important to the overall budget because 50 percent of the reclaimed water stored in a Managed USF is cut to the aquifer and cannot accrue credits for future use. This 50 percent cut to the aquifer has a direct positive effect on overdraft. Total reclaimed water stored was also higher in the Maximized Reclaimed Water Scenario based on the assumption that additional Constructed USF capacity would be built, and therefore less water would be lost to the Pinal AMA as surface water.

14.2.3 Maximized Reclaimed Water Use Scenario Results

The Tucson AMA has a large and growing supply of reclaimed water that, if more fully utilized on an annual basis, could significantly help the AMA's efforts to reach safe-yield by 2025. Results of the Maximized Reclaimed Water Scenario indicate that by increasing annual reclaimed water use by all three sectors, the Tucson AMA could come very close to achieving safe-yield by 2025, assuming Baseline Scenario One demands. It is important to note, that although this scenario did not consider using the reclaimed water reserved for the Secretary to meet AMA demand, utilization of credits or reclaimed water owned or abandoned by the Secretary of the Interior could help further reduce overdraft as well as reduce logistical challenges of getting reclaimed water from its source to a suitable end user. The chart below illustrates that by increasing the annual use of the Tucson AMA's reclaimed water supplies, annual overdraft could significantly be reduced and in some years be eliminated resulting in a safe-yield condition (*See Figure 14-7*).

Figure 14-7 Projected Overdraft - 2025
Maximized Reclaimed Water Scenario vs. Baseline Projections
Tucson Active Management Area



Groups such as the City of Tucson and Pima County Water and Wastewater Study Oversight Committee and the Governor's newly formed Blue Ribbon Panel on Water Sustainability are beginning to address the need to increase reclaimed water use regionally as well as on a statewide basis. The City/County Oversight Committee acknowledges in its Reclaimed Water Technical Report that the "substitution of reclaimed water and reclaimed water for potable source waters is an important element in achieving safe-yield in the Tucson basin" (City of Tucson and Pima County, 2009). The Governor's Blue Ribbon Panel on Water Sustainability also plans to focus on opportunities to increase the use of reclaimed water throughout the state by examining the constraints such as public acceptance, infrastructure needs, and regulatory constraints that currently exist and limit the increased use of this valuable resource.

PART IV THE FOURTH MANAGEMENT PLAN PROCESS

The Code requires ADWR to develop Management Plans for each AMA to assist the AMA in achieving its management goal. The Management Plans contain conservation requirements for the Municipal, Industrial and Agricultural sectors; however, they do not apply to the Indian water use sector. While the Management Plans provide requirements for reductions in water use – it is not the only tool available to ADWR for achieving the management goals and should not be viewed as such.

ADWR has developed Management Plans for each of the previous management periods using similar, yet increasingly more complicated approaches. The 1MP (1984 – 1990) was the first comprehensive attempt to manage groundwater within the AMAs. Development of the mandatory conservation requirements used a very straightforward approach, based on water supply and demand quantification.

The 2MP (1990 – 2000) employed a more advanced supply and demand analysis incorporating current and future conditions. In the development of conservation requirements ADWR put more emphasis on aggressive and cutting-edge conservation practices for the three main water use sectors. Water supply augmentation was also integrated into the water management strategies in addition to a newly created Conservation and Augmentation Assistance grants program.

The 3MP (2000-2010) was the mid-point of the 45-year timeframe from the inception of the Code in 1980 to the year 2025 by which safe-yield was to be attained. The 3MP recognized the impacts of the other water management programs not addressed through the Management Plans, including the AWS Rules; the Underground Storage and Recovery Program; the CAGRD; and the AWBA. Because of the recognition of these additional management programs, supply and demand analysis vastly improved. However, the conservation requirements included in the 3MP were strikingly similar to the 2MP.

The 3MP for the AMAs, as well as the findings of the subsequently formed local AMA “Safe-Yield Task Force” (or other similarly named stakeholder groups) and the Governor’s Water Management Commission in 2001, made a series of observations that should frame the development of future water management strategies. Although these observations recognized certain differences among the AMAs, there were fundamental similarities. The principal observations were:

1) While significant progress has been made since the enactment of the Code, it is unlikely that the statutory goals of the AMAs will be met, given the current authorities granted to ADWR;
2) While it is projected that most AMAs will continue to make progress toward achievement of their goals as currently unused renewable water supplies become utilized, we may begin to move in the opposite direction if increased demands outstrip the availability of renewable supplies.
3) Localized areas within AMAs are and will continue to experience water management problems disproportionate to those of the AMA as a whole due to infrastructure and renewable water supply access, continued allowable groundwater pumping by

grandfathered uses, and recovery of LTSCs outside the areas of impact of the recharge facilities.

These observations are a mixture of “good news/bad news”. It is good news from the standpoint that the existing programs and authorities have served this State, most specifically the AMAs, well. We should all be proud of the work accomplished and the progress made to date. The bad news is that with the current authorities, it will be almost impossible to meet the management goals, and may over time move us farther away. These goals are the fundamental underpinnings to ensuring a long-term sustainable water supply for the State of Arizona. The 4MP must emphasize ensuring sustainable water supplies and the effective and efficient management of the State’s most precious resource for Arizona to thrive.

So what should the 4MP look like? The Management Plans to date have served us well; however, they are not really planning tools that provide succinct options for future water management decisions. They are excellent tools in identifying current and projected water use, mandatory conservation requirements, and potential directions and initiatives that could be pursued to move toward goal achievement and wise, long-term water management. The Management Plans should provide more concise direction regarding what is needed to get to the ultimate goal.

ADWR will approach the 4MP more as a Plan for success than a document that simply identifies the statutory requirements for the main water using sectors. In this Plan ADWR, in cooperation with the public, will build on past successes but recognize that additional observations should be considered, including:

1) Conservation will only get us so far. We will continue to address meaningful conservation requirements, but also will review the “incentives” for utilization of renewable water supplies, reduce the complexity and the administrative workload necessary to implement these programs, and be diligent in their enforcement.
2) Have serious discussions regarding the AMA goals and the implications to the State of not reaching them.
3) Consider different approaches to water management among the AMAs, recognizing local conditions and community values.
4) Address the limitations of the Management Plans and underlying authorities as we determine what course of action to follow.
5) Recognize sub-area issues and consider alternative management strategies to address areas where conditions are positive and conditions are negative.
6) Develop, in cooperation with local water users and other water resource entities (CAWCD, AWBA, CAGRD, etc), a long-term water management strategy to get the AMAs where we need them to be by identifying what specific actions/steps we need to take and what resources will be required to accomplish this strategy.

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APPENDICES

Appendix 1 Assumptions Used for Large Municipal Providers

Category	Scenario
Demand	**SCENARIO ONE**: Large provider population for undesignated providers was projected using statistics. For designated providers, any population projection included in their designation application was used. Then the population projection using these methods was compared to the overall AMA population projection using PAG, CAAG, and DES numbers. A percent difference was calculated, and the projections for each individual large provider, and small providers in sum and exempt well population in sum were "benched" or reduced by that percentage, so that adjusted figures for large providers, small providers, and exempt well population did not exceed the PAG, CAAG, and DES projection for that year. Demand was calculated using the adjusted population projection for each provider and their TMP target. The sum of the calculated TMP demands for all the large providers equals the large provider demand.
	SCENARIO TWO: Large provider population for undesignated providers was projected using statistics. For designated providers, any population projection included in their designation application was used. Then the population projection using these methods was compared to the overall AMA population projection using PAG, CAAG, and DES numbers. A percent difference was calculated, and the projections for each individual large provider, and small providers in sum and exempt well population in sum were "benched" or reduced by that percentage, so that adjusted figures for large providers, small providers, and exempt well population did not exceed the PAG, CAAG, and DES projection for that year. The undesignated provider demand was calculated by multiplying the statistical trend line population for each undesignated provider by the 2000-2006 average GPCD for the provider. For designated providers, their DAWS demand was used. Then the demand for each large provider was adjusted down using the same percentage that was used to adjust the population. The sum of the adjusted demands for all the large providers equals the large provider demand.
	SCENARIO THREE: Large provider population for undesignated providers was projected using statistics. For designated providers, any population projection included in their designation application was used. The undesignated provider demand was calculated by multiplying the statistical trend line population for each undesignated provider by the 2000-2006 average GPCD for the provider. For designated providers, their DAWS demand was used. The sum of the demands for all the large providers equals the large provider demand.
Supply	Individual assumptions were made for each provider based on the DAWS for designated providers, and historical use of supplies for undesignated providers, capped based on treatment capacity. Direct use of renewable supplies was assumed to be used to the maximum extent possible, then storage, then groundwater.

Appendix 2 Assumptions Used for Institutional Providers

Category	Scenario
Demand	**SCENARIO ONE:** Same as Scenario Two.
	SCENARIO TWO: State prison population assumed an additional 1,200 inmates in 2010 and then gradual addition of another 2000 inmates by 2025. The 2000-2006 average GPCD was used to project prison demand. The U of A and Davis-Monthan Air Force Base are not regulated as institutional providers. The U of A was assumed to add another 700 students in 2012 and remain steady afterwards. The 2000-2006 average GPCD was used to project the U of A's demand. Davis-Monthan Air Force Base was held constant at their 2000 population and their 2000-2006 average GPCD. These providers were included in the sum of large provider population and demand, and were thus included in the "benching" described above under the Scenario Two.
	SCENARIO THREE: Same as Scenario Two, but not "benched."
Supply	Individual assumptions were made for each provider based on historical use of supplies. Assumed primarily supply is groundwater, with some use of reclaimed water by U of A.

Appendix 3 Assumptions Used for Small Municipal Providers

Category	Scenario
Demand	**SCENARIO ONE:** The 1985-1999 historical average growth rate for small providers was used to project small provider population. The projected population x the 2000-2006 average GPCD for small providers equaled the unadjusted small provider demand. The small provider population and demand projection were then "benched" as described under the Scenario Two for large providers above.
	SCENARIO TWO: Same as Scenario One.
	SCENARIO THREE: Same as Scenario One, but not "benched."
Supply	100% groundwater

Appendix 4 Assumptions Used for Exempt Well Users

Category	Scenario
Demand	**SCENARIO ONE**: Same as Scenario Two.
	SCENARIO TWO: Exempt well population was projected by using the 1985-2005 Pima county average growth rate. The projected exempt well population, the TMP single family models for new development, and the 2000 Census average persons per household for Pima County were used to calculate projected exempt well demand for each year, 2007-2025. The exempt well population and demand projection were then "benched" as described under the Likely scenario for large providers.
	SCENARIO THREE: Same as Scenario Two but not "benched."
Supply	100% groundwater

Appendix 5 Assumptions Used for Industrial Demand and Supply Projections

User Category		Scenario
Turf	DEMAND	**SCENARIO ONE:** Used log trend of historical water use
		SCENARIO TWO: Used log trend of historical water use
		SCENARIO THREE: Used log trend of historical water use
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use.
Mining	DEMAND	**SCENARIO ONE:** Assumed water use would continue to increase until 2008, after which it would decrease to historical average and then remain constant through projection period.
		SCENARIO TWO: Assumed water use would continue to increase until 2008, after which it would remain constant through projection period.
		SCENARIO THREE: Assumed water use would continue to increase until reaching new historical highs due to expansion of existing mines and addition of a new mine

User Category		Scenario
	SUPPLY	Groundwater and up to 10,000 AF of SAWRSA CAP
Sand & Gravel	DEMAND	**SCENARIO ONE:** Historical average held constant through time
		SCENARIO TWO: Historical average held constant through time
		SCENARIO THREE: Historical average held constant through time
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Dairy	DEMAND	**SCENARIO ONE:** Held constant at current (2006) use
		SCENARIO TWO: Held constant at current (2006) use
		SCENARIO THREE: Held constant at current (2006) use
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Electric Power	DEMAND	**SCENARIO ONE:** Used linear trend line of the historical water use
		SCENARIO TWO: Used linear trend line of the historical water use
		SCENARIO THREE: Used linear trend line of the historical water use
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use
Other	DEMAND	**SCENARIO ONE:** Average of 1996-2006 use held constant through time
		SCENARIO TWO: Average of 1996-2006 use held constant through time
		SCENARIO THREE: Average of 1996-2006 use held constant through time
	SUPPLY	Assumed future groundwater and non-groundwater supplies used in the same proportion as used in 2006 total Industrial use

Appendix 6 Assumptions Used for Agricultural Projections

	Category	Scenario	Assumption
Demand Factors	Maximum GW Allotment (>10 acres)	**ALL**	In Tucson AMA, there is no strong correlation between allotments and demand. Not projected.
Demand	IGFRs > 10 AC	**ONE**	Sum of low demand projections per major ASFC and "other"
		TWO	Sum of medium demand projections per major ASFC and "other"
		THREE	Sum of high demand projections per major ASFC and "other"
	IGFRs < 10 AC	**ALL**	Not projected, since use wasn't reported after 1993. This demand component is negligible.
	Canal & other losses	**ALL**	Not projected, since historical losses were not calculated. Since there is only one Irrigation District with a distribution system in the Tucson AMA (CMID), and the canals are lined, this demand component is negligible.
Supply	Groundwater	**ALL**	Demand not met by other sources.
	GSF (CAP)	**ALL**	The sum of Muni, GRD, AWBA, and Excess user projected storage volumes. Some facilities (BKW, CMID, Red Rock) may see a reduction in acreage, but other facilities (FICO, AVID) may come online.
	GSF (Reclaimed Water)	**ALL**	None in Tucson AMA
	Surface Water	**ALL**	None in Tucson AMA

	Category	Scenario	Assumption
	CAP	**ALL**	2007 and 2008 taken from CAP delivery reports; sum of (BKW+CMID+Kai Farms) Ag Settlement Pool deliveries. For future, assume CMID takes 1000af of pool allocation, and BKW and Kai Red Rock take full pool. In 2015 assume FICO takes its allocation. In 2020 assume AVID takes its allocation. All Ag pool gets a 25% reduction in 2017, and another 25% reduction in 2024.
	Reclaimed Water	**ALL**	No current contracts in Tucson AMA
Incidental Recharge	Total	**ALL**	22% of total demand not including GSF.

Appendix 7 Assumptions Used for Indian Agricultural Projections

Demand	Total	**ONE**	Semi log trend vs. time based on 2001-2006 use
		TWO	Linear trend vs. time based on 2001-2006 use
		THREE	Start with average from 2001-2006, then increase linearly to assume 1/2 utilization of SAWARSA settlement amount by 2025. Assumes the rest is used for potential non-irrigation uses listed in SAWRSA, i.e.: ASARCO agreement, recharge projects, riparian restoration, etc.
Supply	Groundwater	**ALL**	N/A
	Surface Water	**ALL**	N/A
	CAP	**ALL**	Assume all Ag demand is met with CAP supply.
	Reclaimed Water	**ALL**	N/A

Appendix 8 Assumptions Used for Recharge Projections

Storer	Permit Type	Facility Type	Source	Assumption
Municipal	USF	Constructed	CAP	Assume maximum USF constructed storage by municipal providers is 150,000 acre-feet/year. In addition, assumed Rosemont stores through 2014. Assume the operational capacity of all USFs is 235,000 acre-feet/year. NOTE: In years where Tucson AMA projected CAP USF constructed storage by municipal providers + Rosemont + AWBA + GRD + excess CAP is greater than 235,000 acre-feet, the additional excess CAP water is assumed to be stored at USF constructed facilities in the Phoenix AMA.
			Reclaimed Water	A "reclaimed water GPCD" was calculated by dividing historical reclaimed water generated by historical population. The reclaimed water GPCD was multiplied by the projected large provider population to project future reclaimed water generated. The amount of projected uses of reclaimed water, including storage, was subtracted from the amount projected to be generated. The remaining amount was divided in half, with half assumed to be additional reclaimed water stored and half assumed to be discharged. The volume of reclaimed water available for storage varied each year based on the differences between the projected population among the three scenarios. There is no GSF reclaimed water in Tucson AMA. In Tucson AMA the 2007 reclaimed water stored was assumed to be 41,700 acre-feet. The amount of additional reclaimed water available to store was added to 41,700 acre-feet for each projected year. Managed reclaimed water was held constant. USF constructed reclaimed water is the remainder of the assumed reclaimed water to be stored minus managed reclaimed water stored.
		Managed	Reclaimed Water	This was held constant at an annual total of 26,693 acre-feet/yr in sum for all storers based on historical information.

Storer	Permit Type	Facility Type	Source	Assumption
	GSF	CAP		Individual projections of CAP water stored by large municipal providers were prepared, based on the provider's designation, historical use patterns, M&I allocation, and ability to store CAP water. The total municipal CAP storage minus the USF storage equals managed storage.
Water Bank	USF	Constructed	CAP	Projections of USF CAP in Tucson AMA were prepared by the AWBA and are based on financing and available storage capacity. These figures were then modified based on CAP's policy of distribution of excess and the assumptions of CAP availability in each of the three projection scenarios.
GRD	USF	Constructed	CAP	The projected volume of GRD replenishment obligation was assumed to be stored except for some years under the maximum scenario where the 1.595 total CAP use was exceeded, in those years, the amount over the 1.595 was divided based on the CAWCD excess distribution policy. Any amount deducted from the obligation was assumed to be met with previously stored credits and/or reclaimed water storage. NOTE: In years where TAMA projected CAP USF constructed storage by municipal providers + Rosemont + AWBA + GRD + excess CAP is greater than 235,000 acre-feet, the additional excess CAP water is assumed to be stored at USF constructed facilities in the Phoenix AMA.
			Reclaimed Water	No GRD reclaimed water storage is assumed except for some years under the maximum scenario where CAP use in sum for the three AMAs exceeded the total CAP presumed to be available (1.595 maf). For those years the remaining amount of obligation was assumed to be met with the additional reclaimed water available to store.
	GSF	Reclaimed Water		See Municipal Managed Reclaimed Water above.